ICES WGNSSK REPORT 2006

ICES ADVISORY COMMITTEE ON FISHERY MANAGEMENT
ACFM:35

REPORT OF THE WORKING GROUP ON THE ASSESSMENT OF DEMERSAL STOCKS IN THE NORTH SEA AND SKAGERRAK (WGNSSK)

5–14 SEPTEMBER 2006

ICES HEADQUARTERS

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

H.C. Andersens Boulevard 44-46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

Recommended format for purposes of citation:

ICES. 2006. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK), 5–14 September 2006, ICES Headquarters. ACFM:35. 1160 pp.

Contents

0 Executive summary

The ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) met at ICES Headquarters in Copenhagen, Denmark, during 5-14 September 2006. There were 30 participants from 8 countries. The main terms of reference for the Working Group were: to carry out stock assessments and to provide catch forecasts for demersal and industrial stocks in the North Sea, Skagerrak and Eastern Channel; to consider environmental drivers of fish population dynamics and effects of fisheries on ecosystems; to collate data for mixed fisheries evaluations; to evaluate stock recovery and management plans, to comment on the outcome of existing management measures, to update descriptions of fisheries; to report on national sampling levels and data availability; and to consider measurement and estimation of misreporting and discards.

0.1 Working procedures

Much consideration was given to the problem of the increasing **workload** of the WG, both intersessionally and during the meeting itself. Several proposals were made by the Chair during the January 2006 Annual Meeting of Assessment Working Group Chairs (ICES-AMAWGC 2006). The stated intention to provide probabilistic assessments and forecasts did not materialise, as software is not yet available to do so, but an early data submission date was imposed with reasonable success and a substantial amount of intersessional work was carried out by WG members. The end of the meeting was reached with completed and checked text for all sections of the report, save the opening chapters (Sections 0-2) which were not completed until over a month afterwards. The information required by ACFM as the basis for advice was provided in good time for their October meeting.

As in the previous two years, the system of **benchmark/update** assessments was not closely followed by the WG. Ongoing developments in assessment methods and substantial revisions in stock perceptions following the inclusion of new data meant that pure update assessments were seldom appropriate. At the same time, the increasing workload reduces to almost zero the time available for the type of in-depth analysis that would be required for a benchmark analysis. Therefore, a pragmatic approach was taken: if intersessional work was done on an assessment, it became *de facto* a benchmark assessment, otherwise it was viewed as an update.

The **order** of the stock sections in this year's report has been reversed from previous years, so that *Nephrops* are now discussed in Section 3 and cod in Section 14. This was done in an effort to encourage reviewers to devote as much time to stocks such as *Nephrops*, pout and sandeel (usually at the back of the report) as to stocks such as cod, haddock and whiting (usually at the front).

As last year, **quality handbooks** (stock annexes) for each stock are included in the main report as a series of appendices (appendix B3 – B14). This was done to avoid the problem of potentially useful stock-annex information being lost in the grey literature. In general these have not been modified this year, although there are exceptions.

0.2 State of the stocks

For ***Nephrops*** stocks, underwater TV surveys (where available) provided the best guide to state of stocks. The historical practice of basing numerical assessments on pseudo-ages was not followed. In TV-based Functional Units (FUs) Moray Firth (9), Firth of Forth (8), and Farn Deeps (6) abundance seems to be rising slightly. In Fladen Ground (7) abundance is fluctuating and currently towards mid to lower end of observed range. Other FUs were more difficult to assess (as there are no TV surveys) but in Noup (10), Norwegian Deeps (32), Botney Gut-Silver Pit (5) and Off Horn Reef (33) stocks seem fairly stable and no signs of overexploitation (LPUEs remain level and mean sizes are fairly constant). The harvest-rate approach, based on $F_{0.1}$, was proposed as the method for providing (and justifying) catch options where surveys were available. Other FUs and statistical rectangles outside of the main assessed areas were dealt with by *status quo* advice or mean of last three years landings. On this basis, the overall TAC for Sub-Area IV would be slightly reduced from last year. *Status quo* landings are advised for Division IIIa.

The directed fishery for **Norway pout in Sub-area IV** was closed during 2005 and most of 2006. Landings in 2005 (1.9 kt) were the lowest observed; these arose from experimental fishing and a limited bycatch. In-year survey-based monitoring in April 2006 led to the opening of the fishery with a TAC of around 90 kt, although less than 50% of this is likely to be taken. Estimated SSB for this stock in 2005 was well below B_{lim} and fishing mortality was effectively zero. The size of the 2005 year-class was the largest since 1999, while the 2006 year-class was moderately abundant. The potential for a fishery in 2007 will be dependent on the survival and growth of these year-classes, along with the size of the 2007 year-class

Landings in 2005 for **sandeel in Sub-area IV** (172 kt) remained at or near the same low level as in the preceding three years. Landings in 2006 have continued this trend, and following the implementation of a real-time management plan, the fishery was closed in July 2005. Estimated SSB is close to its lowest observed level and is well below B_{lim}. Fishing mortality has declined in recent years and is now below the long-term mean. Recruitment remains low. In order to permit a fishery in 2007, the 2007 year-class would have to be substantially larger than recent year-classes.

Discrepancies between catch-at-age based analyses and survey-based analyses has prevented the WG from assessing the state of **plaice in Division VIId**. Landings have declined steadily since 2002 to 3500 tonnes, the lowest value since 1980.

Plaice landings in **Division IIIa** fell in 2005 to an historical low of 6905 tonnes. The available quota has never been restrictive for this stock. About 82% of the landings were taken in the Skagerrak. Although the assessment is uncertain, the WGs best estimates indicate that has fluctuated rapidly since 1996 and is currently relatively low (~ 0.85); and that SSB is increasing following recruitment of the large 2003 year-class.

As in the previous two meetings, the assessment of **plaice in Subarea IV** included modelled discard estimates for recent years. Landings and discards have both declined in recent years. SSB remains at a relatively low level (between B_{lim} and B_{pa}), while fishing mortality has declined (although it is still above the long-term mean). Recent year-class strength has been poor. Surveys suggest the 2005 year-class to be around the long-term average. On this basis, short-term forecasts at current fishing levels indicate a fall in landings in 2007 (to around 51 kt) and an increase in discards (to around 55 kt). For SSB to reach above B_{pa} by the start of 2008, landings in 2007 would need to be around 33 kt.

Landings for **sole in Division VIId** have fluctuated around a mean level for many years, and show no significant trends. The fishing mortality is estimated to be around F_{pa} The SSB has above B_{pa} (8000t) following improved recruitment in recent years, particularly of the year classes 1998 to 2000 and 2003. There is a tendency to underestimate F and overestimate SSB.

The reported landings for **sole in Subarea IV** in 2005 (16.4 kt) were at a similar level as in recent years. SSB has fluctuated around a moderate-to-low level for several years, although at *status quo* fishing mortality it is forecast to drop below B_{pa} during 2006. The short-term forecast at *status quo F* suggests a fall in landings (to around 12.5 kt in 2007) and a corresponding decline in SSB.

Reported landings for **saithe in Subareas IV and VI and Division IIIa** in 2005 were around the recent average (112 kt). The assessment was a standard update this year. Fishing mortality has now remained at or below 0.3 for six years (F ~ 0.26 in 2005) while SSB continues a steady increase (288 kt in 2005). Recruitment is fluctuating about the mean level. The TAC has been unrestrictive for four years. The short-term forecast as *status quo F* indicates landings of 109 kt in both 2006 and 2007 (2006 TAC ~ 136 kt), along with a slow decline in SSB (to 280 kt by the start if 2008).

Catches of **whiting in Subarea IV and DivisionVIId** continued to decline in 2005, and set a new historical low (21 800 kt). The whiting assessment is again quite uncertain. The same concerns as last year were raised about stock structure, but in the absence of improved information on stock distribution the WG decided to present the same approach as last year (in the full knowledge that this was rejected by ACFM). The final assessment indicates historically low estimates of recruitment (346 million), SSB (104 kt) and fishing mortality (0.25). Without good recruitment the stock is unlikely to recover. Short-term forecasts at *status* quo fishing mortality suggest falling landings (9100 tonnes in 2006, 8200 tonnes in 2007) and slowly increasing levels of both SSB and discards. The fact that the forecast landings for 2006 are less than half the permitted TAC raises concerns about the analysis. This assessment must be considered in the light of industry reports that whiting are more abundant than for several years, particular off the north-east coast of England. The Scottish industry are also reporting good catches of whiting and are likely to take their quota in full, which doesn't correspond to the low forecast landings for 2006.

The strong 1999 year-class again dominated the catches of **haddock in Subarea IV and Division IIIa** (57 300 kt), which were the lowest in the available time-series. The assessment (using the same procedure as last year) indicated a continued decline in SSB (from 298 kt in 2004 to 256 kt in 2005) as the 1999 year-class reduces in number. Fishing mortality has stabilised at or around 0.3 (it has now been in the range 0.25 to 0.35 for four years). The 2005 year-class (recruiting at age 0) is estimated to be quite abundant (35 000 million) and the largest since the 1999 year-class (now estimated to have been 114 000 million, a slight increase on the estimate in last year's assessment). The WG considered the issue of appropriate inputs for the haddock forecast very carefully. In particular, the mean weights-at-age of the slow-growing 1999 and 2000 year-classes have now been modelled in a more realistic manner. The outcome at *status quo* fishing mortality in 2007 is landings of around 58 000 tonnes (compared with estimated landings in 2006 of 46 600 tonnes) and discards of 34 400 tonnes (compared with 20 500 tonnes in 2006). The increases in both catch components are due to the reasonably good 2005 year-class. While the increase in projected landings is good, the increase in discards is not and needs to be considered carefully if this year-class is to benefit the stock and the fishery for as long as possible.

The estimated yield (reported landings and discards) in 2005 for **cod in Subarea IV and Divisions IIIa and VIId** (40 300 kt) was low. A modified assessment has been used this year which is based on the combined survey series for the third quarter, and which uses an uncertainty estimation procedure. The assessment includes estimates of unaccounted removals, as for the last two years. Spawning-stock biomass remains low but stable (~ 35 kt). Fishing mortality is now estimated to have declined since 2000 (median estimate for 2005 ~ 0.86). Recruitment of the 2000-2005 year-classes was poor. Indications from Q1 and Q3 surveys in 2006 are that the 2006 year-class is somewhat stronger. Results from a number of forecast scenarios covering different changes in TAC in 2007 indicate that SSB will continue to decline to a historic low. Only zero catch in 2007 will enable SSB to rise to B_{lim} (70 kt) by the start of 2008.

0.3 Environmental and ecosystem considerations

The WG was asked to "consider existing knowledge on important environmental drivers for stock productivity and management and if such drivers are considered important for management advice, incorporate such knowledge into assessment and prediction, and important impacts of fisheries on the ecosystem." This was addressed in each stock section, where information was available to the WG. However, due to a lack of firm conclusions in the literature on causative mechanisms linking fish stocks and the environment, and poor predictability of ecosystems, few quantitative modifications were made to assessments or forecasts to account for environmental information. The exceptions were those stocks for which recent recruitment is clearly different (in some way) to historical recruitment, in which case the recent recruitment estimates only were used to generate recruitment forecasts. Apart from this, the report is limited to comments on potentially-important ecosystem impacts.

During the WG meeting a proposal was submitted by Martin Pastoors (Chair, ACFM) for consideration and comment, on possible restructuring of the WG to accommodate improved cognisance of ecosystem effects. Following a discussion in plenary, the WG reached a number of conclusions; these are summarised in Section 1.6 of this report.

0.4 Mixed-fisheries data collation and modeling

In previous years, a considerable amount of time has been spent during the WG meeting collating mixed-fisheries data, with little mixed-fisheries modelling. This year mixed-fisheries data was (to a certain extent) collated at the same time as single-species data, so the opportunity was taken during the WG meeting to explore the potential of the Fcube mixed-fisheries analysis system in a series of dry runs. These were not intended to be used as the basis for advice, but to indicate the strengths of the approach, and where it could be improved in the future. The provision of fisheries data in the appropriate fisheries aggregations remains the principal problem preventing the provision of mixed-fisheries management advice. The analyses are described in Section 15.

0.5 Management plan evaluations

A number of requests were received by ICES for the evaluation of management plans during 2006. Those regarding North Sea haddock, sandeel, Norway pout, plaice and sole were passed onto the WG for consideration, along with the standing request to evaluate the cod recovery plan. A substantial part of the WG meeting was devoted to this important issue, particularly during the second week, and the results and conclusions are provided in Section 16.

0.6 Data collation issues

The provision, exchange and raising of landings and discard data remains a serious problem for ICES assessment WGs, and is (in many respects) the most difficult issue that WGs have to deal with. Early submission of data this year ameliorated some of the difficulties, but introduced new ones as some data were not ready in time. Efforts are currently underway to address these concerns, and presentations were given to the WG on both InterCatch and FishFrame. ICES have insisted that InterCatch be used from 2007 onwards to collate WG assessment data. If this approach works then the provision of advice should run much more smoothly: however, there is a substantial training need to be met before this can become a reality. Further details on the WG discussion are given in Section 1.2.5.

1 General

1.1 Terms of reference

The Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak [WGNSSK] (Chair: Coby Needle, UK) met in ICES Headquarters from 5-14 September 2006 to:

a) assess the status of and provide management options for the following stocks: 1) cod in Subarea IV and Division IIIaN (Skagerrak), and Division VIId, 2) haddock in Subarea IV and Division IIIa, 3) whiting and 4) plaice, both in Subarea IV, Division IIIa, and Division VIId, 5) saithe in Subarea IV, Subarea VIa, and Division IIIa, 6) sole in Subarea IV and Division VIId, for Norway pout and sandeel stocks in Subarea IV and Divisions IIIa and VIa, and 7) Nephrops stocks: Functional Units 3, 4, 5, 6, 7, 8, 9, 10, 32 and 33;

b) quantify the species and size composition of by-catches taken in the fisheries for Norway pout and sandeel in the North Sea and adjacent waters, and make this information available to the Working Group on Ecosystem Effects of Fishing Activities;

c) provide the data required to carry out multispecies assessments (quarterly catches and mean weights-at-age in the catch and stock for 2005 for all species in the multispecies model that are assessed by this Working Group).

WGNSSK, WGSSDS, WGHMM, WGMHSA, WGBFAS, WGNSDS, AFWG, HAWG, NWWG, WGNPBW and WGPAND will, in addition to the tasks listed by individual group in 2006:

1) based on input from e.g. WGRED and for the North Sea NORSEPP, consider existing knowledge on important environmental drivers for stock productivity and management and if such drivers are considered important for management advice incorporate such knowledge into assessment and prediction, and important impacts of fisheries on the ecosystem;

2) Evaluate existing management plans to the extent that they have not yet been evaluated. Develop options for management strategies including target reference points if management has not already agreed strategies or target reference points (or HCRs) and where it is considered relevant review limit reference points (and come forward with new ones where none exist) following the guidelines from SGMAS (2005, 2006), AGLTA (2005) and AMAWGC (2004, 2005, and 2006). If mixed fisheries are considered important consider the consistence of options for target reference points and management strategies. If the WG is not in a position to perform this evaluation then identify the problems involved and suggest and initiate a process to perform the management evaluation;

3) where mixed catches are an important feature of the fisheries assess the influence of individual fleet activities on the stocks and the technical interactions;

4) update the description of fisheries exploiting the stocks, including major regulatory changes and their potential effects. Comment on the outcome of existing management measures including technical measures, TACs, effort control and management plans. The description of the fisheries should include an enumeration of the number, capacity and effort of vessels prosecuting the fishery by country;

5) where misreporting is considered significant provide qualitative and where possible quantitative information, for example from inspection schemes, on its distribution on fisheries and the methods used to obtain the information; document the nature of the information and its influence on the assessment and predictions;

6) provide for each stock and fishery information on discards (its composition and distribution in time and space) and the method used to obtain it. Describe how it has been considered in the assessments;

7) report as prescribed by the Secretariat on a national basis an overview of the sampling of the basic assessment data for the stocks considered;

8) provide specific information on possible deficiencies in the 2006 assessments including, at least, any major inadequacies in the data on landings, effort or discards; any major inadequacies in research vessel surveys data, and any major difficulties in model formulation; including inadequacies in available software. The consequences of these deficiencies for both the assessment of the status of the stocks and the projection should be clarified;

9) Further develop and implement the roadmap for medium and long term strategy of the group as developed by AMAWGC.

10) Working Group Chairs will set appropriate deadlines for submission of the basic assessment data. Data submitted after the deadline will be considered at a later meeting at the discretion of the WG Chair.

ToR a1 is addressed in Section 14, ToR a2 in Section 13, ToR a3 in Section 12, ToR a4 in Sections 6-8, ToR a5 in Section 11, ToR a6 in Sections 4, 5, 9 and 10, and ToR a7 in Section 3. Section 1.5 (Data for other Working Groups) provides the information requested in ToRs b and c. Of the additional ToRs to be addressed by all assessment WGs, ToR 1 was not covered due to a current lack of knowledge of causal relationships between the environment and marine fish stocks. For this reason, no quantitative modifications were made to assessments or forecasts to account for environmental information and the report is limited to comments on potentially-important ecosystem impacts. ToR 2 is covered in Section 16. ToRs 3 and 4 are addressed in each stock section (Sections 3 to 14), where information was available to the WG. More general data and analyses on mixed fisheries are given in Section 15. Misreporting, discarding or other sources of unaccounted removals (ToRs 5 and 6) are considered in several stock sections. An overview of sampling rates and data availability for basic assessment data (ToR 7) is given in Section 1.2.4 and 1.2.5, while sampling for the purposes of mixed fisheries data collation is discussed in Section 15. Discussions regarding the quality of each assessment, in terms of data and modelling (ToR 8), are given at the end of each stock section. Considerations on the future strategy of the WG are summarised in Section 1.6. The results of an attempt to encourage adherence to deadlines for data submission are highlighted in Section 1.1.1.

1.1.1 Attempted changes in working practice

The workload of WGNSSK, in common with all assessment WGs, has been steadily increasing in recent years. For 2006 the WG has been asked to deal with ten generic ToRs, in addition to the traditional assessment and forecast requirements. It is clear that such a workload is unlikely to be addressed satisfactorily without substantial intersessional investment in time and resources. The Chair of WGNSSK made a comment to this effect in last year's report (ICES-WGNSSK 2006), and raised the issue during the 2006 Annual Meeting of Assessment WG Chairs (ICES-AMAWGC 2006).

The Chair's proposals on how the change the working practice of the WG are summarised in full in an appendix to the AMAWGC report. The key salient points are listed below, along with the actions that were taken this year to address them.

- In October 2006, ACFM decided that assessment WG Chairs would be allowed to set early submission dates for data. The intention here was to allow much more time than has previously been the case for intersessional exploratory assessments and mixed-fisheries analyses. The Chair accordingly set a date of June 30th, 2006.

- As in previous years, a number of subgroups were set up which started work intersessionally and then acted as fora during the WG meeting for review and discussion of assessments and forecasts. These subgroups were organized deliberately so as to avoid the historical split into roundfish, flatfish, industrial and *Nephrops* divisions, with the intention that fresh approaches would emerge.
- However, subgroups were not used for reading and checking text. This was done in small plenary sessions, led by the Chair, which any WG member could attend (but none were forced to).
- Probabilistic assessments and forecasts, of the type discussed in ICES-AMAWGC (2006), were not used. The Methods WG (ICES-WGMG 2006) concluded that the approach taken was useful as a sensitivity analysis, but could not be used as the basis of probabilistic assessments.

This attempt to change working practice has been moderately successful. Most data were provided in time, although fishery-based data still caused great difficulties and some countries with hitherto good records (such as Scotland) encountered database difficulties that slowed submission. Preliminary assessments for nearly all stocks were presented during the first two days of the WG meeting, and final assessments were in most cases completed by the weekend, thus allowing due attention to be paid to forecasts. The new approach also allowed for much more analysis on the issues of mixed fisheries modeling (Section 15) and management plan evaluations (Section 16). Subgroups worked successfully, and the plenary text read-throughs meant that the Chair had a very good overview of all the assessment issues raised. On the other hand, this reduced to almost nil the time available to the Chair for writing text and organising the final report, which was finished well after the end of the meeting as a consequence. Further discussion on the possible future structure of the WG is given in Section 1.6.

It should be noted that there was **no French participation in this year's WG meeting**. Although a working paper was submitted for the plaice VIId assessment (see Section 6), there was no input from France to discussions of fisheries and stock perceptions. This hindered the WG, particularly for stocks such as Channel plaice and sole, saithe, and North Sea whiting which include important French fisheries. This development is a real concern for the WG and for ICES, and needs to be addressed carefully for next year.

1.2 Data sources and sampling levels

1.2.1 Roundfish and flat-fish stocks

The data used in assessments for stocks of roundfish (cod, haddock, whiting, saithe) and flatfish (plaice, sole) are based on:

- total reported landings by market size categories;
- sampling programmes for weight, length, age, and sometimes maturity, by market size categories;
- observer sampling programmes for discards;
- effort data from logbooks, and catch-per-unit effort (CPUE) or landings-per-unit effort (LPUE) data from associated fleet landings;
- research-vessel survey indices by age; and
- data on natural mortality from multispecies analyses.

1.2.1.1 Landings, age compositions, weights-at-age, maturity

In a number of cases, management areas do not correspond exactly with the areas for which the assessments are carried out. If the management areas are larger, landings cannot always be obtained for the assessment areas separately. In these cases landings have to be estimated by the Working Group (WG) from external information.

For most stocks, the WG estimates of total landings deviate from official figures. The discrepancies are shown in the landings tables in the relevant stock section, under the heading **unallocated landings**. These unallocated landings will in most cases include discrepancies that are due to differences in calculation procedures. For instance, in some cases national conversion factors from gutted to live weights have been changed in the official statistics, but not in the WG database. The differences introduced by conversion factors, and the difference between sums-of-products (SOP) of landed numbers and estimated mean weights on the one hand, and nominal landings on the other, may arise through inadequate sampling or data reporting, and are minor in most cases. SOP corrections are applied in some cases for the flatfish stocks, where deemed necessary, and are a standard procedure for all roundfish stocks.

In a number of cases, uncertainties in the landing data can seriously affect the quality of the assessments and catch forecasts. In some cases, the WG estimates of the landings include specific corrections for misreported or unreported landings. These are discussed in the relevant Stock Annex sections of the Quality Control Handbook (included as an appendix to this report). There are signals that **unallocated removals** of various kinds occur in other stocks, especially in the stocks of valuable species: these removals may be due to fisheries (unrecorded discards, misreporting, or non-reporting) or to ecosystem changes. However, by their nature these could not be verified or quantified. Continued concerns about the quality of North Sea cod landings data in particular have been addressed in this year's report (Section 14) by the use of an assessment method which estimates the magnitude of unallocated removals via research-vessel survey information.

Historical time-series (aggregated at the fleet level) of age compositions, weights-at-age, and length-at-age are archived, maintained and collated in databases at national institutes. Roundfish data (cod, haddock, whiting, and saithe) are collated in Aberdeen (FRS). North Sea plaice and sole are maintained in IJmuiden (RIVO), VIId plaice in Port-en-Bessin (IFREMER), VIId sole in Oostende (DVZ), and IIIa plaice in Charlottenlund (DIFRES). Any revisions that have been made to these data are indicated in the relevant stock sections.

The countries that are responsible for the major proportions of the total landings for each stock generally provide the **age composition** data for those stocks. For the years up to and including 2001, each country was obliged to sample only national vessels. This meant that foreign vessels landing abroad were not sampled. The sampling procedure was changed to address this problem, and from 2002 onwards each country has been required to sample (where possible) the landings of all fleet components landing in their country (EU regulation 1639/2001).

Mean **weights-at-age** are either derived from observations of catch weights-at-age (for flatfish and industrial species), or from fixed weight-length relationships applied to observations of length distributions from catches (for roundfish). In most stocks the annual mean weights-at-age in the stock are set equal to the mean weights-at-age in the catch, due to lack of fishery-independent information on weights. Exceptions are the North Sea and eastern English Channel plaice and sole stocks for which the weight-at-age in the stock is set equal to the weight-at-age in the first quarter (plaice) or second quarter (sole). For all stocks, the mean weights-at-age in the catch of the youngest age groups may not accurately represent the mean weights-at-age in the stock due to fisheries selecting for larger fish.

Estimates of the proportion mature-at-age (**maturity ogives**) are based on historical biological information and are kept constant over the whole time period of the assessment. For a number of stocks a knife-edged maturity ogive has been assumed. Observations on maturity-at-age (from research-vessel surveys, for example) indicate that the age of maturation can change over time. The assumption of constant maturity ogives may introduce bias in estimated spawning-stock biomass (SSB), especially when exceptionally large or small year classes enter the spawning stock.

1.2.1.2 Discards

Estimates of **discards** are used in the assessments for cod, haddock, whiting and plaice in the North Sea. All the discard data for other species that was made available to the WG has been presented in the report (see the relevant stock sections), although they appear to be based on sampling that is too sparse to permit their inclusion yet. There is a continuing discrepancy between the observer sampling required by European legislation, and the data made available to ICES WGs, and this needs to be addressed as a matter of urgency.

The use of discard estimates in assessments is thought to reduce bias, give more realistic estimates of fishing mortality, and lead to more representative inputs for mixed fisheries analyses. However, discard estimates can be noisy and increase the variability of the assessment. Furthermore, for many of the stocks it is unclear whether the available discard estimates form a representative sample of discarding practice in the fisheries.

For cod, haddock and whiting, total annual international discard estimates by age group were derived largely by extrapolation from the Scottish discard sampling programme. Data from other sampling programmes were made available for this process, but not in a form that could be used in the roundfish discard collation procedure. Discard estimates for plaice in the North Sea were obtained by a combination of observations from the Dutch and English beam-trawl fisheries for recent years, and reconstructions based on observed growth for earlier years (see Section 8).

Problems with data collation procedures are discussed in Section 1.2.5.

1.2.1.3 Natural mortality

Natural mortality cannot readily be distinguished from fishing mortality by analyses of catch-at-age and research-vessel survey data. Therefore, unless stock analysis is conducted on the basis of total mortality (as is the case with the SURBA model, Section 1.3.3), natural mortality must be estimated separately from the assessment procedure. The estimates of natural mortality for cod, haddock and whiting are based on historical estimates of multispecies predation rates (ICES-MAWG 1989) and, unless specified otherwise, are kept constant over the whole time period of the assessment. In the plaice and sole stocks, natural mortality is assumed to be 0.1 for all age groups (with an exception for sole to account for the cold winter of 1963). The natural mortality of saithe is assumed to be 0.2 for all age groups, and at 0.4 per quarter for all age groups of Norway pout (although this is discussed further in Section 5). For sandeel, the natural mortalities used are derived from multispecies considerations, although they are not exactly the same (see the sandeel Stock Annex Q4).

1.2.1.4 Commercial fleet and research vessel data

All available time-series of CPUE and effort data from commercial fleets and research-vessel surveys have been presented in this year's report, and a subset of these data have been used to calibrate catch-at-age-based assessments and short-term forecasts (see Table 1.3.2). For most stocks, survey-based assessments have also been presented as exploratory analyses.

The validity of many of the commercial tuning fleets as indicators of stock size and fishing mortality in recent years has become more uncertain, since the enforcement of national quota, ITQs, and technical measures is known to have led to changes in fishing patterns (and in some cases to possible misreporting and discarding). For this reason, commercial CPUE data has been excluded from the assessments of a number of stocks. Such data has been retained in assessments only in cases where no survey data are available, or where commercial CPUE series provide reliable information that cannot be obtained elsewhere. At the time of year when the meeting took place, survey indices from the Dutch beam trawl survey, the IBTS Q3 survey and the English Q3 groundfish survey were not available. The latter was due to be ready for several stocks (beginning with North Sea cod) by the end of September 2005.

Figure 1.2.1 shows the roundfish sampling areas covered by the IBTS Q1 and Q3 surveys.

1.2.2 Norway pout and sandeel

The data used in the assessment for Norway pout and sandeel stocks are based on:

- total landings;
- samples of landings for species composition, weight, length, age, and sometimes maturity. Samples of industrial landings are used for an exact species composition of by-catch species and to get the percentage of target-species;
- fleet data: effort data from logbooks and CPUE data from associated fleet landings;
- survey data: survey indices by age for Norway pout;
- data on sandeel natural mortality from the MSVPA.

1.2.2.1 Landings, age compositions, weights-at-age, maturity

The sampling of Norway pout and sandeel landings are described in detail in the relevant Quality Control Handbooks (see Annexes Q4 and Q5). The applied sampling systems vary between countries.

In Norway, the sampling system since 1993 has been based on catch samples from three market categories: E02 (mainly sandeel), D13 (blue whiting, if not sandeel and catch taken west of 0°E), and D12 (Norway pout, if not sandeel and catch taken east of 0°E). The samples are raised to total landings on the basis of sales slip information on landed categories. Effort is estimated from the total number of trips and an estimate of average days-at-sea per trip.

In Denmark, the catch estimates are based on sales slip information, logbook data, species composition from inspectors, and biological data, including age-length keys from independent biological sampling. Total landings are estimated per statistical rectangle based on total catch estimates from sales slip and logbook data, together with biological and species composition data. Historical time-series of market sampling data for sandeel and Norway pout are kept and maintained in Charlottenlund (DIFRES). Any revisions in the catch- and weight-at-age data are indicated in the relevant stock sections.

In the assessment of Norway pout the weights-at-age in the stock are kept constant over the whole period of assessment. Samples from the landings, however, suggest high variability both between years and between seasons. One of the problems of using mean catch weights is that the 0-group is not fully recruited in the third quarter, giving an overestimate of weight-at-age in the stock for this age group. More knowledge is required before variable weight-at-age in the catches can fully be taken into account in the assessment. For sandeel, the weights-at-age in the catches in the first half-year are used as estimation for weights-at-age in the stock.

The maturity ogives for Norway pout and sandeel are kept constant over the whole period of assessment (although see discussion of maturity estimates for Norway pout in Section 5).

1.2.2.2 Natural mortality

Natural mortality estimates are based on historical information and kept constant over the whole time period of the assessment. Values are given in the relevant stock sections.

1.2.2.3 Commercial fleet and research vessel data

For Norway pout, time-series of CPUE and effort data from Danish and Norwegian commercial fleets and data from research vessels are available. The research vessel data include the IBTS Q1 and Q3 series, and the Scottish and English Q3 series.

For sandeel, only data from the Danish and Norwegian commercial fleets are available. Indices from research-vessel surveys are in development for sandeel, and are described in Section 4.9.

1.2.3 Nephrops

1.2.3.1 Landings, length frequencies

Length and sex compositions of *Nephrops* landings are estimated from either port or onboard sampling. Length data are applied to all catches and raised to total international landings. Rates of discarding by length class are estimated by on-board sampling or shore based sampling of total catch, and extrapolated to all other fleets.

The differences in catchability between sexes have lead to the two sexes being assessed separately. And hence removals are raised separately for each sex. 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 *Nephrops* 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* and again in 2001 to separate ‘true’ as opposed to ‘nominal’ age classes). 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. The output from this procedure was used as part of the analyses to generate appropriate harvest rates, rather than in assessments *per se*.

1.2.3.2 Discards

Discard data are available for a number of *Nephrops* stocks, generally collected on a quarterly basis by Functional Unit. Landings and discards at length are combined (assuming a discard survival rate of 0-25%, depending on the stock) to removals.

1.2.3.3 Natural mortality

A natural mortality rate of 0.3 is assumed for all age or length 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 bearing eggs, and hence an assumed reduction in predation.

1.2.3.4 Commercial fleet and research vessel data

Landings at age and effort data for various national *Nephrops* trawl fleets are used to generate CPUE or LPUE indices. Catch at age are estimated from 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 there are concerns over the accuracy of landings and effort for some stocks. There is no account taken of any technological creep in the indices.

Underwater TV survey: 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 sediment strata and a regular grid. The survey provides a total abundance estimate, and is not age or length structured.

1.2.4 Sampling levels and procedures

Methods of data collection and processing vary between countries and stocks. The sampling procedures applied in the various countries to the various stocks until 2002 were described in detail in the report of the WGNSSK meeting in 1998 (ICES-WGNSSK 1998). Since 2002 an EU regulation (1639/2001) has been in place which has altered market sampling procedures. Firstly, each country is obliged to sample all fleet segments, including foreign vessels, landing in their country. Secondly, a minimum number of market samples per tonnes of landing are required. The national market sampling programmes have been adjusted accordingly.

Table 1.2.1 gives an overview of the sampling levels in 2005 for each stock, for both landed and discarded components of catch.

1.2.5 Data collation (Intercatch, FishFrame) and current problems

One of the key difficulties for the WG is the acquisition and collation of data on which to base assessments, forecasts and other analyses. The collation procedures for single-stock analyses have become increasingly antiquated in recent years, a trend worsened by a marked difference in approach between different subtypes of demersal species (roundfish, flatfish, *Nephrops* and industrial fish all have different data collation procedures). The problem has been exacerbated in the last two years by increased calls for mixed-fisheries (i.e. fleet-based) landings and discards data. Some of these data are simply not available. Others are not made available to the WG for one reason or another, or they may be available but in the wrong format. Lack of resources in staff time hinders data collation in many cases.

The EU Data Collection Regulation (DCR) is intended to rectify these problems. In some cases it seems to have been only partially successful. Fisheries data, particularly discard data, which countries are paid to collect and provide to ICES are not made available to the relevant WGs. Countries which do provide data on discards are highlighted as discarding fish by the EU, leading to increased legislation and an understandable reluctance to participate in observer sampling schemes (seen as self-incriminatory in some quarters). The EU-STECF working groups appear to be more able to acquire fisheries data, perhaps because such data must be destroyed 20 days after the end of the relevant meeting.

In the revised MoU between ICES and the EU, a new clause stipulates that any data collected under the DCR **must** be made available to ICES. It is hoped that this will alleviate some of the aforementioned difficulties. To check progress of this enforced rigour, and to try and deliver quality assurance, the EU have requested that ICES completes reformatted data availability tables for each stock. These are similar to those in Table 1.2.2 but include much more detail on which countries are supplying which data, and for what purpose. ICES presented these new tables during the 2006 WG meeting and requested that these be completed within one week of the close of the meeting. This proved to be an unworkable request, due to considerable time constraints, but the **WG agrees that these are worthwhile summaries of data availability and that they will be completed at the 2007 meeting.**

Several initiatives are underway to try and address these problems. Two of these were presented at the meeting:

1) **Intercatch**. Henrik Kjems-Nielsen (ICES) gave a presentation of recent developments in the Intercatch system, in which he emphasised that **ICES expects WGs to use the system from 2007 onwards**. He clarified what the system is intended to do: namely, to act as a database tool in which stock coordinators can collate national datasets in order to generate assessment files (single-stock and mixed-fisheries) for WGs. The system will not hold raw

national data – the intention is that this will be worked up to the national level using whichever system national data collators wish to use (e.g. FishFrame, see below) **prior** to submission to InterCatch. The WG raised several issues which were addressed which varying degrees of success:

1.1) It was not clear to the WG who was to chase up national data providers. The ICES response was that this is still very much the responsibility of the stock coordinators – in fact, using Intercatch actually increases the reliance of the whole system on the coordinators. Their training is therefore of pivotal importance, and needs to be addressed by ICES.

1.2) Fleet and fishery definitions are still in development, which hinders the creation of fishery-based datasets. The ICES view on this is that fishery definitions can (in the first instance) be very rudimentary, thus allowing the system to operate until such time as improved fishery definitions are agreed. At the moment, **the implications for mixed-fisheries analyses of the Intercatch system are not yet clear.**

1.3) The question of data ownership was raised. As mentioned above, STECF collates data under an agreement that said data will be destroyed 20 days after the end of the relevant meeting. Some countries may object to submission of data to a permanent ICES database. **This question was not resolved by the end of the WG meeting.**

2) **FishFrame**. A summary of developments in FishFrame was presented by Henrik Degel and Teunis Jansen of DIFRES (Charlottenlund). This system can be used in several different ways, but one approach is for national data collators to use it as a tool for working up sampled data to national fleet level (allowing for the correct fill-ins for missing age-length keys, etc). They emphasised that, unlike Intercatch, use of FishFrame is entirely voluntary. Clearly testing in the North Sea context is required (FishFrame was largely developed for use in the Baltic), but equally clearly it has the potential to replace several of our current aging data collation systems. As for Intercatch, training and data ownership are key issues to be addressed. A series of workshops have been given and more are planned, while data access issues may be circumvented by downloading local copies of the FishFrame system. FishFrame has the additional burden of requiring funding (as DIFRES are unable to continue maintaining and developing it for ever). Applications are being prepared for EU funding.

1.2.6 Developments and changes to IBTS series collation

IBTS survey indices have changed slightly since last year due to data and code updates. The extent of these changes is dependent on species. The following points explain why.

1) For the years 2003 to 2005 ICES received revised data from two countries. A number of problems were found in these datasets. Some of them were related to misunderstanding of the exchange format and some were extractions problems from the countries' database to the DATRAS exchange format. This affected both the CPUEs and the ALKs.

2) ICES are at the moment implementing a bootstrap procedure for calculating the variance of the indices. The performance of the "hole filling" in the ALK was running very slowly and in order to bootstrap ICES had to improve this part of the calculations of the indices. When going through the "hole filling" algorithm there were found to be two problems in the old code:

2.1) There was a small error that might effect some of the last ages on the second decimal.

2.2) The procedure for filling the gap between the minimum length and the first observation was changed. A few fish have therefore moved from first to second year class (e.g. from age 1 to 2 in quarter 1).

3) The data type has changed in some of the procedures from float to decimals. This can give a difference of 0.001 when the indices are summed over all ages in a few cases.

4) In 1992 and 1983 there were missing substitutions keys for Norway pout and haddock in area 8 and 9.

The reliability of the separate Scottish and English groundfish Q3 surveys (which form part of the IBTS Q3 index) as cod abundance indices was questioned in last year's report (ICES-WGNSSK 2005), and further in Section 14 of this year's report. This year's cod assessment uses the IBTS Q3 data instead of the separate Scottish and English series; however the cost of this is the removal from analysis of autumn survey data in the current year. During discussions at this year's meeting, ICES indicated that they would be able in future to provide IBTS Q3 data in time for the autumn ACFM meeting. WGNSSK would fully support this timetable and recommends that it be implemented.

1.3 Methods and software

1.3.1 Update and benchmark assessments

ACFM has requested that assessment WGs work to an agreed schedule of update and benchmark assessments. After experiencing problems in 2004 trying to accommodate a strict split between update and benchmark assessments, the WG has taken a different approach during 2005 and 2006. The large number of stocks and ToRs that the WG is asked to address means that the scope for in-depth analysis during the meeting itself is very limited, so that the range of approaches that would be expected in a full benchmark cannot be fulfilled. At the same time, stocks and fisheries in the areas covered by the WG are in such rapid flux that a simple update assessment is seldom appropriate. An update is also inappropriate if the assessment is to be reviewed externally. Therefore the majority of the assessments produced by the WG this year are neither update nor benchmark assessments, but somewhere in between. The range of analyses available in each stock section reflects the amount of work that could be done intersessionally on each stock rather than strict adherence to a predefined timetable. In other words: if intersessional work is done on a stock assessment, then that assessment is treated as a *de facto* benchmark; otherwise it is an update.

1.3.2 Quality control handbooks

Stock annexes (included in this report as Annexes Q3 to Q14) have not in general been updated this year (although there are exceptions). The new format of the first part of each stock section (introduced for the first time in ICES-WGNSSK 2005) has meant that some information (on ecosystem aspects and fisheries, principally) which previously would have been kept within the stock annexes has now been moved to the stock sections. Due to time constraints, most of these stock annexes have not been modified accordingly, so there may be some repetition. As before, the WG intends to undertake a full revision of stock annexes intersessionally.

1.3.3 Assessment methods

Table 1.3.1 lists the biological basis of the stock assessments undertaken by this Working Group. Table 1.3.2 gives an overview of model settings for these assessments.

XSA and SXSA

Extended Survivors' Analysis (XSA; Darby and Flatman 1994) has been used for catch-at-age analysis for most stocks, although it has not been selected as the final assessment in all cases. Three implementations were used. The version (FLXSA) incorporated in the FLR package (FLR Team 2006) was used in many cases to perform exploratory analyses. To date this implementation cannot produce standard output for tuning diagnostics, so version 3.1 of the Lowestoft VPA package was used for generating final runs. Seasonal XSA (Skagen 1993,

1994) was used for exploratory analyses for Norway pout and sandeel to allow for seasonal data; the final assessment for sandeel was generated using SXSA.

For XSA assessments, a full tuning window was used, either with or without a 20-year tricubic time-taper depending on the stock. The general exploratory approach was as follows (Darby and Flatman 1994):

- A separable analysis was carried out to explore the internal consistency of the catch-at-age data, and also to judge whether the plus group was appropriately chosen.
- For appropriate tuning series, single fleet runs were carried out using Laurec-Shepherd *ad hoc* tuning. These runs were used to explore the consistency of research-vessel survey indices or commercial CPUE indices with the catch-at-age data.
- An XSA run was performed with all selected tuning series, no power model (no dependence of catchability on stock size for any age), light shrinkage (s.e. = 2.0), and the oldest available age for the catchability plateau. Tuning diagnostics from this run were examined to determine what the plateau age should be, and whether a power catchability model would be appropriate on any of the younger ages.

If an update assessment was being run (see Section 1.3.1) the first two steps in this process were generally skipped. Shrinkage was kept light if possible (so that s.e. = 2.0). If there were trends in recent fishing mortality estimates, then heavy shrinkage was not used as this would lead to retrospective bias. Stronger shrinkage (s.e. = 0.5) was only considered for those cases in which recent *F* fluctuated without trend, where survey indices were noisy, and where the use of strong shrinkage improved retrospective patterns. In some cases the level of shrinkage had a minimal effect on overall conclusions, and so was left unchanged from previous years.

Following these exploratory steps, a final run was performed. Residuals and the results of retrospective analyses were scrutinised to evaluate the quality of the assessment (or at least, whether survey and commercial data were in agreement about stock trends).

Seasonal XSA (SXSA) was used in the sandeel and Norway pout assessments (Sections 4 and 5) to estimate fishing mortalities and stock numbers at age by half-year, using data up to and including the first half year of 2006. SXSA weights the estimated survivors from manually entered data or according to the variance of the estimated log catchability. The WG used the standard setting with user-defined weighting factors, where estimates of survivors are given a lower weighting in the second half of the year. This setting is used because the fishery inflicts the majority of fishing mortality in the 1st half of the year (when oil content of the fish is higher) and thus the signal from the fishery is considered less reliable in the second half. The residuals used to evaluate the quality of the assessment are equivalent to the log catchability residuals obtained from the standard XSA, and are calculated as:

$$residuals = \log\left(\frac{\hat{N}}{N}\right)$$

where N is the stock number-at-age derived from the VPA and $\hat{N}$ is the stock number-at-age derived from the CPUE index for each tuning fleet.

B-ADAPT

The following text is adapted from Appendix 4 to the 2004 WGNSSK report (ICES-WGNSSK 2004), where further details on the background of the model and simulation testing can be found. The model was extended further this year with the addition of bootstrap uncertainty estimation; this is described in Section 14 of this report and in the 2006 report of the Methods WG (ICES-WGMG 2006).

In recent years indices of North Sea cod population abundance N and fishing mortality F calculated from survey catch per unit effort (CPUE) have indicated higher levels of abundance and mortality rates than those estimated by catch at age analysis. Within the model diagnostics generated from fits of catch at age models to the North Sea cod assessment data, the inconsistencies between the population abundance estimated from the two data sources have been apparent in the residuals about the mean of log survey catchability (q = CPUE/N). The residuals have been positive in recent years at the majority of ages, a pattern that is consistent across surveys. This indicates a mismatch between the levels of reported landings and actual removals. The latter may be due to a number of causes (misreporting, nonreporting, unaccounted discards, natural mortality, changes in catchability of fleet or surveys), and while these cannot be distinguished, an alternative model can be used to estimate a more realistic level of removals than indicated by the reported landings.

It is straightforward to show that if bias is present in the data on removals, the magnitude and sign of the log catchability residuals is proportional to the degree of bias. If $C_{a,y}$ represents catch at age a in year y, $N_{a,y}$ population numbers at age by year, $F_{a,y}$ fishing mortality at age by year, $Z_{a,y}$ total mortality (fishing + natural mortality M) and B_y the bias in year y; in the years without bias

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

and for the years with bias

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

Survey catch per unit effort ($u_{a,y,f}$, where f denotes fleet or survey) is related to population abundance by a constant of proportionality or catchability $q_{a,f}$ which is assumed, in this study, to be constant in time and independent of population abundance

$$N_{a,y} = u_{a,y,f}\ /\ q_{y,f}$$

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

$$B_y = N'_{a,y}\ /\ (u_{a,y,f}\ /q_{y,f})$$

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-parameterised and that it was necessary to introduce a constraint, that one year-class abundance was known exactly, in order to estimate the remaining catchability, bias and population abundance parameters. They concluded that, for the data sets to which they applied the model, the indices of abundance from trawl surveys were so highly variable that this resulted in estimates of bias with wide confidence intervals and therefore the model could only be used as a diagnostic tool.

A modification to the Gavaris and Van Eeckhaute (1998) ADAPT model (referred to here as B-ADAPT) can be made by assuming that the time series of landings can be divided into two periods; a historic time series in which landings were relatively unbiased and a recent period during which landings at age were biased by a common factor across all ages. The fit of the model to the early period of unbiased data provides estimates of appropriately scaled population abundance and survey catchability, thereby removing the indeterminacy noted by Gavaris and Van Eeckhaute (1998).

Note that it is assumed that during both periods, landings numbers at age have relatively low random sampling variability (relative to survey variance) so that the population numbers at age can be determined using the virtual population analysis (VPA) equations. This assumption has been found to hold for the North Sea cod by the EMAS project (EMAS 2001) which examined the errors associated with current sampling programs.

Within B-ADAPT, population numbers are estimated from the VPA equations

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

$$N_{a,y} = N_{a+1,y+1}\ \text{exp}(Z_{a,y})$$

where B_y is estimated for years in which bias was considered to have occurred and defined as 1.0 for years without bias. Selection is assumed to be flat topped with fishing mortality at the oldest age defined as the scaled (s) arithmetic mean of the estimates from n younger ages, where n and s are user defined. That is for the oldest age o:

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

The parameters estimated to fit the population model to the CPUE calibration data are the surviving population numbers $N_{a,fy}$ at the end of the final assessment year fy (estimated for all ages except the oldest) and the bias B_y in each year of the user selected year range. Under the assumption of log normally distributed errors, the least squares objective function for the estimated CPUE indices is

$$\text{SSQ}_{\text{vpa}} = \Sigma_{a,y,f}\, \{\ \ln u_{a,y,f} - [\ln q_{a,f} + \ln N_{a,y}\ ]\}^2$$

The year range of the summation extends across all years in the assessment for which catch at age data is available and also (if required) the year after the last catch at age data year. This allows for the inclusion of survey information collected in the year of the assessment WG meeting.

Testing with simulated data (ICES-WGNSSK 2004, Appendix 4) established that increasing the uncertainty in the survey indices results in estimates of bias and the derived fishing mortality that are more variable from year to year. One solution to this problem is to introduce smoothing to the model estimates.

A constraint used frequently in stock assessment models is that of restricting the amount that fishing mortality can vary from year to year. This reflects limitations on the ability of fleets to rapidly increase capacity and the lack of historic effort regulation reducing catching opportunities. However, given the current over-capacity in the fleets prosecuting the North Sea cod fishery this form of smoothing constraint was not considered appropriate.

Anecdotal information supplied by the commercial industry has indicated that the recent severe changes in the TAC have not been adhered to. Therefore it was considered more appropriate to apply smoothing to the total catches, across the years in which the bias was estimated. Smoothing of catches was introduced by an addition to the objective function sum of squares:

$$\text{SSQ}_{\text{catches}} = \lambda\, \Sigma\, \{\ln\, (B_y\, \Sigma_a\, [C_{a,y}\, \text{CW}_{a,y}]) - \ln\, (B_{y+1}\, \Sigma_a\, [C_{a,y+1}\, \text{CW}_{a,y+1}]\,)\}^2$$

Here $\text{CW}_{a,y}$ are the catch weights at age a in year y and natural logarithms were used to provide residuals of equivalent magnitude to those of log catchability within SSQ_{vpa}. λ is a user defined weight that allowed the effect of the smoothing constraint to be examined. The year range for the summation of the catch smoothing objective function was from the last year of the unbiased catches to the last year of the assessment.

The total objective function used to estimate the model parameters was therefore

$$\text{SSQ} = \text{SSQ}_{\text{vpa}} + \text{SSQ}_{\text{catches}}$$

The least squares objective function was mimimised using the NAG Gauss–Newton algorithm with uncertainty estimated using two methods, calculation of the variance covariance matrix and bootstrap re-sampling of the log catchability residuals to provide new CPUE indices.

SMS

SMS (**S**tochastic **M**ulti **S**pecies model; Lewy and Vinther, 2004) is an age-structured multi-species assessment model which includes biological interactions. However, the model can be used with one species only. In "single species mode" the model can be fitted to observations of catch-at-age and survey CPUE. SMS uses maximum likelihood to weight the various data sources assuming a log-normal error distribution for both data sources. The likelihood for the catch observation is then as defined below:

$$L_C = \prod_{a,y,q} \frac{1}{\sigma_{catch}(aa)\sqrt{2\pi}} \exp(-(\ln(C(a,y,q)) - \ln(\hat{C}(a,y,q)))^2 / (2\sigma^2_{catch}(aa)))$$

where C is the observed catch-at-age number, $\hat{C}$ is expected catch-at-age number, y is year, q is quarter, a is age group, and aa is one or more age groups.

SMS is a "traditional" forward running assessment model where the expected catch is calculated from the catch equation and F-at-age, which is assumed to be separable into an age selection, a year effect and a season (year, half-year, quarter) effect.

As an example, the F model configuration is shown below for a species where the assessment includes ages 0–3+ and quarterly catch data and quarterly time step are used:

$$F = F(a_a) \times F(y_y) \times F(q_q),$$

with F-components defined as follows:

$F(a)$:

Age 0	Fa_0
Age 1	Fa_1
Age 2	Fa_2
Age 3	Fa_3

$F(q)$:

	q1	q2	q3	q4
Age 0	0.0	0.0	Fq	0.25
Age 1	$Fq_{1,1}$	$Fq_{1,2}$	$Fq_{1,3}$	0.25
Age 2	$Fq_{2,1}$	$Fq_{2,2}$	$Fq_{1,3}$	0.25
Age 3	$Fq_{3,1}$	$Fq_{3,2}$	$Fq_{3,3}$	0.25

$F(y)$:

Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	…
1	Fy_2	Fy_3	Fy_4	Fy_5	Fy_6	Fy_7	Fy_8	Fy_9	….

The parameters $F(a_a)$, $F(y_y)$ and $F(q_q)$ are estimated in the model. $F(q_q)$ in the last quarter and $F(y_y)$ in the first year are set to constants to obtain a unique solution. For annual data, the $F(q_q)$ is set to a constant 1and the model uses annual time steps.

One $F(a)$ vector can be estimated for the whole assessment period, or alternatively, individual $F(a)$ vectors can be estimated for subsets of the assessment periods. A separate $F(q)$ matrix is estimated for each $F(a)$ vector.

For the CPUE time series the expected CPUE numbers are calculated as the product of an assumed age (or age group) dependent catchability and the mean stock number in the survey period.

The likelihood for CPUE observations, L_S, is similar to L_C, as both are assumed lognormal distributed. The total likelihood is the product of the likelihood of the catch and the likelihood for CPUE ($L = L_C * L_{\text{CPUE}}$,). Parameters are estimated from a minimisation of -log(L).

The estimated model parameters include stock numbers the first year, recruitment in the remaining years, age selection pattern, and the year and season effect for the separable *F* model, and catchability at age for CPUE time series.

SMS is implemented using ADModelBuilder **(**Otter Research Ltd.), which is a software package to develop non-linear statistical models. The SMS model is still under development, but has extensively been tested over the last two years on both simulated and real data.

SMS can estimate the variance of parameters and derived values like average *F* or SSB from the Hessian matrix. Alternatively, variance can be estimated by using the built-in functionality of the AD-Model builder package to carry out Markov Chain Monte Carlo simulations (MCMS; Gilks et al. 1996) to estimate the posterior distributions of the parameters. For the historical assessment, period uniform priors are used. For prediction, an additional stock/recruitment relation including CV can be used.

SURBA

SURBA (version 3.0) is based on a simple survey-based separable model of mortality. The implementation used at this year's WG includes a Windows user interface which facilitates plotting of results and summary diagnostics. It was used to perform exploratory analyses for most stocks.

The model was first applied to European research-vessel survey data by Cook (1997, 2004), but it has a long history in catch-based fisheries stock assessment (Pope and Shepherd 1982, Deriso et al 1985, Gudmundsson 1986, Johnson and Quinn II 1987, Patterson and Melvin 1996; see Quinn II and Deriso 1999 for a summary). The separable model used in SURBA assumes that total mortality $Z_{a,y}$ for ages *a* and *y* can expressed as $Z_{a,y} = s_a \times f_y$, where s_a and f_y are respectively the age and year effects of mortality. Note that this differs from the usual assumption in that total mortality *Z* is the quantity of interest, rather than fishing mortality *F*. Then, given $Z_{a,y}$, abundance $N_{a,y}$ can be derived as

$$N_{a,y} = r_{y_0} \exp\left(-\sum_{m=a_0}^{a-1} \sum_{n=y_0}^{y-1} Z_{m,n} \right)$$

where a_0 and $y_0 = y - a - a_0$ are respectively the age and year in which the fish measured as $N_{a,y}$ first recruit to the observed population. Thus the abundance at each age and year of a cohort is given by the recruiting abundance r_{y_0} of the relevant cohort modified by the cumulative effect of mortality during its lifetime. Parameters are estimated by minimizing the sum-of-squares of observed and estimated abundance indices.

SURBA remains under development. Significant modifications are planned for the near future, particularly with regard to uncertainty estimation via a parametric bootstrap.

FLR

The complexity of fisheries systems and their management require flexible modelling solutions for evaluations. The FLR system is an attempt to implement a framework for modelling integral fisheries systems including population dynamics, fleet behaviour, stock assessment and management objectives (www.flr-project.org; FLR Team 2006). FLR consists of a number of packages for the open source statistical computer program R, centred around conventions on the representation of stocks, fleets, surveys etc. A broad range of models can be set up, encompassing population dynamics, fleet dynamics and stock assessment models. Moreover, previously developed methods and models developed in standard programming languages can be incorporated in FLR, using interfaces for which documentation is being written.

The stock assessment tools in FLR can also be used on their own in the WG context. The combination of the statistical and graphical tools in R with the stock assessment facilitates the exploration of input data and results. Currently, an effort is being made to incorporate stock assessment models that are used in some of the ICES working groups. Methods for reading in VPA suite files and setting plus-groups in data age structured data are also being developed. Currently XSA, SURBA, ICA, B-ADAPT, and a number of others have been incorporated in the package, and development is continuing.

One of the potential applications of the FLR tool within a WG context is running analyses of the sensitivity of model fits to user-defined parameter settings (ICES-WGMG 2006). An example of this is given in the stock section for saithe (Section 11), and was used during exploratory analyses for several other stocks. This approach cannot yet be used to generate probabilistic assessments, although research is continuing.

FLR has also been used extensively in this report as a framework for management plan evaluations for North Sea haddock and cod. These are described in full in Section 16.1 and 16.2.

ASPIC

ASPIC is a package which fits a general biomass non-equilibrium surplus-production model of the Schaefer type that does not require age-structured data (Prager 1994; Prager et al 1996). In this year's WG meeting, it was used in exploratory analyses for plaice in Division IIIa (see Section 7.3.4). Details and downloads are available at http://www.sefsc.noaa.gov/mprager/aspic.html.

1.3.4 Development of indicators for quality and performance of catch at age analysis

At present, assessments are evaluated largely through qualitative visual inspection of results such as catchability residuals. It could be argued that this is not sufficient, and should be supplemented by a more quantitative approach. The WG discussed this issue at length, with particular regard to the assessment of plaice in Division IIIa (see Section 7). One way of potentially improving assessment methodology is summarised below.

Marchal et al. (2003) proposed three criteria to evaluate the relative performance of different assessments.

The first criterion is the precision of the estimates of log-catchability for each tuning fleet. This criterion is investigated by examining the coefficient of variation (CV) relative to the log-catchability estimates:

$$\mathrm{CV(f,a)} = \frac{\sigma(\mathrm{f,a})}{\ln[q(\mathrm{f,a})]} \qquad (1.1)$$

where ln[q(f,a)] is the estimated value of log-catchability for the fleet f at age a and σ(f,a) the standard deviation associated to the log-catchability residuals. Low CV should correspond to a "good" assessment.

The second is the measure of the trends in the annual trajectories of log-catchability residuals for each tuning fleet. This is investigated by examining the first order auto-correlation ACR of the Log-catchability residuals ε(f,y,a):

$$\mathrm{ACR(f,a)} = \frac{\mathrm{COV}(\varepsilon(\mathrm{f,y-1,a}), \varepsilon(\mathrm{f,y,a}))}{\mathrm{VAR}(\varepsilon(\mathrm{f,y,a}))} \qquad (1.2)$$

where COV refers to the covariance function and VAR to the variance function. Values of ACR close to -1 characterise oscillations around a stable mean; values between -1 and 0 are associated to low trends; 0 value identify a pure random process; 0 to 1 values mean that there is a persistence phenomena within the time series (if one year show positive residual it is likely that the next year residual will be positive too) and value around 1 characterise trends in the residuals time series. One way to interpret this criterion is to compare its value with a confidence interval $\left[-2N^{-1/2}, 2N^{1/2}\right]$ were N is the number of observations (i.e. the number of years). If the criterion belongs to the confidence interval, it can't be interpreted as significantly different from zero. Otherwise the criterion is interpreted as mentioned above.

Those two criteria characterize the fleet performances in an assessment. They are both investigated based on single fleet XSA, and then can be directly compared between runs.

The third criterion is based on the retrospective pattern as the visual way of assessing the quality of the analysis. It evaluates the consistency of the retrospective patterns by measuring the distance between the annual trajectories relative to fishing mortality, SSB and recruitment. Yearly indices are calculated according to the equation below, measuring the variation between the "most recent truth" (the final assessment) and the values estimated by earlier assessments. The accuracy of an assessment is defined by the ability of earlier assessments to predict the truth (Darby and Flatman, 1994), i.e. the narrower is a retrospective pattern, and the more reliable the assessment is :

$$\mathrm{RI1(y)} = \frac{\sum_{i=\max(\mathrm{y,\ T_A})}^{T-1} \left(\frac{\mathrm{X(y,\ i) - X(y,\ T)}}{\mathrm{X(y,\ T)}} \right)^2}{\mathrm{T - max\ (y,\ TA)\ - 1}} \qquad (1.3)$$

Where X is successively Fbar, SSB and R, in year y (between T_0 and T), assessed in year i (comprised between max (y, T_A) and T-1). T_0 is the first year of the data period, T_A the year of the first assessment and T the year of the last assessment. . Dividing the sum of square by the number of years used to calculate it, allows the comparison between all the years indices. These yearly indices are then summed (in equation (4)) over the data period to obtained a synthetic index per variable per assessment.

$$\mathrm{RI2} = \sum_{\mathrm{y=T_0}}^{\mathrm{T}} \left[\mathrm{IX1(y)}\right] \qquad (1.4)$$

Marchal et al. (2003) only calculated the index with the double summation (equations 1.3 and 1.4) combined without dividing the index IX1 by the number of years). However, watching the time evolution of the dispersion gives information about the number of years before the convergence occurs. For both IX1(y) and IX2 the closer to 0 is the value, the better the assessment is.

A last index is also calculated for each variable of interest from the retrospective analysis. The yearly retro deviation index IX3 measures the distance between the value estimated for each terminal year (i) by retro-assessments and the value estimated for the same year by the assessment made one year later (i+1) (see equation (5)).

$$RI3(i) = \frac{X(i,\ i) - X(i,\ i+1)}{X(i,\ i+1)} \qquad (1.5)$$

These indices measure the bias that might be induce year after year, and allows trends investigation, or recurrent bias detection. Marchal et al (2003) concluded that the combination of all those criteria is a useful way to interprete the change in the assessment's outputs in order to choose among the options to be set for the final assessment.

The WG disagreed with this conclusion. Indices of retrospective bias are reasonable indicators of assessment quality, as long as they are used to promote close investigation of the underlying data rather than quick fixes such as heavy shrinkage. The remaining indicators proposed by Marchal et al (2003) show merely whether surveys are different from catch data: they do not show whether the assessment is good or not. Modifying an assessment to reduce log-catchability residuals, for example, may serve simply to produce a result driven largely by catch data – and this may in itself be problematic. The indicators may be objective, but there is also a danger that they could be misleading.

1.3.5 Recruitment estimation

For several stocks, recruitment estimates have been made using RCT3 (Shepherd 1997). This was the case when recruitment indices from 2006 surveys are available, or when *F*-shrinkage in XSA had relatively high weighting on the estimation of recruiting survivors. This creates some inconsistencies in the approaches used. The survey indices may end up being used twice for recruitment estimation – once in the survivors' analysis (and thus in the VPA recruitment) and again with the same survey indices in RCT3. For plaice, haddock, whiting and cod, large discrepancies have been observed in recent Working Groups in the recruitment predicted by RCT3 and the observed recruitment in XSA. In most cases RCT3 seems to overestimate recruitment and WGNSSK considers this may partly explain the overestimation of landings in the short term forecasts for these species.

A problem with the use of the power model for recruiting age groups in XSA, is that it cannot be restricted to those tuning fleets for which the use of this model is appropriate. In the present implementation of XSA the use of the power model may solve problems in some fleets while creating problems in other fleets. The fact that the *F*-shrinkage cannot be turned off for recruiting age groups has in some cases been seen to have an undesirably strong influence on recruitment estimates derived from XSA.

1.3.6 Short-term prognoses and sensitivity analyses

Short-term prognoses (forecasts) were made for all stocks for which a final assessment was presented. Half-year forecasts (to the start of 2007) were produced for the industrial stocks in order to give ACFM further information on which to base advice in the current situation of low biomass. These were based on survivors' estimates at the end of the second quarter in 2006 from Seasonal XSA or SMS, rolled forwards to the start of the first quarter in 2007 using assumed mortality and weights-at-age.

Forecasts in all other cases were based on initial stock sizes as estimated by XSA (in a number of cases supplemented with separate recruitment estimates as described above), natural mortalities and maturity ogives as used in the XSA, and mean weights at age averaged over recent years (normally 3). For haddock, the mean weight-at-age of the large 1999 and moderate 2000 year-classes in the forecast was modelled using a fitted growth curve. Fishing mortalities-at-age in forecasts were taken to be either the 2005 values, or a scaled or unscaled mean *F*-pattern over the most recent 3 years (depending on whether or not mean *F* showed a recent trend). Forecasts and corresponding sensitivity analyses were undertaken using either the Aberdeen suite of forecast programs, the MFDP/MFYPR software, or more recent implementations in the FLR suite. Where the latter have been used, they have been cross-checked with the equivalent standard software – an example of this is given in Section 10 (North Sea sole).

Short-term forecasts have been given on a stock basis, which in some cases includes more than one management area. For management purposes the catch forecast has been split by Sub-area and Division on the basis of the distribution of recent landings.

1.3.7 Stock-recruit modelling and medium-term projections

Standard medium-term projections were not performed for any stock at this year's WG, as there was no specific requirement to do so. For several stocks management evaluations were carried out (see Section 16), but as these incorporate management reactions to stock events, they cannot be considered as traditional medium-term stock projections. Stock-recruit modelling for these evaluations was carried out using a number of approaches, as summarised in Section 16.

1.3.8 Mixed-fisheries modeling

In an effort to address the need for mixed fishery advice, ICES established the Workshop on Simple Models for Mixed Fishery Management (ICES-WKMIXMAN 2006) which met in January 2006. This group reviewed the history of mixed-fisheries modelling, and identified the Fcube approach (Ulrich et al, 2006) as a potential appropriate framework for future development in relation to fleet and fishery-based management advice. Fcube addresses issues created by conflicting single-species management objectives when technical interactions occur between stocks. The general idea behind Fcube is to compare actual catches of individual fleets for a given level of effort, and what they can legally land through their own quota share.

Most of the mixed-fisheries work undertaken at the current WG meeting resulted from the work of WKMIXMAN, as it represented an attempt to perform a 'dry run' of the Fcube methodology through an exploratory implementation for the North Sea demersal fisheries. The objectives were primarily to test the method with available data, to understand its behaviour and outcomes and to evaluate its suitability to address mixed-fisheries issues, rather than to provide finalised mixed-fisheries advice. Permission was granted by most relevant countries to use the STECF data collected during the latest 2006 subgroup meetings reviewing the impact of recent effort regulations, and these data were compiled and aggregated during the WG in a more format suitable to Fcube runs.

A number of Fcube runs have been performed, simulating various simple scenarios of effort management and fleets behaviour. These are summarised in Section 15. In the absence of reliable forecast for most stocks, simulations used data for 2003-2004 to predict effort and catch levels in 2005, and model outcomes could thus be directly compared to observed data.

Model runs showed interesting results and demonstrate the ability of Fcube to address a wide range of issues.

As a conclusion, the WG considered that the results were very encouraging, and that the approach may offer an effective way of including fleet- and fishery-based approaches into the work of WGNSSK and into the ICES advisory process.

In addition to this modelling work, analyses were performed on the STECF data made available to the WG. In particular, the accuracy of the age-disaggregated data down to the fleet and fishery level was scrutinised, showing large variations among nations. A discussion was initiated about the necessity and feasibility of collecting these data in the North Sea.

1.3.9 Management plan evaluations

ICES have a standing requirement (see generic ToR 2 above) to evaluate current management plans for a number of stocks, and (where appropriate) suggest improvements. Section 16 of this report contains analyses and WG conclusions on management-plan evaluations for the following stocks (all North Sea, except Northern Shelf saithe): haddock, cod, saithe, plaice, sole, sandeel and Norway pout. These have been addressed using a variety of methods, as explained in detail in Section 16.

1.3.10 Estimation of biological reference points

Biological reference points are intended to remain unchanged from year to year, **unless** substantial changes occur in the data used (e.g. if discards are included for the first time) or the method employed. The only stock for which this is the case this year is Norway pout (Section 5), for which a new assessment method was used (SMS; see Section 1.3.3) that led to substantial revisions in recruitment estimates. The revisions are explained in full in Section 5. No other re-estimations were deemed necessary.

1.3.11 Software versions

The following table lists the versions of each item of software that was used by the WG.

SOFTWARE	PURPOSE	VERSION
ASPIC	Surplus-production modelling.	Unknown (most recent available version is 5.15).
B-ADAPT	Catch-at-age analysis with estimated misreporting	Compiled 13/09/2006.
FLR	Fisheries toolbox in R: assessments, forecasts, management-plan evaluations.	Core versions 1.3.1 and 2.0 plus *ad hoc* additions.
INSENS	Generation of input files for Aberdeen Suite programmes.	Compiled 20/05/2002.
MFDP	Short-term forecast.	Unknown.
MFYPR	Yield-per-recruit analysis.	Unknown.
RCT3	Recruitment estimation.	Compiled 26/08/1996.
REFPOINT	Calculation of reference points and yield-per-recruit.	Compiled: 12/06/1997.
RETVPA00	Retrospective analysis for XSA.	Compiled 12/06/2002.
SMS	Catch-at-age analysis with a stochastic multi-species model	September 2006.
SURBA	Survey-based analysis.	3.0 (compiled 02/09/2005).
SXSA (Seasonal XSA)	Catch-at-age analysis for seasonal fisheries.	Compiled 01/09/2004.
VPA95 (Lowestoft VPA suite)	Catch-at-age analysis (separable VPA, Laurec-Shepherd tuning, XSA).	Compiled 08/06/1998.
WGFRANSW	Short-term forecasts and sensitivity analysis.	1.0 (compiled 22/05/2001).

1.4 Working papers and relevant reports

1.4.1 Working documents

23 working documents were submitted to the 2006 meeting of WGNSSK. Numbered in the order in which they were received, they are as follows:

WD 1: Rätz, H.-J. and Kafemann, R. German otter trawl board fleet as tuning series for the assessment of saithe in IV, VI and IIIa, 1995–2005.

WD 2: Kraak, S. B. M., Bolle, L. J. and Rijnsdorp, A. D. The determination of biomass reference points for North Sea plaice: The influence of assumptions about discards, weight, maturity and stock-recruitment relationships. ICES CM 2005/V:18

WD 3: Kraak, S. B. M. and Daan, N. The performance of XSA when exploitation varies between sub-areas.

WD 4: Quirijns, F. Catch and Effort data of plaice and sole in the North Sea: bringing different data sources together.

WD 5: van Damme, C., Bolle, L., Dickey-Collas, M., Mimpen, R., Fox, C., Munk, P., Fossum, P. and Kraus, G. Annual egg production estimates of North Sea plaice.

WD 6: Machiels, M. A. M., Kraak, S. B. M. and van Beek, F. A. Evaluation of a management plan as proposed by the European Commission in 2006 for fisheries exploiting stocks of plaice and sole in the North Sea.

WD 7: Borges, L., Kraak, S. B. M. and Machiels, M. A. M. Stock assessment of North Sea plaice using a Bayesian catch-at-age model.

WD 8: Folmer, O. Description and revision of Kattegat survey indices for plaice in IIIa.

WD 9: Maxwell, D. L. and Mitchell, R. P. North Sea Haddock maturity from the 3rd quarter UK (England and Wales) Groundfish Survey - can DCR estimates help the working group?

WD 10: Ulrich, C. and Hamon, K. Effects of changes in commercial tuning fleets for the plaice IIIa.

WD 11: Dobby, H. and Bailey, N. Harvest rates for Nephrops.

WD 12: Boje, J. and Nielsen, E. 0-group survey for plaice in Kattegat (IIIaS) 1985-2005.

WD 13: Storr-Paulsen, M. and Hamon, K. Weight-at-age relation between survey and landings for plaice in IIIa+22 1991-2005.

WD 14: Hamon, K. and Ulrich, C. Effect of changes in stock delimitation for the plaice IIIa.

WD 15: Nielsen, E. and Boje, J. Maturity at age for plaice in Skagerrak and Kattegat (IIIa).

WD 16: Dickey-Collas, M., Pastoors, M. A. and van Keeken, O. A. Precisely wrong or vaguely right: simulations of the inclusion of noisy discard data and trends in fishing effort on the stock assessment of North Sea plaice.

WD 17: Laurenson, C. North Sea Stock Survey 2006.

WD 18: Holmes, S. J. Simulation based evaluation of the cod recovery plan with respect to the North Sea and Skagerrak.

WD 19: Vigneau, J. Preliminary analysis of Plaice VIId stock

WD 20: Darby, C. D. Regional differences in the dynamics of the whiting “stock” in ICES Sub-area IV and Division VIId.

WD 21: Nielsen, E., Boje, J., Ulrich-Rescan, C. and Støttrup, J. A brief summary of plaice biology and stock relations in the Kattegat-Skagerrak area.

WD 22: Degel, H., Nedreaas, K. and Nielsen, J. R. Summary of results from the Danish-Norwegian fishing trials autumn 2005 exploring by-catch levels in the small-meshed fishery in the North Sea targeting Norway pout.

WD 23: Nielsen, J. R. and Madsen, N. Gear technological approaches to reduce un-wanted by-catch in commercial Norway pout fishery in the North Sea.

The following brief sections summarise these papers, and where relevant, the WG discussions about them.

WD 1: Rätz, H.-J. and Kafemann, R.

Summary

In 2004 the German saithe fleet used for tuning in the saithe assessment consisted of 7 vessels. In 2005, this tuning fleet was reduced to 6 vessels. The decreased number of vessels may reflect the poor market situation for saithe.

In the first quarter 2005 two freezer trawlers were engaged in the fishery for the first time. They created discards in the order of 720 t and were excluded from the tuning fleet. No discards occurred during the sampling trips on board the fresh fish trawlers included in the tuning series.

For 2005 the German fleet reported increased landings of about 12,800 t of saithe. This landings represent a continuation of the low quota utilization of about 79%. In 2003 and 2004 the quota uptake remained at 50% only.

The CPUE varied throughout the time series. Compared with the relatively stable period 1995-1999 the catch rates in 2000-2002 almost doubled. In 2003, the CPUE decreased by 30%. In 2004 and 2005, the mean CPUE increased again and exceeded the high level observed recently.

The geographical distribution of the quarterly aggregated landings shifted during recent years. Since 2003 the northern fishing grounds seem to have been more and more avoided by the German fleet. Probably this was in order to reduce sailing time and related investments.

The abundance indices per age group showed that year classes 1992, 1996 and 1998 were strong. Especially, the 1998 year class is being still among the strongest and most important year class for recent catches. For 2005 the calculated abundance indices for age group 3 and 4 seem to indicate a poor recruitment of the stock.

- Discards of 720 t from freezer trawlers in Q1 in 2005.
- German tuning fleet consisted of 6 fresh fish trawlers in 2005.
- CPUE in 2005 is 79 % of the TAC.
- Landings concentrated in southern areas.
- Indications for low recruitment of saithe.

WD 2: Kraak, S. B. M., et al.

Summary

Many fisheries are managed with reference points. The limit biomass (Blim) is defined as the spawning stock biomass (SSB) below which recruitment is impaired or stock dynamics are unknown. Management harvest rules are designed such that Blim should be avoided with a high probability. In order to do so, management action must be taken at a higher biomass, such as the precautionary reference point Bpa. Blim is usually determined through inspection of the historic relation between recruitment and the parental SSB. However, the perception on the historic number of recruits, through the stock assessment, is influenced by assumptions on true catch numbers, e.g. discards. Similarly, the perception of the historic SSB is influenced by assumptions on fish weight and fish maturity. Different assumptions may change the shape of the stock-recruit relationship. Furthermore, decadal changes in the abiotic and biotic environment (regime shifts) may influence the recruitment potential of the spawning stock. We investigated the influence of assumptions about discards, fish weights, maturity, and the choice of the reference period with regards to possible decadal changes in the environment on the determination of Blim of North Sea plaice. The different assumptions indeed changed the shape of the stock-recruit relationship, and led to different Blim reference points. In some cases Blim was close to the lowest observed SSB, in other cases recruitment seemed to have been impaired at observed larger SSBs. We recommend that the calculation of reference points be based on stock assessments that incorporate improved biological realism and improved discard estimates and that the reference period for this calculation correspond to external insights about decadal changes in ecosystem productivity. We also note that in order to be internally consistent the actual values of the reference points should be re-calculated each time that the annual stock assessment results in a (major) change in perception of the historic stock status.

WD 3: Kraak, S. B. M. and Daan, N.

Summary

Through a simulation study we investigated whether XSA can monitor true stock developments in the case that the stock is being fished at different levels in different sub-areas of the total stock's distribution area. Such a situation exists when fishing intensity has been reduced in part of the stock's distribution area, such as appears to be the case with the exploitation of plaice in the northern parts of the North Sea. The situation also exists in the case of closed areas, such as the plaice box.

We constructed a simple model in which the population dynamics was simulated under exploitation levels that could be varied independently in two sub-areas. The simulated catch data and a simulated abundance index were fed into XSA, to investigate how well the true (known) stock development could be assessed. XSA was run with exact and true catch numbers and a tuning index that reflected true abundance exactly. This way any discrepancy between the true stock development and the perceived stock development must be caused by the choice of the model and its assumptions.

We ran three types of simulations.

1) Fishing mortality remains constant in one sub-area and is gradually reduced by 60% over the last 5 years in the other sub-area. Migration occurs between the two sub-areas, which are equal in size (i.e. have equal recruitment).

2) Fishing mortality remains constant in one sub-area and is abruptly reduced to zero and stays zero in the last 5 years in the other sub-area. Migration occurs between the two sub-areas. The closed sub-area is smaller than the sub-area that remains open to fishing.

3) Fishing mortality remains constant in sub-area 1 and is abruptly reduced to zero and stays zero in the last 5 years in sub-area 2. Migration occurs in one direction only; all fish recruit in sub-area 2 and immigrate into sub-area 1. This mimics the closure of the plaice box.

In each case the catch data fed to XSA were total catch data (ignoring sub-areas). The tuning index was simulated in two ways: either representing the total area or representing only the area where fishing remained constant.

In all three cases XSA appeared to be able to estimate correctly the developments in the (total) stock, in terms of fishing mortality, SSB, and recruitment. But the estimates were correct ***only*** if the tuning series reflected abundance of the total stock's distribution area ***and*** with a low degree of "shrinkage".

The implication is that XSA ***must*** be tuned with indices that reflect abundance in the whole stock's distribution area in a representative way. If the tuning index does not cover a closed sub-area or a sub-area with progressively declining fishing pressure proportionally to the size of the area, XSA will overestimate fishing mortality and underestimate SSB, and will therefore miss out on registering the desired effects of management regulations such as area closure or effort restriction. Of course XSA will neither be able to pick up trends in fishing mortality under a strong "shrinkage" assumption.

Comments

This is know as the "dynamic pool assumption" of XSA.

WD 4: Quirijns, F.

Summary

In stock assessment of commercial fish stocks, the terminal fishing mortality rates are generally estimated by tuning the estimated stock numbers to independent estimates of the stock using research vessel survey data and catch per unit of effort (CPUE) series of commercial fleets. Commercial CPUE series generally show a better performance for the older age groups, while the research vessel survey data show a better performance for the younger age groups. However, the potential of bias in commercial CPUE series has raised substantial concern (Gulland 1964;Harley, et al. 2001;ICES 1988; 1995).

The ICES Assessment Working Group on Demersal Stocks in the North Sea and Skagerrak used both survey data and commercial CPUE data until the mid 1990s. The commercial CPUE was calculated as the ratio of the annual landings over the total number of fishing days of the fleet. At that time, however, it was realised that the commercial CPUE data of the Dutch beam trawl-fleet, which dominated the fishery, were likely to be biased due to quota restrictions (Pastoors, et al. 1997). Vessels were reported to adjust their fishing patterns in accordance to the individual quota available for that year. Fishermen reported to leave productive fishing grounds because they lacked the fishing rights and moved to areas with lower catch rates of the restricted species with a bycatch of non-quota, or less restricted species.

Wageningen IMARES carries out a project to improve the use of commercial catch and effort data in order to develop improved CPUE series, which give a reliable estimate of the actual trends in stock size (F-project, 2002-2007). Data collected and compiled in this project are described in the present working document.

WD 5: van Damme, C., et al.

Summary

The annual egg production (AEP) method was applied in 2004 to North Sea plaice, using the results of the ICES PGEGGS ichthyoplankton survey and local sampling of plaice fecundity. The results of studies from the 1980s were also reworked using similar methods. A clear seasonal progression in plaice spawning was seen. The AEP method supports the current ICES XSA stock assessment both in terms of the relative trend in SSB and the current absolute biomass (140 to 180 k tonnes in 2004). The decline in SSB from 1988 to 2004 was approximately 60% as estimated by XSA, and was 50% as estimated by AEP. The AEP also suggests that most of this decline in SSB occurred in the Dogger Bank area and the German Bight areas.

WD 6: Machiels, M. A. M., et al.

Summary

According to the EC, the stocks of plaice and sole in the North Sea are currently being fished at unsustainable levels. The Commission of the European Community has therefore proposed a long-term management plan for the fisheries exploiting these stocks, which is designed to gradually adjust the level of fishing activity so as to achieve greater catches, larger and more stable stocks and more profitable fisheries (5403/06 PECHE 14). The plan defines target levels of annual fishing mortality of 0.3 for plaice and 0.2 for sole. These are values which, according to scientific advice, will allow higher yields for a given level of recruitment, reduce discarding, and allow a reduced biological risk to the fish stocks. The tools to achieve these objectives are the same as those in the other long-term plans already in place. Fishing mortality will be reduced by 10% year-on-year until the target levels have been reached, while annual variations in Total Allowable Catches (TACs) will be kept within limits (15% up or down). Other measures will involve the regulation of fishing effort via fishing days at sea which are supposed to change in proportion with the change in sole fishing mortality (before the 15% TAC change limitation).

This paper results from a request to evaluate the management plan as proposed by the EC. For that purpose a simulation model was developed, which contains several modules. The operating module simulates the true stock and dynamics of the fishing fleet. An observation module mimics the indices generated by fisheries-independent surveys and the observed catches and catch at age composition from the commercial catches. Based on this information a stock assessment using the XSA procedure is executed, which results in perceived numbers at age and fishery mortality rates per age group. The assessment results are inputs for the harvest control rule (HCR) function, which calculates a TAC and the maximum number of days at sea.

Spatial and seasonal differentiation in stock abundance and fleet effort allocation was not included, the two stocks are exploited by a beam trawl fleet, which consists of the combined Dutch and UK fleet. The operating model has been conditioned using data from the ICES working group on demersal stocks in the North Sea and Skagerrak (WGNSSK), by calibrating catchability and recruitment levels from the historical data. The behaviour of the fishing fleet was simulated using a number of options on the fisher’s response to the annual management measures. This fleet behaviour is uncertain and therefore several scenarios were formulated

Results show that through the plan proposed by the EC, F target levels have been reached in 2015. At the same time the effort allowed (maximum number of days at sea) reduces to about 50% of its current (=2006) level. SSB of both species will on average increase and the risk that SSB is below Bpa in 2012 is less then 20%. Under the assumption of a Ricker type stock recruitment relationship, average recruitment until 2015 shows no trend. Assuming a Beverton and Holt stock recruitment function results in a positive trend for the recruitment. Average TACs and landings vary depending on the scenario used for a run. TACs and landings for sole seem to level of at 14000-15000 tons. For plaice TAC and landings increase on average with 4000 tons per year at the end of the simulation period (2014).

WD 7: Borges, L., et al.

Summary

A statistical catch at age model was created in a Bayesian framework to assess the North Sea plaice stock. The model is based on the code made available by Azevedo (2004). The model runs in a WinBUGS environment, a free available software. The model is estimated using the Markov Chain Monte Carlo (MCMC) approach with Gibbs sampling. The model was run for two chains with 50000 iterations each and sampled every 100 iterations to ensure uncorrelated

results. Burn-in period, where the MCMC chain is still stabilizing, was taken as the first 1000 iterations.

The Bayesian statistical catch and age model developed incorporates all options taken in the 2005 North Sea plaice assessment by the ICES WGNSSK. The model is based on the total international catch at age data (70% of which are Dutch catches; 1-10 ages, 1957-2004) and three survey indices: Bottom Trawl Survey with Isis (BTSI, 1-9 ages, 1985-2004) and Tridens (BTST, 2-9 ages, 1996-2004) vessels and Sole Net Survey (SNS, 1-3 ages, 1982-2005). The model considers a separable fishing mortality, the product of selectivity at age and annual fishing level. Furthermore, the Bayesian model assumes constant catchability by each survey.

The Bayesian catch at age model also incorporates five uniform prior distributions for selectivity at age, natural mortality, recruitment, initial population size and catchability per survey.

The results of the final Bayesian model do not differ substantially from those obtained by the 2005 ICES working group. The Bayesian F estimates are in general smaller than the WG estimates, particularly at the beginning/end of the time series where the credible intervals do not overlap with the WG estimates. Regarding recruitment, both models give very similar results except in the last year, where the Bayesian model overestimates recruitment. The spawning stock biomass estimated by the Bayesian model is slightly higher than the XSA estimates, except in late 90's. The majority of the XSA estimates are outside the 95% credible intervals estimated.

WD 8: Folmer, O.

Summary

In 2005, survey indices for plaice from KASU-1 and KASU-2 were revised. The main reason for this was because a new extraction program had to be written for a new database. During the process of transferring data to the new data base and programming the new extraction program, various typing programming mistakes occurred. In 2006, the whole process was carefully scrutinised for detecting such errors and come with more reliable survey indices. This note documents the changes and explains differences between the indices. The revised indices are also described.

WD 9: Maxwell, D. L. and Mitchell, R. P.

Summary

Estimates of haddock maturity from the 3rd quarter UK(England & Wales) Groundfish Survey (EngGFS) are provided. They are based on data processing originally used for the EU data collection regulations. The results show that the working group ogive is in the lower quartile of EngGFS estimates for ages 1 and 2, and closely matches them for ages 3 upwards. They also provide information on the year-to-year variation, which could be used in sensitivity testing of forecasts.

Comments

The WG supports this work, but raised a few concerns. For example, it was unclear to the WG to what extent the differences between the ENGGFS Q3 and the WG maturity estimates (the latter based on the IBTS Q1 survey) were due to seasonal effects. Furthermore, it was unclear, given that haddock spawn in Q1, how useful estimates are based on data from Q3, outside the spawning period. Any further analysis should address these concerns.

WD 10: Ulrich, C. and Hamon, K.

Summary

This study investigates the impact of using alternative commercial tuning series for the assessment of plaice IIIa. Input data have been revised, and for each fleet we test three subsets of trips, two effort measures and 4 standardisation methods (72 runs). Runs are compared through single fleets XSA using FLR, and their performance is evaluated with three objective synthetic indices. Main results are that the SPALY should not be kept, and that fishing days standardised by kW are performing best for all fleets. We propose thus a revision of the commercial tuning series to be used in the assessment of plaice in IIIa.

Comments

Concern was expressed on the use of the suggested performance and quality objective synthetic indices that synthesise log q plots and retrospective analyses. Final evaluation of tuning indices should be made independent of the landings ata age matrix.

WD 11: Dobby, H. and Bailey, N.

Summary

Comments

WD 12: Boje, J. and Nielsen, E.

Summary

Plaice in IIIa spawns in Skagerak and Kattegat. Eggs and larvae drift pelagic in the water masses and their distribution depends on the present wind and current regimes (Nielsen et al. 1998). Spawning occur in late February to late March and the following pelagic phase of the eggs and larvae are found to be approximately 30 days. Nursery grounds for 0-group plaice are found on shallow water (0-2 m) along the coasts in Kattegat and in the Danish Belt Sea. (Area 22). Since 1985 a survey has been conducted to monitor the 0-group abundance at the East coast of Jutland in Kattegat by DIFRES research vessel HAVKATTEN. In the stock assessment of plaice in IIIa recruitment estimates for stock prognosis have formerly been assumed an average of the estimated recruitment derived from the analytical assessment at age 2. Thus no survey observations have formerly been used in this procedure. The use of 0-group indices in the HAVKATTEN survey is evaluated with regard to the stock assessment of plaice in IIIa.

The HAVKATTEN survey measures a high variability in year-class strength between the surveyed areas in Kattegat. This means that in some years strong year-classes are observed in certain areas, while not in other areas and vice versa. However, within the area covered by the survey, a certain variability in recruitment strength must be expected due to environmental variability between localities and years and interactions of those. This is probably the case for changes in drift patterns of eggs and larvae caused by different wind and water current conditions between areas. As it is assumed that recruits in all the surveyed areas 1-7 have common origin, an appropriate index of 0-group is consequently to include all areas surveyed by HAVKATTEN. As the GLM standardised 0-group CPUE perform in agreement with both IBTS and KASU surveys, we suggest the use of the standardised CPUE series.

Comments

WD 13: Storr-Paulsen, M. and Hamon, K.

Summary

To improve plaice assessment in area IIIa the possibility of generating a stock weight-at-age matrix was investigated. Weight-at-age data from the International bottom trawl survey (IBTS), Baltic International Trawl Survey (BITS) as well as weight at age data from the commercial samples were revaluated. As survey weight at age is only available to age 6 a weight in stock had to be compiled from both survey data as well as commercial. There were conflicting signals between survey data for age group 5 and 6.

Comments

The WG suggested to use an average between the surveys in mean weight for age group 1-4. It was also noted that the mean weights from the KASU survey should be corrected for the length distribution in the total sample.

WD 14: Hamon, K. and Ulrich, C.

Summary

It has been suggested that the large variations in F estimates for plaice IIIa could be partly due to the misspecification of stock boundaries to the east. This is supported by biological evidence of mixing populations betweens the Kattegat and the Belt Sea (area 22). The catch at age data for the area 22 was made available for the period 1995-2005 using Kattegat harbour samples, and the commercial and tuning fleets data could also be extended to cover the Belt Sea. Assessment runs have been performed with and without the inclusion of area 22 in the stock, and their performance was compared using synthetic objective indices. We show that the fluctuations in F pattern could be reduced , and that the assessment perform best with extended catch at age and tuning fleets.

WD 15: Nielsen, E. and Boje, J.

Summary

Maturity data from IBTS 1st quarter surveys was compiled for a maturity ogive for the assessment of plaice in IIIa instead of the knife-edge maturity formerly assumed.

A difference in maturity at age are observed between Kattegat and Skagerrak Plaice mature at younger age in Kattegat than in Skagerrak. This could indicate that the two areas belong to different spawning grounds. Although maturity varies from year to year in both areas, no trend is obvious over the time. Therefore it is suggested that a fixed maturity ogive is applied to the stock assessment of plaice in IIIa.

Although it is recognised that the maturity ogive differ between Kattegat and Skagerrak, a combined ogive is suggested weighting the area ogives by catches in the respective areas. The proposed ogive is therefore computed as an average of the two areas weighed by the average catches over the entire period 1993-2005. Even though the resulting ogive does not fit an ideal sigmoid curve, the single maturity proportion by age represents the best estimates available and it is therefore not considered appropriate to smooth the estimates.

Comments

The compilation procedure with respect to sampling was questioned; therefore a new maturity-at-age was compiled during the meeting also from IBTS data.

WD 16: Dickey-Collas, M., et al.

Summary

The ICES stock assessments of North Sea plaice have routinely been carried out with Extended Survivors Analysis (XSA) based on landings and survey data only. Recently, the stock assessments have included data on discarded young fish that are sampled with a high variance. Simulated populations with North Sea plaice-like characteristics were used to explore the dependency of the perceived stock dynamics to the inclusion of discards data at different levels of sampling noise. There could be a trade-off between bias and precision with the inclusion of noisy discard data in the stock assessment. This trade-off has not been investigated or quantified in any recent study. Simulated populations were assessed using the same methods and settings to that used by the ICES assessment working group. The sensitivities of the results were tested against different trends in fishing effort and recruitment and different scenario for “shrinkage” (i.e. the way in which the past is used to estimate the most recent fishing mortalities).

Within the bounds of the assumptions of the simulations, this study showed that the perception of population trends from an XSA stock assessment can be biased when there are trends in fishing effort: decreases in fishing effort lead to underestimation of SSB and overestimation of fishing mortality. When discards were not included in the assessment, bias in SSB was greatest when effort was decreasing and bias in F was greatest when effort was increasing. The biases in SSB and fishing mortality were largely removed by the inclusion of discard data but at a substantial loss of precision. If fishing effort shows clear trend and discards are substantial and at the same time noisily estimated the recent trend from the target population may be hard to track with an XSA type of assessment methodology.

No summaries were provided for the following documents:

WD 17: Laurenson, C.

WD 18: Holmes, S. J.

WD 19: Vigneau, J.

WD 20: Darby, C. D.

WD 21: Nielsen et al.

WD 22: Degel et al.

WD 23: Nieslen and Madsen

1.4.2 Background documents

A number of relevant background documents were considered by the WG, and in many cases have been cited widely in the current report. The list of such documents is given below:

BD1: Horwood, J., O’Brien, C. M. and Darby, C. D. (2006) North Sea cod recovery? *ICES Journal of Marine Science*, 63: 961-968.

BD2: ICES-WGRED (2006). Report of the Working Group on Regional Ecosystem Descriptions. ICES CM 2006/ACE:06.

BD11: EU-STECF Subgroup SGRST: March. Citation pending.

BD12: EU-STECF Subgroup SGRST: June. Citation pending.

BD13: ICES-WKNEPH (2006). Report of the Workshop on *Nephrops* stocks. ICES CM 2006/ACFM:12.

BD14: ICES-SGRECVAP (2006). Report of the Study Group on Recruitment Variability in North Sea Planktivorous Fish. ICES CM 2006/LRC:03.

BD15: EU Nantes meeting (June).

BD16: STECF (2006). Report of the Scientific, Technical and Economic Committee For Fisheries. Evaluation of the report of the Ad Hoc Working Group on Sandeel Fisheries "Estimate of the Abundance of the 2005 Year-class of North Sea Sandeel". [BD16]

BD17: ICES-WKDRCS (2006). Report of the Workshop on the Decline and Recovery of Cod Stocks throughout the North Atlantic, including trophodynamic effects. ICES CM 2006/OCC:12.

BD18: ICES-WGMG (2006). Report of the Working Group on Methods of Fish Stock Assessment. In press.

BD19: ICES-SGMAS (2006). Report of the Study Group on Management Strategies. ICES CM 2006/ACFM:15.

BD2: Rijnsdorp, A. D., Daan, N. and Dekker, W. (in press) Partial fishing mortality per fishing trip: a useful indicator of effective fishing effort in mixed demersal fisheries. *ICES Journal of Marine Science*.

BD3: Ulrich-Rescan, C. and Nielsen, E. (2005) Should western Baltic plaice be included in plaice IIIa assessment? Working Paper to the 2005 meeting of the ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak.

BD4: ICES-IROC (2006). ICES Report on Ocean Climate 2005. *ICES Cooperative Research Report No. 280*. 53 pp.

BD5: ICES-AMAWGC (2006). Report of the Annual Meeting of Assessment Working Group Chairs. ICES CM 2006/ACFM:17.

BD6: ICES-SGRAMA (2006). Report of the Study Group on Risk Assessment and Management Advice. ICES CM 2006/RMC:04.

BD7: ICES-WKMIXMAN (2006). Report of the Workshop on Simple Mixed Fisheries Management Models. ICES CM 2006/ACFM:14.

BD8: ICES-PGCCDBS (2006). Report of the Planning Group on Commercial Catch, Discards and Biological Sampling. ICES CM 2006/ACFM:18.

BD9: ICES-WGFTFB (2006). Report of the Working Group on Fish Technology and Fish Behaviour. ICES CM 2006/FTC:06.

The background documents referred to as such are listed below, along with either the abstract or a summary from a WG member. This section is by no means a comprehensive overview of all the extant appropriate literature, but covers only those papers and reports for which concise summaries were available to the WG.

BD 1: Horwood, J., et al. (2006)

Abstract

Recovery of depleted marine, demersal, commercial fish stocks has proved elusive worldwide. As yet, just a few shared or highly migratory stocks have been restored. Here we review the current status of the depleted North Sea cod (*Gadus morhua*), the scientific advice to managers, and the recovery measures in place. Monitoring the progress of North Sea cod recovery is now hampered by considerable uncertainties in stock assessments associated with low stock size, variable survey indices, and inaccurate catch data. In addition, questions arise as to whether recovery targets are achievable in a changing natural environment. We show that current targets are achievable with fishing mortality rates that are compatible with international agreements even if recruitment levels remain at the current low levels.

Furthermore, recent collations of data on international fishing effort have allowed estimation of the cuts in fishing mortality achieved by restrictions on North Sea effort. By the beginning of 2005, these restrictions are estimated to have reduced fishing mortality rates by about 37%. This is insufficient to ensure recovery of North Sea cod within the next decade.

BD 2: Rijnsdorp, A. D., et al (in press)

Abstract

Effort management has been proposed as an alternative for quota management in mixed demersal fisheries. It requires a metric to estimate the fishing mortality imposed by a given quantity of nominal fishing effort. Here, we estimate the partial fishing mortality rate imposed by one unit of fishing effort (Fpue) during individual fishing trips and explore the usefulness of this indicator for managing North Sea beam trawl fishery vessels >300 hp targeting sole (Solea solea) and plaice (Pleuronectes platessa). Fpue is positively related to vessel engine power, and increased annually by 2.8% (sole) and 1.6% (plaice). The positive trend was due to an increase in skipper skills and investment in auxiliary equipment, the replacement of old vessels by new ones and, to a lesser extent, to upgrade engines. The average Fpue imposed per day at sea by a 2000 hp beam trawler was estimated to be 1.0 x 10-5 (sole) and 0.6 x 10-5 (plaice), and it showed substantial seasonal and spatial variations. The Fpue of sole and plaice were negatively related in summer and showed no relationship in winter. The existence of predictive seasonal and spatial patterns in Fpue opens up the possibility of fine-tuning management by directed effort restrictions and un-coupling management of plaice and sole.

BD 3: Ulrich-Rescan, C. and Nielsen, E. (2005)

Summary

This paper was a WD to the 2005 meeting of WGNSSK, and presented early work on the issue of whether or not to include the Belt Sea in the stock definition of plaice in ICES Division IIIa. These analyses, and further developments thereof, are discussed in full in Section 7 of the current report.

BD 4: ICES-IROC (2006)

Summary

The ICES Report on Ocean Climate is a product of the ICES Working Group on Oceanic Hydrography. It summarises results from long-term observation stations, in terms of sea-surface temperature and salinity, and less commonly, sea-bottom temperature and atmospheric conditions. These are presented in terms of regions: those of main interest to WGNSSK are the Faroe-Shetland Channel, the northern North Sea, the southern North Sea, and the German Bight.

The report's executive summary states that "the upper layers of the North Atlantic and Nordic Seas were warmer and more saline then the long-term average", and that "the trend in the last decade (1995-2005) has been of warming and increasing salinity in the upper ocean." The area description for the North Sea includes the comment that "the sea-surface temperature (SST) of the North Sea has been increasing since June 2001", and reminds the reader repeatedly that SST is above the long-term average (1971-2005). The report concludes that the North Sea is continuing to warm, and that "this will have significant effects on the ecosystem dynamics".

Whilst the long term trend is one of rising temperatures (see, for example, the UK Climate Impacts Partnership website at http://www.ukcip.org.uk/climate_change/default.asp), the natural variability on climate makes it difficult to make predictions from year to year. Looking more closely at the data it can be seen that average annual temperatures have fallen in three

out of the four areas listed above since a high in 2003, and on the basis of a simple linear projection one could conclude that temperatures will return to the long-term mean in one or two years.

However, the data already available for 2006 shows that whilst temperatures in the southern North Sea during March-June were actually cooler than normal, the extremely warm conditions experienced during July 2006 make it likely that overall the average temperatures in 2006 will be warmer than normal.

While the long-term trends in ocean climate are readily understood, the effect of such warming on the ecosystem in general, and on commercially-important fish stocks in particular, are very poorly understood. Causal mechanisms linking climate with fish population dynamics are not clear, so statements about effects on ecosystem dynamics must similarly be treated with caution.

BD 5: ICES-AMAWGC (2006)

Summary

Now in its second year, AMAWGC is a forum for assessment Working Group (WG) chairs to meet with the ACFM chair and other invited participants (for example, survey WG chairs) in order to discuss recent developments and the approach to be taken in the following year for each WG. The meeting is held early in the year to enable as much time as possible for WG chairs to implement any changes to WG practice that might be deemed necessary. It has proved to be a very useful meeting, both for giving a clear steer to WG chairs as to what is expected of their groups, and for ensuring that WGs provide consistent input to ACFM and the subsequent advisory process.

The meeting was structured around a series of key themes for assessment WGs in the coming year, as follows:

Integration of ecosystem issues in fisheries advice. It is very clear that environmental change is a key factor in driving fish stock population dynamics, but thus far it is proved extremely difficult to incorporate this knowledge into management advice. There are a number of reasons for this for example, the environment itself is difficult to predict, and the causal mechanisms linking changes in the environment and the stocks are seldom obvious. However, there are strong incentives to address this problem: as well as scientific interest in understanding processes, ICES' customers are increasingly calling for ecosystem aspects to be considered in advice.

The Working Group on Regional Ecosystem Descriptions (ICES-WGRED 2006) met at the same time as AMAWGC and participated in several joint plenary sessions. The intention was that WGRED would be able to suggest to WG chairs tractable areas in which progress could made, along with advice on how to do it. As it turned out this has proved to be impossible; there is a lack of quantitative knowledge that could be used in the current management system. WGRED's conclusions were limited to such narrative statements as "gadoid growth may be slower this year", which are very difficult to build into advice (although it would be possible if advice was allowed to be more probabilistic – see below). Over the next year WGRED will be collating case studies of management systems robust to environmental change. In the meantime, direct incorporation of environmental effects has been largely postponed for many WGs.

Management strategy evaluations. A review of the recently-held Study Group on Management Strategies (ICES-SGMAS 2006) was presented to AMAWGC. ICES have a standing requirement to evaluate management plans and harvest control rules for North Sea cod and haddock, and Northern Shelf saithe, and AMAWGC have agreed that this will be done by

WGNSSK this year (following the approach advised by SGMAS). It is hoped that much of this can be done intersessionally, but an element of restructuring within WGNSSK will be required to enable key participants to focus on these kinds of analysis rather than assessment work. Several methodological problems also need to be addressed, such as unrealistic projections of stock size, and the issue of risk evaluation.

Survey-assessment interaction Abundance indices from research-vessel surveys are widely used in assessment WGs for calibrating information from the commercial fishery. Currently most of these data are used quite uncritically, for the simple reason that those who put the indices together are not usually the same people who perform the assessments. The ACFM chair is attempting, through AMAWGC, to improve the liaison between assessment and survey WGs. The meeting suggested several ways in which this could be done, such as assessment and survey WG chairs attending parts of each other's meetings, or dedicated sessions at the ICES Annual Science Conference, and these avenues are being explored.

Mixed-fisheries modelling. A review of the recent Workshop on Simple Mixed Fisheries Management Models (ICES-WKMIXMAN 2006) meeting was presented. WKMIXMAN concluded that the current software for running mixed-fishery forecasts (MTAC) was inappropriate, and that due consideration should be given to an alternative approach (F3) which avoids some of the more obvious pitfalls of MTAC. It was decided that in the first instance a dry run of this method would be carried out by allocated individuals in WGNSSK, as this is the WG in which there is a) the most mixed fisheries data, and b) the greatest need for appropriate mixed-fisheries models. The results of this should not be interpreted as advice, however, as the model is still under development.

Stock assessment data collation. Last year ACFM added a new ToR to the generic list that applies to all assessment WGs; this allowed WG chairs to set cut-off points beyond which new data from the commercial fishery the previous year would not be accepted. This is intended to allow more time for preliminary assessments. AMAWGC concluded that this stipulation should also apply to mixed-fisheries data, as these are in fact the same data.

Assessment methods and WG organization. Additional ToRs for assessment WGs imply an increased workload which cannot be met unless some other aspect of the work is reduced or removed. There is a strong feeling within ICES, which is shared by most of the WG chairs, that the focus of assessment WGs should move away from traditional historical stock assessment, and towards forecasting, risk evaluation, management strategies, ecosystem issues, mixed-fisheries modelling, and (in essence) relevant and responsive management advice. This can only be achieved by implementing two main changes. Firstly, data collation and assessment work need to be shifted forwards in time to allow space within the meetings themselves for different kinds of analyses (see below). Secondly, assessments and forecasts should be probabilistic rather than deterministic – in other words, advice would say "landings of 20,000 t will lead to a 20% risk of biomass being below a predefined safe level" rather than "a fishing mortality of 0.5 will lead to landings of 20,000 t and a biomass than is below a predefined safe level". Assessments carried out in this way will be far more scientifically defensible (as they will allow for uncertainty) and will eliminate the tendency for WGs to tinker with assessment settings. The FLR package is one approach which may allow this to be done, and a tutorial workshop was held at AMAWGC to introduce the methods.

A proposal for a new timetable for WGNSSK was presented at AMAWGC. This was accepted in principal although with several caveats. Changes in structure will increase the burden of intersessional work on WG participants, and it is not yet clear whether this can be sustained. Methods are being developed for a probabilistic approach, but the idea has yet to be discussed with client customers. In the meantime, AMAWGC concluded that two or three stocks in the WGNSSK meeting should be treated as test cases for probabilistic assessments. It was also decided that the new timetable would be attempted, recognising that it may prove impractical.

Longer-term plans (roadmaps) for each of the assessment WGs were formulated. The outcome of these attempted changes is summarised in Section 1.1.1 of the current report.

Finally, AMAWGC considered the issue of data collation and coordination. The InterCatch system is intended to be used by stock coordinators to bring together data from different countries and produce the files required by the assessment WGs. There is a very strong steer from ICES that this be used this year, which will have resource implications for participating laboratories as the old systems should also be run for backup purposes. There is certainly a training need that ICES appears willing to address. The conclusions of the 2006 WGNSSK meeting regarding data collation issues are summarised in Section 1.2.5 of the current report.

BD 6: ICES-SGRAMA (2006)

Summary

The ICES Study Group on Risk Assessment and Management Advice (SGRAMA) met in Copenhagen 18–21 April 2006. The SG started its work by reviewing different approaches to risk assessment and focused on differences in the structural approach (the risk assessment framework). The SG has also started the work of identifying components of an ICES risk assessment framework. The work is a part of the group’s terms of reference a) and b). Terms of reference c) and d) have not been considered. Most approaches to risk assessment describe risk identification and risk estimation as two major components of a risk assessment framework. The SG will continue the review of different approaches and also focus on the importance of communication with managers and stakeholders. Communication will be essential in establishing the context or settings within which a risk assessment is produced, and will essential in creating a common understanding (also for the results of an assessment). The Study Group needs more participants with backgrounds from ecology, fisheries system and ecosystem effects of fishing activities. Risk assessments are multi-disciplinary and have the potential of bringing elements of ecosystem approach into fisheries advice.

BD 7: ICES-WKMIXMAN (2006)

The report of the WKMIXMAN meeting is analysed and summarised in Section 15 of the current report.

BD 8: ICES-PGCCDBS (2006)

Summary

The aim of PGCCDBS is to develop and agree procedures and protocols that can be used among Member States (MS) for coordinating the sampling of fish species for assessment purposes. These agreements are made in accordance with the Data Collection Regulation (DCR). The PG acts as a forum to develop methods and guidelines for sampling and the analysis of precision.

It was recognised that several groups had already collated Standard Operation Procedures for some activities over several years (IBTS, MEDITS etc). The PG agreed that this information should be gathered online using the wiki and that, eventually, an open website should be set up. One problem identified is translating all documents into a common language.

Following discussion regarding the ‘quality of data’ issue, one proposal was that MS’s should submit data to species coordinators for use in stock assessment and they should now attach a map showing distribution of sampling. This would enable the assessors to decide whether the data is representative of the area or whether a bias would occur. This could be identified in each WG report.

MS’s would be asked to complete a questionnaire (once) with, for example, their sampling and raising procedures etc. and it could be updated when necessary.

Lengthy consideration was given to the potential linkage between MS's national databases, a Fishframe-like database (a data warehouse system developed by DIFRES) and the development of COST (a Common Open Source Tool) which could be available to all. It was not possible to reach an agreement on the use of a Fishframe-like system. FF and COST will continue to be developed and it looks as if discussion on linkage will continue for some time.

Otolith workshops and exchanges were discussed and a recommendation that only readers who are regarded as expert should be compared with each other; specifically, readers who provide ages to assessment WGs. Also, it was considered inadvisable to compare readings using different methods from the same reader i.e. 'broken' v 'sectioned' otoliths or ilicia v otoliths in anglerfish. The results from the readers preferred method of reading should be used for comparisons. It was agreed that the inclusion of inexperienced or new readers gives an unrealistic outcome. Several otolith exchanges and workshop outcomes were presented, including the whiting otolith exchange conducted by FRS.

The PG received requests from three RCMs to consider setting up species specific workshops to give guidance on collecting and analysing maturity data. The PG considered that these requests covered two separate issues in relation to maturity sampling: a) The methodological approach to setting up the most effective sampling programme for maturity, and b) standardisation of maturity staging. Workshops will take place in 2007 to address these issues. To help move this forward it was decided that MS's should start a library of digital photographs of species at different maturity stages. These images can be compared at the workshops in 2007. Scotia is starting this collection during the current cruise.

The PG discussed the relationship between the ICES Assessment and Advisory framework, and the organisational framework which supports the Data Collection Regulation including SGRN, STECF, the Regional Coordination Meetings and the MSs themselves. Although the DCR has been set up to provide biological data for the Assessment WGs, it was felt that the flow of information and data from the DCR to the WGs was not working effectively. Under this system the WGs have little influence on the collection or delivery of data and appear to be somewhat removed from the whole process. The PG considered there was a need to develop a procedure for ensuring that WGs are more actively involved in requesting information needed and communicating problems back to the DCR system.

BD 9: ICES-WGFTFB (2006)

The WGFTFB report from its 2006 meeting contained a valuable summary of developments in the North Sea fishing fleets of potential relevance to the work of WGNSSK. This summary is reproduced in full in Section 2.1.4.

BD 10: ICES-WGRED (2006)

WGRED met in January 2006 in a parallel session with AMAWGC (ICES-AMAWFC 2006), and reported their findings to a joint plenary at the conclusion of both meetings. While their report contains interesting and valuable descriptions of ecocsystem characteristics of the seas in the ICES area, there is little on causal mechanisms linking environmental drivers with changes in fish stock dynamics. This is a current area of research that is yet to bear much tangible fruit. Regarding WGNSSK in particular, WGRED concluded that the existing models of environmental and ecosystem drivers of stock change were not yet ready to be used in the provision of management advice.

During the 2006 WGNSSK meeting, there was considerable discussion about the way forward with respect to incorporation of ecosystem considerations in stock assessment and management advice, and in particular a proposal from the ACFM Chair for a restructuring of the WG itself. This discussion is reported in full in Section 1.6 below.

BD 11: STECF Sub-Group SGRST on Fishing Effort Management (March 2006)

Summary

The main purpose of the sub-group was to continue the data-collation work that had been begun during the previous year. It also formulated conclusions on the many effort derogations which currently exist in North Sea fisheries. These were hindered by problems in compiling the database on catch for 2003 and 2004 and on effort for 2000-2004. Some data were in the wrong format, in the wrong units or unavailable. Discard data were scarce and age data not always supplied. Beam trawl data from Netherlands and Belgium was not identified by the appropriate mesh size groups. There was a problem with overlap between Scottish and English databases which was resolved eventually. There were however, only minor problems with the Scottish data.

As a result, the effort database corresponding to the basic gear groups without special conditions was largely completed but no attempt was made to start on the version including the special conditions. An initial analysis of the effort data and comparison with the 2005 output was used to check the integrity of the new version. The catch database was incomplete but work would continue in the following week. Estimation of the monetary value of each fishery could not be attempted without the catch database. For this exercise, average market prices for each species over all countries for the whole year were provided by the Commission although some concern was expressed whether this could form the basis for a meaningful economic assessment.

BD 12: STECF Sub-Group SGRST on Fishing Effort Management (June)

This meeting was open to representatives of the fishing industry and other stakeholders who were welcome to be present as observers throughout the meeting. The intentions were a) to continue data collation from March (see BD 11), and b) to review the cod recovery plan. As before, difficulties with data provision limited the extent to which the Sub-group could reach meaningful conclusions. The Sub-group was only able to provide informed opinion on the recovery plan.

BD 13: ICES-WKNEPH (2006)

WKNEPH met in Copenhagen 24-27th January 2006. The group tackled eight TORs (indicated in italics in the text below) and produced a report with five substantive sections. Several outcomes have a bearing on WGNSSK.

Feedback from the area based working groups was mixed. The concentration of technical expertise and the potential for mixed fisheries work in area was very beneficial. On the other hand, belated data collation and unrealistic TORs impaired progress. In addition, inconsistent approaches to Nephrops assessments and presentation of data by different area WGs led to difficulties for ACFM. Some cross-referencing between WG chairs would be advisable.

The identification of Nephrops metiers is progressing although even in the North Sea the method of metier definition differs between countries (eg cluster analysis of catch composition vs gear and mesh categories). WKNEPH emphasised that for such schemes to function in an effective manner, additional fields in logbooks will have to be made mandatory.

WKNEPH was optimistic that new UK legislation on the registration of buyers and sellers and the increases in a number of TACs should improve the quality of landings data for quantitative assessments over the next few years. In common with the 2005 meetings of WGNSSD and WGNSSK, WKNEPH concluded that existing age based assessment models are not suitable for Nephrop but suggested that ongoing developments in length structured and spatially structured models may provide a way forward and could be ready for when improved data are available. During discussion of biological parameters (including a review of the size of sexual maturity across FUs) the group concluded that for many stocks, insufficient growth rate information will impair assessment progress and recommended that efforts be made to gain funding for a coordinated study of growth. Updates on the ongoing estimation of precision in sampling were presented.

The group discussed a range of issues relating to UWTV surveys, the method used for providing advice for a number of Nephrops stocks. Technical issues concerning burrow counting, the relationship between survey biomass and 'exploitable' biomass, and the estimation of a precautionary harvest rate were dealt with in some detail. WKNEPH agreed that the approach suggested by STECF (using a harvest rate based on F0.1) was a helpful first step and recommended that this, and other methodological developments be progressed at a workshop in 2007 focussing on TV techniques.

An update on selectivity work was provided although it was felt that a more thorough review would be possible after the completion of a number of projects (eg RECOVER and NECESSITY).

BD 14: ICES-SGRECVAP (2006)

Purpose: To study mechanisms for the serial low recruitment from 2002 to 2004 inclusive, of autumn spawned herring, spring spawned sandeel and Norway pout in the North Sea.

The ICES study group on recruitment variability in North Sea planktivorous fish [SGRECVAP] (Chair: M Dickey-Collas, Netherlands) met in IJmuiden, The Netherlands, from 16–20 January 2006 met to:

a) Report and assess what mechanisms, both far field and in situ, could lead to severely reduced recruitment in all three species and estimate the probability that these recent recruitment events are purely coincidental.

b) Determine what data are available on the seasonal trends in hydrography, planktonic production, ichthyoplankton-predator abundance, anthropogenic influence and adult fish behaviour in the North Sea to test hypotheses for serial poor recruitment reported in TOR a and carry out preliminary testing;

c) If plausible causative links can be established, report on any candidate early warning signals that could be used to assist in determination of recruitment scenarios for short term projections of stock numbers?

SGRECVAP decided that its first report should document existing knowledge to date, determine whether there were significant common trends in the recruitment patterns of the three species, investigate potential hypotheses for trends in recruitment, and then consider the available time series data which could aid testing of the hypotheses. To consider fully the recruitment of the three target species it was decided that a broader investigation was required that accounted for the interaction of the planktivores with the plankton and the general dynamics of the North Sea ecosystem.

SGRECVAP noted that correlative studies of recruitment with environmental factors are numerous, despite early warnings in the literature that they be misleading and difficult to interpret. It is easy to find spurious correlations, because both recruitment series and environmental series have strong auto-correlations. Significant correlations do not mean causality. It is also easy to find at least one significant correlation while scanning a large number of candidate explanatory variables, which might well happen when highly multi-dimensional data become available. Therefore, correlations that do not have a strong theoretical support are prone to reveal non-significant relationships as new data become available, or when the true degrees of freedom are taken into account. Studies aiming at understanding processes are likely to produce more long-lived knowledge than exploratory correlative studies. Hence SGRECVAP was hypothesis driven and process oriented.

The common trends in the recruitment of sandeel, Norway pout and autumn spawned herring in the North Sea meant that the group needed to investigate broader signals and mechanisms that may impact across the three species and spawning seasons. Many interesting hypotheses for the variability in herring and sandeel have been previously developed but on a single species basis. These hypotheses are described in the report, but SGRECVAP also looked at hypotheses that cover the production of recruits from spawning events from autumn to spring, and from the northern North Sea to the Southern Bight. It is also clear that the North Sea cannot be treated as one unit, as the characteristics of the sea vary by area. Hence the changes in spatial trends would also be accounted for by SGRECVAP.

The meeting was successful in bringing together people of sufficiently varied expertise to enable exploration of a wide range of hypotheses. Conclusions reached at the meeting are listed below.

Conclusions

i. Time series analysis shows a decrease in the recruitment of herring, Norway pout and sandeel in recent years.

ii. The pattern in declining recruitment from 2001 is also seen in the residuals to the stock to recruit relationships, i.e. the production of recruits per spawner has also declined.

iii. The common pattern of decline in recruitment seen in the planktivorous fish is not common to the major commercially exploited fish species in the North Sea. There appears to be a cyclic, possibly decadal, pattern in recruitment when the major commercial fish species are considered (three major peaks/troughs in the TSA).

iv. Chronological clustering shows evidence for a significant shift of at least two periods of recruitment for the major commercial fish species exploited in the North Sea (1986 and 1996/97). For the three target planktivorous species considered there was a significant shift in recruitment in 2001.

v. There are spatial differences in ocean climate and plankton communities within the North Sea that are reflected in the fish communities (e.g., recruitment collapse in Norway pout in the northern North Sea, differences in sandeel abundance in the northern and southern areas, spatial difference in whiting) suggesting a more boreal system in the northern North Sea and a more temperate system in the southern North Sea. Therefore, all analysis should be spatially resolved.

vi. It is already well known that a change in the planktonic community occurred in the North Sea after the mid 1980s. Change has continued to date, on a gradual basis and is linked to the broader, and well documented, process of climate change. Reponses at other trophic levels to this gradual change in the zooplankton may result in abrupt changes. Within an abrupt change there is recognition of spatial gradients of patterns that could lead to differences in conclusions if the patterns are not analysed on the correct spatial scale.

vii. There is enough evidence to conclude that poor recruitment in herring is caused by a higher mortality of herring larvae before February of each year. The mechanisms for this are most likely poor larval feeding, predation or poor hatching condition and probably a combination of these.

viii. Whilst herring, Norway pout and sandeel show a common trend in recruitment, it cannot be assumed that the same mechanism is common for all three species. There is currently not enough information on the production of each life history stage in Norway pout and sandeel to determine the mechanisms driving recruitment. It is clear that the poor sandeel recruitment was associated with low spawning stock biomass (the stock was below Blim in 2000), this was not the case for Norway pout.

ix. More exploration is needed to investigate the hypotheses presented in this report to target ecosystem interactions, especially in the areas suggested for zooplankton, predation and quality/condition. Much of the data needed to enable this research may already exist. SGRECVAP recommends that these resources be investigated to determine availability.

x. SGRECVAP acknowledges that many of the proposed hypotheses cannot be tested without extensive use of empirical data and individual and ecosystem modelling (biophysical models and spatial trophic modelling).

It is anticipated that a second meeting of the group will take place, most likely after the Q1 IBTS survey in 2007, so as to be able to include a further two years data in any analyses.

BD 15: EU Ad Hoc Meeting of Independent Experts on Fleet-Fishery Based Sampling

No summary available.

BD 16: STECF Evaluation of Report of the Ad Hoc Working Group on Sandeel Fisheries

No summary available.

BD 17: ICES-WKDRCS (2006)

No summary available.

BD 18: ICES-WGMG (2006)

The purpose of the Working Group on Methods of Fish Stock Assessments (WGMG) is to develop and critically evaluate the models and software code used in assessments, forecasts and management simulations, and to suggest ways in which these might be improved. WGMG meets on an infrequent basis to address particular concerns raised by ACFM (the last meeting was in 2004), and it was intended that the 2006 meeting would concentrate on assessment and advice when catch data are unreliable, historical reconstruction of discard data, the continuing problem of retrospective bias, recent developments in assessment software, and reference points in long-term management strategies.

Originally intended as a nine-day meeting, WGMG was reduced to six days to allow participants to attend the ICES Symposium on Management Strategies, held subsequently in Galway.

Outcome. The meeting was poorly advertised, and as a result fewer participants attended than has been the case in the past. The course of the meeting was dictated by the interests and expertise of the participants, rather than strictly by the ToRs, and the main issues addressed were:

1. Evaluations of fisheries management plans. Several such plans are due for review by ICES this year, and WGMG considered carefully how these reviews could best be carried out. They concluded that a three-step approach was most likely to be beneficial:

a) Translate the decision process in the management proposal into a structured decision diagram. This will serve as a basis for the design of simulations and reveal holes and ambiguities in the managers' proposals.

b) Design and document the algorithm for expressing the management procedure in a simulation program.

c) Carry out the necessary procedures for quality checking and documenting that the code produces the correct results, and test that the management plan does what it is intended to do.

At each stage it is essential that there be dialogue and feedback between scientists, managers and stakeholders. Currently managers are creating management plans and scientists are devising ways to evaluate simple harvest-control rules, but working in isolation in this way does not facilitate the overall management-plan evaluation. WGMG illustrated these points with case studies of management plans for three stocks (North Sea haddock, northern hake, and Irish Sea cod). It is clear that approaches to this issue will have to be case-specific rather than generic. Multi-species and mixed-fisheries models were also discussed, but these are at a much earlier stage of development.

1. Discard estimates. Progress in reconstructing historical time-series of discard data was presented, for roundfish and Nephrops, although (due to the composition of the Group) there was less feedback than hoped on whether the approach was appropriate.

2. Assessment methods when catch data are unreliable. The model currently used to assess North Sea cod was presented, to general approval, although concerns were raised about its ability to deal with retrospective bias. The use of the Gadget framework to estimate missing catches was explored, as was a novel Bayesian model in which reported catches are treated as a lower bound on the range of true catches. Progress was summarised in the EU FISBOAT project, part of which deals with survey-based assessment methods.

3. Other issues in assessment methodology. These included tests of the sensitivity of assessment models both to data and to user-defined input parameters, possible causes of the retrospective problem, a development of the separable assessment model to account for different patterns of exploitation on strong cohorts, and verification and validation of software.

4. Reference points. WGMG considered that the wholesale revision of mortality and biomass reference points for large numbers of stocks, using generic methods, had little value. Rather, reference points should be revised (if necessary) on a case-by-case basis in the context of management-plan evaluations.

It is not yet clear yet what the future of WGMG is. While it has a poorly-defined function within ICES, it is also the only forum at which generic issues such as management-plan evaluations and data-poor assessment methods are discussed, and as such could have a strong role to play in the future direction of ICES.

BD 19: ICES-SGMAS (2006)

The report is the combined work of two working group meetings in January 2005 and 2006. SGMAS dealt with the general approach to evaluating management plans evaluations in a Precautionary Approach context. In addition, SGMAS provides a description of the approach and operational guidelines for implementation of management strategy evaluations by ICES.

The report provides a check-list of issues to be addressed when evaluating management. In addition to "main stream" stocks advice is provided for short and long lived species and for stocks where the data is poor. The report provides a brief review of the software currently available and indicates which are currently suitable for use in management strategy evaluations, in particular for HCR simulation and how they are documented. Methods that are still under development are also noted. The report appears to document the current state of development with regards to evaluation of management plans and provides tools and issues relevant for the stocks dealt with in WGNSSK.

1.5 Data for other Working Groups

1.5.1 WGECO

Data on species composition of target and by-catches in the industrial fisheries in the North Sea are given in Table 2.1.2 and 2.1.3. Catch of human consumption to reduction purposes is summarised in Tables 2.1.4 and 2.1.5.

1.5.2 SGMSNS

Tables 1.5.1 to 1.5.7 give quarterly catch-at-age data for Subarea IV (North Sea). These data are provided for 2005 only: data for 2002-2004 were presented in the 2005 report of the WG (ICES-WGNSSK 2005). Catch (landings and discards) information are available for cod, haddock, and whiting, while landings data only are given for saithe, plaice, sole and sandeel. As the 2006 sandeel fishery closed in July, the full sandeel catch data for 2006 are also included here.

1.6 Progress on the WGNSSK road-map and the way forward

The report of 2006 meeting of the ICES Annual Meeting of Assessment Working Group Chairs (ICES-AMAWGC 2006) includes "road-maps" developed for each assessment WG. These indicate a list of the generic ToRs, and the plan of work intended to allow each WG to address them in the future. The approach of WGNSSK to each ToR is outlined in Section 1.1; in this the road-map has been followed, as far as has been practicable. Exceptions are noted in Sections 1.1 and 1.1.1, the principal one being the current inability to produce fully probabilistic assessments and forecasts for most stocks.

Generic ToR 9 (applicable to all assessment WGs; see Section 1.1) calls for further development of this road-map. This was not attempted during the 2006 meeting of WGNSSK as the future structure of the group is as yet unclear. Recently, ICES have been working towards a fully integrated advice structure covering fisheries, the environment, and ecosystems, and substantial changes in the form and function of WGNSSK are under discussion. With regards to this, Martin Pastoors (ACFM Chair) submitted a presentation to the WG in which the new structure was outlined, and requested comments from WGNSSK members.

The proposal is for two new WGs to replace WGNSSK. The possible ToRs for these are given below.

The Working Group on the North Sea and Skagerrak Stock Assessments (WGNSSAS) will meet for 4 days in April 2007 to:

- *update assessments of the status* [of the usual WGNSSK stocks] *and provide management options for 2008;*
- *quantify the species and size composition of by-catches taken in the fisheries for Norway pout and sandeel in the North Sea and adjacent waters;*
- *provide the data required to carry out multispecies assessments.*

The Working Group on the Assessment of the North Sea Ecosystem and Fisheries (WGNSECO) will meet for 5-6 days in September 2007 to:

- *hold a 2 day seminar on how to integrate fish stocks, ecosystem and fisheries considerations;*
- *review multi-species assessments of the North Sea ecosystem;*
- *review existing knowledge on important environmental drivers for stock productivity and management;*
- *update the description of fisheries exploiting the stocks and assess the impacts of the fisheries on the ecosystem;*
- *assess the influence of individual fleet activities on the stocks and the technical interactions;*
- *update the major regulatory changes and their potential effects;*
- *review evaluations of existing management measures including technical measures, TACs, effort control and management plans;*
- *review benchmark assessments of a limited number of fish stocks (?)*

WGNSSK held a plenary discussions on these proposals and reached a number of conclusions, as follows.

- The short time allowed for WGNSSAS means that there would need to be extremely strict adherence to the principle of update assessments. There would only be scope to review existing work and write the report. However, it is often the case that changes in fisheries behaviour or stock dynamics, or the availability of new data (such as discards), requires stock assessors to revise assessments and evaluate the outcomes. Firstly, not allowing for these revisions could become dangerous if real stock signals were missed. There is clearly a balance to be struck between doing too much and too little analysis, and the proposal seems to lean too much towards the latter. Secondly, if the strict update principle means that modifications cannot be made, is a meeting actually required? It might be sufficient in this case for update assessments to be submitted electronically; there is no point discussing an assessment that cannot be changed.
- The suggestion to hold WGNSSAS in April would mean that catch data from the previous year are unlikely to be fully collated unless the work schedules of participating institutes are suitably modified. Additionally, the start date of the sampling year could be changed to June. There may also be problems finalising data from the Q1 surveys in time. The update assessments therefore run the risk of being carried out on out-of-date data.
- There are a large number of ToRs for WGNSECO, and not many days in which to address them. The workload may be unrealistic. The ToRs are also extremely diverse, with no clear focus, and it would be a difficult meeting to run effectively.
- WGNSECO does not include consideration of socio-economic factors. These are what determine (in many cases) the behaviour of fishing fleets, and need to be incorporated in any integrated approach.
- Both the proposed groups appear to be more like coordination groups than assessment groups. There would be little scope for analysis in either of them. In the case of WGNSECO, how much does the required information actually change from year to year? It may be that this would not need to be an annual meeting.
- A more general concern was expressed that it is unclear what managers actually want. It is possible that a more top-down approach would be beneficial, in which the intention of the first tranche of advice would be to assist managers in determining what their objectives are. Only then could ICES realistically work towards addressing these objectives. In the meantime the need to keep the TAC machine supplied with numbers is unlikely to go away.

The WG concluded that the proposals as presented are unlikely to achieve the desired result of integration, and may indeed cause more problems than they solve. However, it is also clear that the current structure of the WG is not particularly effective. Data were (mostly) submitted earlier this year allowing for a greater focus on intersessional work, and the meeting was restructured to limit potentially unproductive method exploration, but the WG have still found it difficult to fulfill their extensive workload. Inclusion of more stocks has given the WG more to do without facilitating mixed-fisheries considerations as was intended. With this in mind, the WG suggested a number of ways forward that could be considered:

- There could be a parallel meeting of an ecosystem group alongside the current WGNSSK, with a number of joint sessions (much as happened this year with AMAWGC and WGRED). This would improve the *Ecosystem considerations* sections of the WGNSSK report, but would not perhaps encourage much integration.
- An alternative division into two groups might be as follows. The first group could describe what is happening (now and in the past) in the sea; thus covering fisheries assessments, environmental systems, and ecosystem descriptions. Integrated models between these could be explored. The second group would focus on anthropogenic effects in the seas, and would consider fisheries, economics, and so on. This might be a more logical split than that proposed above.
- In the absence of worked examples, it is not clear to the WG *how* any integrated approach would actually function. There is an argument that workshops are required in the first place to identify or create integrative models and data requirements, before changing to a new system which may be no better than the old.

1.7 Recommendations

The future status of WGNSSK is unclear (see Section 1.6), and the following recommendations apply only if WGNSSK maintains its current structure in 2007. The 2006 meeting was the last as Chair for the current incumbent (Coby Needle, UK). The WG **recommends** that the next Chair should be Chris Darby (UK). The WG **recommends** further that its 2007 meeting should be held in ICES headquarters during September 3-14.

Concerns are expressed in Section 12 over continued difficulties with the assessment of whiting in Sub-Area IV and Division VIId, which may be due to unaccounted sub-stock structure. The WG **recommends** that the ICES Study Group on Stock Identity and Management Units in Whiting (SGSIMUW) be reconvened to address this problem, as a matter of urgency.

The IBTS Q3 series has been used in the assessment for cod for the first time this year (Section 14), in order to address potential sampling rate problems in the separate Scottish and English series. The disadvantage of this approach is that survey data from the autumn of the current year are not now available for the assessment. ICES have indicated that this data will be available in future before the autumn ACFM meeting. The WG **recommends** that this be done.

The WG **recommend** that an ICES study group be established with the main objective to examine the entity of the entire stock complex of plaice within its distribution area in the North sea, English Channel, Skagerrak, Kattegat and western Baltic, in order to evaluate the appropriateness of the existing management areas for plaice and also to suggest protocols for studies that aim at clarifying the stock relationships.

Table 1.2.1. Biological sampling levels by stock and country, as reported to the WG. Preliminary official landings, numbers of vessels/trips/hauls sampled, and numbers of fish measured and aged to analyse commercial catches in 2005. Ages sampled by Germany are for total catch. Sampling levels were not provided by England, France, or Sweden.

Stock	Cod
Type	Landings

	Data				
Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			1364		
Scotland	330		6667	42849	13108
Netherlands	5752		1689	4205	2048
Belgium			1765	3590	980
Denmark	65		9904	6762	6719
France			982		
Germany		9	2734	330	3867
Ireland			0		
Norway			3645	4316	2054
Poland			0		
Spain			0		
Sweden			1129		
Grand Total	6147	9	29879	62052	28776

Stock	Cod
Type	Discards

	Data				
Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			1364		
Scotland	45		6667	4443	1426
Netherlands			1689		
Belgium	8		1765	4105	570
Denmark			9904		
France			982		
Germany		9	2734	3927	3867
Ireland			0		
Norway			3645		
Poland			0		
Spain			0		
Sweden			1129		
Grand Total	53	9	29879	12475	5863

Stock	Haddock
Type	Landings

	Data				
Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			843		
Scotland	361		41584	119147	10947
Netherlands			64		
Belgium			190		
Denmark	11		1889	1540	1466
France			421		
Germany			802	46	816
Ireland			0		
Norway			2162	11115	596
Poland			0		
Spain			0		
Sweden			307		
Grand Total	372		48262	131848	13825

Stock	Haddock
Type	Discards

	Data				
Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			843		
Scotland	45		41584	33992	3158
Netherlands			64		
Belgium			190		
Denmark			1889		
France			421		
Germany			802	0	0
Ireland			0		
Norway			2162		
Poland			0		
Spain			0		
Sweden			307		
Grand Total	45		48262	33992	3158

Stock	Nephrops
Type	Landings

	Data				
Country	No. trips	No.hauls	Official landings	Lengths	Ages
England	17		3622	3825	
Scotland	116		14446	87437	
Netherlands			1019		
Belgium			183	14200	
Denmark			5257		
France			4		
Germany			110		
Ireland			0		
Norway			214		
Poland			0		
Spain			0		
Sweden			1047		
Grand Total	133		25902	105462	

Stock	Nephrops
Type	Discards

	Data				
Country	No. trips	No.hauls	Official landings	Lengths	Ages
England	49		3622	16500	
Scotland	10		14446	16741	
Netherlands			1019		
Belgium			183		
Denmark			5257		
France			4		
Germany			110		
Ireland			0		
Norway			214		
Poland			0		
Spain			0		
Sweden			1047		
Grand Total	59		25902	33241	

Table 1.2.1. (cont.) Biological sampling levels by stock and country, as reported to the WG. Preliminary official landings, numbers of vessels/trips/hauls sampled, and numbers of fish measured and aged to analyse commercial catches in 2005. Ages sampled by Germany are for total catch. Sampling levels were not provided by England, France, or Sweden.

Stock	Norway pout
Type	Landings

Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			0		
Scotland			0		
Netherlands			0		
Belgium			0		
Denmark	395		0	53587	29877
France			3		
Germany			0		
Ireland			0		
Norway			311		
Poland			0		
Spain			0		
Sweden			0		
Grand Total	395		314	53587	29877

Stock	Norway pout
Type	Discards

Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			0		
Scotland			0		
Netherlands			0		
Belgium			0		
Denmark			0		
France			3		
Germany			0		
Ireland			0		
Norway			311		
Poland			0		
Spain			0		
Sweden			0		
Grand Total			314		

Stock	Plaice IIIa
Type	Landings

Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			0		
Scotland			0		
Netherlands			808		
Belgium			0		
Denmark	32		5605	4701	4611
France			0		
Germany			21		
Ireland			0		
Norway			80		
Poland			0		
Spain			0		
Sweden			244		
Grand Total	32		6758	4701	4611

Stock	Plaice IIIa
Type	Discards

Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			0		
Scotland			0		
Netherlands			808		
Belgium			0		
Denmark			5605		
France			0		
Germany			21		
Ireland			0		
Norway			80		
Poland			0		
Spain			0		
Sweden			244		
Grand Total			6758		

Stock	Plaice IV
Type	Landings

Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			7683		
Scotland			5022		
Netherlands	8146		22271	4017	4017
Belgium			3396	12620	1225
Denmark	12		11385	2480	2437
France			112		
Germany			3379	5263	5046
Ireland			0		
Norway			1660		
Poland			0		
Spain			0		
Sweden			0		
Grand Total	8158		54908	24380	12725

Stock	Plaice IV
Type	Discards

Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			7683		
Scotland			5022		
Netherlands			22271		
Belgium	8		3396	8730	380
Denmark			11385		
France			112		
Germany		8	3379	4467	5046
Ireland			0		
Norway			1660		
Poland			0		
Spain			0		
Sweden			0		
Grand Total	8	8	54908	13197	5426

Table 1.2.1. (cont.) Biological sampling levels by stock and country, as reported to the WG. Preliminary official landings, numbers of vessels/trips/hauls sampled, and numbers of fish measured and aged to analyse commercial catches in 2005. Ages sampled by Germany are for total catch. Sampling levels were not provided by England, France, or Sweden.

Stock	Plaice VIId
Type	Landings

Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			0	14327	1818
Scotland			0		
Netherlands			21		
Belgium			830	14255	400
Denmark			0		
France			1756	7850	1751
Germany			0		
Ireland			0		
Norway			0		
Poland			0		
Spain			0		
Sweden			0		
Grand Total			2607	36432	3969

Stock	Plaice VIId
Type	Discards

Country	No. trips	No.hauls	Official landings	Lengths	Ages
England	6	60	0	535	26
Scotland			0		
Netherlands			21		
Belgium	8		830	7930	480
Denmark			0		
France	26	201	1756	1926	
Germany			0		
Ireland			0		
Norway			0		
Poland			0		
Spain			0		
Sweden			0		
Grand Total	40	261	2607	10391	506

Stock	Saithe
Type	Landings

Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			1394		
Scotland	255		12136	15845	6823
Netherlands			40		
Belgium			28		
Denmark	31		7498	3399	3379
France			14223		
Germany			12774	27501	2125
Ireland			168		
Norway			67385	16635	2861
Poland			1100		
Spain			3		
Sweden			2114		
Grand Total	286		118863	63380	15188

Stock	Saithe
Type	Discards

Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			1394		
Scotland	67		12136	4778	1063
Netherlands			40		
Belgium			28		
Denmark			7498		
France			14223		
Germany		1	12774	6949	1343
Ireland			168		
Norway			67385		
Poland			1100		
Spain			3		
Sweden			2114		
Grand Total	67	1	118863	11727	2406

Stock	Sandeel
Type	Landings

Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			0		
Scotland			0		
Netherlands			0		
Belgium			0		
Denmark	2		156829	54674	39
France			7		
Germany			0		
Ireland			0		
Norway			17341		
Poland			0		
Spain			0		
Sweden			8505		
Grand Total	2		182682	54674	39

Stock	Sandeel
Type	Discards

Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			0		
Scotland			0		
Netherlands			0		
Belgium			0		
Denmark			156829		
France			7		
Germany			0		
Ireland			0		
Norway			17341		
Poland			0		
Spain			0		
Sweden			8505		
Grand Total			182682		

Table 1.2.1. (cont.) Biological sampling levels by stock and country, as reported to the WG. Preliminary official landings, numbers of vessels/trips/hauls sampled, and numbers of fish measured and aged to analyse commercial catches in 2005. Ages sampled by Germany are for total catch. Sampling levels were not provided by England, France, or Sweden.

Stock	Sole IV
Type	Landings

Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			667		
Scotland			275		
Netherlands	8870		10917	3390	3390
Belgium			1374	9560	1000
Denmark	3		831	425	414
France			676		
Germany			756	3905	1733
Ireland			0		
Norway			82		
Poland			0		
Spain			0		
Sweden			0		
Grand Total	8873		15578	17280	6537

Stock	Sole IV
Type	Discards

Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			667		
Scotland			275		
Netherlands			10917		
Belgium	8		1374	2190	185
Denmark			831		
France			676		
Germany		7	756	162	1140
Ireland			0		
Norway			82		
Poland			0		
Spain			0		
Sweden			0		
Grand Total	8	7	15578	2352	1325

Stock	Sole VIId
Type	Landings

Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			0		
Scotland			0		
Netherlands			0		
Belgium			1217	14150	520
Denmark			0		
France			2365		
Germany			0		
Ireland			0		
Norway			0		
Poland			0		
Spain			0		
Sweden			0		
Grand Total			3582	14150	520

Stock	Sole VIId
Type	Discards

Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			0		
Scotland			0		
Netherlands			0		
Belgium	8		1217	4570	225
Denmark			0		
France			2365		
Germany			0		
Ireland			0		
Norway			0		
Poland			0		
Spain			0		
Sweden			0		
Grand Total	8		3582	4570	225

Stock	Whiting
Type	Landings

Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			2653		
Scotland	320		5361	63022	7206
Netherlands	2391		927	5457	1200
Belgium			149		
Denmark			106		
France			4878		
Germany			149	12	1462
Ireland			0		
Norway			29	5183	293
Poland			0		
Spain			0		
Sweden			73		
Grand Total	2711		14325	73674	10161

Stock	Whiting
Type	Discards

Country	No. trips	No.hauls	Official landings	Lengths	Ages
England			2653		
Scotland	45		5361	21070	2747
Netherlands			927		
Belgium	8		149	5285	715
Denmark			106		
France			4878		
Germany		5	149	37	1462
Ireland			0		
Norway			29		
Poland			0		
Spain			0		
Sweden			73		
Grand Total	53	5	14325	26392	4924

Table 1.2.2. Summary of data submitted to stock coordinators, by stock. Only EU countries are tabulated. # = data submitted. Blank or - = no data submitted. Parentheses indicate data submitted for occasional years only. OS = official statistics only. IBC = industrial bycatch. No information available for plaice in IIIa.

Cod in IV

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings	#	#			#	#			#				#	#
Yearly Age & Length Composition		#				#			#					#
Quarterly Age composition (Landings)		#				#			#					#
Discards		#				(#)								#
Quarterly Age composition (Discards)						(#)								#
CPUE														#
Surveys														#
Maturity Information														
Sex ratio														

Cod in IIIa

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings	#	#				#			#				#	
Yearly Age & Length Composition		#											#	
Quarterly Age composition (Landings)		#											#	
Discards		#											#	
Quarterly Age composition (Discards)													#	
CPUE														
Surveys														
Maturity Information														
Sex ratio														

Haddock in IV

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings	#	#			#	#			#				#	#
Yearly Age & Length Composition		#												#
Quarterly Age composition (Landings)		#												#
Discards		#				(#)								#
Quarterly Age composition (Discards)														#
CPUE														#
Surveys														#
Maturity Information														
Sex ratio														

Haddock in IIIa

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings	#	#				#			#				#	
Yearly Age & Length Composition		#												
Quarterly Age composition (Landings)		#												
Discards		#											#	
Quarterly Age composition (Discards)													#	
CPUE														
Surveys														
Maturity Information														
Sex ratio														

Whiting in IV

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings	#	#			#	#			#				#	#
Yearly Age & Length Composition		IBC			#	(#)			#					#
Quarterly Age composition (Landings)		IBC			#	(#)			#					#
Discards						(#)								#
CPUE					#									#
Surveys														#
Maturity Information														
Sex ratio														

Whiting in VIId

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings	#				#				#					#
Yearly Age & Length Composition					#									
Quarterly Age composition (Landings)					#									
Discards														
CPUE					#									
Surveys					#									
Maturity Information														
Sex ratio														

Saithe in IV

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings	#	#			#	#			#	OS			#	#
Yearly Age & Length Composition		#			#	#								#
Quarterly Age composition (Landings)		#			#	#								#
Discards		#												#
Quarterly Age composition (Discards)														#
CPUE					#	#								#
Surveys														#
Maturity Information														
Sex ratio														

Saithe in VI

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings					#		#		#					#
Yearly Age & Length Composition					#									#
Quarterly Age composition (Landings)					#									#
Discards														#
Quarterly Age composition (Discards)														#
CPUE					#									#
Surveys														
Maturity Information														
Sex ratio														

Table 1.2.2. Summary of data submitted to stock coordinators, by stock. Only EU countries are tabulated. # = data submitted. Blank or - = no data submitted. Parentheses indicate data submitted for occasional years only. OS = official statistics only. IBC = industrial bycatch. No information available for plaice in IIIa.

Cod in VIId

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings	#				#				#					#
Yearly Age & Length Composition														#
Quarterly Age composition (Landings)														#
Discards														
Quarterly Age composition (Discards)														
CPUE														
Surveys														
Maturity Information														
Sex ratio														

Plaice in VIId

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings	#				#									#
Yearly Age & Length Composition	#				#									#
Quarterly Age composition (Landings)	#				#									#
Discards					#									#
Quarterly Age composition (Discards)					#									#
CPUE	#				#									#
Surveys					#									#
Maturity Information														
Sex ratio	#													#

Plaice IV

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings	#	#			#	#			#					#
Yearly Age & Length Composition	#													
Quarterly Age composition (Landings)		#			#	#			#					
Discards									#					
Quarterly Age composition (Discards)									#					
CPUE									#					
Surveys									#					
Maturity Information									#					
Sex ratio									#					

Plaice IIIa

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings														
Yearly Age & Length Composition														
Quarterly Age composition (Landings)														
Discards														
Quarterly Age composition (Discards)														
CPUE														
Surveys: BTS Surveys: GFS Surveys: YFS														
Maturity Information														
Sex ratio														

Nephrops FU 6 (Farne Deeps)

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings	#								#					#
Yearly Age & Length Composition														(#)
Quarterly Age composition (Landings)														(#)
Discards														#
Quarterly Age composition (Discards)														(#)
CPUE														#
Surveys														#
Maturity Information														(#)
Sex ratio														#

Nephrops FU 7 (Fladen)

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings		#												#
Yearly Age & Length Composition														(#)
Quarterly Age composition (Landings)		(#)												(#)
Discards														#
Quarterly Age composition (Discards)														(#)
CPUE														#
Surveys														#
Maturity Information														#
Sex ratio														#

Nephrops FU 8 (Firth of Forth)

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings														#
Yearly Age & Length Composition														(#)
Quarterly Age composition (Landings)														(#)
Discards														#
Quarterly Age composition (Discards)														(#)
CPUE														#
Surveys														#
Maturity Information														#
Sex ratio														#

Nephrops FU 9 (Moray Firth)

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings														#
Yearly Age & Length Composition														(#)
Quarterly Age composition (Landings)														(#)
Discards														#
Quarterly Age composition (Discards)														(#)
CPUE														#
Surveys														#
Maturity Information														#
Sex ratio														#

Table 1.2.2. Summary of data submitted to stock coordinators, by stock. Only EU countries are tabulated. # = data submitted. Blank or - = no data submitted. Parentheses indicate data submitted for occasional years only. OS = official statistics only. IBC = industrial bycatch. No information available for plaice in IIIa.

Nephrops FU 10 (Noup)

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings														#
Yearly Age & Length Composition														(#)
Quarterly Age composition (Landings)														
Discards														
Quarterly Age composition (Discards)														
CPUE														#
Surveys														(#)
Maturity Information														
Sex ratio														(#)

Nephrops FU 3 & 4 (Skagerrak and Kattegat)

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings		#											#	
Yearly Age & Length Composition		(#)											(#)	
Quarterly Age composition (Landings)														
Discards		#											#	
Quarterly Age composition (Discards)														
CPUE		#											#	
Surveys														
Maturity Information		#											#	
Sex ratio		#											#	

Nephrops FU 32 (Norwegian Deeps)

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings		#												#
Yearly Age & Length Composition		(#)												
Quarterly Age composition (Landings)														
Discards		#												
Quarterly Age composition (Discards)														
CPUE														
Surveys														
Maturity Information														
Sex ratio		#												

Nephrops FU 33 (Off Horn Reef)

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings		#							#					
Yearly Age & Length Composition		(#)												
Quarterly Age composition (Landings)														
Discards		#												
Quarterly Age composition (Discards)														
CPUE		#							#					
Surveys														
Maturity Information														
Sex ratio		#											#	

Nephrops FU 5 (Botney Gut)

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings	#	#							#					
Yearly Age & Length Composition	(#)													
Quarterly Age composition (Landings)														
Discards														
Quarterly Age composition (Discards)														
CPUE	#	#							#					
Surveys														
Maturity Information														
Sex ratio													#	

Norway pout

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings		#												
Yearly Age & Length Composition		#												
Quarterly Age composition (Landings)		#												
Discards														
Quarterly Age composition (Discards)														
CPUE		#												
Surveys		#												
Maturity Information		#												
Sex ratio														

Table 1.2.2. Summary of data submitted to stock coordinators, by stock. Only EU countries are tabulated. # = data submitted. Blank or - = no data submitted. Parentheses indicate data submitted for occasional years only. OS = official statistics only. IBC = industrial bycatch. No information available for plaice in IIIa.

Sole in IV

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings	#	#			#	#			#				#	#
Yearly Age & Length Composition														
Quarterly Age composition (Landings)	#				#	#			#					#
Discards									#					
Quarterly Age composition (Discards)									#					
CPUE									#					
Surveys									#					
Maturity Information									#					
Sex ratio									#					

Sole in VIId

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings	#				#									#
Yearly Age & Length Composition	#													#
Quarterly Age composition (Landings)	#				#									#
Discards	#				#									#
Quarterly Age composition (Discards)														
CPUE	#													#
Surveys					#									#
Maturity Information														
Sex ratio														

Sandeel

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings		#											#	#
Yearly Age & Length Composition		#												
Quarterly Age composition (Landings)		#												
Discards														
Quarterly Age composition (Discards)														
CPUE		#												
Surveys														
Maturity Information														
Sex ratio														

Table 1.3.1. Overview of the biological basis of stock assessments carried out by the WG.

Stock	Area	Stock numbers	Mean wt catch	Mean wt stock	Natural mort.	Prop. Mature	Ages
Cod	3a, 4, 7d	AC from DK, DE, NL, UK. Discard AC from DE and UK. SOP corrected.	Based on AC. No smoothing. Calculated differently for separate catch components	Same as mean weight in catch	M = (0.8, 0.35, 0.25, 0.2, …, 0.2)	Mat = (0.01, 0.05, 0.23, 0.62, 0.86, 1.0, …, 1.0)	1-7+
Haddock	3a, 4	AC from DK and UK. Discard AC from UK. IBC AC from UK.	Based on AC. No smoothing. Calculated differently for separate catch components	Same as mean weight in catch	M = (2.05, 1.65, 0.4, 0.25, 0.25, 0.2, …, 0.2)	Mat = (0.0, 0.01, 0.32, 0.71, 0.87, 0.95, 1.0, …, 1.0)	0-7+
Whiting	4, 7d	AC from FR, DE, NL, UK. Discard AC from DE and UK. IBC AC from DK.	Based on AC. No smoothing. Calculated differently for separate catch components	Same as mean weight in catch	M = (0.95, 0.45, 0.35, 0.3, 0.25, 0.25, 0.2, 0.2)	Mat = (0.11, 0.92, 1.0, …, 1.0)	1-8+
Saithe	3a, 4, 6	AC from DK, DE, FR, N, UK. Discard AC from UK (not used). IBC AC from N (not used).	Based on AC. No smoothing.	Same as mean weight in catch	M = 0.2	Mat = (0.0, 0.15, 0.70, 0.90, 1.0, …, 1.0)	3-10+
Sole	4	AC from NL, DE, UK, FR, B. No discards included. SOP corrected.	Based on AC. No smoothing.	Second quarter catch weights-at-age.	M = 0.1 (0.9 in 1963)	Mat = (0.0, 0.0, 1.0, …, 1.0)	1-10+
Sole	7d	AC from B, FR, UK (since 1985). No discard included. No SOP correction.	Based on AC. No smoothing.	Second quarter catch weights-at-age.	M = 0.1	Mat = (0.0, 0.0, 1.0, …, 1.0)	1-11+
Plaice	4	AC from NL, UK, DK, FR, B. Discards AC from UK and NL. SOP corrected.	Based on AC. No smoothing. Calculated differently for separate catch components	First quarter catch weights.	M = 0.1	Mat = (0.0, 0.5, 0.5, 1.0, …, 1.0)	1-15+
Plaice	3a	AC from DK only. No discards included. SOP corrected.	Based on AC. No smoothing.	Same as mean weight in catch	M = 0.1	Mat = (0.0, 1.0, …, 1.0)	2-11+
Plaice	7d	AC from FR, B, UK. No discards included. SOP corrected.	Based on AC. No smoothing.	First quarter catch weights.	M = 0.1	Mat = (0.0, 0.15, 0.53, 0.96, 1.0, …, 1.0)	1-10+
Norway pout	4	AC from DK and N.	Based on AC. No smoothing.	Fixed mean weight in the stock by age and quarter.	M = 0.4 per quarter.	Mat = (0.0, 0.1, 1.0, …, 1.0)	0-4+
Sandeel	4	AC from DK and N.	Based on AC. No smoothing.	Same as mean weight in catch	First half year: M(1 3) = (1.0, 0.4, 0.4). Second half year: M(0-3) = (0.0, 0.2, …, 0.2)	Mat = (0.0, 0.0, 1.0, …, 1.0)	0-4+
Nephrops	3-10, 32, 33	Relative abundance from UK TV surveys	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable

Table 1.3.2. Overview of model settings used by the WG. No analytic assessments were presented for *Nephrops*

Stock	Area	Assessment method	Assessment age range	Assessment year range	Fbar age range	Time taper	Catchability dependent on stock size for ages =	Catchability independent of age for ages >=	SE of mean F to which estimates shrunk	Minimum SE for population estimates	Prior weighting	Tuning fleet type	Tuning fleet name	Tuning fleet year range	Tuning fleet age range	Tuning fleet alpha-beta
Cod	3a, 4, 7d	B-ADAPT	1-7+	63-05	2-4	None	None	3	Lambda = 0.5	None	None	S	IBTS Q1	83-06	1-5	0-0.25
								4				S	IBTS Q3	91-05	1-4	0.5-0.75
Haddock	3a, 4	XSA	0-7+	63-05	2-4	None	1	3	2.0	0.3	None	S	EngGFS early	77-91	0-5	0.5-0.75
												S	EngGFS	92-05	0-5	0.5-0.75
												S	ScoGFS early	82-97	0-5	0.5-0.75
												S	ScoGFS	98-05	0-5	0.5-0.75
												S	IBTS Q1 backshifted	82-05	0-4	0.99-1.0
Whiting	4, 7d	XSA	1-8+	80-05	2-6	Tricubic over 16 years	None	4	2.0	0.3	None	S	EngGFS GOV	92-05	1-6	0.5-0.75
												S	ScoGFS old	82-97	1-6	0.5-0.75
												S	ScoGFS new	98-05	1-6	0.5-0.75
												S	IBTS Q1	83-06	1-5	0.0-0.25
Saithe	3a, 4, 6	XSA	3-10+	67-05	3-6	Tricubic over 20 years	None	7	1.0	0.3	None	C	FraTRB	90-05	3-9	0-1
												C	GerOTB	95-05	3-9	0-1
												C	NorTRL	80-05	3-9	0-1
												S	NorACU	95-05	3-6	0.5-0.75
												S	IBTS Q3	91-05	3-5	0.5-0.75
Sole	4	XSA	1-10+	57-05	2-6	None	1	7	2.0	0.3	None	S	BTS-Isis	85-05	1-9	0.66-0.75
												S	SNS	82-05	1-4	0.66-0.75
												C	NL BT	90-05	2-9	0-1
Sole	7d	XSA	1-11+	82-05	3-8	None	None	7	2.0	0.3	None	C	Bel BT	86-05	2-10	0-1
												C	UK BT	86-05	2-10	0-1
												S	UK BTS	88-05	1-6	0.5-0.75
												S	YFS	86-05	1	0.5-0.75
Plaice	4	XSA	1-10+	57-05	2-6 (landings) 2-3 (discards)	None	None	6	2.0	0.3	None	S	BTS-Isis	85-05	1-9	0.66-0.75
												S	BTS-Tridens	96-05	1-9	0.66-0.75
												S	SNS	82-05	1-3	0.66-0.75
Plaice	3a	XSA	2-11+	78-05	4-8	Tricubic over 20 years	None	8	0.5	0.3	None	C	Danish gillnetters	95-05	2-10	0-1
												C	Danish seiners	95-05	2-10	0-1
												S	KASU Q4	94-05	1-6	0.83-1.0
												S	KASU Q1 backshifted	95-05	1-6	0.99-1.0
												S	IBTS Q1 backshifted	90-05	1-6	0.99-1.0
												S	IBTS Q3	97-05	1-6	0.83-1.0
Plaice	7d	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Norway pout	4	SMS	0-3	83-06	1-2	N/A	N/A	N/A	N/A	N/A	N/A	C	Comm Q1	82-04	1-3	0.0-0.25
												C	Comm Q3	82-04	1-3	0.50-0.75
												C	Comm Q4	82-04	0-2	0.75-1.0
												S	IBTS Q1	82-06	1-3	0.0-0.25
												S	EngGFS Q3 backshifted	92-05	0-1	0.25-0.5
												S	IBTS Q3	91-05	2-3	0.5-0.75
												S	ScoGFS Q3 backshifted	98-06	0-1	0.25-0.5
Sandeel	4	SXSA	0-4+	83-06	1-2	N/A	N/A	N/A	N/A	N/A	N/A	C	Northern NS first half-year old	83-98	0-4+	0.0-0.5
												C	Northern NS first half-year new	99-06	0-4+	0.0-0.5
												C	Southern NS first half-year old	83-98	0-4+	0.0-0.5
												C	Southern NS first half-year new	99-06	0-4+	0.0-0.5
												C	Northern NS second half-year	83-05	0-4+	0.5-1.0
												C	Southern NS second half-year	83-05	0-4+	0.5-1.0

Table 1.5.1. Quarterly catch-at-age data for cod in Sub-Area IV.

Catch numbers (000s)

			Quarter				
Year	Component	Age	1	2	3	4	All
2005	Landings	0					
		1	0	38	252	773	1064
		2	756	1635	2831	1653	6875
		3	611	626	708	485	2430
		4	445	334	340	221	1340
		5	158	126	90	38	412
		6	156	109	74	24	362
		7	16	12	6	4	39
		8	5	1	3	1	10
		9	2	2	2	1	6
		10	1	1	0		1
		11	0				0
		12	0				
	Discards	0		102	6124	824	7049
		1	304	1396	3287	2394	7381
		2	1448	1597	774	110	3929
		3	22	5	1		28
		4					
		5					
		6					
		7					
		8					
		9					
		10					
		11					
	Catch	0					7049
		1					8445
		2					10804
		3					2459
		4					1340
		5					412
		6					362
		7					39
		8					10
		9					6
		10					1
		11					0

Table 1.5.1. (cont.) Quarterly catch-at-age data for cod in Sub-Area IV.

Catch weights (kg)

			Quarter				
Year	Component	Age	1	2	3	4	All
2005	Landings	0					
		1	0.486	0.535	0.602	0.765	0.718
		2	0.940	0.891	1.175	1.350	1.124
		3	1.364	1.741	2.194	2.440	1.918
		4	3.105	3.597	4.182	4.112	3.667
		5	4.266	5.149	5.682	5.923	4.997
		6	6.329	7.596	8.520	7.563	7.236
		7	8.420	10.100	13.126	9.663	9.838
		8	9.430	10.288	16.246	11.152	11.674
		9	11.909	11.651	14.885	12.032	12.746
		10	14.031	11.055	17.769		13.656
		11	17.226				15.326
		12	13.664				
	Discards	0		0.006	0.022	0.073	0.028
		1	0.147	0.195	0.302	0.376	0.299
		2	0.350	0.457	0.558	0.538	0.440
		3	0.486	0.422	0.831		0.485
		4					
		5					
		6					
		7					
		8					
		9					
		10					
		11					
	Catch	0					0.028
		1					0.352
		2					0.875
		3					1.901
		4					3.667
		5					4.997
		6					7.236
		7					9.838
		8					11.674
		9					12.746
		10					13.656
		11					15.326

Table 1.5.2. Quarterly catch-at-age data for haddock in Sub-Area IV.

Catch numbers (000s):

			Quarter			
Year	Component	Age	1	2	3	4
2005	IBC	1		45	133	
		2		44	54	
		3	2	16	8	
		4	1	3	5	
		5	1	4		
		6	16	23	161	
		7	1			
	Landings	1			195	390
		2	85	1061	1890	2188
		3	730	1785	2707	2735
		4	870	587	701	659
		5	5987	3457	5993	6124
		6	16463	8506	15734	13957
		7	40	38	107	123
		8	11	9	61	9
		9	13	9	8	4
		10	3	2	3	1
		11	3	1	2	1
		12	2	1	1	0
		13	0	0	0	
		14			0	
	Discards	0			300	4056
		1	36	2321	2252	3516
		2	1780	5200	3101	2618
		3	752	1675	587	305
		4	238	107	32	16
		5	1220	1408	553	217
		6	1795	1457	498	79
		7			0	

Table 1.5.2. (cont.) Quarterly catch-at-age data for haddock in Sub-Area IV.

Catch weights (kg):

			Quarter			
Year	Component	Age	1	2	3	4
2005	IBC	1		0.102	0.109	
		2		0.197	0.179	
		3	0.246	0.246	0.222	
		4	0.287	0.287	0.253	
		5	0.287	0.287		
		6	0.518	0.518	0.619	
		7	0.619			
	Landings	1			0.305	0.404
		2	0.387	0.343	0.388	0.406
		3	0.357	0.365	0.438	0.452
		4	0.463	0.479	0.631	0.568
		5	0.449	0.487	0.531	0.553
		6	0.479	0.499	0.566	0.581
		7	0.823	1.130	0.982	0.697
		8	1.503	1.360	0.981	1.130
		9	1.465	1.598	0.907	1.333
		10	1.688	2.113	1.956	2.253
		11	2.792	2.266	2.632	2.753
		12	2.523	2.420	2.620	2.800
		13	2.168	2.322	3.369	
		14			3.431	
	Discards	0			0.026	0.059
		1	0.109	0.116	0.221	0.243
		2	0.214	0.220	0.288	0.293
		3	0.262	0.264	0.341	0.323
		4	0.300	0.306	0.406	0.375
		5	0.304	0.281	0.361	0.326
		6	0.337	0.334	0.404	0.358
		7			0.621	

Table 1.5.3. Quarterly catch-at-age data for whiting in Sub-Area IV.

Catch numbers (000s):

			Quarter			
Year	Component	Age	1	2	3	4
2005	IBC	0			10912	1158
		1	5	734	5447	4875
		2	9	719		
		3	10	485		
		4	8	12	11	
		5	8	16	11	
		6	15	34	8	
		7	1	9		
		8	1	7		
	Landings	0				12
		1	60	413	1068	699
		2	276	928	909	2556
		3	843	812	910	1783
		4	2047	1965	2202	3291
		5	2674	1926	1946	2381
		6	1822	1047	1026	1100
		7	803	451	323	322
		8	110	49	28	16
		9	13	3	3	0
		10	19	11	0	0
		11		0		
		12		0		
	Discards	0			92	1072
		1	797	2233	4521	5119
		2	3717	2872	9194	6751
		3	1567	2187	1508	1038
		4	2484	2396	1287	1399
		5	2435	1254	780	436
		6	1437	610	591	585
		7	233	275	87	130
		8	158	28		27
		9	5	0		

Table 1.5.3. (cont.) Quarterly catch-at-age data for whiting in Sub-Area IV.

Catch weights (kg):

			Quarter			
Year	Component	Age	1	2	3	4
2005	IBC	0			0.014	0.008
		1	0.100	0.098	0.043	0.034
		2	0.144	0.133		
		3	0.178	0.196		
		4	0.202	0.208	0.202	
		5	0.355	0.377	0.355	
		6	0.399	0.461	0.399	
		7	0.407	0.556		
		8	0.407	0.547		
	Landings	0				0.167
		1	0.168	0.165	0.204	0.241
		2	0.206	0.217	0.248	0.259
		3	0.272	0.247	0.275	0.288
		4	0.276	0.240	0.272	0.273
		5	0.322	0.271	0.326	0.320
		6	0.355	0.308	0.338	0.343
		7	0.335	0.287	0.356	0.311
		8	0.319	0.341	0.401	0.412
		9	0.453	0.522	0.671	1.012
		10	0.320	0.300	1.395	1.849
		11		0.337		
		12		0.670		
	Discards	0			0.023	0.051
		1	0.062	0.069	0.088	0.158
		2	0.143	0.132	0.181	0.202
		3	0.192	0.176	0.243	0.250
		4	0.205	0.201	0.250	0.238
		5	0.208	0.207	0.274	0.266
		6	0.209	0.238	0.277	0.254
		7	0.241	0.236	0.271	0.257
		8	0.208	0.240		0.294
		9	0.289	0.339		

Table 1.5.4. Quarterly catch-at-age data for saithe in Sub-Area IV.

Catch numbers (000s):

			Quarter			
Year	Component	Age	1	2	3	4
2005	Landings	2	177	1147	368	170
		3	736	7134	2574	2215
		4	1491	2726	3613	2886
		5	4456	4438	3197	3053
		6	9668	2394	1908	2125
		7	6903	1579	1168	1062
		8	1683	414	256	229
		9	1128	575	308	73
		10	267	73	64	19
		11	230	125	75	12
		12	116	168	31	4
		13	112	2	17	2
		14	34	86	9	1
		15	20	25	2	2

Catch weights (kg):

			Quarter			
Year	Component	Age	1	2	3	4
2005	Landings	2	0.380	0.383	0.782	0.798
		3	0.460	0.516	0.897	0.940
		4	0.979	0.920	1.093	1.226
		5	1.234	1.216	1.365	1.451
		6	1.502	1.584	1.761	1.754
		7	1.876	2.033	2.261	2.132
		8	2.805	3.444	3.212	3.055
		9	3.557	4.006	3.733	4.478
		10	4.703	4.378	5.443	6.248
		11	5.196	6.631	5.749	5.884
		12	6.154	7.014	7.723	7.309
		13	7.274	7.275	6.275	8.014
		14	7.171	9.121	6.748	6.908
		15	8.847	5.902	6.695	5.973

Table 1.5.5. Quarterly catch-at-age data for plaice in Sub-Area IV.

Catch numbers (000s):

			Quarter				
Year	Component	Age	1	2	3	4	All
2005	Landings	1			246	2765	3011
		2	363	1092	7389	7926	16770
		3	3126	6846	7513	6925	24409
		4	22974	24030	15702	14998	77703
		5	5108	5895	3033	2266	16302
		6	3283	2467	1716	1012	8477
		7	2050	1104	914	571	4639
		8	986	688	387	285	2346
		9	731	462	511	346	2049
		10	160	136	64	47	408

Catch weights (kg):

			Quarter				
Year	Component	Age	1	2	3	4	All
2005	Landings	1			0.250	0.280	0.270
		2	0.190	0.190	0.250	0.300	0.270
		3	0.240	0.240	0.300	0.340	0.290
		4	0.300	0.300	0.370	0.410	0.330
		5	0.380	0.380	0.430	0.450	0.400
		6	0.420	0.420	0.460	0.530	0.440
		7	0.430	0.430	0.460	0.530	0.450
		8	0.530	0.530	0.600	0.580	0.540
		9	0.620	0.620	0.520	0.700	0.610
		10	0.970	0.910	0.800	1.220	0.950

Table 1.5.6. Quarterly catch-at-age data for sole in Sub-Area IV.

Catch numbers (000s):

			Quarter				
Year	Component	Age	1	2	3	4	All
2005	Landings	0					
		1			4	1001	1005
		2	368	346	2170	3588	6472
		3	4791	6129	6225	4242	21387
		4	6148	11029	5978	3944	27100
		5	805	1550	1045	1583	4983
		6	622	1140	711	359	2831
		7	354	345	253	343	1295
		8	97	170	108	44	418
		9	128	187	263	209	786
		10	68	117	60	99	344

Catch weights (kg):

			Quarter				
Year	Component	Age	1	2	3	4	All
2005	Landings	0					
		1			0.130	0.170	0.170
		2	0.130	0.150	0.160	0.210	0.190
		3	0.200	0.190	0.200	0.250	0.210
		4	0.260	0.230	0.230	0.280	0.250
		5	0.300	0.240	0.260	0.210	0.240
		6	0.350	0.260	0.300	0.330	0.300
		7	0.280	0.280	0.270	0.260	0.270
		8	0.340	0.400	0.310	0.530	0.370
		9	0.430	0.370	0.290	0.270	0.330
		10	0.570	0.420	0.350	0.310	0.410

Table 1.5.7. Quarterly catch-at-age data for sandeel in Sub-Area IV.

Catch numbers (000s):

			Quarter				
Year	Component	Age	1	2	3	4	All
2005	Landings	0		72			72
		1		16902			16902
		2		5141			5141
		3		378			378
		4		447			447
2006	Landings	0		811			811
		1		32445			32445
		2		2736			2736
		3		982			982
		4		226			226

Catch weights (kg):

			Quarter				
Year	Component	Age	1	2	3	4	All
2005	Landings	0		2.360			2.360
		1		5.820			5.820
		2		9.570			9.570
		3		12.060			12.060
		4		13.430			13.430
2006	Landings	0		1.810			1.810
		1		6.270			6.270
		2		10.830			10.830
		3		13.050			13.050
		4		15.310			15.310

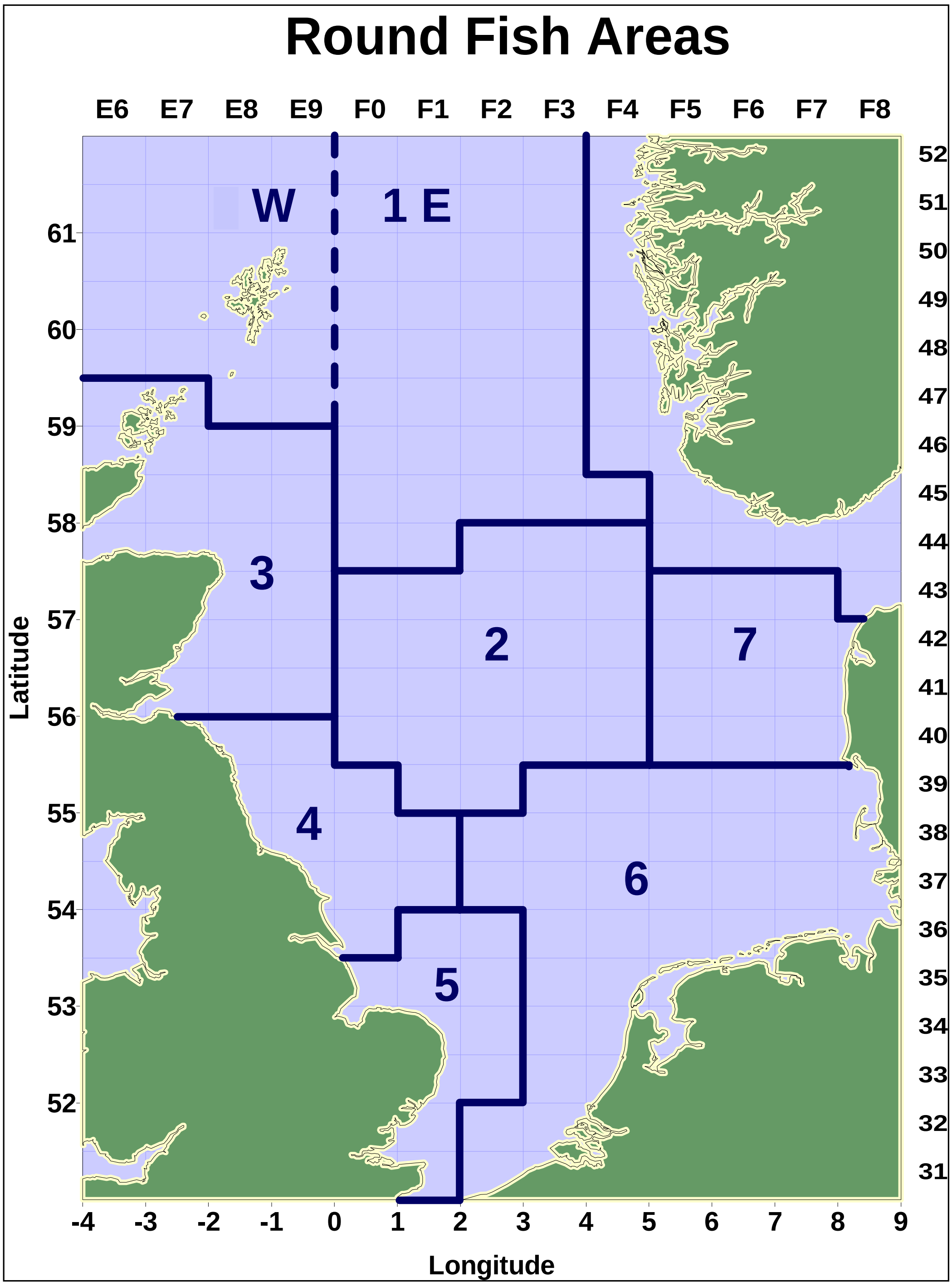


Figure 1.2.1. Roundfish sampling areas for the IBTS Q1 and Q3 survey indices.

2 Overview

2.1 Stocks in the North Sea (Sub-Area IV)

2.1.1 Fishery descriptions

The demersal fisheries in the North Sea can be categorised as a) human consumption fisheries, and b) industrial fisheries which land the majority of their catch for reduction purposes. Demersal human consumption fisheries usually either target a mixture of roundfish species (cod, haddock, whiting), a mixture of flatfish species (plaice and sole) with a by-catch of roundfish, or *Nephrops* with a bycatch of roundfish and flatfish. A fishery directed at saithe exists along the shelf edge. Landings used by the WG for each North Sea stock are summarised in Table 2.1.1. On average 90% of the landings for reduction consist of sandeel, Norway pout, blue whiting and sprat. The industrial landings also contain by-catches of various other species (Table 2.1.2). The industrial by-catches of human consumption species landed for reduction by the Danish small-mash fleet are given for 1985-2005 in Tables 2.1.3 (annual by species), 2.1.4 (annual by species and fleet), and 2.1.5 (quarterly by species and fleet). Data on landings for human consumption from the industrial small-mesh fleets was not made available to the WG this year.

Gear types vary between fisheries. Human consumption fisheries use otter trawls, pair trawls, Nephrops trawls, seines, gill nets, or beam trawls, while industrial fisheries use small meshed otter trawls.

The human-consumption fisheries in the North Sea have been subject to a number of restrictive management measures in recent years, in response to declining stock abundance. These are summarised in Section 2.1.2. In addition, a series of decommissioning rounds have reduced fleet size in a number of countries. These measures have all had an effect on reported effort, although it must be remembered that fleet efficiency is not constant and realised catch rates may not have declined commensurately with effort. Recent trends in reported effort in UK fisheries were described in two working papers (WD3 and WD8) to the 2005 meeting of WGNSSK (ICES-WGNSSK 2005); these showed considerable declines. Trends in commercial effort and CPUE on each stock are reported in the relevant stock sections.

The trends in the landings (WG estimates) of the species assessed by the WG are shown in Table 2.1.1. The industrial fisheries which used to dominate the North Sea catch in weight have become much less prominent. Human consumption landings have steadily declined over the last 30 years, with an intermediate high in the early 80’s. The landings of the industrial fisheries show the largest annual variations, probably due to the short life span of the main target species. The total demersal landings from the North Sea reached over 2 million t in 1974, and have been around 1.5 million t in the 1990s. There are strong technical interactions between the cod, haddock and whiting fisheries on the one hand, and between the sole and plaice fisheries on the other. Links with *Nephrops* fisheries are less clear. The flatfish and roundfish landings are generally taken by different fleet segments, with the exception of gill-netters which may potentially target any of these groups of species. The fisheries landing saithe have a relatively low impact on the others. However, the fisheries directed to cod, haddock and whiting may generate discards of saithe. Most of the saithe landings are taken by the Norwegian, French and German offshore trawlers.

For some stocks, the North Sea assessment area may also cover other regions adjacent to ICES Sub-area IV. Thus, combined assessments were made for cod including IIIaN (Skagerrak) and VIId, for haddock and Norway pout including IIIa, for whiting including VIId, and for saithe including IIIa and VI. Advice for the sandeel stocks at the Shetland Islands and in IIIa is provided separately by ICES, and there are no analytic assessments for them. The state of

Nephrops stocks are evaluated on the basis of discrete Functional Units (FU), which in turn comprise a number of Management Areas (MA) on which estimates of appropriate removals are founded. Quota management for *Nephrops* is still carried out at the Sub-Area and Division level, however.

Biological interactions are not directly incorporated in the assessments or the forecasts for the North Sea stocks. However, average values of natural mortalities estimated by multispecies assessments for cod, haddock, whiting and sandeel are incorporated in the assessments of these species, and exploratory runs using updated natural mortality estimates are presented for some stocks.

Summaries of Scottish fisheries changes during 2005/06

Anecdotal information from the Scottish whitefish and *Nephrops* fleets, obtained through liaison meetings and observer sampling trips, was submitted to the WG and is reproduced below. Much of this information refers to the fisheries as a whole: that which is specific to a particular stock has been repeated in the relevant stock sections.

Fisheries changes

- High fuel prices have been offset to some extent by good market prices for fish, as well as by fuel-saving strategies such as slower steaming times, gear modifications such as lower headline heights and shorter wing-spreads, some switching to pair-trawling, and an increase in landings to local markets.
- These high market prices have led to concerns that the onshore sector in Scotland may collapse. Stocks of frozen Icelandic and Faroese fish are exhausted, which means that buyers must compete for the available Scottish fish, but they will find it difficult to continue to pay high prices for long. Therefore, market prices are unlikely to continue at current levels.
- The other main economic concern at the moment seems to be the cost of leasing quota from agencies, as well as from sea-going and shore-based skippers.
- These costs are preventing skippers from investing in modernisation, and some vessels are showing their age.
- To improve market quality and seek a better price, boxes are being landed with fewer fish in them. As a result boxes are being filled more quickly, and the average length of a trip as reduced from 10 to 8 days.
- Some vessels fishing north of Shetland have voluntarily switched to larger mesh sizes (> 130 mm). It is not clear why this has been done, unless to save handling time in dealing with unmarketable fish.
- Most of the Scottish west coast fleet have spent some time this year in the North Sea, largely because of monkfish quota restrictions in Division VIa. Northern Irish and English *Nephrops* vessels have also been leasing quota and fishing on the Fladen ground. Thus, although the North Sea whitefish fleet has not changed in size in 2006, several vessels normally based elsewhere have moved into the area and realised fishing effort may be slightly larger than expected. On the other hand, effort has reduced in the traditional pair-trawling grounds (Shetland and Viking).
- Effort has increased in recent years in the Moray Firth squid fishery. This is problematic, as the fishery uses small meshes, is largely unregulated, and is thought to be generating substantial discards of young fish. This cannot be determined for sure, however, as the fleet has refused access to FRS (Scotland) observers. The trend of increasing effort may have reversed in 2006.

General biology

- There have been more reports than in recent years of sandeel and Norway pout in the stomachs of the main piscivorous demersal species.

- For the last two years, those whiting and cod examined have been eating large numbers of snake pipefish, the North Sea stock of which seems to have increased greatly in a very short time.

Cod

- Cod is mostly viewed now as a high-value bycatch. The industry claim there is no directed Scottish cod fishery, although it may be the case that a 10-day trip spends 2 or 3 days focussing on cod (that is not a directed fishery in skippers' eyes, but it may be from a scientific perspective).
- There is a strong view that cod are moving north – not from southern to northern North Sea, but on a much finer scale of 20 or 30 miles.
- The industry is reporting clear evidence of an improvement in cod abundance. Good landings of cod of all sizes were obtained during the first half of the year in the Shetland and Viking areas. A high level of 1-year old cod are appearing in discard samples from Shetland, as well as in the Fladen *Nephrops* fishery. 0-group cod have also been found in substantial numbers in saithe and turbot stomachs.
- The SFO (the largest Scottish producer organisation) have run out of cod quota for 2006. The quota availability for haddock and *Nephrops* is still good, so the fleet will continue to fish. Black landing and misreporting of over-quota cod is much more difficult now following increased enforcement and the Scottish Buyers & Sellers regulation, so cod taken in the mixed fishery are likely to be discarded between now and the New Year.

Haddock

- The inshore (east of Scotland) haddock fishery has not materialised this year. The traditional grounds have been poor. The fleet has to travel considerable distances (70 miles and further east) to find haddock, although those that are caught are of good sizes.
- The medium-sized fish which predominated in catches last year are now less prevalent than larger fish. This could be evidence of improved growth of the 1999 year-class.
- Substantial numbers of juvenile haddock (probably the 2005 year-class) have started appearing in catches. This supports survey-based indications that this year-class is strong (relative to the previous four).
- Haddock are still the mainstay of the Scottish whitefish fleet. Quota uptake this year is on the low side and the quota may not be fully taken. This is thought to be due to periodic poor markets earlier in the year, during which skippers decided to reserve their quota for a time when prices improved.

Whiting

- Whiting are more important to the Scottish fleet than in previous years, with good sizes being landed. Quota uptake by August was 65% and the entire quota is likely to be taken this year. The industry expressed surprise at the poor indices from the IBTS Q1 and ScoGFS Q3 surveys, as this did not concur with their perception.
- With a few exceptions, the whitefish fleet are using 120 mm mesh in the northern North Sea (EC zone). However, the use of thick twine means that more whiting than expected are being retained.

Nephrops

- Some difficulties in maintaining catch rates throughout the year, but overall landings have been good.
- Many boats have moved to deeper waters and are landing fewer prawns, but of greater size, better quality and much higher price. Less tails have been landed than previous years. The fleet is focussing on quality (Scottish "langoustines"

have a good reputation) rather than bulk. Because of this, the quota may not be fully taken by the end of the year.

- The northern part of the Fladen ground is being favoured. There is also a claim that the northern boundary of this ground is moving further north.
- The *Nephrops* fleet are optimistic about stock trends, but are concerned about being the centre of EC attention regarding cod bycatch and the severe effort restrictions that may bring.

Other stocks

- Hake are being caught in the North Sea in unprecedented numbers, although as there is little quota they are mostly being discarded. Saithe are also widespread and are being discarded due to lack of quota.

Appendix of the 2006 report of WGFTFB

This report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. This includes information on recent changes in commercial fleet behaviour that may influence commercial CPUE estimates; identification of recent technological advances (creep); ecosystem effects; and the development of new fisheries in the North Sea and Skagerrak. It should be noted that the information contained in this report does not cover fully all fleets engaged in North Sea fisheries; information was obtained from Denmark, Scotland, England, Belgium, Netherlands, Sweden and Norway only.

- Due to increasing fuel prices, 2005/2006 has seen a shift from twin to single trawl by many boats in the Scottish demersal mixed fishery sector – North Sea, IVa, and Fladen grounds, and both *Nephrops* and whitefish fisheries. Also some boats are shifting to pair seine/trawl in the same sectors. The driver for these changes is to reduce fuel costs and to minimise gear damage. (UK, Scotland. Implication: Change in CPUE)
- Fuel costs and quota availability are also having a significant impact on the fishing strategies of the Norwegian offshore demersal fish trawling fleet. Operators are now targeting aggregated fish to increase CPUE to reduce operating costs (fuel) and are either remaining in port or switching to the shrimp fishery. In addition to targeting high aggregations, vessels are also adjusting practice to maximise revenue obtained from by-products, typically targeting fish with a high roe or liver (oil) content. The move into the shrimp fishery has been greatly reduced in recent years due to the low market value of this species. In many instances, fishermen are using this as an alternative to remaining in port in order to maintain their crews. (Norway. Implication: Change in CPUE).
- In the Swedish Nephrops fisheries in the Skagerrak effort has been switched from the trawl fishery to a pot fishery, although no estimates are available of the exact number of vessels involved. (Sweden. Implications: Changes in CPUE).
- There are visible changes in effort in the Danish industry. There has been an increase in haddock landings values by the Danish Seine fleet in the North Sea, although no increase in effort levels. In addition to these small changes in the catch composition the impression from the most recent years is that much effort is being shifted between areas (North Sea and Skagerrak/Kattegat) by the trawl and seine sectors of the Danish fleet without this being visible/changing the overall picture of the total effort allocation on methods and areas. The changes in fleet dynamics are being driven by a variety of underlying mechanism of biological, economical and management related nature with the two major ones being I) the negative stock developments of cod and sand eel with attached regulatory initiatives and II) the ongoing general revision of the Danish management measures towards a system with individual quotas, where building up historical rights (in terms of a catch history) in as many geographical management units as possible is becoming increasingly important for the

individual vessels. (Denmark. Implications: Changes in CPUE; Misreporting of landings by areas)

- There is evidence of Scottish whitefish boats moving between Areas IVa and VIa to retain haddock and monkfish quotas and create track record in both areas. There is evidence of misreporting of haddock and other species caught in VIa and b landed as IVa. (UK, Scotland. Implication: Inaccurate landings data).
- Around a dozen Northern Irish multi-rig vessels participated in the Farne Deeps Nephrops fishery in 2005/2006 as fish and Nephrops quota restrictions meant it wasn't economically viable to remain in area VIIa. (UK, Northern Ireland. Implications: Changes in CPUE).
- There has been a large expansion in the squid fishery in the Moray Firth area. There has been an increase in effort from smaller <10m vessels, but also a number of larger vessels have switched from demersal fisheries for haddock and cod to squid fishery to avoid days at sea restrictions. There is evidence of an increase in gear damage by these larger vessels as they strive to work increasingly hard ground areas. Nets are used with high headline, with heavy ground gear, fished hard down on the seabed. These vessels are using small mesh size (40mm codends), which may result in bycatch/discard of young haddock and cod. (UK, Scotland. Implications: Change in CPUE; Discarding; Increased use of Heavy Rockhopper Footropes with increased potential bottom impact).
- The latest days' allocations under EU Regulation No. 51/2006 still provide no incentive for Nephrops fishermen to use a mesh size larger than 80 mm. If they use gear in the mesh size range (100–119 mm) then they lose days at sea from 227 to 103 per year. There has therefore been a steady shift into smaller mesh fisheries. The proposed use of the Swedish Grid in 2006 for Nephrops fishery, introduced under this regulation to allow extra fishing days, is unlikely to be taken up by the Scottish mixed whitefish/prawn fleet because it requires >70% prawns in the catch which precludes a mixed fishery, and because of perceived problems of handling (grids don't go through powerblocks) and blockage of the grid by mud/debris. A Scottish initiative with industry backing to introduce 95mm codends with 120mm square mesh panel (SMP) for *Nephrops* has been put forward as an alternative gear combination, with a proposed increase in the number of days for this gear combination compared to the 70–99 mm mesh size range. There is still debate as to the correct positioning of the SMP, although trials are planned to test different variations. Initial indications, however, from Denmark and Norway indicate the 120 mm SMP gives good improvements to selectivity for cod and haddock. (UK, Scotland. Implications: Change in CPUE; Discarding; Uptake of TCM).
- In order to reduce discards of cod in the mixed fishery primarily in the North Sea, a 140 mm window was introduced in the EU effort regulations from 2006. Using the window is granted with one day at sea / month. In 2005 the properties of the window was investigated in a catch comparison experiment. There is uptake of this measure in Denmark. (Denmark. Implications: Uptake of TCM with improvements to selectivity).
- In Belgium, with the increased cost of fuel and pressure to use gears that have less bottom impact, beam trawlers are looking at alternative gears, particularly gillnets. The current regulations, however, provide little incentive to switch to such gears such, as the current effort levels contained in the regulation are the same for both gears (~ 140 days). (Belgium. Implications: Management measures counter productive).
- There is evidence from the net makers in Scotland of increased use of "double crown" trouser trawls. These nets have a wider mouth opening, with a twin codend arrangement and are seen by some fishermen as an alternative to twin rigging, given the increase in swept area compared with a standard trawl. (UK, Scotland. Implications: Technology Creep)
- There has been an increasing trend in the past few years for Norwegian fishermen to use thicker rope in the seine net fisheries typically increasing from 32mm to 42mm diameter rope. It is believed that this 'thicker' rope has better fishing

power and it has also opened up more areas to exploitation. In addition more Norwegian vessels are now using the triplex hauling system as opposed to the power block for hauling the seine net, as this system is easier to operate and allows for continued fishing in periods of bad weather. (Norway. Implications: Technology Creep; Increased bottom impact; Change in CPUE)

- Many Norwegian seine net operators are choosing to use minimum mesh sizes in excess of the legal Norwegian minimum mesh size of 125mm full square mesh codend, and opting for 145–160 mm in order to a) ensure access to fishing grounds by reducing the retention of fish below minimum catch size and b) to maximise the economic return from individual quotas by targeting larger fish due to high price differential between size categories e.g. 10Nok/kg for 800g fish and 20–22Nok/kg for fish >2.5kg. (Norway. Implications: Change in CPUE; Voluntary uptake of more selective gear) The Norwegian offshore trawler fleet has gradually been increasing the size and weight of the trawls used e.g. larger trawls, bigger doors and increased ground gear weight to open up previously inaccessible trawling areas. (Norway. Implications: Technology Creep; Increased bottom impact)
- There haven't been any major shifts between fisheries, beam trawlers still account for more than 93% of the Belgian fleet, however, due to high fuel prices, several vessels of this fleet segment have tested different methods in order to reduce their fuel costs. These include (a) reducing the weight of the beam trawl by decreasing the length of the beam or reducing the weight of the shoes. These adaptations were tested and financed by only a few vessels of the big segment (engine power > 300kW); (b) Installing econometers to monitor fuel consumption. At present, econometers are only installed on a few vessels, however in the near future it is to be expected that the use of an econometer will increase, particularly if grant aid becomes available. (c) Limited diversification trials fishing gear to replace beam trawls with other trawl gear. These include 3 small bean trawls (<221Kw) and 1 lager beamer (> 221KW) converting to outrigger trawling, with a further larger beam trawler converting to twin-rigging and a smaller vessel to single-rig trawling. It is to be expected that this kind of (seasonal) replacements will increase in the upcoming years. In addition several fishermen have explored new types of fisheries and/or fishing methods. These changes are only minor, involving 4 vessels, converting from beam trawling to squid, Nephrops and one vessel changing to handlining for sea bass. Indications are though, that this trend will continue in Belgium. (Belgium. Implications: Changes in CPUE; Changes to Fleet Structure).
- Two large beam trawlers in the Belgium fleet (~1200Kw) are currently testing two technical modifications for the beam trawl, including T90-codends in combination with a benthos release panel in the belly of the beam trawl. Indications are that the remaining fleet are considering a voluntary uptake of these modifications. (Belgium. Implications: Voluntary uptake of technical measures).
- There is evidence in Belgium that fishermen in the beam trawl sector, who had previously under reported their engine horsepower, have now re-aligned their engine horsepower upwards to increase their fishing entitlements, allocated under national management measures. Similar situations have arisen in a number of other countries. (Belgium. Implication: Changes in CPUE).
- In Belgium, vessel owners have been encouraged to replace smaller beam trawlers with one large vessel but it is debatable whether the fishing operations of these larger vessels, using heavier gear but over a narrower area, has a greater or lesser effect on benthic habitats than a larger number of smaller boats fishing over a wider area. (Belgium. Implication: Effect on bottom impact).
- The development of electrified beam trawling for flatfish species has been tested in the Netherlands. The main driver is to lessen impact on benthic communities and diminishing discarding of target species sole and plaice, but recently also to decrease fuel consumption. Attempts are currently made to lift the European ban and while there are definite benefits in terms of fuel consumption and less bottom

impact on the use of electricity, concerns have been raised about the possible ecosystem effects of using the electric beam trawl system. (See FTFB expert group report). (Netherlands. Implications: Changes in CPUE; Ecosystem effects).

- Currently Dutch skippers in the beam trawl fleet reacting to high fuel prices are reportedly towing slower and changing gear components, including using larger mesh sizes in forward parts of the trawl and thinner twines in codends. (Netherlands. Implications: Changes in CPUE; Improved selectivity of gear).
- Another development seen in the Dutch beam trawl fleet is the installation of automatic winch controls (Marelec™-system), thus avoiding gear fasteners leading to smaller losses in fishing time, and possibly working on new grounds. (Netherlands. Implications: Technology Creep; Bottom Impact)
- Twin/multiple trawl rigs have increased in use in Denmark increasing the catch efficiency for demersal species (e.g. Nephrops and plaice) significantly and probably to such a level that the changes in CPUE cannot be derived analytically from official catch and effort data. DIFRES is presently working on this subject but results are not yet available on the actual increase in effort. (Denmark. Implications: Changes in CPUE; Technology Creep).
- Approximately 4 UK vessels have switched from twin-rig to quad-rigs in an area in IVb mainly in the Nephrops fishery. The change in CPUE has not been quantified but evidence suggests an increased catches of small lemon sole. (UK, England. Implication: Change IN CPUE; Technology Creep)
- Their gross earnings. The Irish beam trawl fleet, the larger twin-riggers and the 30m+ whitefish trawlers have been hardest hit. Owners have become increasingly fuel conscious, steaming to and from fishing grounds at reduced speed and shutting down all engines while at port. There is also evidence of fishermen begin to experiment with gear designs to improve fuel efficiency. (UK, Ireland. Implication: Change in CPUE)
- There has been increased effort in the Nephrops fisheries in Area VIa. Several of the larger 24m+ demersal trawlers have switched to trawling for Nephrops after the spring whitefish fishery in the south-east finished in early April. These vessels have targeted monkfish previously but due to increased enforcement and the days at sea restrictions for mesh size over 100mm in Area VIa, several of the vessels have switched to Nephrops fisheries. These vessels have concentrated on the Stanton Bank. (Ireland. Implication: Change in CPUE)
- There is concern about moves by certain Galician based companies to acquire “double licences”, enabling the large freezer trawlers working in NAFO waters to switch their fishing effort to Areas VI and VII and international waters, initially fishing against Spanish blue whiting quotas. The first of these vessels (77m trawler) set sail from Vigo in March. According to the Spanish Ministry these vessels are being allowed access to the blue whiting quota, which has traditionally used for “quota swaps” with other countries for monkfish, hake and megrim quota primarily for the large Grand Sol fleet, but sources in Spain have indicated the real reason is to provide a window-of-opportunity to gain eventual access to Areas VI, VII and VIII for the NAFO fleet. The consequences for the Irish industry if this is allowed to happen are potentially catastrophic and there is also a lot of concern amongst the Grand Sol fleet as well. (Ireland, Spain. Implications: Changes in CPUE)
- There has been increased use of duplex “trouser” trawls with two codends. These nets have increased opening with a wide bosom section and increase ground coverage. This type of trawl is used mainly by Nephrops vessels and there are reports of at least one vessel twin-rigging with two Duplex nets. At least one seine net vessel has fished with a Duplex seine net, mainly to improve fish quality. (Ireland. Implication: Technology Creep)
- Due to increasing fuel costs, several Irish twin-rig vessels are now using nets for monkfish constructed in 200mm top and bottom wings and belly sheets with 160mm codends. These nets are low drag and easy to tow and due to the fact that

this fishery is almost 100% monkfish, no marketable catch is lost with the large mesh codends. (Ireland. Implications: Improved selectivity/targeted fishery)

- In 2005, Ireland did not manage to fully catch the hake caught, due to a decline in the number of gillnet vessels and as a result several 24m demersal vessels are planning to pair trawl for hake using Spanish style VHO trawls to target hake. This is seen as a viable fishery, particularly given the gillnet ban currently in force in Areas VI and VII has meant a huge reduction in effort in the area and good signs of hake in all areas. (Ireland. Implications: Changes in CPUE; Targeted fishing with selective gear).
- The latest days' allocations under EU Regulation No. 51/2006 still provide no incentive for Nephrops fishermen to use a mesh size larger than 80mm. If they use gear in the mesh size range (100-119mm) then they lose days at sea from 227 to 103 per year. There has therefore been a steady shift into smaller mesh fisheries. The proposed use of the Swedish Grid in 2006 for Nephrops fishery, introduced under this regulation to allow extra fishing days, is unlikely to be taken up by the Irish Nephrops fleet in Area VIa or VIIa because it requires >70% prawns in the catch which precludes a mixed fishery, and because of perceived problems of handling (grids don't go through powerblocks) and blockage of the grid by mud/debris. (Ireland. Implications: Change in CPUE; Discarding; Uptake of TCM).
- Under Regulation 51/2006 the use of gillnets has been banned outside 200m depth. This was largely as a result of the DEEPNET report, which raised concerns about the deepwater tangle net fisheries for monkfish and deepwater shark involving up to 50 Anglo Spanish vessels. This ban has also affected vessels targeting hake and caused a shift in effort to other areas but greatly reduced the effort in Area VI and VII. This ban is not considered permanent and the EU has indicated that are willing to open the fisheries again if a property management framework for these fisheries can be agreed. (All countries. Implications: Changes in CPUE).

2.1.2 Technical measures

The national management measures with regard to the implementation of the available quota in the fisheries differ between species and countries. The industrial fisheries are subject to regulations for the by-catches of other species (e.g. herring, whiting, haddock, cod). Quotas for these fisheries have only recently been introduced. Technical measures relevant to each stock are listed in each stock section – for convenience, the recent history of technical measures in the area as a whole is also summarised here.

Until 2001, the technical measures applicable to the North Sea demersal stocks in EU waters were laid down in the Council Regulation (EC) No 850/98. Additional technical measures have been established in 2001 by the Commission Regulation (EC) No 2056/2001, for the recovery of the stocks of cod in the North Sea and to the west of Scotland. Their implementation in EU waters is described below. In 2001, an emergency measure was enforced by the Commission to enhance cod spawning (Commission Regulation EC No 259/2001). Council Regulation (EC) 2341/2002, Annex XVII, regulated the fishing effort in 2003 in the context of recovery of certain cod stocks. Council Regulation (EC) No 423/2004, the cod stocks recovery plan, was put into force by 26 February 2004. The TAC and Quota regulation for 2004 in Council Regulation (EC) No 2287/2003 further establishes a revised interim effort management based on days at sea by area, vessel, month and gear (Annex V) and an area based management to enhance the utilisation of the North Sea haddock TAC with the aim to prevent cod by-catches Annex (IV, Article 17). Such effort regulations were revised for 2005 in Council Regulation (EC) No 27/2005, Annex IVa. For 2006 a more complicated effort-limitation scheme was introduced, in which days-at-sea allocations were determined by vessel and gear type, area, and target species (Council Regulation (EC) No 51/2006). The allocations are summarised in full in Table 2.1.6.

2.1.2.1 Minimum landing size

"Undersized marine organisms must not be retained on board or be transhipped, landed, transported, stored, sold, displayed or offered for sale, but must be discarded immediately to the sea" (EC 850/98). Minimum landing sizes in the North Sea are the same as in all European waters (except in Skagerrak and Kattegat, where minimum sizes are slightly smaller). The value for demersal stocks is shown below.

COD	35 CM
Haddock	30 cm
Saithe	35 cm
Whiting	27 cm
Sole	24 cm
Plaice	27 cm

2.1.2.2 Minimum mesh size

Regulations on mesh sizes are more complex than those on landing sizes, as they differ depending on gears used, target species and fishing areas. Many other accompanying measures are implemented simultaneously with mesh sizes. They include regulations on gear dimensions (e.g. number of meshes on the circumference), square-meshed panels, and netting material. The most relevant mesh size regulations of EC No 2056/2001 are presented below.

Towed nets excluding beam trawls

Since January 2002, the minimum mesh size for towed nets fishing for human consumption demersal species in the North Sea is 120 mm. There are however many derogations to this general rule, and the most important are given below:

- ***Nephrops* fishing.** It is possible to use a mesh size in range 70-99 mm, provided catches retained on board consist of at least 30% of *Nephrops*. However, the net needs to be equipped with a 80 mm square-meshed panel if a mesh size of 70-99 mm is to be used in the North Sea and if a mesh size of 70-89 mm is to be used in the Skagerrak and Kattegatt the codend has to be square meshed.
- **Saithe fishing.** It is possible to use a mesh size range of 110-119 mm, provided catches consist of at least 70% of saithe and less than 3% of cod. This exception however does not apply to Norwegian waters, where the minimum mesh size for all human consumption fishing is 120 mm. Since January 2002 Norwegian trawlers (human consumption) have had a minimum mesh size of 120 mm in EU-waters. However, since August 2004 they have been allowed to use down to 110 mm mesh size in EU-waters (but minimum mesh size is still 120 mm in Norwegian waters).
- **Fishing for other stocks.** It is possible to use a mesh size range of 100-119 mm, provided the net is equipped with a square-meshed panel of at least 90 mm mesh size and the catch composition retained on board consists of no more than 3 % of cod.
- **2002 exemption.** In 2002 only, it was possible to use a mesh size range of 110-119 mm, provided catches retained on board consist of at least 50% of a mixture of haddock, whiting, plaice sole, lemon sole, skates and anglerfish, and no more than 25% of cod.

Beam trawls

- **Northern North Sea.** It is prohibited to use any beam trawl of mesh size range 32 to 119 mm in that part of ICES Sub-area IV to the north of 56° 00' N. However, it is permitted to use any beam trawl of mesh size range 100 to 119 mm within the area enclosed by the east coast of the United Kingdom between 55° 00' N and 56° 00' N and by straight lines sequentially joining the following geographical coordinates: a point on the east coast of the United Kingdom at 55°

00' N, 55° 00' N 05° 00' E, 56° 00' N 05° 00' E, a point on the east coast of the United Kingdom at 56° 00' N, provided that the catches taken within this area with such a fishing gear and retained on board consist of no more than 5 % of cod.

- **Southern North Sea.** It is possible to fish for sole south of 56° N with 80-99 mm meshes in the cod end, provided that at least 40 % of the catch is sole, and no more than 5 % of the catch is composed of cod, haddock and saithe.

Combined nets.

It is prohibited to simultaneously carry on board beam trawls of more than two of the mesh size ranges 32 to 99 mm, 100 to 119 mm and equal to or greater than 120 mm.

Fixed gears.

The minimum mesh size of fixed gears is of 140 mm when targeting cod, that is when the proportion of cod catches retained exceeds 30% of total catches.

2.1.2.3 Closed areas

Twelve mile zone

Beam trawling is not allowed in a 12 nm wide zone along the British coast, except for vessel having an engine power not exceeding 221 kW and an overall length of 24 m maximum. In the 12 mile zone extending from the French coast at 51°N to Hirtshals in Denmark trawling is not allowed to vessels over 8m overall length. However, otter trawling is allowed to vessels of maximum 221 kW and 24 m overall length, provided that catches of plaice and sole do not exceed 5% of the total catch. Beam trawling is only allowed to vessels included in a list that has been drawn up for the purposes. The number of vessels on this list is bound to a maximum, but the vessels on it may be replaced by other ones, provided that their engine power does not exceed 221 kW and their overall length is 24 m maximum. Vessels on the list are allowed to fish within the twelve miles zone with beam trawls having an aggregate width of 9 m maximum. To this rule there is a further derogation for vessels having shrimping as their main occupation. Such vessels may be included in annually revised second list and are allowed to use beam trawls exceeding 9 m total width.

Plaice box

To reduce the discarding of plaice in the nursery grounds along the continental coast of the North Sea, an area between 53°N and 57°N has been closed to fishing for trawlers with engine power of more than 221 kw (300 hp) in the second and third quarter since 1989, and for the whole year since 1995.

Cod box

An emergency measure to enhance cod spawning in the North Sea has been enforced in January 2001. The EU and Norway agreed on a temporary closure of the demersal fishery in the main spawning grounds from February 15 until 30 April 2001.

Sandeel box

In the light of studies linking low sandeel availability to poor breeding success of kittiwake, ICES advised in 2000 for a closure of the sandeel fisheries in the Firth of Forth area east of Scotland. All commercial fishing was excluded, except for a maximum of 10 boat days in each of May and June for stock monitoring purposes. The closure was maintained for three years and has been extended into 2006, with a small increase in the effort of the monitoring fishery, after which the effect of the closure will be evaluated.

Cod protection area in the North Sea

The cod protection area defined in Council Regulation (EC) No 2287/2003 Annex IV was intended to enhance the TAC uptake of haddock in the North Sea while preventing cod by-catches. It regulated fishing of haddock of licensed vessels for a maximum of 3 months under the conditions that there was no fishing inside or transiting the cod protection area, that cod did not contribute more than 5 % to the total catch retained on board, that no transhipment of fish at sea occurred, that trawl gear of less than 100 mm mesh size was carried on board or deployed, and that a number of special landing regulations were complied with. It was discontinued at the end of 2004.

2.1.2.4 Fishing effort limitation

Interim fishing effort limitations laid down in Council Regulation (EC) No 2287/2003 Annex V determine maximum days at sea for 2004 by area, month, vessel and gear types and mesh ranges deployed with a variety of derogations, e.g. depending on landings composition in the track record of individual vessels, mesh size, or on the basis of the achieved results of decommissioning programmes that have taken place since 1 January 2002. This has since been superseded by the effort limitations summarised in Table 2.1.6.

2.1.3 Environmental considerations

The WGs conclusions regarding the report of the 2006 ICES Working Group on Regional Ecosystem Descriptions (ICES-WGRED 2006) are given in Section 1.4.2. In brief: although it is clear that the North Sea ecosystem is undergoing change and this will affect fish stocks, the causal mechanisms linking the environment with fish stock dynamics are not yet clearly-enough understood for such information to be used as part of fisheries management advice. Environmental considerations are therefore not given in detail here.

2.1.4 Human consumption fisheries

2.1.4.1 Data

The level of biological sampling in 2005 for the stocks assessed by this WG is summarised in Table 1.2.1. The effect of the EU Data Regulation has been to increase sampling effort in some components of the fisheries, but decrease it in others.

Estimates of discarding rates from the Scottish observer sampling programme were used in the assessments of cod, haddock and whiting in the North Sea, after raising to the level of the international catch. A combination of observed (from the Dutch and English sampling programmes) and reconstructed discard rates were used in the North Sea plaice assessment. Other discard sampling programmes have been in place in recent years, but have not been used in the assessments yet because of short time-series or because of collation problems. In general, some discarding occurs in most human-consumption fisheries, particularly when strong year-classes are approaching the minimum landing size.

For a number of years there have been indications that substantial under-reporting of roundfish and flatfish landings is likely to have occurred. Anecdotal evidence for this is particularly strong for cod during 2001–2003, when the agreed TAC implied a reduction in effort of more than 50% which the WG suggests probably did not occur. In the absence of information from the industry on the likely scale of this under-reporting, the WG have continued to use a modified assessment method for North Sea cod (Section 14) which estimates unallocated removals on the basis of research-vessel survey data. Such removals may be due to reporting problems, unrecorded discards, changes in natural mortality, or changes in survey catchability, and cannot be interpreted as representing mis- or underreporting. In addition, increased enforcement of regulations (and measures such as the

UK Buyers and Sellers Regulation) means that mis- or underreporting may be less now than previously.

Several research-vessel survey indices are available for most species, and were used both to calibrate population estimates from catch-at-age analyses, and in exploratory analyses based on survey data only. Commercial CPUE series were available for a number of fleets and stocks, but for various reasons few of them could be used for assessment purposes (although they are presented and discussed in full for each stock). The use of commercial CPUE indices is being phased out where possible.

Bycatches in the industrial fisheries were significant in the past for haddock, whiting and saithe, but these have reduced considerably in recent years.

2.1.4.2 Stock impressions

Historical estimates for yield, mean fishing mortality, spawning-stock biomass and recruitment are given in Figures 2.1.1 – 2.1.4 for the stocks considered by this WG. Note that the WG was unable to provide a final assessment for plaice in VIId. In addition, analytic assessments are not currently available for the ten *Nephrops* stocks.

In the North Sea all stocks of roundfish and flatfish species have been exposed to high levels of fishing mortality for a long period. For most of these stocks their lowest observed spawning stock size has been seen in recent years. This may be an indication of excessive fishing effort, possibly combined with an effect of a climatic phase which is unfavourable to recruitment. For a number of years, ICES has recommended significant and sustained reductions in fishing mortality on some of the stocks. In order to achieve this, significant reductions in fishing effort are required. In recent years, estimated fishing mortality has declined in most stocks for which analytic assessments are available.

Catches of **cod** in Sub-area IV and Divisions IIIa and VIId have stabilised at a low level over the past three years. Estimated spawning-stock biomass remains low but stable (~ 35 kt). Fishing mortality is now estimated to have declined since 2000 (median estimate for 2005 ~ 0.86). Recruitment of the 2000-2005 year-classes was poor. Indications from Q1 and Q3 surveys in 2006 are that the 2006 year-class is somewhat stronger, but only significant reductions in realised fishing effort will enable biomass increases in the short-term future.

Haddock catches in Sub-area IV and Division IIIa in 2005 were similar to those in 2004: the decline in abundance of the dominant 1999 year-class has been offset to a certain extent by improved growth of individuals. However, this has not prevented a continued decline in SSB (from 298 kt in 2004 to 256 kt in 2005). Fishing mortality has stabilised at or around 0.3 (it has now been in the range 0.25 to 0.35 for four years). The 2005 year-class (recruiting at age 0) is estimated to be quite abundant (35 000 million) and the largest since the 1999 year-class (now estimated to have been 114 000 million, a slight increase on the estimate in last year's assessment).

The assessment of **whiting** in Sub-area IV and Division VIId is again quite uncertain. The same concerns as last year were raised about stock structure, but in the absence of improved information on stock distribution the WG decided to present the same approach as last year (in the full knowledge that this was rejected by ACFM). The final assessment indicates historically low (or nearly so) estimates of yield (landings 15.3 kt), recruitment (346 million), SSB (104 kt) and fishing mortality (0.25). Without good recruitment the stock is unlikely to recover. This assessment must be considered in the light of industry reports that whiting are more abundant than for several years, particular off the north-east coast of England. The Scottish industry are also reporting good catches of whiting and are likely to take their quota in full, which doesn't correspond to the low forecast landings for 2006.

Landings of **saithe** in Sub-areas IV and VI and Division IIIa have been stable for several years at a level well-below the permitted TAC. Fishing mortality has now remained at or below 0.3 for six years (*F* ~ 0.26 in 2005) while SSB continues a steady increase (288 kt in 2005). Recruitment is fluctuating about the mean level.

The reported landings for **sole** in Subarea IV in 2005 (16.4 kt) were at a similar level as in recent years. SSB has fluctuated around a moderate-to-low level for several years, although at *status quo* fishing mortality it is forecast to drop below B_{pa} during 2006.

As in the previous two meetings, the assessment of **plaice** in Subarea IV included modelled discard estimates for recent years. Landings and discards have both declined in recent years. SSB remains at a relatively low level (between B_{lim} and B_{pa}), while fishing mortality has declined (although it is still above the long-term mean). Recent year-class strength has been poor. Surveys suggest the 2005 year-class to be around the long-term average.

The yields for stocks of ***Nephrops*** are fairly stable from year to year. Reported landings for FU 5 (Botney Gut, 100 t), FU 6 (Farne Deeps, 3100 t), FU 8 (Firth of Forth, 2000 t), FU 9 (Moray Firth, 1600 t), FU 10 (Noup, 165 t), and FU 32 (Norwegian Deeps, 990 t) are all at or near the respective recent averages. Both FU 7 (Fladen, 10700 t) and FU 33 (Off Horn Reef, 1000 t) are at or near their highest-observed levels of landings. Indications from TV surveys for FUs 6, 7, 8, and 9 are that stock densities are fluctuating about a long-term mean.

2.1.5 Industrial fisheries

2.1.5.1 Description of fisheries

The industrial fisheries dealt with in this report are the small meshed trawl fisheries targeted at Norway pout and sandeel.

2.1.5.2 Data available

Data on landings, fishing effort and species composition are available from all industrial fisheries.

2.1.5.3 Trends in landings and effort

Sandeel landings in 1974–1985 fluctuated between 428 kt and 787 kt with a mean of 611 kt. In the period 1986–2000 the landings increased to a generally higher level between 591 kt and 1091 kt and a mean of 819 kt. In 1997 the combined Danish and Norwegian landings of more than 1 million tonnes were the highest ever recorded. Landings in 2002 for Norway and Denmark were 804 kt (Table 2.1.2) which is just above the average of 779 kt for the period 1980-2002. Landings in 2003 (303 kt) and 2004 (324 kt) were relatively low. The fishery in 2005 was closed on July 2nd, after landings of 172 kt during the year to date, while the fishery in 2006 also closed early but took rather more sandeel (267 kt).

Norway pout landings showed a downward trend in the period 1974–1988. Thereafter the landings have fluctuated around a level of 150 kt. The respective landings in 1998 and 1999 were 80 kt and 92 kt, which were the lowest landings since 1974. In 2000 Norway pout landings increased to around 184 kt based on a fishery on the strong 1999 year class. Landings in 2001 and 2002 were around 66 kt and 77 kt, respectively. These were the lowest landings recorded since 1967 and well below average for the previous five years. The 2003 (27 kt) and 2004 (13.5 kt) landings continued this trend, and the directed fishery was closed for 2005 and 2006. Both of these years saw small catches of Norway pout as bycatch in other fisheries, and following small experimental fisheries.

2.1.5.4 Stock impressions

Trends in yield, mean *F*, SSB and recruitment for sandeel and Norway pout are given in Figures 2.1.1–2.1.4.

Landings in 2005 for **sandeel** in Sub-area IV (172 kt) remained at or near the same low level as in the preceding three years. Landings in 2006 have continued this trend, and following the implementation of a real-time management plan, the fishery was closed in July 2005. Estimated SSB is close to its lowest observed level and is well below B_{lim}. Fishing mortality has declined in recent years and is now below the long-term mean. Recruitment remains low. In order to permit a fishery in 2007, the 2007 year-class would have to be substantially larger than recent year-classes.

The directed fishery for **Norway pout** in Sub-area IV was closed during 2005 and most of 2006. Landings in 2005 (1.9 kt) were the lowest observed; these arose from experimental fishing and a limited bycatch. In-year survey-based monitoring in April 2006 led to the opening of the fishery with a TAC of around 90 kt, although less than 50% of this is likely to be taken. Estimated SSB for this stock in 2005 was well below B_{lim} and fishing mortality was effectively zero. The size of the 2005 year-class was the largest since 1999, while the 2006 year-class was moderately abundant. The potential for a fishery in 2007 will be dependent on the survival and growth of these year-classes, along with the size of the 2007 year-class

2.2 Stocks in the Skagerrak and Kattegat (Division IIIa)

2.2.1 Fishery descriptions

The fleets operating in the Skagerrak and Kattegat (Division IIIa) include vessels targeting species for both human consumption and reduction purposes. The human consumption fleets include gill-netters and Danish seiners exploiting flatfish and cod, and demersal trawlers involved in various human consumption fisheries (roundfish, flatfish, *Pandalus,* and *Nephrops*). Demersal trawling is also used in fisheries for industrial species and herring, which are landed for reduction purposes.

The roundfish, flatfish, and *Nephrops* stocks have historically been exploited mainly by Danish and Swedish fleets consisting of bottom trawlers (*Nephrops* trawls with >70 mm mesh size and bottom trawls with >105 mm mesh size), gill-netters, and Danish seiners. Since 2003 Dutch beam trawlers have entered the area and exert considerable fishing effort on plaice in Division IIIaN. Recorded effort in the major Danish fleets fishing for plaice and cod has been stable for nearly a decade. These fleets do not comprise the entire fishery, but are however considered representative of trends in effort.

The industrial fishery is a small-mesh trawl fishery mainly carried out by vessels of a size above 20 m. This fleet component has also decreased over the past decade. Highest catches are from fisheries targeting sandeel, sprat and herring. There is also a trawl fishery landing a mixture of species for reduction purposes. Catches from the industrial fishery are given in Table 2.2.1, while bycatches of commercial stocks are summarised in Table 2.2.2.

There are important technical interactions between the fleets. This issue has been discussed by the WG since its 2003 meeting (ICES-WGNSSK 2003) where the analysis was restricted to the North Sea. In 2004 data were also available for the Skagerrak Danish, Norwegian, Swedish and German fisheries. The methodology used was presented in Section 15 of the 2005 report. Most of the human consumption demersal fleets are involved in mixed fisheries. Norway pout and the mixed clupeoid fishery have by-catches of protected species.

Discard data have been collected for cod, whiting, haddock, and flatfish in the area since the second half of 1999. Due to the short time-series, and problems with data collation and submission, the data were not included in the assessment this year. The Skagerrak-Kattegat area is to a large extent a transition area between the North Sea and the Baltic, with regards to the hydrography, the biology, and the identity of stocks in the area. The exchange of water between the North Sea and the Baltic is the main hydrographic feature of the area.

2.2.2 Technical measures

The technical measures in force in the North Sea are largely replicated in the Skagerrak-Kattegat area, with a few exceptions regarding days-at-sea allowances, permitted gears, and minimum landing sizes. See Section 2.1.2 for a summary of the measures in force.

2.2.3 Environmental considerations

Several of the stocks in the Skagerrak may not be separate stocks but may interact with stocks in the North or Baltic Seas. This is the case for cod, haddock, whiting, and Norway pout. Plaice in Division IIIa in considered as being a mix of several sub-populations, which would intermingle both with the North Sea and the Belt Sea/Baltic Sea. This issue is explored further in Section 7.1.5.

2.2.4 Human consumption fisheries

Trends in yield, mean *F*, SSB and recruitment for plaice (the only stock in Division IIIa that is assessed by WGNSSK) are given in Figures 2.1.1–2.1.4.

The official landings of **cod** in Division IIIa in 2005 were 3805 tonnes in the human consumption fishery, which is similar to 2003 and 2004. The majority of catches were taken by Denmark. The WG has no updated information on the distribution of catches, but in previous years around 90% of the Division IIIa total was taken in the Skagerrak. Cod in Skagerrak is assessed together with the North Sea (Division IV) and Eastern Channel (Division VIId) stock. Cod in Kattegat is assessed as a separate stock by the Baltic Fisheries Assessment Working Group. Since 2002, ICES has advised that no fishery should take place on this stock. However, the Kattegat cod is covered by the EC recovery plan (Council Regulation no. 423/2004, of 26 February 2004), which allows a TAC even though biomass is below B_{lim}.

Landings of **haddock** in Division IIIa, in the human consumption fishery, amounted to 784 tonnes in 2005 (which is the lowest in the time-series, and 50% less than 2004). Most of the catches are taken by Danish fleets in the Skagerrak. Haddock in IIIa is assessed together with the North Sea (Division IV) stock.

Landings of **whiting** (for human consumption) were 135 tonnes in 2005, the lowest in the time-series. Most of the landings were taken in the Skagerrak. No analytical assessment of whiting in IIIa was possible.

Landings of **saithe** in Division IIIa are not available, as the official catch statistics aggregate Sub-area IV and Division IIIa. The saithe assessment covers Sub-areas IV and VI, and Division IIIa.

Plaice landings in Division IIIa fell in 2005 to an historical low of 6905 tonnes. The available quota has never been restrictive for this stock. About 82% of the landings were taken in the Skagerrak. Although the assessment is uncertain, the WGs best estimates indicate that has fluctuated rapidly since 1996 and is currently relatively low (~ 0.85); and that SSB is increasing following recruitment of the large 2003 year-class.

The **sole** landings in Division IIIa are mostly taken in Kattegat and this stock is assessed by the Baltic Fisheries Assessment Working Group. Landings in 2004 amounted at around 743 tonnes. Further information may be found in the report of Baltic Fisheries Assessment Working Group.

The ***Nephrops*** stock in Division IIIa consists of two functional units (Kattegat and Skagerrak). Landings in 2005 for both units were around the long-term average.

2.2.5 Industrial fisheries

Most of the landings from the industrial fisheries in Division IIIa consisted of sandeel, sprat and herring, but also blue whiting and Norway pout (Table 2.2.1). Data were provided by Denmark and Sweden for the years 1999-2004. All other years refer to data provided by Denmark only. The Norway pout assessment consists of Divisions IIIa and IV. It was not possible to assess sandeel in Division IIIa,

Bycatches of commercial roundfish in the Danish small-mesh fishery in Division IIIa are summarised in Table 2.2.2 (for years 1989-2004 only). By-catches of cod have been decreasing and remained low in the latest decade, while those of haddock have been decreasing steadily in the latest decade. The whiting bycatch has increased considerably in the past seven years. Almost no by-catches of saithe occur. By-catches of plaice have remained stable in the latest decade compared to a higher historical level (Table 2.2.2.)

2.3 Stocks in the Eastern Channel (Division VIId)

2.3.1 Fishery descriptions

Flatfish

Approximately 500 vessels fish for sole and plaice at some time during the year in the eastern Channel and are heavily dependent on sole. More than 50% of the reported landings come from small vessels (<10 m). The gears used are mainly fixed nets but there is also considerable effort on trawling and potting. The other main commercial fleets fishing for flatfish in Division VIId include Belgian and English offshore beam trawlers (>300HP) which fish mainly for sole and also take plaice.

Roundfish

The offshore French trawlers are the main fleet fishing for cod and whiting using high headline trawls, but cod is also very important for inshore vessels which target this species during the winter using fixed nets. Cod and whiting are caught within a mixed fishery, along with other valuable species including bass, red mullet, gurnards and squid.

Effort

The fishing effort of French otter-trawlers and Belgian beam trawlers has strongly increased since the beginning of the 70’s and the French otter-trawlers show now sign of decrease. The fishing effort of both English beam trawlers and inshore trawlers show decreasing trends since the beginning of the series. Information on the French fixed net fleet, which takes about 50% of the French sole landings and less than 20% of the French plaice landings, is under investigation and should be available in the near future.

2.3.2 Technical measures

The technical measures in force in the North Sea are largely replicated in the eastern Channel area, with a few exceptions regarding days-at-sea allowances, permitted gears, and minimum landing sizes. See Section 2.1.2 for a summary of the measures in force.

2.3.3 Data

Discards

Within EU Regulation 1639/2001, UK, France and Belgium have initiated a discard sampling program. The UK program started in 2002 and is designed to sample North Sea and Eastern Channel. The level of the UK sampling in Eastern Channel is proportional to the ratio of UK effort between the two areas. The French discard sampling has started late in 2003 and it is designed to sample the main fleets in the Eastern Channel. Belgium started a pilot study on discards in 2003. Results will only be indicative for the level of discarding.

Catch at age

French fleets contribute to most of the landings of cod, whiting, sole and plaice, taking around 80–95% of the roundfish species and between 45–60% of the flatfish. Sampling for flatfish species was poor before 1986 but has improved since then. Quarterly sampling for age and sex is taken, and is thought to be representative of more than 80% of the landings of flatfish.

Surveys

The 4th quarter French Groundfish Survey (FraGFS) provides tuning indices for cod, whiting and plaice. A research vessel survey using beam trawl which covers most of Division VIId in August (BTS) is used in tuning assessments for sole and plaice. An International Young Fish Survey (YFS) is carried out along the English coast and in the Baie de Somme on the French coast and is used to calculate an index for 0-gp and 1-gp of sole and plaice.

2.3.4 State of the stocks

Cod and whiting have been assessed with the North Sea stocks since 1998 and are included in the overview for the North Sea (Section 2.1.3). Trends in yield, mean *F*, SSB and recruitment for plaice and sole in Division VIId are given in Figures 2.1.1–2.1.4.

Landings for **sole in Division VIId** have fluctuated around a mean level for many years, and show no significant trends. The fishing mortality is estimated to be around F_{pa} The SSB has above B_{pa} (8000t) following improved recruitment in recent years, particularly of the year classes 1998 to 2000 and 2003. There is a tendency to underestimate F and overestimate SSB.

Discrepancies between catch-at-age based analyses and survey-based analyses has prevented the WG from assessing the state of **plaice in Division VIId**. Landings have declined steadily since 2002 to 3500 tonnes, the lowest value since 1980.

2.4 Industrial fisheries in Division VIa

There are two distinct industrial fisheries operating in Division VIa; a Norway pout fishery and a sandeel fishery. The Norway pout fishery is now exclusively Danish, whereas the sandeel fishery is almost exclusively Scottish and operates in more inshore areas. No information is available on by-catches in the Norway pout fishery. The sandeel fishery has a small by-catch of other species; information from the 1995 and 1996 catches indicated that more than 97% of the catch consisted of *Ammodytes marinus*, with the by-catch consisting mostly of other species of sandeel. Landings from both fisheries have historically been small compared to the fisheries in the North Sea. There were no officially reported landings of sandeel from Division VIa in 2005.

Table 2.1.1. Human consumption (HCO) and industrial bycatch (IBC) landings of assessed species from the North Sea management area (in tonnes), as used by the WG in assessments.

Sum of landings	stock					
year	cod-347d	had-34	ple-nsea	sai-3a46	sol-nsea	whg-47d
1957			70563		12067	
1958			73354		14287	
1959			79300		13832	
1960			87541		18620	
1961			85984		23566	
1962			87472		26877	
1963	116457	68779	107118		26164	
1964	126041	130944	110540		11342	
1965	181036	162307	97143		17043	
1966	221336	226335	101834		33340	
1967	252977	147778	108819	94514	33439	
1968	288368	105830	111534	116789	33179	
1969	200760	331419	121651	131882	27559	
1970	226124	525325	130342	236636	19685	
1971	328098	237340	113944	272481	23652	
1972	353976	195494	122843	275098	21086	
1973	239051	181518	130429	259602	19309	
1974	214279	153116	112540	309439	17989	
1975	205245	151386	108536	308926	20773	
1976	234169	172607	113670	361680	17326	
1977	209154	145083	119188	223395	18003	
1978	297022	91674	113984	166199	20280	
1979	269973	87094	145347	135967	22598	
1980	293644	105071	139951	142395	15807	100810
1981	335497	138731	139747	146092	15403	89524
1982	303251	176635	154547	189861	21579	80549
1983	259287	167353	144038	197774	24927	87972
1984	228286	134505	156147	219642	26839	86281
1985	214629	165672	159838	226129	24248	62127
1986	204053	169157	165347	202758	18201	64114
1987	216212	111779	153670	180776	17368	68300
1988	184240	107978	154475	140778	21590	56103
1989	139936	80288	169818	117609	21805	45189
1990	125314	55558	156240	107945	35120	46896
1991	102478	48731	148004	115576	33513	53025
1992	114020	74614	125190	104147	29341	52188
1993	121749	81539	117113	119073	31491	53196
1994	110634	82730	110392	115255	33002	49242
1995	136096	77503	98356	125183	30467	46442
1996	126320	79176	81673	119669	22651	41074
1997	124158	82496	83048	112740	14901	35920
1998	146014	81070	71534	108699	20868	28464
1999	96225	65569	80662	114655	23475	30412
2000	71371	47569	81148	93566	22641	28807
2001	49694	40861	81963	96389	19944	25216
2002	54865	58308	70217	121377	16945	21716
2003	30872	44087	66502	106908	17920	16372
2004	28188	48697	61436	104476	17147	13583
2005	28708	48380	55700	117282	16355	15304
2006						
Grand Total	7809804	5488086	5480432	6439362	1085564	1298826

Sum of ibc	stock					
year	cod-347d	had-34	ple-nsea	sai-3a46	sol-nsea	whg-47d
1957						
1958						
1959						
1960						
1961						
1962						
1963		13783				
1964		88896				
1965		74921				
1966		46819				
1967		20755				
1968		34327				
1969		338887				
1970		179969				
1971		31812				
1972		29983				
1973		11451				
1974		48895				
1975		42726				
1976		50246				
1977		36982				
1978		11592				
1979		17175				
1980		23796				45757
1981		18306				66609
1982		20658				33042
1983		20316				23680
1984		12764				18897
1985		7001				15325
1986		4331				17966
1987		5889				16479
1988		5475				49219
1989		2770				42711
1990		4559				50718
1991		8014				38311
1992		15420				26901
1993		13156				20099
1994		5741				10354
1995		9909				26561
1996		7973				4702
1997		7299				5965
1998		5376				3141
1999		4168				5183
2000		8751				8886
2001		8097				7357
2002		3717				7327
2003		1149				2743
2004		554				1218
2005		168				882
2006						
Grand Total		1304574				550033

Table 2.1.2. Species composition in the Danish and Norwegian small-meshed fisheries in the North Sea (thousand tonnes). Data provided by WG members. The "other" category is subdivided by species in Table 2.1.3.

Year	Sandeel	Sprat	Herring	Norway pout	Blue whiting	Haddock	Whiting	Saithe	Other	Total
1974	525	314	-	736	62	48	130	42		1857
1975	428	641	-	560	42	41	86	38		1836
1976	488	622	12	435	36	48	150	67		1858
1977	786	304	10	390	38	35	106	6		1675
1978	787	378	8	270	100	11	55	3		1612
1979	578	380	15	320	64	16	59	2		1434
1980	729	323	7	471	76	22	46	-		1674
1981	569	209	84	236	62	17	67	1		1245
1982	611	153	153	360	118	19	33	5	24	1476
1983	537	88	155	423	118	13	24	1	42	1401
1984	669	77	35	355	79	10	19	6	48	1298
1985	622	50	63	197	73	6	15	8	66	1100
1986	848	16	40	174	37	3	18	1	33	1170
1987	825	33	47	147	30	4	16	4	73	1179
1988	893	87	179	102	28	4	49	1	45	1388
1989	1039	63	146	162	28	2	36	1	59	1536
1990	591	71	115	140	22	3	50	8	40	1040
1991	843	110	131	155	28	5	38	1	38	1349
1992	854	214	128	252	45	11	27	-	30	1561
1993	578	153	102	174	17	11	20	1	27	1083
1994	769	281	40	172	11	5	10	-	19	1307
1995	911	278	66	181	64	8	27	1	15	1551
1996	761	81	39	122	93	5	5	0	13	1119
1997	1091	99	15	126	46	7	7	3	21	1416
1998	956	131	16	72	72	5	3	3	24	1283
1999	678	166	23	97	89	4	5	2	40	1103
2000	655	191	24	176	98	8	8	6	21	1187
2001	810	156	21	59	76	6	7	3	14	1152
2002	804	142	26	73	107	4	8	8	15	1186
2003	303	175	16	18	139	1	3	8	18	681
2004	324	193	19	12	107	1	2	7	29	692
2005	172	207	23	1	101	0	1	6	13	524
Avg 75-05	694	196	59	207	66	11	32	7	32	1294

Table 2.1.2. cont. Quarterly species composition in the Danish and Norwegian small-meshed fisheries in the North Sea (thousand tonnes). Data provided by WG members. The "other" category is subdivided by species in Table 2.1.3.

Year quarter	Sandeel	Sprat	Herring	Norway pout	Blue whiting	Haddock	Whiting	Saithe	Other	Total
1998 q1	37	7	7	13	11	1	0	0	5	80
1998 q2	754	1	2	8	12	2	1	0	4	784
1998 q3	153	60	4	29	38	2	1	2	9	298
1998 q4	12	63	4	23	12	0	0	0	6	121
1999 q1	14	14	4	8	23	1	1	1	8	74
1999 q2	507	2	4	22	30	1	2	1	8	577
1999 q3	139	129	10	41	18	1	2	0	7	347
1999 q4	17	21	6	25	17	1	1	0	18	106
2000 q1	10	42	1	9	13	1	0	0	5	82
2000 q2	581	2	4	17	32	3	2	0	4	646
2000 q3	63	133	10	30	39	2	3	6	5	291
2000 q4	0	15	8	119	14	2	3	0	8	169
2001 q1	12	40	2	20	15	1	1	0	3	94
2001 q2	462	1	2	10	32	3	1	2	4	517
2001 q3	314	44	4	4	12	1	2	0	5	386
2001 q4	22	72	13	24	16	1	2	0	2	152
2002 q1	11	5	6	8	18	0	0	0	2	50
2002q2	772	0	3	5	19	1	2	0	4	806
2002q3	21	71	8	31	46	1	3	5	4	189
2002q4	0	66	10	28	24	1	2	3	6	141
2003 q1	3	18	1	2	14	0	0	1	5	45
2003 q2	239	1	2	4	42	0	1	1	3	292
2003 q3	57	56	4	5	56	0	1	4	4	188
2003 q4	4	100	9	7	28	0	1	2	6	157
2004 q1	2	1	4	1	19	0	0	1	12	41
2004 q2	273	0	2	1	33	0	1	1	5	315
2004 q3	50	55	5	4	37	0	0	2	7	160
2004 q4	0	136	9	6	18	0	0	2	5	177
2005 q1	0	12	1	0	11	0	0	0	3	28
2005 q2	158	3	1	1	37	0	0	1	3	204
2005 q3	14	108	6	0	36	0	0	3	3	170
2005 q4	0	84	15	0	16	0	0	2	3	122

0 denotes < 500 tonnes

Table 2.1.3 Sum of Danish and Norwegian North Sea by-catch (tonnes) landed for industrial reduction in the small-meshed fisheries by year and species (excluding Saithe, haddock and whiting accounted for in Table 2.1.2).

Species	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Gadus morhu	544	710	1092	1404	2988	2948	570	1044	1052	876
Scomber scor	4	534	2663	6414	8013	5212	7466	4631	4386	3576
Trachurus tra	22789	16658	7391	18104	22723	14918	5704	6651	6169	4886
Trigla sp.	0	888[2]	45342[2]	5394[2]	9391[2]	2598[2]	5622[2]	4209	1593	1139
Limanda limai	187	3209	4632	3781	7743	4706	5578	3986	4871	528
Argentina spp	8714	5210	3033	1918	778	2801	3434	2024	2874	2209
Hippoglossoic	59	718	1173	946	2160	1673	1024	1694	1428	529
Pleuronectes	34	119	109	372	582	566	1305	218	128	143
Merluccius me	349	165	261	242	290	429	28	359	109	10
Trisopterus m	0	68[3]	0	5[2]	48[2]	121[2]	79[2]	111	36	0
Molva molva[3]	51	1	40	39	37	13	65	10	28	0
Glyptocephalu	236[3]	132	341	44	255[3]	251[3]	1439[3]	195[3]	246	40
Gadiculus arg	1210	729	3043	2494	741	476	801	0	0	0
Others	31715[1]	3853	3604	3670	3528	3154	4444	4553	4106	5141
Total	65892	32994	72724	44827	59277	39866	37559	29685	27026	19077

Species	1995	1996	1997	1998	1999	2000	2001	2002[2]	2003	2004
Gadus morhu	955	366	1688	1281	532	383	192	29	49	44
Scomber scor	2331	2019	3153	1934	2728	2443	1749	1260	2549	6515
Trachurus tra	2746	2369	3332	2576	5116	5312	1159	2338	5791	10272
Trigla sp.	2091	897	2618	1015	2566	1343	2293	1071	847	1101
Limanda limai	1028	1065	2662	6620	4317	441	1441	321	596	386
Argentina spp	292	3101	2604	5205	3580	333	397		1376	786
Hippoglossoic	617	339	1411	2229	1272	493	431	112	208	174
Pleuronectes	33	90	73	91	88	64	56	51	28	1
Merluccius me	0	3625	2364	33	211	231	167	6	301	423
Trisopterus m	9	30	181	261	922	518	0	196	5	91
Molva molva[3]	0	0	31	31	125	19	49	0	42	169
Glyptocephalu	0	97	394	860	437	154	246	58	437	286
Gadiculus arg	0	7	248	248	387	532	942	459	993	1550
Others	5158	50	749	5405	17931	8927	301	2226	4888	6953
Total	15260	14055	21508	27787	40211	21192	12523	8127	20115	28750

Species	2005
Gadus morhu	22
Scomber scor	2195
Trachurus tra	5226
Trigla sp.	597
Limanda limai	287
Argentina spp	1348
Hippoglossoic	61
Pleuronectes	38
Merluccius me	254
Trisopterus m	0
Molva molva[3]	34
Glyptocephalu	87
Gadiculus arg	909
Others	1964
Total	13022

[1]DK cod and mackerel included. [2]Only DK catches. [3]N catches. DK catches in "Others". [4]Until 1995 N catches only. DK catches in "Others".

Table 2.1.4. Danish by-catch landings of cod, haddock and saithe in 1994–2005 from small-meshed fisheries in the North Sea. Landings (tonnes) used for reduction.

Cod	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Sandeel fishery	70	79	288	375	202	51	56	7	12	5	10	2
Sprat fishery	493	174	23	40	11	7	4	4	0	11	3	16
Norway pout fishery	201	680	4	242	161	11	0	81	3	3	1	
Blue whiting fishery	0		24	37	20	28	0	0	14	0	0	
"Others" fishery	14	23	2	94	6	4	1	4	1	2	1	
Total	778	956	341	789	400	101	61	97	30	21	16	18

Haddock	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Sandeel fishery	528	534	1,600	524	202	364	1,226	1,557	220	103	33	0
Sprat fishery	685	1,097	18	11	6	62	66	223	27	15	0	4
Norway pout fishery	1,399	4,766	1,774	1,454	251	318	1,734	1,252	1,545	16	57	13
Blue whiting fishery	10		153	205	66	195	258	218	133	59	16	
"Others" fishery	71	349	77	137	218	117	40	42	183	96	10	0
Total	2,693	6,745	3,622	2,331	744	1,055	3,324	3,292	2,108	289	116	18

Whiting	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Sandeel fishery	1,392	3,322	1,909	2,143	902	2,121	1,539	2,761	1,397	444	653	261
Sprat fishery	4,352	10,386	784	107	673	1,088	2,107	1,700	2,238	1,105	333	545
Norway pout fishery	3,121	7,291	1,373	2,235	178	331	2,935	1,559	1,675	265	232	
Blue whiting fishery	0		126	113	83	169	71	217	123	30	0	
"Others" fishery	187	4,422	22	173	112	116	89	184	127	63	0	19
Total	9,053	25,422	4,214	4,771	1,948	3,825	6,740	6,420	5,560	1,907	1,218	825

Saithe	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Sandeel fishery	0	0	40	0		28		1	0	30	14	
Sprat fishery	11	297	0	0				3	0	0	0	7
Norway pout fishery	135	490	84	209			116	22	246	0	0	7
Blue whiting fishery	0		20	80	11	8	2	84	72	17	51	
"Others" fishery	0	542	0	40	1	4	2	7	109	69	0	
Total	146	1,329	144	329	12	40	120	117	427	116	65	14

All species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Sandeel fishery	611,554	644,473	622,211	761,963	624,925	514,047	551,008	637,518	628,205	274,854	291,445	150,426
Sprat fishery	314,970	344,309	107,243	103,523	145,978	171,757	208,641	170,862	167,472	194,210	200,907	234,251
Norway pout fishery	111,208	140,550	76,390	104,499	33,515	29,361	135,196	47,788	54,980	9,020	8,980	16,867
Blue whiting fishery	419		34,857	13,181	46,052	51,060	34,129	26,038	27,052	21,320	20,295	100102
"Others" fishery	19,480	48,936	8,882	14,554	17,893	26,945	7,433	10,554	8,503	6,184	10,298	6,944
Total	1,057,632	1,178,268	849,584	997,719	868,363	793,169	936,408	892,760	886,212	505,588	531,925	508,590

Table 2.1.5. Quarterly Danish by-catch landings of cod, haddock and saithe in 2005 from small-meshed fisheries in the North Sea. Landings (tonnes) used for reduction purposes.

Cod	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		2			2
Sprat fishery			9	7	16
Norway pout fishery					
"Others" fishery					
Total		2	9	7	18

Haddock	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		0	0		0
Sprat fishery			1	3	4
Norway pout fishery		13			13
"Others" fishery			0		0
Total		14	1	3	18

Whiting	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		260	1		261
Sprat fishery	1		369	175	545
Norway pout fishery					
"Others" fishery	1		18		19
Total	2	260	387	175	825

Saithe	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery					
Sprat fishery				7	7
Norway pout fishery			7		7
"Others" fishery					
Total			7	7	14

All species	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		145,877	4,549		150,426
Sprat fishery	13,754		118,919	101,577	234,251
Norway pout fishery	9,720	7,018	129		16,867
"Others" fishery	1,551		5,394		6,944
Total	25,025	152,895	128,991	101,577	408,488

Table 2.1.6. Maximum days a vessel may be present in 2006 within an area, by fishing gear. Source: Council Regulation (EC) No 51/2006.

			Areas as defined in point:					
Gear group Point 4	Special condition Point 8	Denomination ([1])	2.a Kattegat	2.b 1 — Skaggerak 2 — II, IVa, b,c, 3 — VIId			2.c VIIa	2.d VIa
				1	2	3		
4.a.i		Trawls or Danish seines with mesh size ≥ 16 and < 32 mm	228 ([2])	228 ([2])			228	228
4.a.ii		Trawls or Danish seines with mesh size ≥ 70 and < 90 mm	n.r.	n.r.	227		227	227
4.a.iii		Trawls or Danish seines with mesh size ≥90 and < 100 mm	103	103	227		227	227
4.a.iv		Trawls or Danish seines with mesh size ≥ 100 and < 120 mm	103	103			114	91
4.a.v		Trawls or Danish seines with mesh size ≥ 120 mm	103	103			114	91
4.a.iii	8.1.(a)	Trawls or Danish seines with mesh size ≥ 90 and < 100 mm with a 120 mm square mesh window	137	137	227		227	227
4.a.iv	8.1.(a)	Trawls or Danish seines with mesh size ≥ 100 and < 120 mm with a 120 mm square mesh window	137	137	103		114	91
4.a.v	8.1.(a)	Trawls or Danish seines with mesh size ≥ 120 mm with a 120 mm square mesh window	137	137	103		114	91
4.a.v	8.1.(j)	Trawls or Danish seines with mesh size ≥ 120 mm with a 140 mm square mesh window	149	149	115		126	103
4.a.ii	8.1.(b)	Trawls or Danish seines with mesh size ≥ 70 and < 90 mm complying with the conditions laid down in Appendix 2	Unlimited	Unlimited			Unl.	Unl.
4.a.iii	8.1.(b)	Trawls or Danish seines with mesh size ≥ 90and < 100 mm complying with the conditions laid down in Appendix 2	Unlimited	Unlimited			Unl.	Unl.
4.a.iv	8.1.(c)	Trawls or Danish seines with mesh size ≥ 100 and < 120 mm track records shall represent less than 5 % of cod	148	148			148	148
4.a.v	8.1.(c)	Trawls or Danish seines with mesh size ≥ 120 mm track records shall represent less than 5 % of cod	160	160			160	160

Table 2.1.6. Maximum days a vessel may be present in 2006 within an area, by fishing gear. Source: Council Regulation (EC) No 51/2006.

Gear group Point 4	Special condition Point 8	Denomination [1]	Areas as defined in point: 2.a Kattegat	2.b (1 — Skaggerak, 2 — II, IVa, b,c, 3 — VIId) 1	2.b 2	2.b 3	2.c VIIa	2.d VIa
4.a.iv	8.1.(k)	Trawls or Danish seines with mesh size ≥ 100 and < 120 mm track records shall represent less than 5 % of cod and more than 60 % of plaice	n.r.	n.r.			166	n.r.
4.a.v	8.1.(k)	Trawls or Danish seines with mesh size ≥ 120 mm track records shall represent less than 5 % of cod and more than 60 % of plaice	n.r.	n.r.			178	n.r.
4.a.v	8.1.(h)	Trawls or Danish seines with mesh size ≥ 120 mm operating under a system of automatic suspension of fishing licences	115	115			126	103
4.a.ii	8.1.(d)	Trawls or Danish seines with mesh size ≥ 70 and < 90 mm track records represent less than 5 % of cod, sole and plaice	280	280			280	280
4.a.iii	8.1.(d)	Trawls or Danish seines with mesh size ≥ 90 and < 100 mm track records represent less than 5 % of cod, sole and plaice	Unlimited	Unl.	280		280	280
4.a.iv	8.1.(d)	Trawls or Danish seines with mesh size ≥ 100 and < 120 mm track records represent less than 5 % of cod, sole and plaice	Unlimited	Unlimited			Unl.	Unl.
4.a.v	8.1.(d)	Trawls or Danish seines with mesh size > 120 mm track records represent less than 5 % of cod, sole and plaice	Unlimited	Unlimited			Unl.	Unl.
4.b.i		Beam trawls with mesh size ≥ 80 and < 90 mm	n.r.	143 [2]		Unl.	143	143 [2]
4.b.ii		Beam trawls with mesh size ≥ 90 and < 100 mm	n.r.	143 [2]		Unl.	143	143 [2]
4.b.iii		Beam trawls with mesh size ≥ 100 and < 120 mm	n.r.	143		Unl.	143	143
4.b.iv		Beam trawls with mesh size ≥ 120 mm	n.r.	143		Unl.	143	143
4.b.iii	8.1.(c)	Beam trawls with mesh size ≥ 100and < 120 mm track records shall represent less than 5 % of cod	n.r.	155		Unl.	155	155
4.b.iii	8.1.(i)	Beam trawls with mesh size ≥ 100 and < 120 mm for vessels having used beam trawls of mesh < 100 mm in 2003, 2004 or 2005.	n.r.	155		Unl.	155	155

Table 2.1.6. Maximum days a vessel may be present in 2006 within an area, by fishing gear. Source: Council Regulation (EC) No 51/2006.

<table>
<tr><th colspan="3"></th><th colspan="6">Areas as defined in point:</th></tr>
<tr><th rowspan="2">Gear group Point 4</th><th rowspan="2">Special condi-tion Point 8</th><th rowspan="2">Denomination ([1])</th><th rowspan="2">2.a Kattegat</th><th colspan="3">2.b
1 — Skaggerak
2 — II, IVa, b,c,
3 — VIId</th><th rowspan="2">2.c VIIa</th><th rowspan="2">2.d VIa</th></tr>
<tr><th>1</th><th>2</th><th>3</th></tr>
<tr><td>4.b.iv</td><td>8.1.(c)</td><td>Beam trawls with mesh size ≥ 120 mm track records shall represent less than 5 % of cod</td><td>n.r.</td><td colspan="2">155</td><td>Unl.</td><td>155</td><td>155</td></tr>
<tr><td>4.b.iv</td><td>8.1.(i)</td><td>Beam trawls with mesh size ≥ 120mm for vessels having used beam trawls of mesh < 100mm in 2003, 2004 or 2005.</td><td>n.r.</td><td colspan="2">155</td><td>Unl.</td><td>155</td><td>155</td></tr>
<tr><td>4.b.iv</td><td>8.1.(e)</td><td>Beam trawls with mesh size ≥ 120 mm track records shall represent less than 5 % of cod and more than 60 % of plaice</td><td>n.r.</td><td colspan="2">155</td><td>Unl.</td><td>155</td><td>155</td></tr>
<tr><td>4.c.i</td><td></td><td>Gillnets and entangling nets with mesh size < 110 mm</td><td>140</td><td colspan="3">140</td><td>140</td><td>140</td></tr>
<tr><td>4.c.ii</td><td></td><td>Gillnets and entangling nets with mesh size ≥ 110 mm and < 220 mm</td><td>140</td><td colspan="3">140</td><td>140</td><td>140</td></tr>
<tr><td>4.c.iii</td><td>8.1.(f)</td><td>Gillnets and entangling nets with mesh size ≥ 220 mm track records shall represent less than 5 % of cod and more than 5 % of turbot and lumpsucker</td><td>162</td><td>140</td><td>162</td><td>140</td><td>140</td><td>140</td></tr>
<tr><td>4.d</td><td></td><td>Trammel nets</td><td>140</td><td colspan="3">140</td><td>140</td><td>140</td></tr>
<tr><td>4.d</td><td>8.1.(g)</td><td>Trammel nets with mesh size < 110 mm. The vessel shall be absent from the port no more than 24 h.</td><td>140</td><td>140</td><td colspan="2">205</td><td>140</td><td>140</td></tr>
<tr><td>4.e</td><td></td><td>Long-lines</td><td>173</td><td colspan="3">173</td><td>173</td><td>173</td></tr>
</table>

([1]) Only the denominations in points 4 and 8 are used.
([2]) Application of Regulation (EC) No 850/98 where restrictions exist.

n.r. means non relevant

Table 2.2.1. Catches of the most important species in the industrial fisheries in Division IIIa (000 tonnes). Data are available for 1989-2004 only.

Year	Sandeel	Sprat	Herring	Norway pout	Blue whiting	Total
1989	18	4	52	5	9	88
1990	16	2	51	27	10	106
1991	24	14	44	39	10	131
1992	39	4	66	45	19	173
1993	45	2	71	8	32	158
1994	55	58	30	7	12	162
1995	12	42	34	50	10	148
1996	53	10	26	36	15	140
1997	82	12	6	32	4	136
1998	11	11	5	15	7	49
1999*	13	26	11	7	16	73
2000*	17	19	18	10	7	71
2001*	25	28	16	9	5	83
2002	27	14	15	3	6.4	65
2003	12	11	6	5	7.3	41
2004	15	15	6	0.3	4.3	41
Mean 1989-2004	29	17	29	20	11	108

* 1999-2001 data provided from Denmark and Sweden. Other years, only data from Denmark is presented

Table 2.2.2. Bycatches of the most important human consumption species in the Danish small-meshed fisheries in Division IIIa. Data are available for 1989-2004 only.

Year	Whiting	Haddock	Plaice	Saithe	Cod
1989	3961	64	135	1	399
1990	5304	297	58	9	131
1991	4506	400	86	13	421
1992	3340	513	111	2	293
1993	1987	415	141	13	153
1994	1900	138	65	0	181
1995	2549	247	20	9	304
1996	1232	302	107	1	234
1997	264	77	16	2	45
1998	354	39	5	1	44
1999	695	89	8	0	53
2000	777	140	30	0	42
2001	970	43	35	0	74
2002	975	12	9	0	60
2003	654	82	16	4	50
2004	1120	25	18	23	44
Mean 1989-2004	1912	180	54	5	158

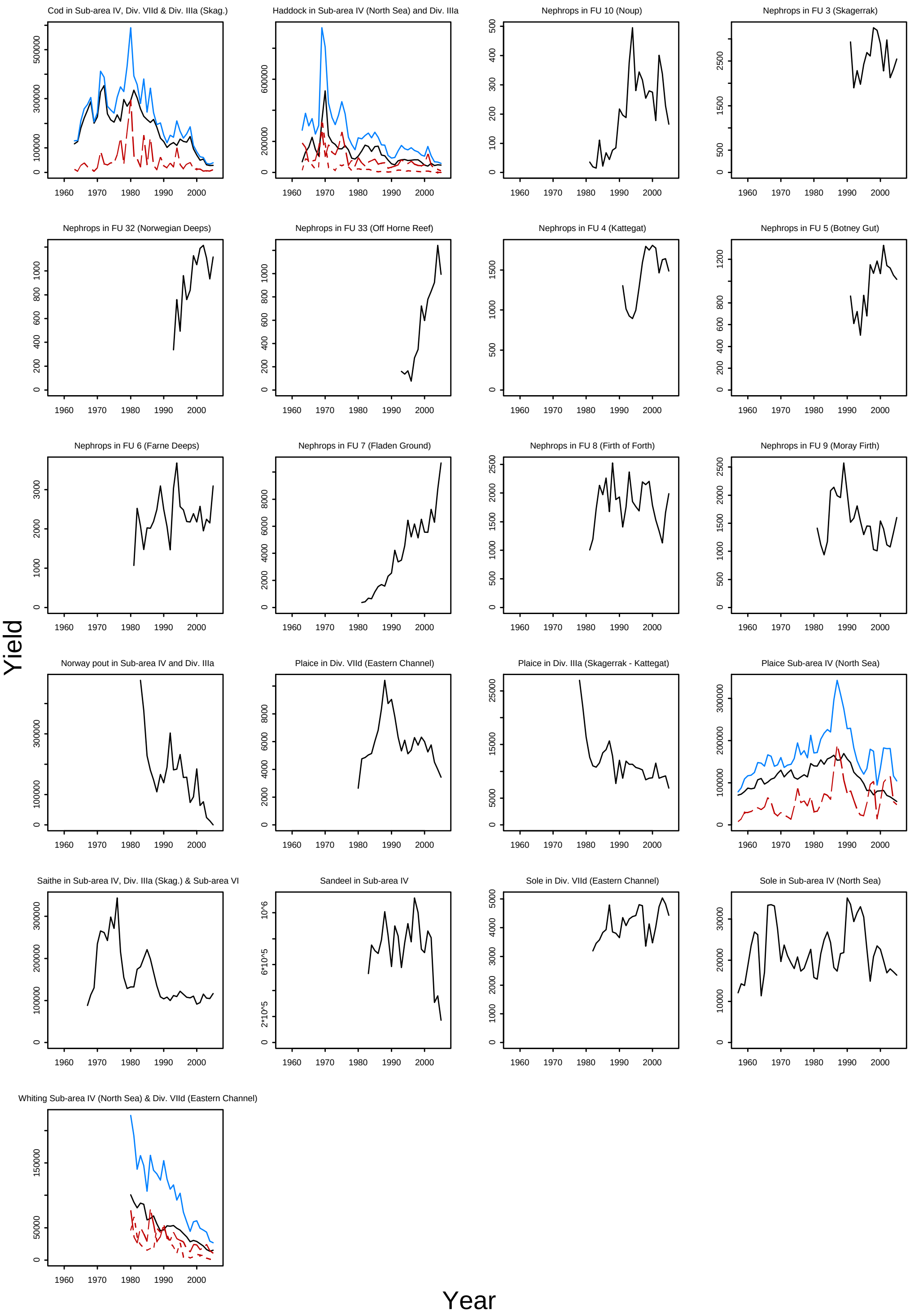


Figure 2.1.1. Historical yield by stock. Where available, time-series of total catch (solid blue lines), human consumption landings (solid black), discards (dashed red) and industrial bycatch (dotted red) are given.

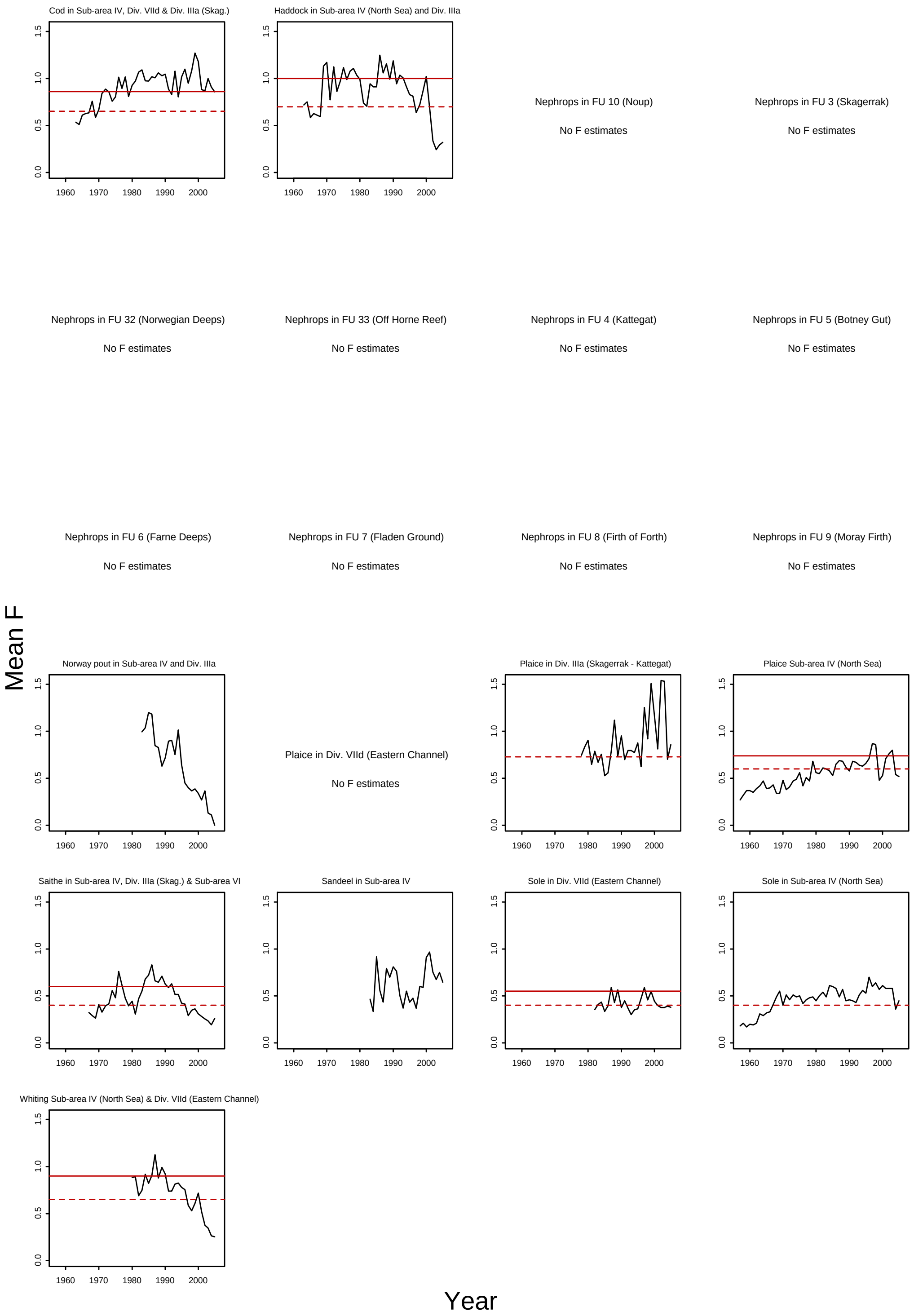


Figure 2.1.2. Historical estimated mean fishing mortality by stock (over age ranges defined in each stock section). Horizontal lines indicate F_{pa} (dotted) and F_{lim} (solid).

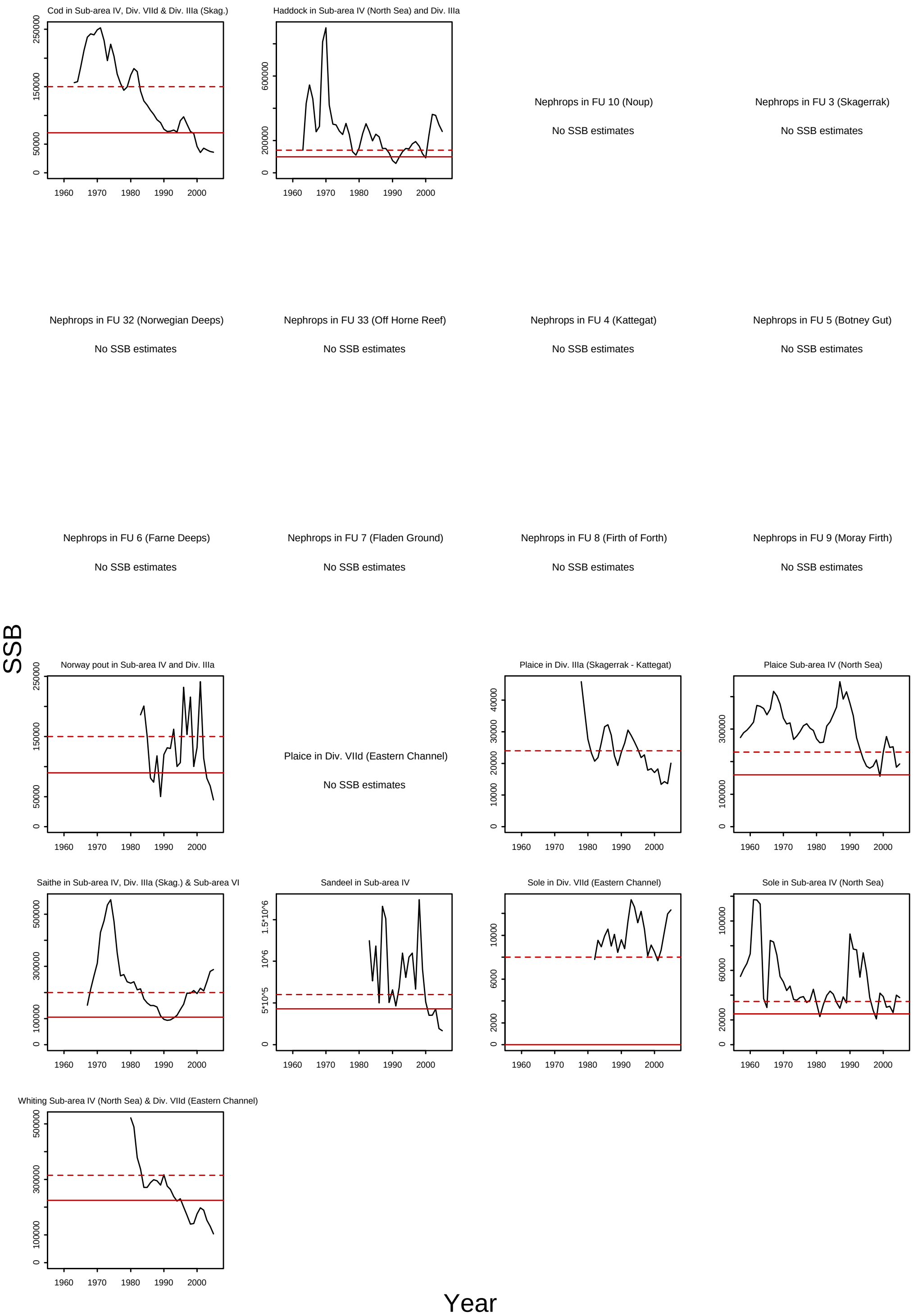


Figure 2.1.3. Historical estimated spawning stock biomass by stock (over age ranges defined in each stock section). Horizontal lines indicate B_{pa} (dotted) and B_{lim} (solid).

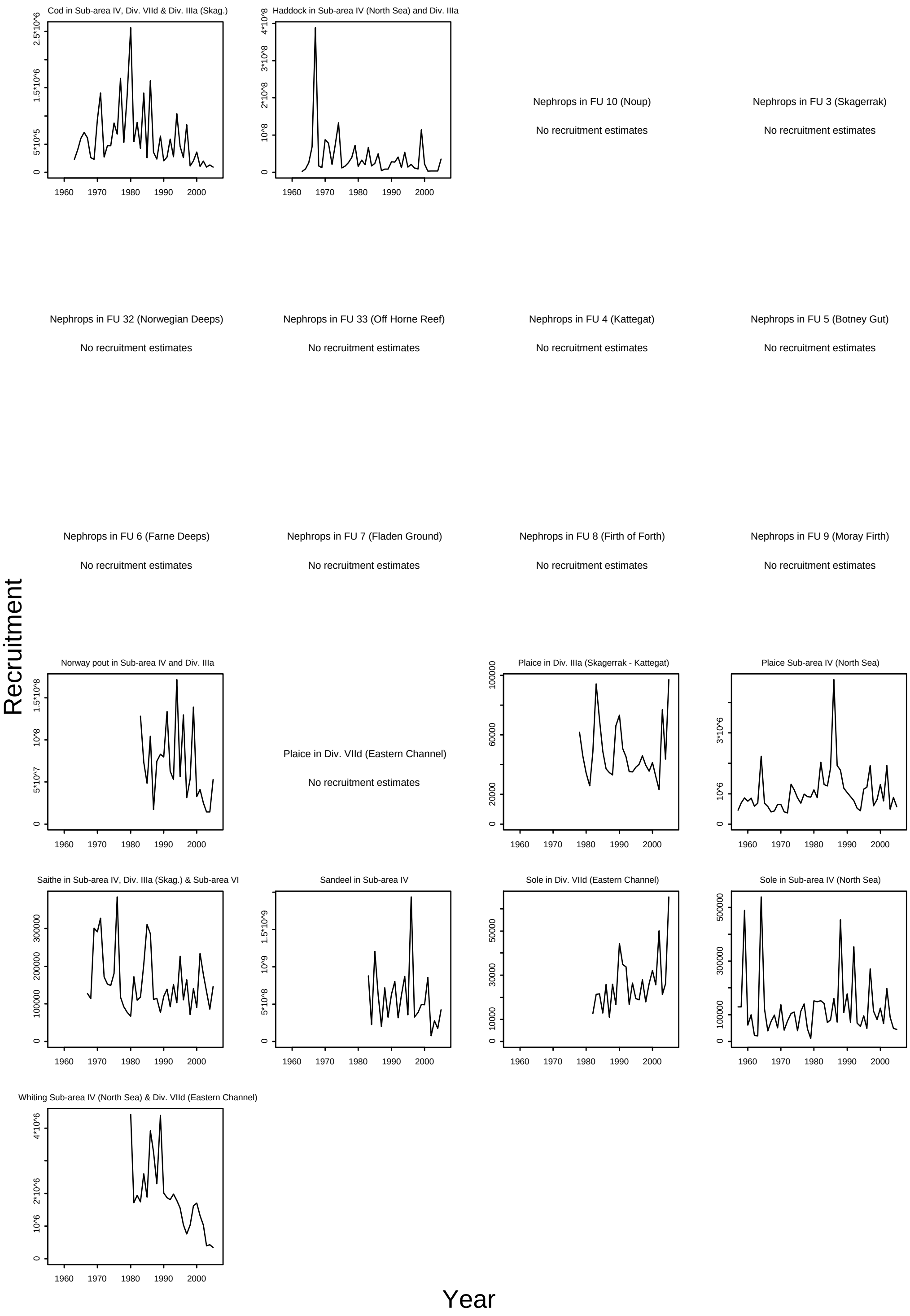


Figure 2.1.4. Historical estimated recruitment by stock (at ages defined in each stock section).

3 *NEPHROPS* (Norway lobster) IN DIVISION IIIa and SUB-AREA IV

Nephrops stocks have previously been identified by WGNEPH on the basis of population distribution, and defined as separate Functional Units. The Functional Units (FU) are defined by the groupings of ICES statistical rectangles given in Table 3.1.1 and illustrated in Figure 3.1.1.

Functional Units are aggregated into Management Areas (MA) Table 3.1.1, the level at which WGNEPH and ACFM have previously recommended management should take place. General comments relating to *Nephrops* stocks are covered in Section 3.1

Nephrops management is provided at the Division level, with Division IIIa discussed in Sections 3.2 and 3.3 and Sub-Area IV in Section 3.4 and 3.5. Within Division, examination and analysis of the data available are provided on a Management Area and stock by stock basis, with Management Area E (FU3&4) in Section 3.2.1, Management Area F (FU9&10) in Section 3.4.1, Management Area G (FU7) in Section 3.4.2, Management Area S (FU32) in Section 3.4.3, Management Area I (FU6&8) in Section 3.4.4 and Management Area H (FU5&33) in Section 3.4.5. Management considerations for Division IIIa and Sub-Area IV are discussed as a whole in Sections 3.3 and 3.5 respectively.

Landings are reported by Management Area (MA) in Table 3.1.2

The trends observed in the North Sea Commission Fisheries Partnership stock survey for *Nephrops* are shown in Figure 3.5.1. These are discussed in the Quality of Assessment sections.

3.1 General comments relating to all *Nephrops* stocks

During the early 1990's ICES assessed *Nephrops* stocks on an annual basis but this changed in 1995 to biennial circle. With the advent of the area WGs, annual assessments resumed again in 2005, when the mosr recent analytic assessments of *Nephrops* were conducted providing scientific advice for 2006. Because of the biology of *Nephrops*, performing assessments and providing catch predictions has not proved straightforward. Particular difficulties arise from the fact that *Nephrops* cannot be aged and because the species (as a burrowing crustacean) exhibits a variable emergence pattern. Furthermore, the biology and behaviour of the sexes differs markedly leading to different exploitation rates.

Assessment approaches

Previously WGNEPH has conducted a variety of analyses on *Nephrops* data, including the review of basic fishery indicators, the use of LCA and XSA, and examination of trends in underwater TV surveys. Other assessment approaches are also being considered by WKNEPH (Workshop on *Nephrops* stocks), including length based SURBA and VPA methods, and CSA.

Length cohort analysis was used in the past to provide a general indication of the state of the stock but the method does not allow the production of time series of stock trends and does not indicate problems with recruitment. Typically, Y/R curves were constructed during the analysis but the tendency of LCA to overestimate mortality rate led to misleading interpretations of the current state of exploitation. In an effort to circumvent the problem of ageing these animals, pseudo-ages from slicing length frequency distributions (on the basis of growth parameters) were used in age-based cohort analysis such as XSA. Concerns raised at WGNEPH, and WGNSDS and WGNSSK in 2005 about the implications of the use of the knife edge slicing technique for catch at age analysis of pseudo ages led to these types of assessments not being performed in 2005. The main problem is that 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. There was broad acceptance by the relevant ACFM review group (RGNSSK) in 2005 that XSA was not appropriate at the present time. RGNSSK also felt that excess information and parameters normally associated with these assessment approaches were unnecessary.

Owing to the variable emergence of *Nephrops*, trawl catch rates are difficult to interpret so that traditional fishery-independent surveys have not been widely employed for *Nephrops*. Instead underwater television (UTV) surveys have been developed to survey *Nephrops* burrows and have been employed on a number of the Functional Units (up to 14 years in the case of the Fladen Ground FU7). The Annex to Section 3 describes some of the background to the survey approach and use of the data. Data from these surveys have been used for a number of years to give an indication of relative trends in *Nephrops* populations and the 2005 RGNSSK agreed that, where available, UTV provided the best indication of stock condition.

The WG agreed that its approach in 2006 should be essentially the same as in 2005. There were no cohort-based numerical assessments performed and judgements about the states of the populations of *Nephrops* in the various FUs in both Division IIIa and Sub-Area IV relied on three main approaches:

- For all FUs there was consideration of basic fishery data such as catch, landings and effort;
- For most FUs, attention was paid to length composition data and this year length distributions were included as well as the mean size information used in previous years. It was felt that the additional information afforded by looking at the tails of length distributions and comparisons with MLS was beneficial;
- For FUs where a reasonable time-series of UTV data is available, this was used as the principle indicator of stock condition.

Providing catch advice

A number of factors presently make the provision of catch advice difficult for *Nephrops* stocks. First of all it has not so far proved possible to define biological reference points for *Nephrops* under the ICES precautionary approach framework. Furthermore, *Nephrops* are not covered by management plans containing targets (relating to biomass or fishing mortality). The absence of clear objectives for these stocks further compounds the difficulties of assessment outlined above and the technical aspects of providing a forecast.

In earlier years, advice was based on average historic landings. However, difficulties have in the past been experienced in the use of this type of advice for *Nephrops*, particularly where the spatial extent of the fishery has expanded. This has led to under-reporting in some of these fisheries. Continuation with the reliance on landings to provide a reliable harvest rate for these stocks is likely to exacerbate the problem. Indeed the application of an unrealistically low TAC implies that effort would be cut at a time when there are clear indications that the stocks have increased in size. Where no other forms of data exist, however, it is difficult to see how some reference to observed landings can be avoided.

The increasing availability of UTV survey information has led to the development of approaches attempting to make use of the material in an absolute way rather than just as an index. For this to be possible, abundance information must be converted to biomass through the use of length composition data and to provide advice on suitable levels of landings for management purposes, an exploitation or harvest rate needs to be applied.

Early suggestions for harvest rates were based around rather arbitrary percentage removals of the observed population. In 2005 the possibilities of using harvest rates based on fairly conservative fishing mortality rate reference points from Y/R analysis were discussed at ICES-WGNSDS (2005) and ICES-WGNSSK (2005). These groups considered it premature to adopt such approaches. The 2005 RGNSSK made frequent reference to the importance of choice of appropriate harvest rate options for giving advice. At its autumn meeting ACFM provided tables of catch options based on various harvest rates applied to UTV-derived estimates of population basing their acceptable options (consistent with no increase in effort) on the option which was close to current landings (ICES-ACFM 2005). Given the many references to the unreliability of landings data, this approach was rather inconsistent. In the intervening year a number of initiatives have attempted to improve the process of using TV abundance estimates for deriving future catch.

While the Y/R analysis based on LCA may not give reliable estimates of current exploitation, the general shape of the yield curve (essentially arising from the biological characteristics of the species) is potentially useful for defining targets that might be used in advice and manaement. At its 2005 autumn meeting, STECF concluded that the use of a harvest rate based on $F_{0.1}$ derived from yield per recruit offers a sustainable approach providing that effort is controlled and providing that stocks are managed at the Functional Unit level (Ref). Icelandic stocks of *Nephrops* have for some time been managed in line with an $F_{0.1}$ target mortality (ICES-AFWG 1992) and a number of other sessile shellfish species are dealt with in the same way (Cryer,1998; Morrison and Cryer, 1999). The finally agreed TACs for ICES Divisions IV and VI in 2006 contained UTV derived catch options based on $F_{0.1}$.

At its meeting earlier in the year WKNEPH concluded that notwithstanding the need for further developmental work, the approach described offers a useful way forward (ICES-WKNEPH 2006). Subsequently WGNSDS adopted the approach in its 2006 catch advice for *Nephrops* in VIa and VIIa (ICES-WGNSDS 2006).

There are clearly areas requiring further refinement which WKNEPH identified in its proposal for a specific UTV Workshop in 2007. Amongst these, the potential for different exploitation rates on the two sexes is important. Differences in burrow emergence patterns in relation to reproductive behaviour mean that mature female *Nephrops* spend much of the period while ovigerous (typically September to April) within their burrows, and are therefore less available to trawl fisheries at this time. This results in lower exploitation of the female component of the stock.

Dobby and Bailey (WD 11) presented simulated seasonal patterns in exploitation (an abstract is provided in Section 1.4.1). The broad conclusions were that when fishing the two sexes at their appropriate $F_{0.1}$, harvest rates on the population could vary depending on the seasonality patterns assumed for *Nephrops* emergence or in the fishery. Importantly it was also found that, when a fixed harvest rate of 20% was applied, the implied Fs on the two sexes remained between $F_{0.1}$ and F_{max} even for quite extreme model scenarios.

Other issues include the potential sensitivity of the calculation method to the choice of input length composition. Inappropriate choice of this could lead to under or overestimates of the amount of future landings. Further work on this and on technical refinements of the survey and analysis technique itself will take place at the aforementioned UTV workshop in 2007. This WG considers that while not perfect, the approach provides an improved basis for advice than previously adopted for *Nephrops* stocks. From the simulation studies performed so far, the use of $F_{0.1}$ to inform the catch option process appear to be fairly conservative and sustainable.

The WG agreed that several different approaches for providing advice on future catches should be used:

- Status quo advice essentially reiterating the ACFM advice of the previous year;
- An average of recent landings, for FUs where fisheries were developing and landings data were the only source of information. Progress to a more satisfactory method should be encouraged;
- Catches based on harvest rates applied to TV abundance estimates (where available), highlighting in particular $F_{0.1}$ as a sustainable option

For the stocks where the third approach was employed, LCA was carried out to derive F reference points using a 3 year average length composition and a combined sex Y/R programme adapted from 'LBA' (a FORTRAN programme used by WGNEPH in the early 1990s). The Y/R analysis was not used to infer the state of the stock. The instantaneous mortality rate reference points were converted to simple removal rates and applied to UTV abundance estimates (average of last 3 years) to derive removal numbers. The equivalent weight of the landed component was then derived using a 3 year averaged length composition from the fishery. Y/R plots for the FUs concerned and tables summarising the derivation of future catch are included.

Biological parameter values relevant to the Y/R calculations were included in the report and assumed discard survival rates were applied to sampled catch numbers in the length compositions to generate removals. In some populations a survival rate of 0.25 is used (FUs 7,8,9,10) based on work by Breen [XXXX: reference missing] in others (FU6) survival is assumed to be zero owing to the extensive practice of sorting the catch back in port.

Medium-term projections were again not conducted. 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 (ICES-WGNSDS 2006).

In order to facilitate participation from a wider range of the members of the WG in discussions of *Nephrops* assessments, the approach used last year of setting up a '*Nephrops* subgroup' was not repeated. Instead assessment results were discussed in plenary, issues were dealt with in various mixed species subgroups, and the WG Chair established a number of text-read sessions. It remains the case, however, that the full benefits for mixed species considerations of integrating *Nephrops* in the area groups remains to be realised. Mixed-fishery models including *Nephrops* are discussed in Section 15.

Ecosystem aspects

Although specific quantitative data are not available for all stocks, qualitative observations suggest that there have been general increases in *Nephrops* abundance observed throughout Divisions IIIa and IV in recent years. The widespread nature of these observations suggest they may be related to environmental influences, perhaps having a positive effect on recruitment.

Individual stocks inhabit distinct areas of suitable muddy sediment. No information is available on the extent to which larval mixing occurs between *Nephrops* stocks.

Cod have been identified as a predator of *Nephrops* in some areas, and the generally low level of the cod stock is likely to have resulted in reduced predation.

3.2 *NEPHROPS* IN Division IIIa

3.2.1 *Nephrops* in Management Area E

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

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

3.2.1.1 General

3.2.1.1.1 Ecosystem aspects

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

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

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

3.2.1.1.2 Functional Units and their Fisheries in 2005 and 2006.

The Danish, Swedish and Norwegian *Nephrops* fisheries in the area are described in the 1999 WG report (ICES-WGNEPH 1999). Some changes have taken place in these fisheries in recent years. For the Swedish fishery, a trend in the twin trawl fishery can be seen towards a more mixed fishery for fish and *Nephrops*, while single trawlers continue to target mainly *Nephrops*.

Since 2004, new technical regulations were introduced for Swedish national waters in both FU 3 and FU 4. As Sweden has bilateral agreements with Denmark and Norway to fish inside the 12 NM limit, the regulations cover only waters exclusively fished by Swedish vessels (inside 3 NM in Kattegat and 4 NM in Skagerrak). The new regulations imply that it is mandatory to use a 35 mm species selective grid and 8 meter of 70 mm full square mesh codend and extension piece when trawling for *Nephrops* on Swedish national waters. Around 50 % of the Swedish annual Skagerrak *Nephrops* landings normally originate from these coastal waters. The Swedish *Nephrops* landings from MA IIIa by gear 1989-2005 is shown in Figure 3.2.1.1. Twin trawls were introduced in 1990 and the grid and square mesh trawls were legislated in Sweden during 2004 and show an increasing use in 2005.

The restrictions in the fisheries for especially cod seem to have resulted in some significant changes in the Danish fisheries for *Nephrops*. Traditionally, *Nephrops* have mainly been caught in trawls using 70-89 mm mesh sizes. In the last five years an increasing proportion of total landings of *Nephrops* have been caught by vessels using gears with mesh sizes >89mm (which previously have been used in the fishery for cod, plaice and other demersal fish species). In Skagerrak and Kattegat it is since 2005 not allowed to use mesh sizes between 70-

89 mm unless the codend and the extension piece is constructed of square meshed netting with a sorting grid (Council Regulation (EC) 27/2005) and since 2006 there is unlimited days at sea regulation for this species selective trawl (Council Regulation (EC) 51/2006).

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

3.2.1.1.3 ICES Advice

In 2005 ICES concluded that:

"Given the apparent stability of the stocks, current levels of exploitation appear to be sustainable."

and advised that:

"Due to uncertainty in the available data ICES is not able to reliably forecast catch. Therefore ICES recommends that fishing effort for fleets targeting *Nephrops* should not be allowed to increase."

Since most of the trawl fisheries for *Nephrops* in Division IIIa are mixed fisheries, the effort in these fisheries may affect by-catch levels of other commercial species caught unless the species and size selectivity properties of the *Nephrops* trawls is improved (e.g. grids and square meshes).

3.2.1.1.4 Management

The 2004 and 2005 TAC for *Nephrops* in ICES area IIIa was 4 700 tonnes but was in late 2005 increased by 10% to 5170 tonnes for 2005 and 2006. This change was not based on any new biological information.

The minimum landings size for *Nephrops* in area IIIa is 40mm carapace length.

Days at sea limits restrict *Nephrops* trawlers to 19 days per month when using 90mm mesh with no square mesh panel, and 22 days with a square mesh panel. New gear regulations imply that it is mandatory to use a 35 mm species selective grid and 8 m of 70 mm full square mesh codend and extension piece when trawling for *Nephrops* in Swedish national waters. As Sweden has bilateral agreements with Denmark and Norway to fish inside the 12 nm limit, the regulations cover only waters exclusively fished by Swedish vessels (inside 3 nm in Kattegat and 4 nm in Skagerrak). Since 2006, days at sea is unlimited for this species selective trawl (Council Regulation (EC) 51/2006).

3.2.1.2 The Skagerrak (FU3)

3.2.1.2.1 Data available

Landings

Denmark, Sweden and Norway exploit this FU. Denmark and Sweden dominate this fishery, with 68 % and 29 % by weight of the landings in 2005. Landings by the Swedish creel fishery represent 13-18 % of the total Swedish *Nephrops* landings from the Skagerrak in the period 1991 to 2002 and has increased to 27-28% in recent two years (Table 3.2.1.4)

In the early 1980s, total *Nephrops* landings from the Skagerrak increased from around 1000 t to just over 2670 t, upon which they remained fluctuating at a level between 2000 and 3000 t. After a drop in 1992-94, the landings increased again to an all time high of about 3250 t in 1998 followed by a fluctuating and a slight decreasing trend (Figure 3.2.1.2).

Length compositions

For the Skagerrak, size distributions of both the landings and discards are available from both Denmark and Sweden for 1991-2005. Of these, the Swedish data series can be considered as being the most complete, since sampling took place regularly throughout the time period and usually covered the whole year. In earlier years the Swedish discard samples were obtained by agreement with selected fishermen, and this might tempt fishermen to bias the samples. However, the reliability of the catch samplings is cross-checked by special discard sampling projects in both the Skagerrak and the Kattegat. In recent years the Swedish *Nephrops* sampling is highly dependent on onboard observers discard sampling for both Skagerrak and Kattegat. Geographically, the samples from the Swedish fishery mainly cover the north-eastern part of the Skagerrak.

In 1991, a biological sampling programme of the Danish *Nephrops* fishery was started on board the fishing vessels, in order to also cover the discards in this fishery. Due to its high cost and the lack of manpower, Danish sampling intensity in the early years was in general not satisfactory, and seasonal variations were not often adequately covered. However, in recent years the Danish at-sea-sampling has improved considerably. The Norwegian *Nephrops* fishery is small and has not been sampled. Trends in mean size in catch and landings are shown in Figure 3.2.1.2 and Table 3.2.1.5. Mean sizes, separated into sex and size categories are all fluctuating without trend. More detailed length composition information is provide in Figure 3.2.1.3 – this broadly confirms the mean size information.

Maturity and natural mortality

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

Catch, effort and research vessel data

Effort data for the Swedish fleet are available from logbooks for 1978-2005 (Figure 3.2.1.2) with the last 16 years being separated into single and twin trawl (Table 3.2.1.6) also see Figures 3.2.1.4. and 3.2.1.5.). The log book trawl category for *Nephrops* single trawlers can be distinguished to target *Nephrops* during the whole period while the twin trawler show a shift to target both fish and *Nephrops* in recent years, resulting in a decreasing trend in LPUE the last seven years (see Figure 3.2.1.2). Total Swedish trawling effort sharply decreased between 1992 and 1996, and has shown a decreasing trend since then. Effort in recent year is about 25% of the peak in the beginning of 1990s. Over the same period of time, the LPUEs first increased to peak in 1998, then decreased slightly again in 2000 and 2001. Since 2002 LPUE of the *Nephrops* directed single trawlers increased again and shows the highest overall LPUE for the whole period in last three years.

Figure 3.2.1.4. show the landings, effort and LPUEs by quarter and sex from Swedish single trawlers. Males are dominating the landings for all years. The effort is usually highest in 2^{nd} and 3^{rd} quarter. After a decline in LPUE for males in 2000 and 2001 an increase is shown for 2002 to 2004 followed by a decline in 2005. The females show a higher contribution to LPUE since 2000 compared to earlier years.

Danish effort figures for the Skagerrak (Table 3.2.1.7 and Figure 3.2.1.2) were estimated from logbook data. For the whole period, it is assumed that effort is exerted mainly by vessels using twin trawls. The overall trend in effort for the Danish fleet is similar to that in the Swedish fishery. After having been at a relatively low level in 1994-97, effort did increase again in the next five years followed by a decrease in recent three years. Also the trend in LPUE is similar to that in the Swedish single trawl fishery, with a declining trend since 1998 and an increase in

2002 but has been stable in recent two years while the Swedish LPUE increases (Figure 3.2.1.2).

It has not been possible to incorporate ‘technological creeping’ in the evaluation of the effort data. However, use of twin trawls has been widespread for many years. Further analyses of the Danish LPUEs were carried out and the results are summarised in Figure 3.2.1.5. The Danish logbook based effort data have been analysed in various ways to elucidate the effect of some factors likely to influence the effort/LPUE:

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

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

Norwegian effort and LPUE data are lacking for the last five years and covered less than 14% of the Norwegian landings in earlier years, and is therefore not included in the analysis.

Conclusions of the landings and effort trends are found in the Management Area E section.

3.2.1.3 The Kattegat (FU4)

3.2.1.3.1 Data available

Catch

Both Denmark and Sweden have *Nephrops* directed fisheries in the Kattegat. In 2005, Denmark accounted for about 79 % of total landings, while Sweden took remaining 21 % (Table 3.2.1.8

After the low that was observed in 1994, total *Nephrops* landings from the Kattegat increased again until 1998. Since then, they seem to fluctuate around 1500 t with a slight decreasing trend (Figure 3.2.1.6).

Length compositions

For the Kattegat, size distributions of both the landings and discards are available from Sweden for 1990-1992 and 2004-2005, and from Denmark for 1992-2005. The at-sea-sampling intensity has increased since 1999 (Section 2). Information on mean size is given in Table 3.2.1.9. Trends in mean size are shown in Figure 3.2.1.6 and after some years of small mean sizes 1993 to 1996 all categories are fluctuating without trend the last nine years. More detailed length composition data are shown in Figure 3.2.1.7.

Maturity and natural mortality

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

Catch, effort and research vessel data

Swedish standardised total effort has been relatively stable over the period 1978-90. An increase is noted in 1993 and 1994, followed by a decrease till 1996, and a stabilisation at intermediate levels in the past years (Figure 3.2.1.6 and Table 3.2.1.10). Figures for total Danish effort are based on logbook records since 1987. Danish effort increased during 1995 to 2001, but since then it has been showing a decreasing trend until 2005 (Figure 3.2.1.6 and Table 3.2.1.11).

It has not been possible to incorporate 'technological creeping' in the evaluation of the effort data. However, use of twin trawls has been widespread for many years. Further analyses of the Danish LPUEs were carried out and the results are summarised in Figure 3.2.1.8. The Danish logbook based effort data have been analysed in various ways to elucidate the effect of some factors likely to influence the effort/LPUE:

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

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

The Swedish twin trawl LPUE and Danish annual LPUEs show similar trends. The LPUEs were at their lowest in beginning of 1990th, then increased until 1998. Thereafter it has decreased until 2002 followed by a increasing trend in last three years. (Tables 3.2.1.10 and 3.2.1.11; Figure 3.2.1.6).

3.2.1.4 The Management Area E (FU 3&4)

3.2.1.4.1 Data Analysis

Reviews of last year's assessment

Last years review of this assessment was:

"LPUE may vary according to changes in gear/vessel efficiency. This is not clear whether it occurs or not. The variation in the relative contribution of single/twin trawls to the total fishery is not commented. Recent changes in the trawl selectivity may also have affect LPUE (or at least CPUE)."

The Swedish trend in LPUE is based on standardised single trawl effort targeting *Nephrops*. There is no information on creeping efficiency for this fishery. The Danish logbook based effort data have in this years report been analysed in various ways to elucidate the effect of some factors likely to influence the effort/LPUE (see section above).

Exploratory assessment

No analytical assessment is presented for this stock.

The assessment of the state of the *Nephrops* stocks in the Skagerrak and Kattegat area is based on the patterns in fluctuations of total combined LPUE by Denmark and Sweden during the period 1990-2005 and the patterns in fluctuations of discards in the fisheries as estimated from the catch samples for the same period. There are no survey data from MA E.

Exploratory analyses of catch data

Combined relative effort declined slightly over the period 1990 to 2005 (Figure 3.2.1.9) while combined relative LPUE has increased over the last three years and is at present at a high level (Figure 3.1.1.10). Changes in LPUE may reflect changes in either stock size or catchability. However, since the LPUE has fluctuated over the longer term (i.e. increased steadily from 1992 to a peak in 1998, declined again until 2001 and has increased in recent years), the WG assumes that these fluctuations reflect similar fluctuations in stock size. High LPUE attributable to sudden changes in catchability (caused by e.g. poor oxygen conditions) are generally of much shorter duration.

Since the abundance of *Nephrops* discards (mainly small specimens below minimum landing size) may also be regarded as an index of recruitment, they can be used to further explain the current developments in the stocks. The large amounts of discards in the periods 1993-95 and 1999-2000 reflect strong recruitment during these years (Figure 3.2.1.11). The high levels of recruitment in 1993-95 are believed to have significantly contributed to the high LPUE in 1998-99. Following this line of argument, the relatively low amounts of discards seen in both areas in 1996-98 could explain the decline in LPUEs in 2000-2001. Further extra-polations along this line imply that the high amount of discards (strong recruitment) in 1999-2000 now appears as the increase in LPUE in 2003 to 2005 (Figure 3.2.1.10).

Conclusions drawn from exploratory analyses

The combined effort decreased 2003 and is currently on a low level while LPUE shows an increasing trend in recent years (Figures 3.2.1.9 and 3.2.1.10). Mean sizes are fluctuating without trend. There are no signs of overexploitation in MA E.

Discards are known to be very high and any improvement of the fishing pattern of the catches would benefit the stock and medium-term yield. The relative amount of discards is similar in the Danish and Swedish catches (Figure 3.2.1.12)

3.2.1.4.2 Biological reference points

No biological reference points are used for this stock.

3.2.1.4.3 Quality of the assessment

Perceptions of the stock are based on Swedish and Danish LPUE data. The TAC is not thought to be restrictive for the fleets exploiting this stock, but no information is available on technological creep in the fishery. Swedish *Nephrops* directed single trawl LPUE and Danish *Nephrops* directed twin trawl LPUE are weighted and used as combined LPUE in the trend analysis.

NSCFP stock survey trends are shown in Figure 3.5.1. These suggest that the *Nephrops* stock shows a slight increase since 2002 in FU 3, and a more marked increase in FU 4 since 2003, agreeing with the trends observed in LPUE.

3.2.1.4.4 Status of the Stock

The assessment for Management Area E does not provide a sufficient basis to formulate catch options based on various effort levels. Instead, given the apparent stability of the stocks, the WG concludes that current levels of exploitation appear to be sustainable.

3.2.1.5 Management Area E Considerations

Since Management Area E covers Division IIIa, management considerations are dealt with in the section below on Division IIIa

3.3 Division IIIa *Nephrops* Management Considerations

The *Nephrops* TAC for IIIa has not been restrictive, and logbook data are considered reliable. The high recruitment (shown as high discard levels) observed in 1999 and 2000 has resulted in high LPUE in 2004 and 2005. The LPUE series all show a peak around 1998 followed by a drop and then an increasing trend in recent years. These observations are believed to reflect high recruitments observed around 1993 and 1999. Following this line of reasoning one could expect a slight decrease in LPUE in coming years if further recruitments are not observed.

From the above mentioned trends in LPUE and discards, together with the absence of obvious trends in the mean size of *Nephrops* in the landings, the WG concludes that the *Nephrops* stocks in the Skagerrak and Kattegat area are fluctuating at a relatively stable level and show no signs of overexploitation.

The observed trends in effort, LPUE and discards are similar for FU 3 and FU 4. Our present knowledge on the biological characteristics of the *Nephrops* stocks in these two areas does not indicate obvious differences, and therefore the two FUs were treated as one single 'stock' in the assessment. When more data for the Swedish creel fishery in FU3 become available, this fishery should be assessed separately (for reasons of its different exploitation pattern).

The assessment for Management Area E does not provide a sufficient basis to formulate catch options based on various effort levels. Instead, given the apparent stability of the stock, the WG concludes that current levels of exploitation appear to be sustainable.

However, even if the nominal effort does not seem to increase it is probable that the effective effort has increased somewhat due to technological creeping. In view of the recent increase in TAC for 2005 and 2006, and following the precautionary approach, the WG does not recommend any further increase in effort.

Mixed fishery aspects

In view of the catch restrictions for cod and other demersal fish species in the North Sea and IIIa it should also be noted that if *Nephrops* fishing effort is allowed to increase, this may have implications for those stocks in mixed fisheries where *Nephrops* is targeted, unless species and size selectivity of the gears is improved (see above). Cod and sole are significant bycatch species in these fisheries in IIIa, and even if data on catch including discards of the bycatch gradually become available, they have not yet been used in the management.

3.4 *NEPHROPS* IN Sub-Area IV

Sub-Area IV contains MA F, G, H, I and S, which include FU 5, 6, 7, 8, 9, 10, 32, and 33. Although ICES provides Management Advice at the MA level, management is actually applied at the scale of ICES Sub-Area through the use of a TAC and an effort regime.

Management at ICES Division Level

The 2005 EC TAC for *Nephrops* in ICES area IV was 22350 tonnes (21350 tonnes in EC waters and 1000 tonnes in Norwegian waters). In 2006 the EC TAC was increased to 29447 tonnes (28147 tonnes in EC waters and 1300 tonnes in Norwegian waters).

The TAC outcome for 2006 differs from the 2005 ICES advice. Although ACFM did not formally advise a TAC number for most FUs in Sub-Area IV, it provided a table of harvest rate options for stocks assessed using UTV surveys and suggested that harvest rates at 15% were consistent with maintaining effort at the present level. This judgement was, however, founded on the time series of reported landings (essentially by adopting the harvest rate which delivered future landings closest to the present ones). Both the WGNSSK and ACFM 2005 reports draw attention to the likelihood of misreporting in these fisheries and it therefore cannot 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 was applied to the

TV abundance estimates for FU6, FU8 and FU9. A more conservative 10% rate was adopted for the Fladen Ground FU7 where the dynamics of the stock are less well known and ICES advice was taken for stocks with no TV survey. The predicted aggregate landing was 28147 tonnes. This became the TAC in EU waters for 2006.

The minimum landings size for *Nephrops* in area IV is 25mm carapace length. Denmark, Sweden and Norway applies a national MLS of 40mm.

Days at sea limits restrict *Nephrops* trawlers to 280 days per year (approximately 25 days per month) when using mesh sizes 70-99mm and with less than 5% catch composition of cod, sole and plaice (see Section 2.1.2).

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

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

Official catch statistics for Sub-Area IV are presented in Table 3.4.1.1

3.4.1 *Nephrops* in Management Area F

3.4.1.1 General

3.4.1.1.1 Ecosystem aspects

Management Area F is located to the north west of Sub-Area IV. In common with other *Nephrops* fisheries the bounds of the Functional Units making up the MA are defined by the limits of muddy substrate. The Functional Units are geographically restricted with little apparent mixing. Although the substrates may be similar, the latitude or location, depth, and local tidal patterns will differ between the FUs and with other MAs which would suggest that each the area of each could be ecologically unique.

The major *Nephrops* fisheries within this management area fall within 30 miles of the UK coast. The Moray Firth (FU9) is a relatively sheltered inshore area, that supports populations of juvenile pelagic fish and relatively high densities of squid at certain times. The Noup (FU10) is located in a more exposed area adjacent to areas supporting diverse demersal fish populations. Further information on the ecosystem aspects of this stock will be collated by the WG before the 2007 meeting.

3.4.1.1.2 Functional Units and their Fisheries in 2005 and 2006

There are two Functional Units in this Management Area, FU 9 Moray Firth and FU 10 Noup. Landings from MA F by FU and other rectangles outside FU are shown in Table 3.4.1.2. Landings from other rectangles are low. The MA forms part of Sub-Area IV for which official catch statistics are presented in Table 3.4.1.1.

The general situation in the Moray Firth is similar to previous years. The area is fished by a number of the smaller class of *Nephrops* boat (12-16m) regularly fishing short trips from Fraserburgh, Macduff and Burghead. Burghead is still the main port for the small inshore vessels for the West of the Firth, joined occasionally by vessels from the Firth of Forth increasing the fleet to about25 boats. Some small vessels attempted twin trawling in 2005 but have reverted to single trawls. Several of the larger *Nephrops* trawlers fish the outer Moray Firth grounds on there way to or from the Fladen grounds (especially when they are fishing the Skate Hole area). Also in times of bad weather many of the larger *Nephrops* trawlers which would normally be fishing the Fladen grounds fish the Moray Firth grounds. In recent years a squid fishery has been seasonally important in the Moray Firth. Squid appear to the east of the Firth and gradually move west during the Summer, increasing in size as they do so. During the autumn the movement is reversed. A large fishery took place in 2004 that attracted a number of *Nephrops* vessels. In 2005, additional vessels joined in the seasonal fishery but catches were noticeably down and in 2006, very few vessels have so far switched to squid fishing.

The Noup grounds are regularly fished by 3-4 boats (16-24m) from Scrabster. They mainly target a mixed fish (mainly flats and monks) and *Nephrops* fishery using 100mm (twin-rig) to stay within the catch composition regulations. Boats land an average of around 1.5 tonnes of *Nephrops* from a 6-7 day trip. Occasionally some of the Fraserburgh *Nephrops* fleets fish the Noup grounds although this did not happen in 2005 and 2006, as many of the boats who used to make the journey have been decommissioned. The Noup ground has previously produced a period of good fishing every year but the area has not been important in the last couple of years.

3.4.1.1.3 Advice

In 2005 ICES concluded that

the available fishery information is inadequate to use analytical methods to evaluate spawning stock or fishing mortality relative to risk. Results from TV surveys suggest that all stocks in this Management Area are exploited at sustainable levels.

a) *Moray Firth: The TV survey estimate of abundance for Nephrops in the Moray Firth suggests that the population increased in 2002 2003, and has remained relatively stable at this higher level since then. Abundance is estimated to be over 40% higher in recent years (2002 2004) compared to the previous period (1999 2001). Indications from the fishery support this and suggest an increase in recruitment in 1995 and 2002.*

b) *Noup: The TV survey estimate of abundance for Nephrops in the Noup suggests that the population declined between the two surveys in 1994 and 1999, but unfortunately no newer data are available. Landings have fluctuated between 200 and 400 tonnes since 1995, with no long-term trend, although effort has declined and LPUE has increased over the same timescale. There is no evidence to suggest any concerns for this stock at thepresent levels of exploitation.*

c) *Small quantities of landings are made outside the main Fladen Ground Functional Unit but within the Management Area.*

and advised that

Due to uncertainty in the available fishery data, ICES is not able to reliably forecast catch. 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.

ACFM also provided a table of harvest rate options.

ICES advice was also provided for all demersal fisheries based on mixed-fishery considerations:

Fisheries in Division IIIa (Skagerrak-Kattegat), in Sub-Area IV (North Sea) and in Division VIId (Eastern Channel) should in 2006 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- *with minimal bycatch or discards of cod;*
- *Implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned abovefor which reduction in fishing pressure is advised;*
- *within the precautionary exploitation limits for all other stocks (see text table above);*
- *Where stocks extent beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits.*
- *With minimum by-catch of spurdog (see Volume 9, section 1.4.6), porbeagle and thornback ray and skate.*

3.4.1.1.4 Management

TAC and effort management affecting this Functional Unit takes place at the ICES Sub-Area and Division level as described at the beginning of Section 3.4.

In addition to the EU management measures, a number of UK measures apply. In addition to the ones outlined at the beginning of Section 3.4, part of the Moray Firth is designated as a Special Area of Conservation for the protection of a population of bottle-nosed dolphins which are periodically resident in the area.

3.4.1.2 Moray Firth (FU 9)

3.4.1.2.1 Data available

Catch

Landings from this Functional Unit are predominantly reported from Scotland, with very small contributions from England in the mid 1990s and are presented in Table 3.4.1.3, together with a breakdown by gear type. The long term landings trends are shown in Figure 3.4.1.1. Total international reported landings in 2005 were 1605 tonnes, all by Scotland. This estimate for total landings has increased in the most recent years, and exceeds the 1541 tonnes landed in 2000. Reported effort by Scottish *Nephrops* trawlers has fluctuated around a relatively stable level since 1990, and in 2005 is just below the average for this period Table 3.4.1.5 and Figure 3.4.1.1). Scottish *Nephrops* trawler LPUE fluctuated around a stable level through the 1990s but has increased in the most recent years. Concerns over the quality of reported statistics mean that some caution is needed in the interpretation of this increase.

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 about 21% by number, or 11% by weight. This represents a marked reduction in discarding rate compared to the average for the period 2002 to 2004 presented last year and may arise from the increasing use of larger size meshes in the northern North Sea *Nephrops* fisheries. It is likely that some *Nephrops* survive the discarding process, an estimate of 25% survival was adopted by WGNEPH in previous meetings in order to calculate removals (landings + dead discards) from the population.

Length compositions

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Levels of sampling are considered good for providing representative length structure of removals in the Moray Firth The sampling levels are shown in Section 1.2.4. Although assessments based on detailed catch analysis are not presently possible (see Section 3.4.1.2.2 below), examination of length compositions can provide a preliminary indication of exploitation effects.

Figure 3.4.1.2 shows a series of annual length compositions raised to fleet landings for the period 1996 to 2005. Catch (removals) and landings length compositions are shown for each sex with the mean catch and landings lengths shown in relation to MLS and 35mm. In both sexes there has been a slight tendency for the mean sizes to increase over time and examination of the tails of the distributions above 35mm shows no evidence of reductions in relative numbers of larger animals.

The observation of relatively stable length compositions is further confirmed in the series of mean sizes of larger *Nephrops* (>35mm) shown in Figure 3.4.1.1 and Table 3.4.1.4. This parameter might be expected to reduce in size if overexploitation were taking place but has in fact shown a slight increase since 1996. The length distributions in Figure 3.4.1.2 also show occasions where large numbers of smaller *Nephrops* appeared (eg 2002). These correspond to dips in mean size in the <35mm category (Figure 3.4.1.1) and are generally interpreted as increases in recruitment, particularly when associated with increases in CPUE of the smaller size category (see below).

Figure 3.4.1.3 shows the average length composition for 2003-2005 divided into landed and discard components

In previous years the raised length compositions of removals were sliced using the WGNEPH program L2AGE into pseudo-age groups with associated weights at age - procedures are described in the Stock Annex (Q3). Owing to the concerns expressed at the 2005 meetings of WGNSDS and WGNSSK over the reliability of age structures derived from slicing and the uncertain quality of landings statistics, slicing procedures were not repeated in 2006

Natural mortality, maturity at age and other biological parameters

Biological parameter values are included in the Stock Annex (Q3). Relevant parameters applied in a simple length based combined yield per recruit to inform the catch forecast process (see section below) were as follows:

Natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females.

Growth parameters:

Males; L_∞ = 62mm, k = 0.165

Immature Females; L_∞ = 62mm, k = 0.165

Mature Females; L_∞ = 56mm, k = 0.06, Size at maturity = 25mm

Weight length parameters:

Males a = 0.00028, b = 3.24

Females a= 0.00074, b = 2.91

Catch, effort and research vessel data

Data collation procedures for the Commercial CPUE and research-vessel survey data series are described in the Stock Annex (Q3).

LPUE data were available for Scottish *Nephrops* trawls. Table 3.4.1.5 shows the data for single trawls, multiple trawls and combined. Examination of the long term commercial LPUE data (Figure 3.4.1.1) suggests that the stock increased in the mid- 1980s, declined to a stable level over the next 12 years or so and has recently increased. It is thought that gear efficiency changes have occurred over time, particularly in relation to multiple trawl gears but this has not been quantified. Concerns over the quality of landings and effort information mean that care is required in placing undue reliance on these trends.

Males generally make the largest contribution to the landings and the LPUEs (Figure 3.4.1.4), although the sex ratio does vary, and females were more important in landings in the early 1990s, exceeding males in 1994. Effort is generally highest in the 3rd quarter of the year in this fishery, but the pattern varies between years, and the seasonal pattern does not appear as strong in recent years. LPUE of both sexes remained relatively constant up to 2002, but has shown an increase since then which is particularly marked in males. LPUE is generally higher for males in the 1st and 4th quarters, and for females in the 3rd quarter – the period when they are not incubating eggs.

CPUE data for each sex, above and below 35 mm CL, are shown in Figure 3.4.1.5. This size was chosen for all the Scottish stocks examined as the general size limit for discarded animals. The data show a slight peak in CPUE for smaller individuals (both sexes) in 1995, with a slight decline after this, relatively stable values until 2001, and increases in both sexes from 2002 onwards. The CPUE for larger males shows relatively stable levels during the late 1990’s, and slightly higher levels in the most recent years, females have declined in the last year. Taken with mean size information above, the latter observation supports the view that exploitation has not had adverse effects on this stock.

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

The numbers of valid stations used in the final analysis in each year are shown in Table 3.4.1.7. On average, about 36 stations have been considered valid each year, and are raised to a stock area of 2195 km^2. General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in the Annex to Section 3.

3.4.1.2.2 Data analyses

Reviews of last year’s assessment

The assessment in 2005 was based principally on the UTV survey series, supported by presentation of basic fishery parameters and mean size information in catches and landings. The WG and ACFM considered the TV data as the best indicator of stock status. According to the survey, abundance increased in 2002 and has remained relatively high, this coincides with commercial CPUE information. The 2005 RGNSSK commented on the lack of information on changes in gear efficiency and inconsistency in the use of LPUE and CPUE when landings figures were stated as uncertain. The Review Group also discussed the basis for choosing suitable harvest rates.

Exploratory analyses of catch data

In view of WG and ACFM concerns expressed previously on the appropriateness of the commercial CPUE tuning fleet, the landings and effort data, the implications of the slicing procedure and the validity of a dynamic pool model for *Nephrops*, no attempts were made to perform XSA or other catch analyses.

Exploratory analyses of survey data

Table 3.4.1.6 shows the basic analysis for the three most recent TV surveys conducted in FU 9 including the 2005 results. The table includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. The ground is predominantly of coarser muddy sand (mS) and most of the variance in the survey is associated with a patchy area of this sediment to the west of the ground.

Figure 3.4.1.6 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density. Abundance is generally higher towards the west of the ground but in recent years higher densities have been recorded throughout. Table 3.4.1.7 and Figure 3.4.1.7 show the time series estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates. With the exception of 2003, the confidence intervals have been fairly stable in this survey.

Final assessment

The underwater TV survey is again presented as the best available information on the Moray Firth *Nephrops* stock. This survey provides a fishery independent estimate of *Nephrops* abundance. At present it is not possible to extract any length or age structure information from the survey, and it therefore only provides information on absolute abundance over the area of the survey.

3.4.1.2.3 Historic Stock trends

The TV survey estimate of abundance for *Nephrops* in the Moray Firth suggests that the population increased between 1992 and 1994 and then declined to a stable level between 1997 and 2001 (no survey was conducted in 1995). Following this the population increased again in 2002, and has remained relatively stable at this higher level since then. Abundance is estimated to be over 40% higher in recent years (2002-2005) compared to the previous period (1999 – 2001).

3.4.1.2.4 Recruitment estimates

Recruitment estimates were not available for this stock.

3.4.1.2.5 Short-term forecasts

A catch prediction for 2007 was made for the Moray Firth FU using the approach outlined in the introductory section on *Nephrops*. In order to provide guidance on a sustainable harvest rate to use, combined sex Y/R calculations were made using an adapted version of LBA (developed by WGNEPH in the 1990s to perform Jones' length cohort analysis and Y/R prediction). The Y/R plot is shown in Figure 3.4.1.8 based on average length compositions of removals for 2003-2005. The text table below shows the $F_{0.1}$ and F_{max} obtained from the curve. The $F_{0.1}$ estimate is similar to other North Sea *Nephrops* stocks for which these calculations were made, driven by the input parameters (see Stock Annex, Q3) which are similar for these stocks. Undue emphasis should probably not be placed on the estimated current F from these calculations owing to the tendency for length cohort analysis to overestimate current fishing mortality through variability in length at age in *Nephrops* leading to overlap of ages. Current F, however, appears to be close to $F_{0.1}$.

FUNCTIONAL UNIT	$F_{0.1}$	F_{MAX}	F_{BAR}
Moray Firth	0.22	0.45	0.23

The estimates of $F_{0.1}$ and F_{max} were included in the calculations of predicted landings under a range of different harvest rates using the approach outlined shown in Figure 3.4.1.9 diagrammatic. In addition to the harvest rates discussed above, predicted landings for arbitrary values of 15%, 20% and 25% have also been computed. Average TV derived abundance values for 2003-2005 and the average length compositions used in the Y/R were used in the calculations. A summary of the input length composition and the calculations made is given in Table 3.4.1.8.

3.4.1.2.6 Medium –term forecasts

Medium term forecasts were not performed for this stock.

3.4.1.2.7 Biological Reference points

Biological reference points have not been defined for this stock.

3.4.1.2.8 Quality of assessment

The length and sex composition of the landings data is considered to be well sampled. Discard sampling has been conducted on a quarterly basis for Scottish *Nephrops* trawlers in this fishery since 1990, and is considered to represent the fishery adequately.

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

Underwater TV surveys have been conducted for this stock since 1993, with a continual annual series available since 1996. The number of valid stations in the survey has remained relatively stable throughout the time period. Confidence intervals around the abundance estimates are greater during the most recent years, when abundance estimates have been slightly higher.

The new TV survey data presented at the meeting extends the time series by 1 year. The abundance estimate has continued to increase (Figure 3.4.1.7).

The trends in abundance observed in the TV survey data have to some extent been reflected in CPUE and mean size data, in that they suggest an increase in recruitment in 1995 and 2002.

NSCFP stock survey trends are shown in Figure 3.5.1. This shows a continuous increase in *Nephrops* in MA F since 2001. This supports the suggestion of an increase in abundance since 2001, with generally moderate or high numbers of recruits.

3.4.1.2.9 Status of the stock

The continuation of abundance at the upper end of the range of TV observation and the slightly increasing mean sizes suggest that the current exploitation rate is sustainable. The evidence from the TV survey suggests that the population has actually been increasing in abundance for a number of years.

3.4.1.2.10 Noup (FU 10)

3.4.1.2.11 Data available

Catch

Landings from this fishery are solely reported from Scotland, and are presented in Table 3.4.1.9, together with a breakdown by gear type. Total international reported landings in 2005 was 165 tonnes, which represents a decline from the recent high value of 401 tonnes in 2002. Reported effort by Scottish *Nephrops* trawlers increased rapidly in the late 1980s and early 1990s, to a peak in 1994, and has shown a general decline since this date Table 3.4.1.10 and

Figure 3.4.10). Scottish *Nephrops* trawler LPUE has shown an increasing trend since the mid 1980's.

Length compositions

Given that the levels of market sampling are low and discard sampling is not available, the length structure of removals in the fishery is not considered to be well represented.

Natural mortality, maturity at age and other biological parameters

No data available

Catch, effort and research vessel data

The low levels of sampling for this fishery mean it is not realistic to draw conclusions from changes in size composition or sex ratio.

The available research-vessel survey data are described in the Stock Annex (Q3) and tabulated in Table 3.4.1.11.

Underwater TV surveys are available for this stock in 1994 and 1999. Figure 3.4.1.11shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density. TV surveying was also attempted in 2005 although poor underwater visibility at the time of the work meant that there were only two stations where some seabed observation could be made.

3.4.1.2.12 Data analyses

Reviews of last year's assessment

No assessment was performed and RGNSSK incorporated comments about this stock in its review of Moray Firth (FU9)

Exploratory analyses of catch data

No analysis of catch data was possible for this stock.

Exploratory analyses of survey data

General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in the Annex to Section 3. The numbers of valid stations used in the final analysis in each year are shown in Table 3.4.1.11, and are raised to a stock area of 339 km^2. Survey data are not available for recent years.

Final assessment

No assessment is presented for this stock

Comparison with last years assessment

3.4.1.2.13 Historic Stock trends

The TV survey estimate of abundance for *Nephrops* in the Noup suggests that the population declined between the two surveys in 1994 and 1999, but unfortunately no newer data are available. Landings have fluctuated between 200 and 400 tonnes since 1995, with no long term trend, although effort has declined and LPUE has increased over the same timescale. There is no evidence to suggest any concerns for this stock at present levels of exploitation.

3.4.1.2.14 Recruitment estimates

Recruitment estimates are not available for this stock

3.4.1.2.15 Short-term forecasts

Short-term TV based forecast were not performed for this stock

3.4.1.2.16 Medium –term forecasts

There were no medium term forecasts for this stock

3.4.1.2.17 Biological Reference points

Biological reference points have not been defined for this stock

3.4.1.2.18 Quality of assessment

The length and sex composition of the landings data are not considered to be well sampled. There is no discard sampling in this fishery.

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

Underwater TV surveys have been conducted for this stock in 1994 and 1999. Confidence intervals around the abundance estimates are lower during the 1999 survey, when abundance estimates were lower.

NSCFP stock survey trends are shown in Figure 3.5.1. These suggest an increase in abundance since 2001 for the northeast of Scotland area, but owing to the small size of FU10 and the larger scale of the survey it is difficult to make comparisons.

3.4.1.2.19 Status of the stock

There is only limited information available for this stock but indications from LPUE of increased abundance suggest the stock is sustainable at current levels of effort.

3.4.1.3 Management Area F Management considerations

Underwater TV surveys of the Moray Firth indicate that stock abundance has been at a stable and relatively high level (over 40% higher than 1999-2001) in recent years, increasing from a lower stable period in the late 1990’s. Indications from the fishery support this, suggesting increased recruitment.

Little information is available for the Noup stock although such TV as is available is fairly constant, and LPUE appears to have been increasing recently.

The WG proposes that the harvest ratio approach based on TV survey abundance is adopted for the Moray Firth, with additional allowances for the Noup stock based on an average of recent landings and ‘other rectangles in the MA, where recent TV data is not available.

The following text table provides a summary (all in tonnes) for the 2 Functional Units and takes account of the *Nephrops* landings which occur in small areas of mud outside the FU. These are less well surveyed or do not have adequate sediment distribution information to include in the main areas shown above. The harvest equivalent to $F_{0.1}$ (highlighted) is considered by the WG to be sustainable.

Harvest rate	Moray Firth	Noup (Ave 03-05)	'Other Squares' (Ave 03-05)	Total
15%	2411	243	77	2731
19.4% (F0.1 = 0.216)	3119			3439
20%	3215			3535
25%	4019			4339
36% (Fmax=0.449)	5787			6107

Effort should not be allowed to increase in this MA, and the WG, ACFM and STECF have repeatedly advised that management should be at a smaller scale than the ICES Division level.

In 2005, high abundance of 0 group cod was recorded in Scottish surveys in the Moray Firth area. The abundance of these cod as 1 year olds still appears to be relatively high. It is important that efforts are made to ensure that these and other fish are not taken as unwanted bycatch in smaller mesh fisheries and technical measures that improve the exploitation pattern would be beneficial in the fisheries of this MA.

3.4.2 *Nephrops* in Management Area G

3.4.2.1 General

3.4.2.1.1 Ecosystem aspects

Management Area G is located towards the centre of the northern part of Sub-Area IV. Its eastern boundary is adjacent to the Norwegian Deeps area.

A density driven gyre centred on the ground influences the hydrographic features of the area. The gyre relies on persistent cold dense bottom water and sustained periods of these conditions may affect *Nephrops* growth and other biological features.

The abundance of fish is currently higher in this area than in a number of the inshore grounds close to the Scottish coast, particularly towards the north of the ground. Further information on the ecosystem aspects of this stock will be collated by the WG before the 2007 meeting.

3.4.2.1.2 Functional Units and their Fisheries in 2005 and 2006

There is one Functional Units in this Management Area, FU 7 the Fladen Ground. Landings from MA G by FU and other rectangles outside the FU are shown in Table 3.4.2.1. Landings from other rectangles are low (around 100 tonnes). The MA forms part of Sub-Area IV for which official catch statistics are presented in Table 3.4.1.1

General information on the fishery can be found in the Stock Annex (Q3). The Fladen fishery (FU7), the largest Scottish *Nephrops* fishery, takes a mixed catch with ground and round fish (mainly haddock, whiting, and monkfish and flatfish), making an important contribution to the boats earnings. The Fladen *Nephrops* fleet consists of vessels from 12m up to 28m fishing mainly with 80mm twin-rig although in 2005 and 2006, even larger multi rigs were trialed. The fleet has a diverse range of boats, and includes some of the largest and most modern purpose built boats in the Scottish fleet and vessels which have recently converted to *Nephrops* fishing.

The majority of the fleet (80%) fish out of Fraserburgh, with the other important ports being Peterhead, Buckie, Macduff, and Aberdeen. Boats fish varying lengths of trip between 3 days (small boats) and 8-9 day trips (larger vessels). A recent tendency towards shorter trip lengths maybe associated with market demand for high quality.

The Fladen fishery generally follows a similar pattern every year, with different areas of the Fladen grounds producing good fishing at different times of the year (boats fish the north of the ground in winter, then push out east towards the sector line in the summer. In the past few years (2004-5) there has been less of this seasonal pattern with fishing being good throughout the year on a range of grounds. There was also no lull in catch rates which traditionally happens in April-May. In 2006 there has been a return to a more normal pattern of fishing with catches poor for most of the spring and slowly getting better throughout the summer. Some participating vessels explored slightly different areas to fish in 2006, particularly on the eastern edge of the ground.

There were more Fladen vessels involved in the Moray Firth squid fishing in 2005 than previous years, but this is not the case in 2006. Quality control appears to have increased dramatically, resulting in prawns in a better conditions at market, this is partly because of handling practices and partly because fishing trips seem to be shorter in more recent years (2005 and 2006). Anecdotal evidence suggests that fewer prawns are being landed in 2006 than before, but they tend to be larger.

3.4.2.1.3 Advice

In 2005 ICES concluded that

The available fishery information is inadequate to use analytical methods to evaluate spawning stock or fishing mortality relative to risk. Results from TV surveys, however, suggest that the stock in this Management Area appear to be exploited at a sustainable level.

The TV survey estimate of abundance for Nephrops in the Fladen Ground suggests that the population increased between 1992 and 1994 and then declined to a stable level between 1997 and 2000 (no survey was conducted in 1996). Following this the population increased again to 2002, and has since declined to the pre-2002 stable level in the most recent years.

Small quantities of landings are made outside the main Fladen Ground Functional Unit but within the Management Area.

and advised that

Information on these stocks is considered inadequate to provide an advice based on 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.

Previous TAC advice was provided on the basis of a harvest rate based on underwater TV burrow surveys. In 2005, ACFM included a range of harvest rate options but did not advise on any particular one.

ICES advice was also provided for all demersal fisheries based on mixed-fishery considerations:

Fisheries in Division IIIa (Skagerrak-Kattegat), in Sub-Area IV (North Sea) and in Division VIId (Eastern Channel) should in 2006 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- with minimal bycatch or discards of cod;
- Implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned abovefor which reduction in fishing pressure is advised;
- within the precautionary exploitation limits for all other stocks (see text table above);

- Where stocks extent beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits.
- With minimum by-catch of spurdog (see Volume 9, section 1.4.6), porbeagle and thornback ray and skate.

3.4.2.1.4 Management

Management is at the ICES Division level as described at the beginning of Section 3.4.

3.4.2.2 Fladen Ground (FU 7)

3.4.2.2.1 Data available

Catch

Landings from this fishery are predominantly reported from Scotland, with small contributions from Denmark and others, and are presented in Table 3.4.2.2, together with a breakdown by gear type. Total international reported landings in 2005 was 10684 tonnes, consisting of 10363 tonnes landed by Scotland and 321 tonnes landed by Denmark. Reported effort by Scottish *Nephrops* trawlers shows an increasing trend up to 2002, but shows a sharp drop in 2003 (Table 3.4.2.4 and Figure 3.4.2.1). Scottish *Nephrops* trawler LPUE fluctuates around a relatively high level, with a considerable increase from 2003 onwards. Concerns over the quality of reported statistics mean that some caution is needed in the interpretation of this increase. Danish LPUE data, however, also shows a recent increase (Table 3.4.2.5).

Discarding of undersized and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 2000. Discarding rates averaged over the period 2003 to 2005 for this stock were about 11% by number, or 7% by weight. This is similar to the discarding rate observed for the 2002 to 2004 period. Discard rates are lower in this Functional Unit which may reflect the wider use of larger meshes (90-99mm) in this area compared to the inshore grounds. It is likely that some *Nephrops* survive the discarding process, an estimate of 25% survival is assumed in order to calculate removals (landings + dead discards) from the population.

Length compositions

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Levels of sampling have increased since 2000 and are considered good for providing representative length structure of removals at the Fladen Ground. The sampling levels are shown in Section 1.2.4. Although assessments based on detailed catch analysis are not presently possible (see Section 3.4.2.2.2 below), examination of length compositions can provide a preliminary indication of exploitation effects.

Figure 3.4.2.2 shows a series of annual length compositions raised to fleet landings for the period 1996 to 2005. Catch (removals) and landings length compositions are shown for each sex with the mean catch and landings lengths shown in relation to MLS and 35mm. In both sexes the mean sizes have been fairly stable over time and examination of the tails of the distributions above 35mm shows no evidence of reductions in relative numbers of larger animals.

The observation of relatively stable length compositions is further confirmed in the series of mean sizes of larger *Nephrops* (>35mm) shown in Figure 3.4.2.1 and Table 3.4.2.3. This parameter might be expected to become smaller if overexploitation were taking place but there is no evidence of this. Smaller animals are less frequent in this fishery than in some inshore grounds (perhaps because of the general use of larger meshes) and the mean sizes of animals <35mm is quite high and also stable.

Figure 3.4.2.3 shows the average length composition for 2003-2005 divided into landed and discard components

In previous years the raised length compositions of removals were experimentally sliced using the WGNEPH program L2AGE into pseudo-age groups with associated weights at age - procedures are described in the Stock Annex (Q3). Owing to the concerns expressed at the 2005 meetings of WGNSDS and WGNSSK over the lack of knowledge on growth in this stock, the reliability of age structures derived from slicing and the uncertain quality of landings statistics, slicing procedures were not repeated in 2006

Natural mortality, maturity at age and other biological parameters

Biological parameter values are included in the Stock Annex (Q3). Relevant parameters applied in a simple length based combined yield per recruit to inform the catch forecast process (see Section 3.4.2.2 below) were as follows:

Natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females.

Growth parameters for age slicing are as follows:

Males; L_∞ = 66mm, k = 0.16

Immature Females; L_∞ = 66mm, k = 0.16

Mature Females; L_∞ = 56mm, k = 0.10, Size at maturity = 25mm

Weight length parameters:

Males a = 0.0003, b = 3.25

Femles a= 0.00074, b = 2.91

Catch, effort and research vessel data

The collation of commercial LPUE, CPUE and research-vessel survey data series are described in the Stock Annex (Q3) for *Nephrops*.

LPUE and CPUE data were available for Scottish *Nephrops* trawls. Table 3.4.2.4 shows the data for single trawls, multiple trawls and combined. Examination of the long term commercial LPUE data (Figure 3.4.2.1) suggests that the stock rapidly increased in the most recent years. Since there are concerns over the quality of fishery data (landings and effort) care is required in the interpretation of these trends.

Males consistently make the largest contribution to the landings and the LPUEs (Figure 3.4.2.4), although the sex ratio does vary. In earlier years effort was generally highest in the latter part of the year in this fishery, but the pattern varies between years, and the seasonal pattern does not appear as strong in recent years. LPUE of both sexes remained relatively constant up to 2002, but has shown a marked increase since then. LPUE is fairly similar through the year for males but for females the pattern is rather erratic in these data.

CPUE data for each sex, above and below 35 mm CL, are shown in Figure 3.4.2.5. This size was chosen for all the Scottish stocks examined as the general size limit for discarded animals. The data show a slight rise in CPUE for smaller individuals (both sexes) in recent years. The CPUE for larger individuals shows a rise during the late 1990’s, and slightly higher levels in the most recent years. Taken with mean size information above, the latter observation possibly suppors the view that exploitation has not had adverse effects on this stock. However, uncertainty in the index arising from the quality of the landings and effort data means it should be treated with caution. Danish effort and LPUE is shown in Table 3.4.2.5

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

The numbers of valid stations used in the final analysis in each year are shown in Table 3.4.2.7. On average, about 60 stations have been considered valid each year, and are raised to a stock area of 28153 km^2. General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in the Annex to Section 3.

3.4.2.2.2 Data analyses

Reviews of last year's assessment

The assessment in 2005 was based principally on the underwater television survey series, supported by presentation of basic fishery parameters and mean size information in catches and landings. The WG and ACFM considered the TV data as the best indicator of stock status . According to the survey, abundance increased in 2002 but declined slightly and stabilised in 2004. The 2005 RGNSSK commented on the low discard rate and thought this might be ascribed to underreporting – in fact it is more likely to be because of the generally larger sizes in the population and the use of larger mesh gears in the fishery. The group commented on the use of mean size being unreliable because of selectivity and recruitment effects – this is however, addressed by the WG's use of a mean >35mm. The difference between harvest rate landings and current landings was raised by RGNSSK – this issue has been addressed generically over the course of the last year.

Exploratory analyses of catch data

In view of WG and ACFM concerns expressed previously on the appropriateness of the commercial CPUE tuning fleet, the landings and effort data, the implications of the slicing procedure and the validity of a dynamic pool model for *Nephrops*, no attempts were made to perform XSA or other catch analyses.

Exploratory analyses of survey data

Table 3.4.2.6 shows the basic analysis for the three most recent TV surveys conducted in FU 7 including the 2005 results. The table includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. The ground has a range of mud types from soft silty clays to coarser sandy muds, the latter predominate. Most of the variance in the survey is associated with this variable sediment which surrounds the main centres of abundance.

Figure 3.4.2.6 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density. Abundance is generally higher in the soft and intermediate sediments located to the centre and south east of the ground. Table 3.4.2.7 and Figure 3.4.2.7 show the time series estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates. In general the confidence intervals have been fairly stable in this survey.

Final assessment

The underwater TV survey is again presented as the best available information on the Fladen Ground *Nephrops* stock. This survey provides a fishery independent estimate of *Nephrops* abundance. At present it is not possible to extract any length or age structure information from the survey, and it therefore only provides information on absolute abundance over the area of the survey.

The new TV survey data presented at the meeting extends the time series by 1 year. The abundance estimate has declined from a high in 2003 (Figure 3.4.2.7).

3.4.2.2.3 Historic Stock trends

The TV survey estimate of abundance for *Nephrops* in the Fladen suggests that the population increased between 1992 and 1994 and then declined to a stable level between 1997 and 2000 (no survey was conducted in 1996). Following this the population increased again to 2002, and then declined to the pre 2002 level, dropping in 2005 to below the average for the time series. The trends in abundance observed in the TV survey data have not been reflected in LPUE data or mean size data. This may be owing to the short time series of discard data, or spatial changes in the fishery or to fishery management regulations

NSCFP stock survey trends are shown in Figure 3.5.1. This shows an increase in *Nephrops* between 2001 and 2002, a slight decrease to 2003, and marked increase since this date. This supports the suggestion of increase in abundance in 2002 for this area, but does not fully reflect the subsequent period or show any change in the levels of discards or recruits.

3.4.2.2.4 Recruitment estimates

Recruitment estimates were not available for this stock.

3.4.2.2.5 Short-term forecasts

A catch prediction for 2007 was made for the Fladen Ground (FU7) using the approach outlined in the introductory section on *Nephrops*. Combined sex Y/R calculations were made using an adapted version of 'LBA' (developed by WGNEPH in the 1990s to perform Jones' length cohort analysis and Y/R prediction). The Y/R plot is shown in Figure 3.4.2.8 based on average length compositions of removals for 2003-2005. The text table below shows the $F_{0.1}$ and F_{max} obtained from the curve. The $F_{0.1}$ estimate is similar to other North Sea *Nephrops* stocks for which these calculations were made, driven by the input parameters (see Stock Annex (Q3)) which are similar for these stocks. Undue emphasis should probably not be placed on the estimated current F from these calculations owing to the tendency for length cohort analysis to overestimate current fishing mortality through variability in length at age in *Nephrops* leading to overlap of ages.

FUNCTIONAL UNIT	$F_{0.1}$	F_{MAX}	F_{BAR}
Fladen Ground	0.20	0.38	0.30

The estimates of $F_{0.1}$ and F_{max} were included in the calculations of predicted landings under a range of different harvest rates using the approach outlined shown in Figure 3.4.1.9. In addition to the harvest rates discussed above, predicted landings for arbitrary values of 10%, 15%, 20% and 25% have also been computed. Average TV derived abundance values for 2003-2005 and the average length compositions used in the Y/R were used in the calculations. A summary of the input length composition and the calculations made is given in Table 3.4.2.8.

Although the Fladen Ground (FU7) is a large stock (the largest in European waters) it also occupies a large area and TV surveys show that the density of animals per unit area is lower than in a number of other grounds. Coupled with the shortage of locally estimated parameter values for this stock, it is felt that the adoption of a harvest rate less than the one implied by $F_{0.1}$ is prudent.

3.4.2.2.6 Medium –term forecasts

Medium term forecasts were not performed for this stock.

3.4.2.2.7 Biological Reference points

Biological reference points have not been defined for this stock.

3.4.2.2.8 Quality of assessment

The length and sex composition of the landings data is considered to be well sampled. Discard sampling has been conducted on a quarterly basis for Scottish *Nephrops* trawlers in this fishery since 2000, and is considered to represent the fishery adequately.

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

Underwater TV surveys have been conducted for this stock since 1992, with a continual annual series available since 1997. The number of valid stations in the survey have remained relatively stable throughout the time period, although have been below average in more recent years. Confidence intervals around the abundance estimates are greater during the most recent years, when abundance estimates have been slightly higher, and station numbers lower.

The trends in abundance observed in the TV survey data have not been reflected in LPUE data or mean size data. This may be owing to the short time series of discard data, or spatial changes in the fishery or to fishery management regulations

NSCFP stock survey trends are shown in Figure 3.5.1. This shows an increase in *Nephrops* between 2001 and 2002, a slight decrease to 2003, and marked increase since this date. This supports the suggestion of increase in abundance in 2002 for this area, but does not fully reflect the subsequent period or show any change in the levels of discards or recruits.[check]

3.4.2.2.9 Status of the stock

TV observations suggest the stock is fluctuating without obvious trend although estimates for the last 3 years have reduced from a high level in 2002. This does not presently give cause for concern and the indications of stable or slightly increasing mean sizes suggest that the current exploitation rate is sustainable.

3.4.2.3 Management Area G Management considerations

Underwater TV surveys of the Fladen Ground (FU7) indicate that stock abundance has been fluctuating in recent years with no obvious trend. The stock size is presently below the average for the time series. Mean size in this stock is relatively high and has not shown any signs of decline. The stock appears to be able to sustain current levels of fishing.

The WG proposes that the harvest ratio approach based on TV survey abundance is adopted for the Fladen Gound, with additional allowances for ‘other rectangles in the MA, where recent TV data is not available.

The following text table provides a summary (all tonnes) for the Functional Units and takes account of the *Nephrops* landings which occur in small areas of mud outside the FU. These are less well surveyed or do not have adequate sediment distribution information to include in the main areas shown above.

Harvest rate	Fladen Gound	'Other Squares' (Ave 03-05)	Total
10%	14392	105	14497
15%	21587		21692
18.2% (F0.1 = 0.201)	26205		26310
20%	28783		28888
25%	35979		36084
31.3% (Fmax=0.38)	45103		45208

The WG considered carefully an appropriate harvest rate for this stock. The estimate of $F_{0.1}$ is quite low and use of this as a guide to the harvest rate appears to represent a sustainable approach for most stocks. Nevertheless, for the reasons given in the short term forecasts section above and owing to the shorter time series from which to build a picture of dynamics for this stock, the WG considers that a more cautious harvest rate would be prudent. A harvest rate of 10% has been highlighted in the Table above. This represents a drop from the equivalent harvest rate forecast provided in 2005 as the stock size declines slightly.

Effort should not be allowed to increase in this MA, and the WG, ACFM and STECF have repeatedly advised that management should be at a smaller scale than the ICES Sub-area and Division level.

An important consideration here is the further development of multiple rigs (into triple and quadruple trawls). Such developments potentially increase efficiency and increases in effective effort. While technological developments represent a feature of most industries, in this situation the opportunity to increase technological efficiency without overall control of the level of effective effort is not considered sustainable.

In 2005, high abundance of 0 group cod was recorded in Scottish surveys in the Moray Firth area. The abundance of these cod as 1 year olds still appears to be relatively high and they have spread into other areas such as the Fladen Ground. Similar comments can be made about the emerging 2005 haddock year class which will begin entering the fishery in 2007 and according to forecasts (Section 13) will result in large discard numbers under the present exploitation pattern. It is important that efforts are made to ensure that these and other fish are not taken as unwanted bycatch in smaller mesh fisheries and technical measures that improve the exploitation pattern would be beneficial in the fisheries of this MA.

3.4.3 *Nephrops* in Management Area S

3.4.3.1 General

This MA includes only FU 32 (Norwegian Deep).

3.4.3.1.1 Ecosystem aspects.

Sediment maps for the Norwegian Deep indicate that the area of suitable sediment for *Nephrops* is larger than the current extent of the fishery, and there may be possibilities of expansion into new grounds, on which *Nephrops* is not currently exploited.

3.4.3.1.2 Norwegian Deep (FU 32) fisheries

Traditionally, Danish and Norwegian fisheries exploit this stock, while exploitation of this *Nephrops* stock by UK vessels have insignificant. Denmark accounts for the majority of landings from this Management area (see Table 3.4.3.1).

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

Traditionally the Norwegian effort for *Nephrops* has been low, and the majority of the Norwegian *Nephrops* landings from FU 32 have largely been as by-catch from the *Pandalus* fishery. Because of the landings restrictions for *Pandalus*, shrimp trawlers have started fishing more specifically for *Nephrops* in the most recent years. Also, there are an increasing number of boats that target *Nephrops* year-round, making one-week trips and landing their catches in Denmark. From 1999 to 2004, 159 to 185 Norwegian vessels landed *Nephrops* from the Norwegian Deep. The average length of the vessels was around 17 m.

There has been a change in the most commonly used mesh size by the Norwegian vessels. In 1999, 90 % of vessels used 70-80 mm trawls according to the reported logbooks. In 2000, small-meshed trawls taking 18 % of *Nephrops* landings performed 29 % of the trawling hours. This is also reflected in the by-catch of landed fish species. Until 1999, reported fish weight was less than 30 % of the landings. From 2000 onwards it has been more than 70 %. Fishing for *Nephrops* using trawls with mesh size 70-120 mm should have square meshes in the cod-end, or have an 80 mm square mesh panel and a top-panel of at least 140 mm diamond meshes. By-catch of cod and haddock should not exceed 10% in weight of total catch.

3.4.3.1.3 Advice

In 2005 ICES noted for this stock that the available information was inadequate to evaluate spawning stock or fishing mortality relative to risk. Furthermore, it was noted that:

- “landings have shown an increasing trend in recent years. Danish LPUE has decreased over the last three years. However, this might be caused by changes in trawl mesh size and fishing pattern”.
- “The perception of the stock is based on Danish LPUE data.“
- “Due to “technological creeping” there are concerns over effort data, because of changes in selectivity or in gear efficiency. Furthermore, LPUE may be affected by changes in catchability (due to sudden changes in the environmental conditions)”.
- “Information on this stock is considered inadequate to provide advice based on precautionary limits.”

No specific advice for this stock was given, and no TAC was suggested for 2006. In previous years TACs based on historical landings have been suggested.

Official catch statistics for Sub-Area IV are presented in Table 3.4.1.1

3.4.3.1.4 Management

The EC fisheries in FU 32 take place mainly in the Norwegian zone of the North Sea. The EU fisheries are managed by a separate TAC for this area. For 2006 the agreed TAC for EC vessels was 1300 t.

3.4.3.2 Norwegian Deeps FU32

3.4.3.2.1 Data available

Catch

International landings from the Norwegian Deep increased from less than 20 t in the mid-1980s to 1,216 t in 2002, the highest figure so far Table 3.4.3.1 and Figure 3.4.3.1. Since then landings have declined slightly and total landings in 2005 amounted to 1117 tonnes. The overall picture is that of a more or less constant landings level of around 1100 t since 1999. Danish vessels take 80-90 % of total landings

Length composition

The average size of *Nephrops* as recorded from Danish catches in the period 2000-2005 (using a 100 mm *Nephrops* trawl) is shown in Figure 3.4.3.1. These averages (both in catches and landings) show a slightly decreasing trend both for males and females. Figure 3.4.3.2 gives the size distributions (2005) in the Danish catches (100 mm mesh size) from 2002 to 2005. No conspicuous changes can be observed. Size data from a Norwegian bottom trawl survey in the 4th quarter (using a 70mm mesh size trawl) are also available, but the sampling level was low in 2005.

Figure 3.4.3.3 shows a time series of length compositions for this stock. There is little evidence of notable change in sizes and maximum sizes have remained quite constant (although the shape of the length distributions does change from year to year). The sample series is fairly short.

Since 2002 the Danish at-sea-sampling programme has provided data for discard estimates. However, the samples have not covered all quarters.

Natural mortality, maturity at age and other biological parameters

No data available

Catch, effort and research vessel data

Effort and LPUE figures for the period 1989-2005 are available from Danish logbooks (Table 3.4.3.2 and Figure 3.4.3.1). The available logbook data from Norwegian *Nephrops* trawlers cover only a small proportion of the landings (27 % in the year 2000). The few vessels having reported *Nephrops* landings in the earlier years, and the change in fleet structure make the Norwegian logbook data unsuitable for any LPUE analysis. In the beginning of the 1990s vessel size increased in the Danish fleet fishing in the Norwegian Deep. This increase and more directed fisheries for *Nephrops* in areas with hitherto low exploitation levels are probably partly responsible for the observed increase in the Danish LPUEs in those years (Table 3.4.3.2). A similar development has been occurring by the Norwegian fleet. Since 1994 the Danish LPUEs have fluctuated somewhat, around 200 kg.day^{-1}. Some of the fluctuations may be caused by fishing vessels locally switching between roundfish and *Nephrops* due to changes in management regulations in the Norwegian zone. It appears that the Danish effort declined in 2004. This decline corresponds to a decline in landings, which to some extent can be explained by a decline in price for *Nephrops* that year.

It has not been possible to incorporate ‘technological creeping’ in the evaluation of the effort data. However, use of twin trawls has been widespread for many years. Figure 3.4.3.4 shows the logbook based effort data analysed in various ways to elucidate the effect of some factors likely to influence the effort/LPUE:

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

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

In previous years the Norwegian bottom trawl survey in this area has provided Norwegian data on size distribution of the *Nephrops*. However, in 2005 sampling intensity was low.

3.4.3.2.2 Data analysis

Review of last year's assessment

The assessment in 2005 was based on mean size and LPUE. RGNSSK questioned this and commented on the short time series. There were a number of issues raised about the Danish effort data series and the shortage of Norwegian information. Close monitoring of the fishery was suggested.

Exploratory analysis of catch data

There was no age based analysis carried out

Exploratory analysis of survey data

Survey data were too sparse to be useful for exploratory analysis

Final assessment

No age based numerical assessment is presented for this stock. The state of the stock was judged on the basis of basic fishery data

3.4.3.2.3 Historic stock trends

The slight decrease in mean size in the catches and landings (could indicate a high exploitation pressure in recent years. The decline in landings in 2003 and 2004 may be explained partly by a lower market price in that period. However, the (Danish) LPUE's in 2004 and 2005 were higher than in the previous years giving no signs of overexploitation of the stock at present.

3.4.3.2.4 Recruitment estimates

There are no recruitment estimates for this stock

3.4.3.2.5 Forecasts

There were no forecasts for this stock

3.4.3.2.6 Biological reference points

No reference points are defined for this stock

3.4.3.2.7 Quality of assessment

The data available for this stock remains limited. Missing Norwegian information on effort

The NSCFP survey (Figure 3.5.1) indicates a generally increasing trend in the Northern North Sea although the responses come from an area which partly includes the Fladen Ground so the information is more difficult to interpret from a Norwegain Deeps perspective.

3.4.3.2.8 Status of stock

Perceptions of this stock (FU 32) are based on Danish LPUE data. However, the effect of technological creep on the effective effort of the fishery is not known. It is noted, that the EC-Norway agreement of 1000 t in 2005 for EC vessels in this area may just have had a restrictive effect for the fleets exploiting this FU/stock. For 2006 the agreed catch for EC vessels was 1300 t.

3.4.3.3 Management considerations for Area S

Recent trends in overall size distribution in the catches indicate that the *Nephrops* stock in the Norwegian Deep is fully exploited. The trend in Danish LPUE figures do not indicate any decline in stock abundance. Given the lack of catch forecasts for FU 32, the WG concludes that the level of exploitation on this stock should not be increased. Recent average landings have been approximately 1,100t (average landings 2002-2005).

The WG considers that the stock should be monitored more closely. The Norwegian logbook system should be improved. Sampling of Norwegian commercial catches from this area should be intensified and analysed. Also the sampling of the Danish vessels should be intensified to cover all seasons of the year.

3.4.4 *Nephrops* in Management Area I

3.4.4.1 General

3.4.4.1.1 Ecosystem aspects

A common feature of *Nephrops* fisheries is that their bounds appear to be defined by the limits of muddy substrate (See Stock Annex, Q3). The stocks are geographically restricted with little apparent mixing. Although the substrate may be similar, the latitude or location, depth, and local tidal patterns will differ between stocks which would suggest that each the area of each could be ecologically unique.

The major *Nephrops* fisheries within this management area fall within 30 miles of the UK coast. Further information on the ecosystem aspects of this stock will be collated by the WG before the 2007 meeting.

3.4.4.1.2 Functional Units and their Fisheries in 2005 and 2006

General information on the fishery can be found in the Stock Annex (Q3). There are two Functional Units in this Management Area: Farn Deeps (FU 6) and Firth of Forth (FU 8).

Landings from MA I by FU and other rectangles outside FU are shown in Table 3.4.4.1. Landings from other rectangles within MA I are lower than from FUs, but have increased since 2000. This increase is largely thought to be related to increased landings from the Devil’s Hole area. The proportion landed declined in 2005 but is still 10% of the total.

Nephrops fishing activity in MA I is centred on two areas, the Farn Deeps (FU6) and the Firth of Forth (FU8). Figure 3.4.4.1 shows counts of VMS observations per 3 minute ‘square’ (latitude and longitude) between October 2005 and March 2006 for all UK vessels moving between 1-3 knots. The dates were chosen to coincide with the main *Nephrops* fishing season in the Farn Deeps. This metric focuses on vessels over 15m and will include those not fishing for *Nephrops*, but the concentration of effort on the Farn deeps can clearly be seen. There are also concentrations of effort visible outside FU6 and FU8 in the Devil’s Hole area.

The fishery in the Farn Deeps is characteristically a winter fishery running from around September through to March. There are around 90 local trawlers (based in ports in N E England) exploiting this fishery. Historically vessels from Scotland would join the local fleet for the main part of the season. Restrictions on fishing for other stocks through quota and closed areas increased the number of vessels visiting this fishery from Scotland and elsewhere from around 90 to about 140 in 2001. The number declined to around 100 in 2005 but there was a marked difference in the fleet. The fleet in 2005 included 9 Northern Irish first timers of which 8 were using multi-trawls. In 2005 over 30 vessels were recorded using multi trawls in this fishery when previously the number fluctuated between 5 and 10. Multi rig trawlers accounted for about 10% of the landings in 2004 and 20% in 2005.

During 2005 and first part of 2006 the number of vessels regularly fishing in the Firth of Forth has been about 23 under 10m and 34 over 10m vessels.

Most of the vessels are resident in ports around the Firth but some vessels (including 2 twin riggers) come north from Eyemouth, also spending part of their time fishing at the Farn Deeps. South Shields boats also came North to the Firth. Single trawl fishing, with 80 mm mesh size is the most prevalent method. A couple of vessels have the capability for twin rigging but have been single rigging thus far in 2006. Night fishing is commonest in the summer shifting to day fishing in winter. A very small amount of creeling for *Nephrops* takes place, this is mostly by crab and lobster boats.

Nephrops is the main target species with diversification by some boats to squid, and also surf clams. Only very small amounts of whitefish are landed. The latest information for 2006 suggests that there are currently large catches of small *Nephrops* attracting boats from Arbroath into the fishery. This is expected to diminish over the autumn. In the past, small prawns generally led to high tail:whole prawn ratios in this fishery but in recent years a small whole prawn 'paella' market developed. In 2005 and 2006 the practice of landing these small *Nephrops* during periods of larger catches (summer) continued. These prawns are of a size usually tailed but a lack of time to process the catch during the short fishing night means that they are either landed whole or dumped with most boats opting for the former. This year the practice has been very commonplace with very large catches of small prawns. There is a market and an acceptable price for these. There is some local doubt as to whether keeping 'paella' is wise use of quota but this is generally not stopping the fleet landing it. Buyers have started putting a limit on 'paella' landings so discarding could possibly increase. In the last year or so there have been plans to develop techniques for 'tubing' of live prawns in a similar fashion to creel vessels, some boats have found buyers and are investing in new infrastructure for this.

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

In 2006, buyers and sellers regulations have led to increased traceability of catches which is expected to lead to an increase in reported catches in this Management Area.

3.4.4.1.3 Advice

The ACFM report from October 2005 (ICES-ACFM 2005) contains the following advice for this Management Area:

The available information is inadequate to use analytical methods to evaluate spawning stock or fishing mortality relative to risk. Results from TV surveys, however, suggest that the stock in this Management Area appear to be exploited at a sustainable level. Effort currently appears to be at its lowest level since 1984 and LPUE appears to be at its highest in the series. The TV surveys appear to confirm this recent increase in abundance. CPUE trends suggest that recruitment has not been strong over the last few years, but the increase in the mesh size could have masked any recruitment signals. All signs suggest that the stock is healthy although the males in this stock do suffer greater fishing pressure.

All stocks in this Management Area appear to be exploited at sustainable levels.

a) *Farn Deeps: LPUEs fluctuated around a generally upward trend up to 1993, were stable for some years, and then after a dip in 2000 increased to an all time high in*

2004 despite apparent declining effort. The increase in the estimate of autumn abundance from the TV surveys in the last few years corresponds to this increase in LPUE, but still remains within the range over the series. Mean size of the smaller length groups for males and females has increased in recent years, but the LPUE for these length groups has remained fairly static. CPUE trends and trends in mean size do not give any clear signals about recruitment; they suggest recruitment has been variable but fairly consistent over recent years.

b) *Firth of Forth: The TV survey estimate of abundance for Nephrops in the Firth of Forth suggests that the population declined between 1993 and 1998 (although no surveys were conducted in 1995 or 1997), increased to a stable level between 1999 and 2001, and then increased to 2003, declining slightly in the most recent year. The recent average abundance (2002 2004) is 23% higher than the previous period (1999 2001). The increases in abundance in the late 1990s and most recent years have been reflected in CPUE and mean size data, in that they suggest an increase in recruitment in 1998 and 2003.*

c) Some landings are made outside the Functional Units but inside the Management Area.

ICES advice was also provided for all demersal fisheries based on mixed-fishery considerations:

Fisheries in Division IIIa (Skagerrak-Kattegat), in Sub-Area IV (North Sea) and in Division VIId (Eastern Channel) should in 2006 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- with minimal bycatch or discards of cod;
- Implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned abovefor which reduction in fishing pressure is advised;
- within the precautionary exploitation limits for all other stocks (see text table above);
- Where stocks extent beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits.
- With minimum by-catch of spurdog (see Volume 9, section 1.4.6), porbeagle and thornback ray and skate.

3.4.4.1.4 Management

These stocks are managed at the ICES Sub-Area and Division level as described in Section 3.4. There are no local management restrictions but the 55° latitude line used in the EU catch composition regulations bisects this fishery. This may have an impact on the distribution of effort.

3.4.4.2 Farn Deeps (FU 6)

3.4.4.2.1 Data available

Catch

Since the beginning of the time-series, the UK fleet has accounted for virtually all landings from the Farn Deeps (Table 3.4.4.2). The WG estimates landings and effort information from EU logbooks sales notes and landing summaries collated by DEFRA and SEERAD.

The annual TAC for area IV in 2005 was fully taken up which would suggest that it may have been limiting. It is apparent that historically, national and regional *Nephrops* TACs may have been restrictive enough to encourage some under-reporting (ICES-WKNEPH 2003, ICES-WGNSSK 2005).

Landings increased to a maximum in 1994 after which they were relatively stable around a mean of 2200 tonnes. Landings in 2005 jumped to 3094 tonnes (Figure 3.4.4.2, Table 3.4.4.2).

Fishing effort for UK (E, W + S) trawlers has been following a general decline since the early 1990s. The trend in effort in recent years may have been due to changes in the fleet such as the decommissioning of larger vessels, the impacts of technical regulations and days at sea legislation (Stock Annex, Q3). In 2005 there was an increase in effort from the usual UK E+W and UK S fleets. In addition to this increase there was an influx of Northern Irish vessels in 2005.

A catch sampling programme has been running since 1994 and discards are estimated from comparison of total unsorted catch samples with landings samples. Prior to this discard and landings were directly sampled. Estimated discarding during this later period has fluctuated around 40% by weight of the catch (60% by number). This is similar to the levels observed between 1984-1993 when direct discard sampling was conducted. The consistency throughout the period confirms the high discard rate. But there are indications of potential sampling bias with the smallest *Nephrops* being less available for measuring when collecting landings samples. This would not affect the shape of the catch compositions but the discarded component could be overestimated.

Length compositions

Landings and catch length compositions and sex ratios are provided by UK (E and W) and were considered reasonably well sampled (see Section 1.2.4). A review of sampling and recording practice in 2006 revealed errors in landings samples which reduced the number of samples that could be used for 2005 and affected one sample collected in 2004 which had to be deleted. Although some of the indices, dependant on the LDs for 2004, have changed since last years assessment, their magnitude and the overall trends have not.

Length distributions of landings and catch are shown in Figure 3.4.4.3. There appears to be some truncation of the upper length range in both sexes to the lower end of historically observed values. Although not of immediate concern this trend will continue to be closely monitored. Figure 3.4.4.4 shows average length compositions of landings and discards (2003-2005)

Mean sizes in the landings for both sexes have generally increased since the early 1990s, although a slight dip was observed for females in 2002 (Table 3.4.4.3 Figure 3.4.4.2). Mean size in 2005 for males is at the long-term average of 34.4 mm CL. The long term increase may have been due to the change in mesh size (see Stock Annex, Q3) or a change in discarding practices, but it may also be a result of the potential sampling biases, with the smallest *Nephrops* being less available for measuring.

There is very little discarding above 35mm CL and this size class is unlikely to be affected by changes in mesh size. Trends in the mean size of the landings above this reference length could therefore be indicative of the age structure. This reference length is overlaid on the length compositions in Figure 3.4.4.3. Mean landed sizes in the above and below 35 mm CL groups have remained stable or gradually increased since 1993 (Figure 3.4.4.2)

Mean size in the < 35 mm CL group for males and females has been more variable in the catch than in the landings and have fluctuated with no overall trend. There has been a general increase in mean size for both sexes since 2001 and both sizes remain within the range for both series.

Natural mortality, maturity at age and other biological parameters

The derivation of these biological parameters is discussed in the Stock Annex (Q3). The parameters applied in a simple length based yield per recruit analysis to inform the catch forecast process were as follows:

Natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females.

Growth parameters were:

Males; L_∞ = 66mm, k = 0.160

Immature Females; L_∞ = 66mm, k = 0.160

Mature Females; L_∞ = 58mm, k = 0.060, Size at maturity = 24mm

Weight length parameters were:

Males a = 0.00038, b = 3.170

Females a = 0.00091, b = 2.895

Discard survival is assumed to be zero as a large proportion of the catch is often sorted whilst returning to port or alongside the quay. Small *Nephrops* discarded over unsuitable ground are highly unlikely to survive.

Catch, effort and research vessel data

Since the beginning of the time-series, the UK fleet has accounted for virtually all landings from the Farn Deeps (Table 3.4.4.2).

CPUE and LPUE indices were derived from the UK (E, W and S) data listed above. Effort was defined as hours fished by trawlers where landings of *Nephrops* were greater than 0. CPUE has been increasing since the early 1990s and is now at the highest level observed (57kg.hour^{-1}). LPUE had remained relatively stable between 1993-2000, at a relatively high level around 26 kg.hour^{-1} (Figure 3.4.4.5, Table 3.4.4.4). Since 2000 annual LPUE has sharply increased to its highest value in the series in 2005 (39 kg.hour^{-1}).

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

Historically males predominate over females in the landings, averaging about 69 % of the annual totals since 1985 (Figure 3.4.4.5) and in 2005 they were 65%.

Effort and landings are generally highest in the 1st and 4th quarter of the year in this fishery. In recent years the third quarter has been gaining in importance whilst the first quarter has declined.

Quarterly LPUE values were more variable than the annual trends, but overall the same pattern is apparent. LPUEs of males are typically highest in the 1st and 4th quarters. The seasonal pattern of LPUE for females is much more variable ranging from very strong seasonality (1998) to almost none (2002). In 2005 LPUE in quarter 3 is twice as high in females than in males and over three times the female long-term average for that quarter. Sampling levels for this quarter were very low (1 sample) at a time where female availability is highly variable and therefore this abnormal sex ratio may be a sampling artefact. However the female LPUE in quarter 4 for 2005 is also the highest in the series.

Male LPUE in quarters 4 of 2004 and quarter 1 of 2005 are the highest in the series. For the rest of the year it remains high but within the historic range. Figure 3.4.4.6 shows the quarterly LPUE figures for the both sexes above and below 35 mm CL. Large males were fished at a higher LPUE than small males and, up until 2005, the increase in overall LPUE was driven by the increase in LPUE for the larger males. The increase in annual LPUE for 2005, however, appears to be driven by an increase in LPUE of small males in the 4th quarter and females of both size classes in the 3rd and 4th quarters.

Underwater TV surveys of the Farn Deeps grounds have been conducted at least once in each year from 1996 onwards. These surveys provide a fishery independant method of assessment and circumnavigate the concerns about the quality of the official statistics. The most consistent series, and the one used in this assessment is the autumn survey which coincides with the start of the winter fishery. The surveys therefore provide an index of the abundance before exploitation. The conduct of the survey is described in the Annex to Section 3. No autumn surveys were conducted in 1996, 1999 or 2000. The 2001 autumn survey design was inconsistent with the standard survey so the abundance estimates are not directly comparable and are not considered in this assessment.

3.4.4.2.2 Data analyses

Reviews of last year's assessment

The 2005 assessment was based on the TV survey series supported by an analysis of the trends in catch and effort indices and mean size information. The WG and ACFM considered the TV data as the best indicator of stock status for this stock. Although relatively short with missing values the survey estimates showed an increase in abundance over the last three years to a value just outside the range of the series.

RGNSSK "considers that strong comments on discards should have been made in the management advice for this FU. Since discards are huge in these two fisheries (40% in number for the Firth of Forth and probably more than 50% for the Farn Deeps, management should consider an improvement in the fishing pattern as an urgent measure"

RGNSSK was concerned about the high discard rate that appears to be a feature of the fisheries in MA I. In the Farn deeps fishery the local enforcement agency has attempted to apply pressure on vessels to sort there catches before returning to port. This may improve on discard survival but will not affect the overall catch composition. The minimum landing size in the Farn Deeps fishery appears to be generally complied with (**Error! Reference source not found.**) XXXX: reference missing. However historic prosecutions for landing below the minimum landing size have occurred historically. As noted above and in the Stock Annex (Q3) discard rates may be overestimated due to the potential for sampling bias and this needs evaluating but the Group were unable to do so for this report. UK National Buyers and Sellers legislation may reduce the potential for this sampling bias.

Nephrops trawl design and selectivity is a feature of some recent CEFAS Fisheries Science Partnership surveys carried out in the Farn Deeps fishery. These were primarily looking at improving on fish discarding but the gear reviewed includes a larger mesh in the codend, which could have an affect on the composition of the *Nephrops* catch.

Exploratory analyses of catch data

Given the concerns of the WG and ACFM in 2005 on the appropriateness of the commercial CPUE tuning fleet, the official landings and effort data, the implications of the age slicing procedure and the validity of a dynamic pool model for *Nephrops*, no attempts were made to perform an XSA or other catch analyses.

Exploratory analyses of survey data

The Autumn TV survey conducted in 2005 adds another abundance estimate to the series. The station locations are shown in Figure 3.4.4.7, with the size of the symbol reflecting the *Nephrops* burrow density.

The areas of high abundance are consistent between years and are to the west of the ground. Figure 3.4.4.8 shows the time series of estimated abundance for the TV surveys, with 95% confidence intervals. The values of burrow density and stock abundance are given in Table 3.4.4.5.

A preliminary review of VMS data covering the survey area and using observations from the main season and vessels known to target *Nephrops* shows activity across the entire ground. The areas of highest effort are not always consistent with the areas of highest burrow density. As there is an apparent inverse relationship between burrow density and carapace length (Chapman and Bailey ***to supply) XXXX: reference missing, these observations could be examples of effort being directed at larger higher value *Nephrops*.

The TV data series for this functional area is relatively short. The confidence intervals around the abundance estimates are smaller than those for other stocks mainly because of the greater number of stations sampled relative to the survey area (Table 3.4.4.5).

Final assessment

The underwater TV survey is presented as the best available information on the state of the Farn Deeps *Nephrops* stock. This survey provides a fishery independent estimate of *Nephrops* abundance. At present it is not possible to extract any length or age structure information from the survey, and it therefore only provides information on absolute abundance over the area for the period of the survey.

The increase in the estimate of autumn abundance from the TV surveys in the last few years corresponds to an increase in LPUE. Apparent effort has been declining yet the LPUE on the larger males has increased.

3.4.4.2.3 Historic Stock trends

Autumn TV surveys show a gradual increase in abundance to a level in 2005 29% above the autumn average and the highest of the series.

The trends in indices from the commercial data discussed in earlier sections indicate that this stock appears to be at a relatively high level and able to sustain the current rate of exploitation.

3.4.4.2.4 Recruitment estimates

Declines in mean size of the <35mm CL size category are generally interpreted as increases in recruitment, particularly when associated with increases in CPUE of the smaller size category. Mean size of the smaller length groups for males and females has increased in recent years but it is unclear as to whether this relates to changes in selectivity or recruitment.

3.4.4.2.5 Short-term forecasts

A series of landings potentials were calculated as described in 3.1 (Table 3.4.4.6). To provide some references in respect of the harvest potentials, values of Fmax and F0.1 were generated using Jones LCA on the 2003-2005 average catch frequency distributions for males and females combined (Figure 3.4.4.4). Discard survival was set to 0% (see above). The yield per recruit curve is provided in Figure 3.4.4.9.

The annual catch compositions are comparable over this period (Figure 3.4.4.3) but with recent changes in the fleet structure and effective effort noted above the assumption about equilibrium and the stability of the fishery for the reference period may not be fully met. Because of these uncertainties it would be unsafe to therefore to focus on Fbar. ICES-WKNEPH (2006), ICES-WGNSDS (2006), STECF and ACFM all consider F0.1 to be a more robust biological reference for these stocks.

This analysis gave overall values of Fmax = 0.29 and F0.1 = 0.21 which equates to harvest ratios of 25% and 19% respectively.

3.4.4.2.6 Medium –term forecasts

No medium-term forecasts were possible for this stock.

3.4.4.2.7 Biological Reference points

Biological reference points are not available for this stock.

3.4.4.2.8 Quality of assessment

The 2004 abundance estimate was revised downwards by 9% following re-validation of the burrow counts. The length composition data for 2004 was also revised. This changed the value of some of the indices used in last years assessments but the impact on these is negligible. Reworking the landings potentials presented at ICES-WGNSSK (2005) showed no significant differences.

NSCFP stock survey trends are shown in Figure 3.5.1. The sample size in the NSCFP stock survey is relatively small for area 4 (n=17). Stock status was perceived to have improved since 2001 but the responses for 2005 indicated abundance was less than 2004, which contradicts the signals apparent in the LPUE series and TV survey. Although the modal response about abundance was less there was a wide spread of responses, 35% of the skippers said abundance had increased. The responses regarding recruitment estimates and changes in size ranges agree with the signals from the trends in LPUE on the lower length groups and differences in the catch distributions.

The TV survey abundance estimate and catch information indicate the stock was at its highest recorded level, however, the NSCFP suvey results add some uncertainty to this.

The harvest ratio approach uses landings and discard length distribution data. Catch samples are considered well sampled but landing samples could be biased through an underestimate of the small component. The calculated discard portion of the catch estimate therefore may effectively contain landed *Nephrops*. Correcting the landing length distribution will affect the discard estimates but not the shape of the catch length distribution. Because discard mortality is set at 100% the estimated Fs are not affected. An overestimate of the discards will underestimate the landings potential if this were the case then the predicted landings presented by the WG would be biased.

The harvest ratio calculations, currently do not account for the fact that, in this fishery males are exploited at a higher rate than females because of differences in their emergence behaviour over the winter; and that the burrow systems counted will include female burrows. However the use of harvest ratios and the implications if the exploitation ratio of males to females is not 50:50 has been investigated for some of the Scottish stocks (Dobby and Bailey WD11, ICES-WGNEPH 2004). This will continue to be the focus of some investigation at the ICES TV workshop in 2007. Dobby and Bailey (WD11), although not conclusive, does suggest that fishing a predominantly male fishery at a harvest ratio of 20% should not raise F on the males above Fmax.

3.4.4.2.9 Status of the stock

The rising trend in abundance suggests the stock is able to sustain current levels of exploitation.

Although there are no explicit recruitment indices, length frequency, mean size and LPUE data indicate consistent recruitment.

3.4.4.3 Firth of Forth (FU 8)

3.4.4.3.1 Data available

Catch

Landings from this fishery are predominantly reported from Scotland, with very small contributions from England, and are presented in Table 3.4.4.7, together with a breakdown by gear type. Total international reported landings in 2005 was 1990 tonnes. This estimate for total landings has increased by over 300 tonnes from 2004 continuing a recent rapid increase in landings. These are still lower than the previous high of over 2528 tonnes landed in 1988. Reported effort by Scottish *Nephrops* trawlers dipped in 2003, but has remained relatively stable since 1995 (Table 3.4.4.8 and Figure 3.4.4.10). Scottish *Nephrops* trawler LPUE was relatively stable in the late 1980's and early 1990's, but has apparently fluctuated widely since then and is currently at a relatively high level. There are concerns over the quality of these fishery data and the trends observed need to be treated with caution.

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 about 43% by number, or 24% by weight. This represents a small decrease in discarding rate compared to the 2002 to 2004 period. Discard rates are higher in this stock than the more northerly North Sea FUs fished for which Scottish discard estimates are available. This could arise from higher densities of small animals in this FU – an observation made during underwater TV surveys or from the fact that the use of larger meshed nets is not so prevalent in this fishery (80mm is more common). The higher discard phenomena is similar to that observed in Farn Deeps, the other FU in this Management Area (see above)

Length compositions

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Levels of sampling are considered good for providing representative length structure of removals in the Firth of Forth. The sampling levels are shown in Section 1.2.4. Although assessments based on detailed catch analysis are not presently possible, examination of length compositions can provide a preliminary indication of exploitation effects.

Figure 3.4.4.11 shows a series of annual length compositions raised to fleet landings for the period 1996 to 2005. Catch (removals) and landings length compositions are shown for each sex with the mean catch and landings lengths shown in relation to MLS and 35mm. In both sexes there has been a tendency for the mean sizes to increase over time and examination of the tails of the distributions above 35mm shows no evidence of reductions in relative numbers of larger animals.

The observation of relatively stable length compositions is further confirmed in the series of mean sizes of larger *Nephrops* (>35mm) shown in Figure 3.4.4.10 and Table 3.4.4.9. This parameter might be expected to reduce in size if overexploitation were taking place but over the last 15 years has in fact been quite stable. The length distributions in Figure 3.4.4.11 and also show occasions where relatively large numbers of smaller *Nephrops* appeared (eg 2003).

These correspond to dips in mean size in the <35mm category (Figure 3.4.4.10) and are generally interpreted as increases in recruitment, particularly when associated with increases in CPUE of the smaller size category (see below).

Figure 3.4.4.12 shows the average length composition for 2003-2005 divided into landed and discard components

In previous years the raised length compositions of removals were sliced using the WGNEPH program L2AGE into pseudo-age groups with associated weights at age - procedures are described in the Stock Annex (Q3). Owing to the concerns expressed at the 2005 meetings of WGNSDS and WGNSSK over the reliability of age structures derived from slicing and the uncertain quality of landings statistics, slicing procedures were not repeated in 2006

Natural mortality, maturity at age and other biological parameters

Biological parameter values are included in the Stock Annex (Q3). Relevant parameters applied in a simple length based combined yield per recruit to inform the catch forecast process (see section below) were as follows:

Natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females.

Growth parameters for age slicing are as follows:

Males; L_∞ = 66mm, k = 0.163

Immature Females; L_∞ = 66mm, k = 0.163

Mature Females; L_∞ = 58mm, k = 0.065, Size at maturity = 26mm

Weight length parameters:

Males a = 0.00028, b = 3.24

Femles a= 0.00085, b = 2.91

Catch, effort and research vessel data

The Commercial CPUE and research-vessel survey data series are described in the Stock Annex (Q3).

LPUE and CPUE data were available for Scottish *Nephrops* trawls. Table 3.4.4.8 shows the data for single trawls, multiple trawls and combined. Examination of the long term commercial LPUE data (Figure 3.4.4.10) suggests that the stock levels are currently stable or increasing.

Males consistently make the largest contribution to the landings and the LPUEs (Figure 3.4.4.13), although the sex ratio does vary. Effort is generally highest in the 3rd quarter of the year in this fishery, but although the pattern was fairly stable in the early years, the pattern does not appear as strong in recent years. LPUE of both sexes has fluctuated through the time series and is currently at a high level this is particularly marked in males. LPUE is generally higher for males in the 1st and 4th quarters, and for females in the 3rd quarter – the period when they are not incubating eggs.

CPUE data for each sex, above and below 35 mm CL, are shown in Figure 3.4.4.14. This size was chosen for all the Scottish stocks examined as the general size limit for discarded animals. The data show a slight peak in CPUE for smaller individuals (both sexes) in 1999, with a decline after this, followed by a slow increase in both sexes from 2002 onwards. The CPUE for larger individuals showed a similar pattern with higher values in the most recent years.

Taken with mean size information above, the latter observation confirms the view that exploitation has not had adverse effects on this stock.

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

The numbers of valid stations used in the final analysis in each year are shown in Table 3.4.4.11. On average, about 40 stations have been considered valid each year, and are raised to a stock area of 915 km^2. General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in the Annex to Section 3.

3.4.4.3.2 Data analyses

Reviews of last year's assessment

The assessment in 2005 was based principally on the underwater television survey series, supported by presentation of basic fishery parameters and mean size information in catches and landings. The WG and ACFM considered the TV data as the best indicator of stock status. According to the survey, abundance increased in 2002 and has remained relatively high, this coincides with commercial CPUE information. RGNSSK commented on the high discard rates and suggested that attention should have been drawn to this in the Management Advice. There was discussion of harvest rate choice as for other Functional Units.

Exploratory analyses of catch data

In view of WG and ACFM concerns expressed previously on the appropriateness of the commercial CPUE tuning fleet, the landings and effort data, the implications of the slicing procedure and the validity of a dynamic pool model for *Nephrops*, no attempts were made to perform XSA or other catch analyses.

Exploratory analyses of survey data

Table 3.4.4.10 shows the basic analysis for the three most recent TV surveys conducted in FU 8 including the 2005 results. The table includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. The ground is predominantly of coarser muddy sand (mS). Depending on the year high variance in the survey is associated with different strata and there is no clear distributional or sedimentary pattern in this area..

Figure 3.4.4.15 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density. Abundance is generally higher towards the central part of the ground and around the May Island. In recent years higher densities have been recorded over quite wide areas. Table 3.4.4.11 and Figure 3.4.4.16 show the time series of estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates. Confidence intervals have been fairly stable in this survey.

Final assessment

The underwater TV survey is again presented as the best available information on the Firth of Forth *Nephrops* stock. This survey provides a fishery independent estimate of *Nephrops* abundance. At present it is not possible to extract any length or age structure information from the survey, and it therefore only provides information on absolute abundance over the area of the survey.

3.4.4.3.3 Historic Stock trends

The TV survey estimate of abundance for *Nephrops* in the Firth of Forth suggests that the population decreased between 1993 and 1998 and then began a steady increase up the most recent survey year (2005). Abundance is estimated to be considerably higher in recent years (2003-2005) compared to the previous period (1994 – 2001).

3.4.4.3.4 Recruitment estimates

Recruitment estimates were not available for this stock.

3.4.4.3.5 Short-term forecasts

A catch prediction for 2007 was made for the Firth of Forth (FU8) using the approach outlined in the introductory section on *Nephrops*. In order to provide guidance on a sustainable harvest rate to use, combined sex Y/R calculations were made using an adapted version of LBA (developed by WGNEPH in the 1990s to perform Jones' length cohort analysis and Y/R prediction). The Y/R plot is shown in Figure 3.4.4.17 based on average length compositions of removals for 2003-2005. The text table below shows the $F_{0.1}$ and F_{max} obtained from the curve. The $F_{0.1}$ estimate is similar to other North Sea *Nephrops* stocks for which these calculations were made, driven by the input parameters (see Stock Annex, Q3) which are similar for these stocks. Undue emphasis should probably not be placed on the estimated current F from these calculations owing to the tendency for length cohort analysis to overestimate current fishing mortality through variability in length at age in *Nephrops* leading to overlap of ages.

FUNCTIONAL UNIT	$F_{0.1}$	F_{MAX}	F_{BAR}
Firth of Forth	0.23	0.37	0.56

The estimates of $F_{0.1}$ and F_{max} were included in the calculations of predicted landings under a range of different harvest rates using the approach outlined shown in Figure 3.4.1.9. In addition to the harvest rates discussed above, predicted landings for arbitrary values of 15%, 20% and 25% have also been computed. Average TV derived abundance values for 2003-2005 and the average length compositions used in the Y/R were used in the calculations. A summary of the input length composition and the calculations made is given in table 3.4.4.12.

3.4.4.3.6 Medium –term forecasts

Medium term forecasts were not performed for this stock.

3.4.4.3.7 Biological Reference points

Biological reference points have not been defined for this stock.

3.4.4.3.8 Quality of assessment

The length and sex composition of the landings data is considered to be well sampled. Discard sampling has been conducted on a quarterly basis for Scottish *Nephrops* trawlers in this fishery since 1990, and is considered to represent the fishery adequately.

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

Underwater TV surveys have been conducted for this stock since 1993, with a continual annual series available since 1998. The number of valid stations in the survey was particularly high between 1999 and 200, and slightly below average in the most recent years. Confidence intervals around the abundance estimates are greater during the most recent years, when abundance estimates have been slightly higher.

The trends in abundance observed in the TV survey data have to some extent been reflected in CPUE and mean size data, in that they suggest an increase in recruitment in the recent period.

NSCFP stock survey trends are shown in Figure 3.5.1. These show generally increasing trends in *Nephrops* in the areas that relate most closely to MA I. This supports the suggestion of an increase in abundance since 2001, with generally moderate or high numbers of recruits.

3.4.4.3.9 Status of the stock

The continuation of abundance at a high level in the time series and the stable mean sizes suggest that the current exploitation rate is sustainable. The evidence from the TV survey suggests that the population has actually been increasing in size for a number of years.

3.4.4.3.10 Management Area I Management considerations

For the Farn Deeps (FU 6) previous WGs have expressed concerns about the higher exploitation on males and about the sustainability of the high levels of directed effort in this fishery. Effort currently appears to be around the lowest levels since 1984 and LPUE appears to be at its highest in the series. The TV surveys confirm this apparent increase in abundance.

CPUE trends do not show any significant changes in recruitment over the last few years but fleet composition and mesh size changes, and size directed effort could have masked any recruitment signals. All signs suggest the stock is sustaining current levels of effort although the males in this stock do suffer greater fishing pressure. Landing potentials were calculated for a range of harvest ratios on the average of the last three TV survey abundance estimates, 2003 to 2005 (**Error! Reference source not found.** XXXX: Reference missing). Taking an average of a rising trend may be of concern but as the 2005 abundance estimate is outside the range of any previously observed abundances *confidence interval* overlap it would be unwise to project this abundance point estimate forward.

Underwater TV surveys of the Firth of Forth (FU8) indicate that stock abundance has been at a relatively high level in recent years, increasing from a lower stable period in the late 1990’s. Indications from the fishery support this, suggesting increased recruitment.

The WG proposes that the harvest ratio approach based on TV survey abundance is adopted for FU6 and FU8 with additional allowances for ‘other rectangles in the MA, where recent TV data is not available.

The following text table provides a summary (all tonnes) for the 2 Functional Units and takes account of the *Nephrops* landings which occur in small areas of mud outside the FU. These are less well surveyed or do not have adequate sediment distribution information to include in the main areas shown above. Recent landings from other rectangles within the MA have been around 600t, mostly from the Devil’s Hole area. Occasional Scottish TV surveys have been conducted in this area, but a series is not yet available. Figure 3.4.4.18 shows preliminary results from a survey conducted in 2005. Catch rates of *Nephrops* at the Devil’s Hole vary with good catches sometimes taken one week, then no *Nephrops* taken the next week. The average size of *Nephrops* in the Devil’s Hole is much larger that those on the Fladen grounds, and is sometimes comparable to those of the shelf edge on the West coast. The harvest equivalent to $F_{0.1}$ (highlighted in the text table above) is considered by the WG to be sustainable.

Harvest rate	Farn Deeps	Firth of Forth	'Other Squares' (Ave 03-05)	Total
15%	3465	1446	593	5504
FU6 18.6% (F0.1=0.21) FU8 20.9% (F0.1=0.23)	4301	2019		6913
20%	4620	1928		7141
25%	5775	2411		8779
25.2% (Fmax=0.206) 36% (Fmax=0.449)	5815	3002		9410

Effort should not be allowed to increase in this MA and the WG, ACFM and STECF have repeatedly advised that management should be at a smaller scale than the ICES Division level.

The distinct seasonality in this fishery leads to higher exploitation in males than females. Bearing this in mind, a harvest ratio considered appropriate for stocks with more balanced exploitation may be too high for the Farn Deeps. Use of harvest ratios and the implications if the exploitation ratio of males to females is not 50:50 has been considered for some of the Scottish stocks and is further investigated in Dobby and Bailey (WD11).

Both Functional Units in this Management Area have high *Nephrops* discard rates and there is an urgent need to reduce these and to improve the exploitation pattern. An additional reason for suggesting improved selectivity in this area relates to bycatch. In 2005, high abundance of 0 group cod was recorded in Scottish surveys in the Moray Firth area. The abundance of these cod as 1 year olds still appears to be relatively high and they have spread into other areas such as the Fladen Ground. Similar comments can be made about the emerging 2005 haddock year class which will begin entering the fishery in 2007 and according to forecasts (see Section 13) will result in large discard numbers under the present exploitation pattern. It is important that efforts are made to ensure that these and other fish are not taken as unwanted bycatch in smaller mesh fisheries and technical measures that improve the exploitation pattern would be beneficial in the fisheries of this MA.

3.4.5 *Nephrops* in Management Area H

3.4.5.1 General

Management area H (Figure 3.1.1) covers the south-eastern part of the North Sea. This area consists of two FUs: the Botney Gut unit (FU 5) and the Horn Reef unit (FU 33). Landings for the 2 FUs and in other squares are given in Table 3.4.5.1

3.4.5.1.1 Ecosystem aspects

It is mentioned for the North Sea as a whole, that qualitative observations suggests that there have been general increases in *Nephrops* abundance in the North Sea in recent years. The FU on Horn reef is an example of significant increase in *Nephrops* densities on new localities in the North Sea during the last 20 years. It may be related to environmental influences, perhaps having a positive effect on recruitment as well as sediment.

3.4.5.1.2 Functional Units and their fisheries in 2005 and 2006

An extensive description of the *Nephrops* directed fisheries in the Botney Gut - Silver Pit area is given in ICES-WGNEPH (2003). 2005 saw a further decline of the Belgian *Nephrops* fishery in the area, to an all-times low of approx. 60 *Nephrops* directed fishing trips.

A description of the Danish *Nephrops* fisheries in Sub-areas IIIa and IV (including the one in the Off Horn Reef area) is given in ICES-WGNEPH (1999). Initially, this *Nephrops* fishery was carried out by Danish vessels only. In 2005 there was a considerable increase in Dutch landings from this area.

3.4.5.1.3 Advice

In 2005 ICES stated:

The available information is inadequate to evaluate spawning stock or fishing mortality relative to risk.

a) Botney Gut: In its 2003 assessment of the Nephrops stock in the Botney Gut–Silver Pit area (FU 5), WGNEPH concluded that the stock was fully exploited and recommended that the TAC for FU 5 be maintained at the previously recommended level of 1100 t (ICES, 2003). The evidence of a (temporary) shift in the length composition of the landings stresses the need to closely monitor this stock, but is not of such a nature that further restrictions of the fishery need to be envisaged. Current levels of exploitation appear to be sustainable.

b) *Off Horn Reef: Trends in LPUE data suggest that stock levels are remaining relatively stable. The current exploitation level seems to be sustainable.*

and advised that :

Information on these stocks is considered inadequate to provide advice based on precautionary limits. Therefore ICES recommends that the level of exploitation, i.e. effort on these stocks should not be increased.

Official catch statistics for Sub-Area IV are presented in Table 3.4.1.1.

3.4.5.1.4 Management

TAC and effort management affecting this Functional Unit takes place at the ICES Division level as described at the beginning of Section 3.4.

3.4.5.2 Botney Gut / Silver Pit (FU 5)

3.4.5.2.1 Data available

Catch

The declining *Nephrops* fleet in Belgium took 117 t of *Nephrops* landings in 2005. Up to 1995, the Belgian fleet took over 75% of the international landings from this stock, but since then, its share has dropped to less than 15%. For some years now, the Netherlands has been the most important fishing nation in FU 5, with over 60% of the total international landings being made by Dutch trawlers, for first sale in the Netherlands or in Belgium. The remaining landings are by UK and Denmark (Table 3.4.5.2).

Total international *Nephrops* landings from FU 5 in 2005 were at 1015 t, a 4% decline compared to 2004 landings. Figure 3.4.5.1 shows the long term trend.

The problems associated with under-reporting of the landings are believed to be adequately resolved, at least as far as the Belgian fleet is concerned. Each year, the Belgian *Nephrops* landing figures are adjusted by means of correction factors (one per market category) based on the ratio between the actual landings, as recorded by the scientific observers responsible for the port sampling programmes, and the officially reported landings, as derived from the sale slips. For the other fleets, no such corrections could be made, since there is no verifiable information on the extent of their non-reported landings.

Discard data are available for the Belgian *Nephrops* fleet only (April 2002 - September 2005). The time-series of discard data is therefore very short, and may not be representative of the international fishery. Samples of the unsorted discards were collected monthly by contracted fishermen and analysed by the staff of the Sea Fisheries Department. Measurements taken included length sampling of *Nephrops* and of all fish species in Appendix XII of EU-Regulation 1639/2001. With the discard samplings, length frequency data were also collected for the most important commercial fish species in the by-landings (viz. cod, haddock, whiting, gurnards, striped red mullet, plaice, dab, lemon sole and sole). In September 2005 however, the contracted vessel for the discard sampling programme went bankrupt and, in the absence of a readily available alternative, the programme was forced to end. In view of the current low level of the Belgian *Nephrops* landings, it is very unlikely that the discard sampling programme will be resumed.

Length compositions

Port sampling programmes of the commercial *Nephrops* landings are in operation in Belgium (since 1986) and the Netherlands (since 2002). Sampling frequency and sample sizes in the Belgian and Dutch port sampling programmes are assumed to be sufficient to produce reliable estimates of the numbers-at-length in the landings. The Belgian port sampling programme however, is increasingly hindered by the decline of the fishery and by the fact that a growing proportion of the landings is taking place in the Netherlands (almost 60% in 2005, as opposed to only 30% in 2004), the consequence being that, for the third year in a row, sampling targets had to be adjusted downward. If these trends continue, it is very likely that the Belgian *Nephrops* sampling programme will be discontinued in one of the coming years. Danish sampling of landed *Nephrops* took place in 2005, however mainly as a compensation for inadequate at-sea-sampling.

The mean sizes of male and female *Nephrops* in the Belgian landings (calculated across the range of size classes >35mm CL to reduce the effect of variations in recruitment and discarding) are shown in Table 3.4.5.4 and Figure 3.4.5.1 The mean sizes of males show evidence of an overall downward trend, while mean sizes of females seem to have stabilised, albeit at a level that is considerably lower than in the early 1990s. It should be noted, however, that the decline is small, of the order of 1 – 2mm and that the mean size of these larger animals remains around 40mm comparable to that at the Fladen Ground for example. Figure 3.4.5.2 shows a time series of landing length compositions. There is little evidence in these of a notable change in sizes and the maximum sizes have remained quite constant.

As no analytical, age-based assessments were performed on this stock, no numbers-at-age and mean weights-at-age were calculated.

Natural mortality, maturity at age and other biological parameters

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

Growth parameters for age slicing were as follows:

Males: L_∞ = 62mm CL, k = 0.165.

Immature females: L_∞ = 62mm CL, k = 0.165.

Mature females: L_∞ = 60mm CL, k = 0.080, Size at 50% maturity = 27mm CL.

Growth parameters were assumed to be similar to those of Scottish *Nephrops* stocks with similar overall size distributions of the landings (see e.g. ICES-WGNEPH, 2003). Female size at 50% maturity was taken from Redant (1994) XXXX: reference missing.

Commercial catch-effort data and research vessel surveys

Effort and LPUE figures are available for Belgian *Nephrops* specialist trawlers (1985-2005), the Dutch fleet (all vessels catching *Nephrops* since 2000) and the Danish bottom trawlers with mesh size > 70 mm (1996-2005, Table 3.4.5.3 and Figure 3.4.5.1).

The effort of the Belgian *Nephrops* fleet has shown an almost continuous decrease since the all-times high in the early 1990s. In 2005, effort was at the lowest level in the time series, with only 5.0 10^3 hours fishing for all *Nephrops* directed voyages combined, and 2.9 10^3 hours fishing for the *Nephrops* specialist trawlers, i.e. vessels fishing for *Nephrops* during most of the year, as opposed to the occasional *Nephrops* trawlers, who only fish for *Nephrops* during the peak season (typically between May and October).

The effort of the Dutch (*Nephrop)s* fleet has been relatively stable, between 7900 and 9800 days at sea annually. The Dutch effort data series however, is for all vessels combined and makes no distinction between specialist and occasional *Nephrops* trawlers. There seems to be no clear trend in the Danish effort since 1996.

The LPUEs of the Belgian *Nephrops* specialist trawlers (Table 3.4.5.3 and Figure 3.4.5.1) have fluctuated without obvious trend until the early 2000s, but most recently jumped to much higher values (around 19.0 kg/hour in 2003 and 2004, and almost 24.0 kg/hour in 2005). However, the LPUE values for the most recent years should be treated with caution since (a) they are based on a very small number of vessels only (around five in 2003 and 2004, and less than five in 2005), (b) the *Nephrops* specialist trawlers remaining are the ones operating twin-rigs (which do have higher catch rates than the single rigs that were in use in the 1980s and 1990s), and (c) there is a tendency - also amongst the specialist trawlers - to concentrate fishing effort in the season with the highest catch rates.

The LPUEs of the Dutch trawlers show a steady increase, from about 51 kg/day in 2000 to just under 83 kg/day in 2005. Again however, it should be noted that the Dutch data series is for all vessels combined, and that the increase in LPUE is not necessarily indicative of an increase in stock size. It may also reflect an increase in directedness of the vessels towards *Nephrops*. Figure 3.4.5.1 indicates a trend in the Danish LPUE similar to the one of Belgian LPUEs up to 2000. However, since then Danish LPUEs have remained at more or less the same level.

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

3.4.5.2.2 Data analyses

Review of last year's assessments

The assessment last year was based on trends in fishery data. RGNSSK requested that more efforts be put into obtaining a time series of landings and effort for the increasing Dutch fishery and recommended close monitoring of the fishery, especially the collection of discards. Concerns were expressed over reported declines in mean size although the data were difficult to interpret.

Exploratory analyses of catch data

No analytical assessments presented.

Exploratory analyses of survey data

Not relevant

Final assessment

There was no final assessment. Stock perceptions are based on trends in LPUE and mean sizes.

3.4.5.2.3 Historic Stock Trends

No analytical assessment presented.

3.4.5.2.4 Recruitment estimates

Recruitment estimates are not available.

3.4.5.2.5 Forecasts

There were no forecasts.

3.4.5.2.6 Biological Reference points

Biological reference points are not defined for this stock.

3.4.5.2.7 Quality of assessments

No analytical assessment were presented. There is a severe shortage of data for this stock. The NSCFP survey (Figure 3.5.1) suggests that in this area *Nephrops* abundance has been fairly constant with some evidence of decline in the far south east of the area.

3.4.5.2.8 Status of stock

The shortage of information on this stock makes an evaluation of stock condition difficult. There is no evidence of significant downward movements in LPUE or mean size and the stock appears to be sustainable at present levels of effort.

3.4.5.3 Off Horn Reef (FU 33)

3.4.5.3.1 Data available

Catch

The landings from FU 33 were marginal for many years. However, from 1996 to 2004, Danish landings increased considerably, from 74 to 1097 t. The other countries reporting landings from the area are Belgium, Netherlands and the UK. In 2005 Denmark still accounted for around 80 % of the total international landings (see Table 3.4.5.5). According to logbook information, most of the Danish *Nephrops* directed fishery in FU 33 takes place in the 3rd quarter.

Denmark accounts for most of the *Nephrops* landings from FU 33. However, after a steady increase in landings from 1996 to 2004, there was a drop of more than 25% in 2005 (from 1100 tons 2004 to 800 t in 2005) (Table 3.4.5.5 and Figure 3.4.5.3). This decline corresponds to a decline in Danish effort in this area in 2005. On the other hand, in 2005 there was a considerable increase in Dutch landings from this area.

Length compositions

Size distributions of the Danish catches 2001 to 2005 are shown in Figure 3.4.5.4. Note the shift in 2005 compared to the previous years. Figure 3.4.5.3 gives the development of the mean size of the catches and landings by sex. These data could indicate either a general decrease in the amount of large individuals in the population or increase in smaller individuals (large recruitment).

A short time series of length compositions is shown in Figure 3.4.5.5. The mean size of landings is fairly constant while the catch declined noticeably (as mentioned above) – the increased numbers around 30mm may indicate increased recruitment.

Since 2001 the Danish at-sea-sampling programme has provided data for discard estimates. However, the samples have not covered all quarters.

Natural mortality, maturity at age and other biological parameters

No data available

Catch, effort and research vessel data

Table 3.4.5.6 and Figure 3.4.5.3 show the development in Danish effort and LPUE. Note that the 10-fold increase in fishing effort from 1996 to 2004 seems to correspond to the above mentioned increase in landings during the same period. It appears from that LPUEs have been rather stable from 1998 to 2004, fluctuating around 200 $kg.day^{-1}$. 2005 saw a further sharp increase in LPUE.

Further analyses of the logbook based effort data give the similar trends in LPUE (Figure 3.4.5.4). It gives the logbook based effort data analysed in various ways to evaluate the effect of various factors likely to influence the effort/LPUE:

- Incorporation of HP in the effort measure
- Vessel size (GLM to standardise LPUE regarding vessel size)
- effect of gear type (mesh size)

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

3.4.5.3.2 Data analysis

Reviews of last year's assessment

Assessments were based on trends in fishery data and mean size. The assessments showed little evidence of declines in stock size and the fishery appeared to be expanding. The review wondered whether there had been increases in efficiency in this fishery. The minimum landing size applied in Denmark (40mm) meant that a large proportion of the catch was discarded. The Review Group questioned whether further increases in effort were possible.

Exploratory analyses of catch data

Given the short series of catch sampling, the data are not considered suitable to conduct catch at age analysis for this stock.

Exploratory analyses of survey

No survey data were available

Final assessment

No analytical assessment is presented for this stock, the final assessment relied on observed trends in LPUE and mean sizes.

3.4.5.3.3 Historic stock trends

The available data do not provide any clear signals on stock development:

- The upward trend in LPUE in 2005 does not indicate a declining stock, rather that suggesting that stock level is remaining relatively stable.
- The decrease in mean size could indicate either high recruitment or a decline in stock reflected by fewer large individuals.

3.4.5.3.4 Recruitment estimates

There are no recruitment estimates.

3.4.5.3.5 Forecasts

Forecasts were not performed.

3.4.5.3.6 Biological reference points

There are no reference points defined for this stock.

3.4.5.3.7 Quality of assessment

NSCFP stock survey trends are shown in Figure 3.5.1. For FU 33 the survey shows an increase between 2001 and 2002, a stable period to 2004, and an increase in 2005. There were no strong indications of changes in recruitment or discarding levels.

Perceptions of the stock are based on Danish LPUE data. The TAC is not thought to be restrictive for the fleet exploiting this stock, but no information is available on technological creep in the fishery.

3.4.5.3.8 Status of stock

The stocks appears able to be sustainable at current levels of effort.

3.4.5.4 Management Area H Management considerations

The perception of the state of these two FUs are based on trends in LPUEs and changes in size compositions in the catches.

- FU 5 (Botney Gut). The Belgian. Dutch and Danish LPUEs as presented above may not be optimal as indicators of stock density. However, they do not indicate any decline in stock density for this FU. As for the size composition in catches, indicated here by mean lengths (Figure 3.4.5.1), no conspicuous declining trend can be seen, either for females or males.
- FU 33 (Horn Reef). Again here, the (increasing) trend the Danish LPUEs (Table 3.4.5.6) is not indicative of any decline in stock density. However, the marked shift in the size distribution for 2005 compared to previous years (Figure 3.4.5.4) could be a sign of a too high exploitation level in recent years. However, as LPUE was at a high level in 2005, the decrease in mean size in the catch could merely be a sign of large recruitment.

Considering Management Area H, the WG recommends that the exploitation of these 2 FUs remain at the same level as in previous years. i.e. status quo.

3.5 Sub-Area IV *Nephrops* Management Considerations

Sub-Area IV contains five different management areas which differ in size, nature of *Nephrops* population biology, extent of fishery development and fleets involved in fishing them. Assessments of the state of the Functional Units contained within the Management Areas involved the use of three types of information, trends in fishery indicators, examination of length compositions and, where available, underwater TV surveys. The WG agreed that UTV surveys provided the best indication of the states of *Nephrops* populations since they are unaffected by the uncertainties and inaccuracy present in much of the fishery data at the present time. In Sub-Area IV, the ones assessed by this method (FUs 6,7,8 and 9) are either stable or increasing slightly. Results for stocks where these surveys are presently not routinely available (FU 5, 10, 32, 33) are more difficult to interpret but in general most appear to be fairly stable and there is little evidence of the stocks being unable to sustain current levels of effort.

In providing advice on future catches of *Nephrops*, the WG expressed concerns over the accuracy of official landing statistics for these stocks, leading to uncertainty as to the current and historic landings. Such uncertainty means that harvest rates based around historic landings cannot be taken as a proxy for current effort. Where possible, other approaches should be used to derive catch options.

The WG recommended that for the FUs with UTV survey data available, that catch options based on harvest rates were an acceptable way forward and supported the STECF, WKNEPH and WGNSSD views that selecting an option based on a harvest rate based on $F_{0.1}$ represented a sustainable approach. For the other FUs and small areas of *Nephrops* ground within the MAs not accounted for in the FUs, the WG suggested either a status quo approach or the average of recent year’s landings, albeit as a temporary approach until data can be improved. Taken together, the catch options suggested for the various MAs amount to just over 27000t in the EU zone of Sub-Area IV with a figure in the region of 1100 to 1300 in the Norwegian zone. These amounts are slightly less than the current TACs in place for Sub-Area IVa.

It should not be overlooked that advice is provided on a Management Area basis, while management through the TAC is applied over the whole North Sea, and includes a number of other FUs exhibiting various states of exploitation. On numerous occasions (see e.g. ICES-WGNEPH 1997, 1999), the WGNEPH has pointed out the difficulties of managing *Nephrops* stocks in this way, and suggested that some subdivision of the TAC area would be desirable. While maintaining the view that *Nephrops* stocks are most appropriately managed at a smaller scale, the WG recognises that this may not be possible or practical for other reasons. The WG feels however, that ways should be found of ensuring that effort and landings are allocated appropriately at a more local level than is possible under the current overall TAC approach. Under the present management and TAC allocation system, changes in the North Sea TAC implied by the advice for one particular stock (as has been the case in the past with the Fladen Ground) would be divided between all nations with North Sea *Nephrops* quota, and would to lead changes in opportunity for all North Sea *Nephrops* fleets, which may lead to the risk of unacceptably high effort levels on more vulnerable grounds (where increases in activity are not advised). The risk of rapid uptake of quota in expanding fisheries (such as the Fladen Ground or Off Horn Reef), and the associated reduction of opportunity in smaller stocks remains while TACs are allocated to large areas.

The WG is of the view that the catch options are deliverable without any need for increased effort in the fisheries of Sub-Area IVa. There was, however, concern expressed that new and emerging gear developments create the possibility of a ‘step-change’ in effective effort that is unlikely to be sustainable and represents a further threat in the mixed fisheries context. Multiple rig developments involving the use of 3 and 4 trawls attached together are currently being trialed on a small scale in various parts of Division IVa. The WG feels that these developments should be curtailed until it is possible to introduce such technological development as part of an overall strategy for effective effort across Sub-Area IV. Without such control, mortality on exploited species could rise markedly without any increase in the number of hours fished, simply through more efficient gear.

The Underwater Television technique for counting burrows and assessing abundance continues to be developed and the WG recognised that further progress can be made and that a number of issues need to be addressed. Dobby and Bailey (WD11; applicable to both North Sea *Nephrops* stocks and those in ICES Division VIa) addressed some of the modelling issues relating to catch option choice and suggest that the current approach is fairly robust and cautious. It is recognised that a number of other key issues require further work and this is planned as follows:

i. improvements in consistency of counting and building in quality control measures;

ii. attempts will be made to provide more accurate estimation of the entire mud area in each of FUs;

iii. further development of the Y/R estimation using a modelling approach incorporating seasonal availability of the two sexes is needed, building on Dobby and Bailey (WD11);

iv. there is an urgent need for a more thorough sensitivity analysis of the approach;

v. 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*.

It is expected that some of this work will be reported at a meeting of WKNEPH proposed for 2007.

The TAC (EC) for Sub-Area IV *Nephrops* has increased from 15200 to 29447 tonnes since 1999, with the most recent TAC based to a large extent on TV estimates. Anecdotal evidence suggests that in earlier years, however, the allocation of opportunity through North Sea wide TAC based on average landings did not necessarily match catch potential and that TACs were restrictive in some stocks, and may have been exceeded. The most recent 2006 TAC increase and the Registration of buyers and sellers are expected to lead to more accurate landings information from these stocks in the future. Monitoring continues and enhanced work on observer trips onboard commercial vessels should furnish additional data. Given thee likely improvements and ongoing developments in the modelling of *Nephrops* populations it is hoped that numerical assessments of the type performed for many fish will be possible in a few years’ time.

Mixed fishery aspects

The overall position of stable or increasing *Nephrops* stocks in Sub-Area IV is similar to that in Division IIIa, VIa 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 (there is, however, a need to address the high levels of discards of *Nephrops* in FUs 6 and FUs 8). Such opportunities also present a challenge in a mixed fisheries context since there is the potential for bycatch in a number of FUs – this is often unwanted bycatch 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.

Analysis of catch rates from half hour tows on trawl surveys of the Farn deeps involving four commercial *Nephrops* trawlers (Bell et al 2004) showed that there was a tendency for catch rates of cod, plaice, haddock and lemon sole to be low when catch rates of *Nephrops* were high and vice versa. This relationship was particular apparent for cod and plaice. The possible reasons are discussed but generally the analysis suggests that specific targeting of *Nephrops* can reduce bycatch. A recent investigation (SGRST 2004) XXXX: reference missing suggests by-catches of cod are generally low in ICES Division VIa Management Area C *Nephrops* fisheries

Nevertheless, the young stages of cod and other species do occur in *Nephrops* fishery areas and any emerging year classes should not be subject to mortality as bycatch in smaller mesh fisheries. This issue has become particularly relevant with the emergence of some improved year classes. In 2005, high abundance of 0 group cod was recorded in Scottish surveys. The abundance of these cod as 1 year olds still appears to be relatively high and they have spread into other areas such as the Fladen Ground. Similar comments can be made about the emerging 2005 haddock year class which will begin entering the fishery in 2007 and according to forecasts (Section 13) will result in large discard numbers under the present exploitation pattern. It is important that efforts are made to ensure that these and other fish are not taken as unwanted bycatch in smaller mesh fisheries and technical measures that improve the exploitation pattern would be beneficial in the fisheries of this MA.

Annex to Section 3

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 (e.g. ambient light level, tidal strength) and biological factors (e.g. moult cycle, females reproductive condition). 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.

Scottish Underwater Survey methodology

An underwater colour TV camera (Kongsberg-Simrad OE1364) is mounted on an aluminium sledge (Shand and Priestly, 1999), towed slowly (< 1kt) astern of the survey vessel. The camera is arranged on the sledge to view obliquely forwards between the runners of the sledge, with a width of view of approximately 1m. Lighting for the camera is provided by underwater lights mounted on the sledge, and powered from the vessel through the umbilical. A micro-range finder is mounted vertically on the sledge to provide information on the height of the camera above the seabed, and the degree of sinking of the sledge runners into the mud sediment. These data, together with camera lens angle specifications, are used to calculate the dimensions of the camera field of view. An odometer wheel is used to measure the distance traveled along the seabed during a TV run, typically lasting for 10 minutes. Data on the vessel location, elapsed time, sledge depth, range finder and odometer readings are recorded during a TV run with ‘in-house’ data logging software.

Recordings are made of each TV run, and burrow counts made both at the time of recording, and subsequently by at least two experienced observers under controlled conditions. Discrepancies between counts are investigated. The counts are converted into densities using information on the width of view of the camera and length of the tow. Burrow occupancy is assumed to be 100% in estimating total stock abundance. Field studies using SCUBA have shown that *Nephrops* regularly maintain and repair their burrows, and that trawling fills in burrow openings. Multiple occupancy of burrows has also been observed. Overall animal abundance is estimated by raising the mean densities to the appropriate strata area. Total survey abundance variance and confidence limits are calculated from strata abundance variances. The abundance and uncertainty estimation procedure is described by Bailey et al. (1993).

UWTV surveys use a random stratified design, with stratification based on sediment distribution and geographic area.

Surveys have been conducted in June or July in most years, but occasionally have been delayed until September owing to other vessel commitments. However, since the survey counts burrows rather than animals, there are no behavioural implications of small changes in survey timing.

English Underwater Survey methodology

This survey was set up after initial consultation with the Scotland, and the methodology adopted and the technology used differs only slightly from that used for the Scottish stocks. The English sledge used is narrower and the camera situated further back, which requires the angle of the camera to the sea bed to be set steeper giving a narrower field of view.

A mesh screen is temporarily fixed to the sledge runners and viewed underwater to measure the field of view. The distance travelled is calculated by using a HIPAP beacon fixed to the sledge which allows the position of the sledge to be recorded at regular intervals using data logging software. An odometer wheel is also used for calibration and as back up. In all, ships position, sledge position, elapsed time, sledge depth, odometer readings, and cable length are recorded along with video for the length of the tow, which is typically 10 mins. Initial counts are made live at sea and subsequently from recordings by two experienced counters under controlled conditions. Discrepancies are investigated.

Estimates of abundance are calculated as described in the Scottish section. Despite the survey station positions being originally randomly stratified by grid and sediment distribution, statistical analysis showed that for this fishery, there was no significant difference between abundance estimates raised unstratified or by stratification. Burrow densities are raised to and confidence intervals calculated for the unstratified survey area.

Surveys were originally conducted in the spring. Autumn surveys were conducted to provide an estimate of abundance before the fishery started and thereby an estimate of depletion at the end of the subsequent spring survey. Because of the availability the research vessel these surveys now take place in the Autumn before the season starts and provides an estimate before exploitation.

Advice from TV data

At the 1999 meeting of WGNEPH, concern was expressed that the TAC set at the time was unrealistically low for the Fladen Ground stock, given its large size and the expanding fishery (ICES, 1999). It was feared that this would encourage mis-reporting and lead to deterioration of the information for the stock, and ultimately the chance of not detecting future problems that might arise. As a consequence, the advice moved away from the previous reliance on the historical landings data as a basis for providing a TAC recommendation. Instead, the independent estimates of stock abundance provided by the TV survey were used to estimate a likely landings level. This estimate was based on a 'harvest ratio' (defined here as catch in numbers/stock abundance) from the lower end of the harvest ratios observed across a range of other *Nephrops* stocks, as calculated during the 1998 *Nephrops* Study Group (ICES, 1998). This preliminary approach was continued at the 2001 and 2003 meetings of the WGNEPH. Given the generally low density of *Nephrops* at the Fladen Ground, and the less well understood stock dynamics and consistency of recruitment compared to more intensively studied inshore stocks, an arbitrary conservative harvest ratio of 7.5% of the mean abundance (over preceding three surveys) was considered appropriate by WGNEPH, and accepted by ACFM. Observed harvest ratio's for other *Nephrops* stocks are generally higher ranging from 9.7 – 33% of the biomass and in many cases these rates have been sustained for many years. The observed rates are based on calculations using reported landings and stock sizes from analytical assessments (ICES-SGLHN 1998). Given concerns over the accuracy of landings and the use of age structured, dynamic pool based analytical approaches for *Nephrops*, the true harvest ratios probably differ from the calculations. Nevertheless, it seems likely that harvest rates in the major, long established *Nephrops* fisheries are well above 7.5% (a harvest ratio of this size implies a very low F value of 0.078). It also seems likely that just as reliance on historic landings was rejected as a basis for TAC advice at the Fladen Ground, the same may well be advisable for other *Nephrops* stocks.

As outlined above the first stage of the process involves estimation of numbers in the population. Previously, the mean abundance over recent years has then been used as the basis for applying the harvest ratio. This figure is multiplied by an appropriate harvest ratio to estimate a suitable limit on the number of animals removed (harvest abundance). To provides an indication of the length structure of the animals of each sex removed from the population, average length frequency distributions (ideally calculated over the three most recent years) for the two sexes from monthly market samples are raised to annual removals (landings + dead discards) using discard estimates from observer trips (with 25% discard survival) and/or catch sampling, and reported landings figures. The length structure of removals is then raised to the harvest abundance, and the weight of the landed component estimated to provide TAC advice.

Uncertainties in the approach 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 selectivity of the fisheries and the survey. Some areas where fisheries exist have not been surveyed and are therefore not included in the raised survey estimates, and this provides a further precautionary buffer. An assumption is made that the population exploited by the fishery is representative of the population generating the burrows observed. For trawl fisheries this is thought to be the case, as *Nephrops* first appear in catches when they become more active foragers on the seabed surface, having left the “juvenile stage” and created their own burrows. Behavioural and selectivity factors mean this is not the case for creel fisheries, where the mean size of catches is far larger than in the population, and creel fishery data is not included in the harvest ratio approach.

The implications of this approach for fisheries with very different exploitation patters for the two sexes has been briefly examined by WGNEPH 2004, but requires further investigation, and will be considered in 2006 by WKNEPH and a TV survey workshop.

Reference F and harvest ratios

In order to better implement the harvest ratio approach, more robust ratios are required, based around established sustainable rates observed for other exploited species (preferably with similar biological characteristics) or around some reference F value, to determine the appropriate percentage of the population to be exploited.

Typical harvest ratio’s that are used for other stocks range from 25-33% of the biomass for cockles in the Burry Inlet. A harvest control rule of 25% of the average fishable biomass has been adopted for Icelandic cod since 1995 (ICES, 2004), following research suggesting this would lead to a low probability of stock collapse. The EU Norway agreement on North Sea herring sets TAC advice equivalent to an F value of 0.25 on adult fish, while for area VIa, a harvest control rule with F between 0.2 and 0.25 has been shown to be sustainable while delivering a reasonably high yield.

Yield per recruit reference points calculated using Length Cohort Analysis (LCA) have been considered for west of Scotland *Nephrops* stocks. These are calculated from the shape of the exploitation pattern and should be relatively independent of the uncertain landings. These reference point estimates are quite consistent between years, and also between areas (for information, values estimated using MFYPR based on XSA outputs are also quite similar). The overall averages of the annual values are F_{max} – 0.39, $F_{0.1}$ – 0.24 and F30% SPR – 0.34. These roughly equate to harvest ratios of 32%, 21% and 29%, respectively. Although $F_{0.1}$ is essentially an arbitrary choice of fishing mortality rate, it has been shown to not unduly reduce spawning abundance for a broad range of models of stock dynamics, and appears robust to alternative stock recruitment relationships (Deriso, 1987). $F_{0.1}$ has been used successfully as a management reference point for Icelandic *Nephrops* stocks for a number of years, and is used as a reference fishing mortality in New Zealand for both cockles (Morrison & Cryer, 1999) and scallops (Cryer, 1998). For North east Atlantic mackerel, medium and long-term predictions have indicated that a long-term harvesting strategy with a fixed F near $F_{0.1}$ would be optimal with respect to long-term yield and low risk (ICES, 2005).

Flow diagram of harvest ratio procedure.

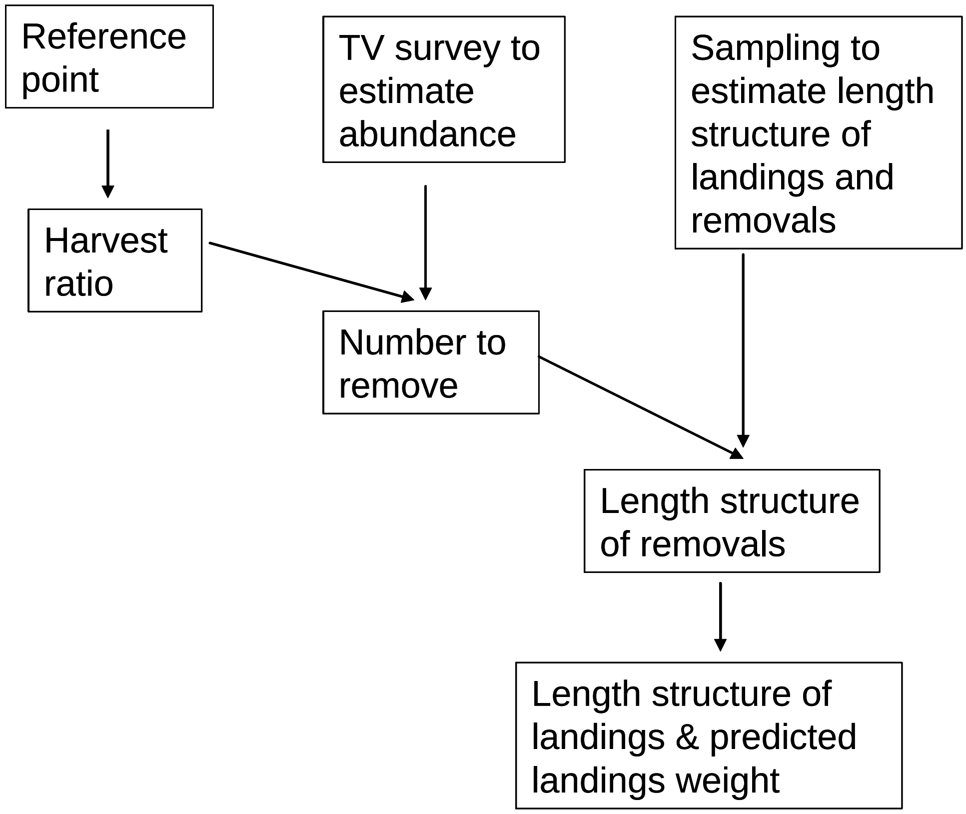


Table 3.1.1 Nephrops Functional Units and descriptions by statistical rectangle.

Functional Unit	Stock	ICES Rectangles	Management Area	Division
3	Skagerrak	47G0-G1; 46F9-G1; 45F8-G1; 44F7-G0; 43F8-F9	E	IIIa
4	Kattegat	44G1-G2; 42-43G0-G2; 41G1-G2	E	IIIa
5	Botney Gut	36-37 F1-F4; 35F2-F3	H	IV
6	Farn Deep	38-40 E8-E9; 37E9	I	IV
7	Fladen	44-49 E9-F1; 45-46E8	G	IV
8	Firth of Forth	40-41E7; 41E6	I	IV
9	Moray Firth	44-45 E6-E7; 44E8	F	IV
10	Noup	47E6	F	IV
32	Norwegian Deep	44-52 F2-F6; 43F5-F7	S	IV
33	Off Horn Reef	39-41E4; 39-41E5	H	IV

Table 3.1.2 Summary of Nephrops landings from the ICES area, by Management Area, 1991-2005

ICES sub-area	**IIIa**	**IV**					**Area IV Total**	**Overall total**
MA	E	F	G	S	I	H		All MAs
1991	4238	1780	4273	178	3823	1023	11077	15315
1992	2912	1822	3402	160	3491	736	9611	12523
1993	3209	2253	3532	338	5661	945	12729	15938
1994	2874	2171	4686	759	5953	682	14251	17125
1995	3427	1654	6624	494	4704	1234	14710	18137
1996	3979	1896	5368	960	4557	921	13702	17681
1997	4206	1856	6266	760	4722	1554	15159	19365
1998	5044	1360	5230	838	4599	1640	13667	18711
1999	4943	1361	6696	1129	5006	2204	16396	21339
2000	4703	1880	5650	1051	4353	1978	14912	19615
2001	4055	1696	5644	1191	4735	2429	15695	19750
2002	4441	1588	7410	1216	3917	2418	16549	20990
2003	3754	1534	6402	1110	4024	2457	15527	19281
2004	3953	1643	8830	934	4399	2621	18427	22380
2005*	4032	1802	10791	1117	5619	2313	21642	25674

* provisional   na = not available

Table 3.2.1.1 Nominal landings (tonnes) of Nephrops in Division IIIa, 1986 – 2005, as officially reported to ICES.

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	2840	2869	3022	3094	2790	2046	2251	2049	2419	2843	2959	3538	3487	3329	2868	3277	2752	2956	2918
Germany	0	0	0	0	0	0	0	0	1	1	5	12	6	7	1	7	12	13	2
Germany, Fed. Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Norway	80	88	54	140	185	104	103	62	90	102	117	184	214	181	138	116	99	95	83
Sweden	1240	1062	829	1098	1249	772	863	763	913	1105	1129	1314	1259	1195	1040	1033	896	904	1044
Total	4160	4019	3905	4332	4224	2922	3217	2874	3423	4051	4210	5048	4966	4712	4047	4433	3759	3969	4047

Table 3.2.1.2 Management Area E (IIIa): Total Nephrops landings (tonnes) by Functional Unit plus Other rectangles, 1991-2005.

Year	FU 3	FU 4	Other	Total
1991	2934	1304	0	4238
1992	1900	1012	0	2912
1993	2285	924	0	3209
1994	1981	893	0	2874
1995	2429	998	0	3427
1996	2694	1285	0	3979
1997	2612	1594	0	4206
1998	3248	1796	0	5044
1999	3194	1749	0	4943
2000	2894	1809	0	4703
2001	2282	1773	0	4055
2002	2977	1464	0	4441
2003	2126	1628	0	3754
2004	2312	1641	0	3953
2005	2546	1486	0	4032

Table 3.2.1.3 Management Area E (IIIa): Total Nephrops landings (tonnes) by country, 1991-2005.

Year	Denmark	Norway	Sweden	Total
1991	2824	195	1219	4238
1992	2052	111	749	2912
1993	2250	100	859	3209
1994	2049	62	763	2874
1995	2419	90	918	3427
1996	2844	101	1034	3979
1997	2959	117	1130	4206
1998	3541	184	1319	5044
1999	3486	214	1243	4943
2000	3325	181	1197	4703
2001	2880	138	1037	4055
2002	3293	116	1032	4441
2003	2757	99	898	3754
2004	2955	95	903	3953
2005	2902	83	1047	4032

Table 3.2.1.4 Nephrops Skagerrak (FU 3): Landings (tonnes) by country, 1991-2005.

Year	Denmark	Norway	Sweden			Total
			Trawl	Creel	Sub-total	
1991	1639	195	949	151	1100	2934
1992	1151	111	524	114	638	1900
1993	1485	100	577	123	700	2285
1994	1298	62	531	90	621	1981
1995	1569	90	659	111	770	2429
1996	1772	101	708	113	821	2694
1997	1687	117	690	118	808	2612
1998	2055	184	864	145	1009	3248
1999	2070	214	793	117	910	3194
2000	1877	181	689	147	836	2894
2001	1416	138	594	134	728	2282
2002	2053	116	658	150	808	2977
2003	1421	99	471	135	606	2126
2004	1595	95	449	173	622	2312
2005	1727	83	538	198	736	2546

Table 3.2.1.5 Nephrops Skagerrak (FU 3): Mean sizes (mm CL) of male and female Nephrops in catches of Danish, Swedish and Norwegian trawlers combined, 1991-2005

Year	**Catches**					
	Undersized		**Full sized**		**All**	
	Males	Females	Males	Females	Males	Females
1991	30.2	30.9	41.2	42.7	30.9	29.8
1992	33.3	32.3	43.3	44.7	33.3	32.2
1993	33.0	31.5	42.0	43.6	33.0	31.5
1994	31.7	29.6	41.7	43.6	31.7	29.6
1995	30.0	28.5	41.6	41.3	32.9	29.8
1996	33.2	31.9	42.9	44.0	37.6	37.0
1997	35.8	34.5	44.6	44.1	39.8	39.1
1998	34.8	34.4	46.1	43.9	40.7	37.3
1999	34.6	33.9	44.9	43.8	39.3	36.1
2000	30.6	30.5	45.6	45.0	32.5	34.1
2001	33.6	33.6	45.5	43.6	37.3	36.4
2002	33.9	33.7	44.0	42.5	37.2	37.3
2003	33.5	32.6	43.2	43.4	38.0	36.7
2004	34.3	33.4	44.6	45.2	38.7	36.6
2005	33.5	32.4	43.7	43.0	36.4	35.3

Table 3.2.1.6 Nephrops Skagerrak (FU 3): Catches and landings (tonnes), effort ('000 hours trawling), CPUE and LPUE (kg/hour trawling) of Swedish Nephrops trawlers, 1991-2005 (data presented for single and twin trawls separately).

Year	Catches	Landings	Effort	CPUE	LPUE
1991	676	401	71.4	9.5	5.6
1992	360	231	73.7	4.9	3.1
1993	614	279	72.6	8.4	3.8
1994	441	246	60.1	7.3	4.1
1995	501	336	60.8	7.8	5.2
1996	754	488	51.1	14.8	9.6
1997	643	437	44.4	14.4	9.8
1998	794	557	49.7	16.0	11.2
1999	605	386	34.5	17.5	9.3
2000	486	329	32.7	14.9	10.9
2001	446	236	26.2	17.0	10.4
2002	503	301	29.4	17.1	8.8
2003	310	254	21.5	13.9	11.4
2004	474	257	20.1	23.6	12.8
2005	760	339	29.7	25.6	11.4

Twin trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1991	740	439	39.5	18.7	11.1
1992	370	238	34.1	10.9	7.0
1993	568	258	35.9	15.8	7.2
1994	444	248	34.1	13.1	7.3
1995	403	270	32.9	12.2	8.2
1996	187	121	13.0	14.4	9.3
1997	219	149	17.5	12.5	8.5
1998	254	178	16.7	15.2	10.6
1999	382	244	27.6	13.8	8.8
2000	349	237	31.3	11.1	10.1
2001	470	249	33.7	14.0	7.4
2002	392	244	33.3	11.8	7.1
2003	168	138	22.5	7.5	6.1
2004	217	118	21.7	10.0	5.4
2005	263	117	22.1	11.9	5.3

Table 3.2.1.7 Nephrops Skagerrak (FU 3): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching Nephrops with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1991-2005.

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

Table 3.2.1.8 Nephrops Kattegat (FU 4): Landings (tonnes) by country, 1991-2005.

Year	Denmark	Sweden			Total
		Trawl	Creel	Sub-total	
1991	1185	119	0	119	1304
1992	901	111	0	111	1012
1993	765	159	0	159	924
1994	751	142	0	142	893
1995	850	148	0	148	998
1996	1072	213	0	213	1285
1997	1272	319	3	322	1594
1998	1486	306	4	310	1796
1999	1416	329	4	333	1749
2000	1448	357	4	361	1809
2001	1464	304	6	309	1773
2002	1240	219	5	224	1464
2003	1336	287	5	292	1628
2004	1360	270	11	281	1641
2005	1175	303	8	311	1486

Table 3.2.1.9 Nephrops Kattegat (FU 4): Mean sizes (mm CL) of male and female Nephrops in discards, landings and catches of Danish trawlers, 1991-2005.

Year	**Discards**					
	Discards		**Landings**		**Catch**	
	Males	Females	Males	Females	Males	Females
1991	30.7	31.1	42.4	42.5	32.5	32.9
1992	33.0	30.3	44.4	43.2	36.7	34.9
1993	30.5	29.3	42.3	43.1	31.3	30.1
1994	29.7	28.3	40.8	40.2	31.2	28.9
1995	30.8	30.5	42.4	42.0	33.7	33.2
1996	32.7	31.3	42.0	44.0	36.7	37.3
1997	33.6	33.2	45.0	44.5	37.1	35.0
1998	34.2	33.2	45.6	44.1	41.3	36.8
1999	32.9	33.8	45.3	40.9	37.8	34.9
2000	35.1	35.2	45.7	42.1	40.4	36.9
2001	32.2	33.0	44.1	41.9	35.9	36.5
2002	34.4	33.3	44.4	43.8	37.2	36.2
2003	33.0	33.2	43.5	42.2	37.1	36.0
2004	34.7	34.2	45.1	43.2	39.9	37.5
2005	33.5	33.9	45.8	43.1	38.7	38.7

Table 3.2.1.10 Nephrops Kattegat (FU 4): Catches and landings (tonnes), effort ('000 hours trawling), CPUE and LPUE (kg/hour trawling) of Swedish Nephrops trawlers, 1991-20055 (data presented for single and twin trawls separately).

Single trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1991	66	39	10.3	6.4	3.7
1992	44	28	11.6	3.8	2.4
1993	128	58	14.9	8.6	3.9
1994	95	53	16.2	5.7	3.2
1995	79	53	9.6	7.8	5.5
1996	207	134	13.7	15.1	9.8
1997	269	183	18.0	15.0	10.2
1998	181	127	13.1	13.8	9.7
1999	146	93	8.1	17.9	11.4
2000	114	77	8.5	13.4	9.1
2001	117	62	7.6	15.4	8.2
2002	42	25	3.7	11.2	6.7
2003	49	40	4.6	10.7	8.7
2004	70	44	4.3	16.2	10.1
2005	147	100	12.3	11.9	8.1

Twin trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1991	93	55	8.8	10.6	6.2
1992	101	65	14.2	7.1	4.6
1993	187	85	17.8	10.6	4.8
1994	138	77	14.2	9.7	5.4
1995	125	84	11.0	12.2	7.7
1996	97	63	7.5	13.0	8.4
1997	183	124	12.7	14.3	9.7
1998	215	151	15.0	14.4	10.1
1999	306	195	20.1	15.2	9.7
2000	330	224	24.5	13.5	9.1
2001	353	187	25.1	14.1	7.4
2002	256	153	23.2	11.0	6.6
2003	222	181	24.8	9	7.3
2004	253	158	16.5	15.4	9.6
2005	198	135	15.3	12.9	8.8

Table 3.2.1.11 Nephrops Kattegat (FU 4): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching Nephrops with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1991-2005.

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

Table 3.4.1.1 Nominal landings (tonnes) of Nephrops in Division IV, 1987 – 2005, as officially reported to ICES.

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	437	500	574	610	427	384	418	304	410	185	311	238	350	252	283	284	229	213	183
Denmark	479	409	508	743	880	581	691	1128	1182	1315	1309	1440	1963	1747	1935	2154	2128	2244	2339
Faeroe Islands	0	0	0	0	0	0	1	3	12	0	1	1	1	0	0	0	0	0	0
France	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germany	0	0	0	0	2	2	16	24	16	69	64	58	104	79	140	125	50	50	109
Germany, Fed. Rep	1	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0
Netherlands	0	0	0	9	3	134	131	159	254	423	627	695	662	572	851	966	940	918	1019
Norway	2	17	17	46	117	125	107	171	74	83	64	93	144	147	115	130	100	93	131
Sweden	0	0	0	0	4	0	1	1	1	0	1	3	4	37	26	14	1	1	3
UK - Eng+Wales+N	0	0	2938	2332	1955	1451	2983	3613	2530	2462	2206	2094	2431	2210	2691	1964	2295	2241	3622
UK - England & Wa	2173	2397	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UK - Scotland	5304	6527	7065	6871	7501	6898	8250	8850	10018	8981	10466	8980	10715	9834	9681	11045	10094	12912	14446
Total	8403	9852	11103	10613	10889	9575	12598	14253	14497	13518	15049	13602	16374	14878	15722	16682	15838	18674	21851

Table 3.4.1.2 Nephrops, Management Area F: Total Nephrops landings (tonnes) by Functional Unit plus Other rectangles, 1981-2005.

Year	FU 9	FU 10	Other	Total
1981	1416	36	0	1452
1982	1120	19	1	1140
1983	940	15	1	956
1984	1170	111	3	1284
1985	2081	22	15	2118
1986	2143	68	44	2255
1987	1991	44	34	2069
1988	1959	76	45	2080
1989	2576	84	44	2704
1990	2038	217	68	2323
1991	1519	196	65	1780
1992	1591	188	43	1822
1993	1808	376	69	2253
1994	1538	495	138	2171
1995	1297	280	77	1654
1996	1451	344	101	1896
1997	1446	316	94	1856
1998	1032	254	74	1360
1999	1008	279	74	1361
2000	1541	275	64	1880
2001	1403	177	116	1696
2002	1118	401	69	1588
2003	1079	337	118	1534
2004	1335	228	80	1643
2005*	1605	165	32	1802

* provisional na = not available

Table 3.4.1.3 Nephrops, Moray Firth (FU 9), Nominal Landings of Nephrops, 1981-2005, as officially reported.

Year	UK Scotland				UK England	Total **
	Nephrops trawl	Other trawl	Creel	Sub-total		
1981	1298	118	0	1416	0	1416
1982	1034	86	0	1120	0	1120
1983	850	90	0	940	0	940
1984	960	209	0	1170	0	1170
1985	1908	173	0	2081	0	2081
1986	1933	210	0	2143	0	2143
1987	1723	268	0	1991	0	1991
1988	1638	321	0	1959	0	1959
1989	2102	474	0	2576	0	2576
1990	1700	338	0	2038	0	2038
1991	1284	233	0	1519	0	1519
1992	1282	305	0	1591	0	1591
1993	1505	303	0	1808	0	1808
1994	1178	360	0	1538	0	1538
1995	967	330	0	1297	0	1297
1996	1084	364	1	1449	2	1451
1997	1102	343	0	1445	1	1446
1998	739	289	4	1032	0	1032
1999	813	194	1	1008	0	1008
2000	1343	195	3	1541	0	1541
2001	1188	213	2	1403	0	1403
2002	883	248	2	1118	0	1118
2003	872	197	10	1079	0	1079
2004	1223	103	9	1335	0	1335
2005	1526	64	12	1602	3	1605

* provisional na = not available

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

Table 3.4.1.4 Nephrops, Moray Firth (FU 9): Mean sizes (CL mm) above and below 35 mm of male and female Nephrops in Scottish catches and landings, 1991-2005.

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

* provisional na = not available

Table 3.4.1.5 Nephrops, Moray Firth (FU 9): 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 combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	1298	36.7	35.4	1298	36.7	35.4	na	na	na
1982	1034	28.2	36.7	1034	28.2	36.7	na	na	na
1983	850	21.4	39.7	850	21.4	39.7	na	na	na
1984	960	23.2	41.4	960	23.2	41.4	na	na	na
1985	1908	49.2	38.8	1908	49.2	38.8	na	na	na
1986	1933	51.6	37.5	1933	51.6	37.5	na	na	na
1987	1723	70.6	24.4	1723	70.6	24.4	na	na	na
1988	1638	60.9	26.9	1638	60.9	26.9	na	na	na
1989	2102	69.6	30.2	2102	69.6	30.2	na	na	na
1990	1700	58.4	29.1	1700	58.4	29.1	na	na	na
1991	1284	47.1	27.3	571	25.1	22.7	713	22.0	32.4
1992	1282	40.9	31.3	624	24.8	25.2	658	16.1	40.9
1993	1505	48.6	31.0	783	28.1	27.9	722	20.6	35.0
1994	1178	47.5	24.8	1023	42.0	24.4	155	5.5	28.2
1995	967	30.6	31.6	857	27.0	31.7	110	3.6	30.6
1996	1084	38.2	28.4	1057	37.4	28.3	27	0.8	33.8
1997	1102	47.7	23.1	960	42.5	22.6	142	5.1	27.8
1998	739	34.4	21.5	576	28.1	20.5	163	6.3	25.9
1999	813	35.5	22.9	699	31.5	22.2	114	4.0	28.5
2000	1343	49.5	27.1	1068	39.8	26.8	275	9.7	28.4
2001	1188	47.6	25.0	913	37.0	24.7	275	10.6	25.9
2002	883	35.5	24.9	649	27.2	23.9	234	7.9	29.6
2003	872	28.9	30.2	737	25.3	29.1	135	3.6	37.5
2004	1223	31.7	38.6	1100	29.2	37.7	123	2.5	49.2
2005*	1526	37.6	40.6	1308	34.0	38.5	218	3.6	60.0

Table 3.4.1.6 Nephrops, Moray Firth (FU 9):Summary of TV results for most recent 3 years (2003-2005) showing strata surveyed, numbers of stations in each strata, mean density and observed variance, overall abundance and variance raised to stratum area. Proportion indicates relative amounts of overall raised variance attributable to each stratum.

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2003 TV survey							
M & SM	169	2	0.29	0.17	49	2398	0.102768 0
MS(west)	682	5	0.29	0.18	198	16613	0.711828 0
MS(mid)	698	10	0.46	0.05	319	2483	0.106373 0
MS(east)	646	15	0.22	0.07	140	1844	0.079031 0
Total	2195	32			706	23338	1
2004 TV survey							
M & SM	169	4	0.42	0.19	71	1329	0.132846 0
MS(west)	682	10	0.28	0.10	188	4744	0.474346 0
MS(mid)	698	16	0.22	0.03	153	976	0.097545 0
MS(east)	646	12	0.42	0.08	273	2953	0.295262 0
Total	2195	42			686	10001	1
2005 TV survey							
M & SM	169	7	0.65	0.19	110	755	0.070
MS(west)	682	10	0.44	0.10	298	4510	0.418
MS(mid)	698	12	0.35	0.04	247	1631	0.151
MS(east)	646	13	0.33	0.12	211	3904	0.362
Total	2195	42			866	10799	1

Table 3.4.1.7 Nephrops, Moray Firth (FU 9): Results of the 1993-2005 TV surveys.

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1993	31	0.19	418	94
1994	29	0.39	850	213
1995	no survey			
1996	27	0.26	563	109
1997	34	0.14	317	66
1998	31	0.18	391	115
1999	52	0.22	484	105
2000	44	0.21	467	118
2001	45	0.19	417	135
2002	31	0.29	630	146
2003	32	0.32	706	306
2004	42	0.31	686	200
2005	42	0.39	866	208

Table 3.4.1.8 Nephrops, Moray Firth (FU 9): Predicted landings potential based on abundance estimates using TV surveys, current landings and discard length distributions for the Moray Firth, and a range of harvest ratios.

Males Weight = a*CL^b a = 0.00028 b = 3.24

Females a = 0.00085 b = 2.91

CL	Landings ('000)	Discards ('000)	Removals ('000)	wt (g)	Landings (t)	CL	Landings ('000)	Discards ('000)	Removals ('000)	wt (g)	Landings (t)
11	0.0	0.0	0.0	0.88	0.00	11	0.0	0.0	0.0	1.17	0.00
13	0.0	0.0	0.0	1.45	0.00	13	0.0	0.0	0.0	1.84	0.00
15	0.0	4.2	3.2	2.23	0.00	15	1.3	42.0	32.8	2.71	3.53
17	5.6	45.9	40.0	3.27	18.30	17	18.6	61.4	64.7	3.82	71.08
19	43.2	209.2	200.1	4.60	198.60	19	50.1	297.7	273.4	5.19	260.17
21	187.3	777.5	770.4	6.26	1172.59	21	272.0	1039.7	1051.8	6.85	1863.97
23	455.4	1386.5	1495.3	8.30	3779.51	23	832.5	1352.8	1847.1	8.83	7348.82
25	1129.0	1886.2	2543.7	10.76	12144.11	25	1661.6	1722.6	2953.6	11.14	18514.75
27	2909.7	1611.4	4118.3	13.68	39792.23	27	3142.9	1320.5	4133.3	13.82	43448.96
29	4170.8	989.4	4912.9	17.10	71326.39	29	4101.6	617.9	4565.0	16.90	69309.87
31	5105.2	373.5	5385.3	21.08	107611.01	31	3885.5	117.7	3973.8	20.39	79223.18
33	5132.4	93.4	5202.5	25.65	131664.96	33	2856.9	0.0	2856.9	24.32	69489.25
35	4327.7	18.4	4341.5	30.87	133608.87	35	1880.3	1.7	1881.6	28.72	54011.51
37	2999.8	6.7	3004.8	36.78	110344.12	37	1439.5	0.0	1439.5	33.62	48395.04
39	1972.5	0.0	1972.5	43.43	85674.07	39	1092.1	0.0	1092.1	39.03	42626.13
41	1285.8	0.0	1285.8	50.87	65412.26	41	513.1	0.0	513.1	44.99	23082.16
43	712.9	0.0	712.9	59.15	42167.06	43	210.9	0.0	210.9	51.51	10862.83
45	435.0	0.0	435.0	68.31	29715.47	45	88.6	0.0	88.6	58.62	5193.71
47	283.5	1.7	284.8	78.41	22229.65	47	59.0	0.0	59.0	66.35	3914.56
49	145.1	0.0	145.1	89.50	12986.38	49	20.5	0.0	20.5	74.72	1531.71
51	86.9	0.0	86.9	101.63	8831.38	51	9.0	0.0	9.0	83.75	753.76
53	45.1	0.0	45.1	114.85	5179.53	53	4.0	0.0	4.0	93.47	373.89
55	18.4	0.0	18.4	129.21	2377.42	55	0.8	0.0	0.8	103.91	83.13
57	10.6	0.0	10.6	144.77	1534.51	57	0.5	0.0	0.5	115.08	57.54
59	3.7	0.0	3.7	161.57	597.82	59	0.1	0.0	0.1	127.01	12.70
61	1.1	0.0	1.1	179.68	197.65	61	0.0	0.0	0.0	139.73	0.00
63	0.4	0.0	0.4	199.15	79.66	63	0.0	0.0	0.0	153.25	0.00
65	0.1	0.0	0.1	220.03	22.00	65	0.0	0.0	0.0	167.61	0.00
67	0.1	0.0	0.1	242.37	24.24	67	0.0	0.0	0.0	182.82	0.00
69	0.0	0.0	0.0	266.24	0.00	69	0.0	0.0	0.0	198.91	0.00
Total			37020.30		888.69				27071.90		480.43

Removals (M+F 000s) 64092.20 Land Wt 1369.12

TV abundance (thousands) 752556.12

Predicted Landings = Land Wt * TV abundance * harvest rate / removals

Predicted Landings (tonnes)

Landings with harvest ratio eq. Fmax (0.44)	5787.33
Landings with harvest ratio eq. to F0.1 (0.22)	3118.73
Landings potential with 25% harvest rate	4018.98
Landings potential with 20% harvest rate	3215.18
Landings potential with 15% harvest rate	2411.39

Table 3.4.1.9 *Nephrops*, Noup (FU 10), Nominal Landings of Nephrops, 1981-2005, as officially reported.

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

* provisional   na = not available

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

Table 3.4.1.10Nephrops, Noup (FU 10): 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 combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	13	0.4	34.3	13	0.4	34.3	na	na	na
1982	12	0.5	24.7	12	0.5	24.7	na	na	na
1983	9	0.3	30.7	9	0.3	30.7	na	na	na
1984	75	2.0	36.9	75	2.0	36.9	na	na	na
1985	2	0.1	25.0	2	0.1	25.0	na	na	na
1986	46	0.7	62.6	46	0.7	62.6	na	na	na
1987	12	0.7	18.1	12	0.7	18.1	na	na	na
1988	23	1.0	34.3	23	1.0	34.3	na	na	na
1989	24	0.9	25.8	24	0.9	25.8	na	na	na
1990	101	2.9	34.6	101	2.9	34.6	na	na	na
1991	110	4.8	22.9	23	0.9	25.6	87	3.9	22.3
1992	56	1.8	31.1	33	1.4	23.6	23	0.4	57.5
1993	200	4.8	41.7	152	3.6	42.0	48	1.2	39.0
1994	308	8.4	36.7	273	7.6	36.0	35	0.8	42.1
1995	162	3.9	41.5	139	3.5	39.9	23	0.4	63.2
1996	180	4.4	40.9	174	4.2	41.4	6	0.2	30.0
1997	185	5.3	34.9	172	4.9	35.1	13	0.4	32.5
1998	183	3.2	57.2	171	3.0	57.0	12	0.2	60.0
1999	211	4.1	51.8	196	3.8	53.0	15	0.3	54.9
2000	196	2.0	98.0	161	1.8	89.4	35	0.2	175.0
2001	89	1.7	52.4	82	1.4	58.6	7	0.3	23.3
2002	244	3.3	73.9	185	2.1	88.1	59	1.2	49.2
2003	258	2.7	95.6	217	2.3	94.3	41	0.4	102.5
2004	175	2.2	79.5	144	2.2	65.5	31	0.0	
2005	81	0.6	135.0	58	0.6	96.7	23	0.0	

Table 3.4.1.11Nephrops, Noup (FU 10): Results of the 1994-1999 TV surveys. No TV surveys were possible for this stock between 2000-2004 and in 2005 poor visibility prevented a full analysis

Year	Stations	Mean density	Abundance	95% confidence interval	Biomass
		burrows/m²	millions	millions	'000 tonnes
1994	10	0.63	250	90	4.0-8.0
1995	no survey				
1996	no survey				
1997	no survey				
1998	no survey				
1999	10	0.30	120	42	1.9-3.8
2000	no survey				
2001	no survey				
2002	no survey				
2003	no survey				
2004	no survey				
2005	2	poor visibility, limited survey - see text			

Table 3.4.2.1 Nephrops, Management Area G: Total Nephrops landings (tonnes) by Functional Unit plus Other rectangles, 1981-2005 .

Year	FU 7	Other	Total
1981	373	2	375
1982	422	0	422
1983	693	0	693
1984	646	7	653
1985	1148	18	1166
1986	1543	17	1560
1987	1696	14	1710
1988	1573	11	1584
1989	2299	31	2330
1990	2540	20	2560
1991	4221	52	4273
1992	3363	39	3402
1993	3493	39	3532
1994	4569	117	4686
1995	6440	184	6624
1996	5218	150	5368
1997	6171	95	6266
1998	5136	94	5230
1999	6521	175	6696
2000	5570	81	5650
2001	5541	103	5644
2002	7247	163	7410
2003	6294	108	6402
2004	8729	101	8830
2005*	10684	107	10791
* provisional na = not available			

Table 3.4.2.2 Nephrops, Fladen (FU 7), Nominal Landings of Nephrops, 1981-2005, as officially reported.

Year	Denmark	UK Scotland			Other countries **	Total
		Nephrops trawl	Other trawl	Sub-total		
1981	0	304	69	373	0	373
1982	0	382	40	422	0	422
1983	0	548	145	693	0	693
1984	0	549	97	646	0	646
1985	7	1016	125	1141	0	1148
1986	50	1398	95	1493	0	1543
1987	323	1024	349	1373	0	1696
1988	81	1306	186	1492	0	1573
1989	165	1719	415	2134	0	2299
1990	236	1703	598	2301	3	2540
1991	424	3024	769	3793	4	4221
1992	359	1794	1179	2973	31	3363
1993	224	2033	1233	3266	3	3493
1994	390	1817	2356	4173	6	4569
1995	439	3569	2428	5997	4	6440
1996	286	2338	2592	4930	2	5218
1997	235	2713	3221	5934	2	6171
1998	173	2291	2672	4963	0	5136
1999	96	2860	3549	6409	16	6521
2000	103	2915	2546	5461	6	5570
2001	64	3539	1936	5475	2	5541
2002	173	4513	2546	7059	15	7247
2003	82	4175	2033	6208	4	6294
2004	136	7274	1319	8593	0	8729
2005*	321	8849	1514	10363	0	10684

* provisional   na = not available

** Other countries includes Belgium, Norway and UK England

Table 3.4.2.3Nephrops, Fladen (FU 7): Mean sizes (CL mm) above and below 35 mm of male and female Nephrops in Scottish catches and landings, 1993-2005.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1993	na	na	30.4	29.6	38.7	38.2
1994	na	na	30.0	28.9	39.2	37.8
1995	na	na	30.6	29.8	39.9	38.1
1996	na	na	30.4	29.1	40.6	38.8
1997	na	na	30.2	29.1	40.9	38.8
1998	na	na	30.8	29.4	40.7	38.4
1999	na	na	30.9	29.6	40.5	38.5
2000	30.8	30.1	31.2	30.5	41.3	38.7
2001	30.1	29.4	30.7	29.7	39.6	38.0
2002	30.6	30.1	31.3	30.7	39.5	38.3
2003	30.9	29.8	31.3	30.1	40.0	38.1
2004	30.8	29.6	31.1	29.8	39.9	38.8
2005*	30.9	30.0	31.2	30.1	40.1	38.2

* provisional   na = not available

Table 3.4.2.4 Nephrops, Fladen (FU 7): 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 combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	304	8.6	35.3	304	8.6	35.3	na	na	na
1982	382	12.2	31.3	382	12.2	31.3	na	na	na
1983	548	15.4	35.6	548	15.4	35.6	na	na	na
1984	549	11.4	48.2	549	11.4	48.2	na	na	na
1985	1016	26.6	38.2	1016	26.6	38.2	na	na	na
1986	1398	37.8	37.0	1398	37.8	37.0	na	na	na
1987	1024	41.6	24.6	1024	41.6	24.6	na	na	na
1988	1306	41.7	31.3	1306	41.7	31.3	na	na	na
1989	1719	47.2	36.4	1719	47.2	36.4	na	na	na
1990	1703	43.4	39.2	1703	43.4	39.2	na	na	na
1991	3024	78.5	38.5	410	11.4	36.0	2614	67.1	39.0
1992	1794	38.8	46.2	340	9.4	36.2	1454	29.4	49.5
1993	2033	49.9	40.7	388	9.6	40.4	1645	40.3	40.8
1994	1817	48.8	37.2	301	8.4	35.8	1516	40.4	37.5
1995	3569	75.3	47.4	2457	52.3	47.0	1022	23.0	44.4
1996	2338	57.2	40.9	2089	51.4	40.6	249	5.8	42.9
1997	2713	76.5	35.5	2013	54.7	36.8	700	21.8	32.1
1998	2291	60.0	38.2	1594	39.6	40.3	697	20.5	34.0
1999	2860	76.8	37.2	1980	50.3	39.4	880	26.5	33.2
2000	2915	92.1	31.7	2002	62.9	31.8	913	29.2	31.3
2001	3539	108.2	32.7	2162	65.8	32.9	1377	42.4	32.5
2002	4513	109.6	41.2	2833	58.9	48.1	1680	50.7	33.1
2003	4175	53.7	77.7	3388	42.8	79.2	787	10.9	72.2
2004	7274	56.1	129.8	6177	47.5	130.2	1097	8.6	127.6
2005*	8849	61.3	144.4	6834	43.4	157.5	2015	17.9	112.7

Table 3.4.2.5Nephrops, Fladen (FU 7): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching Nephrops with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1991-2005.

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

* provisional na = not available

Table 3.4.2.6 Nephrops, Fladen Ground (FU 7):Summary of TV results for most recent 3 years (2003-2005) showing strata surveyed, numbers of stations in each strata, mean density and observed variance, overall abundance and variance raised to stratum area. Proportion indicates relative amounts of overall raised variance attributable to each stratum.

Stratum (ranges of % silt clay)	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2003 TV survey							
>80	3248	9	0.26	0.01	834	7326	0.022975 0
55<80	4967	16	0.27	0.00	1338	5005	0.015694 0
40<55	4304	16	0.26	0.01	1105	15290	0.047948 0
<40	15634	14	0.17	0.02	2613	291273	0.913384 1
Total	28153	55			5890	318894	1
2004 TV survey							
>80	3248	9	0.32	0.01	1025	11403	0.036859 0
55<80	4967	13	0.26	0.01	1314	20481	0.0662 0
40<55	4304	16	0.26	0.01	1135	16682	0.053921 0
<40	15634	14	0.16	0.01	2501	260806	0.843019 1
Total	28153	52			5976	309372	1
2005 TV survey							
>80	3248	13	0.30	0.01	967	5940	0.055
55<80	4967	22	0.25	0.01	1257	9540	0.088
40<55	4304	12	0.22	0.01	961	9410	0.087
<40	15634	25	0.10	0.01	1607	83635	0.771
Total	28153	72			4793	108524	1

Table 3.4.2.7 Nephrops, Fladen (FU 7): Results of the 1992-2005 TV surveys.

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1992	69	0.17	4942	508
1993	74	0.21	6007	768
1994	59	0.30	8329	1099
1995	61	0.24	6733	1209
1996	No survey			
1997	56	0.13	3736	689
1998	60	0.18	5181	968
1999	62	0.20	5597	876
2000	68	0.17	4898	663
2001	50	0.23	6725	1310
2002	54	0.29	8217	1022
2003	55	0.21	5890	1129
2004	52	0.21	5976	1112
2005	72	0.17	4793	659

Table 3.4.2.8 Nephrops, Fladen (FU 7): Predicted landings potential based on abundance estimates using TV surveys, current landings and discard length distributions for the Fladen, and a range of harvest ratios.

Males

Weight = a*CL^b a = 0.00028 b = 3.24

Females

a = 0.00085 b = 2.91

CL	Landings ('000)	Discards ('000)	Removals ('000)	wt (g)	Landings (t)	CL	Landings ('000)	Discards ('000)	Removals ('000)	wt (g)	Landings (t)
11	0.0	0.0	0.0	0.88	0.00	11	0.0	0.0	0.0	1.17	0.00
13	0.0	0.0	0.0	1.45	0.00	13	0.0	0.0	0.0	1.84	0.00
15	12.7	2.3	14.4	2.23	28.33	15	1.9	2.5	3.8	2.71	5.15
17	59.1	11.0	67.4	3.27	193.12	17	82.4	11.7	91.2	3.82	314.91
19	201.1	53.6	241.3	4.60	924.50	19	232.9	113.6	318.1	5.19	1209.44
21	728.8	286.4	943.6	6.26	4562.64	21	1261.9	307.5	1492.5	6.85	8647.57
23	1769.1	738.8	2323.2	8.30	14682.33	23	3783.6	998.2	4532.3	8.83	33399.41
25	4559.6	2130.5	6157.5	10.76	49045.42	25	9304.4	2919.1	11493.7	11.14	103676.36
27	11280.5	3767.6	14106.2	13.68	154268.91	27	16757.2	5184.1	20645.3	13.82	231659.57
29	19035.8	4272.0	22239.8	17.10	325538.25	29	21860.2	5549.3	26022.2	16.90	369399.16
31	26689.0	2581.8	28625.4	21.08	562569.60	31	21351.5	3220.3	23766.7	20.39	435345.19
33	28513.7	950.4	29226.5	25.65	731481.42	33	16190.5	1445.7	17274.8	24.32	393806.46
35	25771.9	494.1	26142.5	30.87	795654.59	35	11056.8	639.8	11536.7	28.72	317605.97
37	21826.4	122.2	21918.1	36.78	802858.47	37	7243.4	319.7	7483.2	33.62	243518.33
39	16076.5	58.2	16120.2	43.43	698270.84	39	4264.1	129.7	4361.4	39.03	166433.55
41	11527.8	20.1	11542.9	50.87	586451.59	41	2150.4	23.1	2167.7	44.99	96737.22
43	7382.2	4.2	7385.4	59.15	436647.03	43	917.5	19.9	932.4	51.51	47257.67
45	4875.8	1.3	4876.8	68.31	333072.89	45	498.0	5.9	502.4	58.62	29192.65
47	2849.3	0.0	2849.3	78.41	223417.82	47	287.5	0.0	287.5	66.35	19075.19
49	1700.4	0.0	1700.4	89.50	152185.03	49	110.7	1.3	111.7	74.72	8271.21
51	919.8	0.0	919.8	101.63	93476.46	51	43.4	0.0	43.4	83.75	3634.78
53	425.8	0.0	425.8	114.85	48901.19	53	33.2	0.0	33.2	93.47	3103.29
55	221.1	0.0	221.1	129.21	28567.75	55	10.8	0.0	10.8	103.91	1122.20
57	116.4	0.0	116.4	144.77	16850.69	57	5.0	0.0	5.0	115.08	575.39
59	50.6	0.0	50.6	161.57	8175.58	59	4.0	0.0	4.0	127.01	508.04
61	22.1	0.0	22.1	179.68	3971.00	61	1.3	0.0	1.3	139.73	181.64
63	6.9	0.0	6.9	199.15	1374.14	63	0.0	0.0	0.0	153.25	0.00
65	0.7	0.0	0.7	220.03	154.02	65	0.0	0.0	0.0	167.61	0.00
67	0.9	0.0	0.9	242.37	218.14	67	0.0	0.0	0.0	182.82	0.00
69	0.2	1.3	1.2	266.24	53.25	69	0.0	0.0	0.0	198.91	0.00
Total			198246.05		6073.59				133121.15		2514.68

Removals (M+F 000s) 331367.20 Land Wt 8588.28

TV abundance (thousands) 5552830.1

Predicted Landings = Land Wt * TV abundance * harvest rate / removals

Predicted Landings (tonnes)

Landings with harvest ratio eq. Fmax (0.38)	45103.12
Landings with harvest ratio eq. to F0.1 (0.201)	26205.42
Landings potential with 25% harvest rate	35979.14
Landings potential with 20% harvest rate	28783.32
Landings potential with 15% harvest rate	21587.49
Landings potential with 10% harvest rate	14391.66

Table 3.4.3.1 Nephrops Norwegian Deep (FU 32): Landings (tonnes) by country, 1993-2005.

Year	Denmark	Norway	UK	Total
1993	220	102	16	338
1994	584	165	10	759
1995	418	74	2	494
1996	868	82	10	960
1997	689	64	7	760
1998	743	91	4	838
1999	972	144	13	1129
2000	871	147	33	1051
2001	1026	112	53	1191
2002	1043	121	52	1216
2003	996	100	14	1110
2004	835	93	6	934
2005	979	132	6	1117
* provisional na = not available				

Table 3.4.3.2 Nephrops Norwegian Deep (FU 32): Danish effort(days and LPUE, 1993 to 2005

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

Table 3.4.4.1Nephrops, Management Area I: Total Nephrops landings (tonnes) by Functional Unit plus Other rectangles, 1981-2005.

Year	FU 6	FU 8	Other	Total
1981	1073	1006	74	***2153***
1982	2524	1195	156	***3875***
1983	2078	1724	100	***3902***
1984	1479	2134	78	***3691***
1985	2027	1969	106	***4103***
1986	2015	2263	143	***4421***
1987	2191	1674	147	***4012***
1988	2505	2528	308	***5341***
1989	3098	1886	158	***5142***
1990	2498	1930	134	***4561***
1991	2064	1404	355	***3823***
1992	1463	1757	271	***3491***
1993	3030	2369	262	***5661***
1994	3684	1850	407	***5940***
1995	2568	1763	373	***4704***
1996	2482	1688	387	***4557***
1997	2189	2194	339	***4722***
1998	2176	2145	278	***4599***
1999	2401	2205	403	***5008***
2000	2178	1785	391	***4353***
2001	2574	1528	633	***4735***
2002	1953	1340	637	***3930***
2003	2245	1126	653	***4024***
2004	2152	1658	589	***4399***
2005*	3094	1990	536	***5619***

* provisional na = not available

Table 3.4.4.2Nephrops Farn Deeps (FU 6): Landings (tonnes) by country, 1981-2005

Year	UK England	UK Scotland	Sub total	Other countries**	Total
1981	1006	67	1073	0	1073
1982	2443	81	2524	0	2524
1983	2073	5	2078	0	2078
1984	1471	8	1479	0	1479
1985	2009	18	2027	0	2027
1986	1987	28	2015	0	2015
1987	2158	33	2191	0	2191
1988	2390	105	2495	0	2495
1989	2930	168	3098	0	3098
1990	2306	192	2498	0	2498
1991	1884	179	2063	0	2063
1992	1403	60	1463	10	1473
1993	2941	89	3030	0	3030
1994	3530	153	3683	0	3683
1995	2478	90	2568	1	2569
1996	2386	96	2482	1	2482
1997	2109	80	2189	0	2189
1998	2029	147	2176	1	2177
1999	2197	194	2391	0	2391
2000	1947	231	2178	0	2178
2001	2319	255	2574	0	2574
2002	1739	215	1953	0	1953
2003	2031	214	2245	0	2245
2004	1951	201	2152	0	2152
2005*	2935	158	3093	0	3094

* provisional na = not available
** Other countries includes Ne, Be and Dk

Table 3.4.4.3 Nephrops Farn Deeps (FU 6): Mean sizes (CL mm) of male and female Nephrops in English catches and landings, 1985-2005.

Year	Catches		Landings	
	Males	Females	Males	Females
1985	30.1	28.5	35.4	33.8
1986	31.7	30.2	35.3	33.7
1987	28.6	27.0	35.3	33.3
1988	28.7	27.3	35.0	33.9
1989	29.0	28.2	32.4	31.9
1990	27.1	27.4	31.8	31.3
1991	28.9	27.1	33.5	33.1
1992	30.8	29.0	33.0	31.9
1993	32.1	28.7	33.4	30.1
1994	30.5	27.7	33.8	30.5
1995	28.4	27.4	33.8	31.6
1996	29.8	28.2	34.5	32.1
1997	29.9	29.6	33.5	32.1
1998	30.0	28.9	34.9	33.7
1999	29.6	27.5	35.1	33.6
2000	28.7	27.9	34.1	33.6
2001	28.3	27.5	36.2	35.0
2002	29.9	28.0	34.7	32.9
2003	30.3	28.1	36.0	35.4
2004	31.7	28.6	36.7	33.9
2005*	30.3	29.5	34.4	34.1

* provisional na = not available

Table 3.4.4.4 Nephrops Farn Deeps (FU 6): Catches and landings (tonnes), effort ('000 hours trawling), CPUE and LPUE (kg/hour trawling) of UK Nephrops trawlers, 1985-2005.

Year	Catches	Landings	Effort	CPUE	LPUE
1985	4224	2012	88.7	47.6	22.7
1986	2800	1995	90.1	31.1	22.1
1987	4435	2177	98.3	45.1	22.2
1988	5530	2472	118.1	46.8	20.9
1989	4639	3076	133.5	34.7	23.0
1990	4096	2471	116.2	35.3	21.3
1991	3075	2020	114.7	26.8	17.6
1992	2287	1437	69.5	32.9	20.7
1993	3567	3011	111.8	31.9	26.9
1994	5190	3684	143.4	36.2	25.7
1995	3152	2539	97.0	32.5	26.2
1996	3681	2475	90.5	40.7	27.4
1997	2501	2155	85.3	29.3	25.3
1998	2134	2128	78.2	27.3	27.2
1999	3748	2369	86.7	43.2	27.3
2000	3526	2073	88.7	39.8	23.4
2001	5069	2412	103.6	48.9	23.3
2002	3080	1898	75.2	40.9	25.2
2003	3891	2165	77.9	49.9	27.8
2004	3061	1986	60.8	50.3	32.7
2005*	4134	2819	72.9	56.7	38.7
* provisional na = not available					

Table 3.4.4.5 Nephrops Farn Deeps (FU 6): Results from TV surveys carried out in 1996-2005, giving estimates of stock abundance and biomass.

Year	Stations	Season	Mean density	Abundance	95% confidence interval
			burrows/m²	millions	millions
1996	71	Spring	0.58	1789	154
	-	Autumn	No survey		
1997	105	Spring	0.59	1821	185
	87	Autumn	0.61	1892	214
1998	78	Spring	0.25	759	84
	91	Autumn	0.44	1372	132
1999	95	Spring	0.34	1051	125
	-	Autumn	No survey		
2000	98	Spring	0.40	1242	116
	-	Autumn	No survey		
2001	-	Spring	No survey		
	180	Autumn	0.67	2057	125
2002	180	Spring	0.52	1591	100
	37	Autumn	0.41	1268	220
2003	-	Spring	No survey		
	89	Autumn	0.45	1382	170
2004	-	Spring	No survey		
	76	Autumn	0.57	1747	234
2005	-	Spring	No survey		
	105	Autumn	0.71	2196	266

Table 3.4.4.6 Nephrops, Farn Deeps (FU 6): Predicted landings potential based on abundance estimates using TV surveys, current landings and discard length distributions for the Farn Deeps, and a range of harvest ratios, with an indication of the 95% confidence interval.

Males a = 0.00038 b = 3.17

CL	Landings (000s)	Discards (000s)	Removals (000s)	Removals tonnes	Landings tonnes
12	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0
15	0.0	31.2	31.2	0.1	0.0
16	0.0	87.7	87.7	0.2	0.0
17	0.0	239.8	239.8	0.8	0.0
18	0.0	358.4	358.4	1.5	0.0
19	0.0	616.6	616.6	3.0	0.0
20	0.0	1172.3	1172.3	6.6	0.0
21	0.0	2144.4	2144.4	14.0	0.0
22	42.6	3626.6	3669.2	27.7	0.3
23	190.1	4924.1	5114.2	44.4	1.6
24	114.6	5929.7	6044.3	59.9	1.1
25	362.2	6819.4	7181.6	80.8	4.1
26	569.2	7122.6	7691.8	97.7	7.2
27	1203.7	6848.1	8051.8	115.1	17.2
28	1470.4	6879.9	8350.3	133.7	23.5
29	2043.3	6272.8	8316.1	148.5	36.5
30	3238.0	4526.8	7764.9	154.2	64.3
31	3978.8	3519.9	7498.8	164.9	87.5
32	3948.8	2312.2	6261.0	152.1	95.9
33	4515.8	736.5	5252.3	140.5	120.8
34	3953.9	619.4	4573.3	134.3	116.1
35	4072.4	0.0	4072.4	130.9	130.9
36	3817.9	0.0	3817.9	134.1	134.1
37	3177.7	0.0	3177.7	121.6	121.6
38	3173.0	0.0	3173.0	132.0	132.0
39	2353.4	0.0	2353.4	106.2	106.2
40	2248.1	0.0	2248.1	109.8	109.8
41	1994.1	0.0	1994.1	105.3	105.3
42	1406.7	0.0	1406.7	80.1	80.1
43	1119.7	0.0	1119.7	68.6	68.6
44	938.9	0.0	938.9	61.9	61.9
45	509.0	0.0	509.0	36.0	36.0
46	527.1	0.0	527.1	39.9	39.9
47	317.0	0.0	317.0	25.7	25.7
48	170.0	0.0	170.0	14.7	14.7
49	123.7	0.0	123.7	11.4	11.4
50	61.0	0.0	61.0	6.0	6.0
51	52.4	0.0	52.4	5.5	5.5
52	50.7	0.0	50.7	5.6	5.6
53	27.4	0.0	27.4	3.2	3.2
54	25.7	0.0	25.7	3.2	3.2
55	16.7	0.0	16.7	2.2	2.2
56	14.5	0.0	14.5	2.0	2.0
57	21.5	0.0	21.5	3.2	3.2
58	13.2	0.0	13.2	2.1	2.1
59	16.1	0.0	16.1	2.7	2.7
60	3.7	0.0	3.7	0.6	0.6
61	2.5	0.0	2.5	0.5	0.5
62	4.0	0.0	4.0	0.8	0.8
63	2.4	0.0	2.4	0.5	0.5
64	1.6	0.0	1.6	0.4	0.4
65	2.9	0.0	2.9	0.7	0.7
66	0.3	0.0	0.3	0.1	0.1
67	0.0	0.0	0.0	0.0	0.0
68	0.0	0.0	0.0	0.0	0.0
69	0.5	0.0	0.5	0.1	0.1

Females a = 0.00091 b = 2.895

CL	Landings (000s)	Discards (000s)	Removals (000s)	Removals tonnes	Landings tonnes
12	0.0	8.6	8.6	0.0	0.0
13	0.0	1.9	1.9	0.0	0.0
14	0.0	9.5	9.5	0.0	0.0
15	0.0	48.0	48.0	0.1	0.0
16	0.0	116.9	116.9	0.3	0.0
17	0.0	313.4	313.4	1.1	0.0
18	0.0	329.1	329.1	1.3	0.0
19	0.0	821.9	821.9	3.9	0.0
20	0.0	1567.3	1567.3	8.8	0.0
21	51.2	2958.4	3009.6	19.7	0.3
22	15.9	4208.7	4224.7	31.9	0.1
23	26.7	5548.7	5575.4	48.4	0.2
24	176.3	5339.7	5516.0	54.6	1.7
25	233.6	5808.1	6041.7	67.9	2.5
26	410.8	5009.7	5420.5	68.9	4.9
27	684.1	3691.6	4375.8	62.5	9.1
28	949.6	3244.8	4194.5	67.1	14.0
29	890.9	3353.7	4244.7	75.8	14.5
30	1878.4	2467.9	4346.3	86.3	33.8
31	2343.1	1895.9	4239.0	93.2	46.2
32	2358.7	1571.8	3930.5	95.5	50.9
33	3072.6	315.8	3388.3	90.6	72.4
34	2822.4	28.1	2850.5	83.7	72.4
35	2090.1	0.0	2090.1	67.2	58.3
36	2032.5	0.0	2032.5	71.4	61.4
37	1604.5	0.0	1604.5	61.4	52.4
38	1345.0	0.0	1345.0	55.9	47.4
39	1088.8	0.0	1088.8	49.1	41.4
40	800.2	0.0	800.2	39.1	32.7
41	506.9	0.0	506.9	26.8	22.2
42	332.8	0.0	332.8	18.9	15.6
43	221.4	0.0	221.4	13.6	11.1
44	230.4	0.0	230.4	15.2	12.4
45	70.5	0.0	70.5	5.0	4.0
46	104.4	0.0	104.4	7.9	6.4
47	114.3	0.0	114.3	9.3	7.4
48	30.1	0.0	30.1	2.6	2.1
49	18.1	0.0	18.1	1.7	1.3
50	6.8	0.0	6.8	0.7	0.5
51	2.8	0.0	2.8	0.3	0.2
52	2.6	0.0	2.6	0.3	0.2
53	31.7	0.0	31.7	3.8	2.9
54	0.1	0.0	0.1	0.0	0.0
55	0.0	0.0	0.0	0.0	0.0
56	0.0	0.0	0.0	0.0	0.0
57	0.0	0.0	0.0	0.0	0.0
58	0.0	0.0	0.0	0.0	0.0
59	0.0	0.0	0.0	0.0	0.0
60	0.0	0.0	0.0	0.0	0.0
61	0.0	0.0	0.0	0.0	0.0
62	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0
64	0.0	0.0	0.0	0.0	0.0
65	0.0	0.0	0.0	0.0	0.0
66	0.0	0.0	0.0	0.0	0.0
67	0.0	0.0	0.0	0.0	0.0
68	0.0	0.0	0.0	0.0	0.0
69	0.0	0.0	0.0	0.0	0.0

	Males		Females	
Total	116686.04	1793.75	75208.30	703.19

Removals (M + F 000s) 191894.34 Land. Wt 2496.94

TV abundance (000s) 1775340

Predicted landings = Landed weight * TV abundance * Harvest Ratio / Removals

Predicted Landings tonnes

Landings with harvest ratio eq. to Fmax (0.290)	5815.33
Landings with harvest ratio eq. to F0.1 (0.206)	4300.61
Landings potential with 25% removals	5775.21
Landings potential with 20% removals	4620.17
Landings potential with 15% removals	3465.13

Table 3.4.4.7Nephrops, Firth of Forth (FU 8), Nominal Landings of Nephrops, 1981-2005, as officially reported.

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

* provisional   na = not available

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

Table 3.4.4.8Nephrops, Firth of Forth (FU 8): 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 combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	945	42.6	22.2	945	42.6	22.2	na	na	na
1982	1138	51.7	22.0	1138	51.7	22.0	na	na	na
1983	1681	60.7	27.7	1681	60.7	27.7	na	na	na
1984	2078	84.7	24.5	2078	84.7	24.5	na	na	na
1985	1908	73.9	25.8	1908	73.9	25.8	na	na	na
1986	2204	74.7	29.5	2204	74.7	29.5	na	na	na
1987	1582	62.1	25.5	1582	62.1	25.5	na	na	na
1988	2455	94.8	25.9	2455	94.8	25.9	na	na	na
1989	1833	78.7	23.3	1833	78.7	23.3	na	na	na
1990	1901	81.8	23.2	1901	81.8	23.2	na	na	na
1991	1359	69.4	19.6	1231	63.9	19.3	128	5.5	23.3
1992	1714	73.1	23.4	1480	63.3	23.4	198	8.5	23.3
1993	2349	100.3	23.4	2340	100.1	23.4	9	0.2	45.0
1994	1827	87.6	20.9	1827	87.6	20.9	0	0.0	0.0
1995	1708	78.9	21.6	1708	78.9	21.6	0	0.0	0.0
1996	1621	69.7	23.3	1621	69.7	23.3	0	0.0	0.0
1997	2137	71.6	29.8	2137	71.6	29.8	0	0.0	0.0
1998	2105	70.7	29.8	2105	70.7	29.8	0	0.0	0.0
1999	2192	67.7	32.4	2192	67.7	32.4	0	0.0	0.0
2000	1775	75.3	23.6	1761	75.0	23.5	14	0.3	46.7
2001	1484	68.8	21.6	1464	68.3	21.4	20	0.5	40.0
2002	1302	63.6	20.5	1286	63.3	20.3	16	0.3	53.3
2003	1115	53.0	21.0	1082	52.4	20.6	33	0.6	55.0
2004	1651	63.2	26.1	1633	62.9	26.0	18	0.4	49.7
2005*	1973	66.6	29.6	1970	66.5	29.6	3	0.1	58.8

Table 3.4.4.9Nephrops, Firth of Forth (FU 8): Mean sizes (CL mm) above and below 35 mm of male and female Nephrops in Scottish catches and landings, 1991-2005.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1981	na	na	31.5	31.0	39.7	38.7
1982	na	na	30.4	30.1	40.0	39.1
1983	na	na	31.1	30.8	40.2	38.7
1984	na	na	30.3	29.7	39.4	38.4
1985	na	na	30.6	29.9	39.5	38.2
1986	na	na	29.7	29.2	39.1	38.5
1987	na	na	29.9	29.6	39.1	38.2
1988	na	na	28.5	28.5	39.2	39.0
1989	na	na	29.2	28.9	38.7	38.9
1990	28.5	27.5	29.8	28.6	38.3	38.8
1991	28.7	27.5	29.8	28.7	38.3	38.7
1992	29.5	28.0	30.2	28.7	38.1	38.7
1993	28.7	28.0	30.3	29.5	39.0	38.6
1994	25.7	25.1	29.1	28.5	38.8	37.8
1995	27.9	27.1	29.4	28.9	38.7	37.9
1996	28.0	27.4	29.8	28.8	38.6	38.6
1997	27.3	27.0	29.2	28.7	38.8	38.2
1998	27.7	26.4	29.0	27.9	38.6	38.4
1999	27.2	26.5	29.6	28.8	38.0	37.9
2000	28.5	27.2	30.7	29.8	38.2	38.3
2001	28.1	26.7	30.6	29.2	38.0	37.9
2002	27.1	26.3	29.8	29.3	38.3	37.9
2003	27.2	25.5	30.2	29.1	38.1	38.0
2004	28.7	27.8	30.7	29.9	38.4	37.7
2005*	27.6	26.9	30.3	30.0	38.8	38.2

* provisional   na = not available

Table 3.4.4.10 Nephrops, Firth of Forth (FU 8):Summary of TV results for most recent 3 years (2003-2005) showing strata surveyed, numbers of stations in each strata, mean density and observed variance, overall abundance and variance raised to stratum area. Proportion indicates relative amounts of overall raised variance attributable to each stratum.

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2003 TV survey							
M & SM	171	5	0.90	0.32	154	1856	0.330244 0
MS(west)	139	10	0.65	0.23	90	447	0.079472 0
MS(mid)	211	6	0.90	0.29	189	2177	0.387326 0
MS(east)	395	15	0.76	0.11	302	1141	0.202958 0
Total	915	36			735	5620	1
2004 TV survey							
M & SM	171	7	0.66	0.30	112	1232	0.308457 0
MS(west)	139	5	0.30	0.10	42	377	0.094338 0
MS(mid)	211	10	0.82	0.20	172	895	0.223968 0
MS(east)	395	15	0.68	0.14	267	1491	0.373238 0
Total	915	37			594	3995	1
2005 TV survey							
M & SM	171	12	0.86	0.51	147	1223	0.238
MS(west)	139	8	0.43	0.29	60	709	0.138
MS(mid)	211	13	0.99	0.37	209	1276	0.248
MS(east)	395	21	0.70	0.26	277	1942	0.377
Total	915	54			694	5150	1

Table 3.4.11 Nephrops, Firth of Forth (FU 8): Results of the 1993-2005 TV surveys.

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1993	37	0.72	655	167
1994	30	0.58	529	92
1995	no survey			
1996	27	0.48	443	104
1997	no survey			
1998	32	0.38	345	95
1999	49	0.60	546	92
2000	53	0.57	523	83
2001	46	0.54	494	93
2002	41	0.66	600	140
2003	36	0.80	735	150
2004	37	0.65	594	126
2005	54	0.76	694	144

Table 3.4.4.12Nephrops, Firth of Forth (FU 8): Predicted landings potential based on abundance estimates using TV surveys, current landings and discard length distributions for the Firth of Forth, and a range of harvest ratios.

Males — Weight = a*CL^b; a = 0.00028; b = 3.24

Females — a = 0.00085; b = 2.91

Males CL	Landings ('000)	Discards ('000)	Removals ('000)	wt (g)	Landings (t)	Females CL	Landings ('000)	Discards ('000)	Removals ('000)	wt (g)	Landings (t)
11	0.0	3.9	2.9	0.88	0.00	11	0.0	0.0	0.0	1.17	0.00
13	0.0	6.8	5.1	1.45	0.00	13	0.0	9.7	7.3	1.84	0.00
15	2.1	60.9	47.8	2.23	4.69	15	0.1	207.4	155.7	2.71	0.27
17	11.6	667.1	511.9	3.27	37.91	17	0.3	835.0	626.6	3.82	1.15
19	55.0	2402.5	1856.9	4.60	252.85	19	43.7	2835.7	2170.5	5.19	226.93
21	277.5	4618.2	3741.2	6.26	1737.28	21	236.8	4741.9	3793.2	6.85	1622.75
23	860.0	6873.8	6015.4	8.30	7137.41	23	928.1	7648.3	6664.3	8.83	8192.73
25	2892.1	7526.0	8536.6	10.76	31108.92	25	2849.7	7101.5	8175.8	11.14	31753.42
27	5953.4	3747.9	8764.3	13.68	81417.00	27	4850.1	3521.7	7491.4	13.82	67050.11
29	8184.3	1117.0	9022.1	17.10	139962.74	29	5752.3	928.3	6448.5	16.90	97203.81
31	8376.4	269.4	8578.5	21.08	176563.68	31	4898.3	112.1	4982.4	20.39	99873.61
33	7058.9	59.2	7103.3	25.65	181086.78	33	3744.4	18.3	3758.1	24.32	91076.18
35	5056.4	2.1	5058.0	30.87	156105.99	35	2356.4	9.1	2363.2	28.72	67687.46
37	2986.8	2.0	2988.3	36.78	109865.93	37	1347.3	5.4	1351.4	33.62	45295.34
39	1810.6	0.0	1810.6	43.43	78642.07	39	648.8	0.0	648.8	39.03	25323.54
41	1016.7	0.0	1016.7	50.87	51722.39	41	307.4	0.0	307.4	44.99	13828.60
43	544.1	0.0	544.1	59.15	32182.77	43	133.6	0.0	133.6	51.51	6881.33
45	272.6	0.0	272.6	68.31	18621.70	45	71.0	0.0	71.0	58.62	4162.00
47	126.0	0.0	126.0	78.41	9879.85	47	30.0	0.0	30.0	66.35	1990.45
49	55.9	0.0	55.9	89.50	5003.02	49	12.1	0.0	12.1	74.72	904.08
51	21.4	0.0	21.4	101.63	2174.82	51	7.1	0.0	7.1	83.75	594.63
53	8.2	0.0	8.2	114.85	941.73	53	2.4	0.0	2.4	93.47	224.33
55	2.0	0.0	2.0	129.21	258.41	55	2.1	0.0	2.1	103.91	218.21
57	0.5	0.0	0.5	144.77	72.38	57	0.4	0.0	0.4	115.08	46.03
59	0.4	0.0	0.4	161.57	64.63	59	0.1	0.0	0.1	127.01	12.70
61	0.1	0.0	0.1	179.68	17.97	61	0.0	0.0	0.0	139.73	0.00
63	0.0	0.0	0.0	199.15	0.00	63	0.0	0.0	0.0	153.25	0.00
65	0.0	0.0	0.0	220.03	0.00	65	0.0	0.0	0.0	167.61	0.00
67	0.1	0.0	0.1	242.37	24.24	67	0.0	0.0	0.0	182.82	0.00
69	0.0	0.0	0.0	266.24	0.00	69	0.0	0.0	0.0	198.91	0.00
Total			66090.70		1084.89				49203.30		564.17

Removals (M+F 000s) 115294.00 Land Wt 1649.06

TV abundance (thousands) 674141.26

Predicted Landings = Land Wt * TV abundance * harvest rate / removals

Predicted Landings (tonnes)

Landings with harvest ratio eq. Fmax (0.37)	3001.98
Landings with harvest ratio eq. to F0.1 (0.21)	2019.37
Landings potential with 25% harvest rate	2410.57
Landings potential with 20% harvest rate	1928.46
Landings potential with 15% harvest rate	1446.34

Table 3.4.5.1Nephrops Management Area H (North Sea South East): Total Nephrops landings (tonnes) by Functional Unit plus Other rectangles, 1991-2005.

Year	FU 5	FU 33	Other	Total
1991	862	74	88	1023
1992	611	76	48	736
1993	721	160	64	945
1994	503	137	41	682
1995	869	165	200	1234
1996	679	77	165	921
1997	1150	277	128	1554
1998	1071	350	219	1640
1999	1185	725	294	2204
2000	1070	600	308	1978
2001	1329	759	340	2429
2002	1142	839	437	2418
2003	1120	911	426	2457
2004	1054	1227	340	2621
2005*	1015	994	304	2313
* provisional na = not available				

Table 3.4.5.2Nephrops Botney Gut - Silver Pit (FU 5): Landings (tonnes) by country, 1991-2005.

Year	Belgium	Denmark	Netherl.	UK	Total **
1991	682	176	na	4	***862***
1992	571	22	na	19	***611***
1993	694	20	na	7	***721***
1994	494	0	na	9	***503***
1995	641	77	148	3	***869***
1996	266	41	317	55	***679***
1997	486	67	540	56	***1150***
1998	372	88	584	28	***1071***
1999	436	53	538	158	***1185***
2000	366	83	402	218	***1070***
2001	353	145	553	278	***1329***
2002	281	94	617	151	***1142***
2003	265	36	661	158	***1120***
2004	171	39	646	198	***1054***
2005 *	117	87	654	144	***1015***
* provisional na = not available					
** Totals for 1991-94 exclusive of landings by the Netherlands					

Table 3.4.5.3Nephrops Botney Gut - Silver Pit (FU 5): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Belgian Nephrops trawlers, 1991-2005. Dutch trawlers 2000 – 2005 and Danish trawlers 1996 -2005

Year	Belgium (1)			Netherlands (2)			Denmark (3)		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
	tons	'000 hrs	kg/hour	tons	days at sea	kg/day	tons	days at sea	kg/day
1991	566	74.0	7.7						
1992	525	74.5	7.0						
1993	672	58.3	11.5						
1994	453	35.5	12.7						
1995	559	32.5	17.2						
1996	245	30.1	8.1				34	132	261.0
1997	399	31.8	12.5				24	59	412.0
1998	309	28.6	10.8				78	174	447.0
1999	322	31.8	10.1				44	107	408.0
2000	174	21.8	8.0	402	7936	50.7	76	247	306.0
2001	195	21.5	9.1	553	9797	56.5	78	283	275.0
2002	144	15.8	9.1	617	8999	68.6	47	200	237.0
2003	118	6.2	19.3	661	9043	73.1	33	132	247.3
2004	106	5.7	18.8	646	8676	74.5	36	149	241.9
2005 *	69	2.9	23.9	654	7912	82.7	77	266	290.9

* provisional na = not available

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

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

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

Table 3.4.5.4 Nephrops Botney Gut - Silver Pit (FU 5): Mean sizes of Nephrops > 35 mm CL landed by Belgian Nephrops trawlers, 1991-2005.

Year	Landings	
	Males	Females
1991	40.8	41.3
1992	40.9	40.9
1993	41.0	40.9
1994	40.3	40.6
1995	40.7	39.8
1996	41.3	39.4
1997	41.2	39.0
1998	41.0	39.2
1999	40.9	39.5
2000	40.8	39.9
2001	40.3	39.7
2002	39.7	39.3
2003	40.5	39.3
2004	40.1	39.9
2005 *	40.2	39.5

* provisional na = not available

Table 3.4.5.5 Nephrops Off Horn Reef (FU 33): Landings (tonnes) by country, 1993-2005.

Year	Belgium	Denmark	Netherl.	UK	Total **
1993	0	159	na	1	160
1994	0	137	na	0	137
1995	3	158	3	1	164
1996	1	74	2	0	77
1997	0	274	2	0	276
1998	4	333	12	1	350
1999	22	683	12	6	724
2000	13	537	39	9	597
2001	52	667	61	+	780
2002	21	772	51	4	848
2003	15	842	67	1	925
2004	37	1097	109	1	1244
2005*	0	803	191	0	994

* provisional   na = not available

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

Table 3.4.5.6Nephrops Off Horns Reef (FU 33): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching Nephrops with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1993-2005.

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

* provisional   na = not available

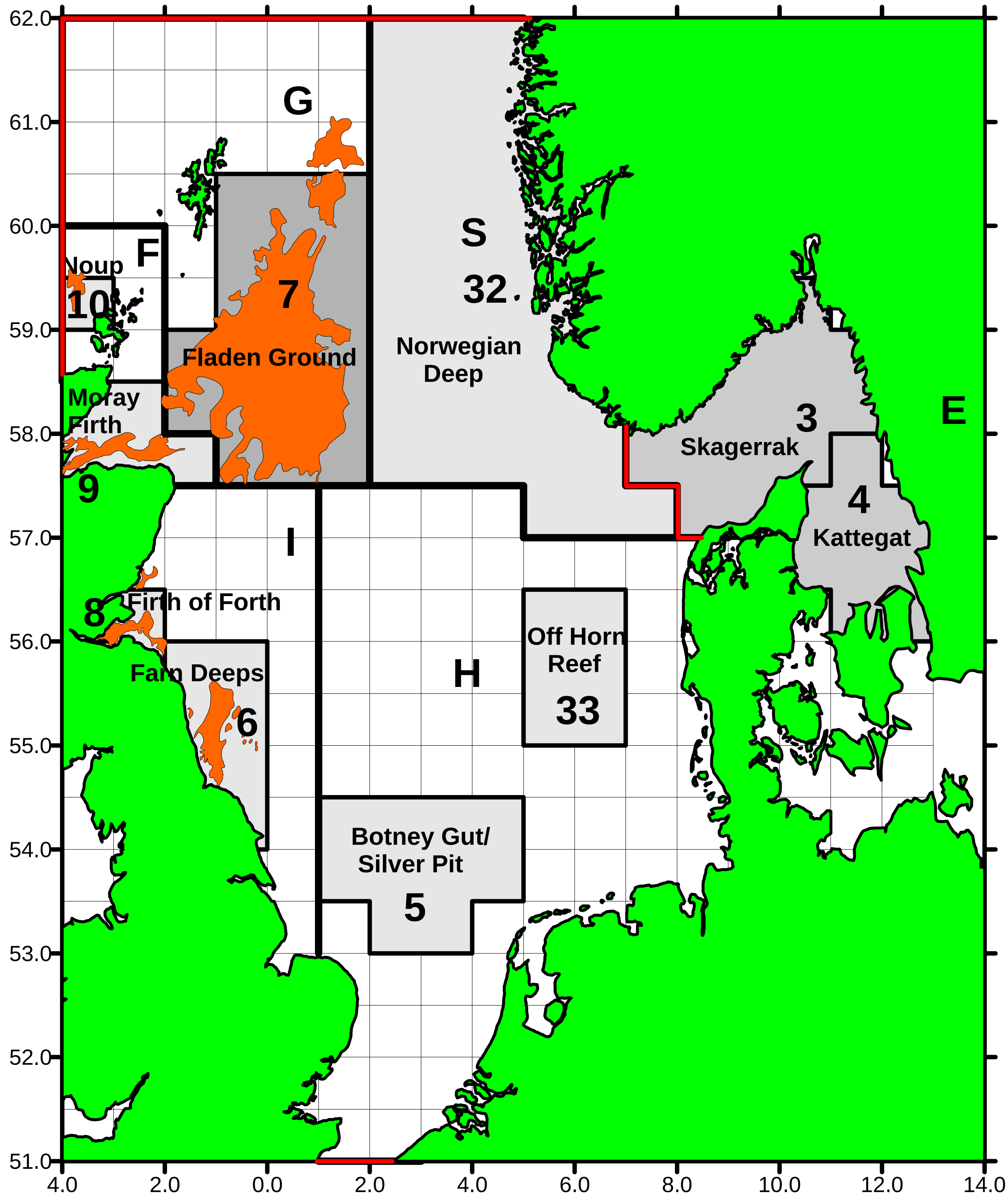


Figure 3.1.1 Nephrops Functional Units and Management Areas in the North Sea and Skagerrak/Kattegat region.

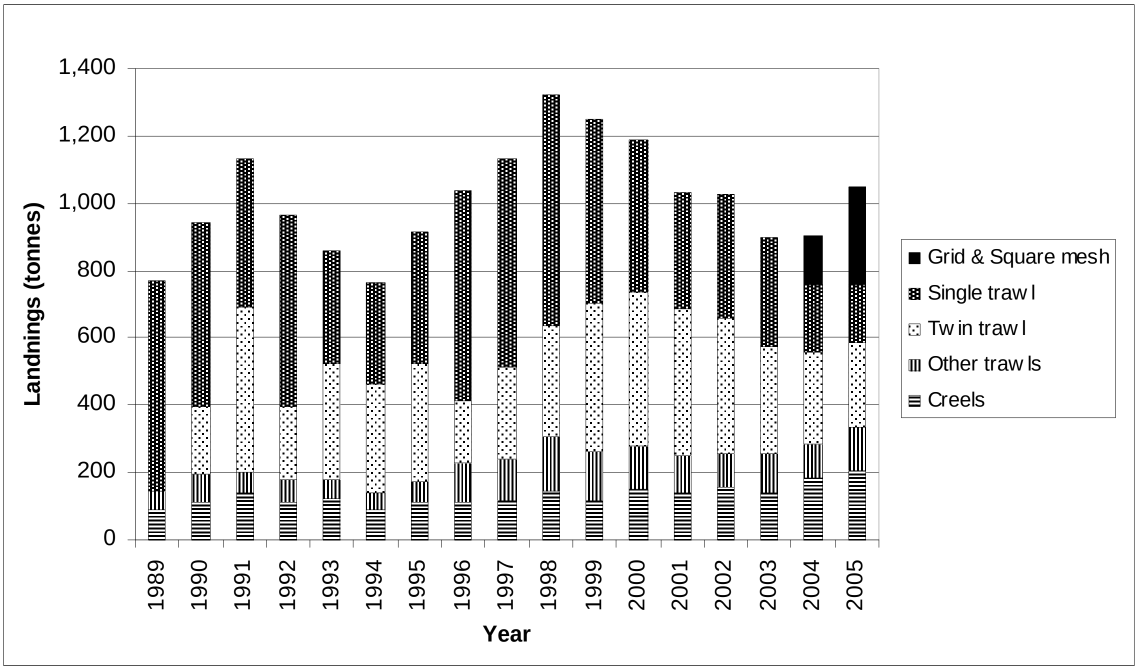


Figure 3.2.1.1 Nephrops Swedish Nephrops landings from MAIIIa by gear 1989-2005

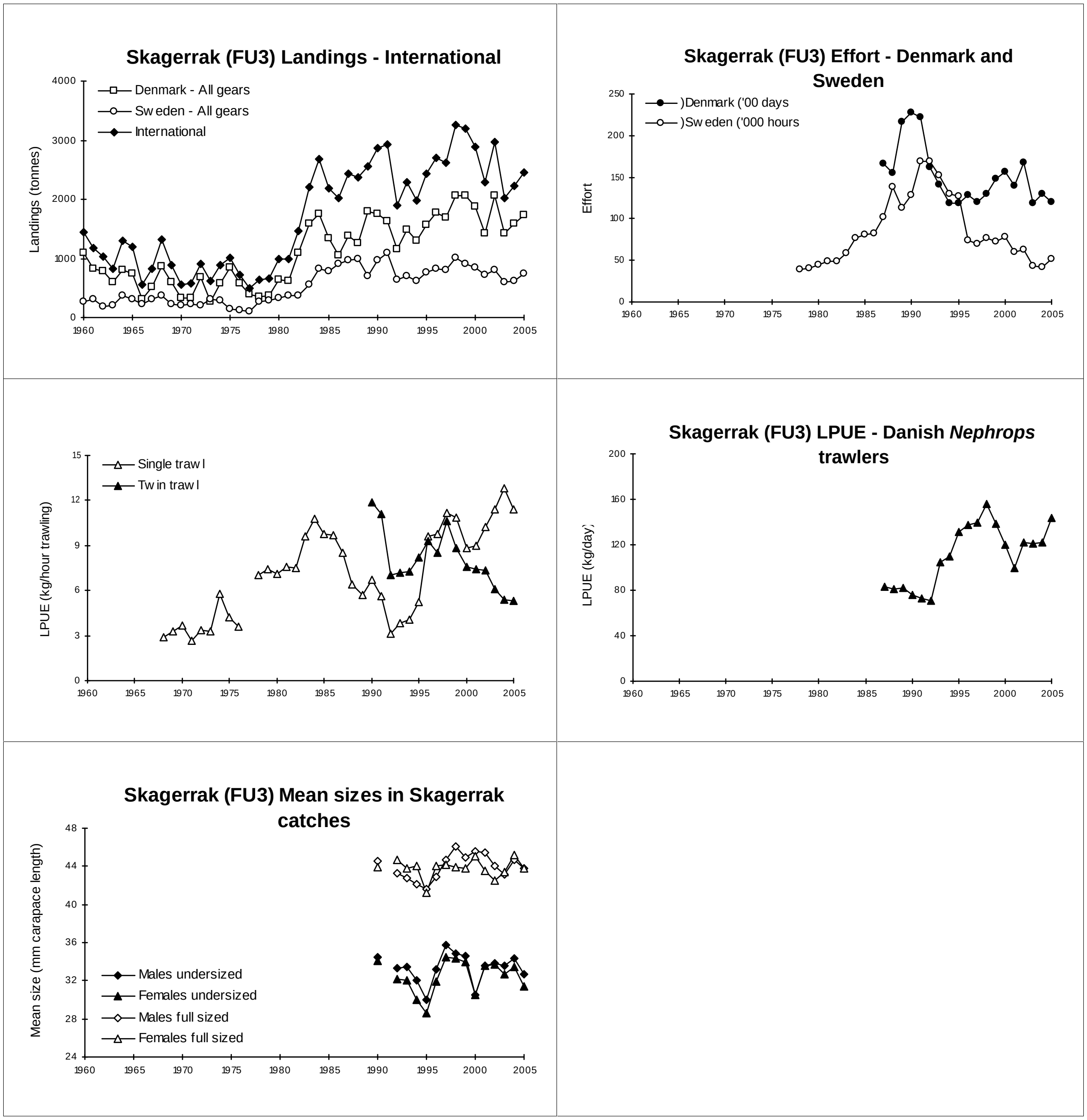


Figure 3.2.1.2 Nephrops Skagerrak (FU 3): Long-term trends in landings, effort, LPUEs, and mean sizes of Nephrops.

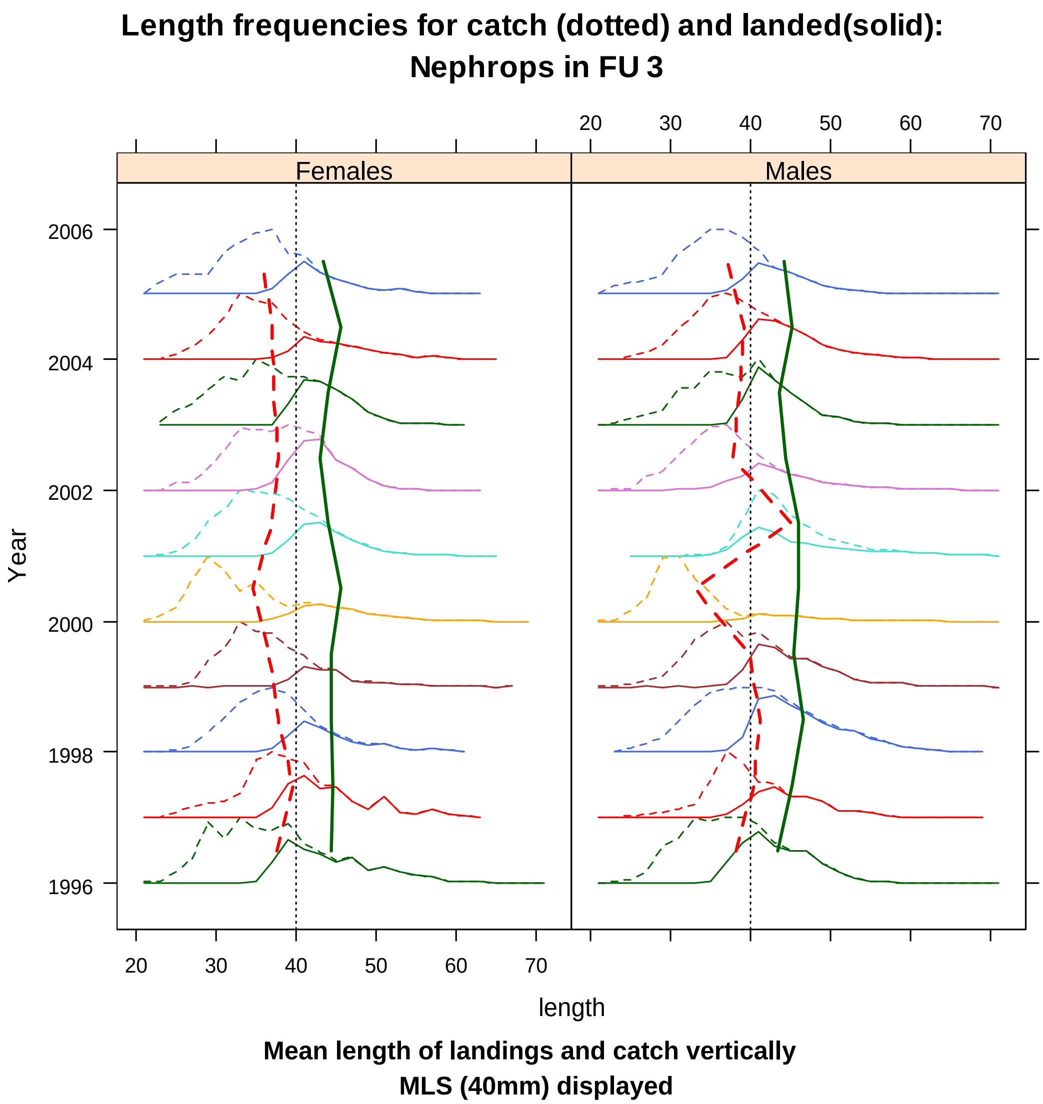


Figure 3.2.1.3 Nephrops Skagerrak (FU 3)Length composition of catch (dotted) and landed (solid) of males (right) and females left from 1996 (bottom) to 200 (top). Mean sizes of catch and landings (using same line types) is shown in relation to MLS

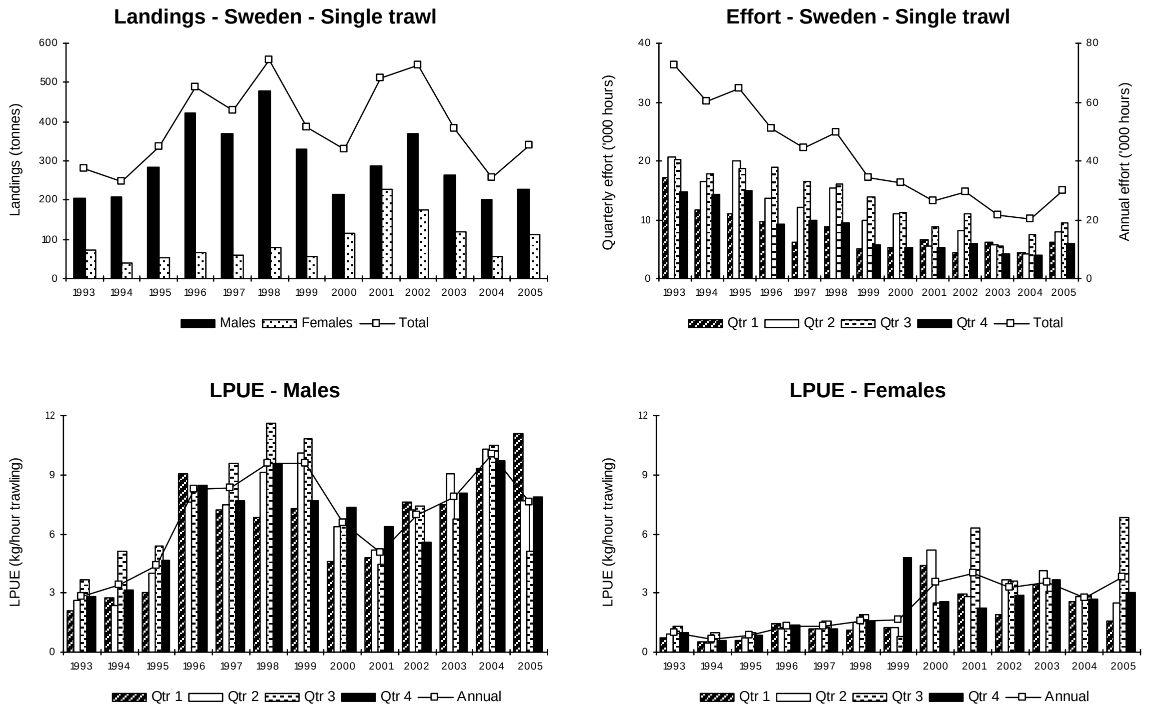


Figure 3.2.1.4 Nephrops Skagerrak (FU 3): Landings, effort and LPUEs by quarter and sex from Swedish Nephrops trawlers - Single trawl.

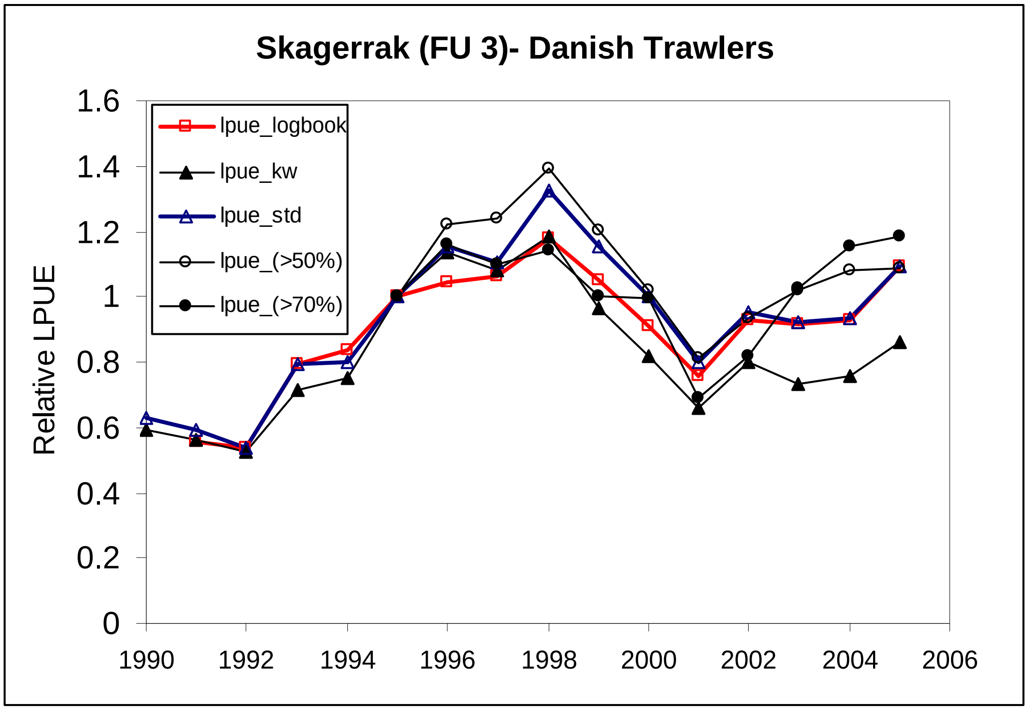


Figure 3.2.1.5. Nephrops Skagerrak (FU 3): Analysis of Danish LPUE in FU3. LPUE indices relative to 1995 (see text)

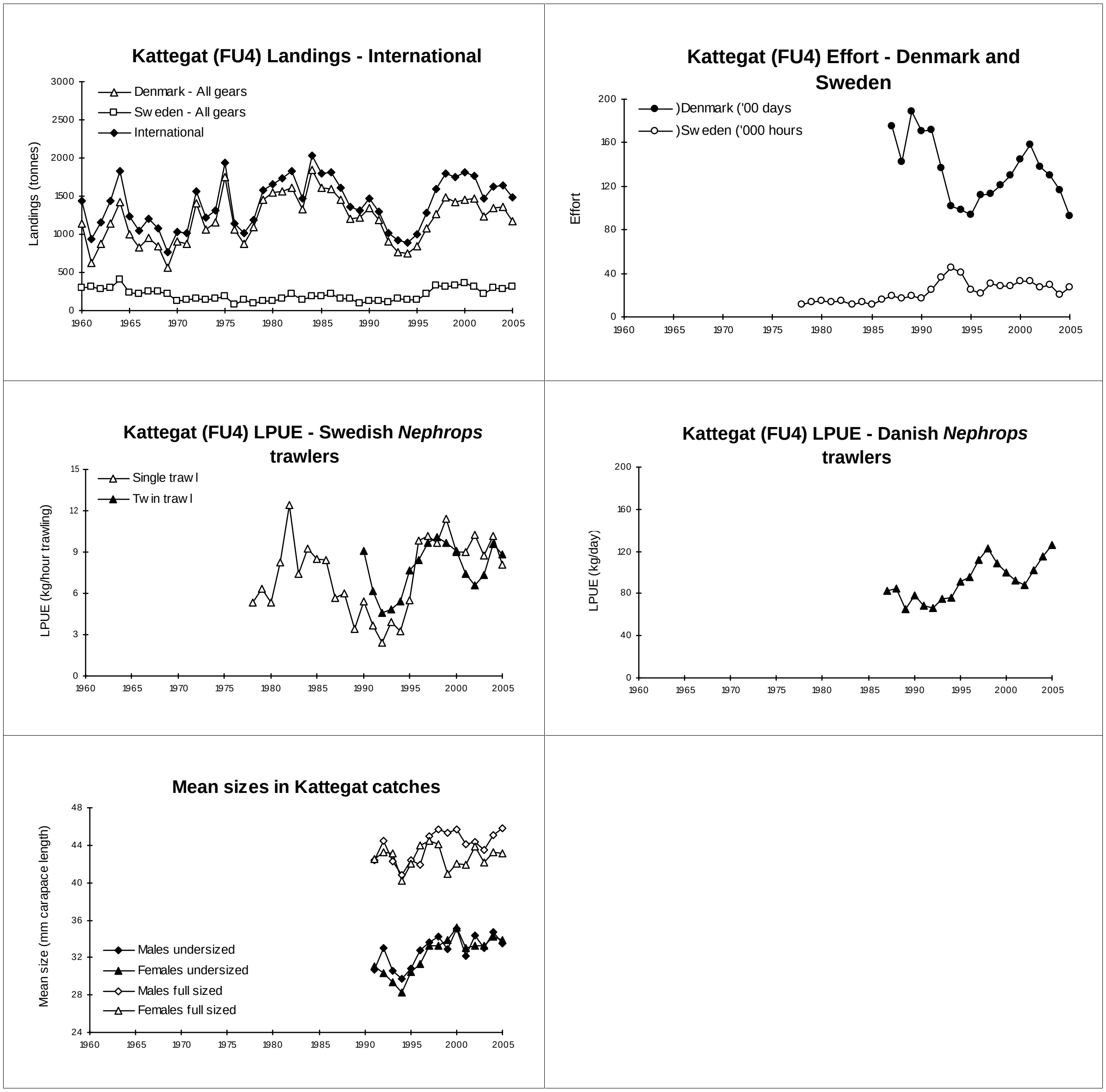


Figure 3.2.1.6 Nephrops Kattegat (FU 4): Long-term trends in landings, effort, LPUEs, and mean sizes of Nephrops.

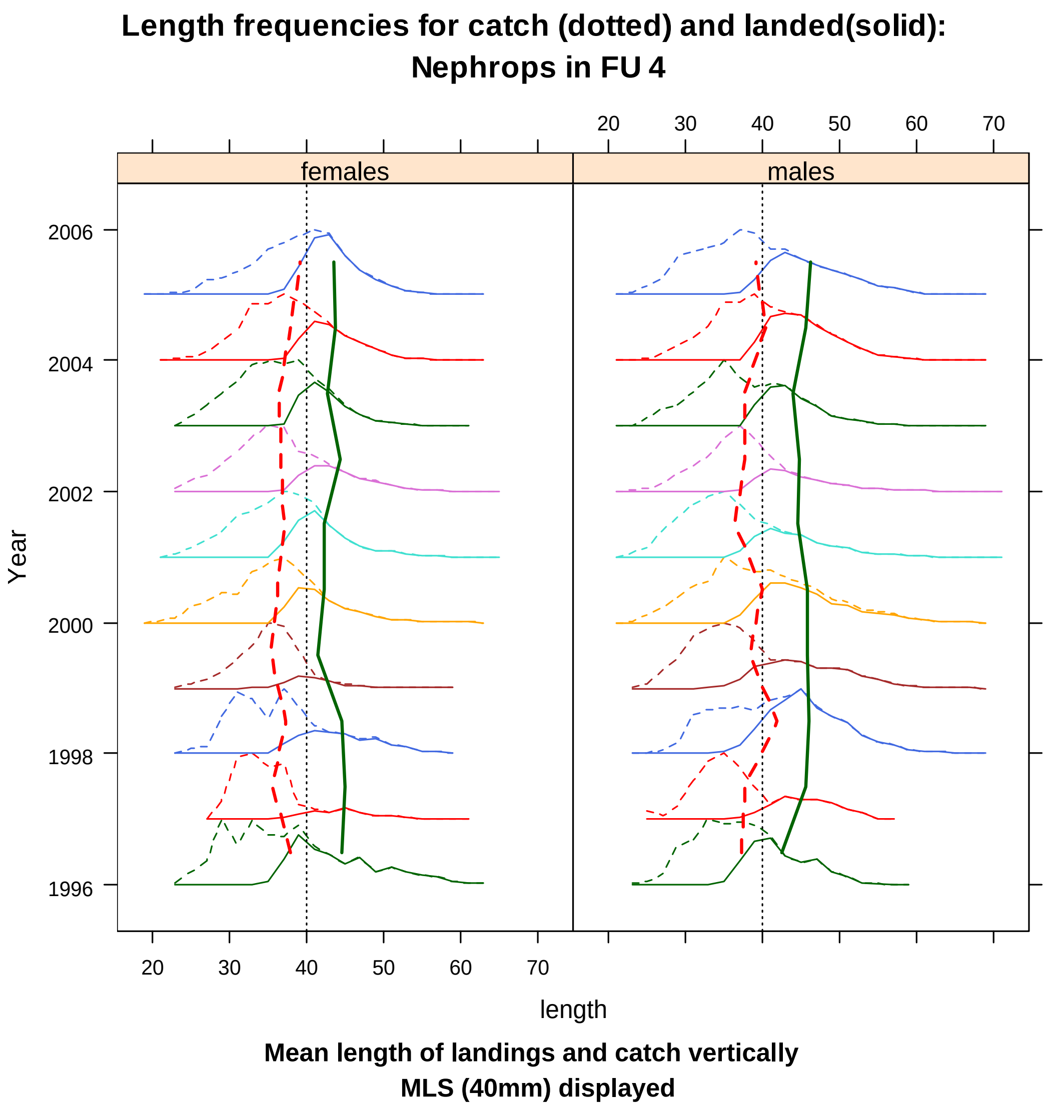


Figure 3.2.1.7 Nephrops Kattegat (FU 4)Length composition of catch (dotted) and landed (solid) of males (right) and females left from 1996 (bottom) to 2005 (top). Mean sizes of catch and landings (using same line types) is shown in relation to MLS

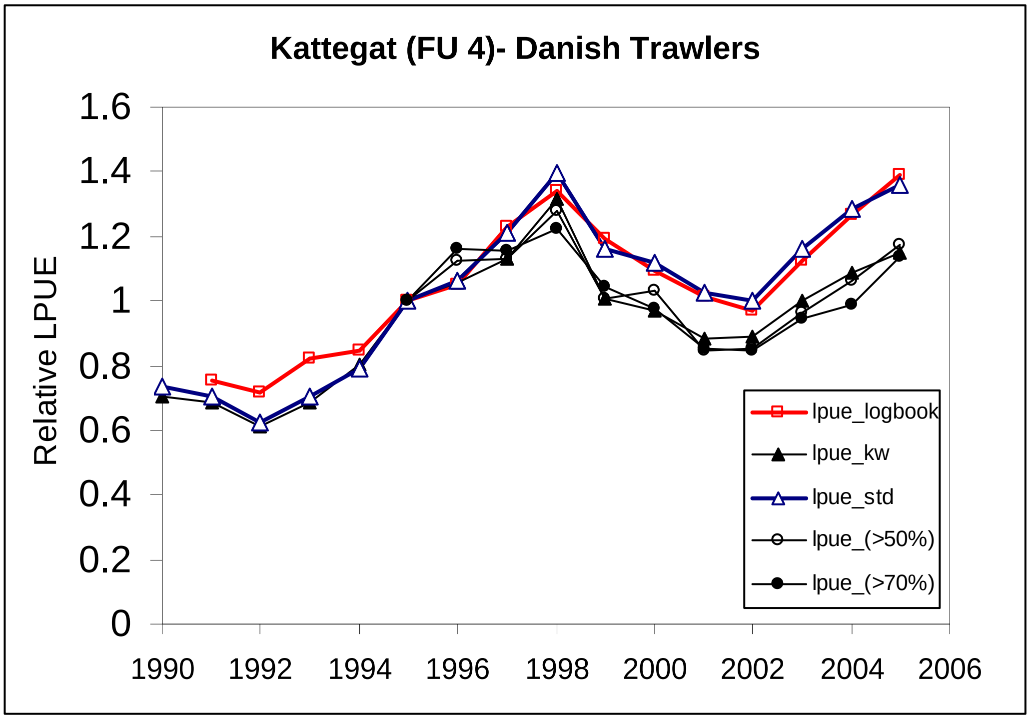


Figure 3.2.1.8. Nephrops Kattegat (FU 4): Analysis of Danish LPUE in FU3. LPUE indices relative to 1995 (see text)

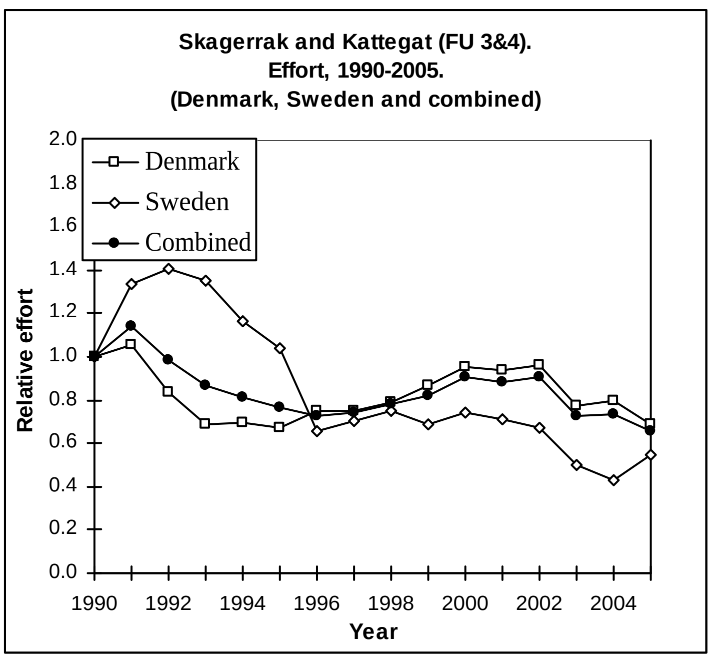


Figure 3.2.1.9 Nephrops Skagerrak (FU3) and Kattegat (FU4) Relative changes in effort

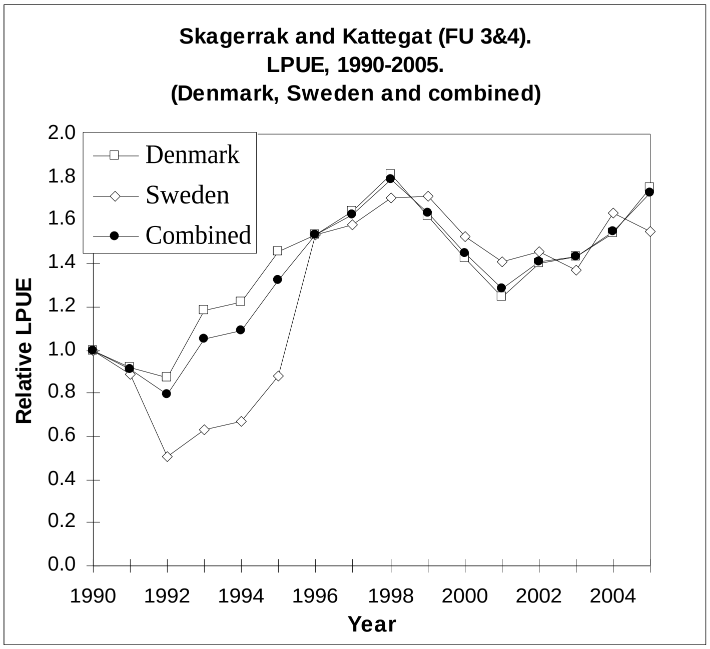


Figure 3.2.1.10 Nephrops Skagerrak (FU3) and Kattegat (FU4) Relative changes in LPUE

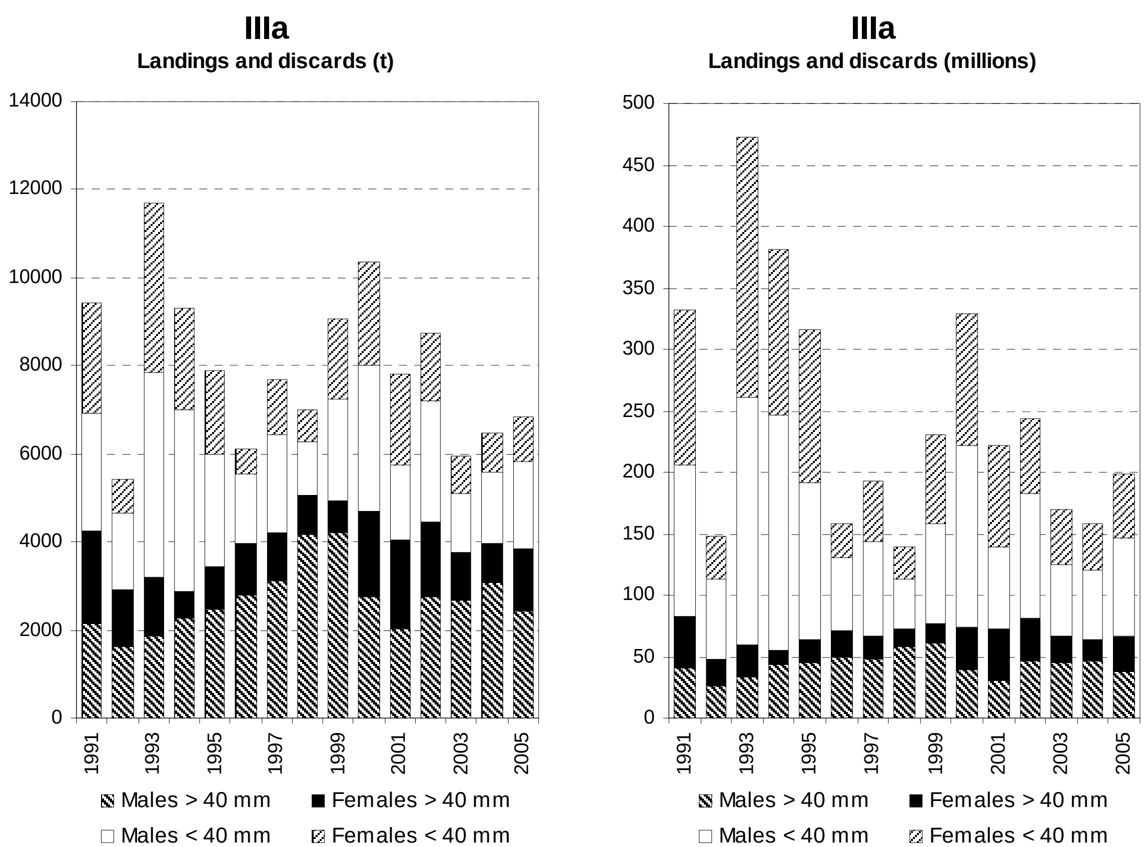


Figure 3.2.1.11 Nephrops Skagerrak (FU 3) and Kattegat (FU 4): Composition of Nephrops catches, split by catch fraction (landings and discards) and by sex, 1991-2005 (Skagerrak) and 1991-2004 (Kattegat).

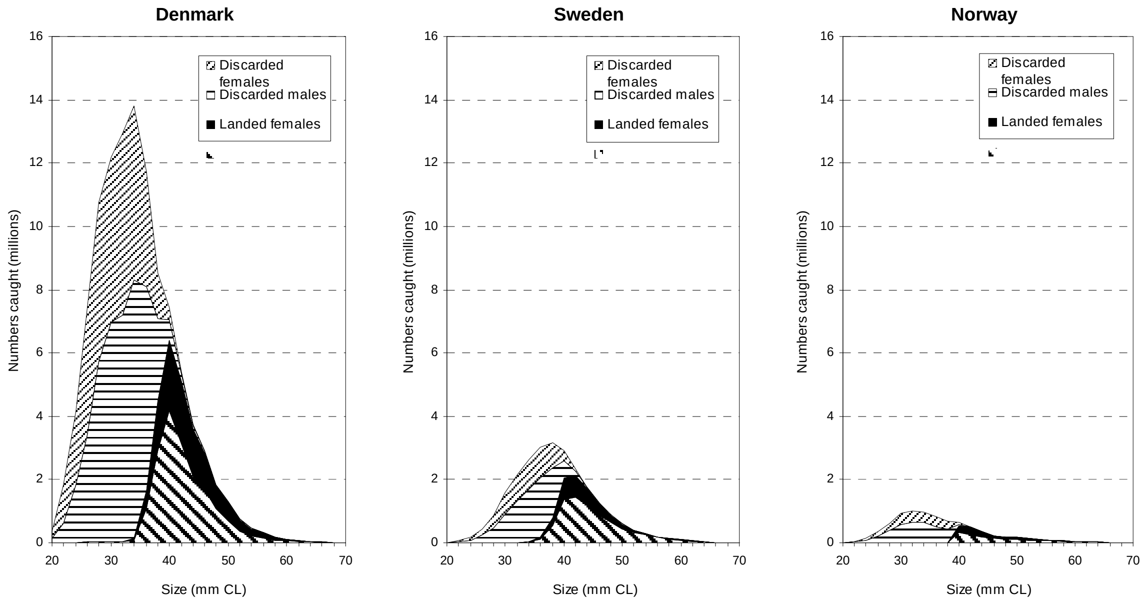


Figure 3.2.1.12 Nephrops Skagerrak (FU 3): Length frequency distributions of Nephrops catches, split by catch fraction (landings and discards) and sex. Data for Denmark, Sweden and Norway shown separately. Average for 1990-2005 (Denmark and Sweden) and 1991-2002 (Norway).

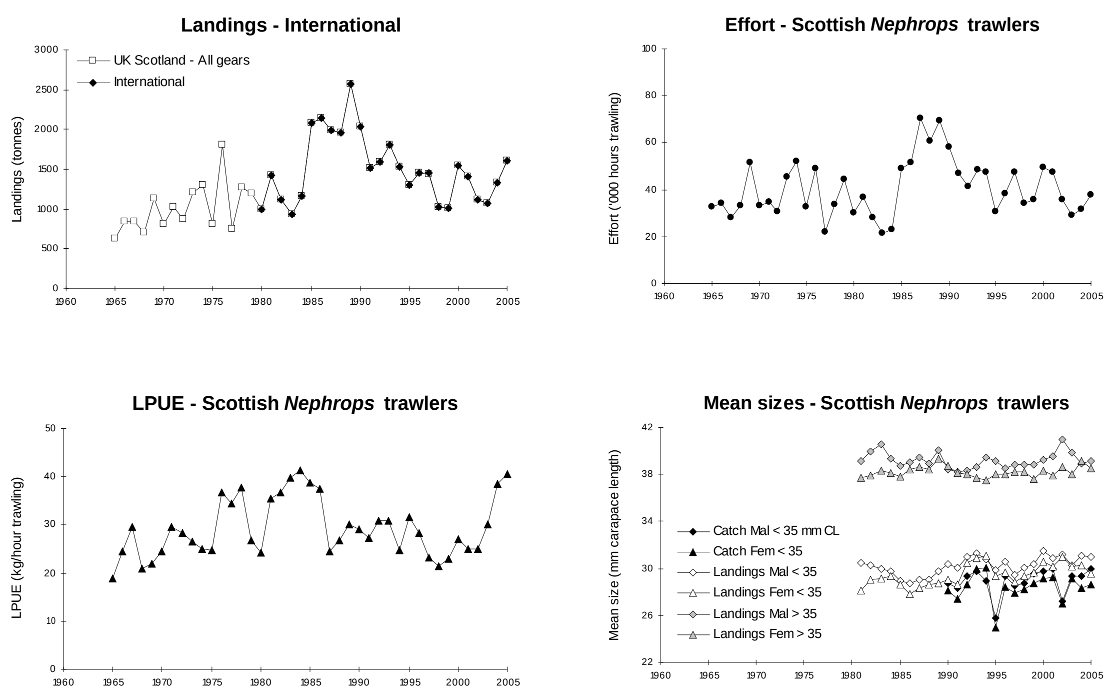


Figure 3.4.1.1 Nephrops, Moray Firth (FU 9), Long term landings, effort, LPUE and mean sizes.

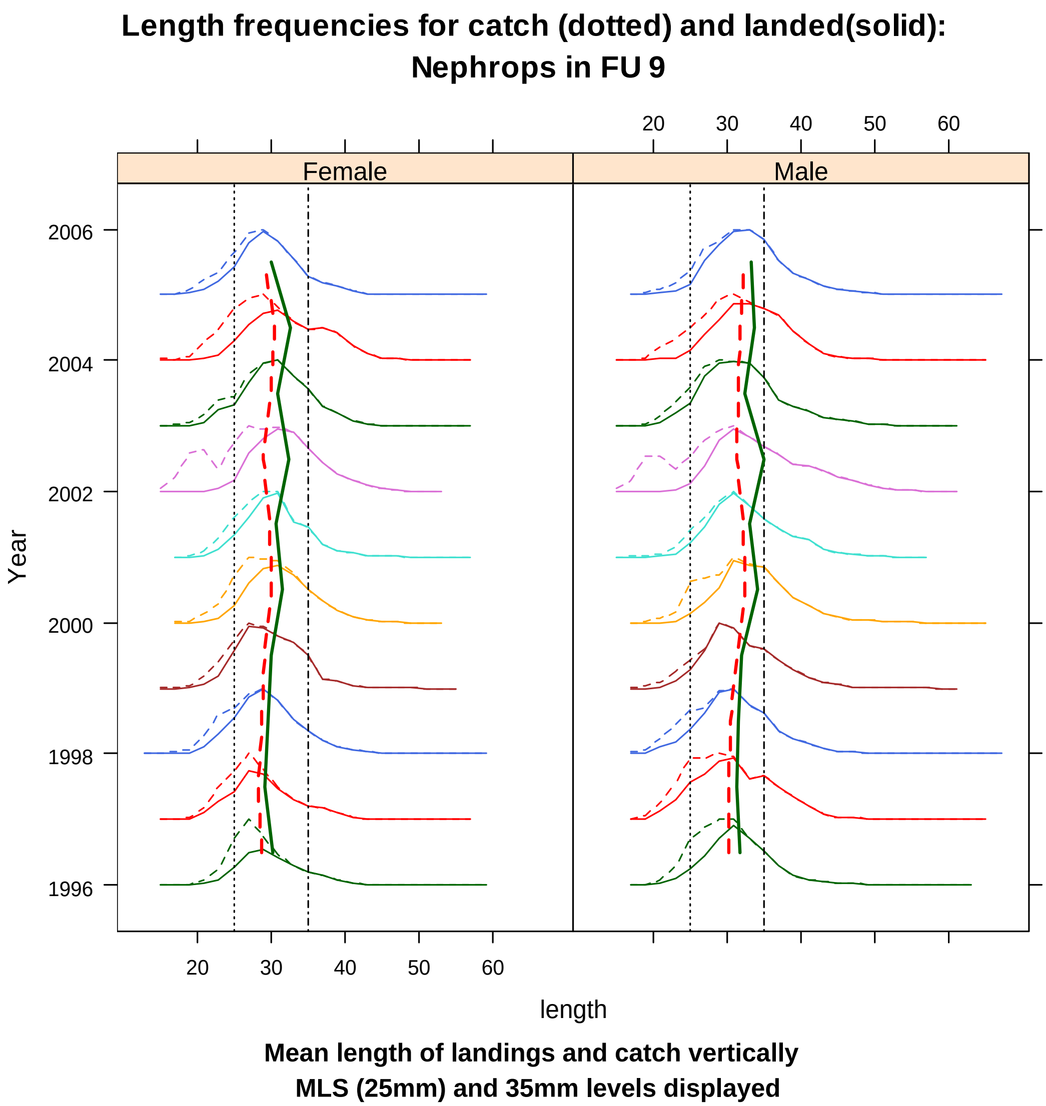


Figure 3.4.1.2 Nephrops Moray Firth (FU 9)Length composition of catch (dotted) and landed (solid) of males (right) and females left from 1996 (bottom) to 2005 (top). Mean sizes of catch and landings (using same line types) is shown in relation to MLS

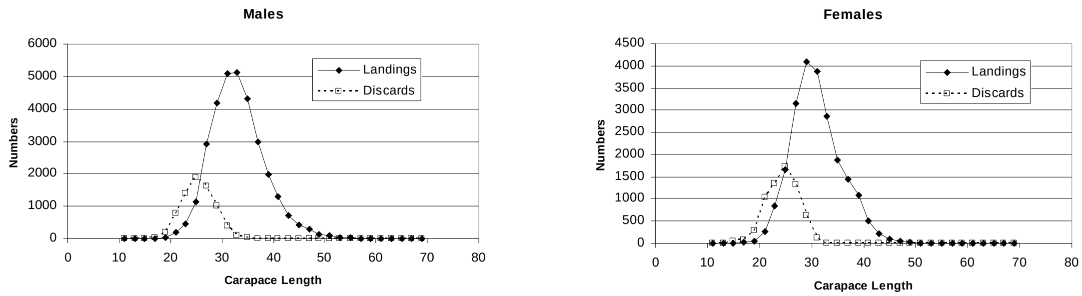


Figure 3.4.1.3 Nephrops, Moray Firth (FU 9), Length frequency distributions of male and female landings and discards, averaged over 2003 – 2005.

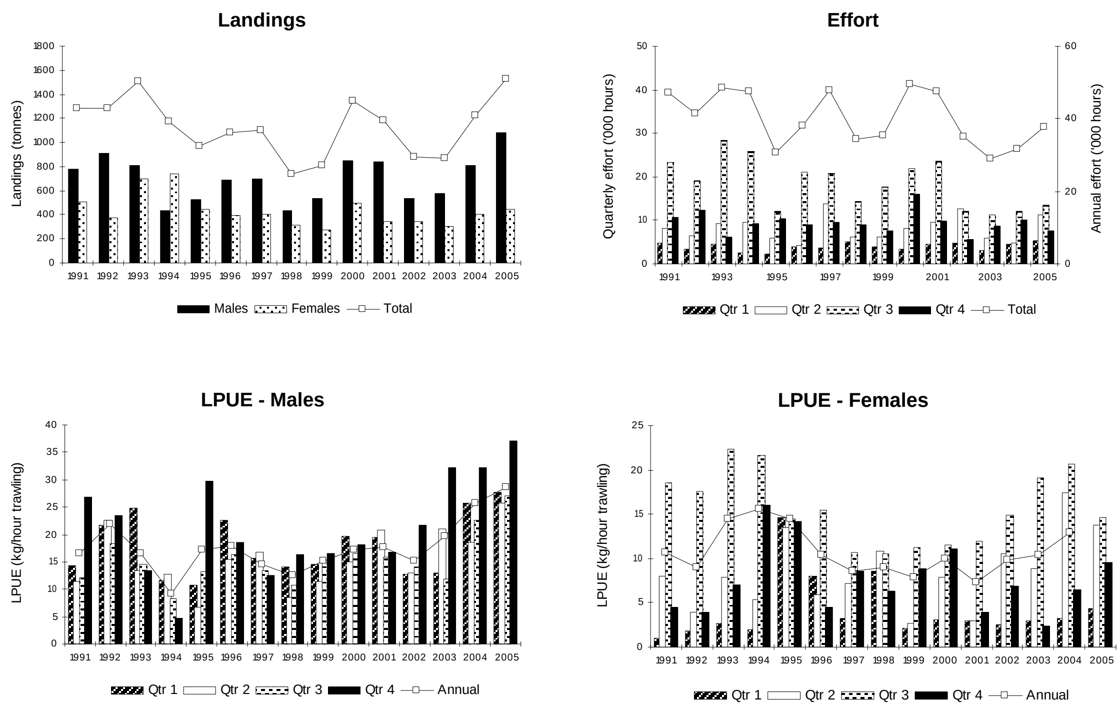


Figure 3.4.1.4 Nephrops, Moray Firth (FU 9), Landings, effort and LPUEs by quarter and sex from Scottish Nephrops trawlers.

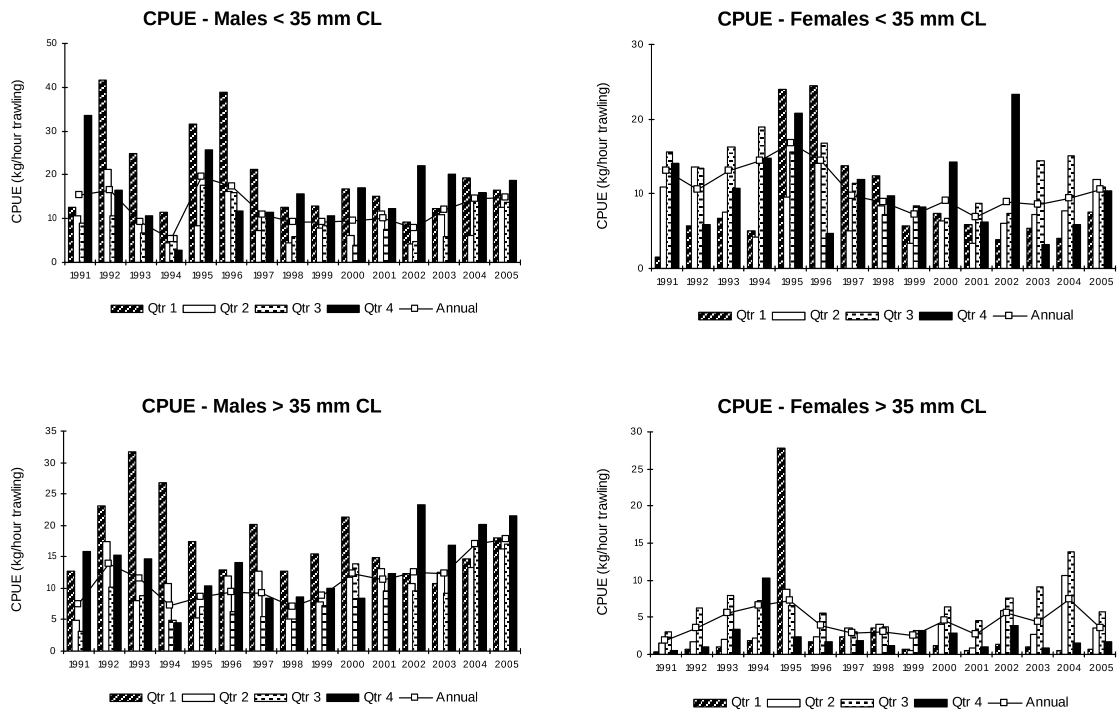


Figure 3.4.1.5 Nephrops, Moray Firth (FU 9), CPUEs by sex and quarter for selected size groups, Scottish Nephrops trawlers.

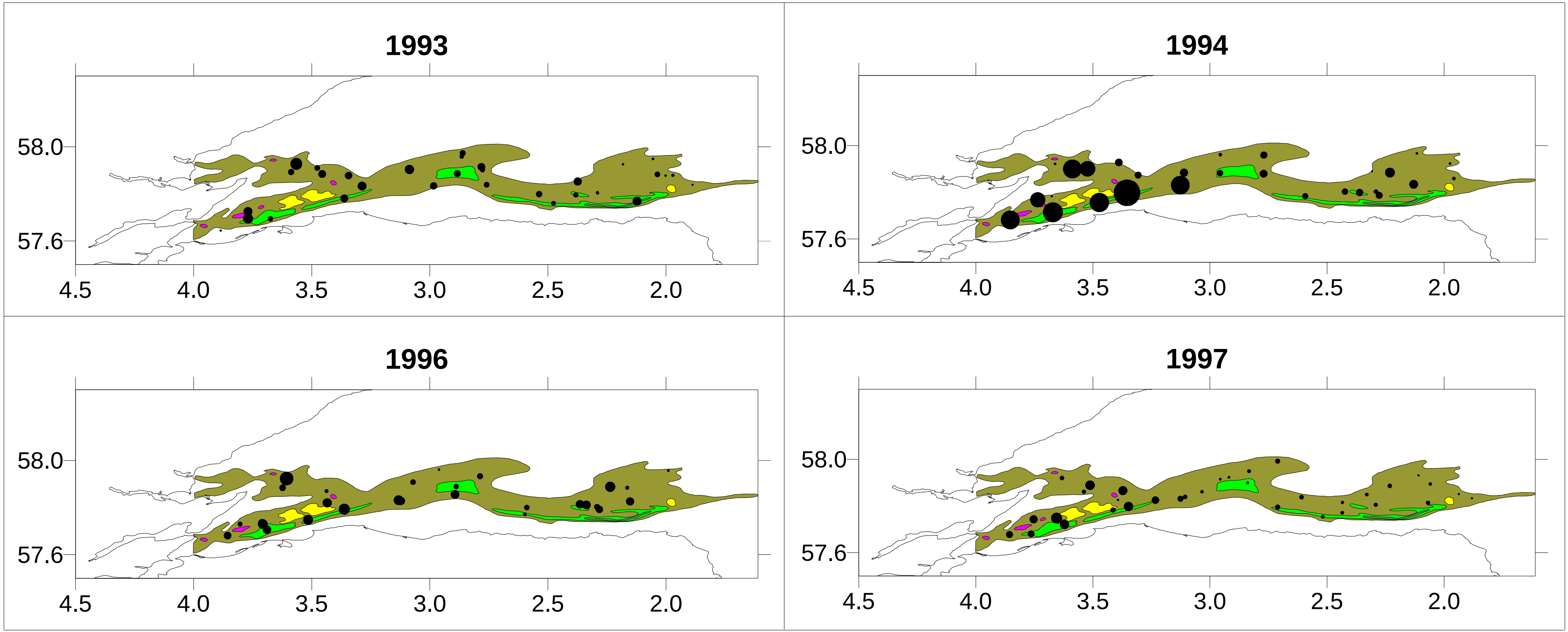


Figure 3.4..1.6 Nephrops, Moray Firth (FU 9), TV survey station distribution and relative density, 1993 – 1997. (no survey in 1995) Green and brown areas represent areas of suitable sediment for Nephrops.

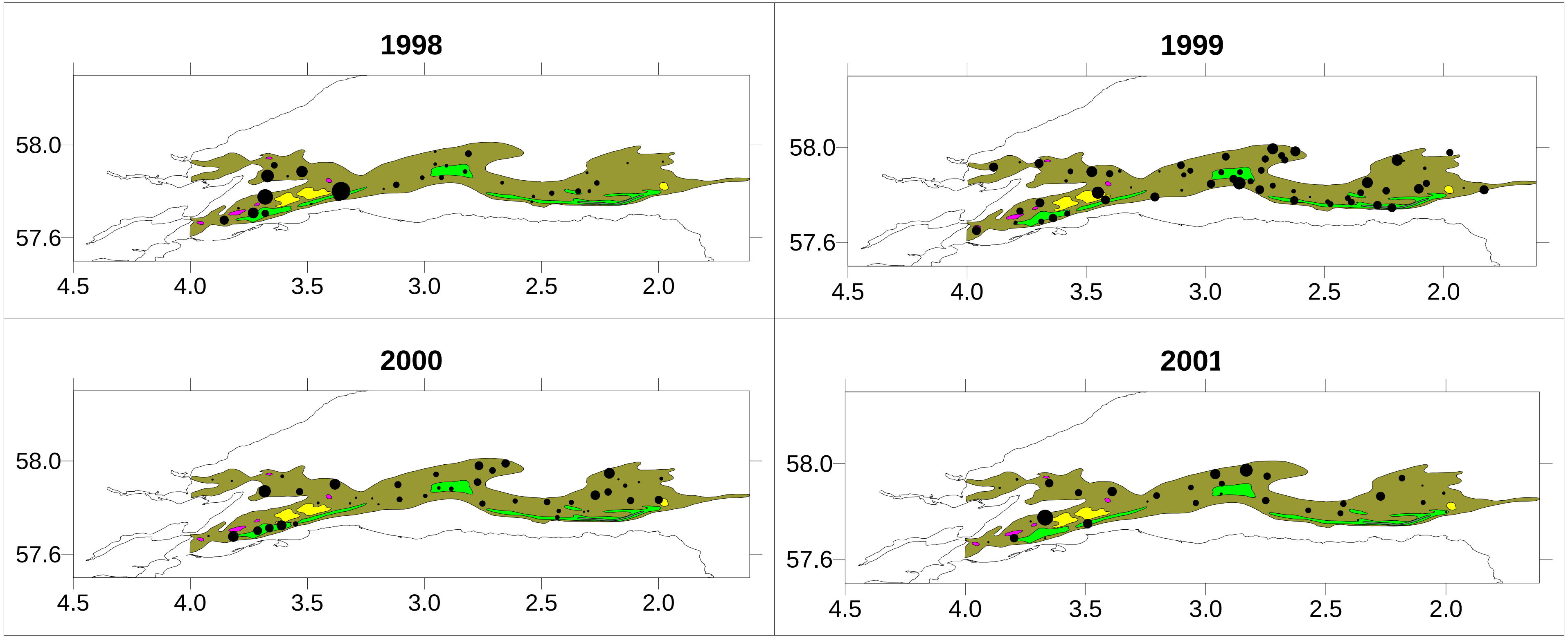


Figure 3.4.1.6cont Nephrops, Moray Firth (FU 9), TV survey station distribution and relative density, 1998 – 2001. Green and brown areas represent areas of suitable sediment for Nephrops.

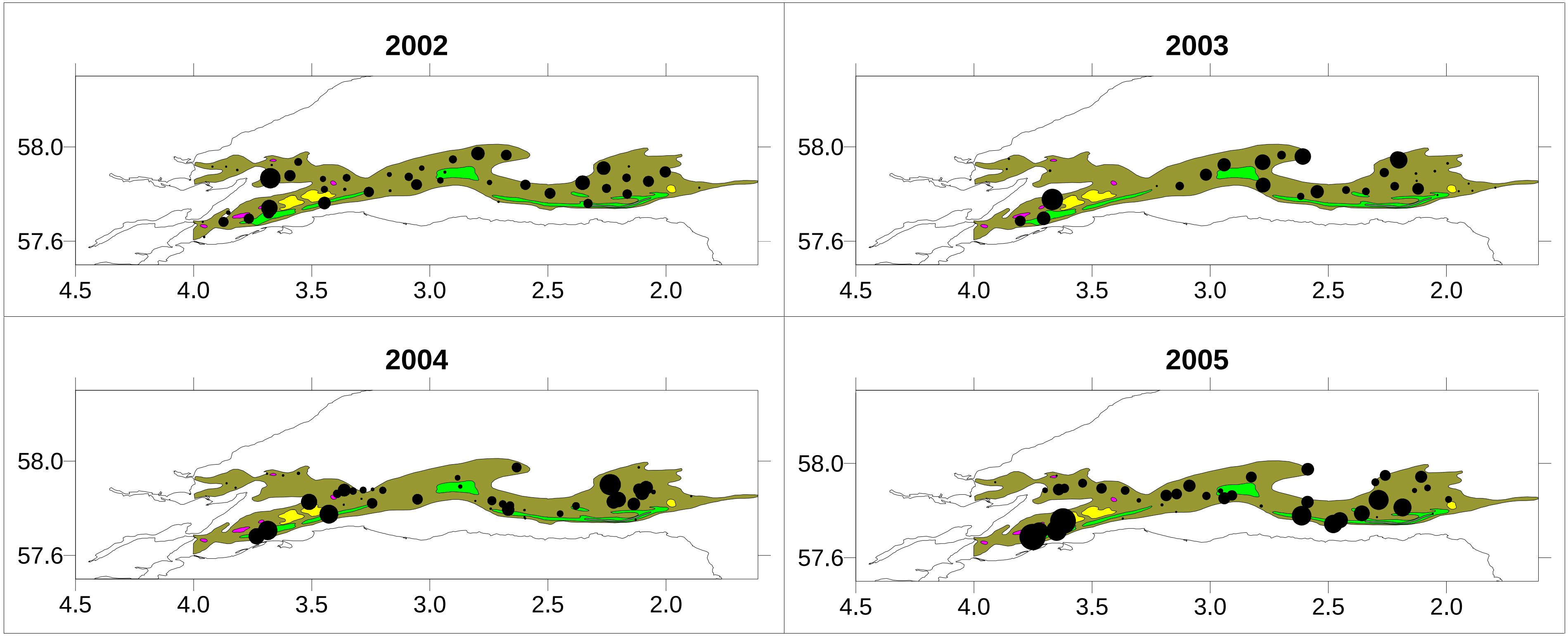


Figure 3.4.1.6 cont Nephrops, Moray Firth (FU 9), TV survey station distribution and relative density, 2002 – 2005. Green and brown areas represent areas of suitable sediment for Nephrops.

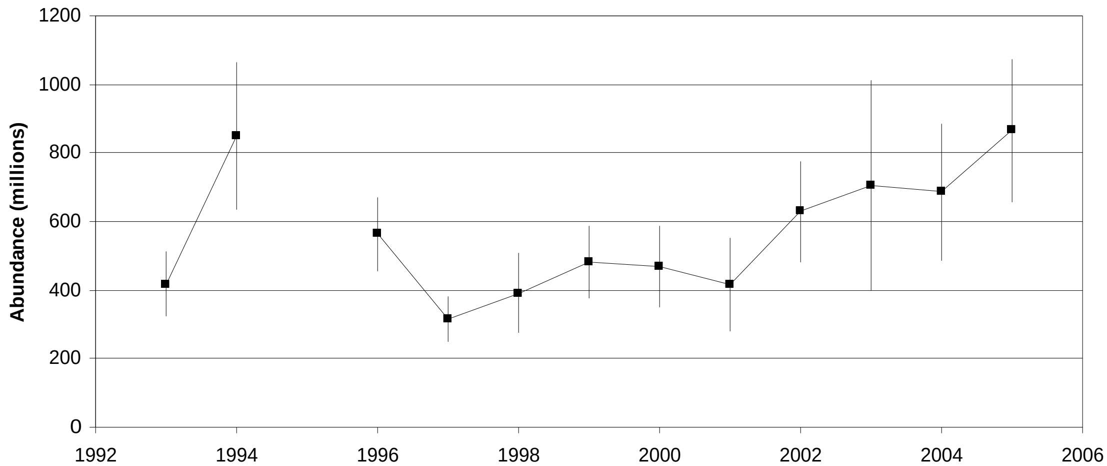


Figure 3.4.1.7 Nephrops, Moray Firth (FU 9), Time series of TV survey abundance estimates, with 95% confidence intervals, 1993 – 2005.

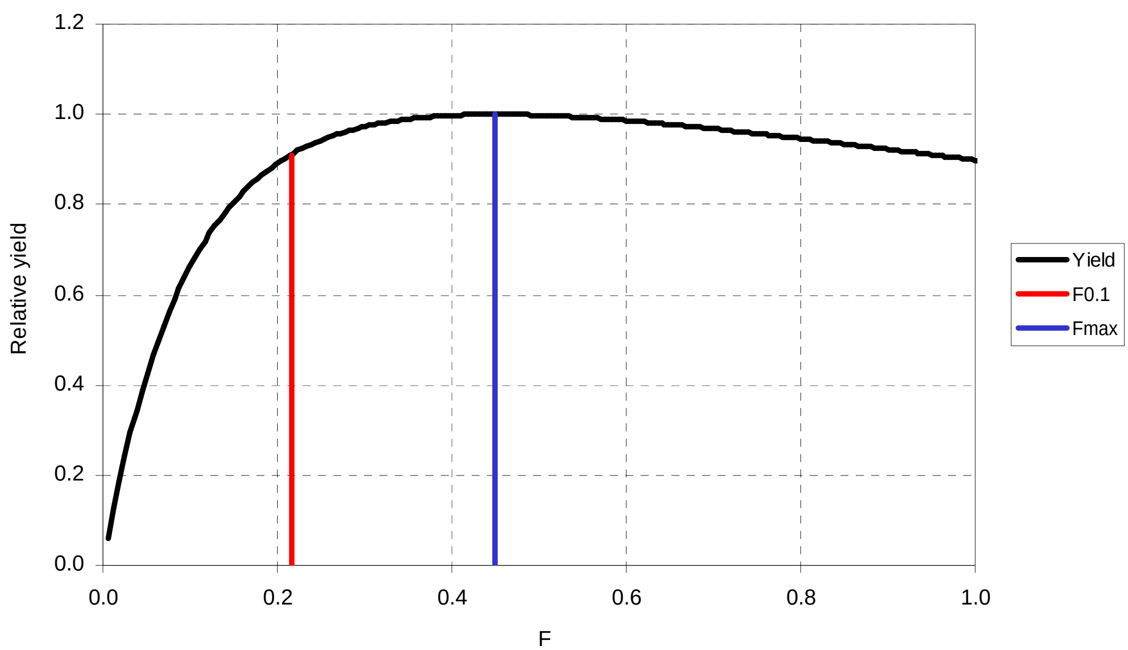


Figure 3.4.1.8 Nephrops, Moray Firth (FU 9)Combined sex yield per recruit plot (ave length distribution 2003-2005) showing position of F_{max} and $F_{0.1}$

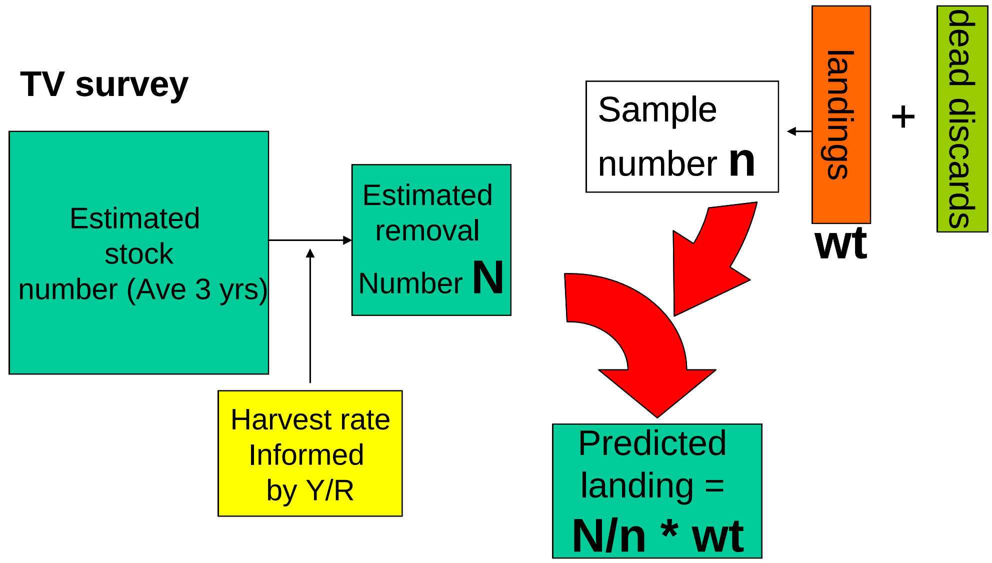


Figure 3.4.1.9 Diagram to illustrate the process of calculating a predicted landing from TV survey abundance estimates

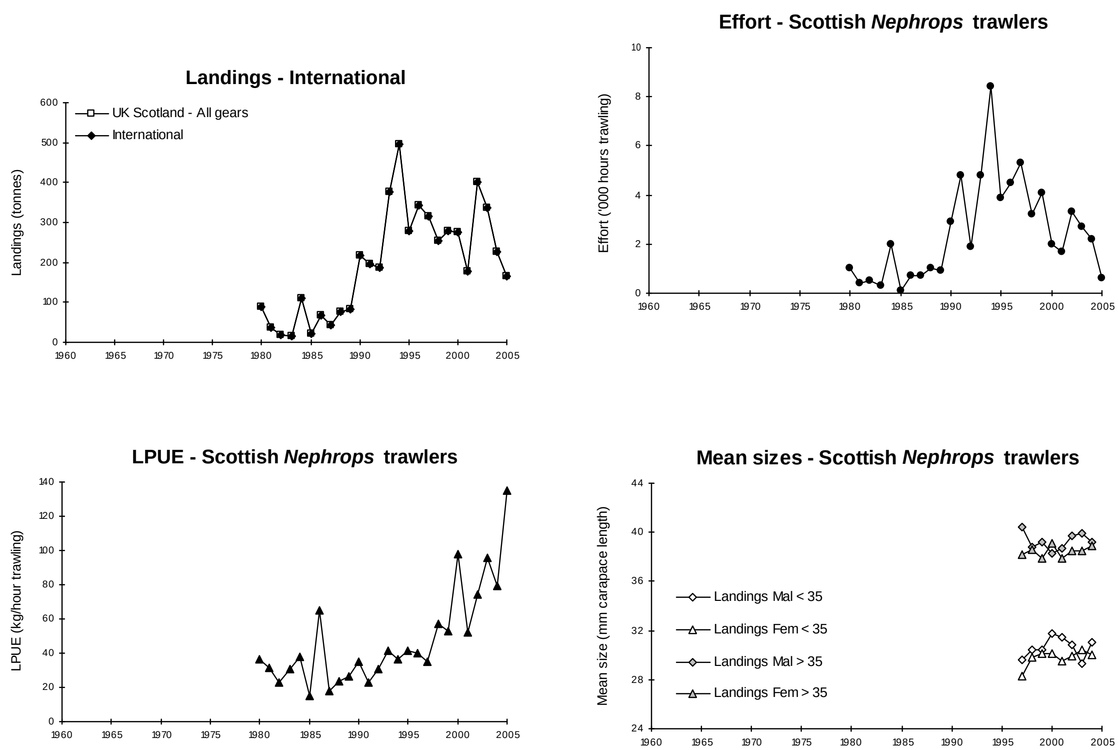


Figure 3.4.1.10 Nephrops, Noup (FU 10), Long term landings, effort, LPUE and mean sizes.

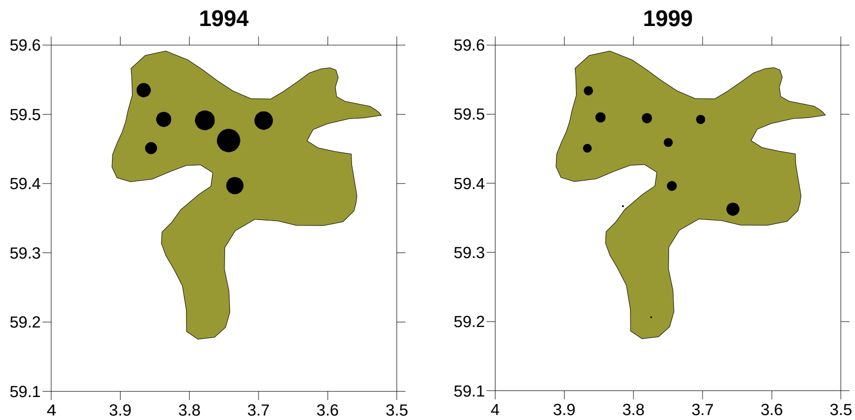


Figure 3.4.1.11 Nephrops, Noup (FU 10), TV survey station distribution and relative density, 1994 and 1999. Green and brown areas represent areas of suitable sediment for Nephrops.

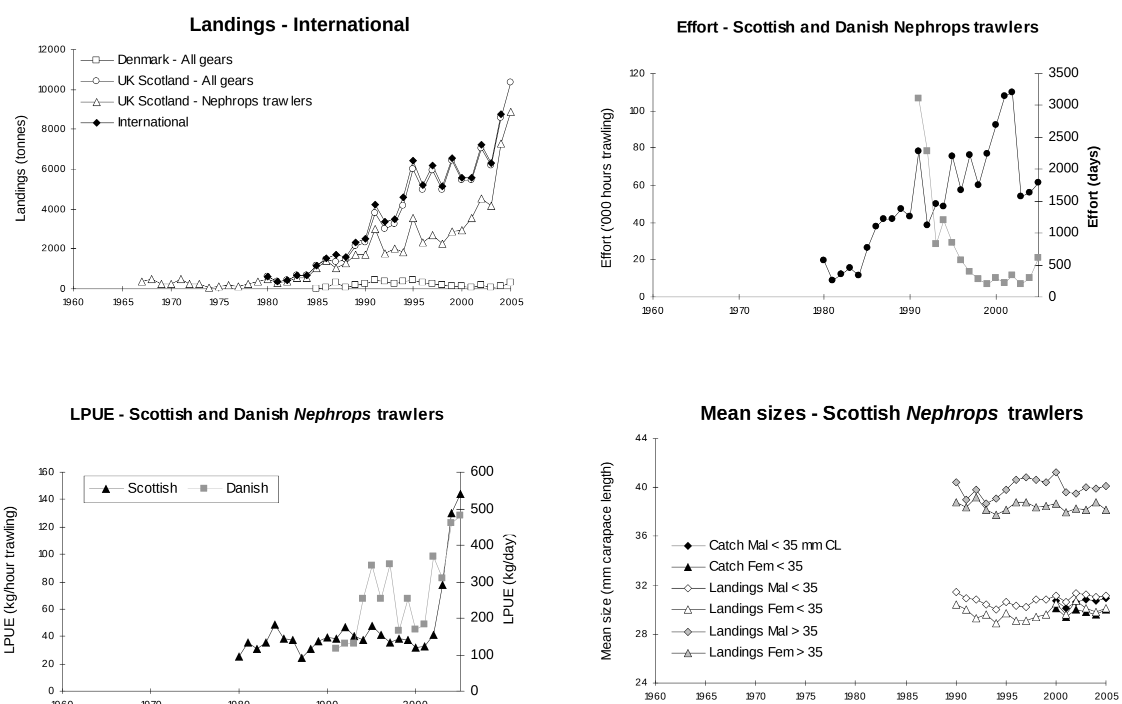


Figure 3.4.2.1 Nephrops, Fladen (FU 7), Long term landings, effort, LPUE and mean sizes.

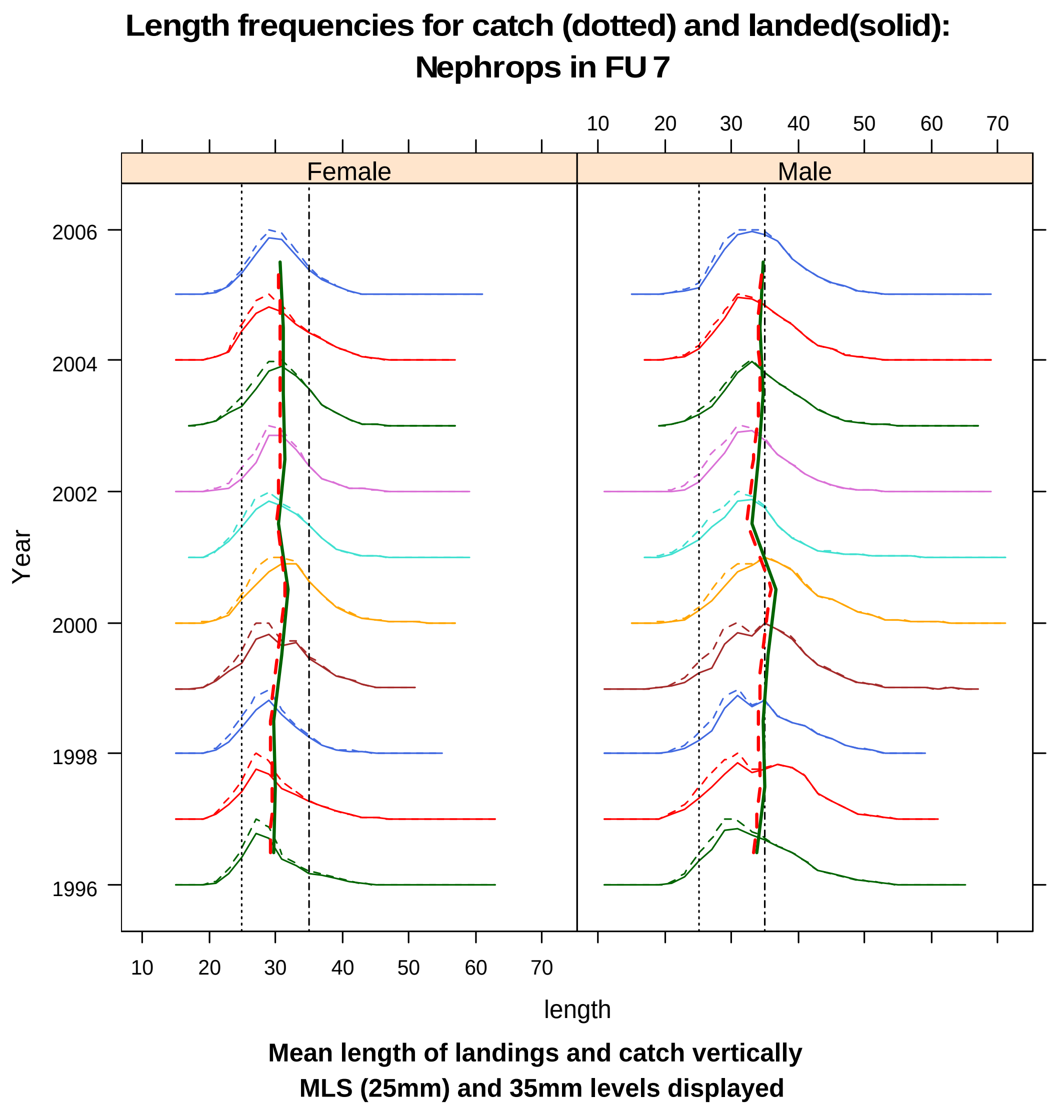


Figure 3.4.2.2 Nephrops Fladen Ground (FU 7)Length composition of catch (dotted) and landed (solid) of males (right) and females left from 1996 (bottom) to 2005 (top). Mean sizes of catch and landings (using same line types) is shown in relation to MLS

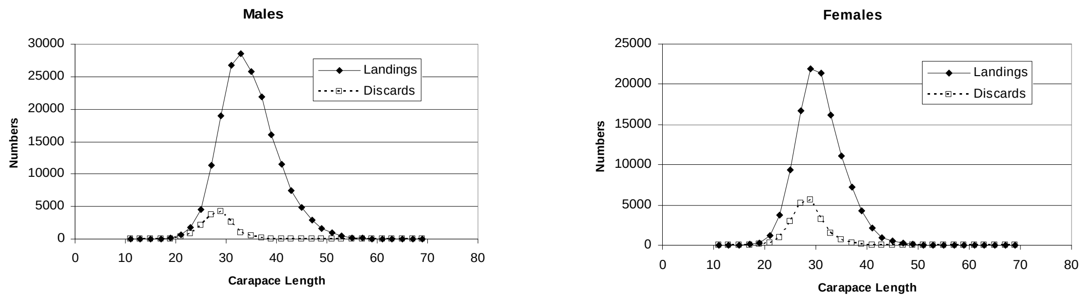


Figure 3.4.2.3 Nephrops, Fladen (FU 7), Length frequency distributions of male and female landings and discards, averaged over 2003 – 2005.

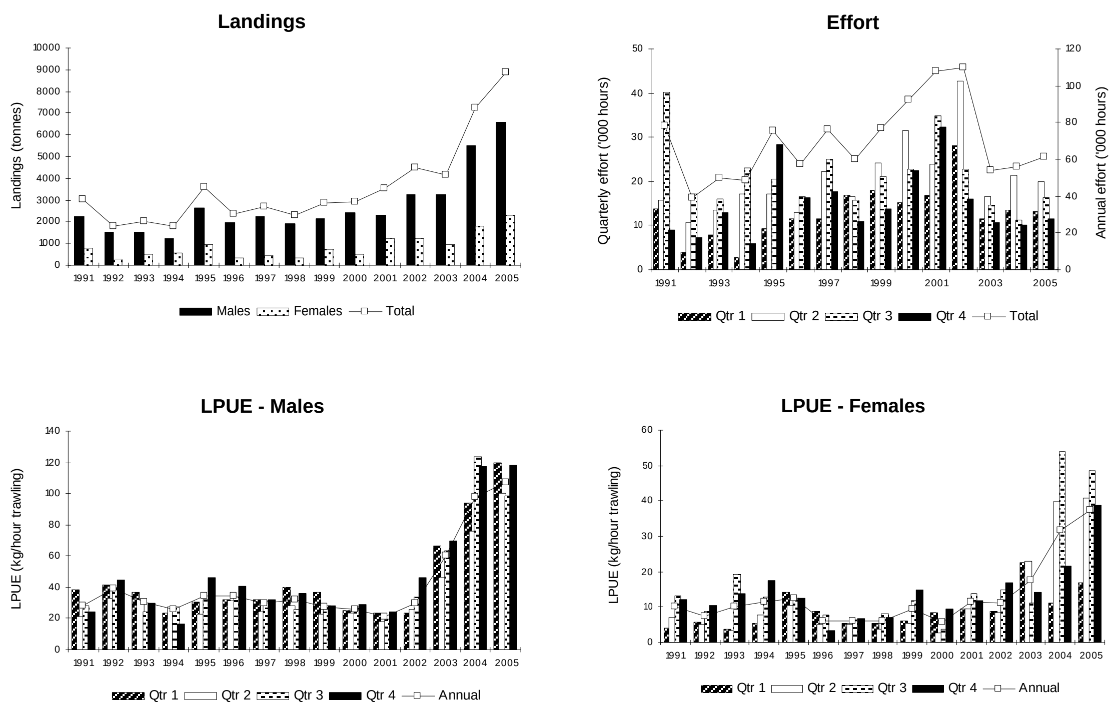


Figure 3.4.2.4 Nephrops, Fladen (FU 7), Landings, effort and LPUEs by quarter and sex from Scottish Nephrops trawlers.

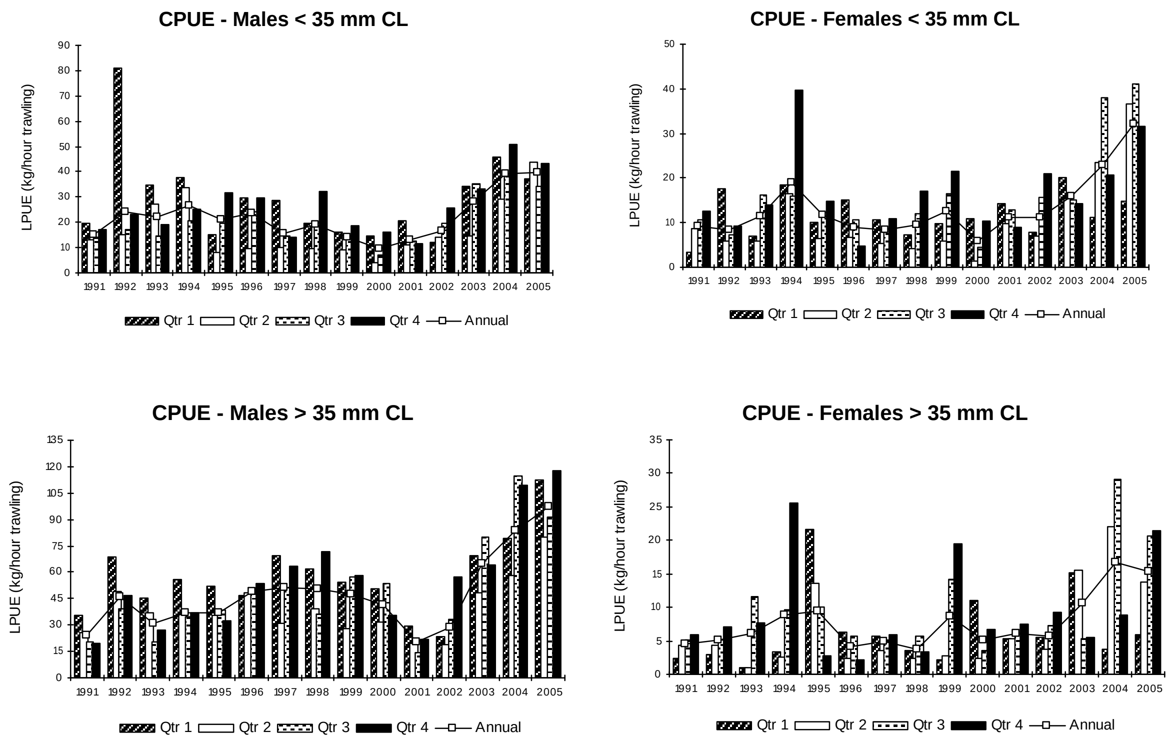


Figure 3.4.2.5 Nephrops, Fladen (FU 7), CPUEs by sex and quarter for selected size groups, Scottish Nephrops trawlers.

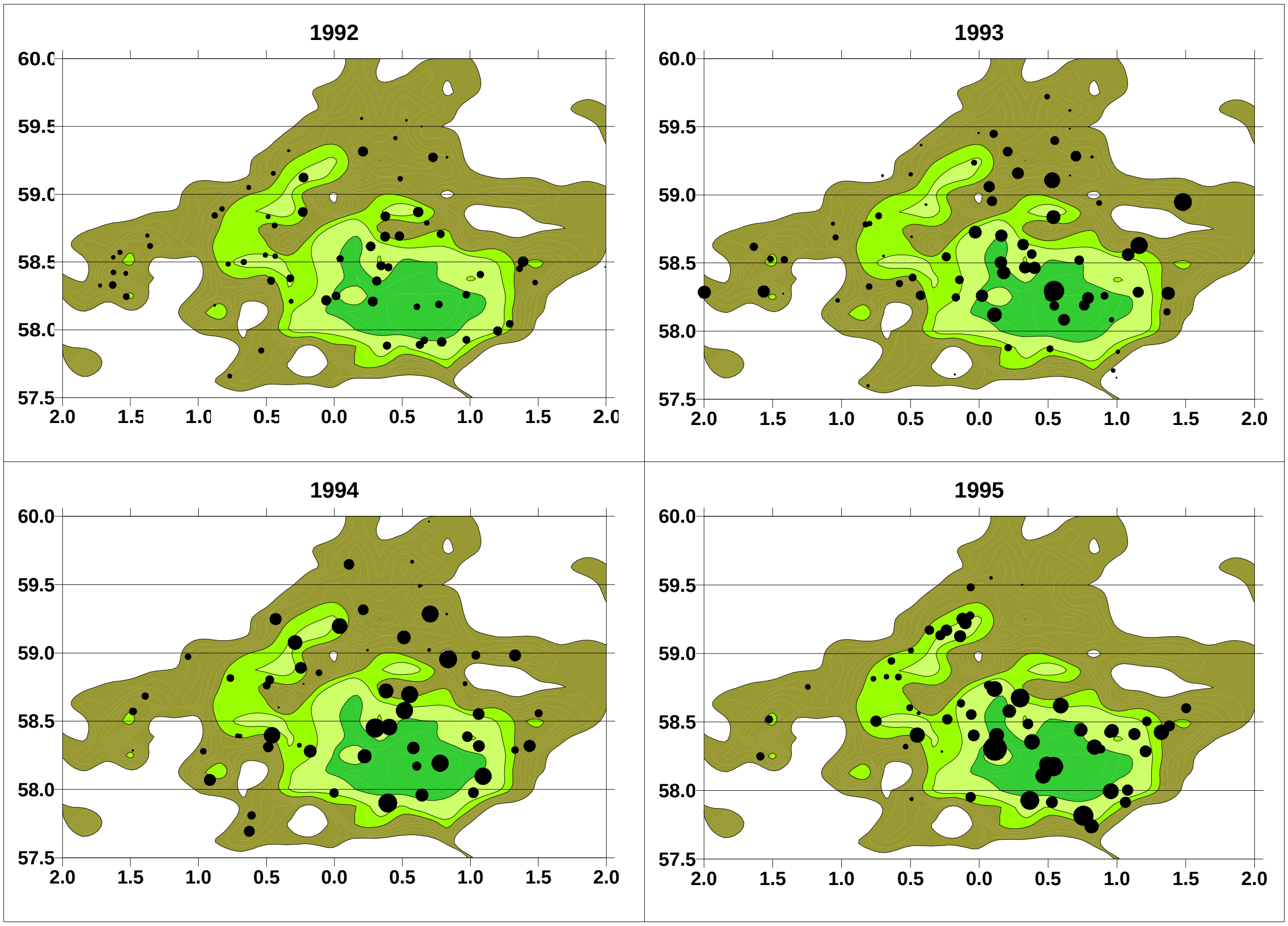


Figure 3.4.2.6 Nephrops, Fladen (FU 7), TV survey station distribution and relative density, 1992 – 1995. Green and brown areas represent areas of suitable sediment for Nephrops.

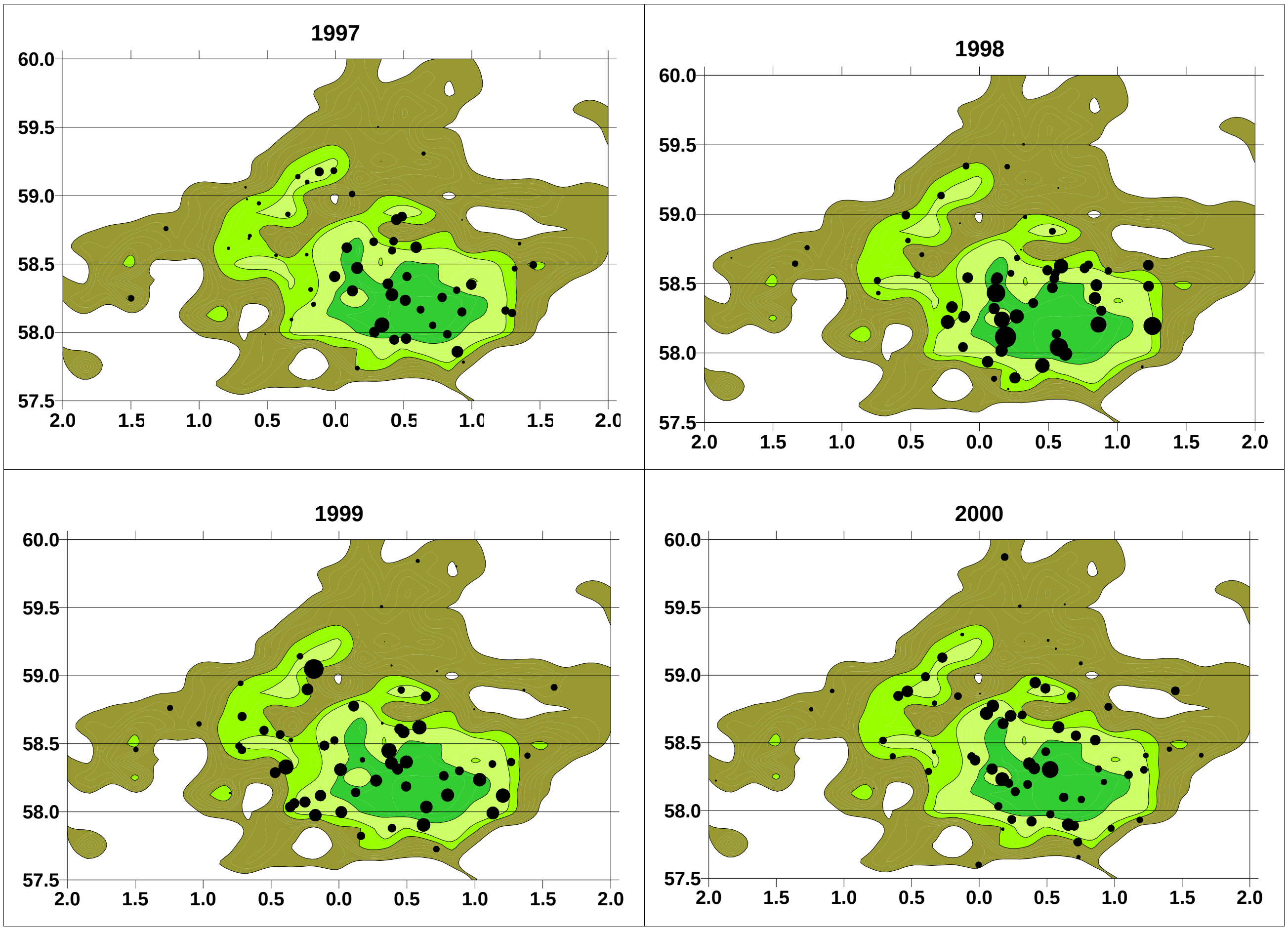


Figure 3.4.2.6 cont Nephrops, Fladen (FU 7), TV survey station distribution and relative density, 1997 – 1999 (no survey in 1996). Green and brown areas represent areas of suitable sediment for Nephrops.

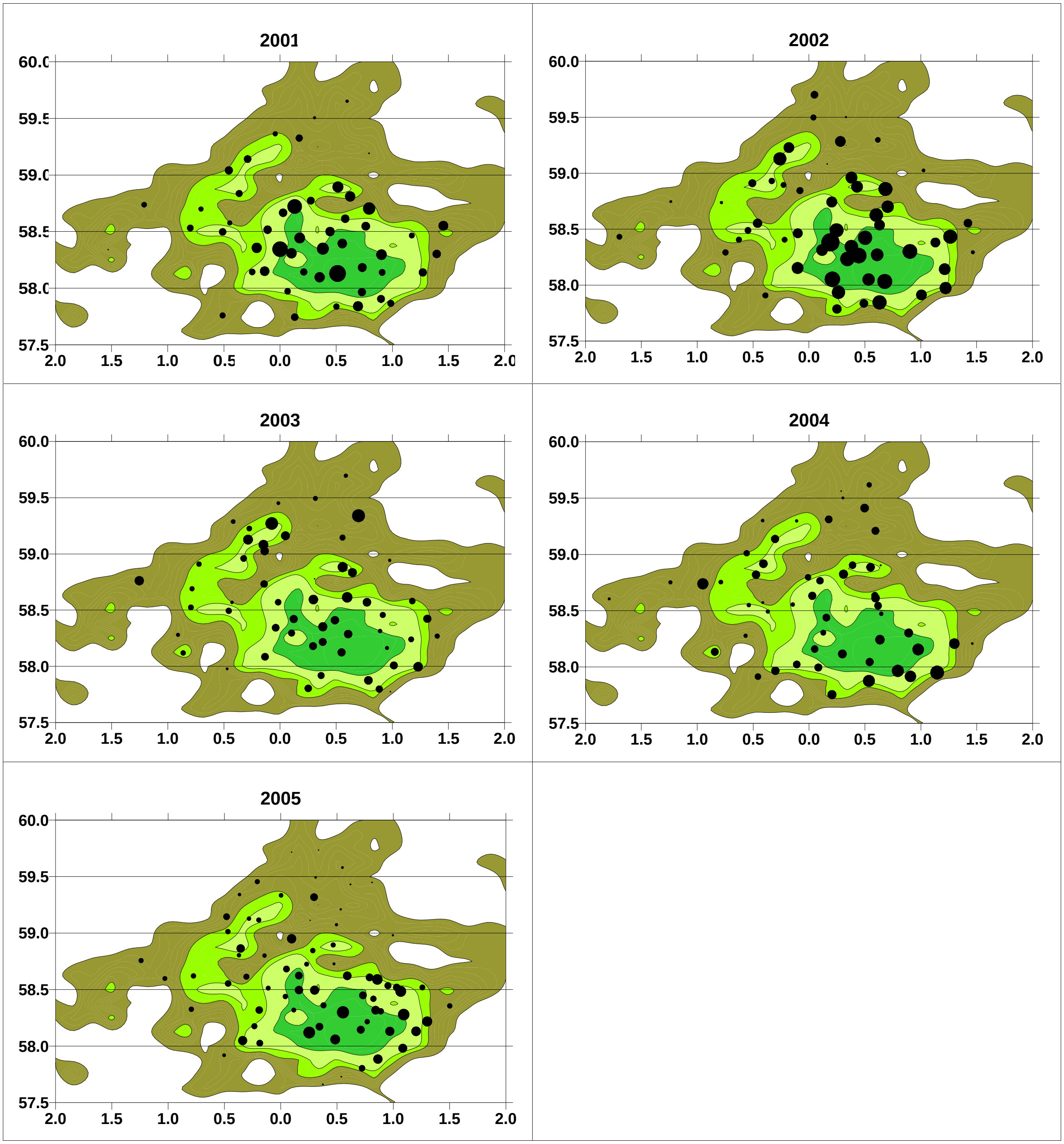


Figure 3.4.2.6 cont Nephrops, Fladen (FU 7), TV survey station distribution and relative density, 2001 – 2005. Green and brown areas represent areas of suitable sediment for Nephrops.

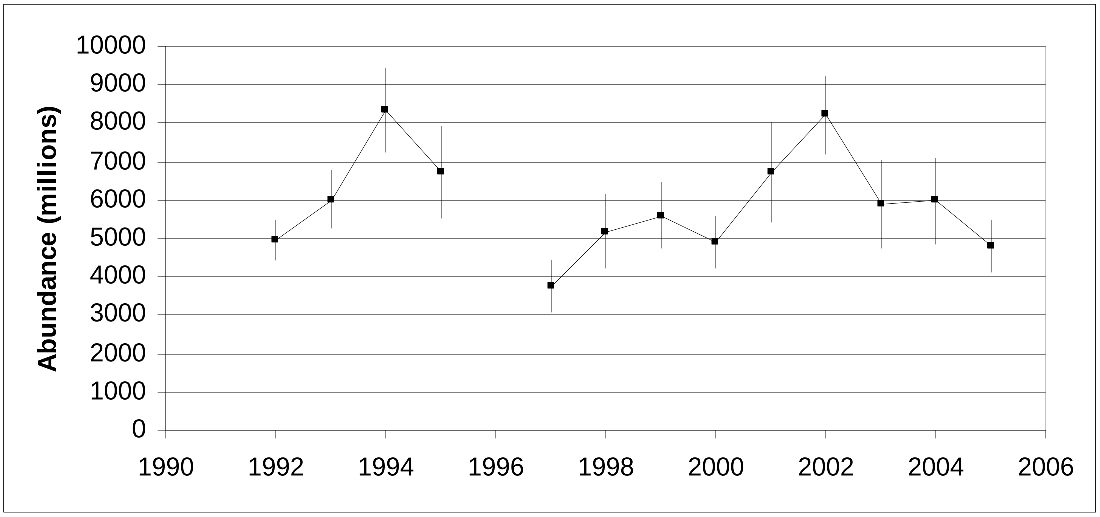


Figure 3.4.2.7 Nephrops, Fladen (FU 7), Time series of TV survey abundance estimates, with 95% confidence intervals, 1992 – 2005.

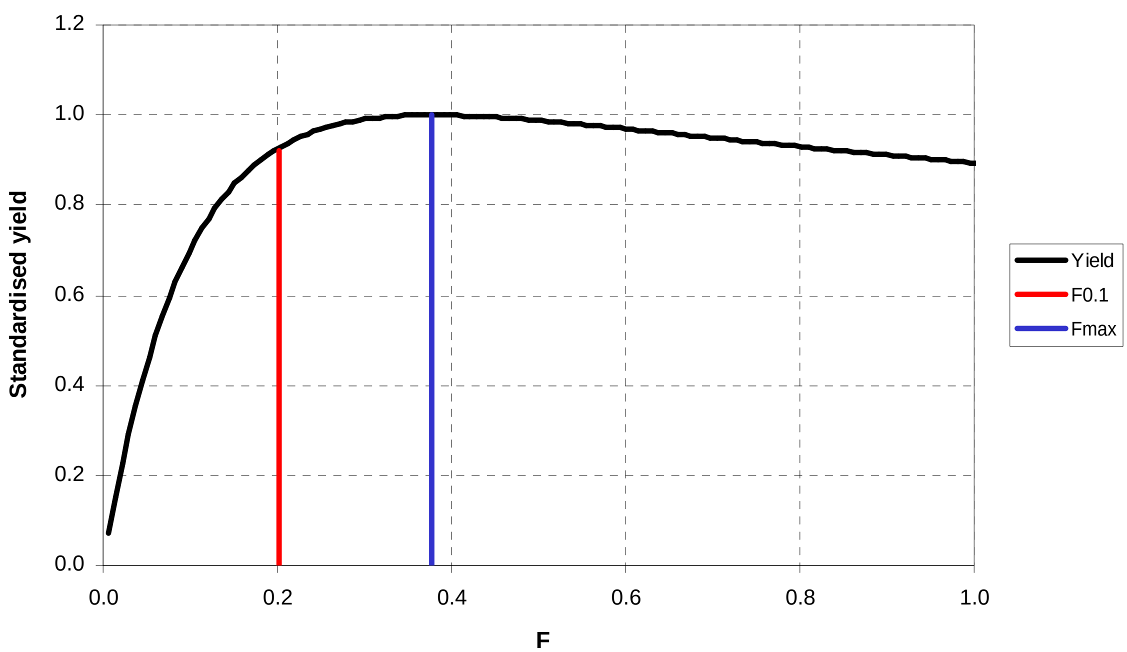


Figure 3.4.2.8 Nephrops, Fladen (FU 7) Combined sex yield per recruit plot (ave length distribution 2003-2005) showing position of F_{max} and $F_{0.1}$

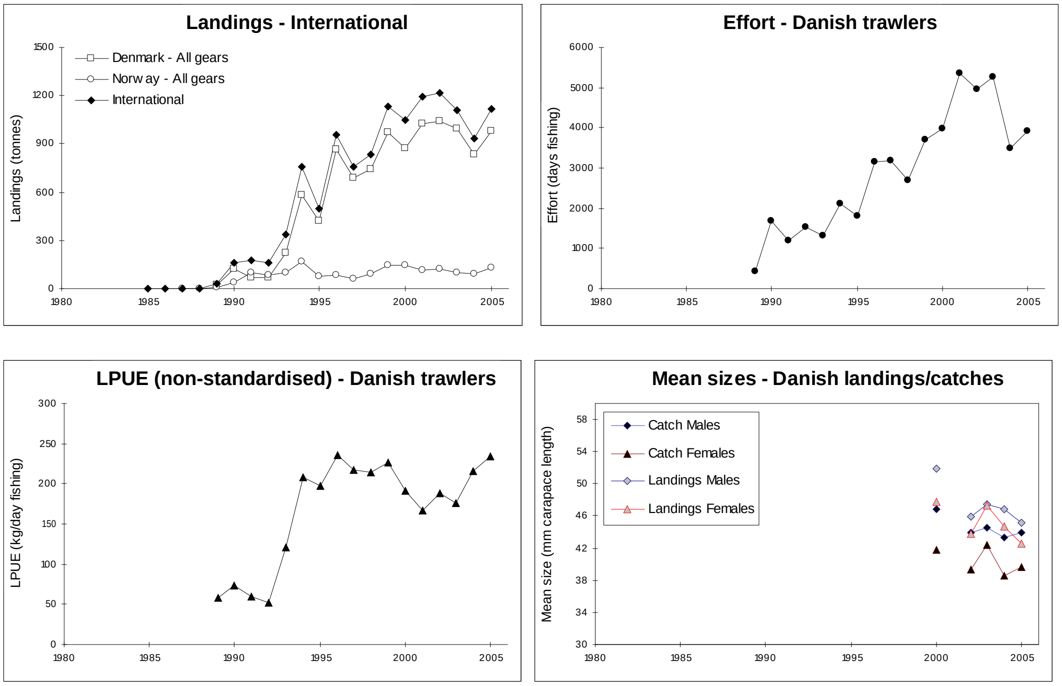


Figure 3.4.3.1 Nephrops Norwegian Deep (FU 32): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of Nephrops.

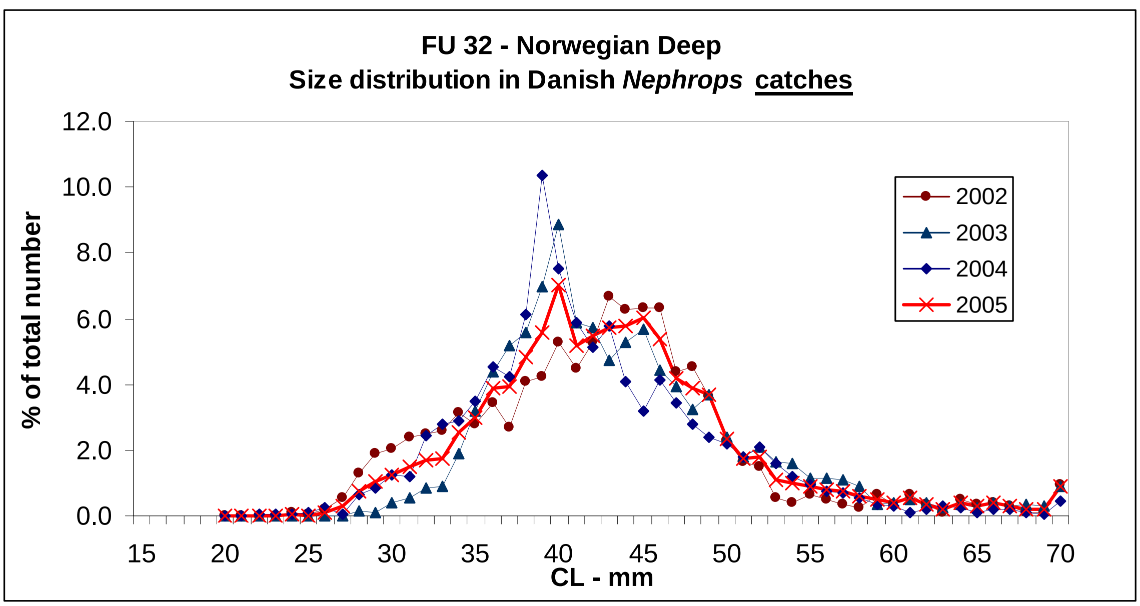


Figure 3.4.3.2 Nephrops Norwegian Deep (FU 32): LFDs from Danish Nephrops/finfish trawlers in FU 32 (using 100 mm mesh trawls).

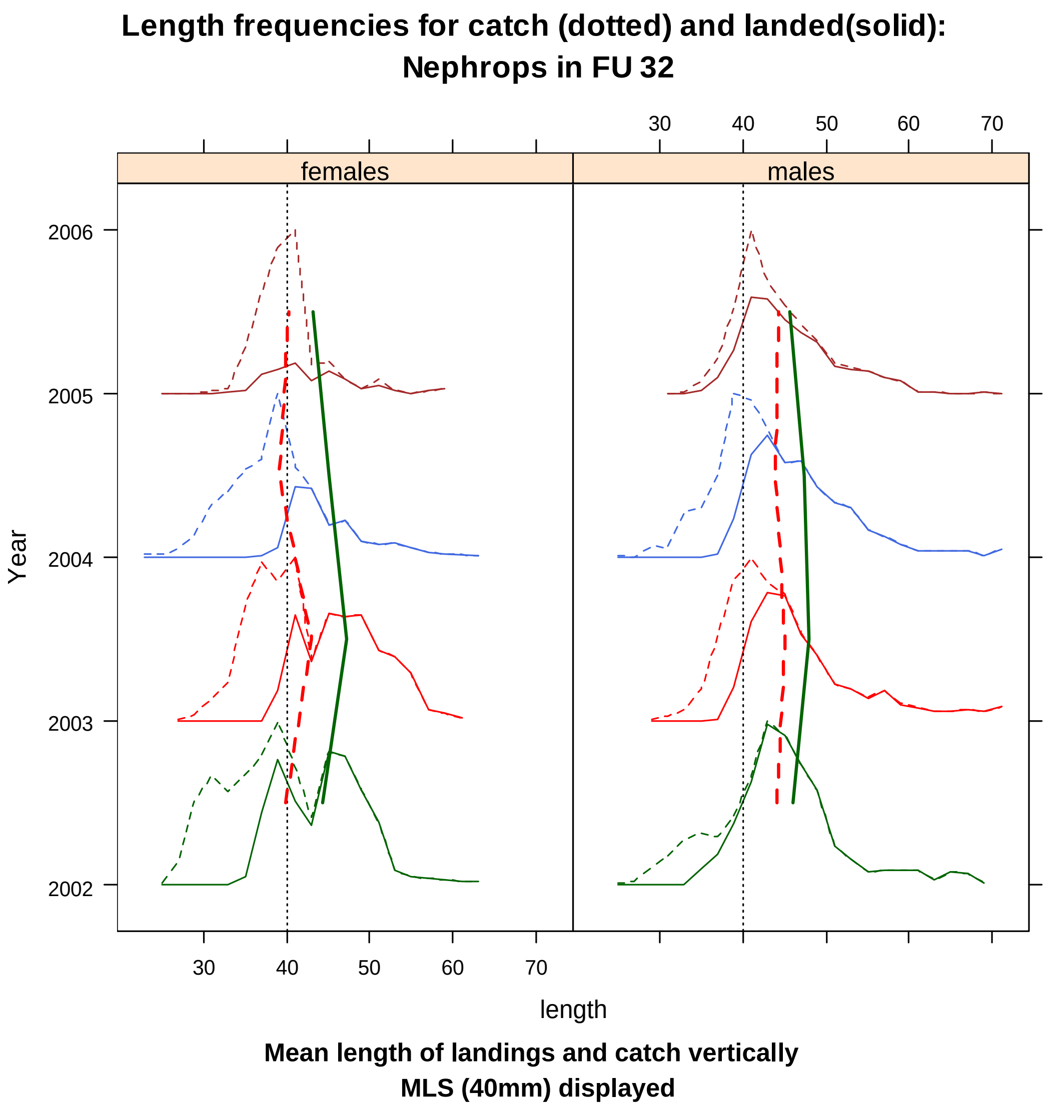


Figure 3.4.3.3 Nephrops Norwegian Deep (FU 32) Length composition of catch (dotted) and landed (solid) of males (right) and females left from 1996 (bottom) to 2005 (top). Mean sizes of catch and landings (using same line types) is shown in relation to MLS

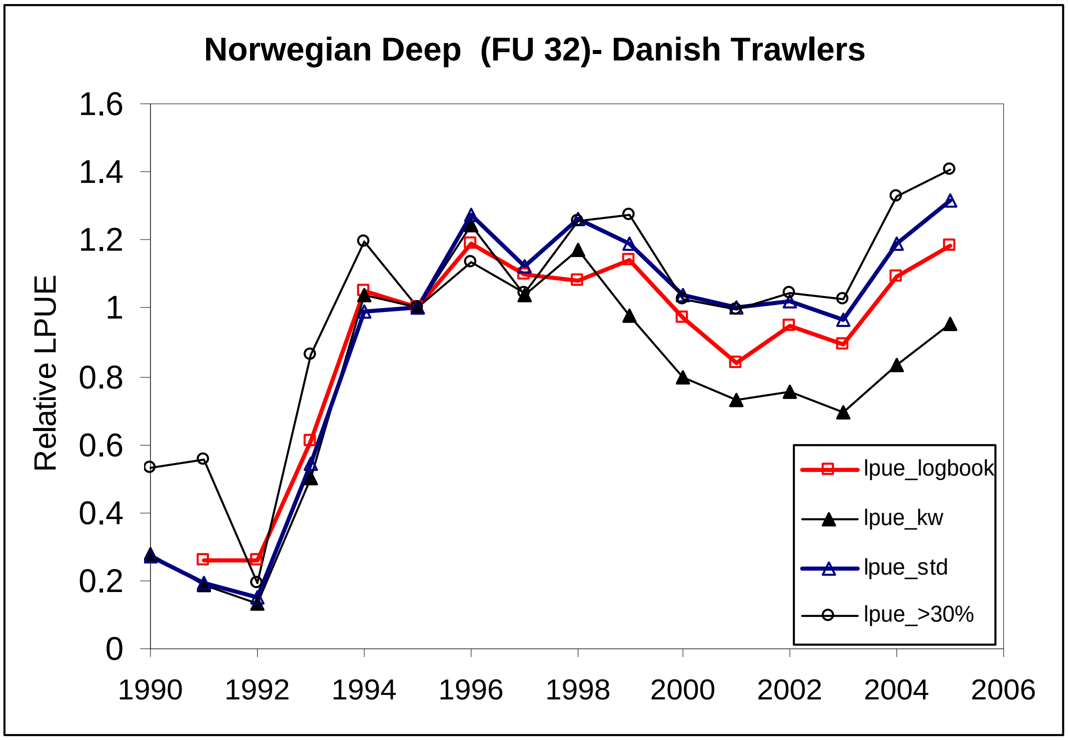


Figure 3.4.3.4. Nephrops Norwegian Deep (FU 32) Relative LPUE of Danish trawlers calculated in various ways

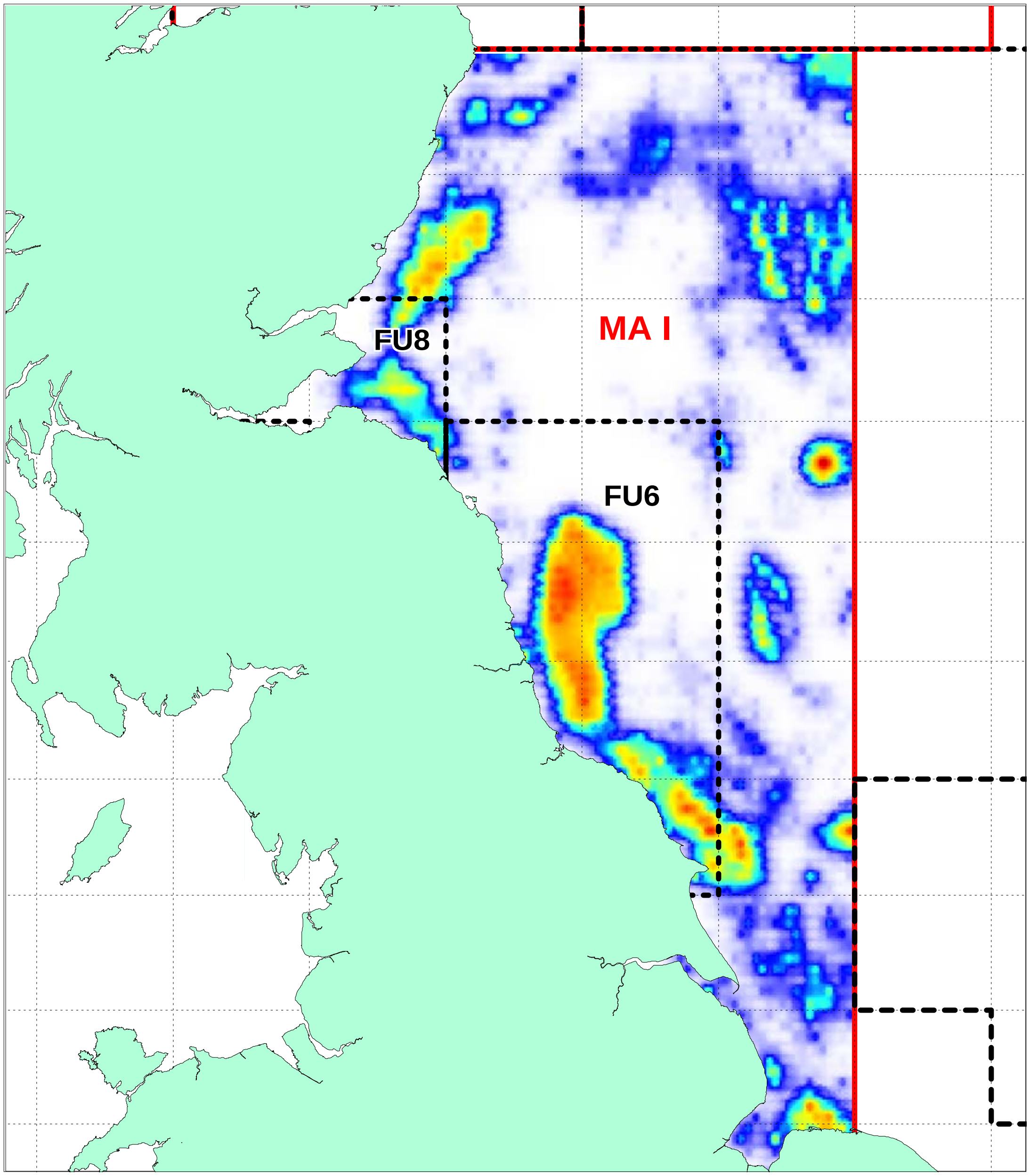


Figure 3.4.4.1 Nephrops Farn Deeps (FU 6) counts of VMS observations per 3 minute 'square' (latitude and longitude) between October 2005 and March 2006 for all UK vessels moving between 1-3 knots

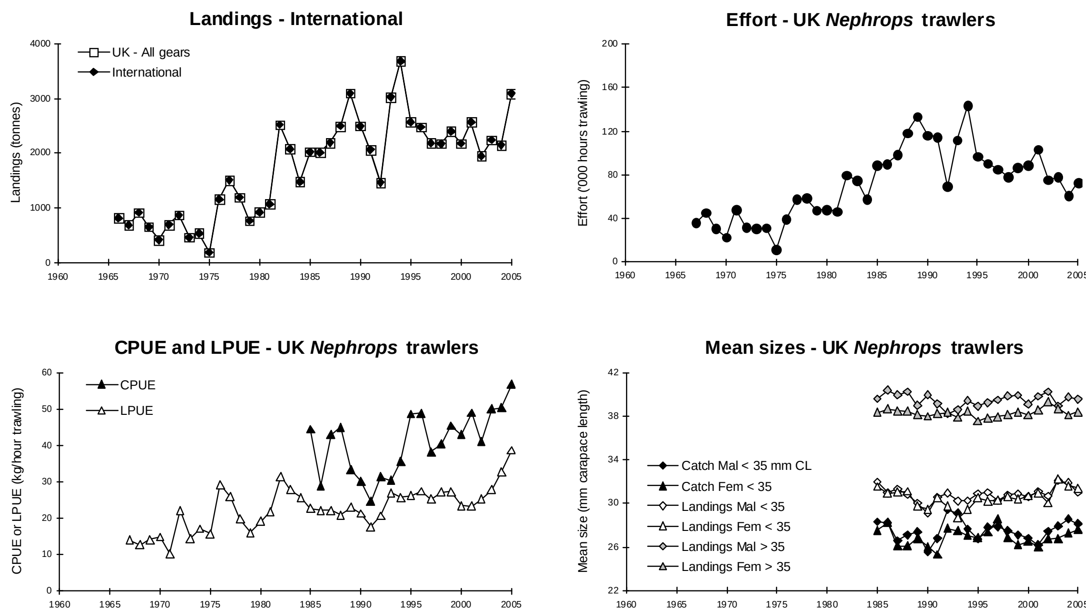


Figure 3.4.4.2 Nephrops Farn Deeps (FU 6): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of Nephrops

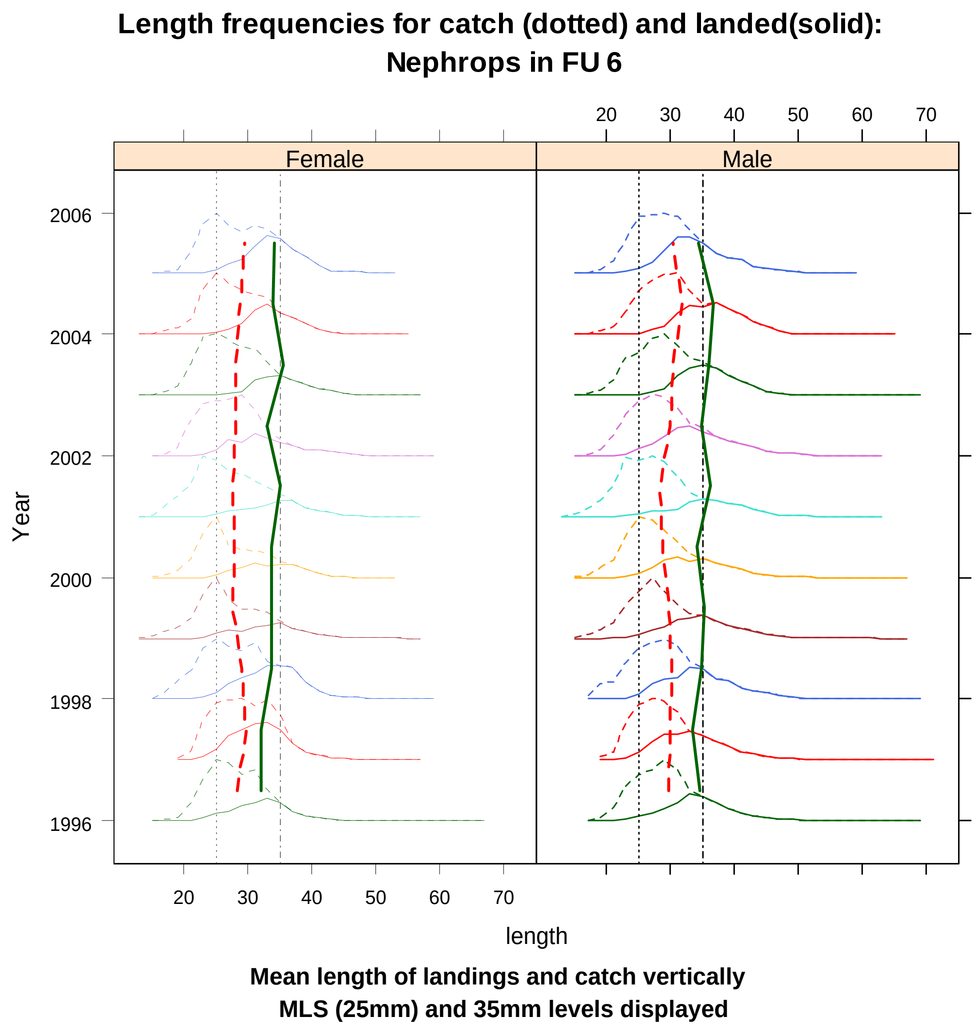


Figure 3.4.4.3 Nephrops Farn Deeps (FU 6) Length composition of catch (dotted) and landed (solid) of males (right) and females left from 1996 (bottom) to 2005 (top). Mean sizes of catch and landings (using same line types) is shown in relation to MLS

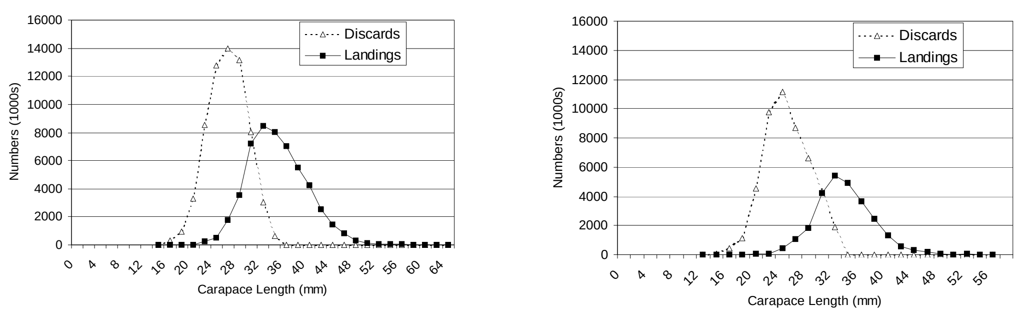


Figure 3.4.4.4 Nephrops Farn Deeps (FU 6): Length frequency distributions of male and female landings and discards, averaged over 2003 – 2005.

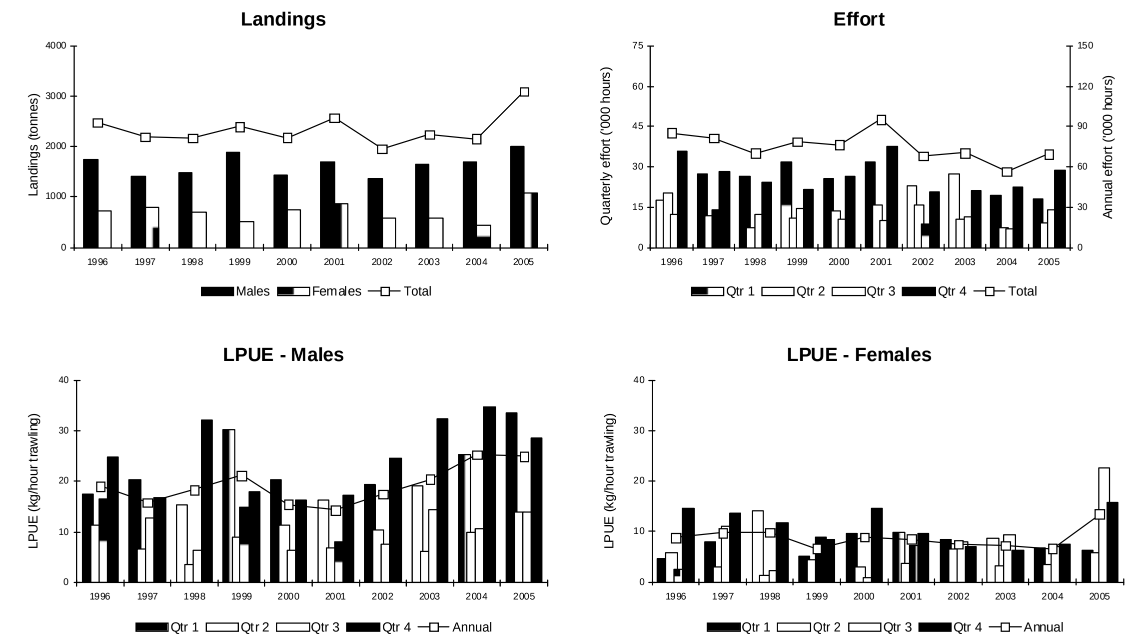


Figure 3.4.4.5 Nephrops Farn Deeps (FU 6): Landings, effort and LPUEs by quarter and sex from English Nephrops trawlers.

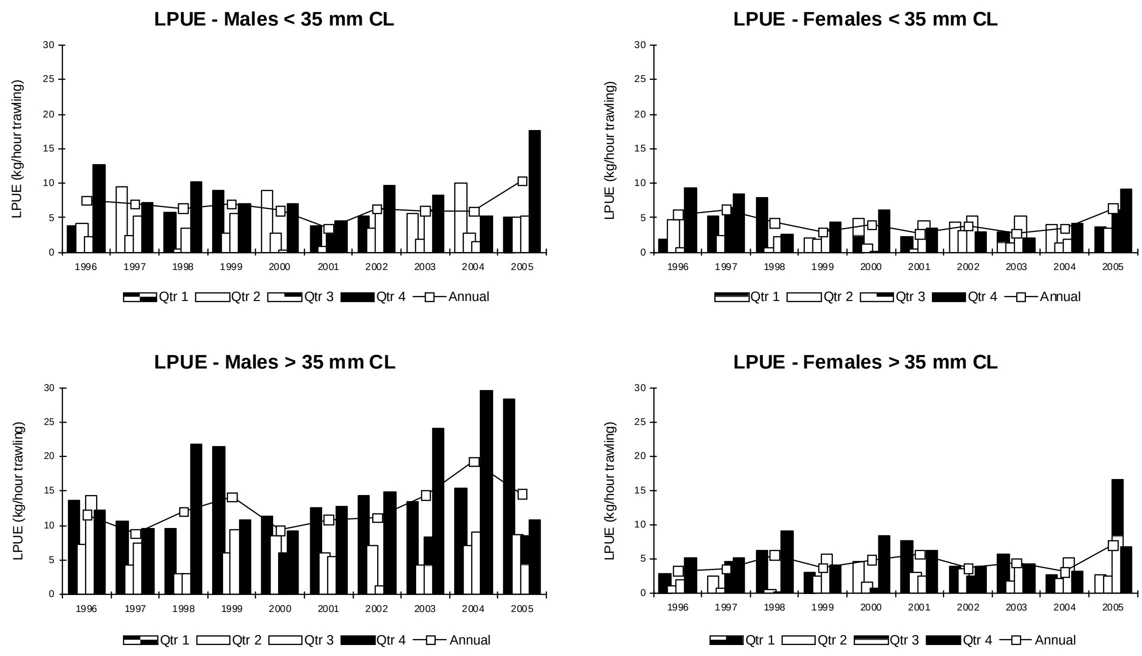


Figure 3.4.4.6 Nephrops Farn Deeps (FU 6): LPUEs by sex and quarter for selected size groups, English Nephrops trawlers.

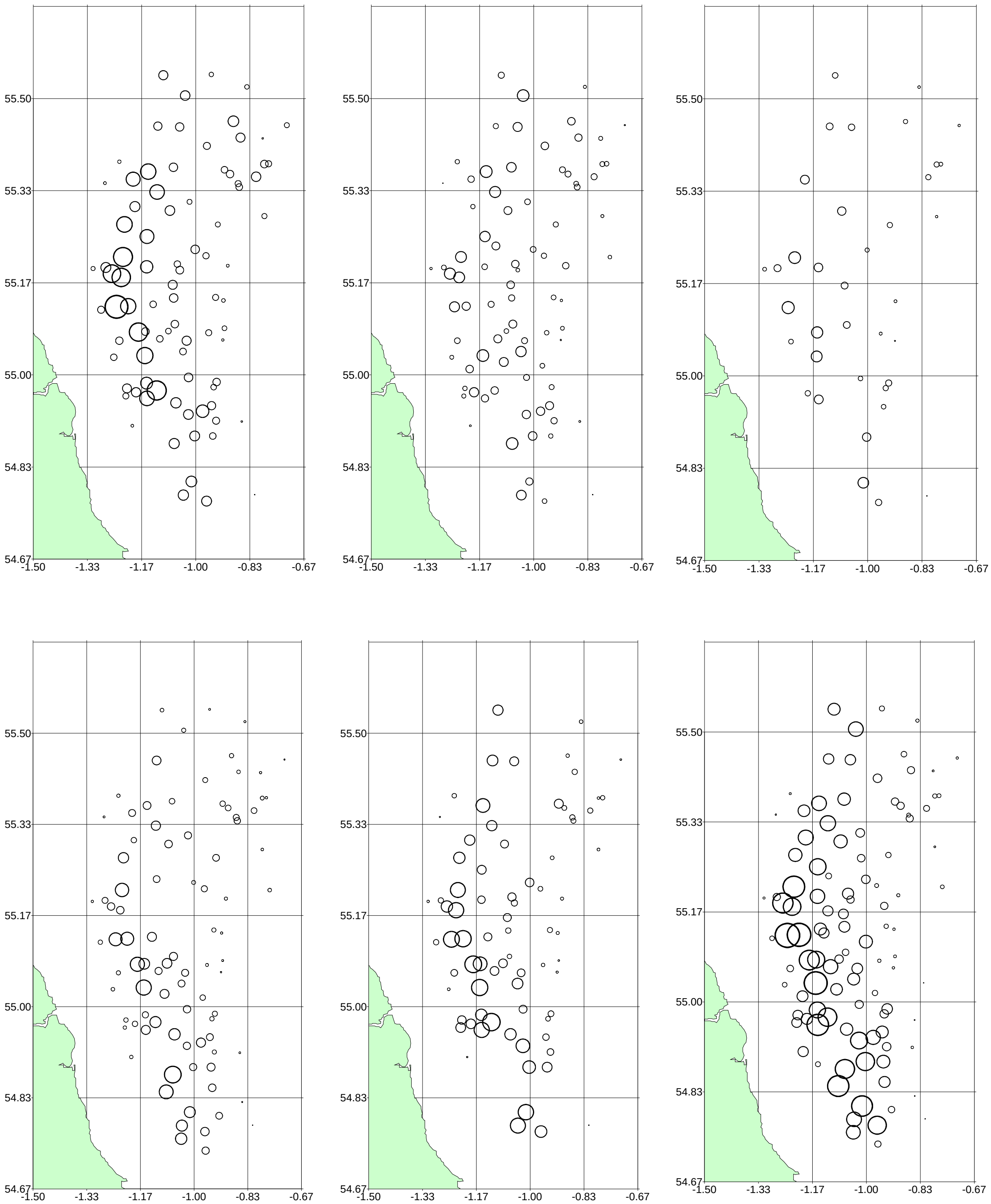


Figure 3.4.4.7 Nephrops Farn Deeps (FU6) - Station distribution and relative burrow density, from Autumn surveys 1997 – 2005. Top row 1997,1998 & 1999 (left to right), bottom row 2002,2003 & 2004 (left to right).

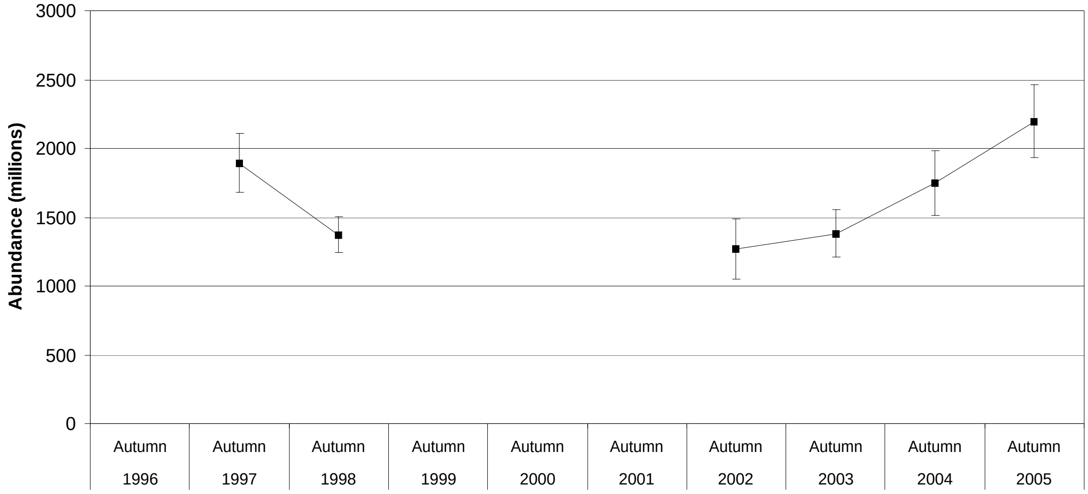
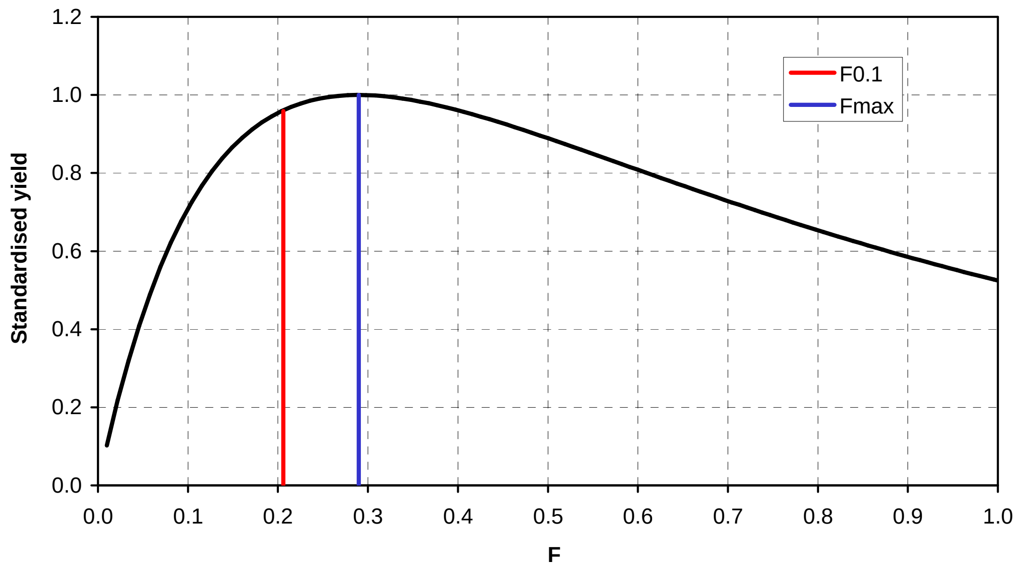


Figure 3.4.4.8 Nephrops, Farn Deeps (FU 6), Time series of TV survey abundance estimates, with 95% confidence intervals, 1996 – 2005.



Reference point	Absolute F
F0.1	0.2061
FMax	0.2898
Fbar	0.4275

Figure 3.4.4.9 Nephrops, Farn Deeps (FU 6) Combined sex yield per recruit plot (ave length distribution 2003-2005) showing position of F_{max} and $F_{0.1}$

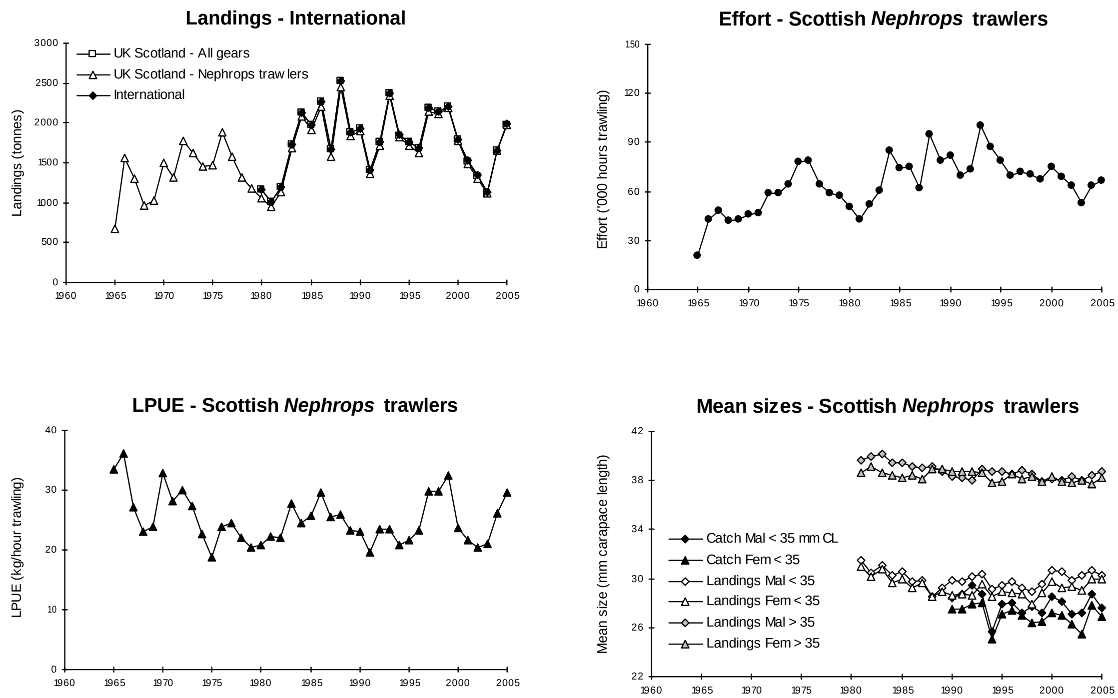


Figure 3.4.4.10 Nephrops, Firth of Forth (FU 8), Long term landings, effort, LPUE and mean sizes.

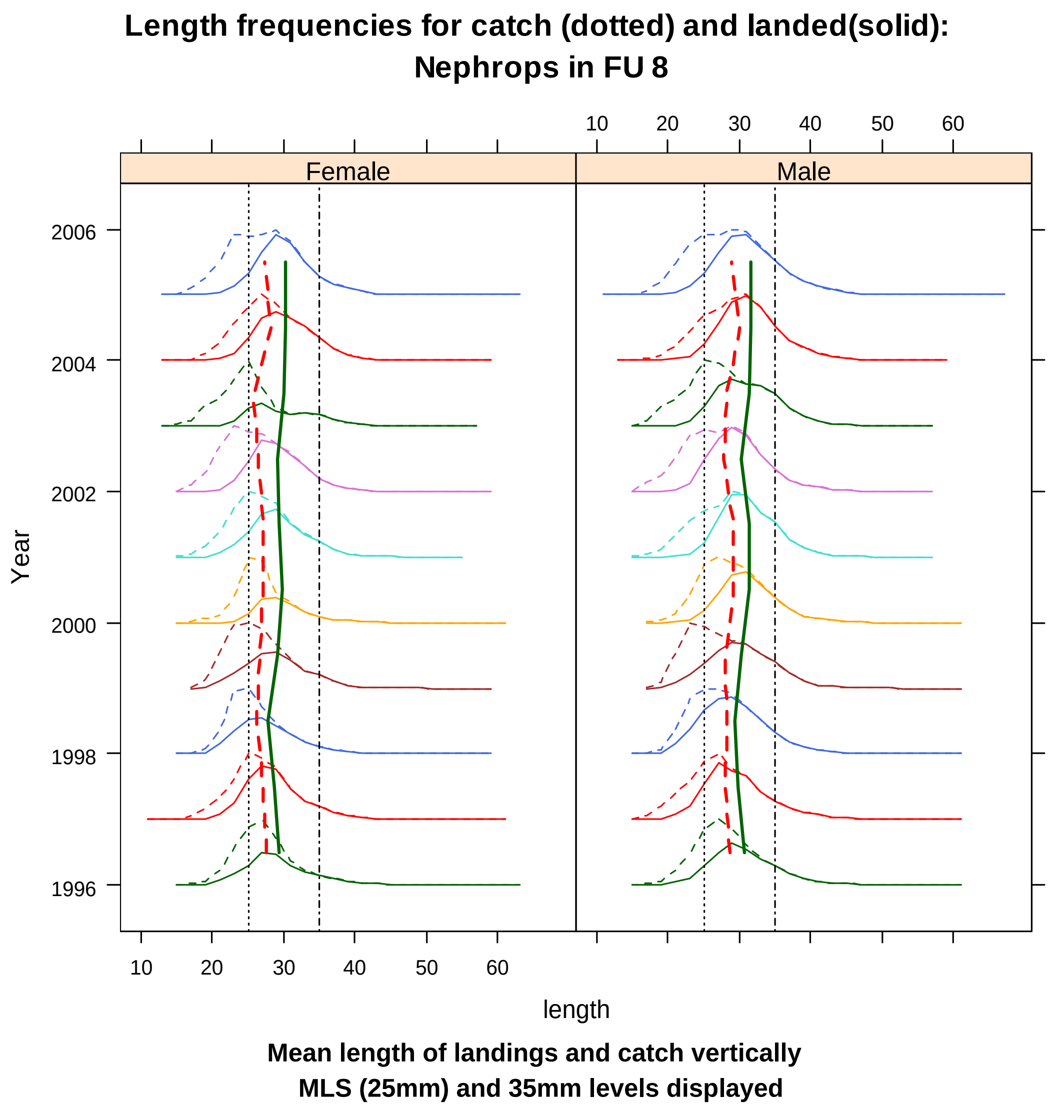
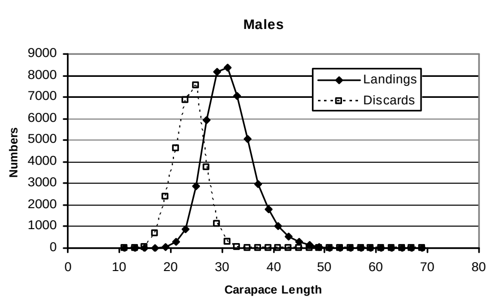


Figure 3.4.4.11 Nephrops Firth of Forth (FU 8) Length composition of catch (dotted) and landed (solid) of males (right) and females left from 1996 (bottom) to 2005 (top). Mean sizes of catch and landings (using same line types) is shown in relation to MLS



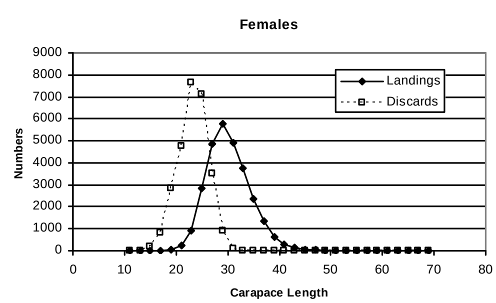


Figure 3.4.4.12 Nephrops, Firth of Forth (FU 8), Length frequency distributions of male and female landings and discards, averaged over 2003 – 2005.

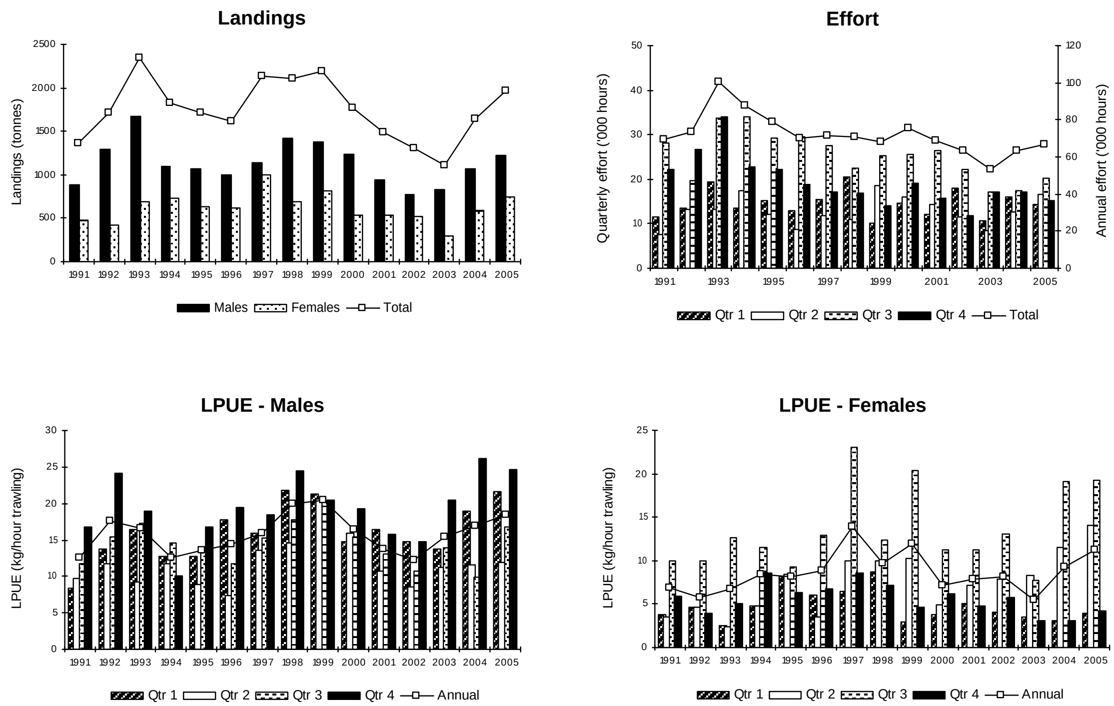


Figure 3.4.4.13 Nephrops, Firth of Forth (FU 8), Landings, effort and LPUEs by quarter and sex from Scottish Nephrops trawlers.

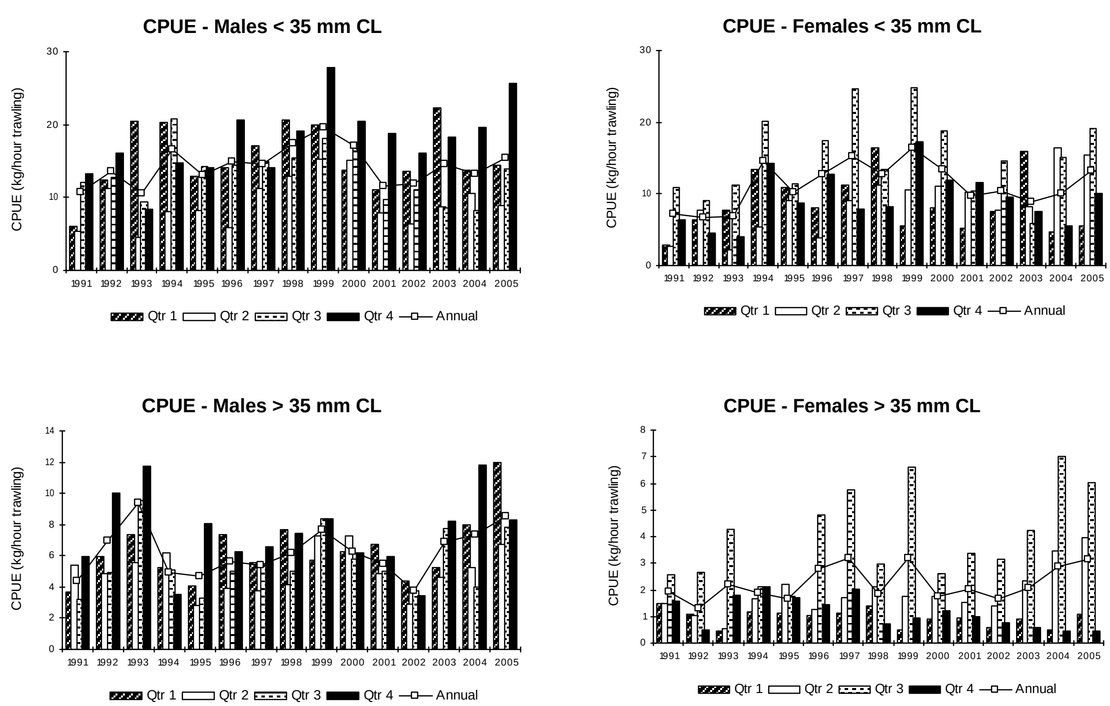


Figure 3.4.4.14 Nephrops, Firth of Forth (FU 8), CPUEs by sex and quarter for selected size groups, Scottish Nephrops trawlers.

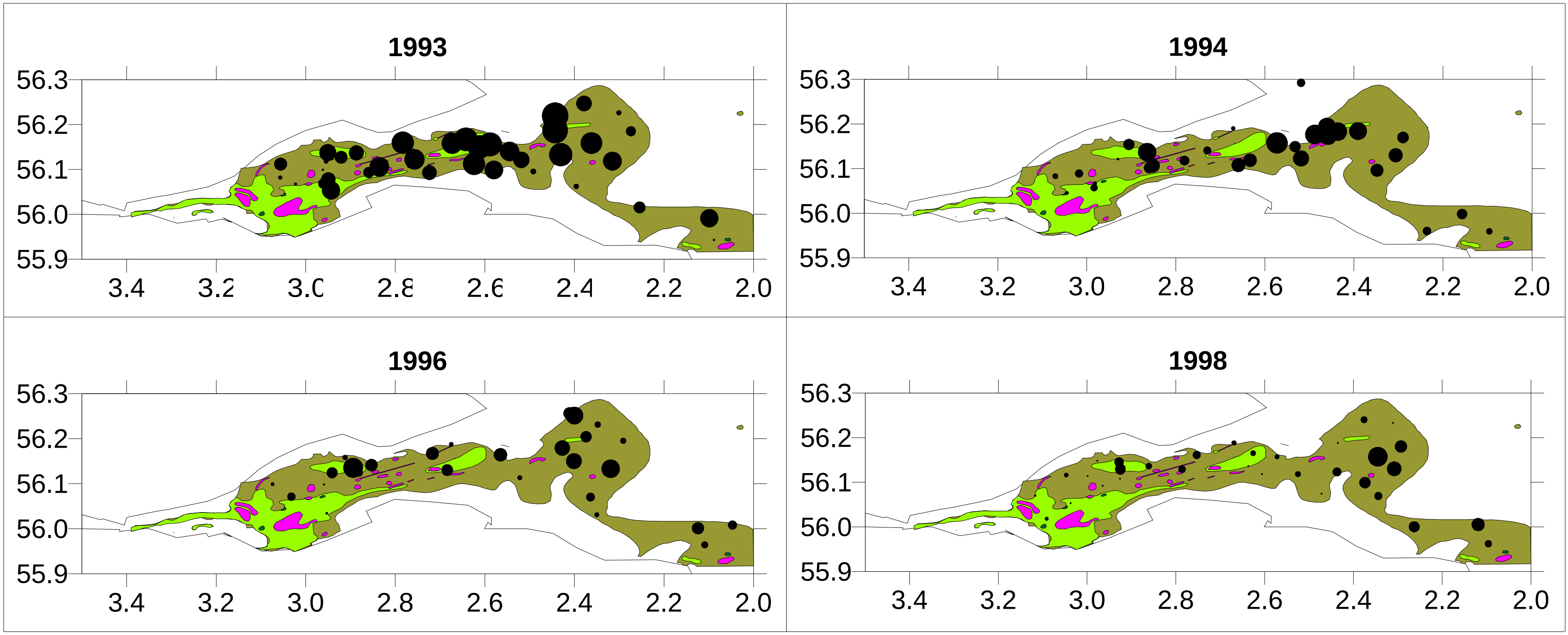


Figure 3.4.4..15 5Nephrops, Firth of Forth (FU 8), TV survey station distribution and relative density, 1993 – 1998 (no surveys in 1995 and 1997). Green and brown areas represent areas of suitable sediment for Nephrops.

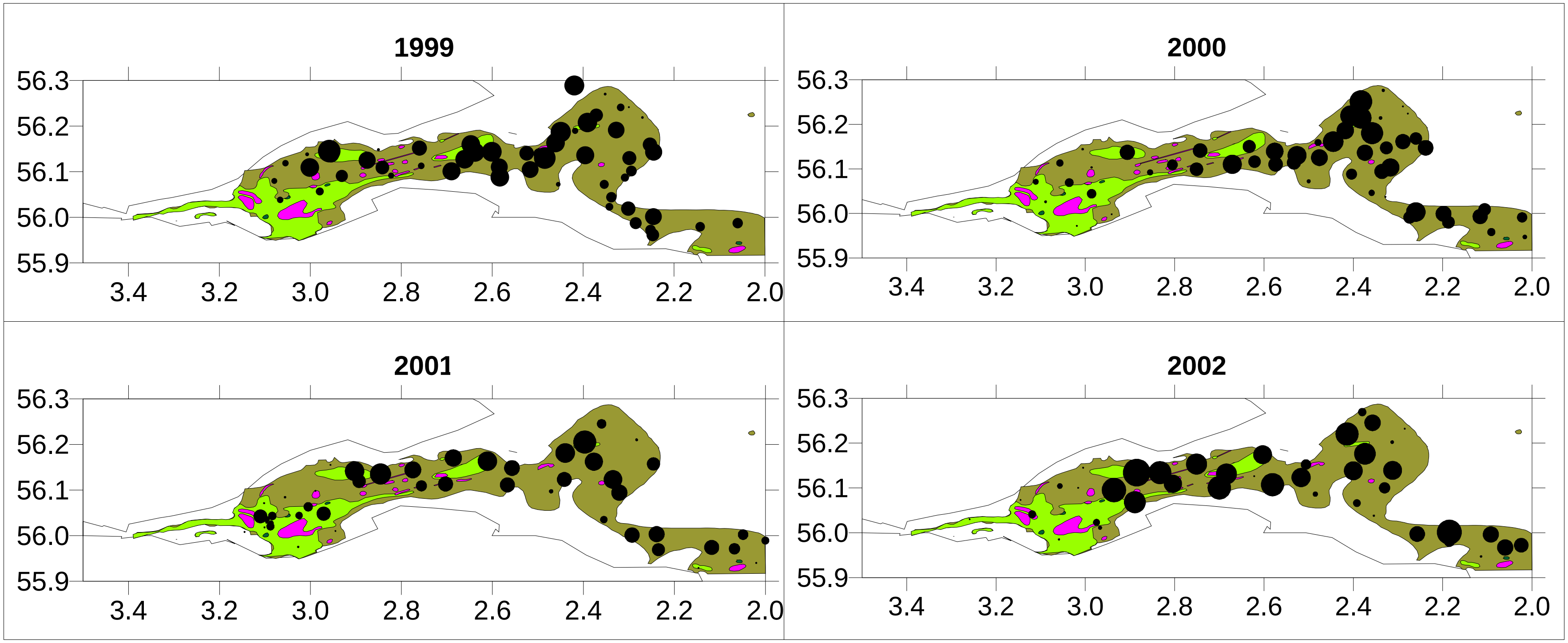


Figure 3.4.4.15 cont Nephrops, Firth of Forth (FU 8), TV survey station distribution and relative density, 1999 – 2002. Green and brown areas represent areas of suitable sediment for Nephrops.

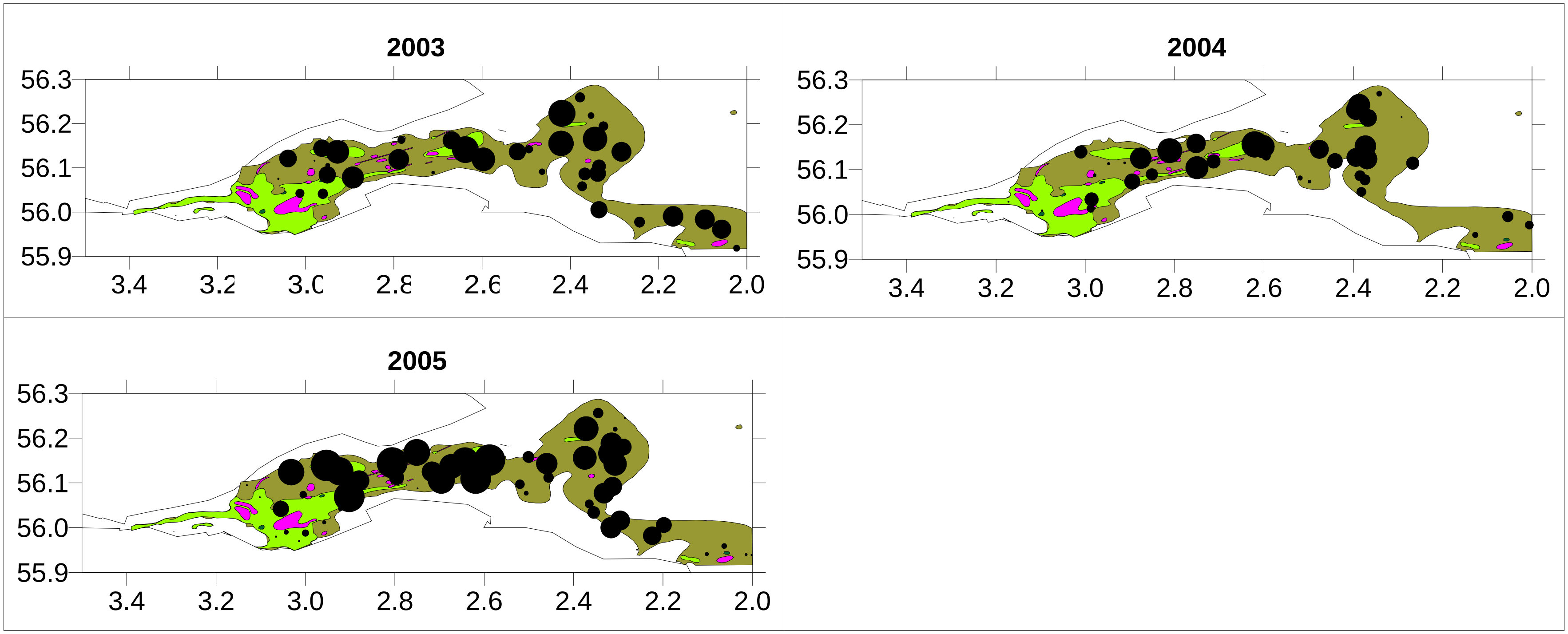


Figure 3.4.4..15 Nephrops, Firth of Forth (FU 8), TV survey station distribution and relative density, 2003 – 2005. Green and brown areas represent areas of suitable sediment for Nephrops.

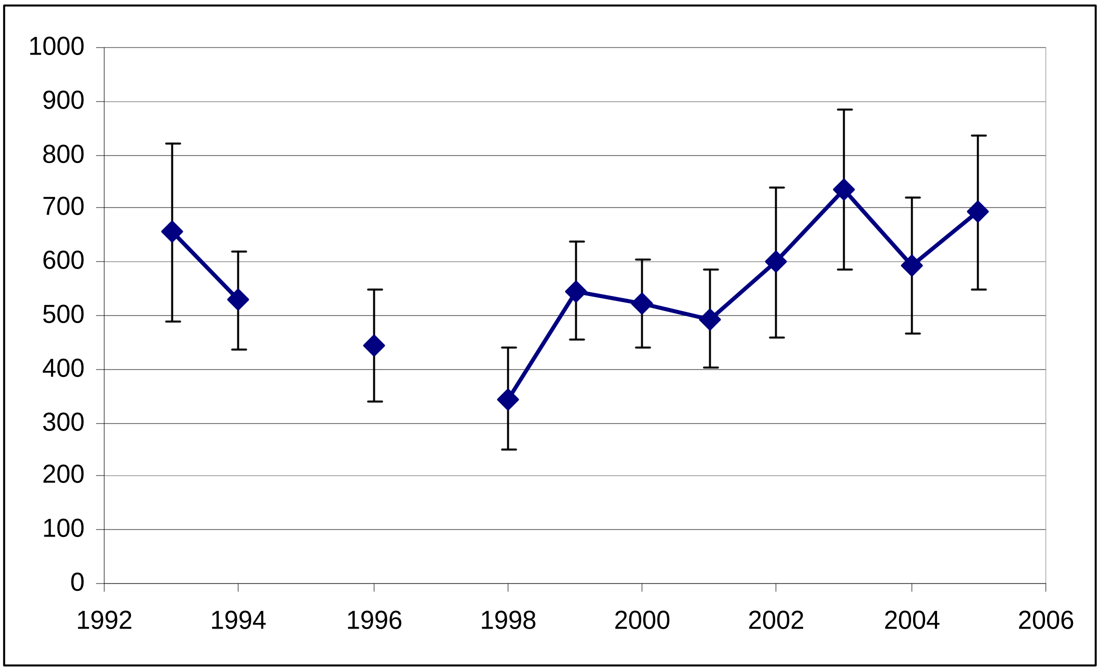


Figure 3.4.4.16 Nephrops, Firth of Forth (FU 8), Time series of TV survey abundance estimates, with 95% confidence intervals, 1993 – 2005.

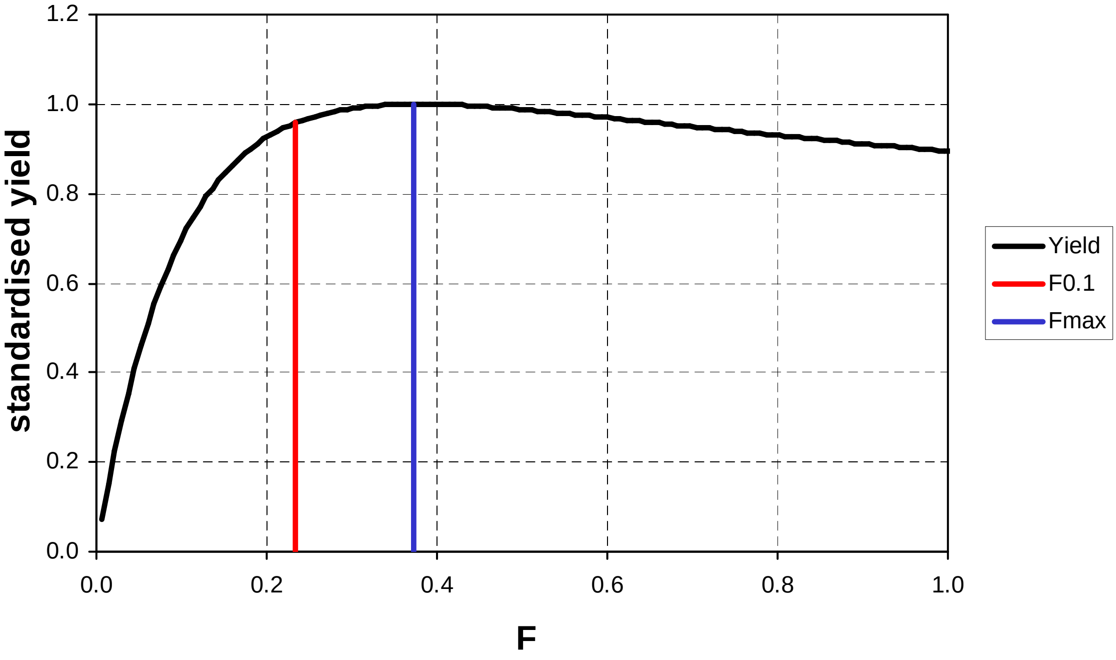


Figure 3.4.4.17 Nephrops, Firth of Forth (FU 8) Combined sex yield per recruit plot (ave length distribution 2003-2005) showing position of F_{max} and $F_{0.1}$

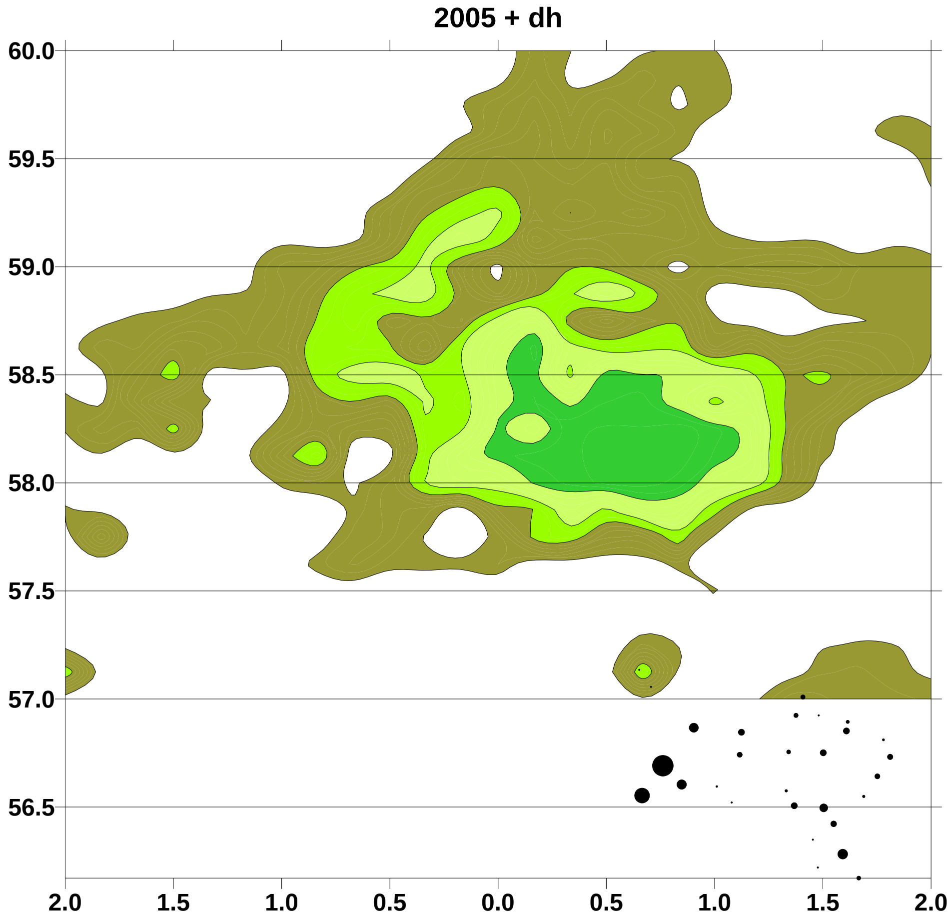


Figure 3.4.4.18 Nephrops, Firth of Forth (FU 8) Distribution of TV stations at the Devils Hole Ground in 2005. The area is located in MAI. For reference the plot is shown in thecontext of the adjacent offshore Fladen Ground FU7 in MA G

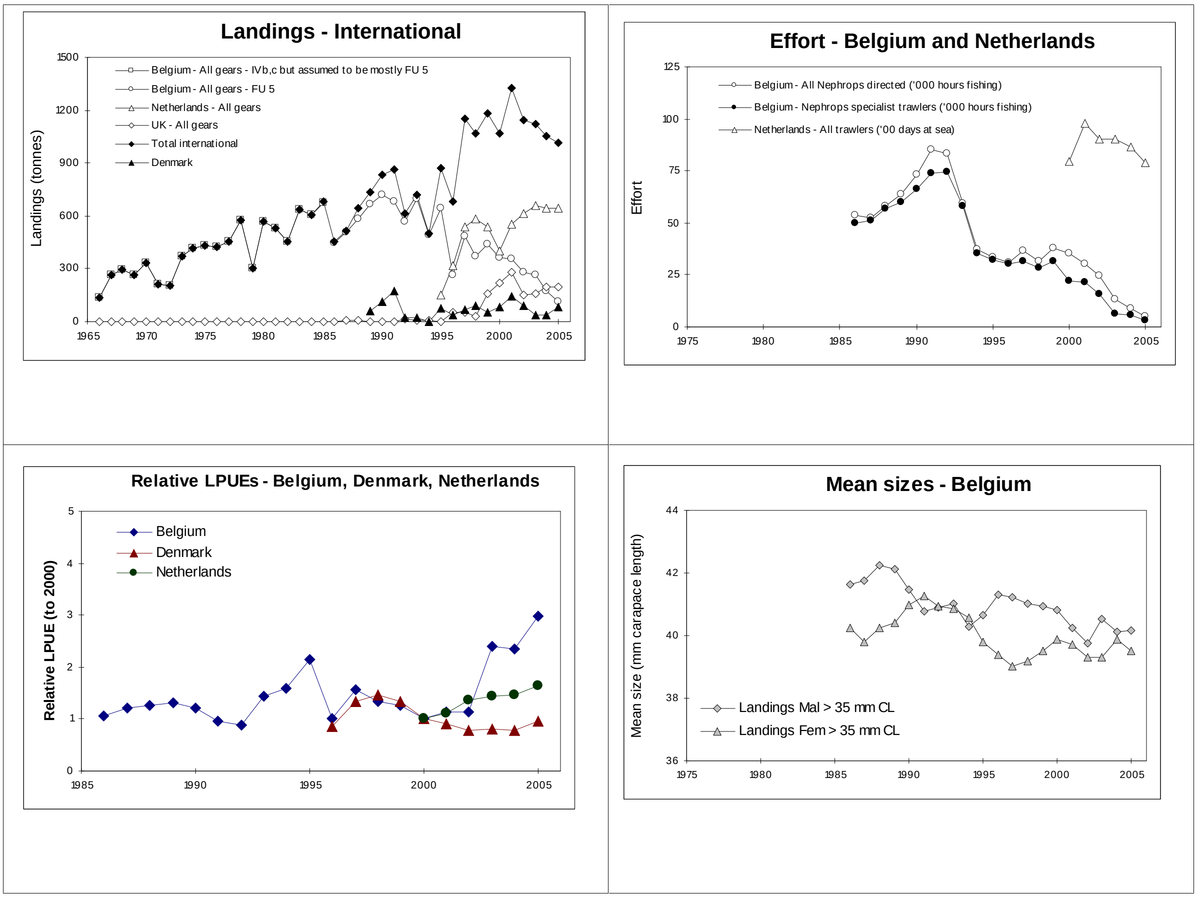


Figure 3.4.5.1 Botney Gut - Silver Pit (FU 5): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of Nephrops.

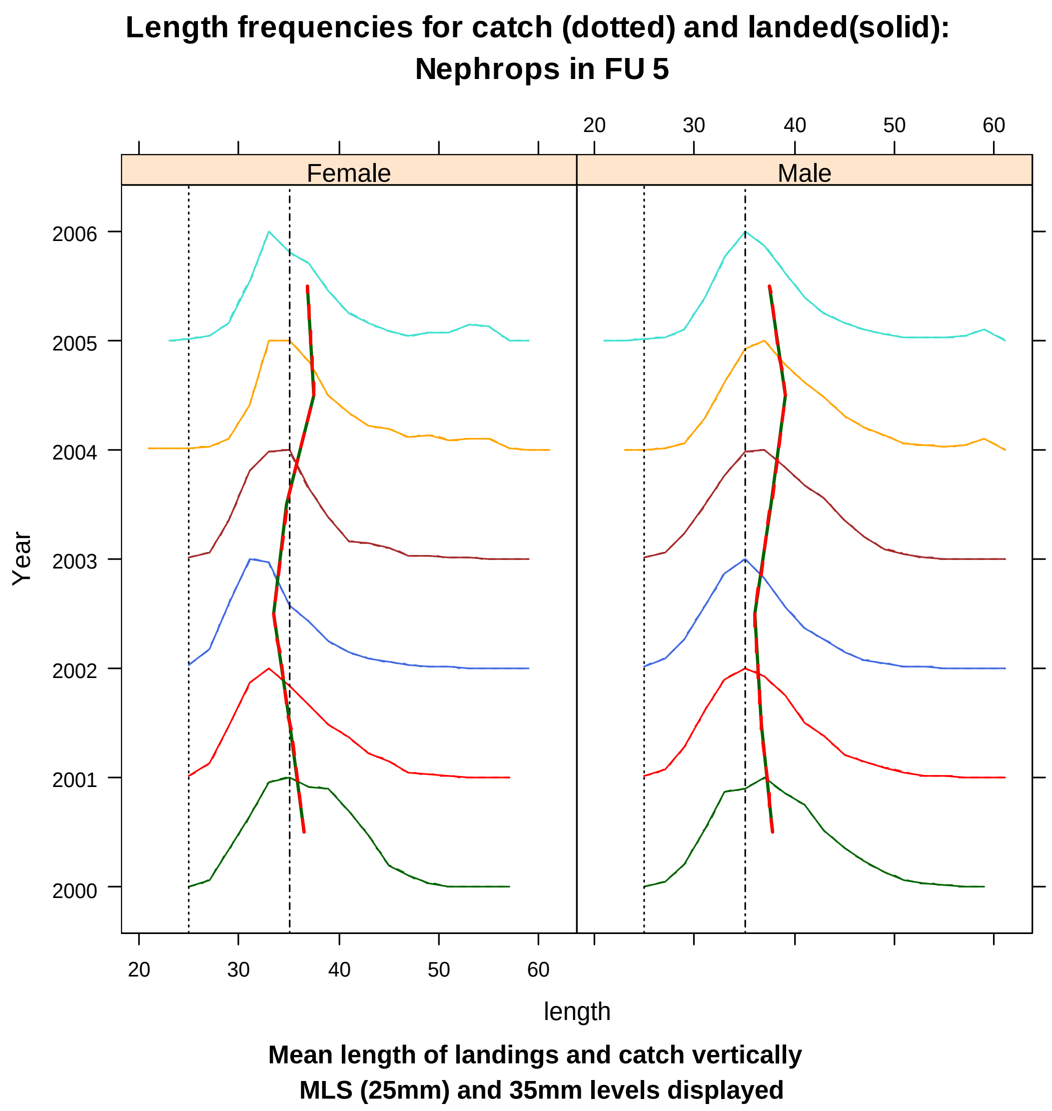


Figure 3.4.5.2 Nephrops Botney Gut – Silver Pit (FU 5) Length composition of catch (dotted) and landed (solid) of males (right) and females left from 2000 (bottom) to 2005 (top). Mean sizes of catch and landings (using same line types) is shown in relation to MLS

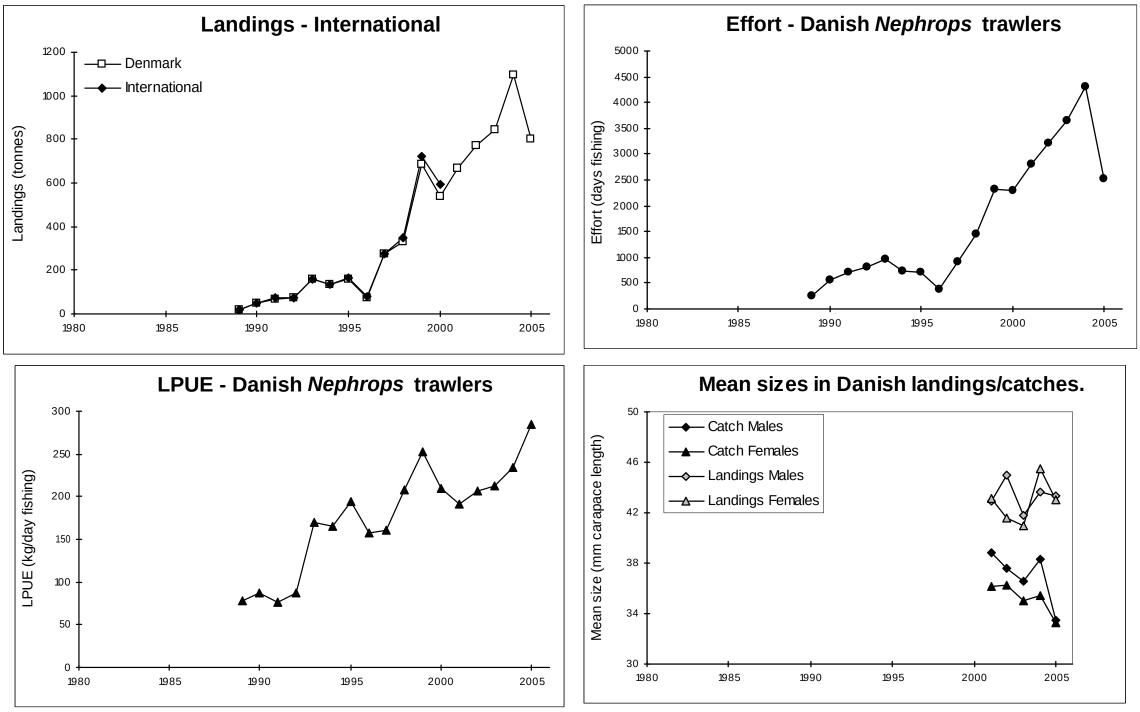


Figure 3.4.5.3 Nephrops Off Horn Reef (FU 33): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of Nephrops.

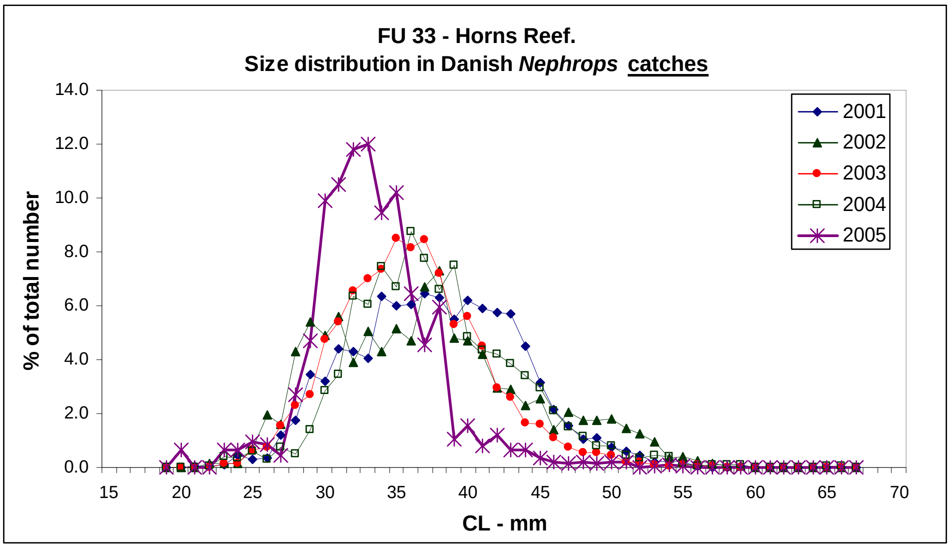


Figure 3.4.5.4 Nephrops Off Horn Reef Size distributions of Danish catches, 2001-2005

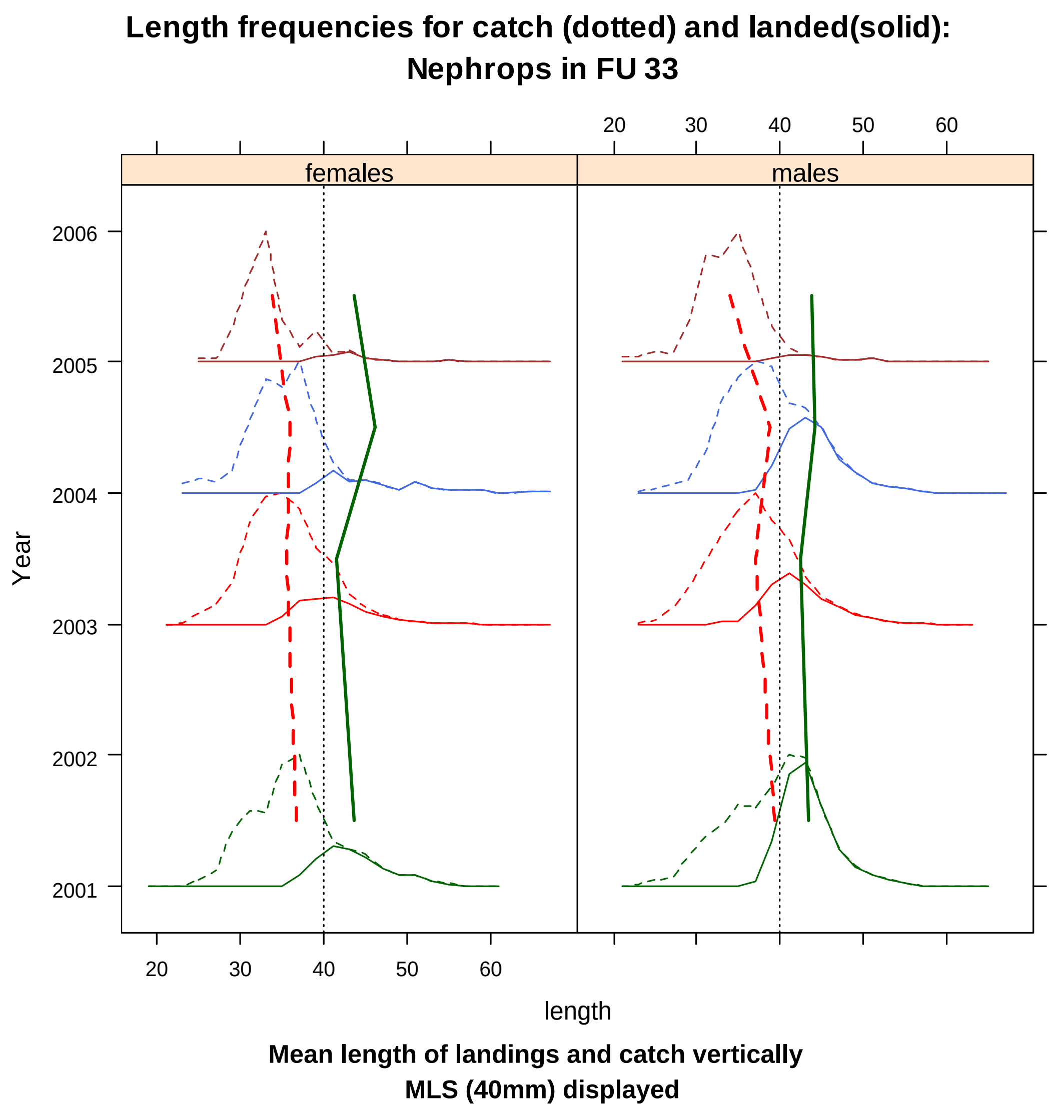


Figure 3.4.5.5 Nephrops Off Horn Reef (FU 33) Length composition of catch (dotted) and landed (solid) of males (right) and females left from 2000 (bottom) to 2005 (top). Mean sizes of catch and landings (using same line types) is shown in relation to MLS

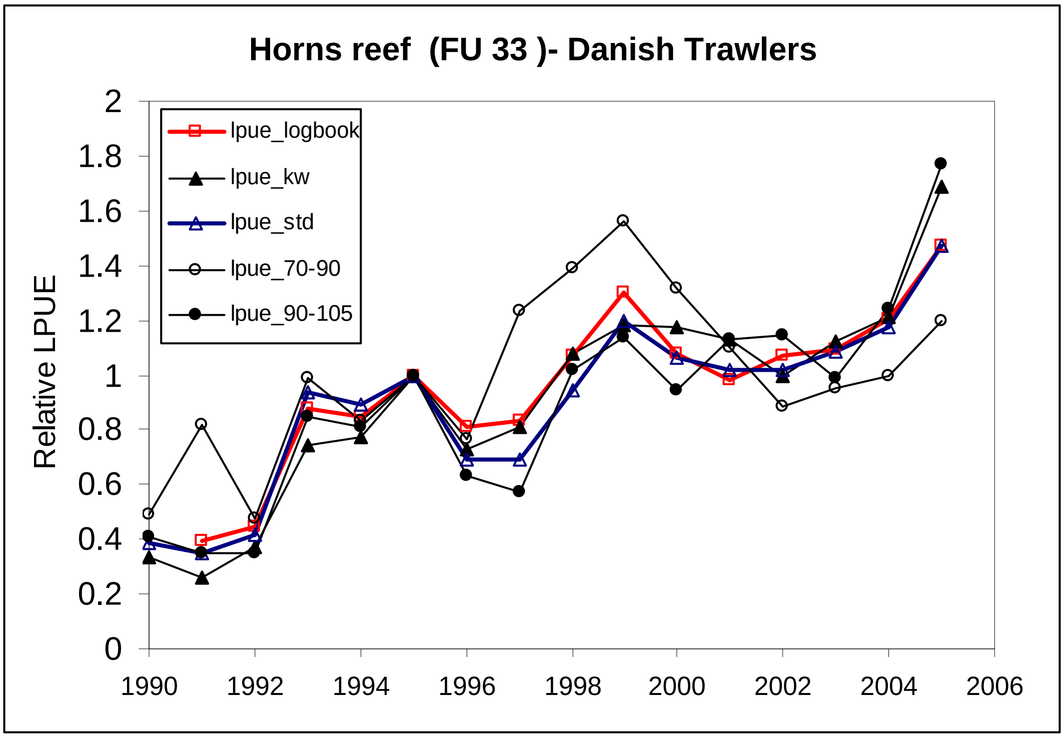


Figure 3.4.5.6 Nephrops Off Horn Reef (FU 33) Danish relative LPUE calculated in various ways

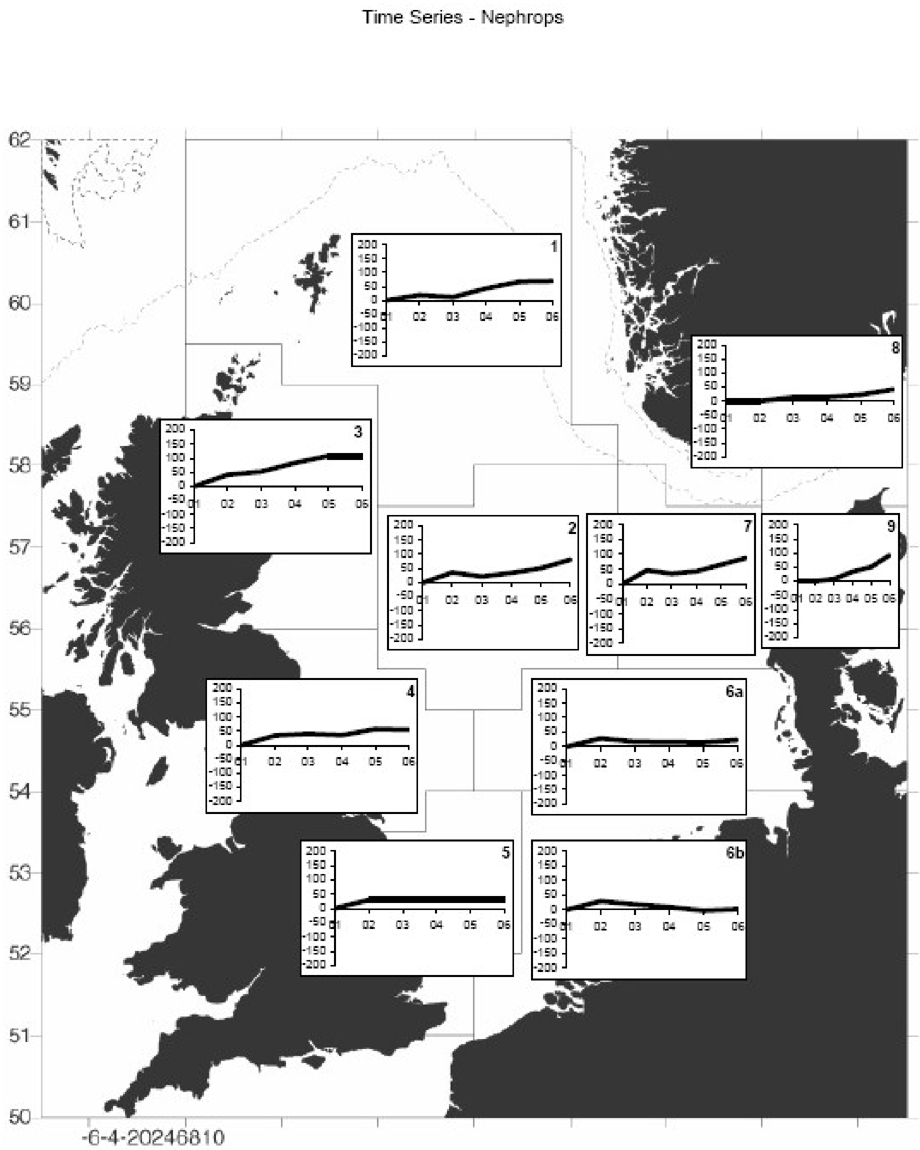


Figure 3.5.1 North Sea Commission Fisheries Partnership stock survey for Nephrops

4 Sandeel in IV

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

4.1 General

4.1.1 Ecosystem aspects

Due to the stationary habit of post-settled sandeels, a patchy distribution of the sandeel habitat, and a limited interchange of the planktonic stages between the spawning areas the sandeel stock in IV consist of a number of sub-populations. Due to a to coarse spatial aggregation level of the fisheries data that is used in the sandeel assessment and a lack of biological information for defining the limits of each of the reproductively isolated population units, it is presently not possible to make an assessment that take account of the sub-population structure of sandeels (see also section 26.5).

The catches of sandeels in area IV consist mainly of the lesser sandeel Ammodytes marinus. However, other species of sandeels is also caught. At some of the grounds in the Dogger Bank area the smooth sandeel Gymnammodytes semisquamatus can be important, and in the catches from more coastal grounds the other Ammodytes species Ammodytes tobianus can be important. The greater sandeel Hyperoplus lanceolatus appears in the catches from all grounds, but usually in insignificant numbers compared to A. marinus. The population dynamics of A. tobianus, G. semisquamatus, and H. lanceolatus are largely unknown, and so are the possible effects on these species of commercial fisheries.

The stock dynamics of sandeels is driven by a highly variable recruitment and a high natural mortality in addition to fishing. The recruitment seems more linked to environmental factors than to the size of the spawning stock biomass. This was confirmed by analyses carried out by the ICES Study Group on Recruitment Variability in North Sea Planktivorous Fish (ICES-SGRECVAP 2006). SGRECVAP considered there was a common trend in recruitment for herring, Norway pout and sandeel with significant shift in recruitment in 2001. However, it could not be assumed that the same mechanism was common for all three species. It was clear that the poor sandeel recruitment from 2002 occurred at low spawning-stock biomass. Further, although the decline in recruitment in sandeels could be linked to both the NAO index and to annual average abundance of Calannus finmarchicus in the central North Sea, it was not possible to determine the mechanisms driving recruitment in sandeels or the link between changes in the environment and sandeel population dynamics.

Sandeels are important prey species for many marine predators, but the effects of variation in the size of this stock on predators are poorly known. Although the direct effects of sandeel fishing that have been identified on other species fished for human consumption, e.g. haddock and whiting are relatively small in comparison to the effects of directed fisheries for human consumption species there is still relatively scant information on the indirect effects of the sandeel fishery. However, even where environmental conditions have been shown to strongly influence breeding success of seabirds, additional detrimental effects of sandeels fishing along the UK east coast have been demonstrated with confidence for the black legged kittiwake and with some likelihood for sandwich tern (Frederiksen et al. 2004, 2005).

Other ecosystem effects of the sandeel fishery are discussed in section 16.5 and ICES-ACE (2003).

4.1.2 Fisheries

General information about the sandeel fishery can be found in the stock quality handbook (no. Q4).

The sandeel fishing season was unusual short in both 2005 and 2006, starting later and ending earlier than in previous years. The late start of the fishery was partly because the Danish fishery first opened the 1st April, in accordance with a national regulation introduced in 2005. Further, weekly data on the oil content of sandeels in the commercial landings, provided by Danish fish meal factories, indicated a late onset of sandeels feeding season in both 2005 and 2006 and that sandeels therefore became available to the fishery later than usual. Landings in the second half year of both 2005 and 2006 were on a low level compared to previous years. Only 14.000 tones were recorded in 2005 and 17.000 tones in 2006.

Regulation of the fishery is no explanation to the small fishery observed from 2003 and onwards (see section 4.2.1). The TAC in force has never been restrictive in the sandeel fishery, and in 2005 (the only year when additional regulation was introduced) the fishery was first regulated in July after the main fishing season.

4.1.3 ICES Advice

Based on the 2005 assessment ICES (ICES-ACFM 2005) concluded that the North Sea sandeel stock has reduced reproductive capacity. SSB in 2004 was estimated to be historic low and under B_{lim}, and to be below B_{pa} from 2000 and onwards. ICES stated that the stock status could not be evaluated in the absence of a defined F reference point. ICES advised that the fishery in 2006 should remain closed until information was available which assured that the stock could be rebuilt to B_{pa} by 2007. The information on which this could be based included a survey in December 2005 and exploratory fishing in April 2006. If the survey indicated that the 2005 year class was at least about average, then real time monitoring of a fishery in 2006 could be implemented.

ICES (ICES-ACFM 2005) also advised that there is a need to develop management objectives to ensure that the stock remains high enough to provide food for a variety of predator species. Further, local depletion of sandeel aggregations should be prevented, particularly in areas where predators congregate.

In the light of studies linking low sandeel availability to poor breeding success of kittiwake, ICES advised in 2000 for a closure of the sandeel fisheries in the Firth of Forth area east of Scotland (see Figure 4.1.2.1).

4.1.4 Management

TAC

The TAC for 2005 was set to 660 960 tonnes in the EU zone. No TAC was defined in the EU zone from the start of the 2006 fishing season. A maximum limit on 20% of the effort applied in 2003 was in force in 2006, until a TAC could be defined on the basis of an estimate of the size of the 2005 year.

Closed periods

Since 2005 Danish vessels has not been allowed to fish sandeels before 31st of March.

In 2005 the sandeel fishery in the Norwegian EEZ was opened April 1 and closed again June 23 to avoid fishery on 0-group sandeels.

Closed areas

All commercial fishing in the Firth of Forth area has been prohibited since 2000, except for a maximum of 10 boat days in each of May and June for stock monitoring purposes. The closure was maintained for three years (see e.g. Wright et al. 2002) and has been extended until 2006, with an increase in the effort of the monitoring fishery to 40 boat days. There is presently no decision for how the fishery in the Firth of Forth area will be managed in 2007.

Recent investigations (Greenstreet et al. 2006) showed the biomass of age 1+ sandeels increased sharply in the Firth of Forth area in the first year of the closure and remained higher in all four of the closure years analysed, than in any of the preceding three years, when the fishery was operating. Further, the biomass of 0-group sandeels in three of the four closure years exceeded the biomass present in the three years of commercial fishing. The closure appears to have coincided with a period of enhanced recruit production.

Real time management (RTM) of the sandeel fishery in the EU zone in 2006

The Council of the EU agreed in December 2005 that the Commission should implement a fishing effort regulation in 2007 for vessels fishing for sandeel in the North Sea and the Skagerrak. The Council of the EU adopted a harvest control rule based on the size of the 2005 year-class.

An *ad hoc* Working Group on sandeel fisheries estimated the size of the 2005 year class to 507 billion or 532 billion using data up to and including week 17 or part of week 18 (see STECF 2006).

Based on the report of the *ad hoc* WG, STECF (2006) recommended:

- "… *they*" (the year class estimates) "*should not be accepted as a true reflection of the size of the 2005 year class and hence should not be used to automatically invoke the harvest rule agreed in Annex IID of Council Regulation (EC) 51/2006 of 22 December 2005*".
- "… *catches in 2006 should be restricted to a level that is predicted to result in the SSB being above Bpa (600,000 t) in 2007, under the assumption that the 2005 year-class strength at age 0 was less than 507 billion*".
- "... *alternative management and assessment methods for North Sea sandeel are evaluated, including the utility of alternative harvest control rules and closed areas taking into account ecosystem-orientated management aims*".

STECF concluded "… *it is reasonable to assume that the 2005 year-class strength at age 0 was at least as strong as the preceding 2003 and 2004 year-classes, which were estimated at 345 billion and 324 billion respectively and notes that this conclusion implies automatic implementation of option b) of the harvest rule. However STECF notes that implementation of option b) of the harvest rule could result in catches up to 300,000 t, which would offer no assurance that SSB in 2007 will be above Bpa*".

STECF noted "… *that there is a real possibility that SSB will be above Bpa in 2007 if effort and catches in 2006 are limited to the levels observed in 2005. This implies that catches in 2006 should be limited to about 170,000 t*".

Following the advice from STECF the fishery for the rest of the 2006 fishing season was managed through a TAC on 300000 t and a maximum limit on effort on 40% of the effort applied in 2003 (EC No. 989/2006)..

The text table below presents the recruitment of sandeels age-0 estimated through RTM, using data up to and including week 17) and recruitment estimated during this WG (SXSA analysis, see section 4.3).

Year class	RTM	SXSA
2003	650	278
2004	148	177
2005	507	425

There is some agreement between the RTM and assessment estimates for the 2004 and 2005 year class, whereas the RTM estimate for the 2003 year class was an overestimate. The RTM estimation procedure was modified in 2004, to reduce the risk of overestimating small year classes, following advice from STECF (2004). This modified procedure was used to estimate the 2004 and 2005 year class.

The Norwegian in-year monitoring fishery for sandeel in 2006

The Norwegian Ministry of Fisheries and Coastal affairs decided to conduct a limited monitoring fishery in spring 2006 in the Norwegian EEZ. IMR was given the responsibility to develop methodology and to suggest re-opening criteria it was decided to conduct the experimental fishery in week 16-18 with 6 commercial vessels. Logbooks from the industrial fleet are not available. However, data from the Norwegian satellite-based vessel monitoring system (VMS) which are available from 2001 onwards can be used to estimate effort, and CPUE can then be estimated by combining VMS and landings data (which exist electronically on trip level). The correlation between estimated CPUE of age 1 (based on VMS and landings data) and estimated abundance of age 1 (from the latest ICES assessment) was positive and significant ($p < 0.05$) for the years 2001-2005 (both for data from the entire fleet and for data from the 6 selected vessels). This indicated that the CPUE from the monitoring fishery in 2006 could be used to predict the strength of the 2005 year-class. As the fishery in 2001-2005 was highly contracted compared to before 2000 (see Section 4.2.1), it was necessary to obtain a measure of the distribution of sandeel in NEEZ. Therefore, during the 3 weeks of the monitoring fishery each vessel was assigned two “free” weeks (ordinary fishery), whereas in one week the vessels were directed by IMR and had to visit all the important sandeel fishing grounds in NEEZ. The purpose of this design was twofold: (1) use CPUE from the “free” weeks to predict the 2005 year class strength and (2) assess the spatial distribution of the stock based on the results from the directed week.

Because of the low number of vessels participating in the experimental fishery compared to ordinary fishery, less competition on the fishing grounds for sandeel schools and the best fishing places could be expected. This could result in increased efficiency and overestimation of the stock. However, there was no information as to how much reduced competition could affect the estimates. In the Barents Sea, the CPUE for Greenland halibut approximately doubled when changing from ordinary to experimental fishery (ICES-AFWG 2006). Because of the unknown impact of reduced competition, it was not possible to establish an objective criterion for reopening the fishery. Based on this uncertainty and the poor situation for sandeel in NEEZ, IMR decided to base the advice for reopening the fishery on the 2005 year-class being above average (even though the deterministic forecast made by ICES in 2005 on a North Sea scale predicted that an year-class corresponding to the 25 % percentile could be sufficient). A scientific survey conducted in parallel with the monitoring fishery also gave information regarding the second criteria (distribution). The CPUE from the monitoring fishery predicted the number of age 1 sandeel in 2006 to be about 60 % of the average (1983-2005), and the spatial distribution of the stock in 2006 was significantly different from the period 1995-1999 (sandeel was only found on two of the traditional fishing grounds). IMR therefore recommended not to open the fishery, this recommendation being accepted and implemented by the Norwegian government.

4.2 Data available

4.2.1 Catch

Landing and trends in landings

Landings statistics of sandeels is given in Tables 4.2.1.1 to 4.2.1.5. For 2004 and 2005 official landings were only available as total landings for Area IV. Figure 4.1.2.1 shows the areas for which catches are tabulated in Tables 4.2.1.1 to 4.2.1.5. The catch history is shown in Figure 4.2.1.1.

The sandeel fishery developed during the 1970's, and landings peaked in 1998 at more than 1 million tons. Since then there have been a rapid decrease in landings, and the total landings were at a historic low level in 2005 with a small increase from 2005 to 2006 (Figure 4.2.1.1 and Table 4.2.1.2). Danish and Norwegian landings in 2003 were only 44% and 17% of those in 2002.

There are different patterns in landings of sandeel in the EU and Norwegian economical zone (EEZ) (Figure 4.2.1.2). In the EU EEZ landings remained relative stable between 1994 and 2002, followed by ~50% reductions in 2003 and 2004, and 76% reduction in 2005 as compared to the average between 1994 and 2002. In NEEZ there were marked reductions in the landings around 2000. In 2003 and 2004 landings decreased drastically by almost 90% and 94% in 2005. In 2006 there was only a limited experimental fishery in NEEZ, which showed that the I-group abundance was at the same level as in 2005.

The distribution of landings

The spatial distribution of sandeel landings is considered as a good representation of stock distribution, except for areas where severe restrictions on fishing effort is applied (i.e. the Firth of Forth, Shetland areas, and Norwegian EEZ in 2006). Figure 4.2.1.3 shows the distribution of catches for 2005 and first half year of 2006 by quarter and ICES statistical rectangle. Yearly landings for the period 1995-2005 distributed by ICES rectangle are shown in Figure 4.2.1.4.

Large variations in the fishing pattern occurred concurrent with the decline in the total fishery and CPUE (section 4.2.5). The distribution of landings in the southern North Sea in 2003 to 2005 seemed more extensive than the typical long-term pattern in the same area. Further, grounds usually less exploited became more important for the total fishery during the same period. In 2006 there was another large change in the fishing pattern, when the fishery showed a strong concentration at the fishing grounds in the Dogger Bank area. Although this overall large variation in fishing pattern there is a general high importance for most years of the Dogger Bank area.

In the Northern North Sea, mainly NEEZ, the change in the spatial pattern was significantly different from southern part. The highest landings from a single statistical square were taken in 1995 on the Vikingbank (Figure 4.2.1.4), the most northerly fishing ground for sandeel in the North Sea. However, in 1996 landings from the Vikingbank dropped substantially, and since 1997 have been close to zero. The marked reduction in landings around 2000 in NEEZ (Fig. 4.2.1.2) was accompanied by a marked contraction of the fishery to a small area in the southern part of NEEZ, the Vestbank area. In this area landings remained high in 2001 and 2002 due to the strong 2001 year-class. However, the 2001 year-class was only abundant in the Vestbank area, which resulted in a highly concentrated fishery and the decimation of the year-class before it reached maturity in 2003. This may have led to the collapse of the sandeel fishery in NEEZ. In the EU EEZ any contraction of the fishery has been less apparent.

For this years assessments Danish landing of 13739 t of sandeels in second half year of 2005 was added to first half year landings data on 141057 t. This was necessary because insufficient biological as well as effort data exist for second half year of 2005. An alternative would be to apply biological data from previous years second half year on the catches from second half year of 2005. However, this was found inappropriate because of the large change in fishing pattern that have occurred in recent years (see section 4.2.5) and because of insufficient effort data. Applying ALK's from first half year of 2005 on catches from second half year could underestimate the fraction of especially 0-group sandeels in the catches, as 0-group sandeels can be important in the second half year. However, more than 99% of landings from second half year of 2005 come from July (Table 4.2.1.5) when 0-group sandeels usually are not important. A delay in the onset of sandeels feeding season (section 4.1.2) supports this view.

4.2.2 Age compositions

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

4.2.3 Weight at age

The compilation of age-length-weight keys was carried out using the method described in the stock annex. The mean weights-at-age in the catch for the northern and southern North Sea in the time period 2001 to 2006 are given by country in Tables 4.2.3.1 and 4.2.3.2. The mean weight at age in the catch used in the assessment is the mean weights at age in the catch for the Southern and Northern North Sea weighted by catch numbers. Mean weight in the catch from 1983 to 2006, used in the assessment is given in Table 4.2.2.3 by half year.

The mean weight at age in the stock is mean weight in the catch first half-year, and an arbitrary chosen weight at 1 gram was used for the 0-group. Mean weight in the stock from 1983 to 2006 is given in Table 4.2.3.4 by half year. Mean weight in the stock from second half year of 2004 was also used for second half year of 2005 where no data was available. The alternative of using average figures over a range of years was found inappropriate due to changes in mean weigh at age in recent years. This change is probably due to large changes in the fishing pattern (see section 4.2.5).

The time series of mean weight in the catch and in the stock is shown in Figure 4.2.3.1 and 4.2.3.2. Mean weight at age show large fluctuations over time. Most remarkable is a decrease in mean weight at age for age 2 and 3 sandeels in the first half year, the period where most of the catch is taken. This large variability is due to temporal and spatial variability in the growth of sandeels, and because the industrial fishery target different part of the sandeel populations during the year and between years (section 4.2.5). Additional information about the variation in catch weight at age can be found in the stock quality handbook (Q4). No major or unusual change in mean weight in the stock and in the catch was recorded in 2005 and 2006 compared to previous years, although a tendency towards an increase in mean weight is observed for all age classes.

4.2.4 Maturity and natural mortality

Maturity and natural mortality, used also in this year’s assessment, are assumed at fixed values and are described in the stock annex. The proportion mature is assumed constant over the whole period with 100% mature from age 2 and 0% of age 0 and 1.

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

AGE	FIRST HALF YEAR	SECOND HALF YEAR
0	0.0	0.8
1	1.0	0.2
2	0.4	0.2
3	0.4	0.2
4+	0.4	0.2

4.2.5 Catch, effort and research vessel data

The catch data the assessments

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

Recent changes in the fleet composition

The size distribution of the Danish fleet has changed through time, with a clear tendency towards fewer and larger vessels (ICES-WGNSSK 2006). This change is especially apparent in 2005, when only 98 Danish vessels participated in the North Sea sandeel fishery, compared to 200 vessels in 2004 (Table 4.2.5.1). Although the number of vessels in the fleet increased to 124 in 2005, this is still low compared with historical fleet numbers. The capacity of the Danish fleet participating in the North Sea sandeel fishery is not likely to increase in the short term, due to decommissioning of a substantial number of vessels during the last years. The same tendency, as that for the Danish vessels, is seen for the Norwegian vessels fishing sandeels (Table 4.2.5.1). It should however be noted, that in 2006 only 6 Norwegian vessels were allowed to participate in an experimental sandeels fishery in the Norwegian EEZ.

Trends in overall effort and CPUE

Figure 4.2.5.1 and Tables 4.2.5.2 and 4.2.5.3 show the trends in the international effort over years. The figures for 2006 only include first half year. However, landings in second half year of 2006 (about 17.000t) were small compared to landings from first half year on 266.500t. Total international standardized effort peaked in 1989, and was at a relative stable level from 1989 to 2001. There was a large decrease in effort from 2001 to 2002 and another decrease in effort from 2004 to 2005. The low effort in 2005 was retained in 2006. The reduced fleet capacity (Table 4.2.5.1) and high fuel prices may have been the reason to the low effort in 2006.

Figure 4.2.5.1 shows the trends in CPUE over years. CPUE fluctuated without a clear trend throughout the period 1983 to 2001. A large increase in CPUE was observed from 2001 to 2002, followed by a steep decrease from 2002 to 2003. CPUE has been increasing since 2004. A discussion about the possible problems of using CPUE as an index of sandeel population size is included in section 4.3.3 and 4.9.

The tuning series used in the assessments

As in previous assessments effort data from the commercial fishery in the northern and southern North Sea are treated as two independent tuning fleets separated into first and second half year. Because of the trends in the residuals for 1-group sandeels in the first half year, the two tuning fleets in the first half year were in the final assessment from 2005 split into two time periods, i.e. before and after 1999. This change in the tuning series removed the trends in the residuals of log stock numbers, and the tendency to underestimate F and overestimate SSB was reduced. Information about the size of the trawls used by Danish vessels fishing sandeels (Figure 4.2.5.2) show an increase in trawl size from 1988 to 1994 and a larger increase from 1997 to 1998. This is a clear indication of an increase in catchability of the Danish vessels fishing sandeels, due to gear technology. However based only on this information it is not possible to quantify the likely change in catchability over the years.

The definition of tuning fleets used in 2005 was also used in this year’s assessment. The following tuning series were used (Table 4.2.5.4):

- Fleet 1: Northern North Sea 1983-1998 first half year
- Fleet 2: Northern North Sea 1999-2006 first half year
- Fleet 3: Southern North Sea 1983-1998 first half year
- Fleet 4: Southern North Sea 1999-2006 first half year
- Fleet 5: Northern North Sea 1983-2005 second half year
- Fleet 6: Southern North Sea 1983-2005 second half year

The effort data for the southern North Sea prior to 1999 are only available for Danish vessels, but since 1999 Norwegian vessels have also provided effort data. These data for the first half year has since 2003 been included in tuning series. The effect of this on the assessment was analysed in the 2004 assessment (see ICES-WGNSSK 2005). The tuning fleet used for the northern North Sea is a mixture of Danish and Norwegian vessels. A separation of the Danish and Norwegian fleets is only possible from 1996, due to the lack of Norwegian age-length keys for the period before 1996. Separate national fleets are preferable because this will make the procedure for the generation of the tuning series more transparent. This issue should be part of a revision of the CPUE tuning series addressed at the next benchmark assessment.

Effort data for Norwegian vessels were not available for the southern North Sea in 2005 and 2006 due to no fishing in 2005 and in 2006 when Norwegian vessels were not allowed to fish in EU waters. No effort data was available for the Danish vessels for the second half year of 2005 (see section 4.2.1).

Standardisation of effort data

Due to the change in size distribution of the vessels fishing sandeels in the North Sea (see e.g. ICES-WGNSSK 2005) and the relationship between vessel size and fishing power effort standardisation is required when establishing the commercial tuning series used in the sandeel assessment. The standardisation was carried out using the same procedure as during last years WG meeting. The standardisation procedure is described in the stock quality handbook (Q4).

The combined Norwegian and Danish effort is shown in Tables 4.2.5.2 and 4.2.5.3. The tuning fleets used in the assessments area given in Table 4.2.5.4. The CPUE for these fleets are summarised in Figures 4.2.5.3 and 4.2.5.4.

Trends in CPUE tuning series

Similar trends were observed in CPUE in the northern and southern North Sea in first and second half year (Figure 4.2.5.3). The exception is 2002 when there was a marked decrease in CPUE in the first half year and a large decrease in the second half year. The CPUE was on a historic low level in 2003, after when CPUE increased. This increase is due to an increase in CPUE only for age-1 sandeels, whereas CPUE for age 2+ sandeels has not increased (Figure 4.2.5.4).

The historic high CPUE of the 2001 year class in 2001 (Figure 4.2.5.4), was followed by a high CPUE of age-1 sandeels in 2002 but only by about average CPUE of age-2 sandeels in 2003.

Fisheries independent tuning

There are no survey time-series available for this stock.

4.3 Data analyses

Seasonal XSA (SXSA) is used as the assessment model for sandeels in IV because it allows the use of data from first half year of the assessment year, and it therefore provides a more up to date evaluation of the stock status than the XSA. Comparison between the SXSA and XSA has been carried out during several WG meetings and in all cases the models show about the same trends in stock development. This year the XSA model was also used as a comparison to the SXSA. This comparison is relevant because of almost no fishing in second half year of both 2005 and 2006 (see section 4.1.2 and 4.2.5).

4.3.1 Reviews of last year’s assessment

The ACFM review group (RGNSSK) agreed with the WG that it is important to carry out surveys for sandeels. The major source of uncertainty in the assessment is the lack of a fishery-independent survey. The use of standardized commercial CPUE may result in auto-correlation problems between the tuning series and the catch at age data, which may mask uncertainty in the analysis. The RGNSSK considered that a detailed analysis of the current commercial CPUE data should be carried out in order to account for an increase in fleet efficiency in recent years.

An analysis on the possible increase in fleet catchability is found in Section 4.2.5.

4.3.2 Exploratory catch-at-age-based analyses

Settings used in the assessment models

The same tuning series (Table 4.2.5.4, presented in section 4.2.5) were used for the XSA and SXSA analysis.

The Seasonal XSA developed by Skagen (1993) was used to estimate fishing mortalities and stock numbers at age by half year, using data from 1983 to 2005 and first half year of 2006. The settings used in the SXSA are listed in Table 4.3.2.1.

The following settings were used in the XSA model:

TIME SERIES WEIGHTS	NONE
Power model	No
Catchability independent of age	>=2
F-shrinkage S.E.	1.5 (5 years and 2 ages)
Min. standard error for pop. estimate	0.3
Prior weighting	none
Number of iterations	20
Convergence	Yes

Settings used this year in the assessment models compared to 2004 and 2005

The settings used for this year's SXSA assessment are the same as those used for the final 2005 SXSA assessment. These settings were also used in 2004, except for the tuning fleets which were not split into time series before and after 1998.

Also the settings used in the XSA analysis are the same as the settings used in 2004 and 2005, except for the tuning series which in neither 2004 nor 2005 were split into time series before and after 1998.

Results of the SXSA analysis

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

The residuals of log stock number for the SXSA analysis are given in Figure 4.3.2.1. There are no clear trends in the residuals of log stock numbers for any of the age groups. The retrospective analysis (Figure 4.3.2.2) shows that the SXSA has a tendency for underestimating F and overestimating recruitment. This tendency is also seen in the plot of the historical performance of the assessments (Figure 4.3.2.4). This plot also shows a tendency for underestimating SSB. The implications of this retrospective bias are discussed in sections 4.6 and 4.9.

Results of the XSA analysis

The stock summary of the XSA analysis is presented in Table 4.3.2.7.

4.3.3 Exploratory survey-based analyses

Runs carried out with the SURBA software using only CPUE data gave more optimistic SSB estimate for the recent years than the converged Seasonal XSA estimates (Figure 4.3.3.1a-b).

SURBA may over-estimate SSB in the recent stock biomass due to an ongoing improved efficiency in the fishing fleet. Clearly, if this efficiency improvement is ignored, a Harvest Control Rule, which is based on CPUE data, will give a too high estimate of the stock size.

4.3.4 Conclusions drawn from exploratory analyses

The SXSA and the XSA give similar trends for both SSB, recruitment, and F_{1-2} (Figure 4.3.2.4). Recruitment in 2005 is in both assessments estimated to just below average. Both assessments show a decline in F_{1-2} from 2004 to 2006.

4.3.5 Final assessment

SXSA was chosen as the final assessment, because it allows the use of data from the first half year of the assessment year. Results from SXSA and XSA models were very similar.

4.4 Historic Stock Trends

The stock summary is given in Figure 4.3.2.3. The final assessment estimate SSB in 2005 to be historic low and under B_{lim}. Further, SSB is estimated to be below B_{pa} from 2000 and for the rest of the time series. Also in 1986 and from 1989 to 1992 SSB was on a low level, but SSB has previous to 2000 not been below B_{pa} for two consecutive years. One reason for the low SSB in recent years is low recruitments from 2002, of which the recruitment in 2002 was historic low. The decrease in SSB in recent years has occurred in spite of that the effort of the fleet has decreased during the same time period (see section 4.2.5).

The large 2001 year class did not lead to an increase in SSB in 2003. This year class was exposed to a high fishing mortality as 0-group in 2001 and as 1-group in 2002 (Table 4.3.2.2. and 4.3.2.3).

The decrease in the sandeel stock has led to a large decrease in sandeel landings. Danish landings has declined 56% from 2002 to 2003 and Norwegian landings declined by more than 80%. The decrease in landings seen since 2003 has been particularly large in the northern part of the North Sea, with a reduction on 83% in 2003 and 96% in 2006 compared to average landings in 1994-2002 in the same area (Figures 4.2.1.2 and 4.2.1.3 and Tables 4.2.1.3 and 4.2.1.4), and the proportion of total landings in the northern part of the North Sea decreased from 22% in 2002 to 5% in 2006.

This SXSA assessment shows a large increase in TSB from 2005 to 2006, due to the recruitment in 2005 that is estimated to just below average. This is in line with results from DIFRES surveys carried out in December 2004 and 2005 (see section 4.5). These surveys predicted an increase in sandeel abundance at most of the grounds surveyed (DIFRES unpublished information). The exception was grounds in the north eastern part of the North Sea, at which an IMR survey also measured low sandeel abundance in 2006. Both the fishery (section 4.2.1) and scientific surveys (section 4.5) indicate that the stock size in the northern part of the North Sea is on a much lower level than in the southern part of the North Sea.

Owing to the large change in the North Sea sandeel stock a harvest control rule has been implemented since 2004, to adjust the fishing effort to the reduced size of the sandeel population in order to prevent recruitment overfishing (see e.g. STECF, 2004, 2005a and 2006).

4.5 Recruitment estimates

As no recruitment estimates from surveys are available, recruitment estimated in the assessments are based exclusively on commercial catch-at-age data. The tuning diagnostics indicate that the 0-group CPUE is a rather poor predictor of recruitment.

Provisional information about the 2006 year class

Due to low fishing in second half year of 2006 (see section 4.2.1) there are no fishing data from 2006 that can be used to estimate the size of the 2006 year-class.

The Danish Institute for Fisheries Research (DIFRES) will carry out a survey in December 2006 that may provide information about the size of the 2006 year class (see the text below). Further the Institute of Marine research (IMR) plan to conduct two surveys in 2007 to measure the abundance 1-group and older sandeels in April/May and the abundance of 0-group sandeels in August/September (see the text below).

Recruitment estimates used for short term forecasting

For the short term forecast (section 4.6) the 25th percentile, on 322 10^9 age-0 sandeels, of the long-term average recruitment estimated in the final SXSA assessment was used as the recruitment in 2006 and 2007. This was used because recruitment has been low from 2002 to 2004 and is estimated to below average in 2005.

Fisheries independent information on sandeel abundance

There is no fishery independent time series of sandeel abundance in the North Sea because the ICES co-ordinated surveys are not suited to measure densities of this species and because there are no other annual dedicated research sampling programmes for this species.

A range of surveys have been carried out by Danish, English, German, Norwegian and Scottish research institutes, but these field investigations have been targeted to answer specific questions about the biology in smaller localised areas, more than to investigate overall changes in sandeel abundance.

In recent years research has also been focused towards investigations of survey designs that may provide abundance indices of sandeels for the use of stock assessment if implemented in future large scale sampling programmes. Different sampling devices and approaches have been used, e.g. i) sampling of juvenile and adult sandeels from the water column using demersal and pelagic trawls and acoustic measuring techniques, ii) sampling of the pelagic life stages by use of different types of larval sampling devises, iii) sampling of post-settled fish from the seabed using different types of seabed sampling devises, demersal trawls and dredges. There have not been any systematic comparisons of all the different sampling approaches used. However, a comparison of the methods used for measuring abundance of post-settled sandeels (juvenile and older sandeels) has been carried out by Greenstreet et al. (2006), using survey data and commercial CPUE data from the Firth of Forth area. This analysis showed that survey indices of sandeels must take account of the highly variable fraction of sandeels that may reside in the seabed during the time of survey, in order to provide unbiased estimates of sandeel abundance.

Three EU fishery research institutes (FRS, DIFRES and CEFAS) and IMR in Norway have employed a modified scallop dredge to obtain estimates of relative density of sandeels in the sand for some specific areas and times. This sampling approach is useful because sandeels tend to lie dormant in the sediment during the night time and late autumn and winter. DIFRES has collected information about relative abundance and age/length distribution of post-settled sandeels on surveys since 1996 using this modified scallop dredge. Sampling has since 2003 been standardised according to sampling time and locations, in order to establish a time series of data that can be used as relative abundance estimates of post-settled sandeels. Sampling is carried out in the end of the year, when sandeels have commenced their winter dormancy period, and the catchability of the gear is supposed to be largest. Sampling is carried out at 28 fixed positions at known sandeel habitat situated at the most important fishing banks in the North Sea from the Little Fisher Bank in the North Eastern North Sea, to the Dogger Bank area in the south western North Sea. This survey was able to predict an increase in local abundance of sandeels from 2005 to 2006, as suggested by the fishing pattern (section 4.2.1) and the forecast (section 4.6).

Institute of Marine research (IMR) plan to conduct two surveys in 2007 to further develop methodology and to measure the abundance 1-group and older sandeels in April/May and the abundance of 0-group sandeels in August/September. During these surveys a multi-frequency echo-sounder (18, 38, 200 and 400kHz) is used to identify and measure the abundance of sandeels in the free water-masses during daytime, and a Van Veen grab and a modified scallop dredge (Danish type) are used to sample sandeels in the seabed during night. This survey approach was tested during a preliminary survey in April/May 2005, and surveys in April/May and July/August 2006.

4.6 Short-term forecasts

The high natural mortality of sandeel and the few year classes in the fishery make the stock size and catch opportunities largely dependent on the size of the incoming year classes.

Although recruits (age 0) usually have appeared in the second half years fishery at the time of the WG, the biological samples from this fishery are normally not available. Further, the 2006 fishing season was unusual because there was no fishery after July (see section 4.2.1). There is therefore no information in the 2006 catch data that can be used for the estimation of the 2006 year-class.

0-group CPUE is a poor predictor of recruitment (ICES-WGNSSK 2003) why traditional deterministic forecasts are not considered appropriate. However, because of the low sandeel stock the working group did provide an indicative short term prognosis during the working group meetings in 2004 and 2005, using a range of scenarios for the recruitment and exploitation pattern. The same approach as in 2005 was taken during this WG meeting to carry out a short term prognosis for 2007 and 2008.

Using the same forecast procedure as last year, SSB in 2007 is predicted to rise to just above B_{lim} but remain below B_{pa}. The input data for this is given in the first text table below. It was noted that short term forecasts from 2004 and 2005 overestimated the SSB in 2005 and 2006 by a factor 2-3 when compared to the SSB estimated by the SXSA in 2006 (section 16.5). This overestimation bias has been addressed using an alternative forecast methodology described below.

Standard prognosis for 2007 and 2008

The prediction was made using half year time steps.

In the absence of information about the recruitment a low recruitment was assumed for 2006 and 2007. This was used because recruitment has been low from 2002 to 2004 and is estimated to below average in 2005 in this year’s assessment. Recruitment in 2006 and 2007 was assumed to be 322 109, which is the 25th percentile of the long-term average recruitment (section 4.5). Stock and catch weights for the second half year of 2006 and for 2007 and for first half year of 2007 were taken as averages of half year values of 2004-2005. Stock numbers at 1st of January 2006 were taken from the final SXSA assessment. F-at-age for second half year of 2006 was taken as F-at-age for first half year of 2006 multiplied by 0.07 (landings in second half year divided by landings in first half year of 2006, see section 4.2.5).

F-at-age for the first half year of the forecast year was taken as the average exploitation pattern for 2004-2005, scaled to F1-2 in 2005. 2005 first half year Fsq=0.582. F-at-age for the second half year of the forecast year was taken as average of 2004 and 2005 F-at-age. Data used in this forecast is given in Table 4.6.1.

SSB(2007) = 498000 t; landings (2006) = 276000 t. Input data in Table 4.6.1.

Rationale	Relative effort F(2007)/F(2005)	Basis	F(2007)	Landings (2007) `000 t	SSB(2008) `000 t
Zero catch	0	F=0	0.000	0	762
	0.1	Fsq*0.1	0.073	68	708
	0.2	Fsq*0.2	0.145	132	658
	0.3	Fsq*0.3	0.218	193	612
	0.4	Fsq*0.4	0.291	249	569
	0.5	Fsq*0.5	0.364	303	529
	0.6	Fsq*0.6	0.436	353	492
	0.7	Fsq*0.7	0.509	401	457
	0.8	Fsq*0.8	0.582	445	425
	0.9	Fsq*0.9	0.655	488	395
Status quo	1.0	Fsq*1	0.727	527	367
	1.1	Fsq*1.1	0.800	565	341
	1.2	Fsq*1.2	0.873	601	317

Shaded scenarios are not considered consistent with the precautionary approach.

Revised prognosis methodology

Another short term forecast was carried out, where the start population and the F-s-at-age in the first half year of 2006 was corrected according to the bias identified in the assessment (see section 4.3). In order to estimate potential bias in the terminal population sizes and F's, an analysis was made from the retrospective SXSA runs. A bias factor was determined for each year by dividing the terminal estimate of each retrospective run with the "true" value as estimated by this year's final assessment (Figures 4.6.1 and 4.6.2). The bias factor taken forwards to the short term forecast was the mean ratio over the period 2000-2005. As retrospective corrections continue to be made for several years, the bias correction factors for the most recent 1-2 years may be underestimates. Additional analyses were made to investigate the change in bias correction when comparing terminal values with "converged" values taken from retrospective runs 1 or 2 years later. This demonstrated that the bulk of the correction is made in the first year with much smaller corrections in the second year (Table 4.6.2). There is no trend in the bias estimates, the bias estimates in 2004 and 2005 are not significantly smaller than preceding and we are using a mean value, therefore the potential bias in the bias correction factor is thought to be small. The input data used in this forecast is given in Table 4.6.3.

SSB(2007) = 249000 t; landings (2006) = 244000 t. Input data in Table 4.6.3.

Rationale	Relative effort F(2007)/F(2005)	Basis	F(2007)	Landings (2007) `000 t	SSB(2008) `000 t
Zero catch	0	F=0	0.000	0	600
	0.1	Fsq*0.1	0.073	54	557
	0.2	Fsq*0.2	0.145	105	518
	0.3	Fsq*0.3	0.218	153	481
	0.4	Fsq*0.4	0.291	198	447
	0.5	Fsq*0.5	0.364	241	415
	0.6	Fsq*0.6	0.436	281	386
	0.7	Fsq*0.7	0.509	319	359
	0.8	Fsq*0.8	0.582	355	333
	0.9	Fsq*0.9	0.655	389	310
Status quo	1.0	Fsq*1	0.727	421	288
	1.1	Fsq*1.1	0.800	452	268
	1.2	Fsq*1.2	0.873	481	249

Shaded scenarios are not considered consistent with the precautionary approach.

There are large differences between the two forecasts. In case of a low recruitment, as assumed in both forecasts, the first forecast (without bias correction) suggests a maximum catch on 209000 t, whereas the second forecast (with the bias correction) suggests a maximum catch on 0 t in order to meet the objective of SSB to be above Bpa in 2008. Further, the first forecast estimates SSB in 2007 to 498.000t, whereas the second forecast estimate SSB in 2007 to 249000t. Under the assumption of continued low recruitment, the forecast using the bias corrected input data is considered to be more realistic than that using uncorrected input data.

The settings applied in the forecast using bias corrected input data were used to estimate the relationship between recruitment in 2006 and the catch in 2007 that will lead to SSB being 600 000 t in 2008, i.e. the maximum catch in 2007 that will meet the objective of SSB to be above Bpa in 2008. The result of this analysis (Figure 4.6.3) is the relationship:

TAC2007=-597+R2006*1.83 (1)

where R2006 is recruitment in 2006 and TAC2007 is the catch in 2007 that will result in SSB=Bpa in 2008.

This relationship (1) is suggested as a harvest control rule for the fishery in 2007. This is proposed as an alternative to the rule used in 2003-2005 that was found by STECF (2005b) not to provide a thorough protection against overfishing in case of a low stock size.

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

4.7 Medium-term forecasts

Appropriate medium-term forecasts cannot be made for sandeels, due to their short life span

4.8 Biological reference points

B_{lim} is set at 430,000 t, the lowest observed SSB. The Bpa is estimated to 600,000 t. Further information about biological reference points for sandeels in IV can be found in section 16.5 and in the stock quality handbook (Q4).

4.9 Quality of the assessment

There are large uncertainties in the assessment of sandeels in IV due to:

- the assumption about stock structure used in the assessment;
- lack of fisheries independent tuning data;
- large changes in fishing pattern in recent years;
- and possible large changes in fleet catchability in recent years.

Because of these uncertainties the assessment presented is likely to underestimate fishing mortalities and overestimate stock numbers in most recent years. The following gives a more detailed description of the uncertainties in the assessment

Comparisons with assessment results from previous meetings of WGNSSK are given in Figure 4.9.1.

The assumption about population structure and recent changes in fishing pattern

There is large variation in local abundance of sandeels, due to differences in habitat quality, mortality, and recruitment taken place at a small spatial scale (see section 4.1.1 and the stock quality handbook). This variability in local abundance leads to large variation in the fishing pattern (section 4.2.1), where the industrial fishery targets different sandeel populations (section 4.1.1) between years (Figure 4.2.1.3). The fishery data from the last year’s fishery therefore probably represent other stock components of sandeels than the data from the years when the stock was on a higher level (ICES-WGNSSK 2006).

The sub-population structure of A. marinus and the highly variable fishing pattern lead to large variability in mean weight at age used in the sandeel assessment (see section 4.2.3). Large between year variations in growth also contribute to this variability. Using such “noisy” biological data as the basis for the assessment has large implications for the performance of the assessment, by increasing uncertainty (see the stock quality handbook). A look at the F values from SXSA shows a very variable exploitation pattern from year to year, and extreme F values for age 4. This indicates that there might be a considerable sampling uncertainty in the international catch at age data probably due to that various stock components dominate from year to year.

Tuning data

The assessment of sandeels in IV is carried out without fisheries independent indices of sandeel abundance. The tuning fleets used in the assessment represent almost all landings of sandeels in the North Sea. The use of standardized commercial CPUE may result in auto-correlation problems between the tuning series and the catch at age data, which may mask uncertainty in the analysis. Further, schooling fish like sandeels may be caught efficiently at low stock densities (e.g. Ulltang 1980), which is why commercial tuning data are likely to overestimate the stock size at low densities (e.g. Pope 1980).

The SXSA assumes constant catchability in the CPUE time series. Changes in efficiency will violate the assumption of constant catchability. So far the only adjustment in fleet efficiency is linked to vessel horse power and a division of the tuning series in 1998, due to an increase in trawl net size from 1998 and onwards. Other factors such as better methods for detecting sandeel schools using multi-frequency echo-sounders and sonars, development in fishing gear technology to trawl on rougher bottom substrate, and high precision positions systems for mapping bottom topography and to identify new trawling positions have not been adjusted for. If such improvements have resulted in substantial increased efficiency, the sandeel stock may have been decreasing over the years, whereas landings and CPUE have remained relatively high due to increased efficiency and exploitation of new areas.

This use of commercial CPUE data for tuning the assessment in lack of fisheries independent tuning data is the likely explanation for the tendency of the assessments to underestimating F and overestimating SSB (section 4.3.2).

Suggestions for modifications of the assessment

The assessment should take account of the stock structure of sandeels. It is accordingly important to define the population units to be assessed. In section 16.5 a suggestion is given for an approach to carry out these analyses.

The demands to data, regarding spatial and temporal resolution, for such analyses on a subpopulation level are not satisfied by the data used for the present assessment of sandeels in IV. Further, the sampling level is probably to low for the stock components more sporadic exploited to allow for an assessment of all stock components, as information about age, length, weight and maturity (that all show large spatial trends) would be required for each of the stocks that will have to be assessed.

It is a prerequisite for the improvement of the assessment that fisheries independent time series of sandeel abundance is established that can be used in the assessment. Unfortunately, poor coordination between European institutes of both methodology and effort may cause a seriously delay the process of establishing such a time series (see section 4.5).

4.10 Status of the Stock

SSB in 2005 is estimated to be historic low and under Blim. Further, SSB is estimated to be below Bpa from 2000 and for the rest of the time series. SSB has previous to 2000 not been below Bpa for two consecutive years.

This year's assessment shows a large increase in TSB from 2005 to 2006, due to the improved recruitment in 2005 that is currently estimated to just below average although given the tendency to overestimate stock size this value is likely to be revised downwards. The increase in recruitment is however in line with results from scientific surveys (see section 4.5). Information from both the fishery and from scientific surveys indicate that the stock in the Northern part of the North Sea is at a much lower level than in the southern part of the North Sea.

The bias-corrected short term forecast was considered by the Working Group to be more realistic leadings to an estimate of SSB in 2007 of 249 000t.

SSB in 2008 is entirely dependent on the size of the 2006 year class and mortality in 2007.

4.11 Management Considerations

No fishing mortality (F) reference points are given for sandeels in the North Sea because there is only a weak correlation between the size of the spawning stock biomass and the recruitment. The recruitment of sandeels seems more linked to environmental factors than to the size of the spawning stock biomass (section 4.1.1).

A drastic change in the stock situation of sandeels in IV seemed to have occurred from 2003, and onwards. The change in 2003 came from a historic low recruitment in 2002. There seem to be an improvement in the stock size from 2005 to 2006, due to the recruitment in 2005. However this improvement only implies to the southern part of the North Sea, whereas the stock in the Northern part of the North Sea is still on a much lower level. The stock development in recent years is uncertain due to a tendency of the assessment to overestimating stock size and underestimating fishing mortality.

Presently there is no information about the size of the 2006 year class. However, surveys will be carried out in December 2006 and April/May 2007 that will provide more information about the size of this year class. The in-year monitoring of the commercial fishery appears to have over-estimated 1-group size in the past 3 years, most likely due to increased catchability at small stock sizes.

If the 2006 year class is low (~300 billion), only a total closure would enable the stock to attain B_{pa} in 2008. A recruitment of ~500 billion (which is just below the long term average) would permit a fishery of ~300kt whilst allowing the stock to attain B_{pa} in 2008. The in-year monitoring fishery (up to week 17) between 2003 and 2006 took 7-50kt. It would require a recruitment of ~350 billion in 2006 to allow the monitoring fishery to take 50kt catch and the stock still reach B_{pa} in 2008.

Risk of local depletion

The low stock size increases the risk of local depletion. There is therefore a need to monitor the stock situation and hence the fishery on a finer spatial scale. Access to VMS data is a prerequisite for this. From the Norwegian economical zone there is evidence of the fishery causing local depletion of sandeels (section 4.2.1).

Changes in the fleet composition

There was a 50% decline in the number of Danish vessels (from 200 to 98 vessels) fishing sandeels from 2004 to 2005. In 2006 the Danish fleet increased to 124 vessels participating in the sandeel fishery. The capacity of the Danish fleet participating in the North Sea sandeel fishery is not likely to increase much further, due to decommission of a substantial number of vessels during the last years. Also for the Norwegian fleet a drastic decline in number of vessels fishing sandeels has been observed in recent years.

Table 4.2.1.1. SANDEEL in IV. Official landings reported to ICES

SANDEELS IVa

Country	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	23,138	3,388	4,742	1,058	111	399	N/A	N/A
Faroe Islands	11,000	6,582					N/A	N/A
Norway	172,887	44,620	11,522*	4,121*	185*	280*	N/A	N/A
Sweden	55	495	55	-	-	73	N/A	N/A
UK (E/W/NI)	-	-	-	-	-	-	N/A	N/A
UK (Scotland)	5,742	4,195	4,781	970	543	186	N/A	N/A
Total	212,822	59,280	21,100	6,149	839	938		

*Preliminary.

SANDEELS IVb

Country	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	603,491	503,572	533,905	638,657	627,097	245,096	N/A	N/A
Faroe Islands	-	-					N/A	N/A
Germany	-	-	-	-	-	534	N/A	N/A
Ireland	-	389	-	-	-		N/A	N/A
Norway	170,737	142,969	107,493*	183,329*	175,799*	29,336*	N/A	N/A
Sweden	8,465	21,920	27,867	47,080	36,842	21,444	N/A	N/A
UK (E/W/NI)	-	-	-	-	-	-	N/A	N/A
UK (Scotland)	18,008	7,280	5,978	-	2,442	115	N/A	N/A
Total	800,701	676,130	675243	869066	842180	296525		

*Preliminary.

SANDEELS IVc

Country	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	9,674	10,356	11,993	7,177	4,996	28,646	N/A	N/A
France	-	-	1	-	-	-*	N/A	N/A
Netherlands	+	+	-	-	+	-*	N/A	N/A
Sweden	-	-	-	-	-	160	N/A	N/A
UK (E/W/NI)	-	-	+	-	-	+	N/A	N/A
Total	9,674	10,356	11,994	7,177	4,996	28,806		

*Preliminary.

Summary table official landings

	1998	1999	2000	2001	2002	2003	2004	2005
Total IV tonnes	1,023,197	745,766	708,337	882,392	848,015	326,269	372,343	
TAC	1,000,000	1,000,000	1,020,000	1,020,000	1,020,000	918,000	826,200	660,960

By-catch and other landings

	1998	1999	2000	2001	2002	2003	2004	2005
Area IV tonnes: official-WG	18,797	10,628	9,188	20,781	37,315	00,849	N/A	N/A

Summary table - landing data provided by Working Group members

	1998	1999	2000	2001	2002	2003	2004	2005
Total IV - tonnes	1,004,400	735,138	699,149	861,611	810,700	325,420	361,600	172,100

Table 4.2.1.2. SANDEEL in IV. Landings ('000 t), 1952-2005 (Data provided by Working Group members)

Year	Denmark	Germany	Faroes	Ireland	Netherlands	Norway	Sweden	UK	Total
1952	1.6	-	-	-	-	-	-	-	1.6
1953	4.5	+	-	-	-	-	-	-	4.5
1954	10.8	+	-	-	-	-	-	-	10.8
1955	37.6	+	-	-	-	-	-	-	37.6
1956	81.9	5.3	-	-	+	1.5	-	-	88.7
1957	73.3	25.5	-	-	3.7	3.2	-	-	105.7
1958	74.4	20.2	-	-	1.5	4.8	-	-	100.9
1959	77.1	17.4	-	-	5.1	8.0	-	-	107.6
1960	100.8	7.7	-	-	+	12.1	-	-	120.6
1961	73.6	4.5	-	-	+	5.1	-	-	83.2
1962	97.4	1.4	-	-	-	10.5	-	-	109.3
1963	134.4	16.4	-	-	-	11.5	-	-	162.3
1964	104.7	12.9	-	-	-	10.4	-	-	128.0
1965	123.6	2.1	-	-	-	4.9	-	-	130.6
1966	138.5	4.4	-	-	-	0.2	-	-	143.1
1967	187.4	0.3	-	-	-	1.0	-	-	188.7
1968	193.6	+	-	-	-	0.1	-	-	193.7
1969	112.8	+	-	-	-	-	-	0.5	113.3
1970	187.8	+	-	-	-	+	-	3.6	191.4
1971	371.6	0.1	-	-	-	2.1	-	8.3	382.1
1972	329.0	+	-	-	-	18.6	8.8	2.1	358.5
1973	273.0	-	1.4	-	-	17.2	1.1	4.2	296.9
1974	424.1	-	6.4	-	-	78.6	0.2	15.5	524.8
1975	355.6	-	4.9	-	-	54.0	0.1	13.6	428.2
1976	424.7	-	-	-	-	44.2	-	18.7	487.6
1977	664.3	-	11.4	-	-	78.7	5.7	25.5	785.6
1978	647.5	-	12.1	-	-	93.5	1.2	32.5	786.8
1979	449.8	-	13.2	-	-	101.4	-	13.4	577.8
1980	542.2	-	7.2	-	-	144.8	-	34.3	728.5
1981	464.4	-	4.9	-	-	52.6	-	46.7	568.6
1982	506.9	-	4.9	-	-	46.5	0.4	52.2	610.9
1983	485.1	-	2.0	-	-	12.2	0.2	37.0	536.5
1984	596.3	-	11.3	-	-	28.3	-	32.6	668.5
1985	587.6	-	3.9	-	-	13.1	-	17.2	621.8
1986	752.5	-	1.2	-	-	82.1	-	12.0	847.8
1987	605.4	-	18.6	-	-	193.4	-	7.2	824.6
1988	686.4	-	15.5	-	-	185.1	-	5.8	892.8
1989	824.4	-	16.6	-	-	186.8	-	11.5	1039.1
1990	496.0	-	2.2	-	0.3	88.9	-	3.9	591.3
1991	701.4	-	11.2	-	-	128.8	-	1.2	842.6
1992	751.1	-	9.1	-	-	89.3	0.5	4.9	854.9
1993	482.2	-	-	-	-	95.5	-	1.5	579.2
1994	603.5	-	10.3	-	-	165.8	-	5.9	785.5
1995	647.8	-	-	-	-	263.4	-	6.7	917.9
1996	601.6	-	5.0	-	-	160.7	-	9.7	776.9
1997	751.9	-	11.2	-	-	350.1	-	24.6	1137.8
1998	617.8	-	11.0	-	+	343.3	8.5	23.8	1004.4
1999	500.1	-	13.2	0.4	+	187.6	22.4	11.5	735.1
2000	541.0	-	-	-	+	119.0	28.4	10.8	699.1
2001	630.8	-	-	-	-	183.0	46.5	1.3	861.6
2002	629.7	-	-	-	-	176.0	0.1	4.9	810.7
2003	274.0	-	-	-	-	29.6	21.5	0.5	325.6
2004	277.1	2.7	-	-	-	48.5	33.2	+	361.5
2005	154.8	-	-	-	-	17.3	-	-	172.1
2006	229.9	3.2	-	-	-	5.6	27.8	-	266.5

2006 only include first half year.

+ = less than half unit.

- = no information or no catch.

Table 4.2.1.3. SANDEEL in IV. Monthly landings (ton) by Denmark, Norway and Scotland from each area defined in Fig 4.1.2.1. Data provided by Working Group members.

	1A	1B	1C	2A	2B	2C	3	4	5	6	Shetland	Total
1999												0
Mar	1448	2587	136	1047	9371	0	466	73	218	0	479	15826
Apr	52710	3030	0	64860	17779	0	644	80	55	1360	1080	141598
May	151806	15520	0	42635	45709	0	7299	1567	82	1271	461	266351
Jun	52943	9427	0	6199	8224	0	3304	12744	1097	18254	6	112198
Jul	7816	1883	0	15142	13918	0	14841	2434	1270	5274	0	62578
Aug	1	0	0	1770	29621	0	15376	0	0	99	2043	48909
Sept	1	155	0	930	26486	0	4129	0	0	883	88	32672
Oct	0	0	0	42	16440	0	1754	0	0	68	0	18305
Dec	0	0	0	181	358	0	198	0	0	0	0	737
Total	266725	32603	136	132807	167905	0	48011	16898	2722	27208	4157	699174
2000												0
Mar	800	42	0	3257	5618	0	739	0	0	393	687	11536
Apr	30931	19012	0	15259	71384	281	33583	479	0	595	1436	172959
May	110128	6843	0	24941	42647	0	53911	6685	3089	662	1651	250558
Jun	73632	3262	26	18564	16440	0	17287	11240	2503	29205	0	172160
Jul	10610	33	4	25193	3286	11	5996	2024	2692	12201	0	62049
Aug	0	0	0	3	113	0	117	0	1	127	560	921
Sept	0	0	0	21	393	0	18	0	0	145	0	577
Oct	0	0	0	0	0	0	2	0	0	1	0	3
Total	226102	29192	30	87238	139882	292	111652	20428	8285	43329	4334	670763
2001												0
Mar	3205	0	0	5235	2078	0	915	218	334	180	144	12309
Apr	60040	10891	0	19956	16609	0	1968	916	0	265	295	110940
May	96489	2014	0	71446	20668	0	15266	4829	510	3767	589	215578
Jun	72384	0	1556	15160	8103	120	8265	4790	4291	22748	0	137417
Jul	6703	90	0	67814	24065	0	8769	1664	2204	13747	0	125056
Aug	473	0	0	51965	61169	0	8679	0	0	2927	236	125449
Sep	578	0	0	24926	31178	0	4802	0	0	4840	0	66324
Oct	0	0	0	6464	14027	0	972	0	0	500	0	21963
Total	239872	13026	1556	262966	177898	120	49635	12417	7339	48974	1264	815067
2002												
Mar	3077	0	0	3911	2715	0	928	322	0	0	0	10953
Apr	104033	1745	0	66992	51007	0	15466	904	59	475	109	240790
May	176437	3341	0	78497	37385	0	37058	915	151	3272	12	337068
Jun	118879	125	0	27386	19380	10	10561	8673	2531	12498	0	200043
Jul	1128	0	0	90	48	0	193	2744	204	9869	0	14276
Aug	0	0	0	109	261	0	397	0	0	5146	422	6335
Sept	0	0	0	0	74	0	290	0	0	0	0	364
Oct	0	0	0	1	0	0	0	0	0	2	0	3
Dec	0	0	0	0	0	0	0	0	2	0	0	2
Total	403554	5211	0	176986	110870	10	64893	13558	2947	31262	543	809834
2003												
Mar	1947	52	0	97	380	7	225	325	0	0		3033
Apr	28806	5026	0	8341	6072	0	1900	81	0	662	49	50937
May	59890	1812	24	8884	9357	0	4532	10995	1020	9991	16	106521
Jun	11737	49	0	11906	398	10	2140	20891	13318	21639		82088
Jul	3604	0	0	9857	2013	0	3272	2738	1697	5790		28971
Aug	960	6	0	4381	4687	0	11293	16	175	687	121	22326
Sept	0	255	73	35	1551	0	2955	0	0	1094		5963
Oct	0	0	0	114	0	0	1589	0	0	127		1830
Nov	0	0	0	0	0	0	2070	0	0	0		2070
Dec	0	0	0	0	0	0	45	0	0	0		45
Total	106944	7200	97	43615	24458	17	30021	35046	16210	39990	186	303784
2004												
Feb	0	0	0	0	0	0	0	0	0	7		7
Mar	326	0	0	1001		0	37		260	2		1626
Apr	15893	627	0	15824	4847	0	10732	471	322	834		49550
May	46631	1044	0	21607	5495	0	22629	20484	233	8578		126701
Jun	21841	146	0	5077	1800	0	13821	13680	4789	35909		97063
Jul	1146	116		813	2272		6019	7430	1184	12923		31903
Aug	325			3963	5449		2589			3357		15683
Sept					3006		116			2		3124
Oct												
Total	86162	1933	0	48285	22869	0	55943	42065	6788	61612	0	325657
2005												
Apr	4017			71	1476		462	144		57		6227
May	34506	57		9536	7512		6507	13333	30	1549		73030
Jun	19216	21		8952	2545		8107	8224	17956	14111		79132
Jul				1668			987	922	1416	8726		13719
Aug				3			2			13		18
Sep												0
Okt										1		1
Total	57739	78	0	20230	11533	0	16065	22623	17986	24456	0	172127
%	34%	0%	0%	12%	7%	0%	9%	13%	10%	14%	0%	99%
Average 1994-2005												
	37%	2%	0%	20%	17%	0%	10%	4%	2%	7%	0%	100%
2006												
Apr	10141			8733	1387		188	111		82		20642
May	81547			25020	3096		3830	201		6455		120149
Jun	59827	34		3184	47		4815	12035	5236	9506		94684
Total	151515	34	0	36937	4530	0	8833	12347	5236	16043	0	235475
%	64%	0%	0%	16%	2%	0%	4%	5%	2%	7%	0%	100%

Table 4.2.1.4. SANDEEL in IV. Annual landings ('000 t) by area of the North Sea. Data provided by Working Group members (Denmark, Norway and Scotland).

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

Sampling areas: Northern - Areas 1B, 1C, 2B, 2C, 3.
Southern - Areas 1A, 2A, 4, 5, 6.

Table 4.2.1.5. SANDEEL in IV. Monthly landings (t) by Denmark, Norway and Scotland (data provided by Working Group Members)

Year	Month	Denmark	Norway	Scotland	Total
1999	Mar	6,851	8,496	479	15,826
	Apr	115,596	24,149	1,854	141,599
	May	202,813	56,961	6,578	266,352
	Jun	97,284	14,478	434	112,197
	Jul	49,333	13,245	0	62,578
	Aug	19,044	27,823	2,043	48,910
	Sept	6,217	26,366	88	32,672
	Oct	2,567	15,738	0	18,305
	Nov	405	332		737
	Total	500,110	187,589	11,476	699,175
2000	Mar	7,524	3,325	687	11,536
	Apr	126,644	44,879	1,436	172,959
	May	195,866	48,292	6,400	250,558
	Jun	150,394	20,089	1,677	172,160
	Jul	60,126	1,923		62,049
	Aug	247	113	560	921
	Sept	184	393		577
	Oct	3			3
	Total	540,988	119,015	10,759	670,763
2001	Mar	10,684	1,481	144	12,310
	Apr	95,723	14,922	295	110,940
	May	183,757	31,231	589	215,577
	Jun	127,292	10,124	0	137,416
	Jul	106,654	18,403	0	125,057
	Aug	65,021	60,192	236	125,449
	Sep	33,741	32,583	0	66,324
	Oct	7,910	14,054	0	21,963
	Nov	30	0	0	30
	Total	630,811	182,991	1,264	815,066
2002	Mar	10,236	717	0	10,953
	Apr	177,597	63,083	109	240,789
	May	247,494	86,942	2,898	337,334
	Jun	174,467	24,568	1,448	200,483
	Jul	14,228	48	0	14,276
	Aug	5,652	261	422	6,335
	Sep	0	364	0	364
	Oct	3	0	0	3
	Dec	2	0	0	2
	Total	629,679	175,983	4,877	810,539
2003	Mar	2,802	231		3,033
	Apr	42,885	8,003	366	51,254
	May	96,105	10,401		106,506
	Jun	80,271	1,817		82,088
	Jul	27,784	1,186		28,970
	Aug	15,782	6,422	121	22,325
	Sep	4,407	1,555		5,962
	Oct	1,831	0		1,831
	Nov	2,070	0		2,070
	Dec	45	0		45
	Total	273,982	29,615	487	304,084
2004	Feb	7	0		7
	Mar	1,444	183		1,627
	Apr	42,664	6,886		49,550
	May	100,715	25,986	29	126,730
	Jun	89,369	7,695		97,064
	Aug	30,485	1,419		31,904
	Sep	12,191	3,492		15,683
	Oct	254	2,869		3,123
	Total	277,129	48,530	29	325,688
2005	Apr	4,350	1,876		6,226
	May	60,473	12,556		73,029
	Jun	76,234	2,900		79,134
	Jul	13,719			13,719
	Oct	18			18
	Sep	2			2
	Total	154,796	17,332	0	172,128
2006	Apr	19,258	1,385		20,643
	May	115,949	4,200		120,149
	Jun	94,683			94,683
		229,890	5,585	0	235,475

Table 4.2.2.1. SANDEEL in IV. Catch numbers at age (numbers · 10^{-5}) by half year.

Fishery in the northern North Sea

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

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

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

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

Fishery in the southern North Sea

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

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

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

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

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

		Denmark		Norway		Combined	
		Half-year		Half-year		Half-year	
Year	Age	1	2	1	2	1	2
2001	0	1.89	2.48	1.62	3.28	1.68	3.10
	1	5.48	9.73	7.21	9.07	6.29	9.61
	2	10.10	17.00	15.63	17.61	11.78	17.50
	3	11.55	-	19.81	9.07	15.82	9.07
	4	13.09	-	25.45	-	-	-
	5	16.93	-	-	-	-	-
	5+			8.03			
	6	21.04	-	-	-	-	-
	4++	15.20	-	9.18	-	11.58	-
2002	0	-	-	1.77	-	1.77	-
	1	4.89	7.33	7.65	-	6.17	7.33
	2	9.05	17.52	12.17	-	11.77	17.52
	3	23.36	-	18.27	-	18.40	-
	4	25.29	-	-	-	-	-
	5	-	-		-	-	-
	5+						
	6	26.42	-	-	-		
	4++	26.08	-	32.12	-	31.98	-
2003	0	2.26	3.56		2.82	2.26	3.37
	1	5.34	15.74	5.23	12.13	5.30	13.00
	2	13.03	17.90	15.72		14.70	17.90
	3	11.86		20.57		17.81	
	4	14.47				14.47	
	5	17.24				17.24	
	5+						
	6						
	4++	14.82		29.93		18.69	
2004	0		3.76	1.73	3.46	1.73	3.56
	1	6.07	13.13	7.36		6.27	13.13
	2	11.10		10.07	21.42	10.64	21.42
	3	11.23	18.50	15.78		13.40	18.50
	4	25.01				25.01	
	5	33.17				33.17	
	5+						
	6						
	4++	30.69		27.53		28.39	
2005	0	1.00				1.00	
	1	7.36		7.56		7.43	
	2	15.44		14.28		14.42	
	3	17.16		15.99		16.06	
	4	22.56				22.56	
	5	33.00				33.00	
	5+						
	6						
	4++	23.41		23.94		23.90	
2006	0						
	1	8.35		6.99		7.92	
	2	13.79		15.28		14.42	
	3	26.02		24.03		25.47	
	4	16.30				16.30	
	5	31.00				31.00	
	5+						
	6						
	4++	30.95		23.00		30.61	

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

		Half-year	
Year	Age	1	2
2002	0	1.07	-
	1	6.14	8.40
	2	8.10	12.53
	3	12.49	-
	4	15.58	-
	5	18.25	-
	6	17.79	-
	7	15.93	-
	8+	-	-
	4++	16.73	-
2003	0	2.13	2.65
	1	5.25	7.47
	2	7.86	15.72
	3	9.33	17.30
	4	11.65	13.80
	5	15.27	-
	6	24.43	-
	7	15.05	-
	8+	15.90	-
	4++	12.47	13.80
2004	0		2.60
	1	5.49	7.35
	2	10.49	13.31
	3	11.34	13.37
	4	10.27	12.97
	5		
	6		
	7		
	8+		
	4++	10.27	12.97
2005	0	2.46	-
	1	5.54	-
	2	9.19	-
	3	10.73	-
	4	11.93	-
	5	13.63	-
	6	14.35	-
	7	12.67	-
	8+		-
	4++	12.18	-
2006	0	1.81	-
	1	6.19	-
	2	10.66	-
	3	12.83	-
	4	14.09	-
	5	15.35	-
	6	16.06	-
	7		-
	8+		-
	4++	15.15	-

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

Northern North Sea, first half-year

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

Northern North Sea, second half-year

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

Southern North Sea, first half-year

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

Southern North Sea, second half-year

year	age-0	age-1	age-2	age-3	age-4+
1983	2.42	7.50	10.75	14.12	17.71
1984	2.42	7.50	10.75	14.12	17.71
1985	2.42	7.50	10.75	14.12	18.66
1986	2.42	7.50	10.75	14.12	18.76
1987	1.30	8.90	10.80	21.40	19.85
1988	1.00	10.50	14.00	17.00	19.11
1989	1.00	10.50	14.00	17.00	19.01
1990	1.00	10.50	14.00	17.00	20.05
1991	2.60	7.50	13.60	12.00	
1992	3.40	9.43	16.61	20.04	22.58
1993	3.08	10.13	15.66	17.04	21.96
1994		8.56	17.16	19.50	23.74
1995		6.60	13.60	17.70	21.22
1996	2.34	9.90	16.66	21.77	33.39
1997	4.72	7.99	13.54	14.73	18.88
1998	2.79	3.01	12.65	11.57	17.14
1999	5.42	10.02	11.05	16.85	15.68
2000	1.66	6.61	13.68	15.74	18.34
2001	2.40	9.51	17.00		
2002		8.40	12.53		
2003	2.65	7.47	15.72	17.30	13.80
2004	2.6	7.35	13.31	13.37	12.97
2005					

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

First half-year

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

Second half-year

Year	age-0	age-1	age-2	age-3	age-4+
1983	1.11	11.83	14.73	19.14	24.35
1984	1.19	10.58	16.58	19.54	21.90
1985	1.19	10.69	14.65	22.49	24.95
1986	1.72	10.64	14.75	17.96	30.44
1987	1.43	11.18	14.29	17.26	20.91
1988	1.44	10.81	18.07	17.19	20.61
1989	1.28	10.76	15.80	17.05	19.39
1990	1.36	10.72	15.51	19.37	19.95
1991	1.10	10.67	15.49	18.02	19.39
1992	1.54	10.57	14.85	18.67	20.44
1993	1.44	10.91	14.25	17.61	20.49
1994	6.58	10.95	27.46	45.24	31.15
1995	5.08	10.14	13.66	17.96	21.19
1996	2.90	10.33	16.13	20.52	32.88
1997	1.94	8.04	11.70	15.27	18.86
1998	2.49	3.84	12.03	13.92	17.11
1999	3.15	8.29	10.49	17.14	15.68
2000	1.66	7.56	14.29	15.96	18.87
2001	2.67	9.56	17.42	9.07	
2002		8.29	12.60		
2003	3.07	8.10	16.30	17.30	13.80
2004	3.13	9.00	13.46	13.51	12.97
2005	3.13	9.00	13.46	13.51	12.97

Table 4.2.5.1. SANDEEL in IV. Effort of Danish vessels (kilo watt days · 10^3) and number of Danish and Norwegian vessels participating I the sandeel fishery in the North Sea by year. In 2006 only experimental fishing was allowed for 6 Norwegian vessels.

	Denmark		Norway
Year	**Kilo watt days (thousands)**	**Number of vessels**	**Number of vessels**
2002	7,867	207	53
2003	7,306	171	35
2004	7,334	200	40
2005	3,390	98	22
05 Sep. 2006	3,946	124	6

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

	Norwegian			Danish			Total	Derived
Year	Standardized Fishing days	Catch sampled for fishing effort ('000t)	CPUE (t/day)	Catch sampled for fishing effort ('000 t)	CPUE (t/day)	Mean CPUE (t/day)	internat. catch ('000t)	internat. effort ('000 days)
				First half-year				
1976	593	11.1	18.7	-	-	18.7	110.3	5.90
1977	2061	50.4	24.4	-	-	24.5	276.0	11.27
1978	1761	44.9	25.5	-	-	25.5	109.7	4.30
1979	1451	29.6	20.4	-	-	20.4	47.7	2.34
1980	2733	112.8	41.3	-	-	41.3	220.9	5.35
1981	1804	42.8	23.7	-	-	23.7	93.3	3.94
1982	1231	26.9	21.9	13.5	34.9	26.2	62.3	2.38
1983	338	8.7	25.7	17.4	28.9	27.8	54.5	1.96
1984	139	3.5	25.2	54.1	41.2	40.2	74.1	1.84
1985	382	8.7	22.8	47.4	46.7	43.0	69.9	1.63
1986	1565	60.4	38.6	154.1	54.7	50.2	221.3	4.41
1987	2219	122.9	55.4	214.4	51.8	53.1	360.9	6.80
1988	3600	143.8	39.9	158.6	39.0	39.5	332.0	8.41
1989	4211	146.9	34.9	247.0	35.1	35.0	435.2	12.43
1990	2299	58.6	25.5	89.7	24.7	25.0	148.7	5.94
1991	1748	67.7	38.7	198.4	39.0	39.0	282.2	7.24
1992	1214	53.7	44.2	106.7	33.6	37.1	151.2	4.07
1993	1565	70.7	45.2	138.2	33.6	37.5	189.0	5.04
1994	2707	130.1	48.1	289.0	56.4	53.8	413.4	7.68
1995	3429	208.6	60.8	146.4	44.7	54.2	348.5	6.43
1996	2036	100.9	49.6	101.8	30.8	40.1	203.1	5.06
1997	3489	254.9	73.1	190.0	50.9	63.6	456.5	7.18
1998	2622	220.8	84.2	125.8	37.1	67.1	364.8	5.44
1999	2217	77.4	34.9	47.5	32.9	34.2	137.2	4.02
2000	2328	104.5	44.9	154.7	40.6	42.3	271.1	6.40
2001	672	44.6	66.4	45.9	34.3	50.1	88.5	1.77
2002	1003	119.5	119.2	58.5	44.8	94.8	179.7	1.90
2003	914	17.1	18.7	15.3	16.0	17.41	53.8	3.09
2004	692	19.3	27.9	41.6	24.5	25.59	61.2	2.39
2005	469	13.8	29.4	13.7	28.2	28.78	27.7	0.96
2006	112	5.6	50.0	8.5	27.8	36.68	13.4	0.37
				Second half-year				
1976	108	2.0	18.5	-	-	18.5	44.9	2.43
1977	445	11.8	26.5	-	-	26.5	110.0	4.15
1978	811	22.5	27.6	-	-	27.8	53.3	1.92
1979	1688	52.2	30.9	-	-	30.9	147.7	4.78
1980	1117	33.1	29.6	-	-	29.5	71.1	2.41
1981	398	7.9	19.6	-	-	19.9	44.9	2.26
1982	-	-	-	1.8	32.3	33.0	12.0	0.36
1983	65	2.4	36.9	12.3	36.6	37.3	23.7	0.64
1984	-	-	-	10.7	29.6	30.2	17.7	0.59
1985	-	-	-	16.4	38.0	38.8	16.8	0.43
1986	555	21.8	39.3	96.1	60.2	57.4	153.8	2.68
1987	1586	68.1	42.9	3.1	24.7	42.1	76.9	1.83
1988	922	26.9	29.2	64.3	29.4	29.3	71.4	2.43
1989	590	11.5	19.5	44.9	25.6	24.4	57.2	2.35
1990	721	22.8	31.6	61.0	31.1	31.3	70.8	2.26
1991	943	30.3	32.1	72.0	38.7	36.8	90.7	2.47
1992	24	1.5	63.8	43.0	34.8	35.8	25.5	0.71
1993	972	30.7	31.6	59.1	28.4	29.5	87.0	2.95
1994	777	35.7	45.9	82.8	43.6	44.3	76.4	1.73
1995	1009	53.3	52.8	59.4	44.8	48.6	72.6	1.49
1996	749	42.9	57.3	93.9	36.5	43.0	140.7	3.27
1997	1542	95.7	62.1	22.9	27.5	55.4	121.5	2.19
1998	2257	114.4	50.7	35.5	24.6	44.5	148.5	3.34
1999	1665	77.8	46.7	37.8	29.3	41.0	125.2	3.05
2000	0	0.0	0.0	7.6	33.3	33.3	10.0	0.30
2001	1508	122.2	81.0	28.0	36.9	72.8	153.8	2.11
2002	0	0.7	0.0	0.5	10.6	4.5	1.3	0.29
2003	295	7.5	25.4	19.5	21.0	22.23	29.8	1.34
2004	404	7.8	19.3	6.3	18.1	18.76	19.6	1.04
2005	0	0	-	0.0	-	-	*	-

- No data   * Added to first half year

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

	First half year			Second half year		
Year	CPUE (t/day)	Total Int'l catch ('000 t)	Total int'l effort ('000 days)	CPUE (t/day)	Total Int'l catch ('000 t)	Total int'l effort ('000 days)
1982	48.2	427	8.85	35.7	53	1.47
1983	42.8	360	8.41	33.9	59	1.75
1984	50.5	461	9.13	32.9	71	2.16
1985	41.9	417	9.95	33.6	111	3.29
1986	53.7	386	7.20	44.1	76	1.71
1987	57.4	298	5.19	37.1	105	2.83
1988	46.7	462	9.89	30.2	33	1.11
1989	43.8	506	11.54	29.5	19	0.63
1990	31.0	342	11.03	35.6	24	0.67
1991	47.0	327	6.95	46.6	132	2.84
1992	54.9	621	11.31	36.2	73	2.02
1993	38.6	268	6.94	32.0	34	1.07
1994	53.4	226	4.24	48.9	48	0.97
1995	56.8	429	7.56	52.0	68	1.30
1996	41.6	294	7.05	50.1	139	2.77
1997	64.2	421	6.55	41.1	138	3.36
1998	46.6	448	9.61	26.2	43	1.64
1999	40.9	432	10.56	31.9	36	1.13
2000	43.1	360	8.36	33.4	53	1.59
2001	38.7	433	11.20	46.4	185	3.98
2002	62.2	609	9.79	22.4	19	0.86
2003	22.6	211	9.33	20.5	31	1.53
2004	25.2	250	9.91	24.0	31	1.30
2005	28.0	145	5.16		*	*
2006	39.0	254	6.50			

* Added to first half year

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

Year	Season	Fleet	Effort	a-0	a-1	a-2	a-3	a-4+
1976	1	1	5.9	237	5697.2	1130	445	155.1
1977	1	1	11.3	3686.2	24306.5	2350.5	516.3	144
1978	1	1	4.3	0	6126.9	2337.8	572.5	143.5
1979	1	1	2.3	0	2335.2	1327.6	242.2	11.8
1980	1	1	5.4	17.3	13394.1	8865	1049.6	827.3
1981	1	1	3.9	17	5505	4109	904	174
1982	1	1	2.4	2	3518	2132	556	85
1983	1	1	2	0	5684	1215	89	12
1984	1	1	1.8	0	11692.2	1646.7	152.7	4.5
1985	1	1	1.6	1	2688	3292	1002	480
1986	1	1	4.4	7	23934	2600	200	0
1987	1	1	6.8	0	26236	10855	350	155
1988	1	1	8.41	2453	9855	25922	1319	26
1989	1	1	12.43	6124	56661	2219	3385	0
1990	1	1	5.94	0	13101	3907	578	175
1991	1	1	7.24	0	41855	2342	908	318
1992	1	1	4.07	137	9871	4056	486	305
1993	1	1	5.04	1112	15768	2635	1023	646
1994	1	1	7.68	397.9	28490.2	7225.3	5953.5	2155.5
1995	1	1	6.43	0	36140	3360	1091	145
1996	1	1	5.06	0	11523.6	5384.6	760.8	300.7
1997	1	1	7.18	2433.8	67037.8	3640.3	5254.3	1205.7
1998	1	1	5.44	2277.7	6667.1	33215.8	2038.9	410.1
1999	1	2	4.02	264.8	2117.7	3490.8	5086	1022.7
2000	1	2	6.4	0	22887.2	8809.9	1419.8	1469.7
2001	1	2	1.77	87.4	6433.8	2407.8	472	1034.6
2002	1	2	1.9	11.5	21718.8	2649	401.5	219.2
2003	1	2	3.09	598.7	2315.3	1304.6	456.1	635.4
2004	1	2	2.39	178.6	6819.1	541.5	375.3	212.8
2005	1	2	0.96	5.2	2550.1	411.6	97.3	49.3
2006	1	2	0.37	0	1407.7	121.7	16.5	2.4
1982	1	3	8.9	242	56545	6224	3277	1939
1983	1	3	8.4	955	2232	35029	934	387
1984	1	3	9.1	20.4	62517	2257.1	13271.7	442.1
1985	1	3	10	6573	7790	39301	2490	265
1986	1	3	7.2	0	43629	7333	1604	30
1987	1	3	5.19	0	4351	22771	1158	165
1988	1	3	9.89	1420	2349	10074	17914	2769
1989	1	3	11.54	29	44444	4525	957	3368
1990	1	3	11.03	0	20179	16670	2467	745
1991	1	3	6.95	0	20058	9224	1320	454
1992	1	3	11.31	2	60337	10021	1002	621
1993	1	3	6.94	0	3581	14659	3707	1012
1994	1	3	4.24	0	24697.1	2594.2	2654.4	715.3
1995	1	3	7.56	0	39060	6503	1531	1226
1996	1	3	7.05	0	10193.9	16015.3	6403.4	1169.1
1997	1	3	6.55	0	52358.7	3647.9	2404.6	683.3
1998	1	3	9.61	56.6	9545.8	39552.9	3188	2260.3

Table 4.2.5.4. Continued.

Year	Season	Fleet	Effort	a-0	a-1	a-2	a-3	a-4+
1999	1	4	10.56	0	31950.9	6498.7	13149.8	946.7
2000	1	4	8.36	1126.2	35612.8	5972.9	1825.3	3528
2001	1	4	11.2	579.2	64084	13530.7	1158	2389.1
2002	1	4	9.79	420.1	84858	8666.7	1059.9	250
2003	1	4	9.33	6148.4	4981.9	15588.3	3592.7	1203.8
2004	1	4	9.91	0	33909.4	1112.5	4302.4	270.3
2005	1	4	5.16	73.5	15841.8	5203.8	311.6	438.5
2006	1	4	6.5	868.7	33255.5	2801.4	1034.9	239.7
1976	2	5	2.4	6125.6	648	83.5	367.8	36.6
1977	2	5	4.2	3067.2	2855.7	913.3	141.9	141.1
1978	2	5	1.9	7820.2	1001	307.3	38.9	1.9
1979	2	5	4.8	44202.9	1310.1	433.1	66.2	9.5
1980	2	5	2.4	8348.8	1172.7	213.9	19.4	7.5
1981	2	5	2.3	9128	346	94	14	6
1982	2	5	0.4	6530	65	0	0	0
1983	2	5	0.6	7911	303	316	19	0
1984	2	5	0.6	0	1207.2	120.6	42.6	0
1985	2	5	0.4	349	109	239	89	11
1986	2	5	2.7	7105	7077	473	0	0
1987	2	5	1.83	455	5768	198	0	0
1988	2	5	2.43	13196	1283	340	119	17
1989	2	5	2.35	3380	4038	274	0	0
1990	2	5	2.26	12107	1670	342	51	15
1991	2	5	2.47	13616	866	28	8	3
1992	2	5	0.71	6797	48	3	0	0
1993	2	5	2.95	26960	1004	112	34	22
1994	2	5	1.73	457	828.6	1211	396.3	24.7
1995	2	5	1.49	4046	3374	338	26	2
1996	2	5	3.27	31817.4	1705.7	1771.5	135.8	55.3
1997	2	5	2.19	2431	11345.6	633.2	24.9	1.9
1998	2	5	3.34	35220	10005.3	1837	78.8	0.6
1999	2	5	3.05	33652.8	693.5	550.7	57.8	0
2000	2	5	0.3	0	467.2	83.9	23.6	46.1
2001	2	5	2.11	46385.4	771.2	72.8	134.3	0
2002	2	5	0.29	0	157	6.4	0	0
2003	2	5	1.34	7509.8	118	163.7	0	0
2004	2	5	1.04	2960.9	656.1	8.8	11.4	0
2005	2	5	0	0	0	0	0	0
1982	2	6	1.5	5039	4718	490	344	40
1983	2	6	1.8	9298	240	2806	513	2
1984	2	6	2.2	0	9422.5	91.6	577.3	43.8
1985	2	6	3.3	11940	1896	3229	2234	298
1986	2	6	1.7	112	5350	293	241	18
1987	2	6	2.83	298	3095	6664	196	51
1988	2	6	1.11	0	0	234	2084	68
1989	2	6	0.63	1	1619	165	35	123
1990	2	6	0.67	597	1438	477	71	21
1991	2	6	2.84	12115	11411	344	111	0
1992	2	6	2.02	134	3903	382	157	34
1993	2	6	1.07	838	1037	953	266	87
1994	2	6	0.97	0	4092.9	322.3	197.6	136.9
1995	2	6	1.3	0	3166	2789	307	157
1996	2	6	2.77	2088.1	2030.5	4080.4	536.1	1023
1997	2	6	3.36	198	15238.3	535.5	406.2	135.6
1998	2	6	1.64	1141.8	737.5	2672.5	209.4	65.2
1999	2	6	1.13	1322.1	202.5	58.2	1391.8	166.4
2000	2	6	1.59	6659	3600.6	495.9	339.2	329.5
2001	2	6	3.98	73442.6	819.3	15.1	0	0
2002	2	6	0.86	0	1370.4	472.2	0	0
2003	2	6	1.53	5319.6	921.8	452	163.2	27.8
2004	2	6	1.3	2382.7	1637.4	472.9	405	68
2005	2	6	0	0	0	0	0	0

Table 4.3.2.1. SANDEEL in IV. Options for seasonal survivor analysis (SXSA)

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

Data were input from the following files:
  1: Catch in numbers:       CANUM4.hyr
  2: Weight in catch:        WECA4.hyr
  3: Weight in stock:        WEST4.hyr
  4: Natural mortalities:    natmor.hyr
  5: Maturity ogive:         matprop.hyr
  6: Tuning data (CPUE):     Tuning4.hyr
  7: *Weighting for rhats:   tweq.new
  8: *Weighting for shats:   twred.xsa
  9: *Catches to be fitted:

The following fleets were used:
Fleet:  1: Northern First Half 76-98
Fleet:  2: Northern First Half 99-06
Fleet:  3: Southern First Half 82-98
Fleet:  4: Southern First Half 99-06
Fleet:  5: Northern Secon Half 76-05
Fleet:  6: Southern Secon Half 82-05

The following values was used:
 1: First VPA year                  1983
 2: Last VPA year                   2006
 3: Youngest age                       0
 4: Oldest true age                    3
 5: Number of seasons                  2
 6: Recruiting season                  2
 7: Last season in last year           1
 8: Spawning season                    1
 9: Number of fleets                   2

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

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

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

 The iteration will carry on until convergence.

Weighting factors for computing catchability for both fleets (Weighting for rhats)

Year 1983-2005                Year 2006
Season  1    2                Season  1   2
Age                            Age
0       1    1          0    0.5        0.1
1       1    1          1    0.5        0.1
2       1    1          2    0.5        0.1
3       1    1          3    0.5        0.1

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

Season  1    2
AGE
0       *  0.02
1       1  0.1
2       1  0.1
3       1  0.1
```

Table 4.3.2.2 SANDEEL in IV. SXSA fishing mortality at age.

Partial fishing mortality
Northern North Sea

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.013	*	0.000	*	0.000	*	0.017	*	0.003	*	0.027
1	0.089	0.010	0.055	0.015	0.044	0.004	0.077	0.052	0.162	0.081	0.191	0.057
2	0.021	0.012	0.079	0.009	0.087	0.027	0.172	0.071	0.135	0.005	0.786	0.036
3	0.034	0.015	0.012	0.012	0.118	0.024	0.045	0.000	0.087	0.000	0.066	0.020
4+	0.051	0.000	0.008	0.000	0.221	0.010	0.000	0.000	0.053	0.000	0.014	0.115
F (1- 2)	0.055	0.011	0.067	0.012	0.066	0.016	0.125	0.062	0.148	0.043	0.488	0.047

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.015	*	0.028	*	0.025	*	0.031	*	0.065	*	0.001
1	0.357	0.087	0.168	0.059	0.277	0.016	0.052	0.001	0.197	0.029	0.197	0.015
2	0.169	0.041	0.169	0.042	0.161	0.005	0.145	0.000	0.057	0.004	0.351	0.116
3	0.709	0.000	0.167	0.041	0.189	0.003	0.137	0.000	0.118	0.008	0.387	0.053
4+	0.000	0.000	0.196	0.057	0.443	0.014	0.190	0.000	0.540	0.143	1.152	0.188
F (1- 2)	0.263	0.064	0.169	0.050	0.219	0.011	0.098	0.000	0.127	0.017	0.274	0.066

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.016	*	0.024	*	0.011	*	0.139	*	0.103	*	0.000
1	0.166	0.039	0.126	0.044	0.137	0.056	0.078	0.289	0.026	0.022	0.222	0.014
2	0.096	0.017	0.104	0.067	0.149	0.044	0.305	0.038	0.205	0.067	0.544	0.015
3	0.183	0.008	0.072	0.030	0.375	0.004	0.257	0.022	0.196	0.005	0.323	0.014
4+	0.030	0.001	0.082	0.035	0.400	0.001	0.085	0.000	0.298	0.000	0.225	0.018
F (1- 2)	0.131	0.028	0.115	0.055	0.143	0.050	0.191	0.163	0.115	0.045	0.383	0.015

Year	2001		2002		2003		2004		2005		2006
Season	1	2	1	2	1	2	1	2	1	2	1
AGE											
0	*	0.085	*	0.000	*	0.040	*	0.025	*	0.000	*
1	0.058	0.023	0.143	0.004	0.121	0.017	0.119	0.043	0.063	0.000	0.013
2	0.157	0.015	0.140	0.001	0.055	0.016	0.131	0.004	0.052	0.000	0.012
3	0.147	0.082	0.140	0.000	0.096	0.000	0.071	0.006	0.080	0.000	0.008
4+	2.787	*	0.229	0.000	*	*	0.204	0.000	0.037	0.000	0.002
F (1- 2)	0.108	0.019	0.141	0.002	0.088	0.016	0.125	0.024	0.057	0.000	0.013

Partial fishing mortality
Southern North Sea

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.016	*	0.000	*	0.014	*	0.000	*	0.002	*	0.000
1	0.035	0.008	0.293	0.115	0.129	0.069	0.140	0.040	0.027	0.044	0.045	0.000
2	0.600	0.105	0.109	0.007	1.040	0.366	0.486	0.044	0.283	0.158	0.305	0.025
3	0.355	0.404	1.052	0.164	0.293	0.600	0.365	0.101	0.289	0.087	0.892	0.352
4+	1.654	0.471	0.823	0.227	0.122	0.259	0.012	0.010	0.056	0.025	1.536	0.460
F (1- 2)	0.318	0.056	0.201	0.061	0.584	0.218	0.313	0.042	0.155	0.101	0.175	0.013

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.000	*	0.001	*	0.022	*	0.001	*	0.002	*	0.000
1	0.280	0.035	0.259	0.051	0.133	0.217	0.317	0.052	0.045	0.030	0.171	0.074
2	0.344	0.024	0.722	0.058	0.632	0.059	0.358	0.026	0.318	0.036	0.126	0.031
3	0.200	0.020	0.712	0.057	0.275	0.043	0.283	0.081	0.427	0.062	0.173	0.026
4+	1.610	1.126	0.836	0.079	0.633	0.000	0.387	0.043	0.846	0.567	0.382	1.044
F (1- 2)	0.312	0.030	0.490	0.054	0.383	0.138	0.337	0.039	0.181	0.033	0.149	0.052

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.000	*	0.002	*	0.001	*	0.005	*	0.004	*	0.020
1	0.182	0.037	0.111	0.052	0.107	0.075	0.111	0.021	0.389	0.006	0.345	0.111
2	0.189	0.138	0.310	0.154	0.150	0.037	0.364	0.055	0.381	0.007	0.369	0.088
3	0.261	0.097	0.607	0.118	0.172	0.058	0.402	0.059	0.506	0.126	0.415	0.194
4+	0.256	0.054	0.320	0.648	0.227	0.098	0.470	0.027	0.276	0.101	0.540	0.127
F (1- 2)	0.186	0.088	0.211	0.103	0.128	0.056	0.237	0.038	0.385	0.007	0.357	0.100

Year	2001		2002		2003		2004		2005		2006
Season	1	2	1	2	1	2	1	2	1	2	1
AGE											
0	*	0.135	*	0.000	*	0.029	*	0.020	*	0.000	*
1	0.582	0.025	0.559	0.032	0.261	0.130	0.591	0.108	0.389	0.000	0.310
2	0.881	0.003	0.458	0.052	0.659	0.044	0.270	0.221	0.659	0.000	0.281
3	0.360	0.000	0.371	0.000	0.754	0.091	0.817	0.228	0.256	0.000	0.481
4+	6.436	*	0.261	0.000	*	*	0.259	0.126	0.333	0.000	0.238
F (1- 2)	0.732	0.014	0.508	0.042	0.460	0.087	0.430	0.164	0.524	0.000	0.295

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

Year	age-0	age-1	age-2	age-3	age-4+	F1-2
1983	0.029	0.146	0.787	0.771	4.168	0.466
1984	0.000	0.455	0.219	1.354	1.163	0.337
1985	0.015	0.231	1.602	0.967	0.601	0.916
1986	0.017	0.290	0.828	0.535	0.020	0.559
1987	0.005	0.278	0.594	0.487	0.140	0.436
1988	0.027	0.291	1.296	1.384	2.925	0.794
1989	0.015	0.775	0.622	1.045	3.767	0.698
1990	0.029	0.532	1.087	1.071	1.378	0.810
1991	0.047	0.585	0.942	0.552	1.345	0.764
1992	0.032	0.434	0.578	0.531	0.688	0.506
1993	0.067	0.298	0.446	0.662	2.566	0.372
1994	0.001	0.455	0.649	0.686	3.604	0.552
1995	0.016	0.425	0.440	0.577	0.361	0.433
1996	0.026	0.314	0.637	0.878	1.029	0.476
1997	0.012	0.342	0.395	0.657	0.795	0.368
1998	0.144	0.384	0.823	0.801	0.648	0.603
1999	0.107	0.472	0.712	0.892	0.731	0.592
2000	0.020	0.698	1.116	0.995	1.007	0.907
2001	0.222	0.736	1.197	0.628	0.000	0.967
2002	0.000	0.799	0.707	0.566	0.548	0.753
2003	0.069	0.503	0.848	1.031	0.000	0.676
2004	0.045	0.875	0.627	1.191	0.620	0.751
2005	0.000	0.495	0.796	0.370	0.411	0.646
2006	0.000	0.327	0.295	0.498	0.242	0.311

Table 4.3.2.4. SANDEEL in IV. SXSA stock numbers at age (millions)

Stock numbers (at start of season)
****

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	880899.	*	227376.	*	1206994.	*	624245.	*	199804.	*	719031.
1	105582.	34040.	384278.	96358.	102167.	31230.	534100.	155505.	275654.	82855.	89273.	25440.
2	90749.	31157.	27378.	15156.	69273.	11563.	23755.	7791.	116073.	50275.	59817.	10625.
3	3757.	1681.	22684.	4215.	12217.	5330.	6329.	2765.	5685.	2576.	34953.	7683.
4+	498.	6.	898.	236.	3043.	1430.	3153.	2089.	3740.	2245.	3724.	208.
SSN	95005.		50960.		84533.		33237.		125498.		98493.	
SSB	1245668.		766256.		1182263.		502097.		1658417.		1511668.	
TSN	200587.	947783.	435238.	343341.	186700.	1256547.	567336.	792395.	401151.	337756.	187766.	762987.
TSB	1776745.	1871748.	2341796.	1628859.	1610341.	2095120.	2734634.	2956447.	2953988.	2021885.	1904469.	1638757.

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	325696.	*	636688.	*	806364.	*	319293.	*	623087.	*	872670.
1	314236.	54278.	144078.	32818.	277567.	64559.	345075.	84363.	138821.	39334.	261337.	63881.
2	19667.	7662.	39320.	9510.	24057.	6656.	41748.	16459.	65495.	29744.	30357.	12309.
3	8180.	1928.	5876.	1446.	7045.	2898.	5113.	2209.	13127.	4927.	23388.	8630.
4+	4390.	185.	1587.	311.	1295.	236.	2456.	888.	2363.	226.	3849.	230.
SSN	32237.		46783.		32397.		49317.		80985.		57594.	
SSB	505717.		657273.		464186.		685424.		1097235.		807352.	
TSN	346473.	389749.	190861.	680773.	309964.	880714.	394391.	423211.	219807.	697317.	318932.	957720.
TSB	1888355.	1158439.	1271046.	1399405.	1654947.	1735755.	2093329.	1687235.	1721932.	1841624.	2443324.	7177263.

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	358947.	*	1937319.	*	328718.	*	390379.	*	496476.	*	495117.
1	391810.	98150.	158573.	45163.	847766.	239458.	145940.	43855.	151035.	34899.	199637.	37960.
2	47848.	23913.	74441.	32378.	33596.	16553.	171998.	55715.	26185.	9373.	27762.	6506.
3	8691.	3659.	16749.	5362.	21214.	7950.	12495.	4096.	41536.	12912.	7123.	2118.
4+	6570.	3281.	5237.	2307.	4695.	1601.	7304.	2710.	5252.	1908.	10671.	3061.
SSN	63109.		96427.		59505.		191797.		72972.		45556.	
SSB	1048836.		1097364.		668294.		1738525.		905471.		514386.	
TSN	454918.	487951.	255000.	2022529.	907271.	594279.	337737.	496756.	224007.	555569.	245193.	544762.
TSB	3842439.	3280597.	2167732.	6792909.	5441216.	2908203.	2469685.	1914088.	1749755.	2202768.	1792062.	1293416.

Year	2001		2002		2003		2004		2005		2006
Season	1	2	1	2	1	2	1	2	1	2	1
AGE											
0	*	860696.	*	77439.	*	277503.	*	176857.	*	425496.	*
1	218007.	37429.	306413.	48081.	34796.	8375.	116090.	18004.	75885.	16761.	191188.
2	27399.	5316.	29205.	10312.	37983.	11630.	5916.	2611.	12665.	3892.	13723.
3	4802.	1885.	4273.	1668.	8010.	2054.	8965.	2180.	1702.	806.	3187.
4+	3572.	0.	1421.	569.	1831.	0.	1534.	633.	1864.	850.	1356.
SSN	35773.		34900.		47824.		16415.		16232.		18266.
SSB	352302.		355872.		427871.		193536.		166304.		210756.
TSN	253780.	905326.	341312.	138069.	82620.	299562.	132505.	200285.	92117.	447806.	209454.
TSB	1313711.	2765584.	2237245.	528524.	610896.	1144881.	845965.	788403.	607197.	1556964.	1407590.

Table 4.3.2.5. SANDEEL in IV. SXSA catchability.

Fleet 1: Northern North Sea 83-98

	Log inverse q		q	
Season	1	2	1	2
Age				
0	*	*	*	*
1	3.685	*	0.0251	*
2	3.596	*	0.0274	*
3	3.596	*	0.0274	*

Fleet 2: Northern North Sea 99-06

	Log inverse q		q	
Season	1	2	1	2
Age				
0	*	*	*	*
1	3.340	*	0.0354	*
2	2.936	*	0.0531	*
3	2.936	*	0.0531	*

Fleet 3: Southern North Sea 83-98

	Log inverse q		q	
Season	1	2	1	2
Age				
0	*	*	*	*
1	4.224	*	0.0146	*
2	3.186	*	0.0413	*
3	3.186	*	0.0413	*

Fleet 4: Southern North Sea 99-06

	Log inverse q		q	
Season	1	2	1	2
Age				
0	*	*	*	*
1	3.041	*	0.0478	*
2	2.924	*	0.0537	*
3	2.924	*	0.0537	*

Fleet 5: Northern North Sea 83-05

	Log inverse q		q	
Season	1	2	1	2
Age				
0	*	4.580	*	0.0103
1	*	4.144	*	0.0159
2	*	4.660	*	0.0095
3	*	4.660	*	0.0095

Fleet 6: Southern North Sea 83-05

	Log inverse q		q	
Season	1	2	1	2
Age				
0	*	6.269	*	0.0019
1	*	3.566	*	0.0283
2	*	3.555	*	0.0286
3	*	3.555	*	0.0286

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

Year	Recruitment Age 0 thousands	SSB tonnes	Landings tonnes	Mean F Ages 1-2
1983	880899	1245668	530640	0.466
1984	227376	766256	750040	0.337
1985	1206994	1182263	707105	0.916
1986	624245	502097	685950	0.559
1987	199804	1658417	791050	0.436
1988	719031	1511668	1007304	0.794
1989	325696	505717	826835	0.698
1990	636688	657273	584912	0.810
1991	806364	464186	898959	0.764
1992	319293	685424	820140	0.506
1993	623087	1097235	576932	0.372
1994	872670	807352	770747	0.552
1995	358947	1048836	915043	0.433
1996	1937319	1097364	776126	0.476
1997	328718	668294	1114044	0.368
1998	390379	1738525	1000375	0.603
1999	496476	905471	718668	0.592
2000	495117	514386	692498	0.907
2001	860696	352302	858619	0.967
2002	77439	355872	806921	0.753
2003	277503	427871	309725	0.676
2004	176857	193536	359361	0.751
2005	425496	166304	171790	0.646
2006		210756	266024	0.311
2007		498000*		
Average	576830	781795	705825	0.612
Units	(Millions)	(Tonnes)	(Tonnes)	

*Forecast

Table 4.3.2.7. SANDEEL in IV. Assessment summary for XSA.

Year	Recruitment Age 0 thousands	SSB tonnes	Landings tonnes	Mean F Ages 1-2
1983	951996032	1857770	530640	0.324
1984	263330000	1166860	750040	0.337
1985	1476445440	1302746	707105	0.885
1986	635147072	531799	685950	0.474
1987	230487712	2128237	791050	0.368
1988	765168832	1922333	1007304	0.906
1989	334092512	562460	826835	0.699
1990	710128896	739709	584912	0.872
1991	837801920	497625	898959	0.819
1992	344847840	824660	820140	0.467
1993	770896704	1288427	576932	0.379
1994	870138688	914542	770747	0.500
1995	378513408	1333014	915043	0.396
1996	2038048256	1293541	776126	0.517
1997	324243968	674841	1114044	0.365
1998	404296128	1883663	1000375	0.611
1999	519328448	980814	718668	0.607
2000	565874048	532011	692498	1.057
2001	967480128	414802	858619	1.064
2002	77337704	404734	806921	0.701
2003	316036640	576004	309725	0.632
2004	203651824	236769	359361	0.779
2005	430636384	203478	171790	0.546
2006		258451	266024	0.335
2007		549846*		
Average	626779504	938720	705825	0.610
Units	(Thousands)	(Tonnes)	(Tonnes)	

*Forecast

Table 4.6.1. SANDEEL in IV. Data used for short term forecast without bias correction.

Input in the assesment year

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2006	1	0	0	0.000	0.0000	0.0000	0	0
2006	1	1	191118	0.323	0.0063	0.0063	1	0
2006	1	2	13723	0.293	0.0108	0.0108	0.4	1
2006	1	3	3187	0.489	0.0130	0.0130	0.4	1
2006	1	4	1356	0.240	0.0153	0.0153	0.4	1
2006	2	0	322495	0.000	0.0031	0.0031	0.8	0
2006	2	1	-	0.023	0.0090	0.0090	0.2	0
2006	2	2	-	0.021	0.0135	0.0135	0.2	1
2006	2	3	-	0.036	0.0135	0.0135	0.2	1
2006	2	4	-	0.017	0.0130	0.0130	0.2	1

Input for forecast Year and forward

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2007	1	0	-	0.000	0.000	0.000	0	0
2007	1	1	-	0.594	0.0057	0.0057	1	0
2007	1	2	-	0.569	0.0100	0.0100	0.4	1
2007	1	3	-	0.626	0.0118	0.0118	0.4	1
2007	1	4	-	0.426	0.0158	0.0158	0.4	1
2007	2	0	322495	0.057	0.0031	0.0031	0.8	0
2007	2	1	-	0.149	0.0090	0.0090	0.2	0
2007	2	2	-	0.143	0.0135	0.0135	0.2	1
2007	2	3	-	0.163	0.0135	0.0135	0.2	1
2007	2	4	-	0.063	0.0130	0.0130	0.2	1

Table 4.6.2. SANDEEL in IV. Analysis of the change in bias correction when comparing terminal values of F and N with "converged" values taken from retrospective runs 1 or 2 years later. Bold figures are those used as correction factors in the short term forecast with corrected Fs-at-age and N-at-age.

		Age				
	Bias source	0	1	2	3	4
1-year ahead	F	NA	0.62	0.90	1.05	1.09
	N	NA	1.65	1.26	1.01	1.18
2-years ahead	F	NA	0.60	0.96	1.06	0.96
	N	NA	1.78	1.17	1.00	1.14
comparison with 2006	**F**	**NA**	**0.58**	**0.87**	**1.01**	**0.75**
	N	**NA**	**1.79**	**1.27**	**1.02**	**1.16**

Table 4.6.3. SANDEEL in IV. Data used for short term forecast where N (numbers at age in first half year of 2006) and F in first half year of 2006 have been corrected for bias.

Input in the assesment year

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2006	1	0	0	0.000	0.0000	0.0000	0	0
2006	1	1	106770	0.557	0.0063	0.0063	1	0
2006	1	2	10806	0.337	0.0108	0.0108	0.4	1
2006	1	3	3125	0.484	0.0130	0.0130	0.4	1
2006	1	4	1169	0.320	0.0153	0.0153	0.4	1
2006	2	0	322495	0.000	0.0031	0.0031	0.8	0
2006	2	1	0	0.040	0.0090	0.0090	0.2	0
2006	2	2	0	0.024	0.0135	0.0135	0.2	1
2006	2	3	0	0.035	0.0135	0.0135	0.2	1
2006	2	4	0	0.023	0.0130	0.0130	0.2	1

Input for forecast Year and forward

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2007	1	0	0	0.000	0.000	0.000	0	0
2007	1	1	0	0.594	0.006	0.006	1	0
2007	1	2	0	0.569	0.010	0.010	0.4	1
2007	1	3	0	0.626	0.012	0.012	0.4	1
2007	1	4	0	0.426	0.016	0.016	0.4	1
2007	2	0	322495	0.057	0.003	0.003	0.8	0
2007	2	1	0	0.149	0.009	0.009	0.2	0
2007	2	2	0	0.143	0.013	0.013	0.2	1
2007	2	3	0	0.163	0.014	0.014	0.2	1
2007	2	4	0	0.063	0.013	0.013	0.2	1

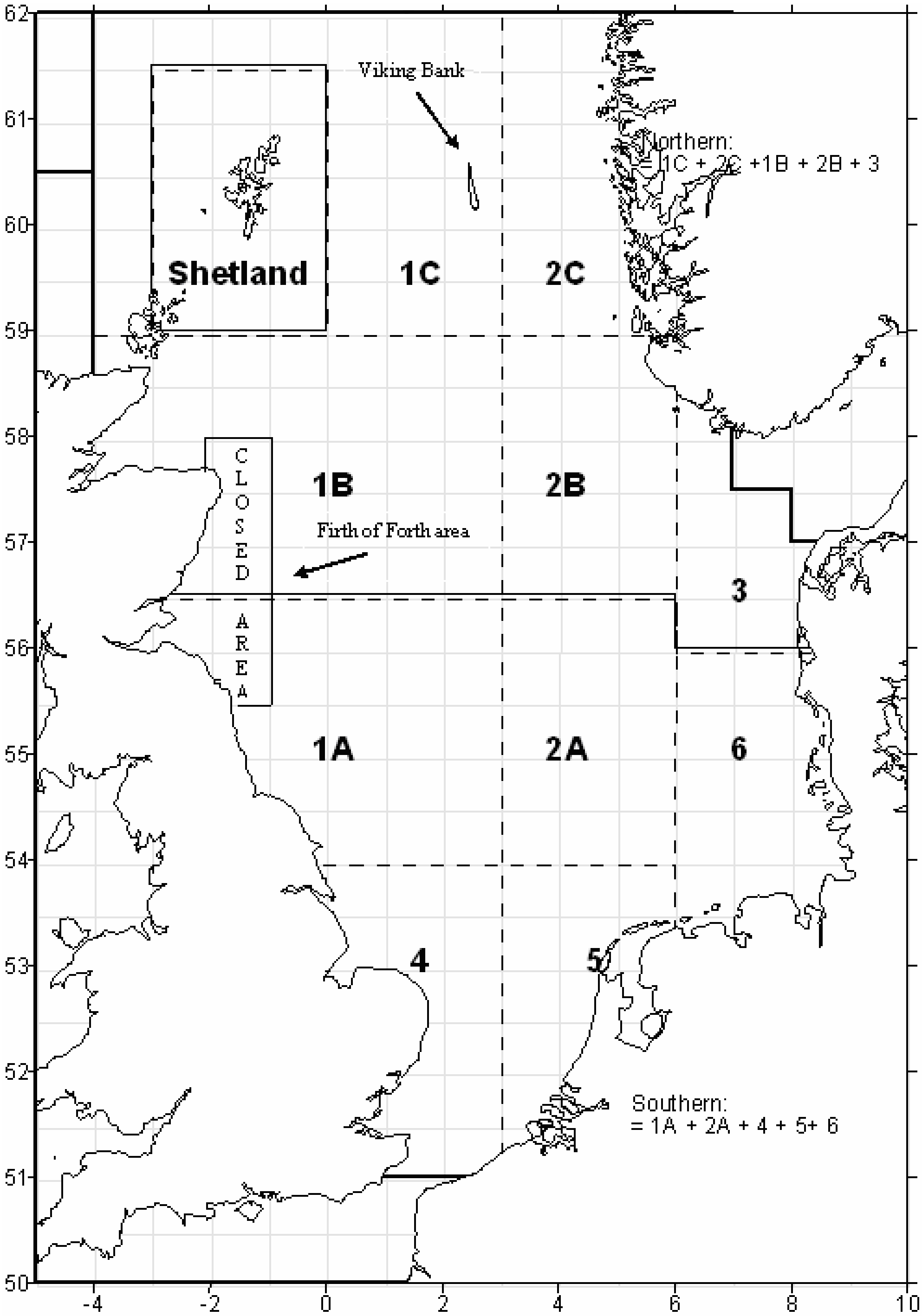


Figure 4.1.2.1. SANDEEL in IV. Sandeel in IV. Danish sandeel sampling areas.

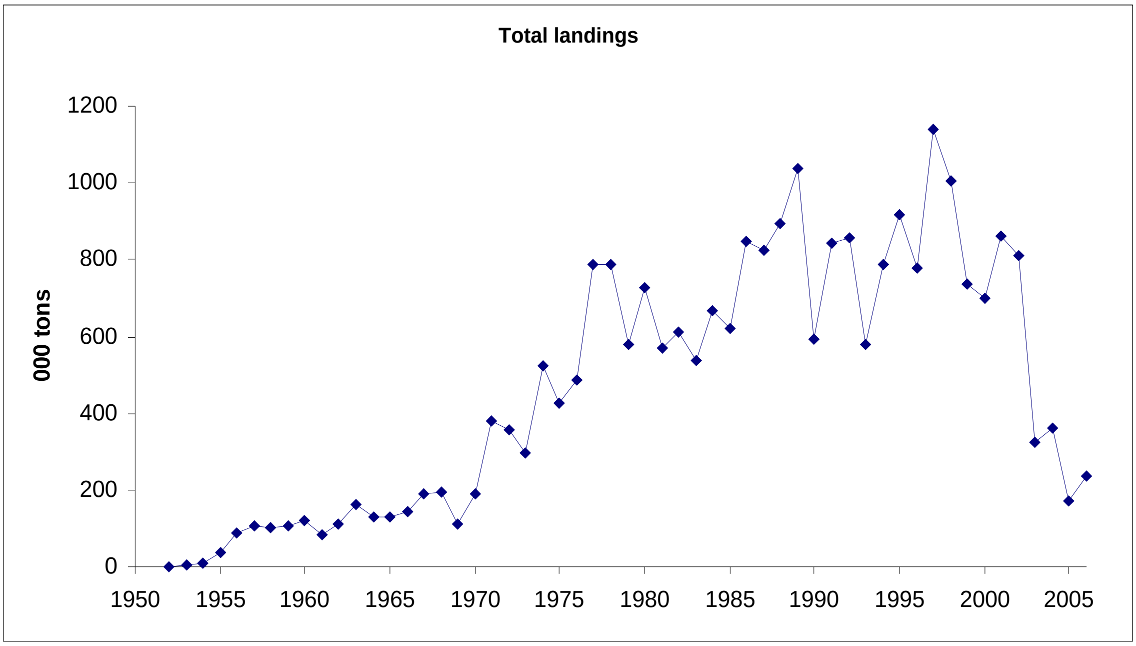


Figure 4.2.1.1. SANDEEL in IV. Total international landings. 2006 only represent first half year (see the text for further details about landings in second half year of 2006).

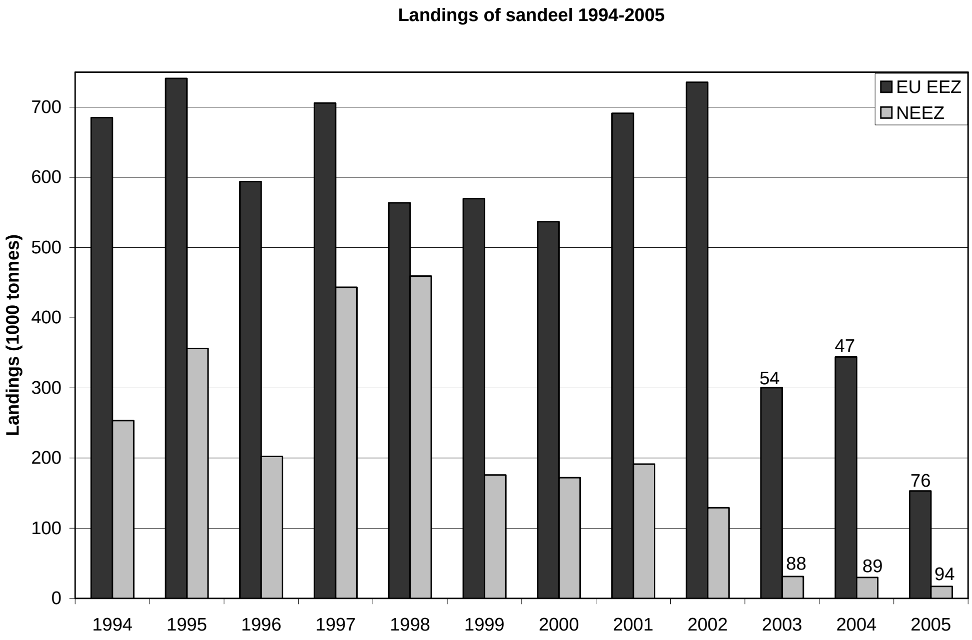


Fig. 4.2.1.2. Landings of sandeel in the EU EEZ and NEEZ in 1994-2005. For 2003-2005 numbers indicate reduction in landings in the two zones compared to 1994-2002

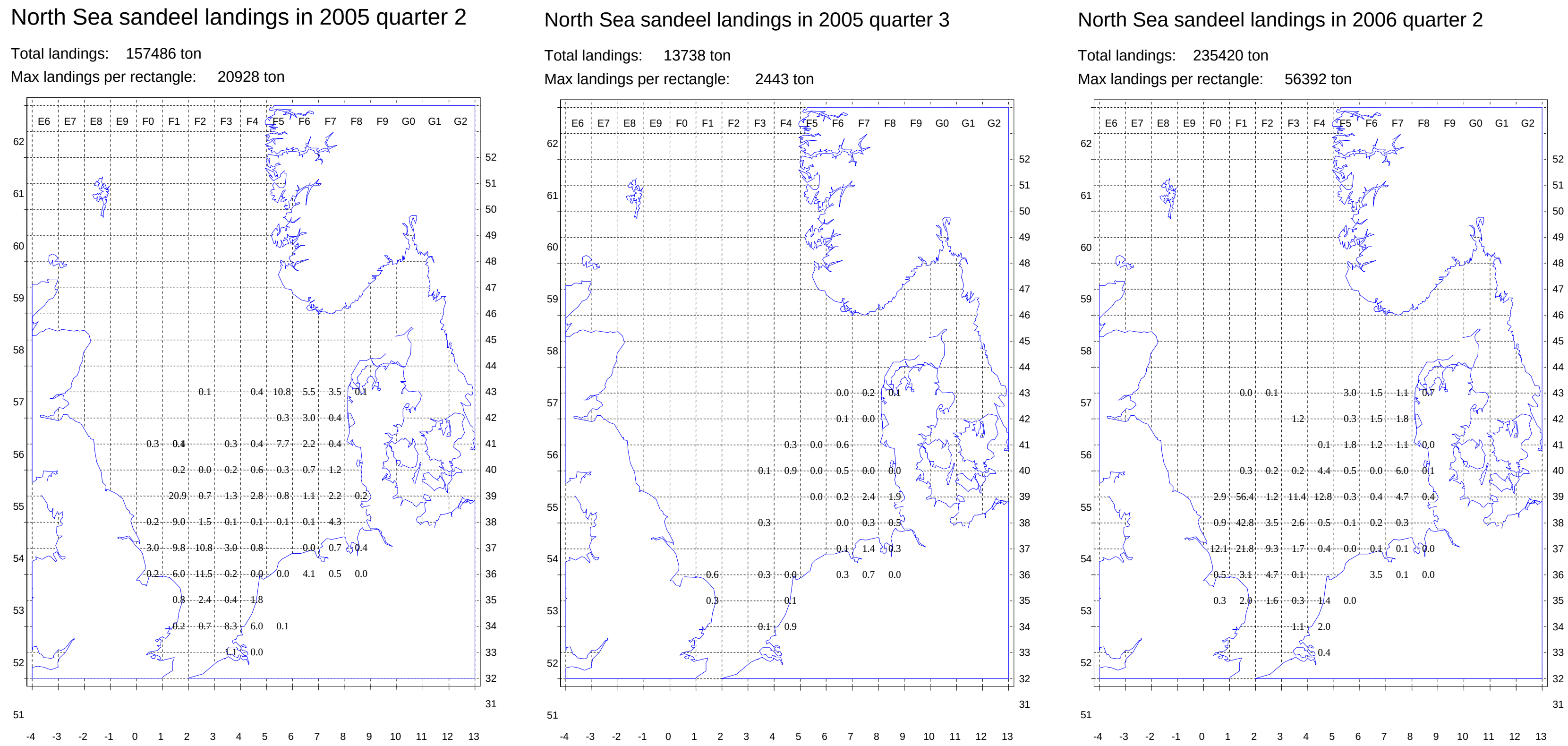


Figure 4.2.1.3. SANDEEL in IV. Quarterly catches of sandeels by Denmark and Norway in 2005 and 2006 by ICES rectangle (‘000 tonnes).

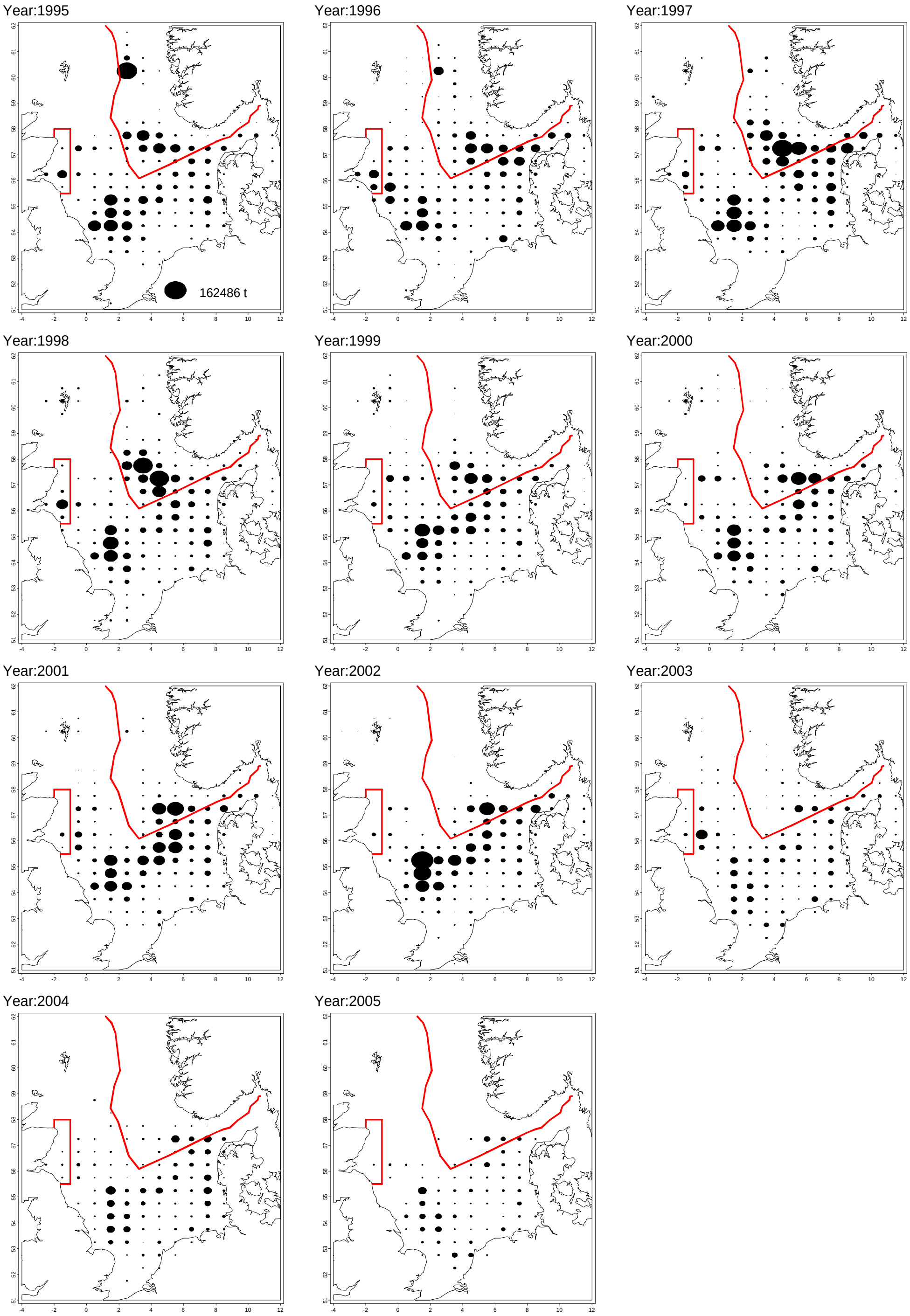
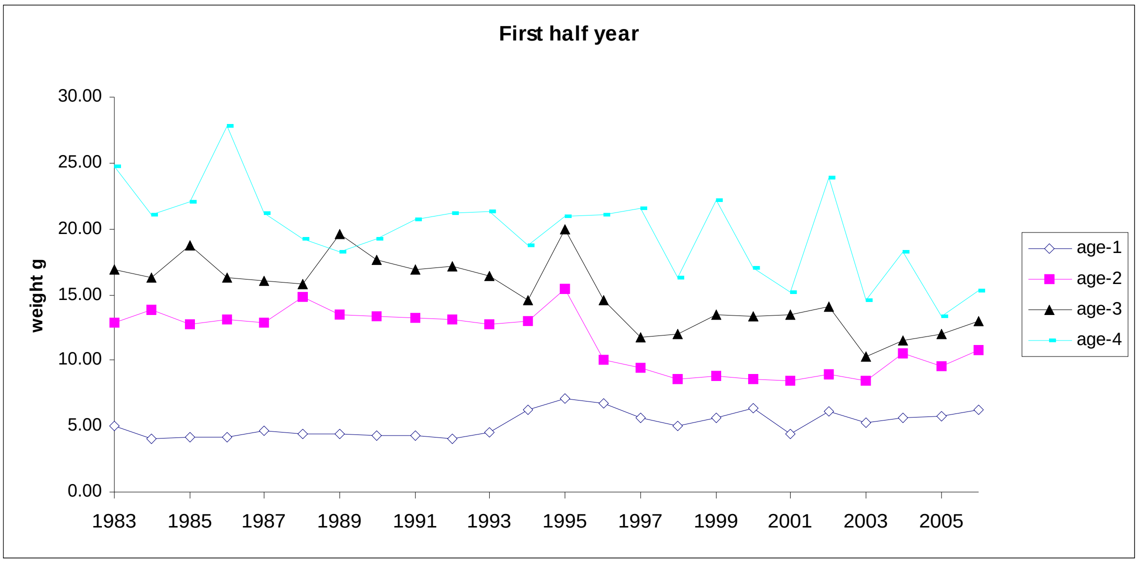


Figure 4.2.1.4. SANDEEL in IV. Landings of Sandeel by year and ICES rectangles for the period 1995-2005. Landings include Danish and Norwegian landing for the whole period. Scottish landings are included from 1997 and onwards; Swedish landings are included from 1998. Landing from other countries are negligible. The area of the circles corresponds to landings by rectangle. All rectangle landings are scaled to the largest rectangle landings shown at the 1995 map. The area that was closed to sandeel fishery in 2000 and the boundary between the EU and the Norwegian EEZ are shown on the map

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



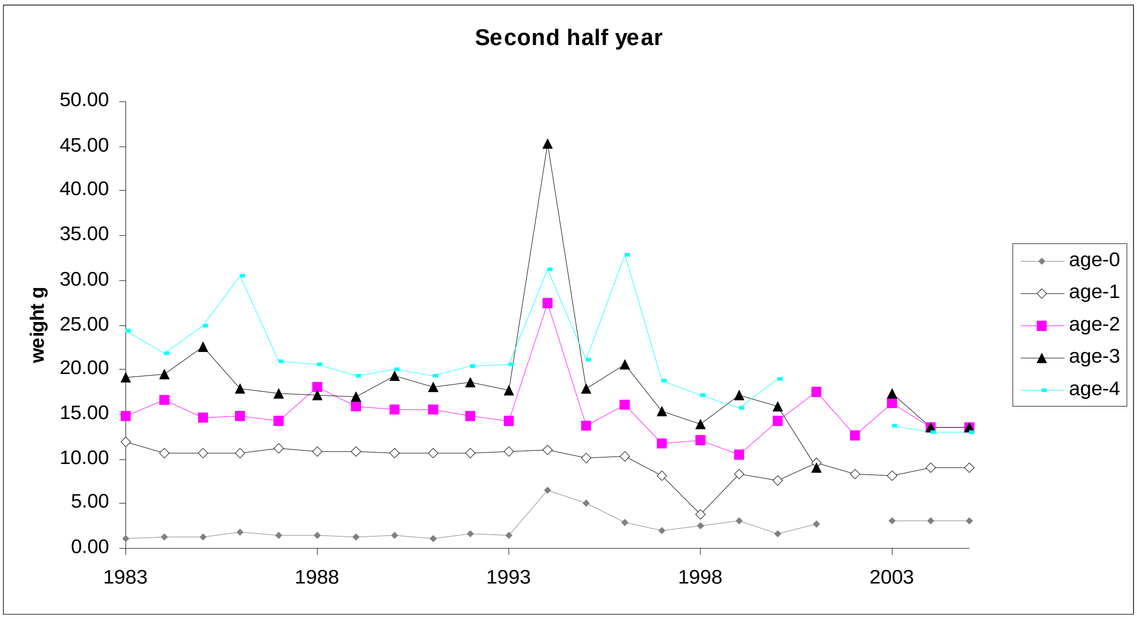


Figure 4.2.3.2 SANDEEL in IV. Mean weight at age in the stock by half year.

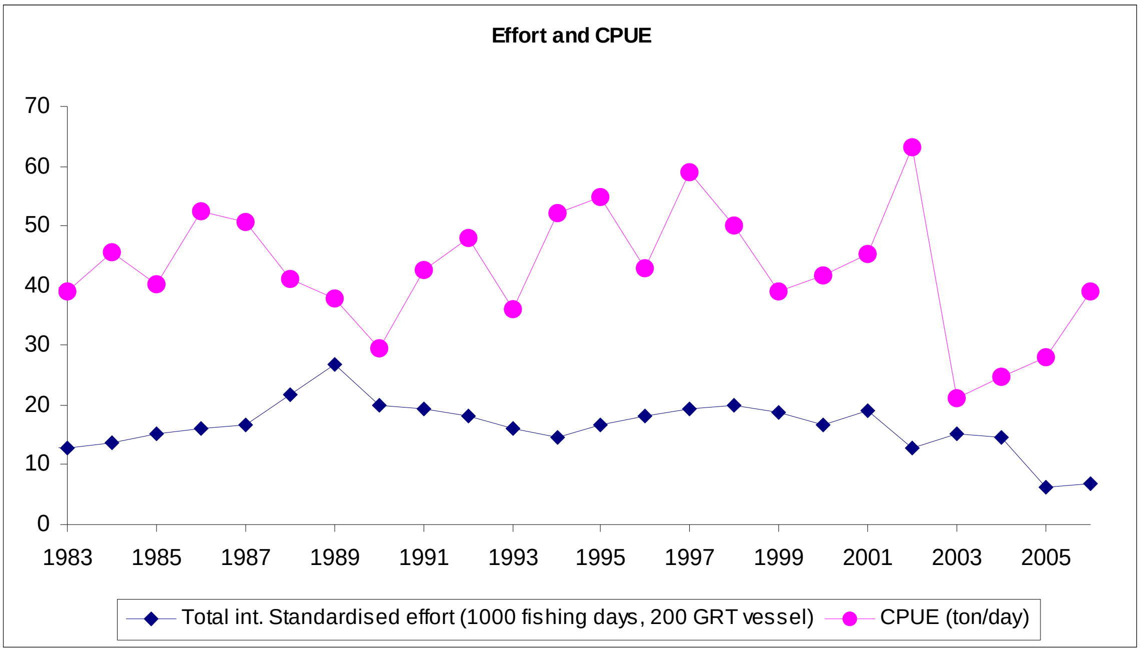


Figure 4.2.5.1. SANDEEL in IV. Total international effort and CPUE.2006 only represent first half year (see the text for further details about landings in second half year of 2006).

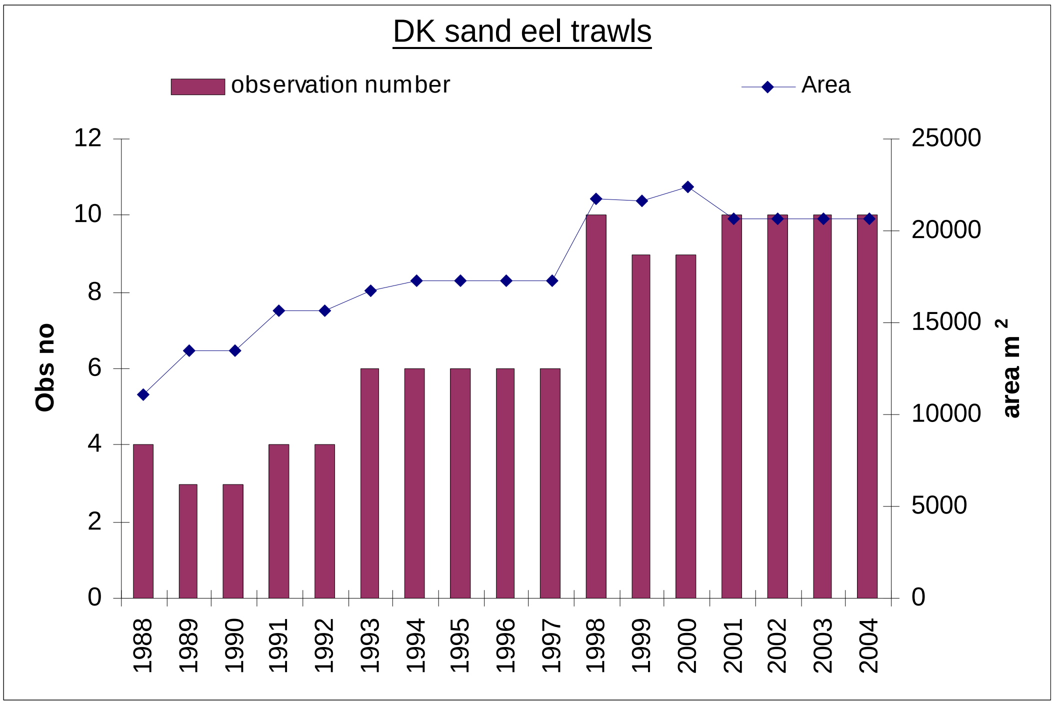
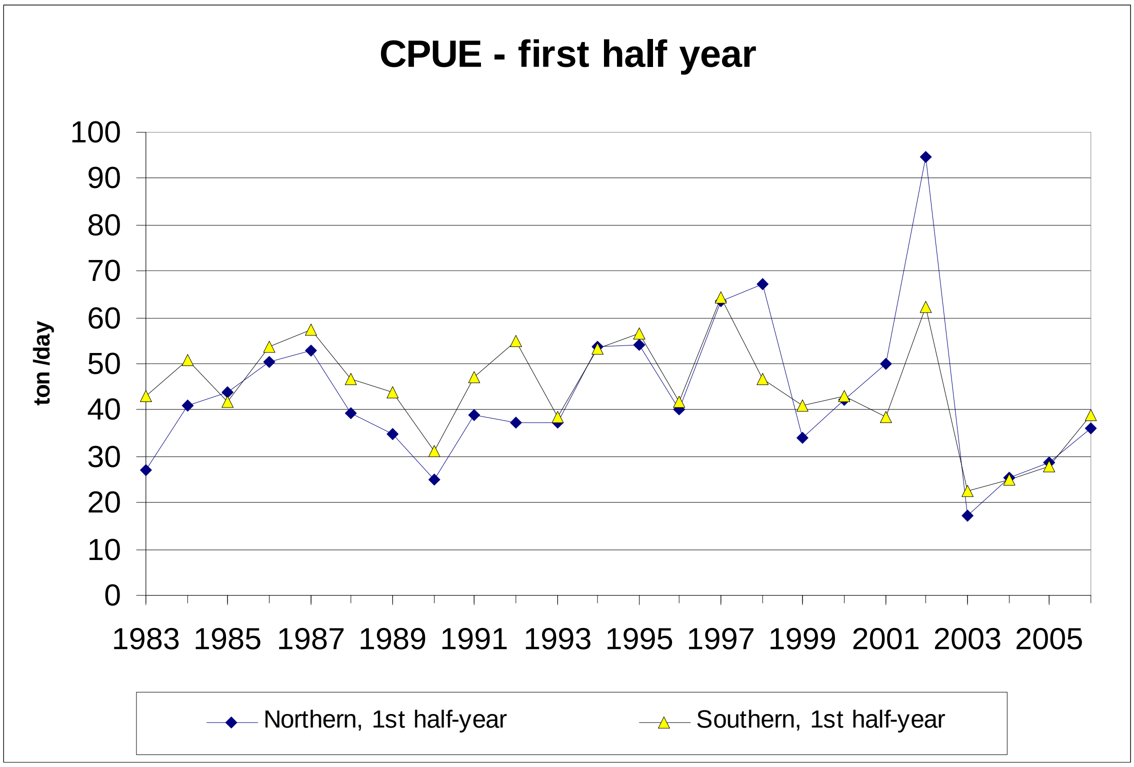


Figure 4.2.5.2. SANDEEL in IV. Changes in the size of the trawl nets used by Danish industrial trawlers. DIFRES unpublished information.



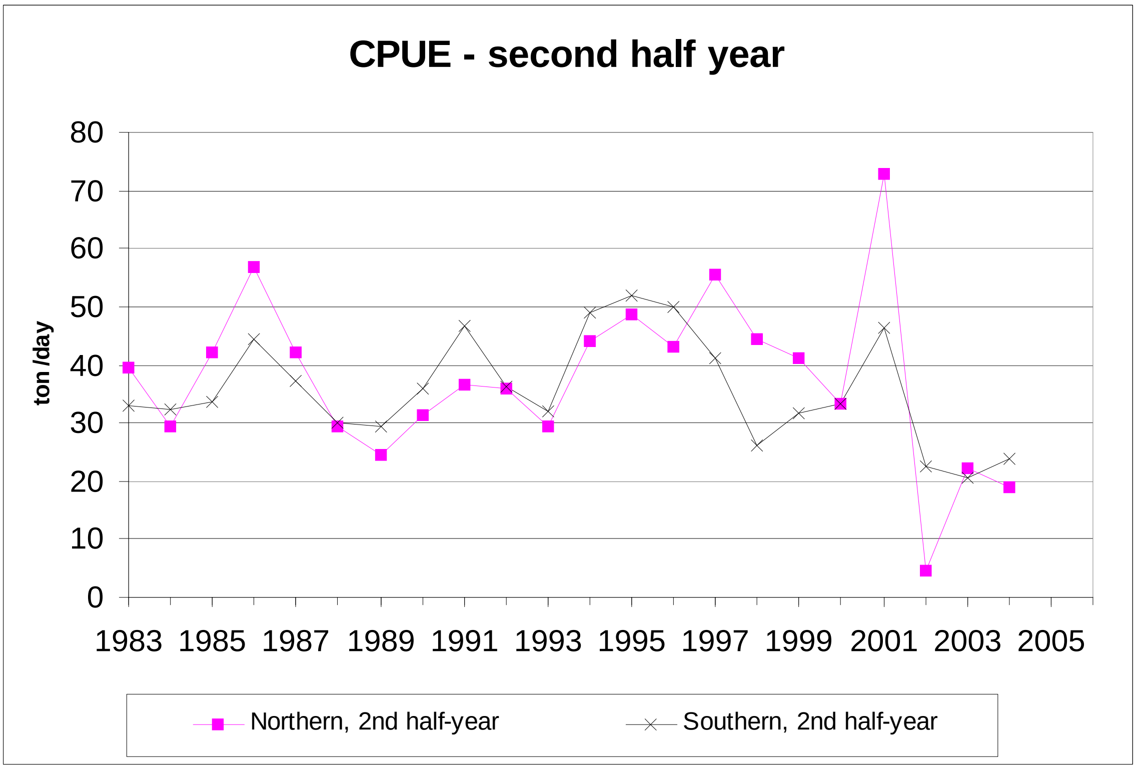


Figure 4.2.5.3. SANDEEL in IV. CPUE (ton/day) by area, half year and year.

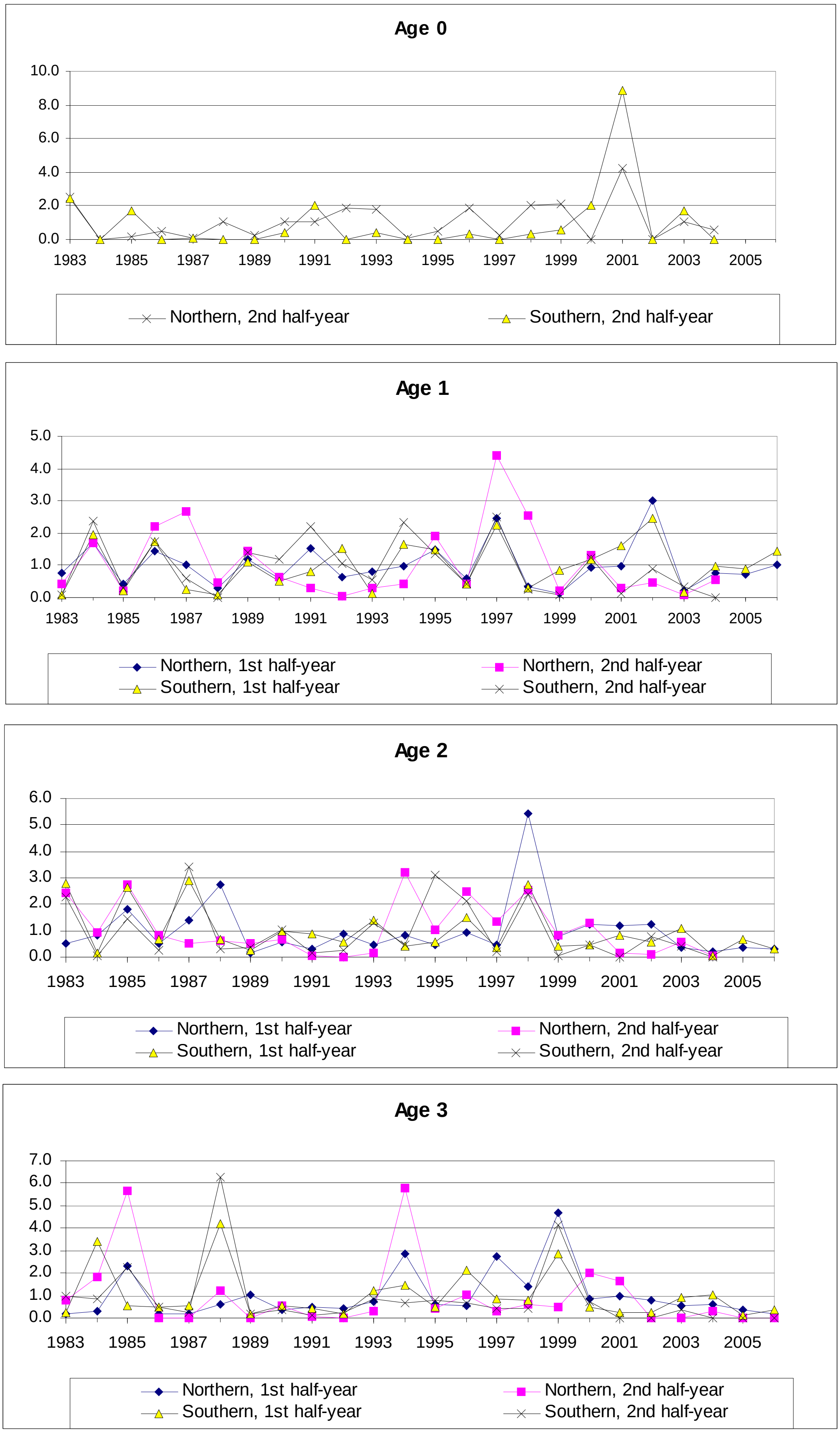


Figure 4.2.5.4 SANDEEL in IV. CPUE (ton/day) by area age group and year.

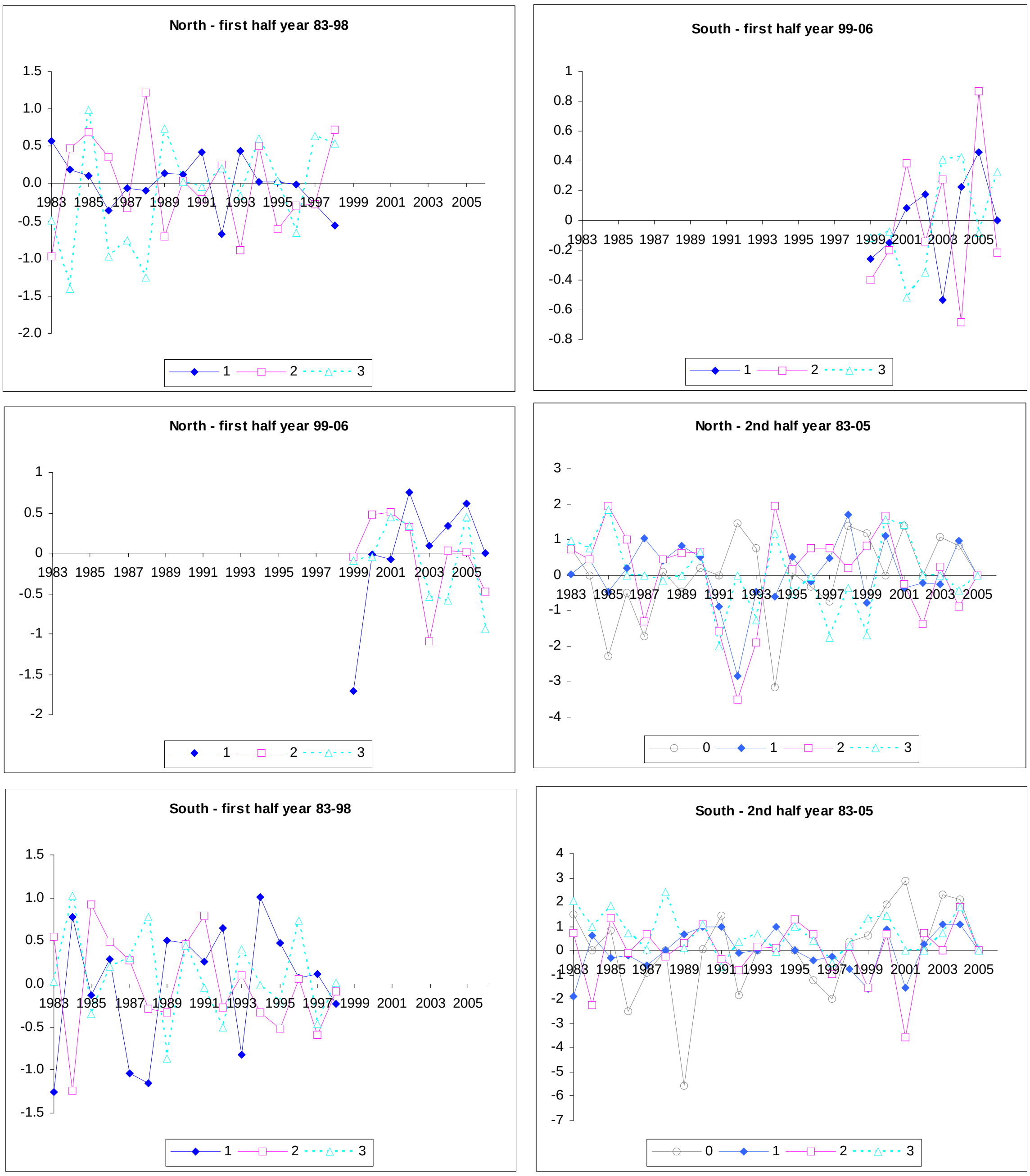


Figure 4.3.2.1 SANDEEL in IV. Log residual stocknr. (nhat/n) by fleet. SXSA.

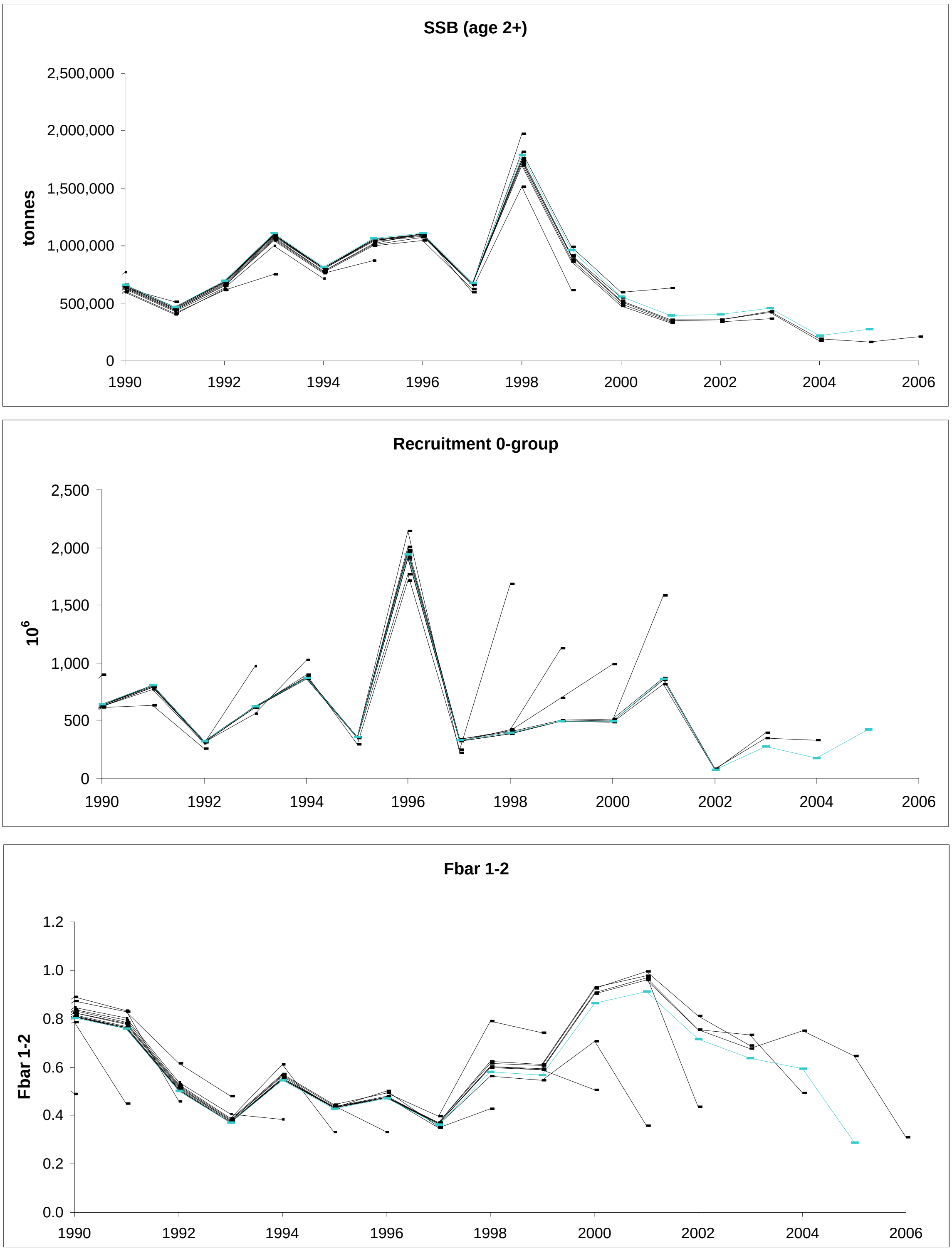


Figure 4.3.2.2. SANDEEL in IV. Retrospective analysis of SSB, recruitment, and F_{bar} 1990-2006 for the SXSA analysis.

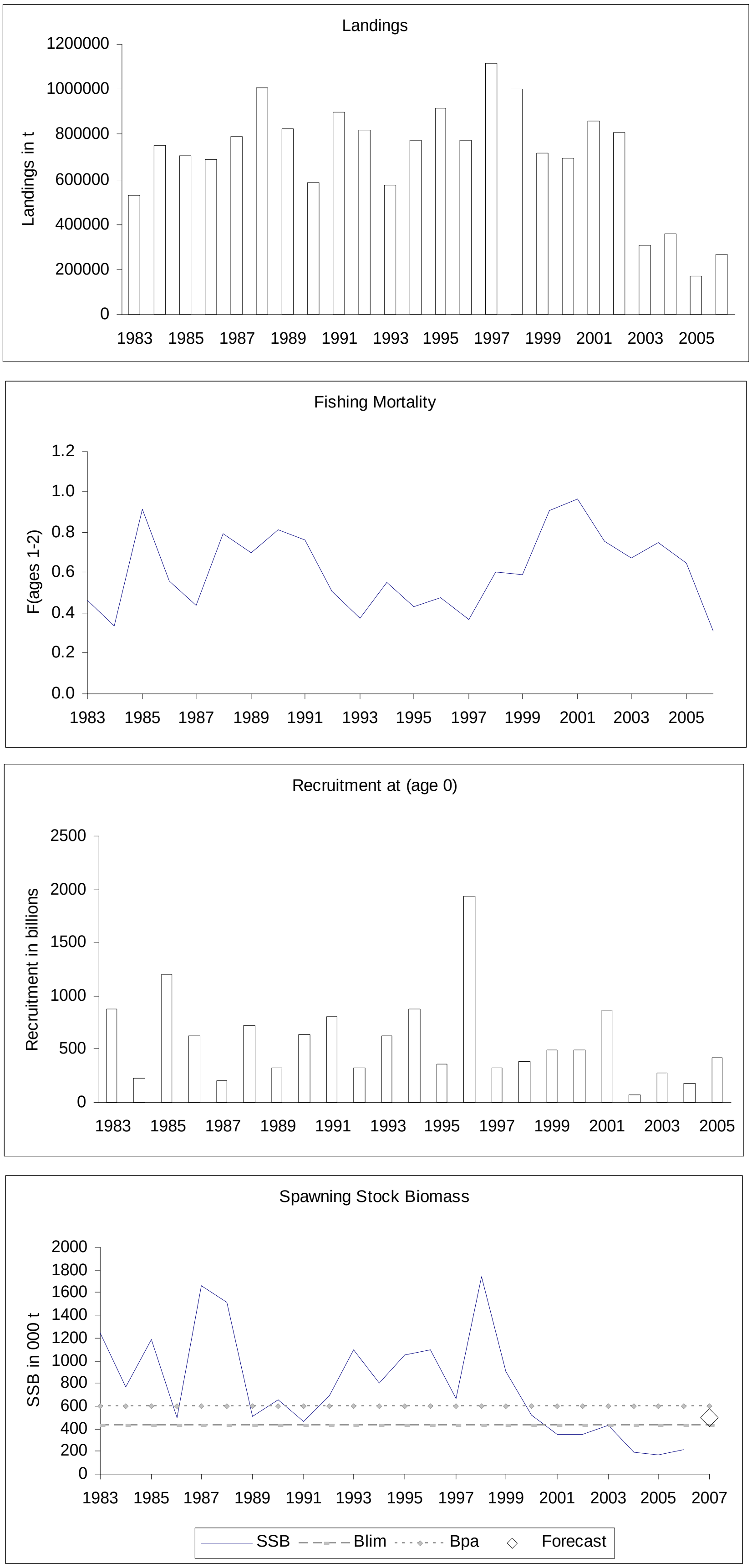
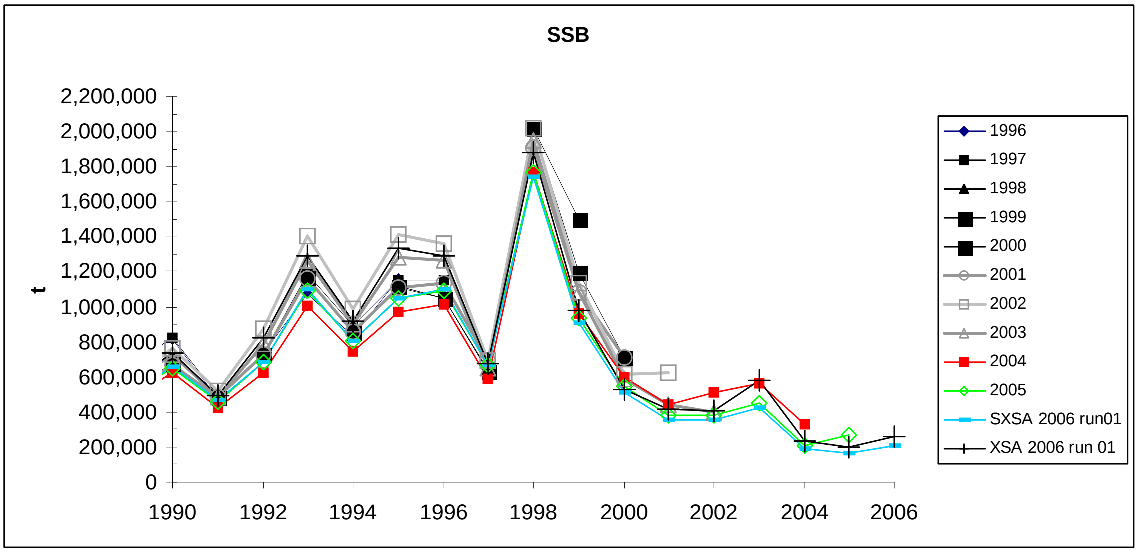
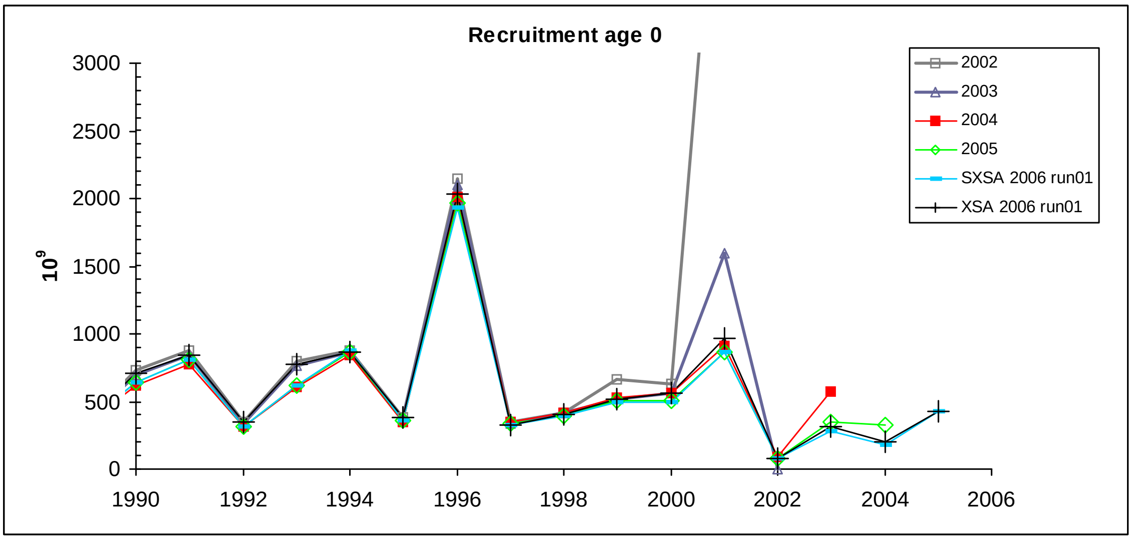


Figure 4.3.2.3. SANDEEL in IV. SXSA Stock Summary.





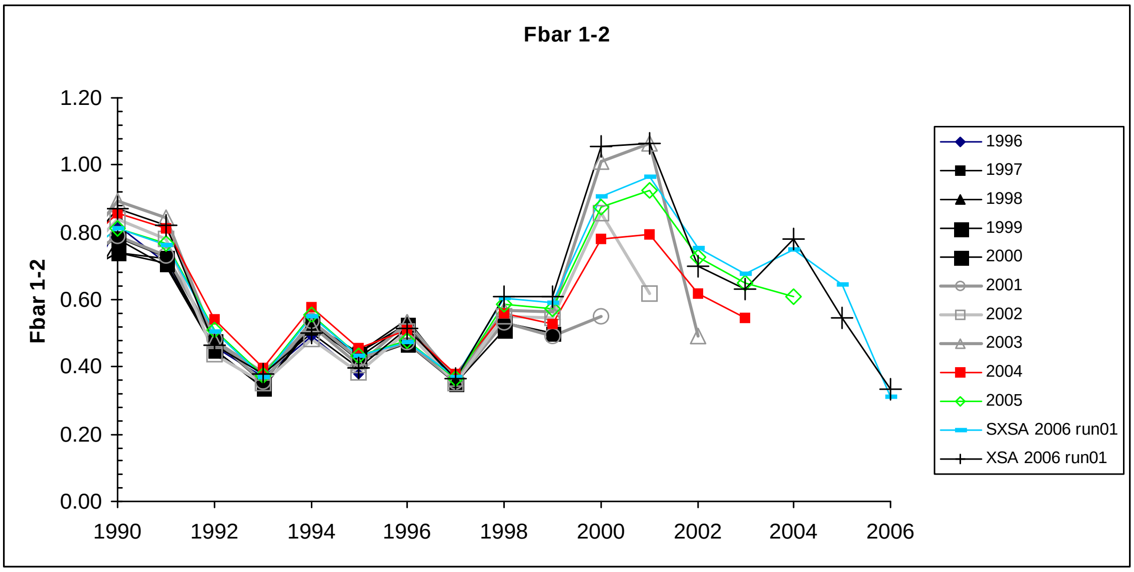


Figure 4.3.2.4. SANDEEL in IV. Comparison of historical performance of assessments in 2006. $F_{bar1\text{-}2}$ in 2006 based on data for only first half year of 2006.

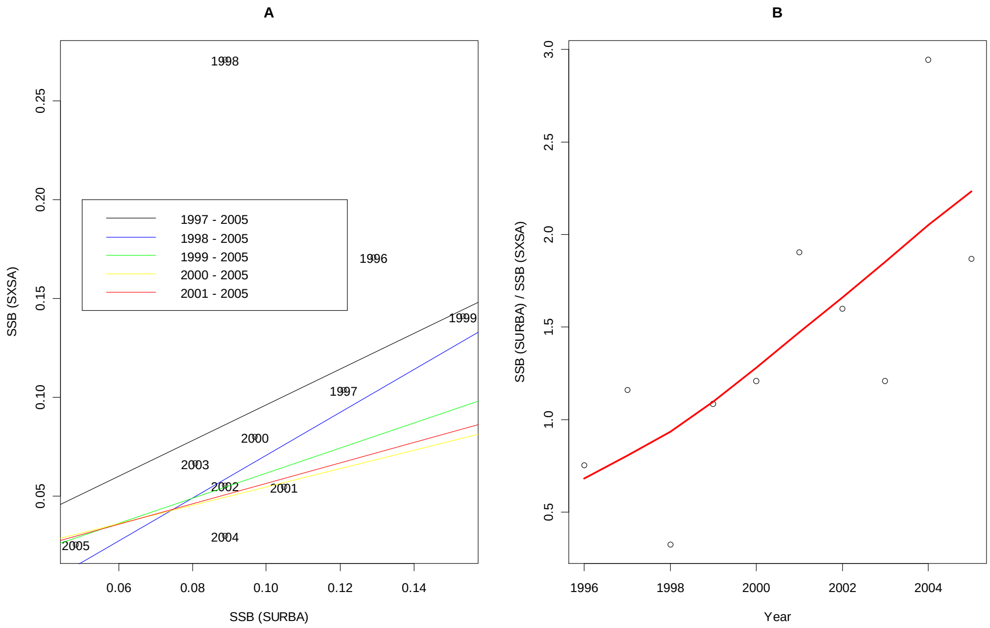


Figure 4.3.3.1. SANDEEL in IV. Mean standardized SSB estimated by Seasonal XSA vs. mean standardized SSB estimated in SURBA. The colour lines indicate the estimated linear regression line (years used in the linear regression are indicated in the legend) between the SSBs estimated by the two methods. Note that the slope decreases when older data are excluded in the regression. B: The mean standardized SSB (SURBA) - SSB (Seasonal XSA) ratio by year is indicated as points. The inserted smoothed line reflects the trend.

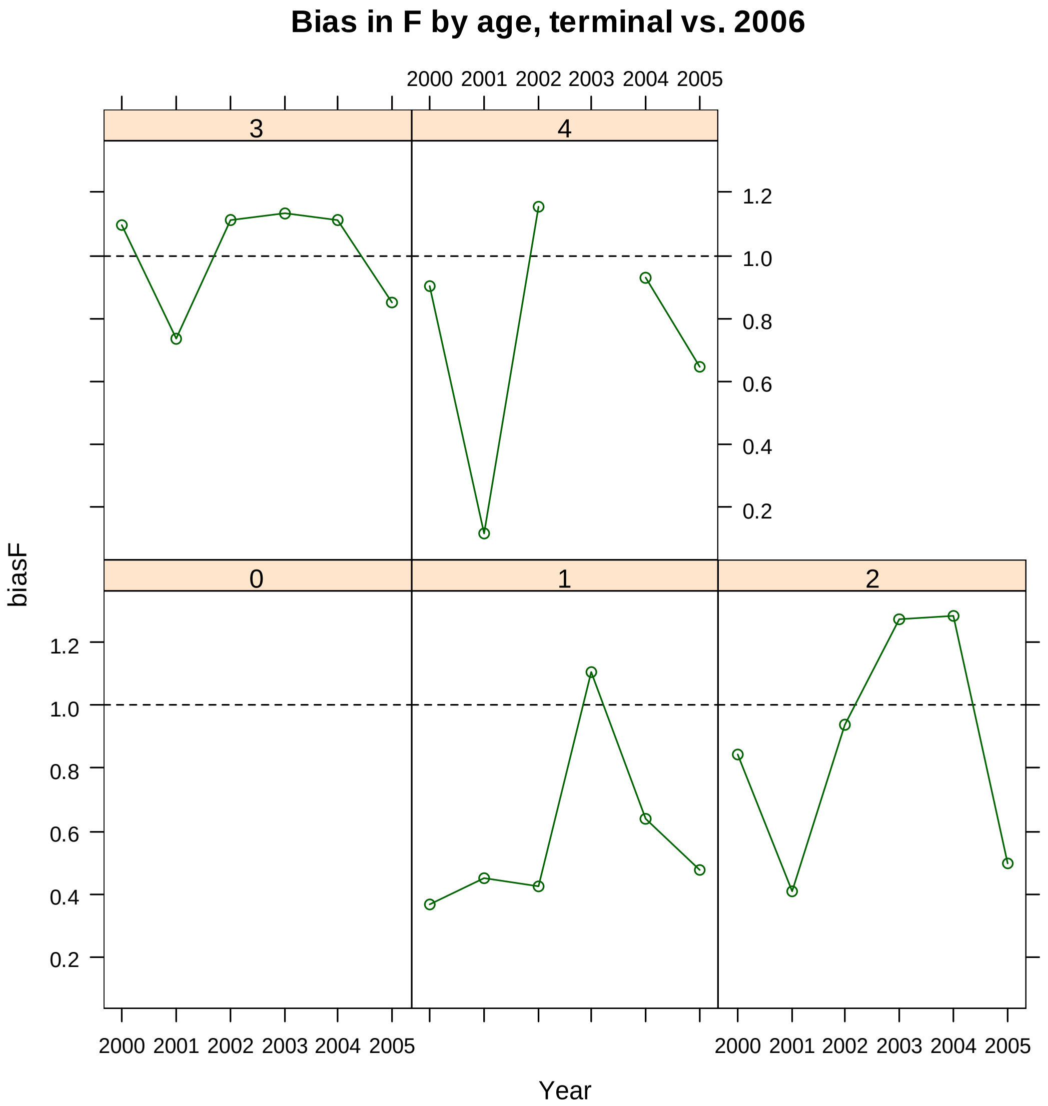


Figure 4.6.1. SANDEEL in IV. Ratio of terminal F from retrospective runs to F estimate from 2006 SXSA assessment. Panels are ages.

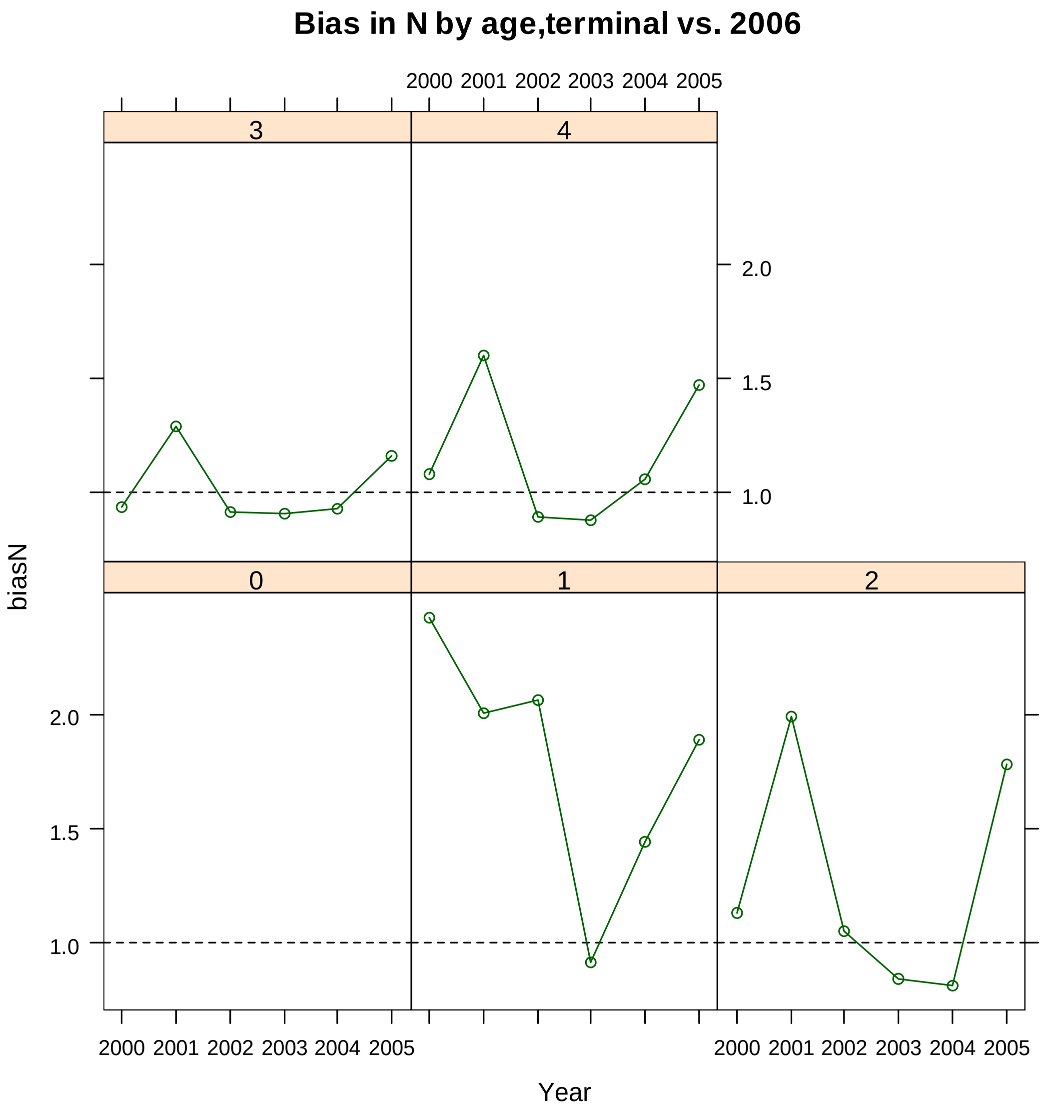


Figure 4.6.2. SANDEEL in IV. Ratio of terminal N from retrospective runs to N estimate from 2006 SXSA assessment. Panels are ages.

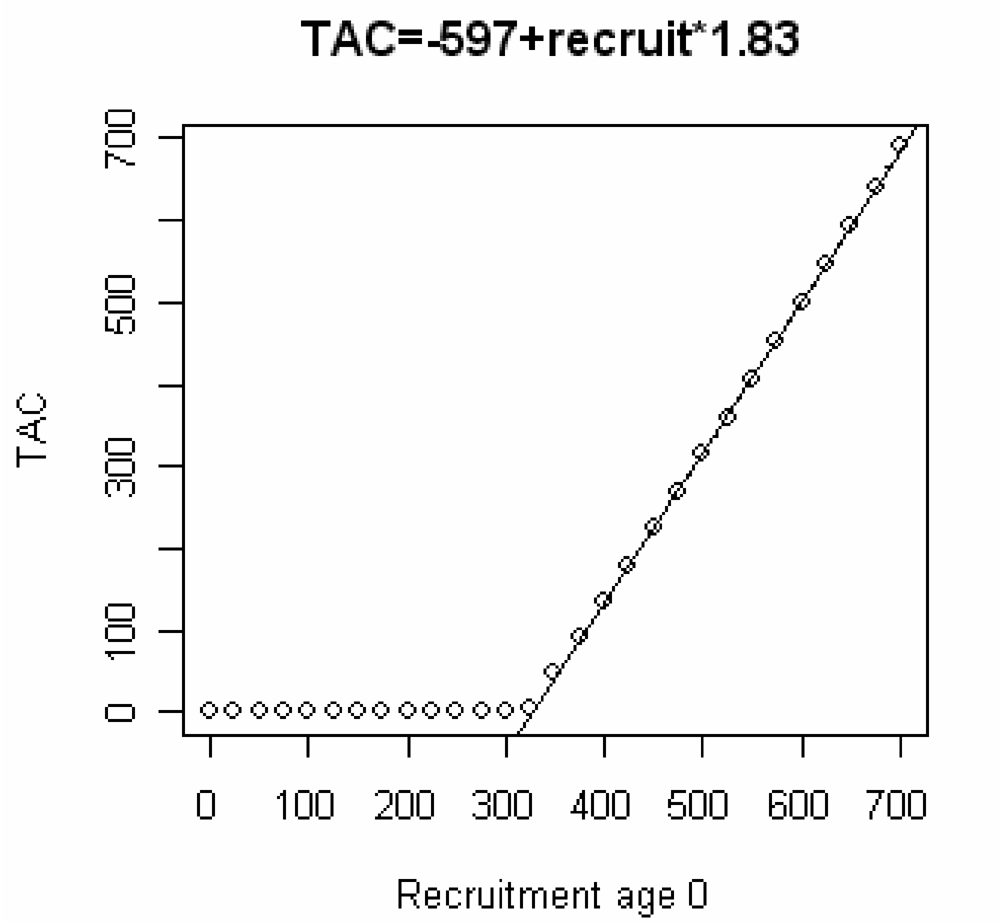


Figure 4.6.3. SANDEEL in IV. Regression of recruitment in 2006 against TAC in 2007, where TAC in 2007 will lead to SSB in 2008 being B_{pa}.

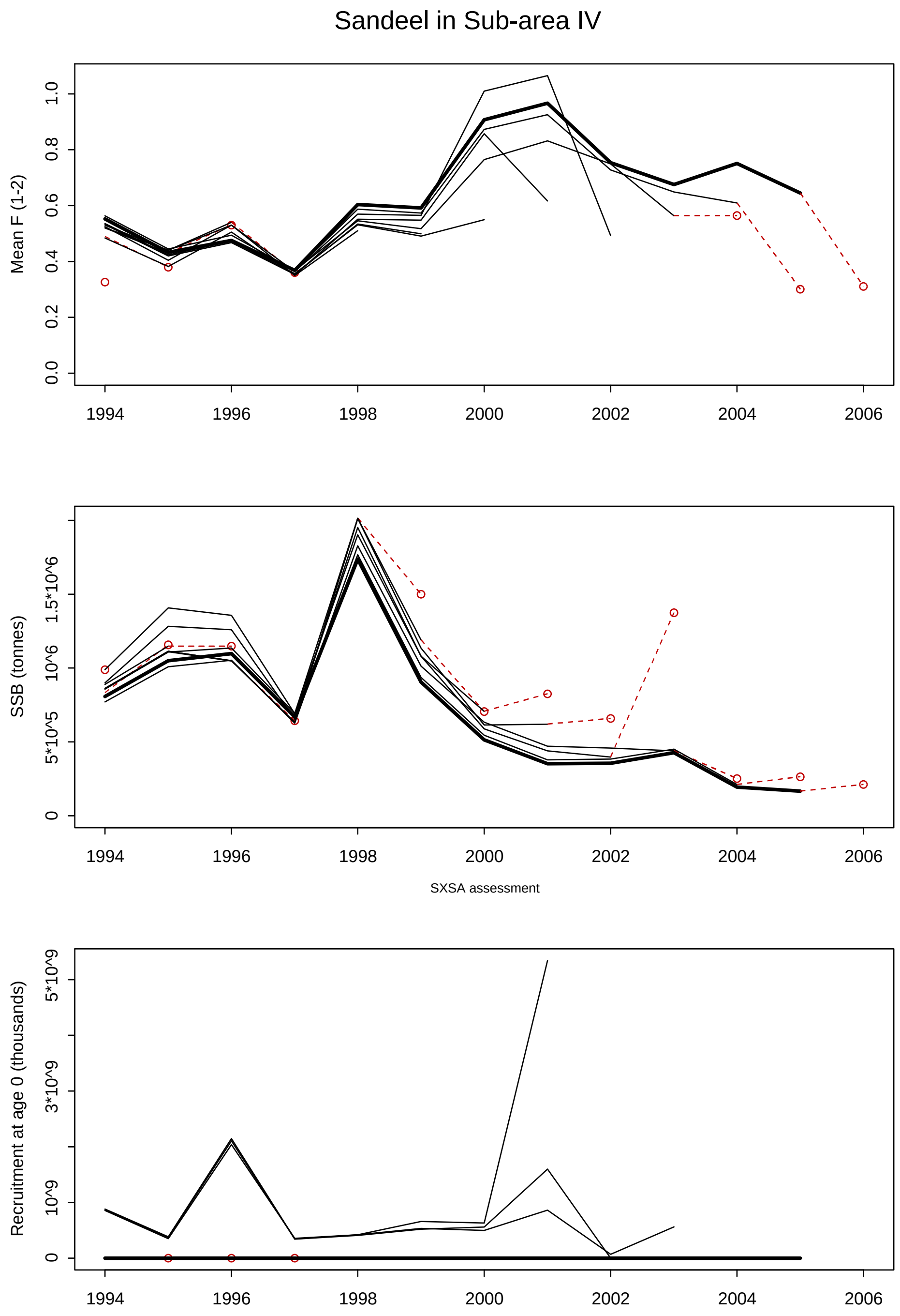


Figure 4.9.1. Sandeel. Historical performance of the assessment. Circles indicate single-year forecasts.

5 NORWAY POUT IN ICES SUB-AREA IV AND DIVISION IIIa

The September 2006 assessment of Norway pout in the North Sea and Skagerrak is partly a benchmark assessment focusing on the levels and time series for natural mortality to be used in the assessment. Besides considering the natural mortalities the benchmarking has also considered the most appropriate assessment model to be used best describing the dynamics of the stock. Necessary re-calculation of stock reference points has been performed. All other aspects and settings in the assessment is an up-date assessment of the 2004 benchmark assessment and the up-date September 2005 assessment, as well as the April 2006 real time monitoring/management assessments. Due to closure of the Norway pout fishery and no catches in 2005 and in the first half year 2006 exploratory and comparative assessment runs have been carried out in September 2005 (ICES-WGNSSK 2006) as well as in April 2006 (ICES-ACFM 2007) using new survey CPUE data and both the SXSA and SMS assessment models. Also, the September 2006 assessment uses new survey information (among other from third quarter 2006) and run both assessment models for the stock.

5.1 General

5.1.1 Ecosystem aspects

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

Around 10 % of the Norway pout reach maturity already at age 1, however, most individuals reach maturity at age 2.

Preliminary results from an analysis of regionalized survey data on Norway pout maturity, presented in Larsen et al. (2001), gave no evidence for a stock separation in the whole northern area.

The population dynamics of Norway pout in the North Sea and Skagerrak are very dependent on changes caused by recruitment variation and variation in predation mortality (or other natural mortality causes) (Sparholt et al. 2002a,b). Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species. With present fishing mortality levels in recent years the status of the stock is more determined by natural processes and less by the fishery. However, there is a need to ensure that the stock remains high enough to provide food for a variety of predator species. This stock is among other important as food source for other species (e.g. saithe, haddock and mackerel).

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. By-catches of other species should also be taken into account in management of the fishery. Existing technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been maintained. By-catch of herring, saithe, cod, haddock, whiting, and monkfish at various levels in the small meshed fishery in the North Sea and Skagerrak directed towards Norway pout has been documented (Degal et al. WD 22; see also Section 16.5.2.2). Scientific documentation reveals that by-catch reduction gear selective devices can be used in the fishery, significantly reducing by-catch of juvenile gadoids and other non-target species (Nielsen and Madsen WD 23; Section 16.5.2.2).

5.1.2 Fisheries

The fishery is mainly performed by Danish and Norwegian vessels using small mesh trawls in the north-western North Sea especially at the Fladen Ground and along the edge of the Norwegian Trench in the north-eastern part of the North Sea. Main fishing seasons are 3rd and 4th quarters of the year with also high catches in 1st quarter of the year especially previous to 1999 (see the Stock Annex Q5).

The spatial distribution of the catches from the fishery by ICES statistical rectangle and season of year for 2004 from the Danish commercial fishery for Norway pout is shown in **Figure** 12.1.1 of the 2005 report (ICES-WGNSSK 2006). Ten year averages of the distribution of catches by year and quarter are shown in figures in the Stock Annex (Q5).

Landings have been low since 2001, and the 2003-2004 landings were on the lowest level ever recorded since 1961. The mixed commercial, small meshed fishery conducted mainly by Denmark and Norway directed towards Norway pout as one of the target species has been closed for 2005 and in the first half year of 2006. Trends in yield are shown in **Figure**s 5.3.3-4.

As a consequence of the closure of the fishery there has been no directed effort for Norway pout in 2005 and in the first part of 2006, except for a very small Danish-Norwegian trial fishery in the 3rd quarter of 2005. Effort in 2003 and 2004 has been historically low and well below the average of the 5 previous years (**Table** 5.2.9). The effort in the Norway pout fishery was in 2002 at the same level as in the previous eight years before 2001.

5.1.3 ICES advice

There is no specific management objective set for this stock. With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery.

Based on estimates of SSB, ICES has classified the stock as being at risk of reduced reproductive capacity in 2005 and 2006 (SSB was below $\mathbf{B}_{lim}$ and well below B_{pa} in 2005). On that basis ICES advised a closure of the fishery (TAC=0 t except for a yearly 5000 t by-catch TAC to Norway) in 2005 as well as in the first part of 2006. Long-term average fishing mortality is approximately 50% of the natural mortality for this stock. Estimated fishing mortality has decreased in recent years and was in 2004 on the lowest level in the time series, and because of the fishery closure in 2005 and in the first part of 2006 the fishing mortality has been very close to zero in 2005 and in the first part of 2006. Fishing effort has in general decreased in recent years reaching historically minima in 2001 and in 2003-2005. Recruitment has been low since 2000 including historical minima in 2003-2004, however the assessed 2005 recruitment based on the 2005 3rd quarter survey index and the 2006 1st quarter survey index indicate a recruitment of 0-group Norway pout in 2005 corresponding to the long term geometric mean. On this basis the stock was re-assessed in an up-date the assessment in April 2006 when additional survey information was available. With confirmation of the average recruitment in 2005 and assumption of a 25% level of long average recruitment in 2006 the ICES advice in spring 2006 gave a forecast of the stock being above Bpa 1st of January 2007 sustaining a fishery of around 90 000 ton in 2006. Accordingly, the advice was re-opening of the fishery with a TAC on approximately 90 000 ton.

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. By-catches of other species should also be taken into account in management of the fishery. Existing measures to protect other species should be maintained.

Biological reference points for the stock have until September 2006 been set by ICES at B_{lim} = 90 000 t as the lowest observed biomass (in 1987) and B_{pa} = 150 000 t until revision of the reference points in the second half year 2006. ICES has advised that these reference points should be maintained until new reference points are calculated.

5.1.4 Management

There are no explicit and specific management objectives for this stock. The European Community has decided to apply the precautionary approach in taking measures to protect and conserve living aquatic resources, to provide for their sustainable exploitation and to minimise the impact of fishing on marine ecosystems.

In 2004 the TAC was set to 198 000 t in the EC zone and 50 000 t in the Norwegian zone. On basis of the advice for 2005 from ICES, EU and Norway agreed to close the directed Norway pout fishery in 2005 and in the first part of 2006. Accordingly, the TAC was in 2005 and for the first part of 2006 set to 0 in the EC zone and 5 000 t in the Norwegian zone – the latter to allow for by-catches of Norway pout in the directed Norwegian blue whiting fishery. On basis of the real time management advice provided by ICES in spring 2006 EU has from 1st of September 2006 set a TAC of approximately 90 000 t for 2006 intended for the whole stock. Norway has in the beginning of September 2006 opened a directed Norway pout fishery without quota limitations in Norwegian EEZ. However, an area (Egersund Bank) will be closed for this fishery from 1st of October 2006.

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

An overview of recent relevant management measures and regulations for the Norway pout fishery and the stock can be found in the Stock Annex (Q5).

5.2 Data available

5.2.1 Landings

Data for annual nominal landings of Norway pout as officially reported to ICES are shown in **Table** 5.2.1. Because the mixed commercial, small meshed fishery conducted mainly by Denmark and Norway directed towards Norway pout as one of the target species has been closed there has been no reported landings of Norway pout in 2005 and first part of 2006 from directed fishery. Consequently, there were no landings of Norway pout in this period except for 962 ton by-catch of Norway pout in the Norwegian blue whiting fishery in the North Sea in 2005 (mainly in the 2nd and 3rd quarter of 2005), and 1957 ton in first half year 2006, as well as 160 ton by-catch in 2005 and 0 ton by-catch in first half year 2006 of Norway pout in the Danish small meshed fishery targeting mainly blue whiting and sandeel. By-catches (and landings) of Norway pout in fisheries directed for other species are not included in the assessment as no biological sampling are performed of those. Additionally, there has been landed 781 ton (Denmark) and 250 ton (Norway) from a directed Danish and Norwegian Norway pout trial fishery in the North Sea in the 3rd quarter of 2005. These landings were so low that no biological sampling has been made from them, and accordingly they have been ignored in the assessment. Historical data for annual landings as provided by Working Group members are presented in **Table** 5.2.2, and data for national landings by quarter of year and by geographical area are given in **Table** 5.2.3. In the SXSA assessment by April 2006 and September 2006 total landings (catches) per quarter of 2005 and first part of 2006 have been set to 400 ton in total (evenly distributed over age groups except for 0-group in 1st and 2nd quarter of the year) in order to make the assessment model run (which is considered to be a maximum estimate of actual landings / catches in the directed Norway pout fishery during this period), i.e. catches at very low levels in general have been used. In the assessment with the SMS model no assumptions about catches in 2005-06 have been made (see also Section 5.3.2).

5.2.2 Age compositions in Landings

Age compositions were available from Norway and Denmark. Catch at age by quarter of year is shown in **Table** 5.2.4. No biological samples were taken from the very low Norway pout catches in 2005 and first half year 2006.

5.2.3 Weight at age

For the assessment mean weights at age in the catch for 3rd and 4th quarter 2004 has been used for 3rd and 4th quarter 2005, and accordingly mean weight at age in catch for 1st and 2nd quarter of 2005 (which are mainly based on data from 1st and 2nd quarter 2004) has been used for 1st and 2nd quarter of 2006, respectively. This has been necessary because no biological samplings of the very small catches in 2005 and the first half year 2006 has been performed. The assumption of no changes in weight at age in catch in the two recent years does not affect assessment output significantly because the catches in the same period were extremely low.

Mean weight at age in the catch is shown in **Table** 5.2.5 and mean weight at age in the stock is given in **Table** 5.2.6. The estimation of mean weights at age in the catches and the used mean weights in the stock in the assessment is described in the stock quality handbook.

Mean weight at age in the catch is estimated as a weighted average of Danish and Norwegian data. Historical levels and variation in mean weight at age in catch by quarter of year is shown in **Figure** 5.2.1. In general, the mean weights at age in the catches are variable between seasons of year.

The same mean weight at age in the stock is used for all years (**Table** 5.2.6). The reason for mean weight at age in catch is not used as estimator of weight in the stock is mainly because of the smallest 0-group fish are not fully recruited to the fishery in 3rd quarter of the year because of likely strong effects of selectivity in the fishery.

5.2.4 Maturity and natural mortality

Maturity and natural mortality used in the assessment is described in the stock quality handbook. Proportion mature and natural mortality by age and quarter used in the assessment is given in **Table** 5.2.6.

In the 2001-2002 assessments exploratory runs were made with revised input data for natural mortality by age based on the results from two papers presented to the WG in 2001 (Sparholt et al 2002a,b).

In 2002, the WG suggested that an assessment with partly the traditional settings (constant M) and a new assessment with the revised values for M were made for at least a 3 year period in order to compare the output and the performance of the assessments before the working group decided on possible adoption of the revised values for M to be used in the assessment. This attitude has been adopted by the working group each year since then. In the September 2005 up-date assessment an exploratory run with revised values for M was performed as well.

The revised natural mortality estimates from Sparholt et al (2002a,b) are given in Table 5.2.6. The resulting SSB (1st quarter of year), F and R for the final exploratory run have each year been compared to those for the accepted run with standard settings (see e.g. Figure 12.3.12 of the 2005 report (ICES WGNSSK (2006)). It has from all these exploratory runs appeared that the implications of these revised input data are significant (including for TSB (3rd quarter of year) – which has not been shown). The results of the exploratory runs have been consistent throughout all years of exploratory runs.

On that basis the working group in 2005 recommended that there be made a limited benchmark assessment for Norway pout in the 2006 assessment with specific reference to evaluation of effects of using revised natural mortalities, and that the WG on this basis decides on which natural mortalities to use in the assessment.

In this benchmark assessment three data time series for natural mortality has been considered and compared through exploratory assessment runs:

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

The results from these comparative analyses are given in Section 5.3.2

5.2.5 Catch, Effort and Research Vessel Data

Description of catch, effort and research vessel data used in the assessment is given in the stock quality control handbook. Data used in the present assessment is given in **Table**s 5.2.7-5.2.11 as described below. However, no commercial fishery tuning fleet is included for 2005 and the first half year 2006 (end of assessment period) because no data exist due to closure of the commercial fishery for Norway pout in these years.

Effort standardization:

The method for effort standardization of the commercial Norway pout fishery tuning fleet is described in the stock quality control handbook. The same method of effort standardization as in previous years was used in the 2006 assessments, however, due to closure of the fishery no new information exist for 2005-2006 to use in the effort standardization. The results of the standardization are also presented in the stock quality handbook.

Danish effort data

Table 5.2.7 shows CPUE data by vessel size category and year for the Danish commercial fishery in ICES area IVa. The basis for these data is described in the stock quality handbook. However, no Danish effort data exist for the commercial fishery tuning fleet in 2005-2006 due to closure of the fishery.

Norwegian effort data

Observed average GRT and effort for the Norwegian commercial fleets are given in **Table** 5.2.8, however, no Norwegian effort data exist for the commercial fishery tuning fleet in 2005-2006.

Standardized effort data

The resulting combined and standardized Danish and Norwegian effort for the commercial fishery used in the assessment is presented in **Table** 5.2.9. However, no standardized effort data for the commercial fishery tuning fleet is included for 2005.

Commercial fishery standardized CPUE data

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

Research vessel data

Survey indices series of abundance of Norway pout by age and quarter are for the assessment period available from the IBTS (International Bottom Trawl Survey 1. and 3. quarter) and the EGFS (English Ground Fish Survey, 3. quarter) and SGFS (Scottish Ground Fish Survey, 3. quarter), **Table** 5.2.11. For this assessment new incoming information has been used from the EGFS Q3 2005 and SGFS Q3 2006 with respect to 0- and 1-group indices compared to the up-date assessment in April 2006, as well as IBTS Q1 2006 indices for all age groups and IBTS Q3 indices for age 2-3 are included compared to the autumn 2005 assessment. The rather high CPUE 0-group indices from the SGFS and EGFS August 2005 are confirmed by the relative high 1-group index from the IBTS quarter 1 survey in 2006 as well as the 1-group index in SGFS August 2006. The 0-group index from SGFS August 2006 indicates a relatively weak 2006 year class. Surveys covering the Norway pout stock are described in the quality control handbook. Survey data time series used in tuning of the Norway pout stock assessment are described below.

Revision of assessment tuning fleets

The revision of the tuning fleets used in the benchmark 2004 assessment as used also in the September 2005 and April 2006 up-date assessments and also in this September 2006 assessment is summarised in **Table** 5.3.1.

5.3 Catch at Age Data Analyses

5.3.1 Review of last year's assessment

Norway pout in ICES Subarea IV (North Sea) and Division IIIa (Skagerrak-Kattegat)

In addition to the WG suggestions for next year benchmark, RGNSSK suggested revising the BRPs in 2006 though keeping in mind the role of Norway pout in the ecosystem.

In summary RGNSSK concluded:

The assessment (SXSA) is considered appropriate to indicate trends in the stock. It provides stock status of all year classes up to the second quarter of the assessment year 2005. Also it gives an indication of the projected recruitment on January 1 of the following year. Comparative runs with the SXSA, SMS and SURBA assessment models gave consistent estimates of stock status and dynamics. Consequently, the accepted assessment using small artificial landings in the first and second quarter of the year 2005 does not change the perception of the stock status. The 3^{rd} and 1^{st} quarter IBTS survey and the 4th quarter commercial fishery indices provide relatively good indicators of the year-class strengths and the size of the stock. Studies presented to the working group in 2001 indicate that natural mortality used in the assessment may be inappropriate. Use of new estimates of natural mortality significantly change the perception of spawning biomass. In addition, these will likely influence the biological reference points. The estimates of the SSB, recruitment and the average fishing mortality of the 1- and 2-group are consistent with the estimates of previous years assessment.

Central comments in the ACFM review of the real-time monitoring up-date assessment performed for Norway pout in April 2006 can be summarized as:

The analysis in spring 2006 is very deterministic. It would be usefull if there some indication of the variance in the estimates of recruitment and stock size. A number of assumptions have been made about growth, recruitment and exploitation, and the SSB in 2007 is sensitive to these. The 2005 year class seems to be close to the long term average rather than above and likely not to be statistically different from the mean. When performing real time management *advice in form of an up-date assessment like this then a focused report which does not try to match the traditional WG Report format is adequate.*

5.3.2 Final Assessment

The SMS (Stochastic Multi-species Model) was used to estimate quarterly stock numbers (and fishing mortalities) for Norway pout in the North Sea and Skagerrak in April 2006. The catch at age analysis was carried out according to the specifications in the stock quality control handbook. This includes a general description of and reference to documentation for the SMS model given in the quality control handbook as well as in Section 1.3.3).

The September 2006 assessment of Norway pout in the North Sea and Skagerrak is mainly an update assessment from the 2004 benchmark assessment using the same tuning fleets and parameter settings (**Table** 5.3.1). However, the use of input natural mortalities in the assessment as well as the standard assessment model used in the assessment has been evaluated and included in a partial benchmarking of the assessment in September 2006. The specific benchmarking analyses are described under Section 5.3.3. An overview of indices used in this year assessment is provided in **Table** 5.3.1. Recruitment season to the fishery was in 2004 backshifted from 3rd quarter of the year to 2nd quarter of the year in order to gain benefit from the most recent 0-group indices from the 3rd quarter surveys (SGFS and EGFS as explained above) in the SXSA assessment (**Table** 5.3.2). However, by use of the SMS assessment model it is possible to include these most recent estimates for 3rd quarter in the final assessment year without back-shifting. Overall the recruitment season used in the assessment has no influence on the results of the assessment with respect to perception of stock dynamics and levels of biomass and fishing mortality. However, the recruitment estimate is influenced by which quarter it is given for. The oldest true age used by both the SMS and SXSA models are age 3, and the youngest age is age 0. The SMS uses no plus-group while the SXSA uses the 4+-group. This means that the fishing mortality for the 3 group is used for the 4+-group in the SXSA and set to 0 in SMS. As there are only very few 4 year old fish in the stock in general and nearly no catch of those this difference has no effect. Both models use the geometric mean for the stock-recruitment relationship (see **Figure** 5.8.1).

The final Norway pout assessment is made with the SMS method running the assessment up to and including the second quarter of the year of the assessment year. Because of the closure of the fishery in 2005 and in the first part of 2006 there are no catch data for Norway pout in 2005 and in the first and second quarter of the year 2006. The 0-catches have been included in the SMS model. In order to run an SXSA up-date assessment using the same assessment model as in the benchmark assessment from 2004 it has, accordingly, been necessary to introduce artificial small catch numbers for all quarters of the year in 2005 and in the first and second quarter of the year for the terminal assessment year (2006).

Results of the analysis are presented in **Table** 5.3.2 (assessment model parameters, settings, and options), **Table** 5.3.3 (population numbers at age (recruitment), SSB and TSB), **Table** 5.3.4 (fishing mortalities by year), **Table** 5.3.5 (diagnostics from the SMS), and **Table** 5.3.8 (stock summary). The stock summary is also shown in **Figure**s 5.3.3-4. Catch residuals plots are shown in **Figure** 5.3.1a and tuning fleet (survey) residuals are shown in **Figure** 5.3.1b. Retrospective plots of F, SSB and recruitment are shown in **Figure** 5.3.5. The confidence limits (percentiles) of the SSB, F and recruitment estimates from the SMS assessment are shown in **Figure** 5.3.6. Comparison of observed and model catch is shown in **Figure** 5.3.7. The summary of the results of the assessment is shown in **Table** 5.3.8 and **Figure** 5.3.3-4.

As the assessment model has been changed residuals for the SXSA run comparable to the SMS run have been shown as well in **Figure** 5.3.2

Fishing mortality has generally been lower than natural mortality and has decreased in recent decade below the long term average (0.6). Fishing mortality for the 1st and 2nd quarter has decreased to insignificant levels in recent years (F less than 0.05), while fishing mortality for 4th quarter, that historically constitutes the main part of the annual F, has not decreased in recent 3-4 years up to 2004 (**Figure** 12.3.3 of the 2005 report, ICES-WGNSSK 2006). Fishing mortality in 2005 and in the first part of 2006 has been zero due to closure of the Norway pout fishery in 2005 and in the first part of 2006 (see **Figure** 5.3.3).

Spawning stock biomass (SSB) has since 2001 decreased continuously until 2005 but has increased again in 2006 due to the average 2005 year class. In 2005, the stock biomass fell to a level well below $\mathbf{B_{lim}}$ in 2005 which is the lowest level ever recorded. In start of 2006 the spawning stock biomass has increased to be around $\mathbf{B_{lim}}$ for 2006.

5.3.3 Exploratory catch at age analyses

Analysis of output from SXSA and SMS and to evaluate the effect on the assessment of no catches in 2005 and 2006:

Due to closure of the Norway pout fishery and no catches in 2005 and in the first part of 2006 there has been made exploratory and comparative assessment runs using different assessment models (SXSA, SMS) to evaluate the effect on the assessment of this situation during the April 2006 assessment. This has been considered necessary to evaluate the effect of the absolute value of the artificial catch numbers on the on the SXSA output and to use a modified version of SMS that allows for no fishing in the end of the assessment period, where the SMS assessment uses identical input data as the SXSA assessment. Also the aim has been to evaluate how the SMS reacts to a situation with several years of no catches.

In the April 2006 assessments exploratory runs of SXSA was made where the artificial catch numbers in 2005 and 2006 was 4-doubled (but still low, from 400 t per quarter of year to 1600 t per quarter) compared to the very low catch levels used in the accepted assessment. The results of these comparative runs are not shown, however, the resulting output of the assessments were identical giving the same perception of the stock status and dynamics. Furthermore, in the September 2005 up-date assessment a SXSA assessment was performed with the change of using catch numbers in the first and second quarter of 2005 corresponding to 50% of the 2004 quarter 1 and 2 catch numbers (instead of 10% of the catches in the accepted assessment). The results of these comparative runs are shown in **Figure** 5.3.8 of the September 2005 report (ICES-WGNSSK 2006). The resulting outputs of these assessments were identical giving the same perception of the stock status and dynamics. From these SXSA runs it can be concluded that the absolute values of the artificial (small) catches does not practically affect the assessment output.

In April 2006 a SMS run was made with an assumption of no catches in 2005-2006. SMS was modified to exclude the likelihood of catch observation for 2005-2006 (and 2007) from the objective function. CPUE observations for 2005 and 2006 were, however, used in the model and objective function. By letting the model include 2007 as terminal year it is possible to forecast stock status under the assumption of no fishery in 2006-2007, and recruitments that follows the SMS recruitment function (geometric mean).

It appeared that the diagnostics of the SMS looked very similar to the one produced for the 2005 assessment As it was also shown in the 2004 benchmark assessment, the SMS model results in a rather similar weighting of the catch at age data as well as the tuning fleets as the SXSA model does. As seen in the previous years assessments, the SMS model tends to estimate lower SSB and higher F compared to results of the SXSA model, however, the perception of the stock status and dynamics are very much similar from the results of both model runs. Recruitment estimates of the two models cannot be directly compared as the SMS gives recruitment in third quarter of the year while the SXSA gives recruitment in the second quarter of the year.

Comparison of SXSA and SMS model output and assessment model evaluation:

The September 2006 limited benchmarking also considered the most appropriate assessment model to be used and considered in order to describe the dynamics of the stock.

Previously, the SXSA model has been used in the assessment of Norway pout. The method is described in the Stock Annex (Q5) and Section 1.3.3.

The SMS is like the SXSA a seasonal based model being able to deal with assessment of a short lived species (where there are only few age groups in the VPA) and seasonality in fishing patterns.

The SMS (Stochastic Multi Species model; see Section 1.3.3 and the Stock Annex Q5) objective functions (in "single species mode") for catch at age numbers and survey indices at age time series are minimized assuming a log-normal error distribution for both data sources. The expected catch is calculated from the catch equation and F at age, which is assumed to be separable into a year effect, an age selection, and an age-season selection. The SMS assumes constant seasonal and age-dependent F-pattern. SMS uses maximum likelihood to weight the various data sources. For years with no fishery (here 2005 and 2006 in this assessment) SMS simply set F to zero and exclude catch observations from the objective function. In such case only the survey indices are used in the model. The SXSA needs catch input for all quarters, all years, and in years with no catch infinitive small catch values have to be put into the model as an approximation. SXSA handles catch at age observation as exact, i.e. the SXSA does not rely on the assumption of constant exploitation pattern in catch at age data as for example the SMS does. As a stochastic model, SMS uses catch observations as observed with noise, but assumes a separable F. Both assumptions are violated to a certain degree.

SMS being a stochastic model can estimate the variance of parameters and derived values like average F and SSB. The SXSA is a deterministic model.

The Norway pout assessment includes normally catches from the first and second quarter of the assessment year. SMS uses survey indices from the third quarter of the assessment year under the assumption that the survey is conducted the very beginning of the third quarter. SXSA model has not that option and data from the third quarter of the assessment year can only be used by “back-shifting” the survey one quarter back in time.

The SMS model estimates recruitment in 3rd quarter of the year and not in the start of the 2nd quarter of the year which the SXSA use. Actual recruitment is in the 2nd quarter of the year. Consequently, the assumed natural mortality of 0.4 for the 0-group in first and second quarter of the year is not included in the SMS compared to use of this in 2nd quarter of the year for the SXSA for the 0-group.

The diagnostics and results of the exploratory runs for comparison between SXSA and SMS assessment are shown in **Table** 5.3.5-7 and **Figures** 5.3.1a,b, 5.3.2 and 5.3.5. A comparison of the output to the SXSA assessment for 2005 and 2006 is shown in **Figure** 5.3.8 while a comparison of the output of SXSA and SMS September 2006 assessment is shown in **Figure** 5.3.9.

The models give comparable results and the same perception of the Norway pout stock dynamics, which have been documented in the 2004 benchmark assessment, the September 2005 and April 2006 update assessments (see above), as well as in this September 2006 exploratory runs. However, as SMS is a stochastic model it also provides uncertainties of the results. Accordingly, SMS was chosen as the new standard assessment model for Norway pout. However, it was decided that near future assessments should also include a comparative, exploratory SXSA assessment.

Exploratory catch at age analyses using different natural mortalities in the assessment

Studies presented to the working group in 2001 and published in 2002 indicate that natural mortality may be significantly different between age groups compared to constant as currently assumed in the assessment model Sparholt et al (2002a,b). The proportion of the natural mortality due to predation was found highest at age 1. Non-predation mortality on Norway pout increases with age and is very high for age 2 and older fish resulting in relatively higher overall M values for age 2 and 3 compared to age 1.

From 2001 and onwards exploratory runs with XSA using traditional and revised M values have been presented as explained in Section 5.2.4. On that basis the working group in September 2005 recommended that there in September 2006 is made a limited benchmark assessment with evaluation of effects of using revised natural mortalities, and that the working group on this basis decides on which natural mortalities to use in the assessment.

The benchmarking has evaluated three independent sources and data time series for natural mortality and made exploratory SMS assessment model runs for those:

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

The estimates of natural mortality by Sparholt et al (2002a,b) indicate age and periodical tendencies and differences in natural mortality with higher M for age 2 and 3 compared to age 1 (and 0). The estimates are based on analysis of IBTS quarter 1 survey time series in two periods from 1977-1981 and 1987-1991. The results also revealed high variation in total mortality (Z) by age and period using different survey time series (IBTS Q1 1977-81, 1987-1991, 1979-1999, SGFS Q3 1987-1991, 1980-1997, and EGFS Q3 1982-1992) as well as other source time series (commercial catch data time series 1977-1981, 1987-1991, and numbers consumed by year class 1977-1981, 1987-1991). Even though the results using different sources and surveys confirmed overall age specific tendencies in Z there were high variability and some in-consistency in the estimates from different sources in different periods.

The estimated M and Z values by age based on the 1987-1991 IBTS Q1 data from this study are shown in **Figures** 5.2.3-4 as well as in **Table** 5.2.6**.** The M values from 1987-1991 has been extrapolated and used as constant values by age and quarter for all years for the period 1983-2006 in exploratory SMS assessment runs comparing use of baseline M and M from Sparholt et al (2002a,b) (**Figure** 5.2.3-4). The results showed different levels of SSB, F, recruitment and TSB but same perception of stock dynamics in accordance with previous years results (**Figure** 5.3.10).

Estimates of total mortality based on the SURBA model estimates (2005 SURBA run) using all survey time series included in the baseline assessment (as given in **Table** 5.3.2) covering the period 1983-2005 is also presented in **Figure** 5.2.3**.** It appears that for the period up to 1990-1995 Z estimated from SURBA and Sparholt et al (2002a,b) is on the same level for both the 1-2 group and 2-3 group, and there also seems to be age specific differences in Z. In the period from 1995 and onwards the Z-estimates from SURBA are lower compared to the constant M values obtained from Sparholt et al (2002a,b). In recent years from 2002-03 SURBA estimates of Z increases again compared to the period 1995-2001.

In conclusion, the survey based mortality estimates indicate age specific differences in Z and M. However, different survey time series indicate high variability in the mortality with somewhat contradicting tendencies between periods. Sparholt et al (2002a,b) discussed their results in context of changed catchability in the surveys, migration out of the area, or age specific distribution patterns of Norway pout and concluded that the mortality patterns were not caused by this.

The MSVPA estimates of Z in the period 1983-2003 also shown in **Figure** 5.2.3-4 and obtained from ICES SGMSNS (2006) are higher than the survey based estimates from Sparholt et al (2002a,b) and from SURBA for the 1-2 age groups, but on the same level for the 2-3 age groups indicating relatively high difference for the 1-group. Higher natural mortality (M) values for the 1-group from MSVPA compared to those from Sparholt et al (2002a,b) are evident from **Figure** 5.2.4. The MSVPA indicate that M by quarter of year is on the same level for all three age groups (1-3) by year during the whole assessment period.

MSVPA M increase in 2002 and 2003 for both age 1, 2 and 3 (as was also observed in SURBA estimated Z). Whether this tendency of change in level of MSVPA M for in recent years has continued is unknown because MSVPA M estimates in 2004 and 2005 are not available (ICES-SGMSNS 2006). The SURBA estimates for 2003-2005 might indicate that the increasing tendency in Z (and accordingly M as F is 0) is not continuing from 2003 to 2004-05 (**Figure** 5.2.3). Accordingly, when using the MSVPA natural mortalities it is necessary to make assumptions about natural mortality for the years 2004 and 2005. The rather constant level of natural mortality for all age groups in the MSVPA in previous years might be changing (increasing) in recent years from 2002 and onwards as indicated on **Figure** 5.2.3-4, but this can not be finally documented. When up-date estimates of MSVPA M-values are available it should again be considered to use MSVPA estimates of M in the assessment. In the exploratory runs with SMS using MSVPA values, the M for 2004 and 2005 was assumed to be equal to the 2003 values. The results of this exploratory run revealed that there was no difference in perception of the stock compared to the baseline assessment with constant M (**Figure** 5.3.11). This should be seen in context of the constant M by age and quarter chosen in the baseline assessment at 0.4 by quarter and age is based on the rather constant level of M estimates from MSVPA in the period 1983-2001.

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

Overall, the independent sources of information on mortality are contradicting between age groups and inconclusive between periods (variable). Consequently, it has been chosen to continue using the baseline assessment constant values for M at age and quarter as in previous years assessment.

5.3.4 Conclusions of the explorative comparison runs

The exploratory runs give very much similar results and showed no differences in the perception of the stock status and dynamics. With respect to the exploratory runs using different natural mortalities no conclusions could be reached as the different sources showed different trends with no obvious biological explanation. On that basis it was decided that the final assessment in September 2006 continues to use the standard constant natural mortality values by age, year and season. The exploratory comparisons between assessment using the traditional SXSA assessment model and the SMS model give comparable results and the same perception of the Norway pout stock dynamics. As SMS is a stochastic model it also provides uncertainties of the results. Accordingly, the SMS was chosen as the new standard assessment method for Norway pout in this September 2006 assessment. However, it was decided that near future assessments should also include a comparative, exploratory SXSA assessment.

5.3.5 Comparison with 2005 assessment:

The final, accepted assessment run was compared to the September 2005 and April 2006 up-date assessments. The results of the comparative run between the September 2006 and the September 2005 assessments are shown in **Figure** 5.3.8 using the SXSA model. The resulting outputs of these assessments showed to be identical giving similar perception of stock status and dynamics.

5.4 Hstorical stock trends

Historical stock performance is consistent with the September 2005 and April 2006 up-date assessments.

5.5 Recruitment Estimates

The long-term average recruitment (age 0, 3rd quarter) is 67 billions (arithmetic mean) and 52 billions (geometric mean) for the period 1983-2006 (**Table** 5.3.8). Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species.

No strong year-classes have appeared in the period 2000-2004 since the strong 1999 year-class. The 2003 and 2004 year-classes are the lowest in the time series. The recruitment in 2005 (53 billions) is at level of the long term average. The recruitment estimated based on the 0-group index from the SGFS August 2006 indicate a relatively weak 2006 year class (41 billions).

5.6 Short-term prognoses

Deterministic short-term prognoses were performed for the Norway pout stock. The forecast was calculated as a stock projection up to 1st of January 2008.

The purpose of the forecast is to calculate possible catch of Norway pout in 2007 leaving a SSB at or above Bpa 1st of January 2008 (B_{pa} = 82 000 t).

The projection up to 1st of January 2008 is based on the SMS assessment estimate of stock numbers at age at the start of 2006. The forecast is using a geometric mean for the stock-recruitment relationship (see **Figure** 5.8.1).

The forecast is using the estimated average exploitation pattern for the whole period 1983-2004 from the SMS assessment output (**Table** 5.3.3) for the 2007 fishery, and it includes only exploitation of Norway pout in 4th quarter of 2006 in its calculation (as the fishery has been closed in 1st and 2nd and most of the 3rd quarter of the year 2006). The long term average exploitation pattern is used because the fishery has been closed in the most recent period.

Given the set TAC of approximately 90 000 t in 2006 and that approximately 35% of the catch in average is taken in 4th quarter of the year (based on the historic average distribution of catches between quarters of the year) there has been calculated an assumed catch and landing of 34 000 t in 4th quarter 2006. The exploitation pattern in 4th quarter of the year 2006 has accordingly been scaled from the historical exploitation pattern to obtain this catch of 34 000 t in 2006 in relation to the set TAC as input in the forecast (**Table** 5.6.1).

The weight at age in catch used in the forecast is a 10 year average for the weight at age per quarter of year up to 2003 (2003 included). The constant weight at age by year and quarter of year used in the SMS assessment has also been used in the forecast for 2006 and 2007 (**Table** 5.6.1)

Ten percent of age 1 is mature and is included in SSB. Therefore, the recruitment in 2007 does influence the SSB in 2008. Recruitment in 2007 is assumed to be at 25% level of the long term geometric mean for the period 1984-2006. This conservative level has been chosen to take into account that the frequency of strong year classes seems to have decreased in the recent 10-15 year period compared to previously.

The results of the forecast are presented in Table 5.6.2. It can be seen that if the objective is to maintain spawning stock biomass above B_{pa} by 1st of January 2008 then a catch of around 25 000 tons can be taken in 2007 using the assumption of 25% of average recruitment in 2006 and that catch in 2006 will be 34 000 t. The short term forecast predicts a SSB 1st of January 2007 to be around 106 000 tonnes.

5.7 Medium-term projections

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

5.8 Biological reference points

Revised biological reference points:

ICES CONSIDERS THAT:	ICES PROPOSES THAT:
B_{lim} is 50 000 t	B_{pa} be established at 82 000 t. Below this value the probability of below average recruitment increases.
Note:	

Technical basis:

$B_{lim} = B_{loss}$ = 50 000 t.	$B_{pa} = B_{lim}\, e^{1.645\,S}$: 82 000 t.
F_{lim} None advised.	F_{pa} None advised.

Biomass based reference points have in September 2006 (previously unchanged since 1997) been re-calculated and changed because B_{loss} has changed and because it has been decided to use the SMS assessment model compared to the previously used SXSA assessment model as the standard assessment method. The latter changes the absolute level of recruitment. The calculation of the new reference points has taken into consideration these changes.

B_{lim} is defined as B_{loss} and is based on the observations of stock developments in SSB (especially in 1989 and 2005) been set to 50 000 t. B_{pa} has been calculated from

$B_{pa} = B_{lim}\, e^{1.645\,S}$, where S is standard deviation (SD).

The SMS assessment model estimates (from the Hessian Matrix, see Section 1.3.3) a coefficient of variation (CV) of the SSB in the terminal year of 15 % (approximately equivalent to a SD of 0.15 in a log normal error distribution). A SD estimate around 0.15 is, however, not considered to reflect the real uncertainty in the assessment. Accordingly, a double value (2*SD = 0.3) has been chosen as the S-value for calculating B_{pa}. This SD-level of 0.3 also corresponds to the level for SD around 0.2-0.3 recommended to use in the manual for the Lowestoft PA Software (CEFAS 1999).

The scenarios of B_{pa} using different SD-levels are the following: SD's at 0.1, 0.2, 0.3 and 0.4 results in B_{pa}-values of respectively 59 000 t, 69 000 t, 82 000 t and 97 000 t, respectively.

The relationship between the previous Blim and Bpa (90 000 and 150 000 t) and the new values (50 000 and 82 000 t) are both 0.6, and accordingly, this relationship has not changed.

The stock-recruitment relationship for the Norway pout stock and periodical patterns in this is shown in **Figure** 5.8.1.

5.9 Quality of the assessment

The estimates of the SSB, recruitment and the average fishing mortality of the 1- and 2-group are consistent with the estimates of previous years assessment. This appears from the results of the assessment as well as from **Figures** 5.3.5 and 5.3.8 with among other the comparisons of the 2005 up-date assessment. Comparative runs with the SXSA and SMS assessment models gave consistent estimates of stock status and dynamics, **Figure** 5.3.9. Consequently, the accepted assessment does not introduce a new perception of the stock dynamics (although the absolute levels are different).

The assessment is considered appropriate to indicate trends in the stock and immediate changes in the stock because of the seasonal assessment taking into account the seasonality in fishery, use seasonal based fishery independent information, and using most recent information about recruitment. The assessment provides stock status and year class strengths of all year classes in the stock up to the second quarter of the assessment year. Also it gives a good indication of the stock status the 1. January the following year based on projection of existing recruitment information in 3rd quarter of the assessment year included in the assessment.

Historical stock performance for September 2006 assessment is shown in Figure 5.9.1.

5.10 Status of the stock

Recruitment has been low since 2000 including historical minima in 2003-2004. The assessed 2005 recruitment is around the long term mean (**Table** 5.3.3 and **Table** 5.3.8), while the assessment indicates a below average recruitment in 2006 based on the 3rd quarter 2006 SGFS survey index. Stock biomass (SSB) was around B_{lim} in 1st quarter of 2006 (**Tables** 5.3.3 and 5.3.8). However, based on the average 2005 year class the spawning stock is during 2006 expected to increase to levels above B_{pa} by 1st of January 2007 (105 000 t given a fishery of 35 000 t in 2006). Fishing mortality has generally been lower than the natural mortality for this stock and has decreased in recent years well below the long term average F (0.6). Estimated fishing mortality has decreased in 2004 to the lowest level in the time series, and because of the fishery closure in 2005 and the first part of 2006 the fishing mortality has been very close to zero in 2005 and in the first part of 2006. A TAC has from 1st of September and the rest of 2006 been set to approximately 90 000 t resulting in an expected fishing mortality corresponding to 60% of the long term average F in 4th quarter of the year (**Table** 5.6.1). Fishing effort has in general decreased in recent years reaching historically minima in 2001 and in 2003-2006.

5.11 Management considerations

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

There are no explicit and specific management objectives for this stock. The European Community has decided to apply the precautionary approach in taking measures to protect and conserve living aquatic resources, to provide for their sustainable exploitation and to minimise the impact of fishing on marine ecosystems.

On basis of the advice from ICES, EU and Norway agreed to close the directed Norway pout fishery in 2005 and in the first part of 2006. Accordingly, the TAC was in 2005 and for the first part of 2006 set to 0 in the EC zone and 5 000 t in the Norwegian zone – the latter to allow for by-catches of Norway pout in the directed Norwegian blue whiting fishery. As a result of the newly introduced the real time management of the stock based on provide ICES advice in spring 2006 the fishery has been re-opened by 1st of September 2006 with a set TAC for 2006 of approximately 90 000 t.

The stock was in the first part of 2006 considered to be at the B_{lim}-level. However, based on the average 2005 year class the spawning stock is during 2006 expected to increase to levels above B_{pa} by 1st of January 2007. Given the forecast and the assumptions behind this given in September 2006 the stock is expected to still remain within biological safe limits by 1st of January 2008 allowing a limited fishery in 4th quarter 2006 and in 2007. The forecast based on the autumn 2006 ICES advice is a SSB at around 105 000 t by 1st of January 2007 and a SSB above B_{pa} by first of January 2008 with a limited fishery around 25 000 t in 2007.

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

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species.

In managing this fishery, by-catches of cod, haddock, whiting, saithe, herring, and blue whiting should be taken into account, and existing technical measures to protect these by-catch species should be maintained. Furthermore, as commercial, exploratory fishery and provision of recent by-catch information has shown by-catch-ratios to be significant and recent scientific research based on at sea trials in the commercial fishery has shown that use of gear technological by-catch devices can reduce by-catches of juvenile gadoids significantly, the working group concludes that these gear technological by-catch reduction devices (or modified forms of those) should be brought into use in the fishery. Introduction of those should be followed up upon by adequate landings or at sea catch control measures to assure effective implementation of the existing by-catch measures.

There is consistent quarterly based information available to perform real time monitoring and management of the stock. This can be carried out both with fishery independent and fishery dependent information as well as a combination of those. In spring 2006 ICES provided real time management advice for the stock resulting in a real time management with re-opening the fishery for the second half year 2006. Real time advice and management should also be provided for the stock in spring 2007. This is mainly to improve the assessment with use of the most recent information on recruitment in 2006 as well as to include actual landings from 4th quarter 2006 in the assessment giving better basis for making forecast for 2007.

Table 5.2.1 NORWAY POUT nominal landings (tonnes) from the North Sea and Skagerrak / Kattegat, ICES areas IV and IIIa in the period 1998-2005, as officially reported to ICES and EU. By-catches of Norway pout in other (small meshed) fishery included.

Norway pout ICES area IIIa

Country	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	11,080	7,194	14,545	13,619	3,780	4,235	110	-
Faroe Islands	-	-	-	-	-	50	-	-
Norway	-	-	-	-	96	30	41	-
Sweden	-	-	133	780	-	-	-	-
Germany	-	-	-	-	-	-	54	-
Total	11,080	7,194	14,678	14,399	3,876	4,315	205	0

*Preliminary.

Norway pout ICES area IVa

Country	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	42,154	39,319	133,149	44,818	68,858	12,223	10,762	941***
Faroe Islands	4,707	2,534		49	3,367	2,199	-	-
Netherlands	-	-	-	-	-	-	-	-
Germany	-	-	-	-	-	-	27	-
Norway	22,213	44,841	48,061	17,158	23,657	11,357	4,958	311
Sweden	-	-	-	-	-	-	-	-
Total	69,074	86,694	181,210	62,025	95,882	25,779	15,747	1,092

*Preliminary.

Norway pout ICES area IVb

Country	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	3,258	5,299	158	632	556	191	473	-
Germany	-	-	2	-	-	-	26	-
Netherlands	2	-	3	-	-	-	-	-
Norway	57	-	34	-	-	-	-	-
Sweden	-	-	-	-	-	-	2	-
UK (E/W/NI)	-	-	+	-	+	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-
Total	3,317	5,299	197	632	556	191	501	0

*Preliminary.

Norway pout ICES area IVc

Country	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	-	514	182	304	-	-	-	-
Netherlands	-	+	-	-	-	-	-	-
UK (E/W/NI)	-	-	-	+	-	-	-	-
Total	0	0	0	0	0	0	0	0

*Preliminary.

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

Country	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	56,492	51,812	147,852	59,069	73,194	16,649	11,345	941**
Faroe Islands	4,707	2,534	0	49	3,367	2,249	0	0
Norway	22,270	44,841	48,095	17,158	23,753	11,387	4,999	311
Sweden	0	0	133	780	0	0	2	0
Netherlands	2	0	3	0	0	0	0	0
Germany	0	0	2	0	0	0	107	0
UK	0	0	0	0	0	0	0	0
Total nominal landings	83,471	99,187	196,085	77,056	100,314	30,285	16,453	1,252
By-catch of other species and other	-3,671	-7,187	-11,685	-11,456	-23,614	-5,385	-2,953	-
WG estimate of total landings (IV+IIIaN)	79800	92000	184400	65600	76700	24900	13500	-
Agreed TAC	220000	220000	220000	211200	198000	198000	198000	0****

* provisional
** provisional
*** 781 ton from trial fishery (directed fishery); 160 ton from by-catches in other fisheries
+ Landings less than 1
n/a not available
**** A by-catch qouta of 5000 t has been set.

Table 5.2.2 NORWAY POUT annual landings ('000 t) in the North Sea and Skagerrak (not incl. Kattegat, IIIaS) by country, for 1961-2005 (Data provided by Working Group members). (Norwegian landing data include landings of by-catch of other species). Includes by-catch of Norway pout in other (small meshed) fisheries).

Year	Denmark		Faroes	Norway	Sweden	UK (Scotland)	Others	Total
	North Sea	Skagerrak						
1961	20.5	-	-	8.1	-	-	-	28.6
1962	121.8	-	-	27.9	-	-	-	149.7
1963	67.4	-	-	70.4	-	-	-	137.8
1964	10.4	-	-	51	-	-	-	61.4
1965	8.2	-	-	35	-	-	-	43.2
1966	35.2	-	-	17.8	-	-	+	53.0
1967	169.6	-	-	12.9	-	-	+	182.5
1968	410.8	-	-	40.9	-	-	+	451.7
1969	52.5	-	19.6	41.4	-	-	+	113.5
1970	142.1	-	32	63.5	-	0.2	0.2	238.0
1971	178.5	-	47.2	79.3	-	0.1	0.2	305.3
1972	259.6	-	56.8	120.5	6.8	0.9	0.2	444.8
1973	215.2	-	51.2	63	2.9	13	0.6	345.9
1974	464.5	-	85.0	154.2	2.1	26.7	3.3	735.8
1975	251.2	-	63.6	218.9	2.3	22.7	1	559.7
1976	244.9	-	64.6	108.9	+	17.3	1.7	437.4
1977	232.2	-	48.8	98.3	2.9	4.6	1	387.8
1978	163.4	-	18.5	80.8	0.7	5.5	-	268.9
1979	219.9	9	21.9	75.4	-	3	-	329.2
1980	366.2	11.6	34.1	70.2	-	0.6	-	482.7
1981	167.5	2.8	16.4	51.6	-	+	-	238.3
1982	256.3	35.6	12.3	88	-	-	-	392.2
1983	301.1	28.5	30.7	97.3	-	+	-	457.6
1984	251.9	38.1	19.11	83.8	-	0.1	-	393.01
1985	163.7	8.6	9.9	22.8	-	0.1	-	205.1
1986	146.3	4	2.5	21.5	-	-	-	174.3
1987	108.3	2.1	4.8	34.1	-	-	-	149.3
1988	79	7.9	1.3	21.1	-	-	-	109.3
1989	95.7	4.2	0.8	65.3	+	0.1	0.3	166.4
1990	61.5	23.8	0.9	77.1	+	-	-	163.3
1991	85	32	1.3	68.3	+	-	+	186.6
1992	146.9	41.7	2.6	105.5	+	-	0.1	296.8
1993	97.3	6.7	2.4	76.7	-	-	+	183.1
1994	97.9	6.3	3.6	74.2	-	-	+	182
1995	138.1	46.4	8.9	43.1	0.1	+	0.2	236.8
1996	74.3	33.8	7.6	47.8	0.2	0.1	+	163.8
1997	94.2	29.3	7.0	39.1	+	+	0.1	169.7
1998	39.8	13.2	4.7	22,1	-	-	+	57.7
1999	41	6.8	2.5	44.2	+	-	-	94.5
2000	127	9.3	-	48	0.1	-	+	184.4
2001	40.6	7.5	-	16.8	0.7	+	+	65.6
2002	50.2	2.8	3.4	23.6	-	-	-	80.0
2003	9.9	3.4	2.4	11.4	-	-	-	27.1
2004	8.1	0.3	-	5	-	-	0.1	13.5
2005	0.9*	-	-	1.0	-	-	-	1.9

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

Table 5.2.3 NORWAY POUT, North Sea and Skagerak. National landings (t) by quarter of year 1993-2006. (Data provided by Working Group members. Norwegian landing data include landings of by-catch of other species). (By-catch of Norway pout in other (small meshed) fisheries included).

Year	Quarter	Denmark									Norway		Total
	Area	IIIaN	IIIaS	Div. IIIa	IVaE	IVaW	IVb	IVc	Div. IV	Div. IV + IIIaN	IVaE	Div. IV	Div. IV + IIIaN
1993	1	319	30	350	16,471	6,581	151	-	23,203	23,522			
	2	1,052	77	1,129	594	102	802	-	1,498	2,550			
	3	3,629	531	4,161	7,461	25,072	409	-	32,941	36,570			
	4	1,728	406	2,133	10,685	28,994	9	-	39,688	41,416			
	Total	6,729	1,044	7,773	35,210	60,748	1,371	-	97,330	104,058			
1994	1	568	75	643	18,660	3,588	533	-	22,781	23,350			
	2	4	0	4	511	170	-	-	681	685			
	3	2,137	74	2,211	5,674	12,604	493	-	18,772	20,908			
	4	3,623	116	3,739	5,597	49,935	91	-	55,622	59,246			
	Total	6,332	265	6,598	30,442	66,298	1,117	-	97,857	104,189			
1995	1	576	9	585	19,421	1,336	7	-	20,764	21,339	15521	15521	36,860
	2	10,495	290	10,793	2,841	30	3,670	-	6,540	17,035	10639	10639	27,674
	3	20,563	976	21,540	13,316	17,681	11,445	-	42,442	63,004	5790	5790	68,794
	4	14,748	2,681	17,430	10,812	56,159	1,426	-	68,396	83,145	11131	11131	94,276
	Total	46,382	3,956	50,347	46,390	75,205	16,547	-	138,142	184,524	43,081	43081	227,605
1996	1	1,231	164	1,395	6,133	3,149	658	2	9,943	11,174	10604	10604	21,778
	2	7,323	970	8,293	1,018	452	1,476	-	2,946	10,269	4281	4281	14,550
	3	20,176	836	21,012	7,119	17,553	1,517	-	26,188	46,364	27466	27466	73,830
	4	5,028	500	5,528	9,640	25,498	42	-	35,180	40,208	5466	5466	45,674
	Total	33,758	2,470	36,228	23,910	46,652	3,692	2	74,257	108,015	47,817	47817	155,832
1997	1	2,707	460	3,167	6,203	2,219	7	-	8,429	11,137	4183	4183	15,320
	2	5,656	200	5,857	141	-	45		185	5,842	8466	8466	14,308
	3	16,432	649	17,081	19,054	21,024	740	-	40,818	57,250	21546	21546	78,796
	4	4,464	1,042	5,505	6,555	38,202	7		44,765	49,228	4884	4884	54,112
	Total	29,259	2,351	31,610	31,953	61,445	799	-	94,197	123,456	39,079	39079	162,535
1998	1	1,117	317	1,434	7,111	2,292	-	-	9,403	10,520	8913	8913	19,433
	2	3,881	103	3,984	131	5	124	-	259	4,140	7885	7885	12,025
	3	6,011	406	6,417	7,161	1,763	2,372	-	11,297	17,308	3559	3559	20,867
	4	2,161	677	2,838	1,051	17,752	77	-	18,880	21,041	1778	1778	22,819
	Total	13,171	1,503	14,673	15,454	21,811	2,573	-	39,838	53,009	22,135	22135	75,144
1999	1	4	12	15	2,769	1,246	1	-	4,016	4,020	3021	3021	7,041
	2	1,568	36	1,605	953	361	418	-	1,731	3,300	10321	10321	13,621
	3	3,094	109	3,203	7,500	3,710	2,584	-	13,794	16,887	24449	24449	41,336
	4	2,156	517	2,673	3,577	16,921	928	1	21,426	23,583	6385	6385	29,968
	Total	6,822	674	7,496	14,799	22,237	3,931	1	40,968	47,790	44,176	44176	91,966
2000	1	0	11	12	3,726	1,038	-	-	4,764	4,765	5440	5440	10,205
	2	929	15	944	684	22	227	-	933	1,862	9779	9779	11,641
	3	7,380	139	7,519	1,708	5,613	515	-	7,836	15,216	28428	28428	43,644
	4	947	209	1,157	1,656	111,732	76	-	113,464	114,411	4334	4334	118,745
	Total	9,257	375	9,631	7,774	118,406	818	-	126,998	136,255	47,981	47981	184,236
2001	1			302	7,341	9,734	103	72	17,250	17,250	3838	3838	21,088
	2			2,174	31	30	269	-	330	330	9268	9268	9,598
	3			2,006	15	154	191	-	360	360	2263	2263	2,623
	4			3,059	2,553	19,826	329	-	22,708	22,708	1426	1426	24,134
	Total			7,541	9,940	29,744	892	72	40,648	40,648	16,795	16795	57,443
2002	1	-	1	1	4,869	1,660	114	-	6,643	6,643	1896	1896	8,539
	2	883	161	1,045	56	9	22	-	87	970	5563	5563	6,533
	3	1,567	213	1,778	2,234	14,739	104	-	17,077	18,644	14147	14147	32,791
	4	393	100	492	1,787	24,273	335	-	26,395	26,788	2033	2033	28,821
	Total	2,843	475	3,316	8,946	40,681	575	-	50,202	53,045	23,639	23639	76,684
2003	1	-	1	1	615	581	22	-	1,218	1,218	1977	1977	3,195
	2	246	160	406	76	-	22	-	98	344	2773	2773	3,117
	3	2,984	1,005	3,989	172	1,613	89	-	1,874	4,858	5989	5989	10,847
	4	188	547	735	0	6270	457	-	6,727	6,915	644	644	7,559
	Total	3,418	1,713	5,131	863	8,464	590	-	9,917	13,335	11,383	11,383	24,718
2004	1	316	-	316	87	650	-	-	737	1,053	989	989	2,042
	2	-	-	-	-	-	7	-	7	7	660	660	667
	3	14	-	14	289	1,195	9	-	1,493	1,507	2484	2484	3,991
	4	13	-	13	93	5,683	107	-	5,883	5,896	865	865	6,761
	Total	343	-	343	469	7,528	123	-	8,120	8,463	4,998	4,998	13,461
2005	1	-	-	-	9	-	-	-	9	9	12	12	21
	2	-	-	-	151	-	-	-	151	151	352	352	503
	3	-	-	-	781	-	-	-	781	781	387	387	1,168
	4	-	-	-	-	-	-	-	-	-	211	211	211
	Total	-	-	-	941	-	-	-	941	941	962	962	1,903
2006	1	-	-	-	-	-	-	-	-	-	199	199	199
	2	-	-	-	-	-	-	-	-	-	1,758	1758	1,758

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

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

Table 5.2.5 NORWAY POUT in the North Sea and Skagerrak. Mean weights (grams) at age in catch, by quarter 1983-2006, from Danish and Norwegian catches combined. Data for 1974 to 1982 are assumed to be the same as in 1983

Year	1983				1984				1985			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			4.00	6.00			6.54	6.54			8.37	6.23
1	7.00	15.00	25.00	23.00	6.55	8.97	17.83	20.22	7.86	12.56	23.10	26.97
2	22.00	34.00	43.00	42.00	24.04	22.66	34.28	35.07	22.7	28.81	36.52	40.90
3	40.00	50.00	60.00	58.00	39.54	37.00	34.10	46.23	45.26	43.38	58.99	
4									41.80			
Year	1986				1987				1988			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0				7.20			5.80	7.40			9.42	7.91
1	6.69	14.49	28.81	26.90	8.13	12.59	20.16	23.36	9.23	11.61	26.54	30.60
2	29.74	42.92	43.39	44.00	28.26	31.51	34.53	37.32	27.31	33.26	39.82	43.31
3	44.08	55.39	47.60		52.93			46.60	38.38			
4	82.51				63.09				69.48			
Year	1989				1990				1991			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			7.48	6.69			6.40	6.67			6.06	6.64
1	7.98	13.49	26.58	26.76	6.51	13.75	20.29	28.70	7.85	12.95	30.95	30.65
2	26.74	28.70	35.44	34.70	25.47	25.30	32.92	38.90	20.54	28.75	44.28	43.10
3	39.95	44.39		46.50	37.72	40.35	39.40	52.94	35.43	49.87	67.25	59.37
4					68.00				44.30			
Year	1992				1993				1994			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0		8.00	6.70	8.14			4.40	8.14			5.40	8.81
1	8.78	11.71	26.52	27.49	9.32	14.76	25.03	26.24	8.56	15.22	29.26	31.23
2	25.73	31.25	42.42	44.14	24.94	30.58	35.19	36.44	25.91	29.27	38.91	49.59
3	41.80	49.49	50.00	50.30	46.50	48.73	55.40	70.80	42.09	46.88	53.95	
4	43.90											
Year	1995				1996				1997			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			5.01	7.19			3.88	5.95			3.61	10.18
1	7.70	10.99	25.37	24.6	8.95	12.06	27.81	28.09	7.01	11.69	20.14	22.11
2	24.69	22.95	33.40	39.57	21.47	25.72	40.90	38.81	23.11	26.40	31.13	32.69
3	50.78	37.69	45.56	57.00	37.58	37.94	50.44	56.00	39.11	34.47	44.03	38.62
4												
Year	1998				1999				2000			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			4.82	8.32			2.84	7.56			7.21	13.86
1	8.76	12.55	23.82	24.33	8.98	12.40	22.16	25.60	10.05	15.65	23.76	22.98
2	22.16	25.27	31.73	30.93	25.84	24.15	32.66	37.74	19.21	25.14	38.90	34.48
3	34.84	32.18	44.92	33.24	36.66	35.24	43.98	51.63	32.10	41.30	39.61	50.04
4	42.40	40.00			46.57	46.57						
Year	2001				2002				2003			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			6.34	7.90			7.28	7.20			9.12	9.79
1	8.34	16.79	27.00	30.01	8.59	16.40	27.13	27.47	11.58	13.13	28.33	15.98
2	21.50	23.57	39.54	35.51	25.98	30.39	43.37	36.87	22.85	26.19	38.01	31.87
3	39.84	37.63	54.20	55.70	32.30	40.10	54.11	41.28	34.96	39.89	46.24	45.79
4											70.00	70.00
Year	2004				2005				2006			
Quarter of year	1	2	3	4	1	2	3	4	1	2		
Age 0			9.80	7.89			9.8	7.89				
1	11.54	14.63	31.02	31.75	11.97	14.65	31.02	31.75	11.97	14.65		
2	27.41	26.22	38.44	39.31	27.90	26.24	38.44	39.31	27.90	26.24		
3	41.52	34.80	49.50	49.80	41.36	34.80	49.50	49.8	41.36	34.80		
4												

Table 5.2.6 NORWAY POUT. Mean weight at age in the stock, proportion mature and natural mortality used in the assessment as well as revised natural mortality used in the exploratory assessment run.

Age	Weight (g)				Proportion mature	M (quarterly)	Revised M vers. 1 (quarterly)
	Q1	Q2	Q3	Q4			(Exploratory run)
0	-	-	4	6	0	0.4	0.25
1	7	15	25	23	0.1	0.4	0.25
2	22	34	43	42	1	0.4	0.55
3	40	50	60	58	1	0.4	0.75

Table 5.2.7 NORWAY POUT. Danish CPUE data (tonnes / fishing day) and fishing activities by vessel category for 1988-2005. Non-standardized CPUE-data for the Danish part of the commercial tuning fleet. (Logbook information).

Vessel GRT	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
51-100	20.27	14.58	10.03	12.56	31.75	31	24.8	29.53	-	20	-	-	-	-	-	-	-	-
101-150	18.83	19.59	17.38	24.14	26.42	23.72	26.76	38.96	20.48	22.68	-	-	-	-	-	-	-	-
151-200	22.71	23.17	25.6	28.22	34.2	27.36	31.52	34.73	22.05	27.45	16.85	12.43	29.13	-	20.45	-	-	-
201-250	30.44	26.1	24.87	29.74	36	27.76	40.59	39.34	24.96	30.59	19.68	26.69	48.55	25.35	17.09	12.94	8.88	n/a*
251-300	23.29	26.14	21.3	28.15	31.9	32.05	36.98	38.84	31.43	32.55	17.48	23.98	45.92	20.02	21.73	10.8	5.50	n/a*
301-	38.81	28.58	24.96	36.48	42.6	34.89	44.91	57.9	39.14	43.01	32.32	31	64.33	52.95	46.36	30.86	37.14	n/a*

* Non-available data from 2005 is due to closure of the Norway pout fishery

Table 5.2.8 NORWAY POUT. Effort in days fishing and average GRT of Norwegian vessels fishing for Norway pout by quarter, 1983-2006.

	Quarter 1		Quarter 2		Quarter 3		Quarter 4	
Year	Effort	Aver. GRT	Effort	Aver. GRT	Effort	Aver. GRT	Effort	Aver. GRT
1983	293	167.6	1168	168.4	2039	159.9	552	171.7
1984	509	178.5	1442	141.6	1576	161.2	315	212.4
1985	363	166.9	417	169.1	230	202.8	250	221.4
1986	429	184.3	598	148.2	195	197.4	222	226.0
1987	412	199.3	555	170.5	208	158.4	334	196.3
1988	296	216.4	152	146.5	73	191.1	590	202.9
1989	132	228.5	586	113.5	1054	192.1	1687	178.7
1990	369	211.0	2022	171.7	1102	193.9	1143	187.6
1991	774	196.1	820	180.0	1013	179.4	836	187.7
1992	847	206.3	352	181.3	1030	202.2	1133	199.8
1993	475	227.5	1045	206.6	1129	217.8	501	219.8
1994	436	226.5	450	223.5	1302	212.0	686	211.4
1995	545	223.6	237	233.8	155	221.7	297	218.1
1996	456	213.6	136	219.9	547	208.3	132	207.2
1997	132	202.4	193	218.9	601	194.8	218	182.3
1998	497	192.6	272	213.6	263	176.8	203	193.8
1999	267	173.0	735	180.1	1165	187.4	229	166.9
2000	294	197.1	348	180.7	929	205.3	196	219.3
2001	252	203.4	297	192.9	130	165.0	65	219.4
2002	90	208.6	246	189.1	1022	211.7	205	182.2
2003	162	219.1	320	215.3	550	252.8	75	208.4
2004	94	214.6	85	196.7	210	220.9	99	197.0
2005*	0	0.0	0	0.0	0	0.0	0	0.0
2006*	0	0.0	0	0.0				

* 0-values in 2005 and first half year 2006 is due to closure of the fishery

Table 5.2.9 NORWAY POUT. Combined Danish and Norwegian fishing effort (standardised) to be used in the assessment.

	Quarter 1			Quarter 2			Quarter 3			Quarter 4			Year total		
Year	Norway	Denmark	Total	Norway	Denmark	Total	Norway	Denmark	Total	Norway	Denmark	Total	Norway	Denmark	Total
1987	441	1127	1568	547	31	578	197	1194	1391	355	1637	1992	1540	3989	5529
1988	315	883	1198	144	13	156	75	417	492	617	1894	2511	1150	3207	4357
1989	146	777	923	485	195	680	1093	1749	2841	1701	2284	3985	3424	5004	8428
1990	406	991	1397	2002	87	2089	1162	463	1625	1185	1653	2838	4754	3195	7949
1991	824	1319	2143	833	33	866	1027	484	1512	869	1724	2593	3553	3561	7113
1992	866	2092	2958	354	17	371	1051	1530	2581	1154	1242	2396	3424	4881	8306
1993	483	1234	1717	1056	37	1094	1145	1560	2705	508	1671	2179	3193	4502	7695
1994	464	1265	1728	477	74	551	1364	617	1981	718	1227	1945	3023	3183	6205
1995	578	809	1387	254	99	353	164	853	1017	313	1487	1800	1309	3248	4557
1996	478	579	1057	144	185	328	571	760	1330	138	1240	1378	1330	2763	4093
1997	137	394	531	204	17	220	617	1244	1861	220	1121	1341	1178	2775	3953
1998	509	446	955	285	34	319	264	562	825	208	457	665	1266	1498	2764
1999	266	305	571	740	56	796	1185	387	1572	226	733	959	2418	1481	3898
2000	303	303	606	351	75	426	966	221	1186	207	1903	2110	1826	2501	4327
2001	261	441	702	304	15	319	128	48	176	69	541	610	762	1045	1807
2002	94	388	481	251	21	272	1070	676	1746	207	551	758	1622	1636	3258
2003	171	212	383	336	15	352	600	79	679	78	101	179	1185	407	1593
2004	99	151	246	87	36	122	222	65	287	102	95	197	510	347	857
2005*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2006*	0	0	0	0	0	0									

* 0-values in 2005 and 2006 is due to closure of the Norway pout fishery

Table 5.2.10 NORWAY POUT. CPUE indices (´000s per fishing day) by age and quarter from Danish and Norwegian commercial fishery (CF) in the North Sea (Area IV, commercial tuning fleet).

Year	CF, 1st quarter				CF, 2nd quarter				CF, 3rd quarter				CF, 4th quarter			
	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group
1982	.	2144.5	169.0	87.9	.	1705.7	144.3	12.1	30.3	1320.2	86.5	12.4	368.4	1050.5	16.0	0.0
1983	.	1524.2	470.0	5.4	.	1044.9	706.5	5.5	74.3	969.6	262.0	2.8	604.9	972.9	85.9	1.7
1984	.	1137.9	566.8	59.1	.	1518.0	784.9	181.1	0.2	990.2	314.9	1.5	462.0	723.1	152.1	0.0
1985	.	877.1	528.2	74.3	.	1310.5	221.5	20.3	2.6	599.0	339.0	8.3	183.6	809.5	47.2	0.0
1986	.	108.5	292.9	19.8	.	267.9	89.3	3.0	0.0	531.1	109.7	2.7	892.9	277.1	5.9	0.0
1987	.	1699.6	253.8	7.7	.	1856.4	103.8	0.0	5.8	1139.5	118.6	0.0	110.9	1073.3	115.5	2.5
1988	.	205.2	583.1	16.4	.	525.6	457.7	0.0	48.2	372.4	508.9	0.0	1173.6	251.6	161.3	0.0
1989	.	1860.8	52.1	7.6	.	1019.8	214.9	9.6	2.4	386.0	69.6	0.0	1184.7	488.1	22.6	3.2
1990	.	1063.6	450.8	25.7	.	865.0	258.2	14.7	9.5	571.0	126.6	7.2	444.1	394.5	39.7	2.3
1991	.	692.9	623.0	43.3	.	484.3	458.2	22.0	50.2	668.2	44.0	1.0	1005.4	397.3	71.5	6.6
1992	.	1129.0	360.7	39.6	.	2686.5	619.9	53.4	13.0	1010.4	144.0	0.4	190.3	1103.2	105.9	1.0
1993	.	1121.0	403.3	7.9	.	689.2	431.6	52.7	3.9	384.4	328.5	6.9	426.5	474.2	203.0	0.8
1994	.	1100.8	340.9	32.6	.	675.7	517.0	52.4	93.9	519.3	203.1	35.6	1950.6	590.1	68.9	0.0
1995	.	2846.0	171.0	4.0	.	3179.5	726.3	90.1	117.6	1860.5	38.5	2.9	198.3	1701.8	32.9	1.7
1996	.	365.0	730.6	13.2	.	121.1	408.5	115.7	121.8	346.2	714.4	27.4	1063.4	472.0	241.7	0.2
1997	.	988.8	479.3	146.6	.	435.0	593.0	540.5	1.9	1254.0	154.0	56.4	75.0	1344.0	152.5	25.8
1998	.	149.9	722.7	49.3	.	182.8	756.7	54.8	31.0	319.1	349.7	1.1	232.4	773.4	322.0	20.0
1999	.	351.0	224.6	128.0	.	280.3	230.0	116.8	0.0	725.5	213.5	21.9	1084.5	515.2	166.6	24.1
2000	.	1077.6	304.8	4.5	.	575.3	426.9	113.6	20.0	894.8	206.9	17.2	121.9	2174.1	114.5	2.8
2001	.	300.3	1196.9	50.0	.	216.0	662.1	312.0	30.5	369.2	142.7	6.3	557.3	321.6	718.4	1.5
2002	.	1008.8	307.7	34.7	.	1139.9	58.9	18.0	194.2	321.0	157.7	13.5	382.7	601.2	454.3	34.8
2003	.	153.2	199.6	57.0	.	165.9	134.6	70.3	20.2	220.9	106.0	11.0	3.9	276.4	893.3	178.2
2004	.	26.8	189.0	34.9	.	28.8	130.4	45.5	0.0	176.1	177.6	24.0	289.1	505.5	394.6	8.6
2005	.	n/a*	n/a*	n/a*	.	n/a*	n/a*	n/a*	n/a*	n/a*	n/a*	n/a*	n/a*	n/a*	n/a*	n/a*

* not available due to closure of the Norway pout fishery in 2005 and first part of 2006

Table 5.2.11 NORWAY POUT. Research vessel indices (CPUE in catch in number per trawl hour) of abundance for Norway pout.

Year	IBTS/IYFS[1] February			EGFS[2,3] August				SGFS[4] August				IBTS 3rd Quarter[1]			
	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group
1970	35	6	-	-	-		-	-	-	-	-	-	-		-
1971	1,556	22	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	3,425	653	-	-	-	-	-	-	-	-	-	-	-	-	-
1973	4,207	438	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	25,626	399	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	4,242	2,412	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	4,599	385	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	4,813	334	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	1,913	1,215	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	2,690	240	-	-	-	-	-	-	-	-	-	-	-	-	-
1980	4,081	611	-	-	-	-	-	-	1,928	346	12	-	-	-	-
1981	1,375	557	-	-	-	-	-	-	185	127	9	-	-	-	-
1982	3,315	403	-	6,594	2,609	39	77	8	991	44	22	-	-	-	-
1983	2,258	592	7	6,067	1,558	114	0.4	13	490	91	1	-	-	-	-
1984	4,994	982	75	457	3,605	359	14	2	615	69	9	-	-	-	-
1985	2,342	1,429	73	362	1,201	307	0	5	636	173	5	-	-	-	-
1986	2,070	383	20	285	717	150	80	38	389	54	9	-	-	-	-
1987	3,171	481	61	8	552	122	0.9	7	338	23	1	-	-	-	-
1988	124	722	15	165	102	134	20	14	38	209	4	-	-	-	-
1989	2,013	255	172	1,531	1,274	621	20	2	382	21	14	-	-	-	-
1990	1,295	748	39	2,692	917	158	23	58	206	51	2	-	-	-	-
1991	2,450	712	130	1,509	683	399	6	10	732	42	6	7,301	1,039	189	2
1992	5,071	885	32	2,885	6,193	1,069	157	12	1,715	221	24	2,559	4,318	633	48
1993	2,682	2,644	258	5,699	3,278	1,715	0	2	580	329	20	4,104	1,831	608	53
1994	1,839	374	66	7,764	1,305	112	7	136	387	106	6	3,196	704	102	14
1995	5,940	785	77	7,546	6,174	387	14	37	2,438	234	21	2,860	4,440	597	69
1996	923	2,631	228	3,456	1,332	319	3	127	412	321	8	4,554	763	362	12
1997	9,752	1,474	670	1,103	5,579	364	32	1	2,154	130	32	490	3,447	236	46
1998	1,010	5,336	265	2,684	411	247	0	2,628	938	1,027	5	2,931	801	748	12
1999	3,527	597	667	6,358	1,930	88	26	3,603	1,784	180	37	7,844	2,367	201	94
2000	8,095	1,535	65	2,005	6,261	141	2	2,094	6,656	207	23	1,643	7,868	282	11
2001	1,305	2,861	235	3,948	1,013	693	5	756	727	710	26	2,088	1,274	862	27
2002	1,795	809	880	9,737	1,784	61	21	2,559	1,192	151	123	1,974	766	64	48
2003	1,239	575	94	379	681	85	5	1,767	779	126	1	1,812	1,063	146	7
2004	895	376	34	564	542	90	7	731	719	175	19	793	647	153	12
2005	691	131	37	5970	693	57	9	3,073	343	132	18	2,614	439	125	17
2006	3,340	146	27	n/a	n/a	n/a	n/a	1,127	1,285	69	9	n/a	n/a	n/a	n/a

[1]International Bottom Trawl Survey, arithmetic mean catch in no./h in standard area. [2]English groundfish survey, arithmetic mean catch in no./h, 22 selected rectangles within Roundfish areas 1, 2, and 3. [3]1982-91 EGFS numbers adjusted from Granton trawl to GOV trawl by multiplying by 3.5. [4]Scottish groundfish surveys, arithmetic mean catch no./h. Survey design changed in 1998 and 2000. [5]English groundfish survey: Data for 1996, 2001, 2002, and 2003 have been revised compared to the 2003 assessment.

Table 5.3.1 Norway pout. Stock indices used in final 2004 benchmark assessment as well as in the 2005-2006 assessments compared to the 2003 assessment.

		2003 ASSESSMENT	2004, 2005, April 2006 ASSESSMENT	Sept. 2006 ASSESSMENT
Recruiting season		3rd quarter	2nd quarter (SXSA)	3rd quarter (SMS); 2nd quarter (SXSA)
Last season in last year		3rd quarter	2nd quarter (SXSA)	3rd quarter (SMS); 2nd quarter (SXSA)
Plus-group		4+	4+ (SXSA)	None (SMS); 4+ (SXSA)
FLT01: comm Q1				
	Year range	1982-2003	1982-2004	1982-2004
	Quarter	1	1	1
	Ages	1-3	1-3	1-3
FLT01: comm Q2			NOT USED	NOT USED
	Year range	1982-2003		
	Quarter	2		
	Ages	1-3		
FLT01: comm Q3				
	Year range	1982-2003	1982-2004	1982-2004
	Quarter	3	3	3
	Ages	0-3	1-3	1-3
FLT01: comm Q4				
	Year range	1982-2003	1982-2004	1982-2004
	Quarter	4	4	4
	Ages	0-3	0-3	0-2 (SMS); 0-3 (SXSA)
FLT02: ibtsq1				
	Year range	1982-2003	1982-2006	1982-2006
	Quarter	1	1	1
	Ages	1-3	1-3	1-3
FLT03: egfs				
	Year range	1982-2003	1992-2005	1992-2005
	Quarter	3	Q3 -> Q2	Q3 -> Q2
	Ages	0-3	0-1	0-1
FLT04: ibtsq3		NOT USED		
	Year range		1991-2005	1991-2005
	Quarter		3	3
	Ages		2-3	2-3
FLT05: sgfs				
	Year range	1982-2003	1998-2006	1998-2006
	Quarter	3	Q3 -> Q2	Q3 -> Q2
	Ages	0-3	0-1	0-1

Table 5.3.2 Stochastic Multi-Species Model (SMS) analysis of Norway pout in the North Sea and Skagerrak. Parameters, settings and options of the SMS as well as the input data used in the SMS.

SURVIVORS ANALYSIS OF: Norway pout stock in September 2006

Run: Baseline September 2006 with SMS Model

The following parameters were used:

```
Year range:                                             1983 - 2006
Seasons per year:                                       4
The last season in the last year is season:             3
Youngest age:                                           0
Oldest true age:                                        3
Plus group:                                             No plus group
Recruitment in season:                                  3
Spawning in season:                                     1
Single species mode:                                    Yes, number of species = 1
```

The following fleets were included:

```
Fleet  1: (Q1: Age 1-3; Q2: None; Q3: Age 1-3; Q4: Age 0-2) commercial q134
Fleet  2:                                                   ibtsq1       (Age
1-3)
Fleet  3:                                                   egfsq2       (Age
0-1)
Fleet  4:                                                   sgfsq2       (Age
0-1)
Fleet  5:                                                   ibtsq3       (Age
2-3)
```

Data were input from the following files:

```
Catch in numbers:                                       canum.in
Weight in catch:                                        weca.in
Weight in stock:                                        west.in
Natural mortalities:                                    natmor.in
Maturity ogive:                                         propmat.in
Tuning data (CPUE):                                     fleet_catch.in
Tuning fleet names:                                     fleet_names.in
Tuning fleet settings:                                  fleet_info.dat
```

The following tuning fleet options were used in the SMS model (summary from fleet_info.dat):

```
Minimum CV of CPUE observations:                        0.2

Fleet specific options:
1-2, First year last year,
3-4. Alpha and beta - the start and end of the fishing period for the fleet given as
     fractions of the season (or year if annual data are used)
5-6  First and last age,
7.   last age with age dependent catchability,
8.   last age for stock size dependent catchability (power model), -1 indicated no
     ages uses power model
9.   season for survey,
10.  number of variance groups for estimated catchability
     by species and fleet
1 commercial q1:                                        1983 2004 0 1 1 3 3 -1 1 3
1 commercial q3:                                        1983 2004 0 1 1 3 3 -1 3 3
1 commercial q4:                                        1983 2004 0 1 0 2 2 -1 4 3
2 IBTS q1:                                              1983 2006 0 1 1 3 3 -1 1 3
3 EGFS q 3:                                             1992 2005 0 1 0 1 1 -1 3 2
4 SGFS q3:                                              1998 2006 0 0 0 1 1 -1 3 2
5 ibts_q3:                                              1991 2005 0 1 2 3 3 -1 3 2
```

Table 5.3.2 (Cont'd)

Variance groups:	
Fleet: 1 season 1:	1 2 3
Fleet: 1 season 3:	1 2 3
Fleet: 1 season 4:	0 1 2
Fleet: 2:	1 2 3
Fleet: 3:	0 1
Fleet: 4:	0 1
Fleet: 5:	2 3

The following SMS model settings were used in the SMS model (summary from SMS.dat):

SSB/R relationship:	Geometric mean
Object function weighting:	
First=catch observations	1.0
Second=CPUE observations	1.0
Third=SSB/R relations	1.0
Minimum CV of commercial catch at age observations option min.catch.CV):	0.20
Minimum CV of S/R relation (option min.SR.CV):	0.20
No. of separate catch sigma groups by species:	4 (one variance group by age)
Exploitation pattern by age and season:	Age 0 (3rd-4th quarter) Age 1 (1st, 3rd, 4th quarter) Ages 2-3 (1st, 3rd, 4th quarter)

If tuning survey index has the value 0 then 5% of the average of the rest of the observations are used because the logarithm to zero can not be taken:
Minimum "observed" catch, negative value gives percentage (-10 ~ 10%) of average catch in age-group
if option>0 and catch=0 then catch=option
if option<0 then catch=average(catch at age)*(-option)/100 -5

Assuming fixed exploitation pattern by age and season

Number of years with zero catch:	2 (2005, 2006)

Table 5.3.3 Stochastic Multi-Species Model (SMS) analysis of Norway pout in the North Sea and Skagerrak. Stock numbers, SSB and TSB at start of year, 1st January). (Summary from details_ICES.out)

Age		1983	1984	1985	1986	1987	1988	1989	1990
	0	0	0	0	0	0	0	0	0
	1	68599418	54728144	31270856	20500178	44037876	7590235	32102167	36177180
	2	6173632	7035053	5460903	2803083	1856966	4986439	870962	4209279
	3	54519	198550	210060	121921	64386	78125	217497	54546
TSB		1014858	547991	355380	218448	356571	168534	255701	356726
SSB		186020	201023	150432	80895	74255	118140	50333	120110

Age		1991	1992	1993	1994	1995	1996	1997	1998
	0	0	0	0	0	0	0	0	0
	1	34525503	57288688	26966411	22987124	73149106	24533530	56917989	13913955
	2	4471235	3788514	6253092	3257173	2328375	9506792	3641617	8722562
	3	224557	172758	144289	313446	101294	142357	833421	348107
TSB		351210	500261	339015	250877	579858	390630	517573	336555
SSB		131517	130360	162216	100287	106480	232017	153295	215560

Age		1999	2000	2001	2002	2003	2004	2005	2006
	0	0	0	0	0	0	0	0	0
	1	23684739	61255391	14470196	18226780	11141075	6462715	6522961	23836944
	2	2184764	3661392	9787837	2427921	2863191	2054900	1209100	1316963
	3	890632	213837	391995	1196359	248196	452371	337446	244113
TSB		263408	553517	340857	244536	198760	118469	103854	219094
SSB		100269	131983	241141	114027	80717	67827	44664	55424

Table 5.3.4 Stochastic Multi-Species Model (SMS) analysis of Norway pout in the North Sea and Skagerrak. Fishing mortalities at start of year, 1st January). (Summary from details_ICES.out)

Age		1983	1984	1985	1986	1987	1988	1989	1990
	0	0.0517	0.0538	0.0620	0.0612	0.0442	0.0431	0.0330	0.0375
	1	0.6774	0.7048	0.8120	0.8015	0.5783	0.5650	0.4316	0.4908
	2	1.8370	1.9113	2.2020	2.1736	1.5684	1.5323	1.1706	1.3309
	3	1.8370	1.9113	2.2020	2.1736	1.5684	1.5323	1.1706	1.3309
Avg. F 1-2		1.257	1.308	1.507	1.488	1.073	1.049	0.801	0.911

Age		1991	1992	1993	1994	1995	1996	1997	1998
	0	0.0465	0.0470	0.0392	0.0527	0.0336	0.0235	0.0210	0.0192
	1	0.6097	0.6150	0.5137	0.6898	0.4405	0.3076	0.2757	0.2514
	2	1.6535	1.6679	1.3932	1.8706	1.1946	0.8342	0.7477	0.6817
	3	1.6535	1.6679	1.3932	1.8706	1.1946	0.8342	0.7477	0.6817
Avg. F 1-2		1.132	1.141	0.953	1.280	0.818	0.571	0.512	0.467

Age		1999	2000	2001	2002	2003	2004	2005	2006
	0	0.0204	0.0179	0.0141	0.0192	0.0069	0.0058	0.0000	0.0000
	1	0.2670	0.2339	0.1851	0.2510	0.0904	0.0762	0.0000	0.0000
	2	0.7241	0.6344	0.5019	0.6806	0.2452	0.2066	0.0000	0.0000
	3	0.7241	0.6344	0.5019	0.6806	0.2452	0.2066	0.0000	0.0000
Avg. F 1-2		0.496	0.434	0.343	0.466	0.168	0.141	0.000	0.000

Table 5.3.5 Stochastic Multi-Species Model (SMS) analysis of Norway pout in the North Sea and Skagerrak. Diagnostics from the SMS model. (Summary from SMS.rep)

```
Objective function (negative log likelihood):                    82.3664

objective function weight:                                       Catch  CPUE   S/R
                                                                 1      1      1

Unweighted objective function contributions (total):
               Catch    CPUE     S/R    Stom.  Penalty    Sum
               82.5    -3.5     3.4     0.0 0.00e+000    82.4


Unweighted objective function contributions (per observation):
                Catch   CPUE     S/R   Stomachs
               0.22   -0.01    0.14    0.00


Contribution by fleet:
----------------------
commercial q1              total: -10.904   mean:  -0.165
commercial q3              total:   3.702   mean:   0.056
commercial q4              total:   5.647   mean:   0.086
ibts q1                    total:   0.067   mean:   0.001
egfs q3                    total:  -4.692   mean:  -0.168
sgfs q3                    total:  -7.490   mean:  -0.416
ibts q3                    total:  10.186   mean:   0.340



F, Year effect:
---------------
         sp. 1
1983:    1.000
1984:    1.040
1985:    1.199
1986:    1.183
1987:    0.854
1988:    0.834
1989:    0.637
1990:    0.725
1991:    0.900
1992:    0.908
1993:    0.758
1994:    1.018
1995:    0.650
1996:    0.454
1997:    0.407
1998:    0.371
1999:    0.394
2000:    0.345
2001:    0.273
2002:    0.370
2003:    0.133
2004:    0.112
2005:    0.000
2006:    0.000

F, season effect:
-----------------
age: 0
    1983-2006:   0.000 0.000 0.015 0.250
age: 1
    1983-2006:   0.041 0.033 0.131 0.250
age: 2 - 3
    1983-2006:   0.080 0.067 0.155 0.250
```

Table 5.3.5 (Cont'd)

F, age effect:

	0	1	2	3
1983-2006:	0.195	1.489	3.330	3.330

Exploitation pattern (scaled to mean F=1)

		0	1	2	3
1983-2006	season 1:	0.000	0.048	0.211	0.211
	season 2:	0.000	0.039	0.177	0.177
	season 3:	0.002	0.155	0.411	0.411
	season 4:	0.039	0.296	0.662	0.662

sqrt(catch variance) ~ CV:

	season			
age	1	2	3	4
0			1.922	0.505
1	0.478	0.632	0.427	0.392
2	0.321	0.754	0.887	0.605
3	0.925	1.489	1.428	1.962

Survey catchability:

	age 0	age 1	age 2	age 3
commercial q1		0.264	1.244	1.537
commercial q3		0.623	2.018	1.026
commercial q4	0.111	1.241	3.141	
ibts q1		0.986	2.891	5.236
egfs q3	0.767	2.301		
sgfs q3	0.497	1.595		
ibts q3			2.741	2.523

sqrt(Survey variance) ~ CV:

	age 0	age 1	age 2	age 3
commercial q1		0.66	0.25	0.82
commercial q3		0.33	0.61	1.33
commercial q4	0.89	0.41	0.80	
ibts q1		0.53	0.49	0.87
egfs q3	0.71	0.37		
sgfs q3	0.57	0.28		
ibts q3			0.62	1.16

Recruit-SSB		GM	recruit s2	recruit s
Norway pout	Geometric mean (GM):	17.829	0.487	0.698

Table 5.3.6 Baseline run with SXSA (seasonal extended survivor analysis) of Norway pout in the North Sea and Skagerrak. Parameters, settings and the options of the SXSA as well as the input data used in the SXSA.

SURVIVORS ANALYSIS OF: Norway pout stock in September 2006

Run: Baseline Sept 2006 (Summary from NP0906_1)

The following parameters were used:

Year range:	1983 - 2006
Seasons per year:	4
The last season in the last year is season :	2
Youngest age:	0
Oldest age:	3
Plus age:	4
Recruitment in season:	2
Spawning in season:	1

The following fleets were included:

Fleet 1: (Q1: Age 1-3; Q2: None; Q3: Age 1-3; Q4: 0-3)	commercial q134
Fleet 2:	ibtsq1 (Age 1-3)
Fleet 3:	egfsq2 (Age 0-1)
Fleet 4:	sgfsq2 (Age 0-1)
Fleet 5:	ibtsq3 (Age 2-3)

The following options were used:

1: Inv. catchability: (1: Linear; 2: Log; 3: Cos. filter)	2
2: Indiv. shats: (1: Direct; 2: Using z)	2
3: Comb. shats: (1: Linear; 2: Log.)	2
4: Fit catches: (0: No fit; 1: No SOP corr; 2: SOP corr.)	0
5: Est. unknown catches: (0: No; 1: No SOP corr; 2: SOP corr; 3: Sep. F)	0
6: Weighting of rhats: (0: Manual)	0
7: Weighting of shats: (0: Manual; 1: Linear; 2: Log.)	2
8: Handling of the plus group: (1: Dynamic; 2: Extra age group)	1

Data were input from the following files:

Catch in numbers:	canum.qrt
Weight in catch:	weca.qrt
Weight in stock:	west.qrt
Natural mortalities:	natmor.qrt
Maturity ogive:	matprop.qrt
Tuning data (CPUE):	tun2005.xsa
Weighting for rhats:	rweigh.xsa

Table 5.3.7 SXSA (Seasonal extended survivor analysis) of Norway pout in the North Sea and Skagerrak. Diagnostics of the SXSA.

Log inverse catchabilities, fleet no: 1 (commercial q134)

Year 1983-2006 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	11.580
1	10.726	*	9.876	9.211
2	9.254	*	8.815	8.426
3	9.254	*	8.815	8.426

Log inverse catchabilities, fleet no: 2 (ibtsq1)

Year 1983-2006 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	2.509	*	*	*
2	1.491	*	*	*
3	1.491	*	*	*

Log inverse catchabilities, fleet no: 3 (egfsq2)

Year 1992-2005 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4		
AGE						
0	*	3.164	*	*	*	*
1	*	2.097	*	*	*	*
2	*	*	*	*	*	*
3	*	*	*	*	*	*

Log inverse catchabilities, fleet no: 4 (sgfsq2)

Year 1998-2006 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	3.396	*	*
1	*	2.301	*	*
2	*	*	*	*
3	*	*	*	*

Table 5.3.7 Cont´d.).

Log inverse catchabilities, fleet no: 5 (ibtsq3)

Year 1991-2004 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	*	*	*	*
2	*	*	1.523	*
3	*	*	1.523	*

Weighting factors for computing survivors:
Fleet no: 1 (commercial q134)

Year 1983-2006 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	1.055
1	1.324	*	3.069	2.108
2	2.133	*	1.872	1.228
3	1.287	*	0.850	*

Weighting factors for computing survivors:
Fleet no: 2 (ibtsq1)

Year 1983-2006 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	1.590	*	*	*
2	1.697	*	*	*
3	0.968	*	*	*

Weighting factors for computing survivors:
Fleet no: 3 (egfsq2)

Year 1992-2005 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	1.319	*	*
1	*	2.147	*	*
2	*	*	*	*
3	*	*	*	*

Table 5.3.7 Cont´d.).

Weighting factors for computing survivors:
Fleet no: 4 (sgfsq2)

Year 1998-2006 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	1.650	*	*
1	*	2.267	*	*
2	*	*	*	*
3	*	*	*	*

Weighting factors for computing survivors:
Fleet no: 5 (ibtsq3)

Year 1991-2005 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	*	*	*	*
2	*	*	1.219	*
3	*	*	0.715	*

Table 5.3.8 Norway pout IIIa, IV. Stock summary table. (SMS Baseline September 2006). (Recruits in millions. SSB and TSB in t, and Yield in '000 t).

Year	Recruits(age 0 3rd qı	SSB (Q1)	TSB (Q3)	Landings ('000 t)	Fbar(1-2
1983	128264	186020	1014858	475746	0.996
1984	73442	201023	547991	376555	1.037
1985	48542	150432	355380	227450	1.199
1986	104192	80895	218448	180376	1.183
1987	17655	74255	356571	148856	0.848
1988	74594	118140	168534	109294	0.829
1989	83211	50333	255701	166559	0.631
1990	79771	120110	356726	138719	0.718
1991	133573	131517	351210	190194	0.895
1992	62900	130360	500261	302365	0.903
1993	53205	162216	339015	181256	0.752
1994	171599	100287	250877	183585	1.015
1995	56468	106480	579858	231772	0.644
1996	129683	232017	390630	156079	0.449
1997	31625	153295	517573	156938	0.402
1998	53733	215560	336555	73974	0.366
1999	139134	100269	263408	92276	0.389
2000	32784	131983	553517	184969	0.341
2001	41142	241141	340857	64372	0.269
2002	25275	114027	244536	77109	0.366
2003	14483	80717	198760	24574	0.131
2004	14602	67827	118469	13488	0.111
2005	53050	44664	103854	0	0
2006	32450	55424	219094		
Arit mean	**66,911**	**119,596**	**322,268**		**0.562**
Geomean	**52,806**				

Table 5.3.9 Stochastic Multi-Species Model (SMS) analysis of Norway pout in the North Sea and Skagerrak using new natural mortalities (M) from Sparholt, Larsen, Nielsen (2002a,b). Diagnostics from the SMS model. Summary from SMS.rep)

```
Objective function (negative log likelihood):  79.1518

Objective function weight:                         Catch  CPUE   S/R
                                                     1     1     1

Unweighted objective function contributions (total):
               Catch    CPUE     S/R    Stom.  Penalty    Sum
               82.9    -6.5     2.7     0.0 0.00e+000    79.2


Unweighted objective function contributions (per observation):
                Catch   CPUE     S/R   Stomachs
                 0.22   -0.02    0.11    0.00

Contribution by fleet:
----------------------
commercial q1              total:  -8.379   mean:  -0.127
commercial q3              total:   4.623   mean:   0.070
commercial q4              total:   6.921   mean:   0.105
ibts q1                    total:  -5.815   mean:  -0.081
egfs q3                    total:  -3.735   mean:  -0.133
sgfs q3                    total:  -7.715   mean:  -0.429
ibts q3                    total:   7.623   mean:   0.254


F, Year effect:
---------------
         sp. 1
1983:    1.000
1984:    1.057
1985:    1.112
1986:    1.010
1987:    0.711
1988:    0.606
1989:    0.570
1990:    0.614
1991:    0.793
1992:    0.810
1993:    0.677
1994:    0.838
1995:    0.501
1996:    0.364
1997:    0.323
1998:    0.289
1999:    0.314
2000:    0.270
2001:    0.193
2002:    0.302
2003:    0.111
2004:    0.096
2005:    0.000
2006:    0.000


F, season effect:
-----------------
age: 0
    1983-2006:   0.000 0.000 0.017 0.250
age: 1
    1983-2006:   0.069 0.048 0.161 0.250
age: 2 - 3
    1983-2006:   0.071 0.065 0.172 0.250
```

Table 5.3.9 (Cont'd)

F, age effect:

	0	1	2	3
1983-2006:	0.254	1.003	2.277	2.277

Exploitation pattern (scaled to mean F=1)

		0	1	2	3
1983-2006	season 1:	0.000	0.076	0.180	0.180
	season 2:	0.000	0.053	0.165	0.165
	season 3:	0.005	0.179	0.436	0.436
	season 4:	0.070	0.278	0.632	0.632

sqrt(catch variance) ~ CV:

	season			
age	1	2	3	4
0			1.917	0.524
1	0.491	0.631	0.375	0.397
2	0.345	0.736	0.853	0.681
3	0.920	1.565	1.476	2.080

Survey catchability:

	age 0	age 1	age 2	age 3
commercial q1		0.250	0.620	0.914
commercial q3		0.427	1.155	1.044
commercial q4	0.121	0.687	1.774	
ibts q1		0.929	1.453	3.256
egfs q3	0.919	1.500		
sgfs q3	0.627	1.097		
ibts q3			1.619	2.940

sqrt(Survey variance) ~ CV:

	age 0	age 1	age 2	age 3
commercial q1		0.69	0.27	0.84
commercial q3		0.34	0.60	1.36
commercial q4	0.90	0.39	0.88	
ibts q1		0.50	0.45	0.78
egfs q3	0.71	0.39		
sgfs q3	0.57	0.27		
ibts q3			0.60	1.02

Recruit-SSB		GM	recruit s2	recruit s
Norway pout	Geometric mean (GM):	17.529	0.460	0.678

Table 5.3.10 Stochastic Multi-Species Model (SMS) analysis of Norway pout in the North Sea and Skagerrak using natural mortalities (M) from the MSVPA model. Diagnostics from the SMS model. (Summary from SMS.rep).

```
Objective function (negative log likelihood):  94.4835

Objective function weight:                          Catch  CPUE   S/R
                                                      1     1     1

Unweighted objective function contributions (total):
               Catch    CPUE     S/R    Stom.  Penalty    Sum
               102.7    -1.6    -6.6     0.0 0.00e+000    94.5


Unweighted objective function contributions (per observation):
                Catch   CPUE     S/R   Stomachs
                0.27   -0.00   -0.27    0.00


Contribution by fleet:
----------------------
commercial q1              total:  -3.181   mean:  -0.048
commercial q3              total:   8.831   mean:   0.134
commercial q4              total:  13.399   mean:   0.203
ibts q1                    total: -14.913   mean:  -0.207
egfs q3                    total:  -5.524   mean:  -0.197
sgfs q3                    total:  -8.102   mean:  -0.450
ibts q3                    total:   7.889   mean:   0.263


F, Year effect:
---------------
         sp. 1
1983:    1.000
1984:    0.976
1985:    1.000
1986:    0.958
1987:    0.758
1988:    0.776
1989:    0.632
1990:    0.735
1991:    0.948
1992:    0.858
1993:    0.744
1994:    0.909
1995:    0.531
1996:    0.390
1997:    0.369
1998:    0.318
1999:    0.430
2000:    0.356
2001:    0.191
2002:    0.233
2003:    0.116
2004:    0.116
2005:    0.000
2006:    0.000

F, season effect:
-----------------
age: 0
    1983-2006:   0.000 0.000 0.014 0.250
age: 1
    1983-2006:   0.028 0.028 0.135 0.250
age: 2 - 3
    1983-2006:   0.079 0.078 0.189 0.250
```

Table 5.3.10 (Cont'd)

F, age effect:

	0	1	2	3
1983-2006:	0.127	1.652	3.961	3.961

Exploitation pattern (scaled to mean F=1)

		0	1	2	3
1983-2006	season 1:	0.000	0.030	0.202	0.202
	season 2:	0.000	0.030	0.200	0.200
	season 3:	0.001	0.144	0.485	0.485
	season 4:	0.021	0.268	0.642	0.642

sqrt(catch variance) ~ CV:

	season			
age	1	2	3	4
0			1.909	0.660
1	0.663	0.681	0.407	0.382
2	0.383	0.661	0.941	0.737
3	0.940	1.444	1.459	1.984

Survey catchability:

	age 0	age 1	age 2	age 3
commercial q1		0.181	1.280	1.947
commercial q3		0.620	2.836	1.882
commercial q4	0.065	1.193	3.971	
ibts q1		0.656	3.100	7.240
egfs q3	0.350	2.244		
sgfs q3	0.175	1.617		
ibts q3			4.222	5.134

sqrt(Survey variance) ~ CV:

	age 0	age 1	age 2	age 3
commercial q1		0.84	0.27	0.84
commercial q3		0.33	0.72	1.40
commercial q4	1.03	0.41	0.96	
ibts q1		0.48	0.39	0.63
egfs q3	0.63	0.39		
sgfs q3	0.51	0.29		
ibts q3			0.59	1.06

Recruit-SSB	GM	recruit s2	recruit s
Norway pout: Geometric mean(GM):	18.488	0.213	0.461

Table 5.6.1 Input data to forecast for Norway pout in the North Sea and Skagerak September 2006.

Input in the assesment year

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2006	1	0	0	0	0.000	0.000	0.4	0
2006	1	1	23837	0	0.007	0.010	0.4	0.1
2006	1	2	1317	0	0.022	0.023	0.4	1
2006	1	3	244	0	0.040	0.036	0.4	1
2006	2	0	0	0	0.000	0.000	0.4	0
2006	2	1	0	0	0.015	0.015	0.4	0
2006	2	2	0	0	0.034	0.026	0.4	0
2006	2	3	0	0	0.050	0.039	0.4	0
2006	3	0	32450	0	0.004	0.008	0.4	0
2006	3	1	0	0	0.025	0.027	0.4	0
2006	3	2	0	0	0.043	0.040	0.4	0
2006	3	3	0	0	0.060	0.049	0.4	0
2006	4	0	0	0.023	0.006	0.009	0.4	0
2006	4	1	0	0.178	0.023	0.026	0.4	0
2006	4	2	0	0.397	0.042	0.036	0.4	0
2006	4	3	0	0.397	0.058	0.049	0.4	0

Input for forecast year and forward

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2007	1	0	0	0.000	0.000	0.000	0.4	0
2007	1	1	0	0.048	0.007	0.010	0.4	0.1
2007	1	2	0	0.211	0.022	0.023	0.4	1
2007	1	3	0	0.211	0.040	0.036	0.4	1
2007	2	0	0	0.000	0.000	0.000	0.4	0
2007	2	1	0	0.039	0.015	0.015	0.4	0
2007	2	2	0	0.177	0.034	0.026	0.4	0
2007	2	3	0	0.177	0.050	0.039	0.4	0
2007	3	0	13250	0.002	0.004	0.008	0.4	0
2007	3	1	0	0.155	0.025	0.027	0.4	0
2007	3	2	0	0.411	0.043	0.040	0.4	0
2007	3	3	0	0.411	0.060	0.049	0.4	0
2007	4	0	0	0.039	0.006	0.009	0.4	0
2007	4	1	0	0.296	0.023	0.026	0.4	0
2007	4	2	0	0.662	0.042	0.036	0.4	0
2007	4	3	0	0.662	0.058	0.049	0.4	0

Table 5.6.2 Results of the forecast for Norway pout in the North Sea and Skagerak September 2006.

Rationale	F-multiplier	Landings (2007) (' 000 t)	SSB, 1st January 2008 (' 000 t)
Zero catch	0	0	100
	0.1	14	92
	0.2	26	85
	0.3	37	79
	0.4	48	73
	0.5	58	68
	0.6	67	63
	0.7	75	59
	0.8	83	55
	0.9	90	52
	1	97	49
	1.1	103	46
	1.2	109	43

Shaded scenarios are not considered consistent with the precautionary approach.

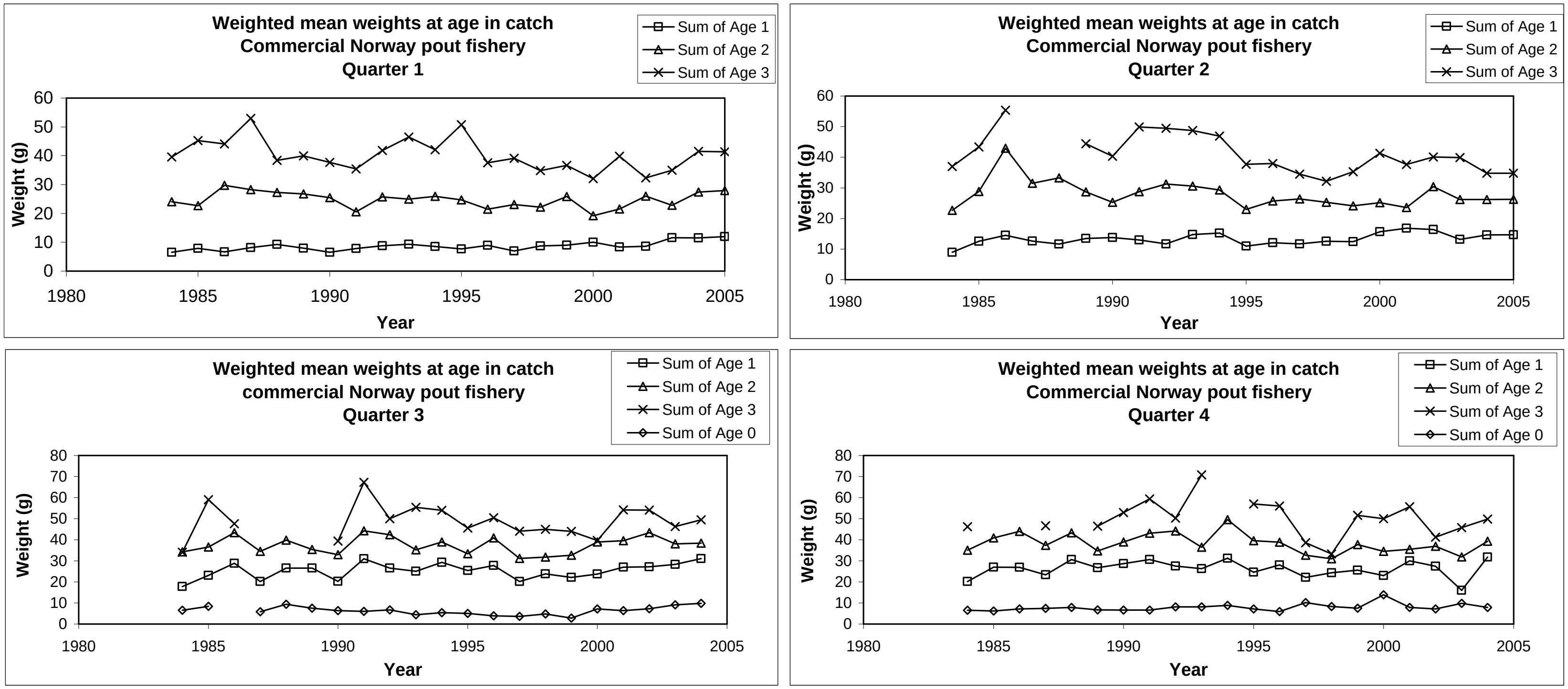


Figure 5.2.1. NORWAY POUT. Weighted mean weights at age in catch of the Danish and Norwegian commercial fishery for Norway pout by quarter of year during the period 1982-2005 (1st half year 2005).

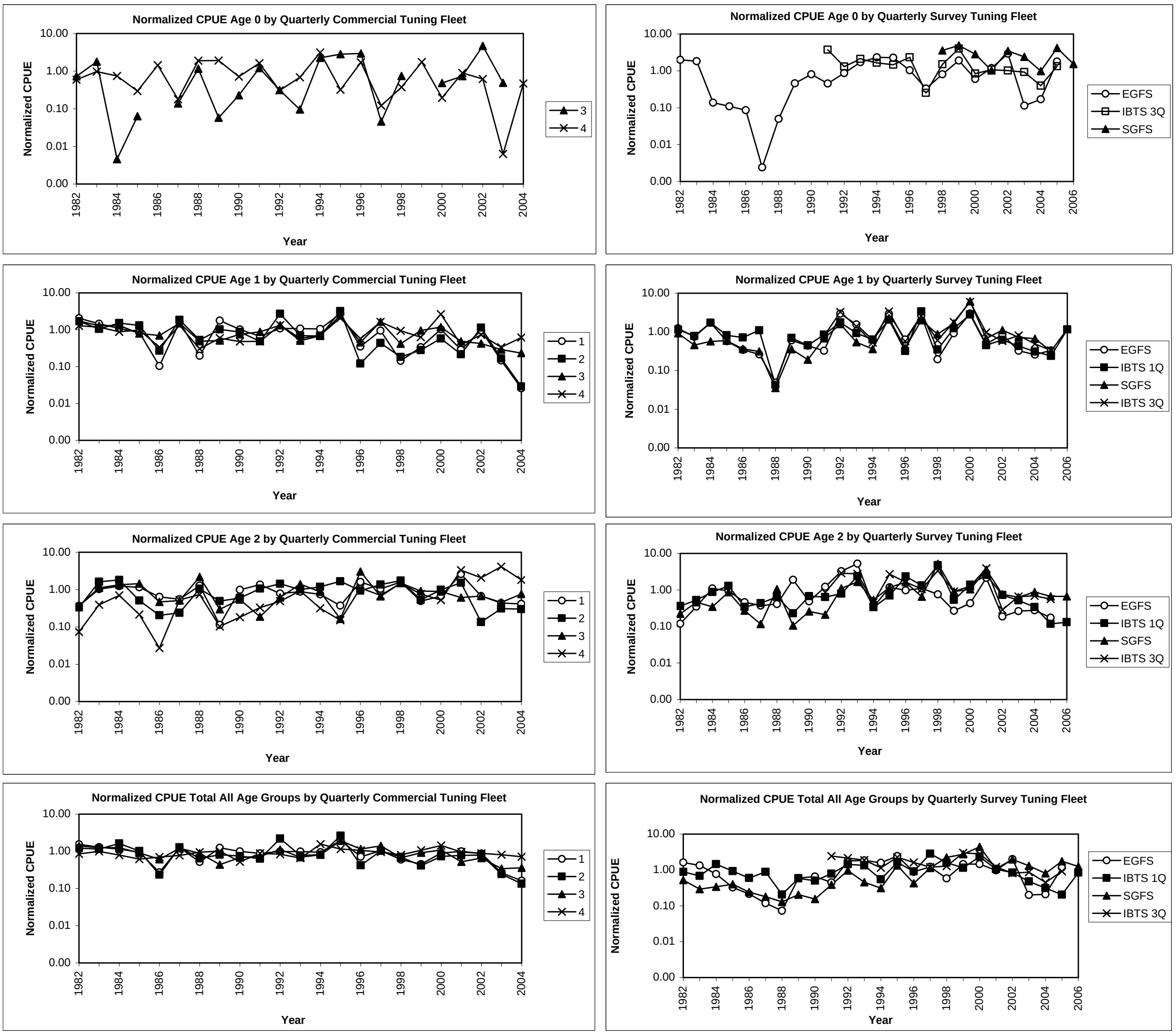
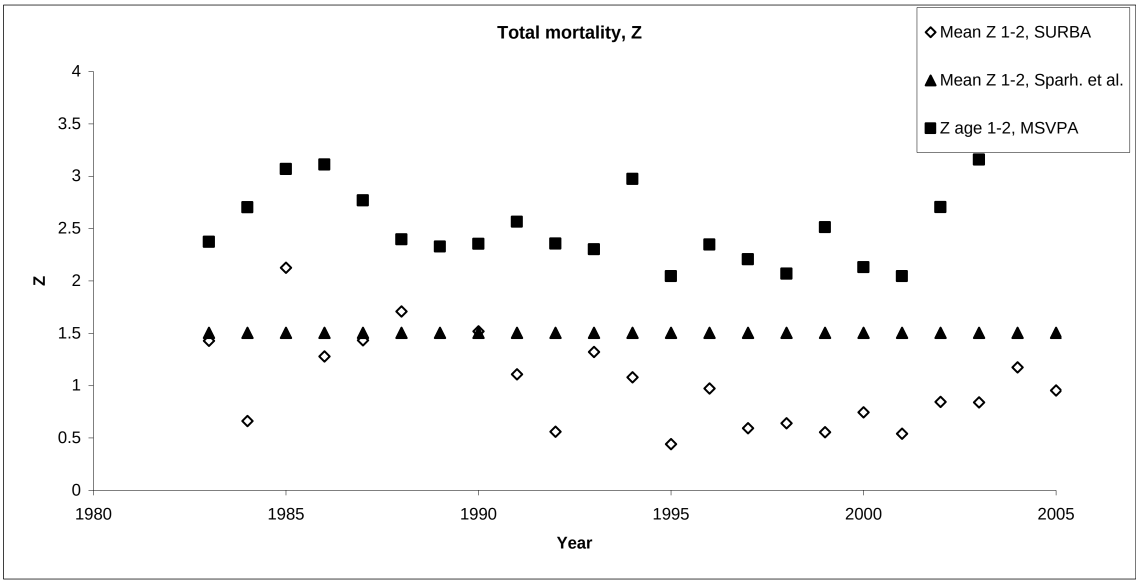


Figure 5.2.2 NORWAY POUT. Trends in CPUE (normalized to unit mean) by quarterly commercial tuning fleet and survey tuning fleet used in the Norway pout SXSA Assessment for each age group and all age groups together.



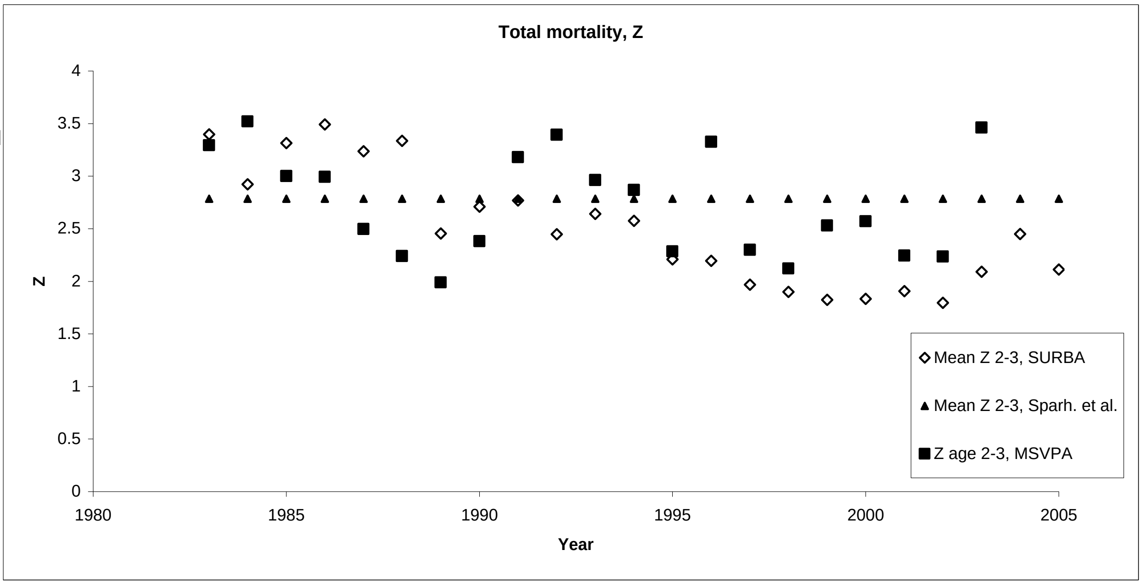


Figure 5.2.3 Comparison of total mortality (Z) estimates by age from Sparholt, Larsen and Nielsen (2002a,b) and Z-estimates from MSVPA, and the SURBA-run 2005.

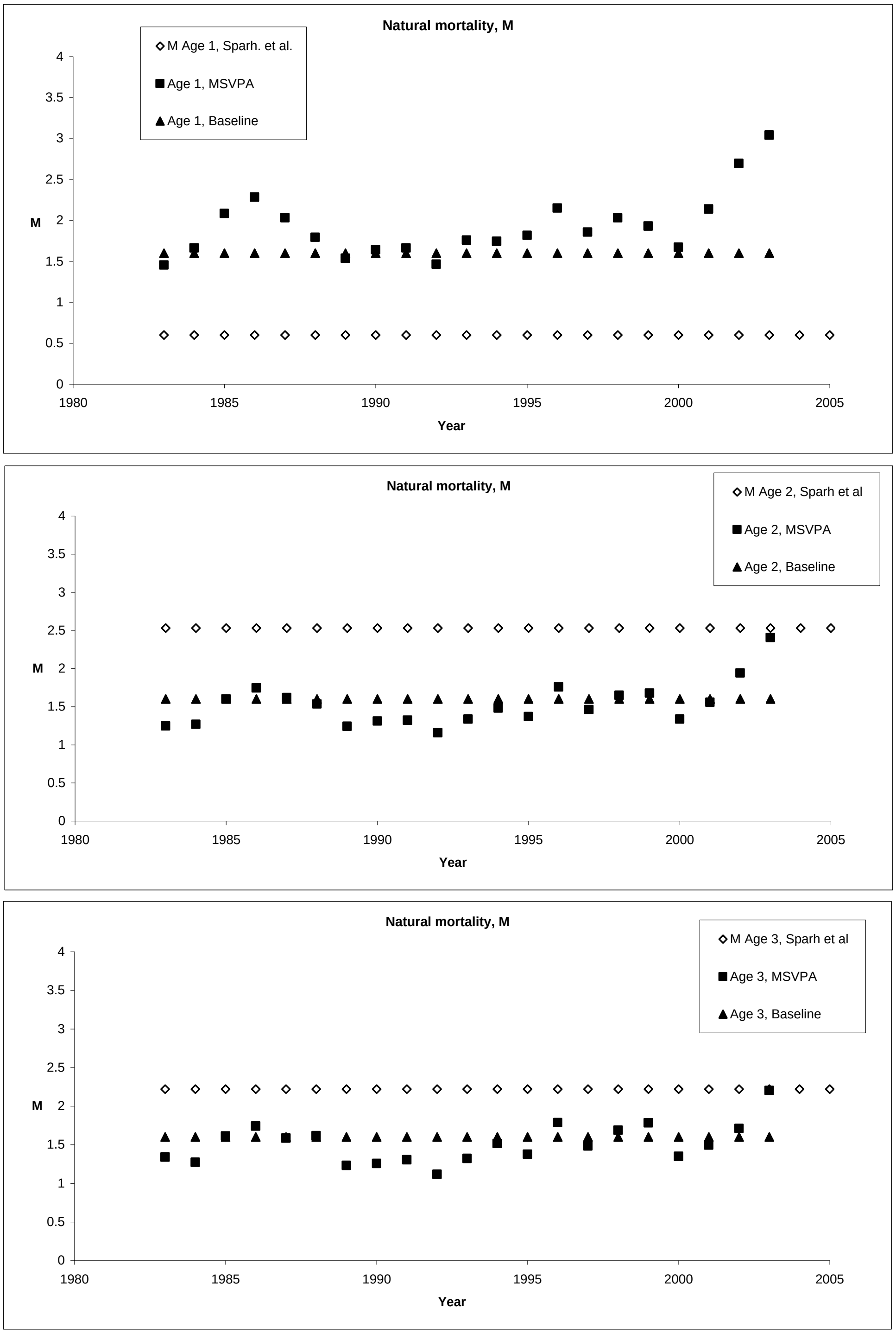


Figure 5.2.4 Comparison of M (M1+M2) estimates by age from the papers by Sparholt, Nielsen and Larsen (2002a,b) and from the MSVPA, as well as the constant M used in the baseline assessment.

Catch residuals SMS (baseline, standard M)

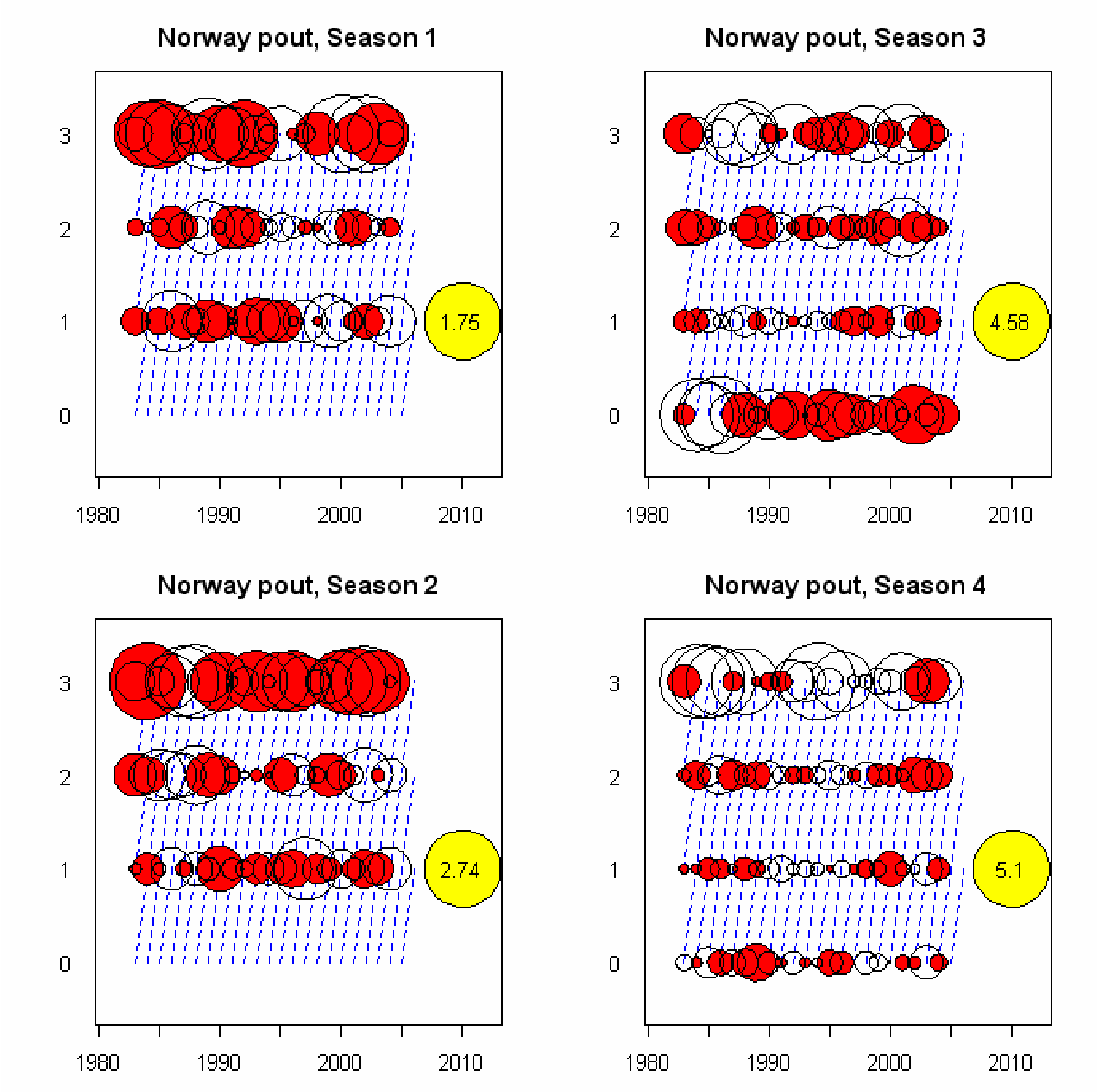


Figure 5.3.1aCatch residuals. Log residual catch numbers by age and quarter of year (log(Chat/C). SMS – Norway pout in the North Sea and Skagerak.

Tuning fleet (survey) residuals SMS (baseline, standard M)

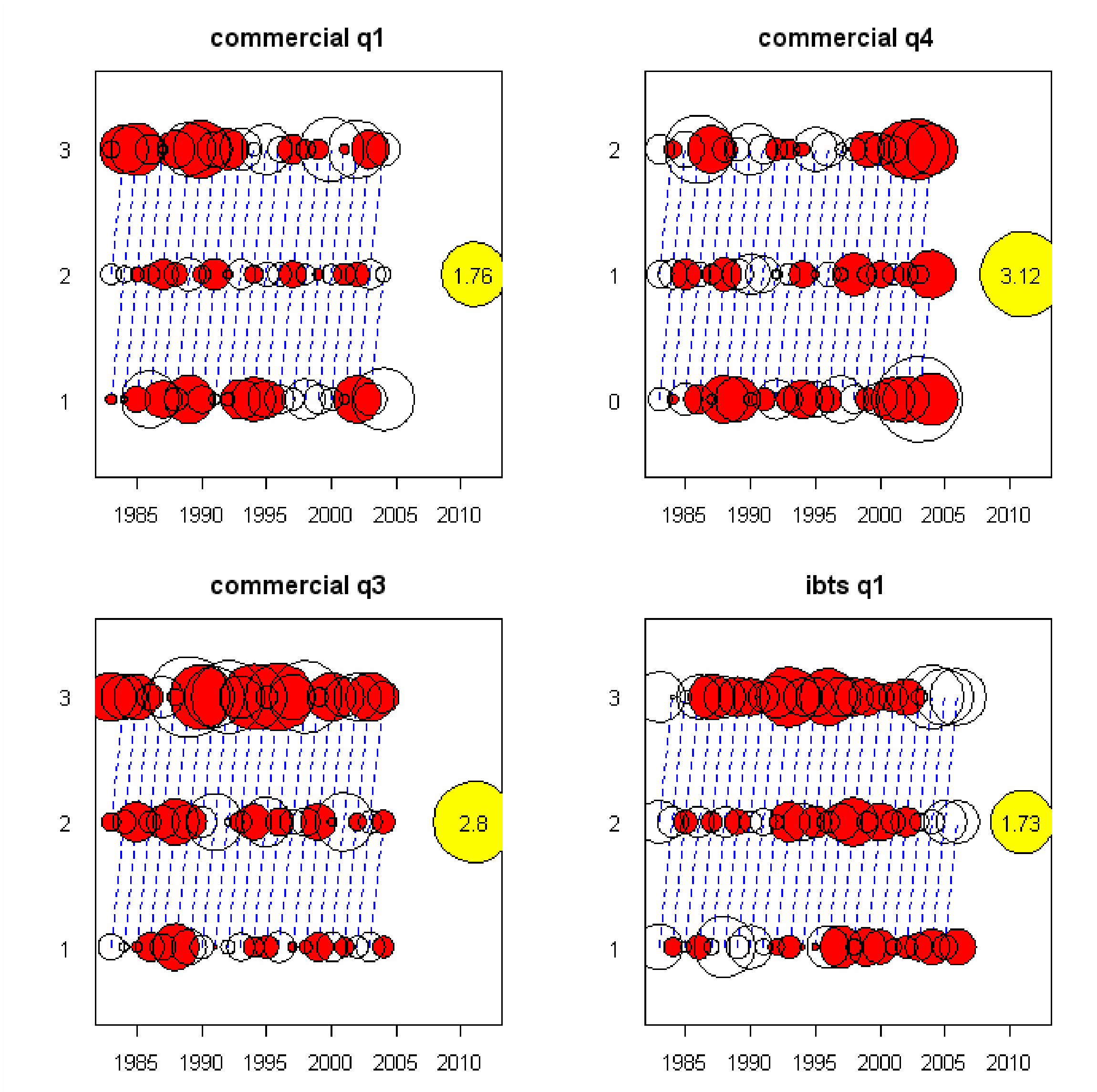


Figure 5.3.1b Tuning fleet residuals. Log residual catch rates by age and fleet (log(CPUEhat/CPUE). SMS – Norway pout in the North Sea and Skagerak.

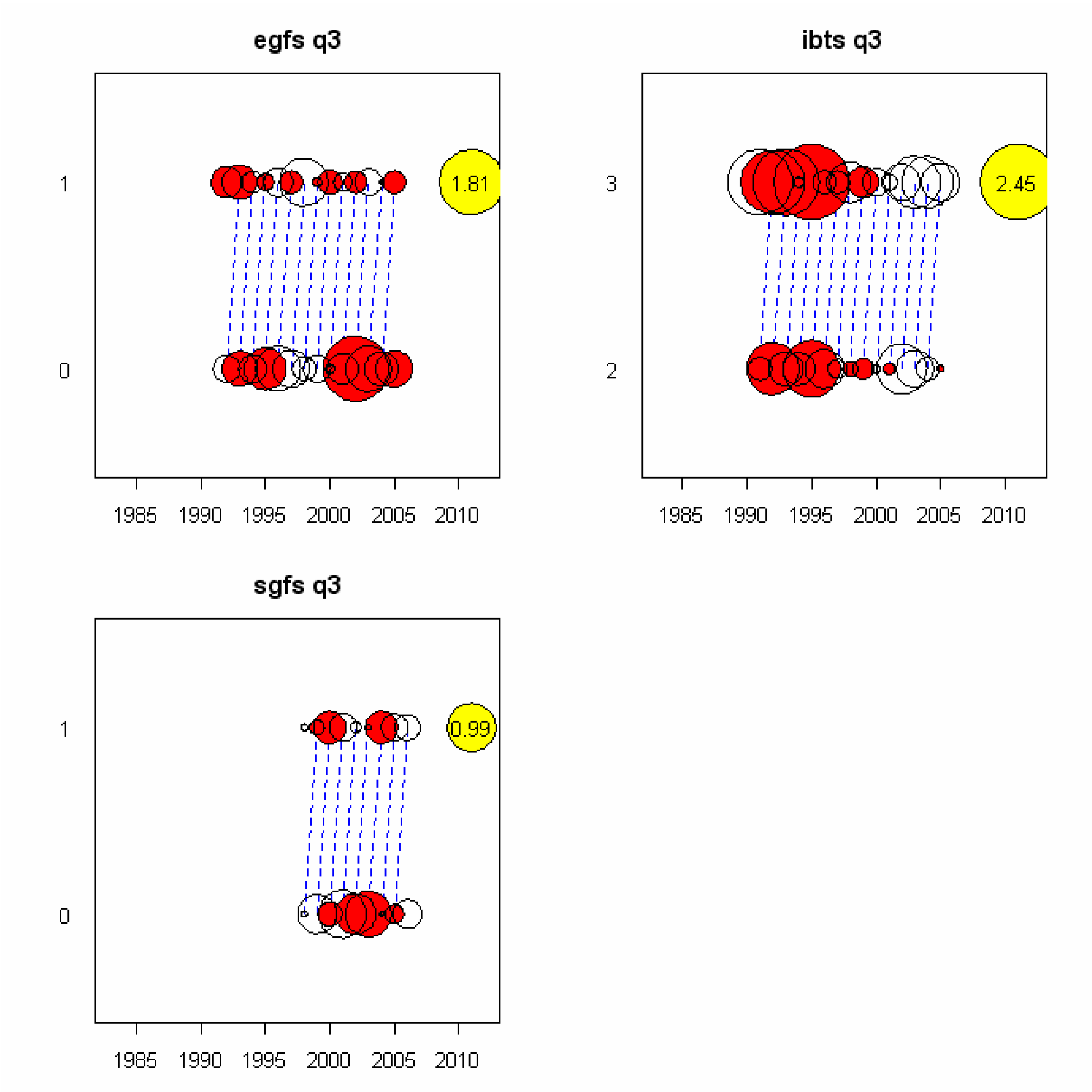


Figure 5.3.1b (Cont'd)

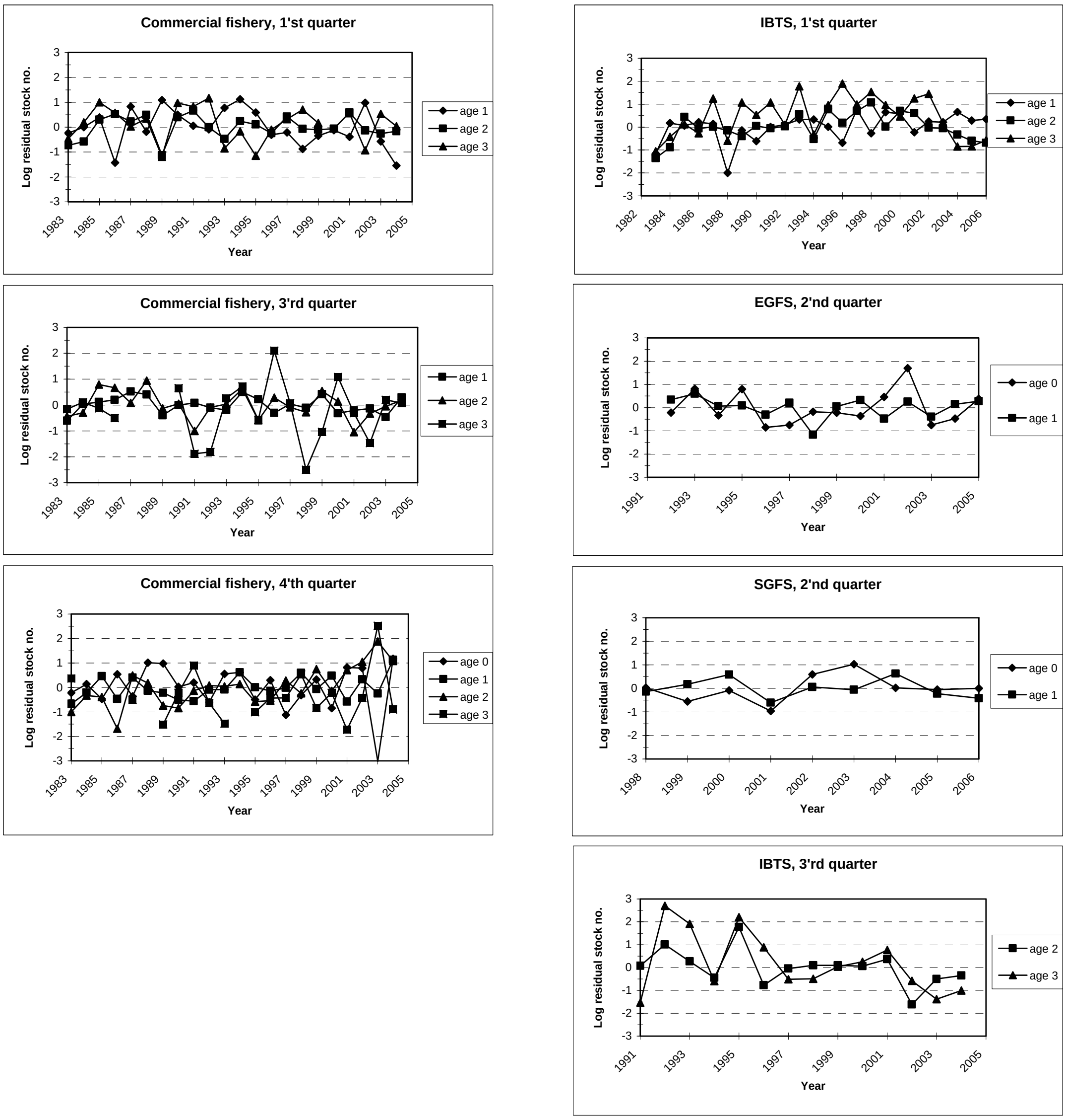
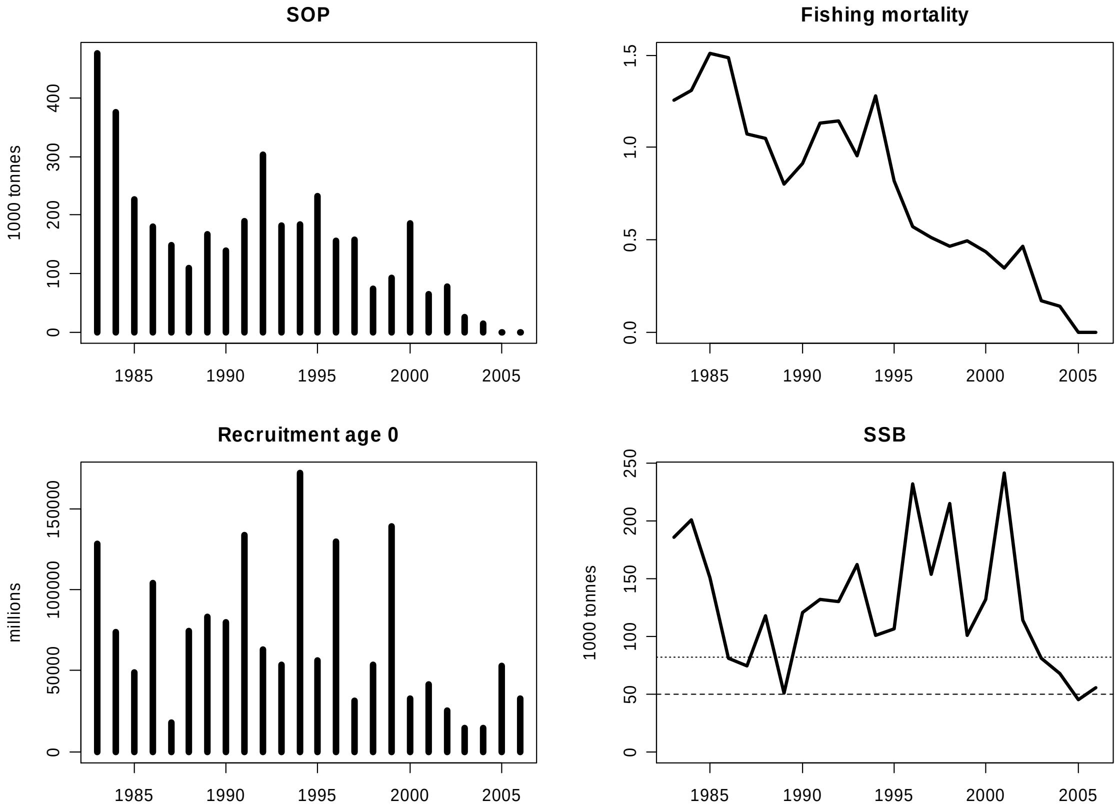


Figure 5.3.2 Log residual stock numbers (log (Nhat/N)) per age group divided by fleet and season. SXSA-Norway pout in the North Sea and Skagerak.



(SMS run with standard M settings (baseline))

Figure 5.3.3 Norway pout in the North Sea. Stock Summary Plots.

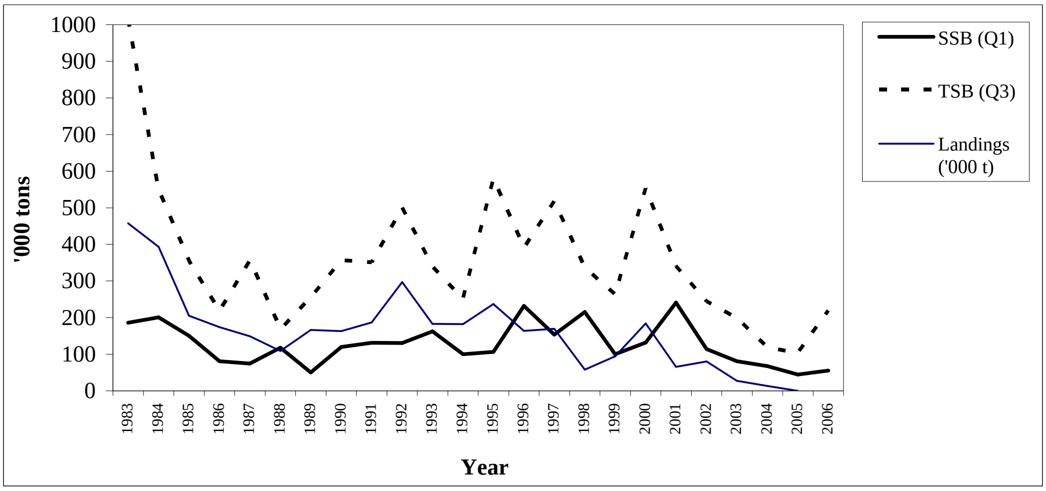
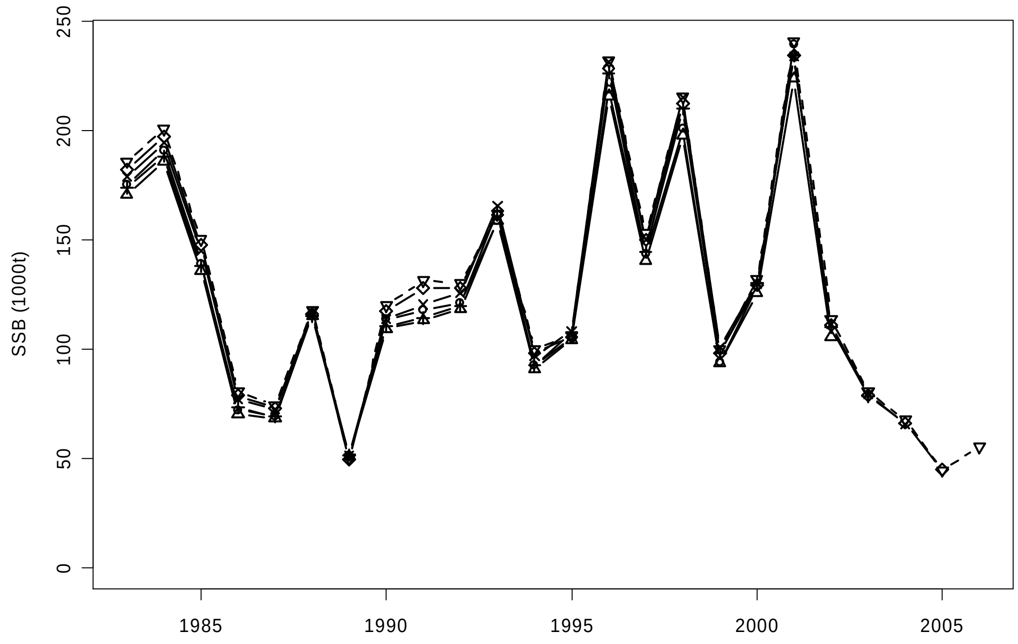


Figure 5.3.4 Trends in yield, SSB and TSB for Norway pout in the North Sea and Skagerrak during the period 1983-2005.



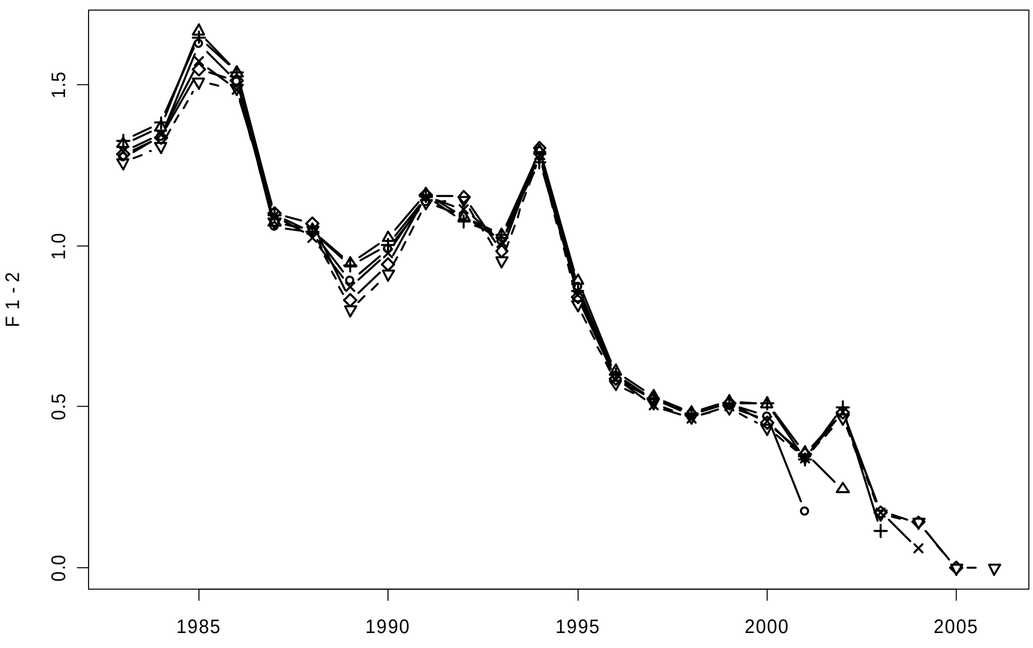


Figure 5.3.5 Retrospective analyses of SSB and $F_{ann(1-2)}$ and Recruitment for the period 2001-2006. (Using SMS with standard M (baseline)).

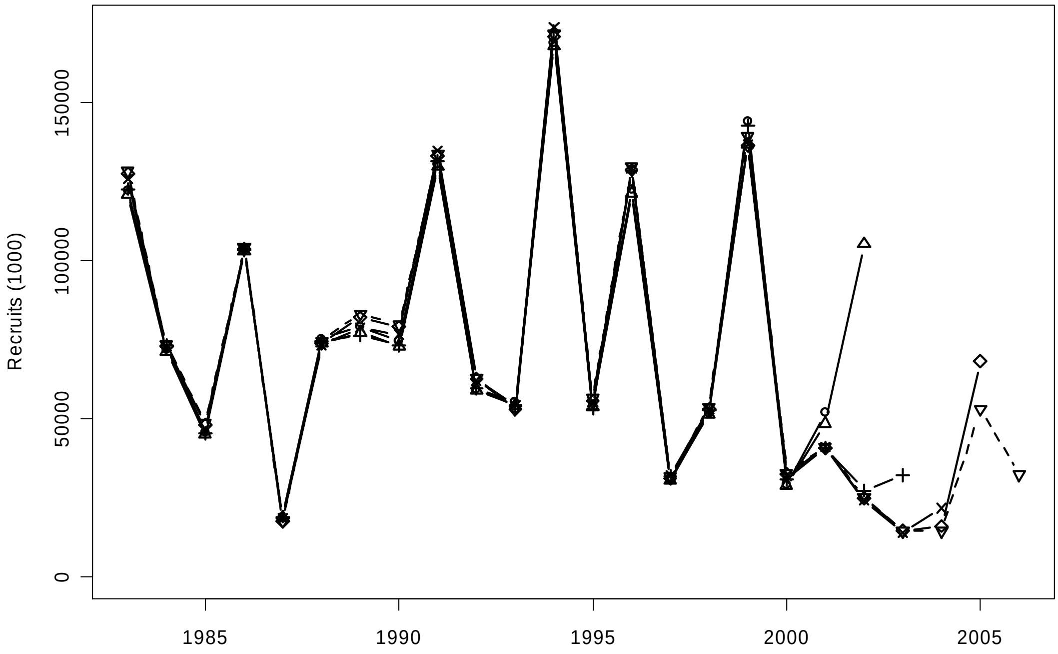


Figure 5.3.5 (Cont'd)

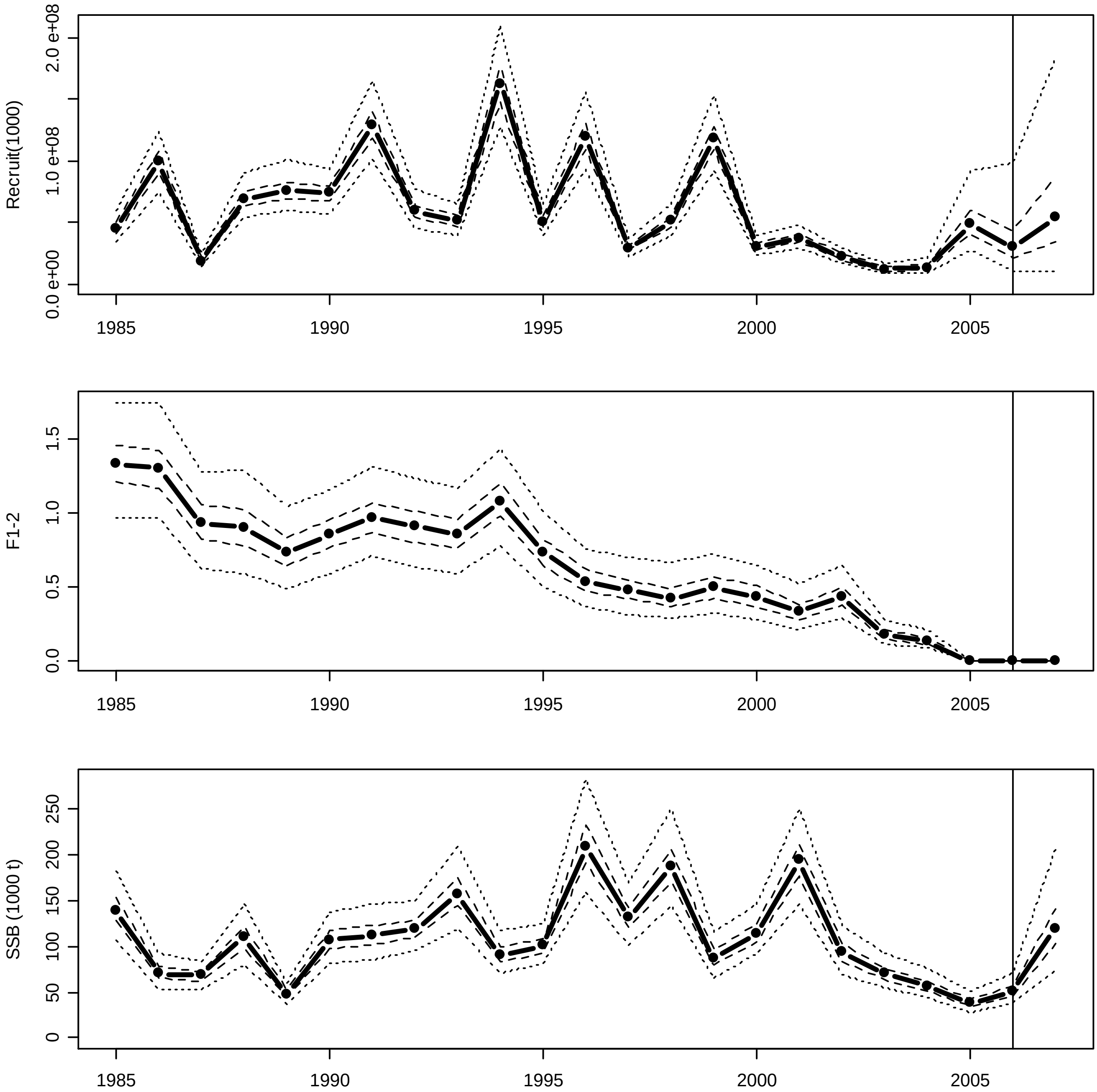


Figure 5.3.6 Posterior density (2.5, 25, 50, 75 and 97.5 percentiles) of recruits, average F and SSB estimated from 500000 Markov Chain Monte Carlo simulations.

Figure 5.3.7 Comparison of observed and model catch. Using SMS with standard M (baseline).

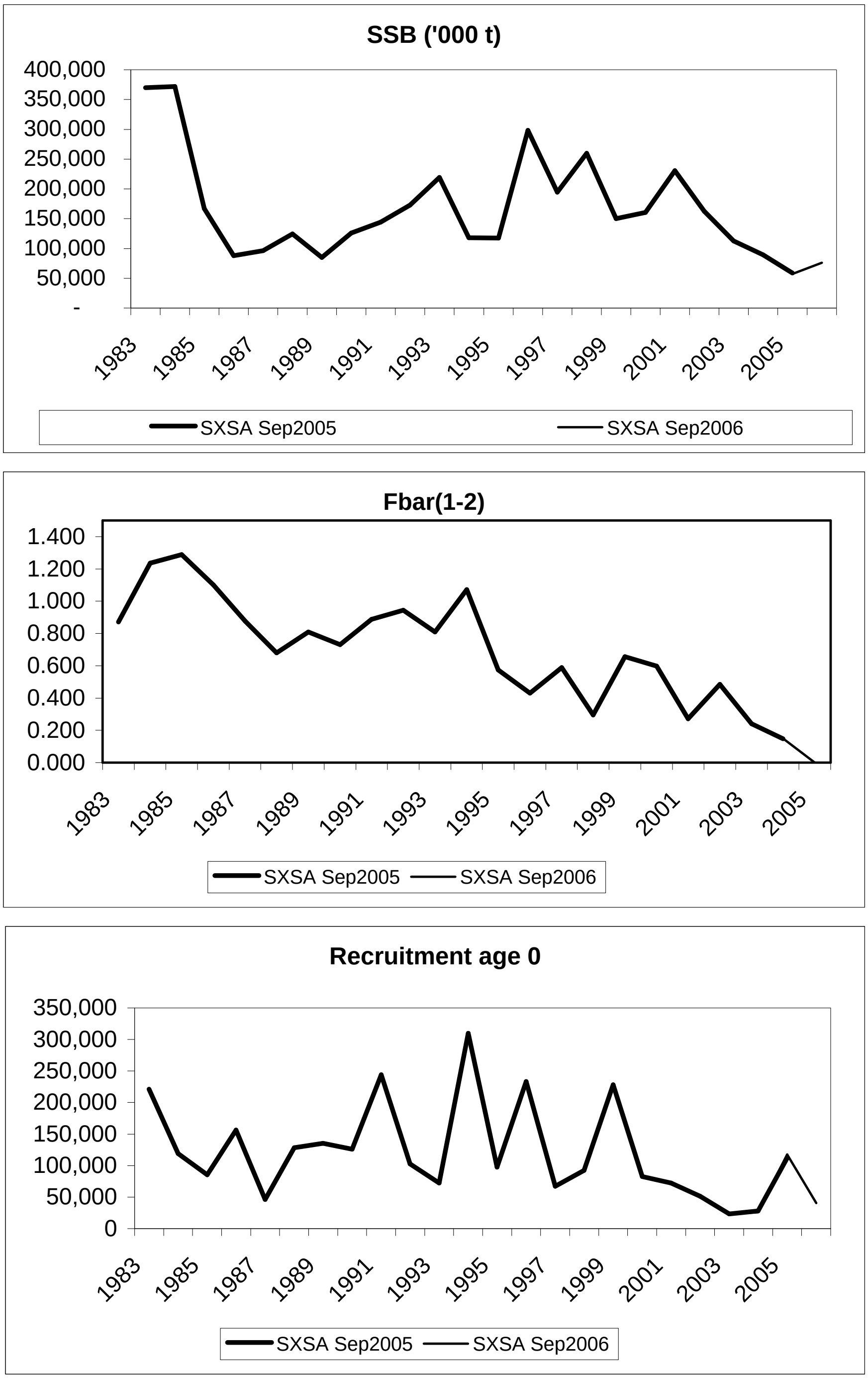


Figure 5.3.8 Norway pout IIIa and IV. Comparison of Sept. 2006 SXSA baseline assessment with SXSA Sept. 2005 baseline assessment.

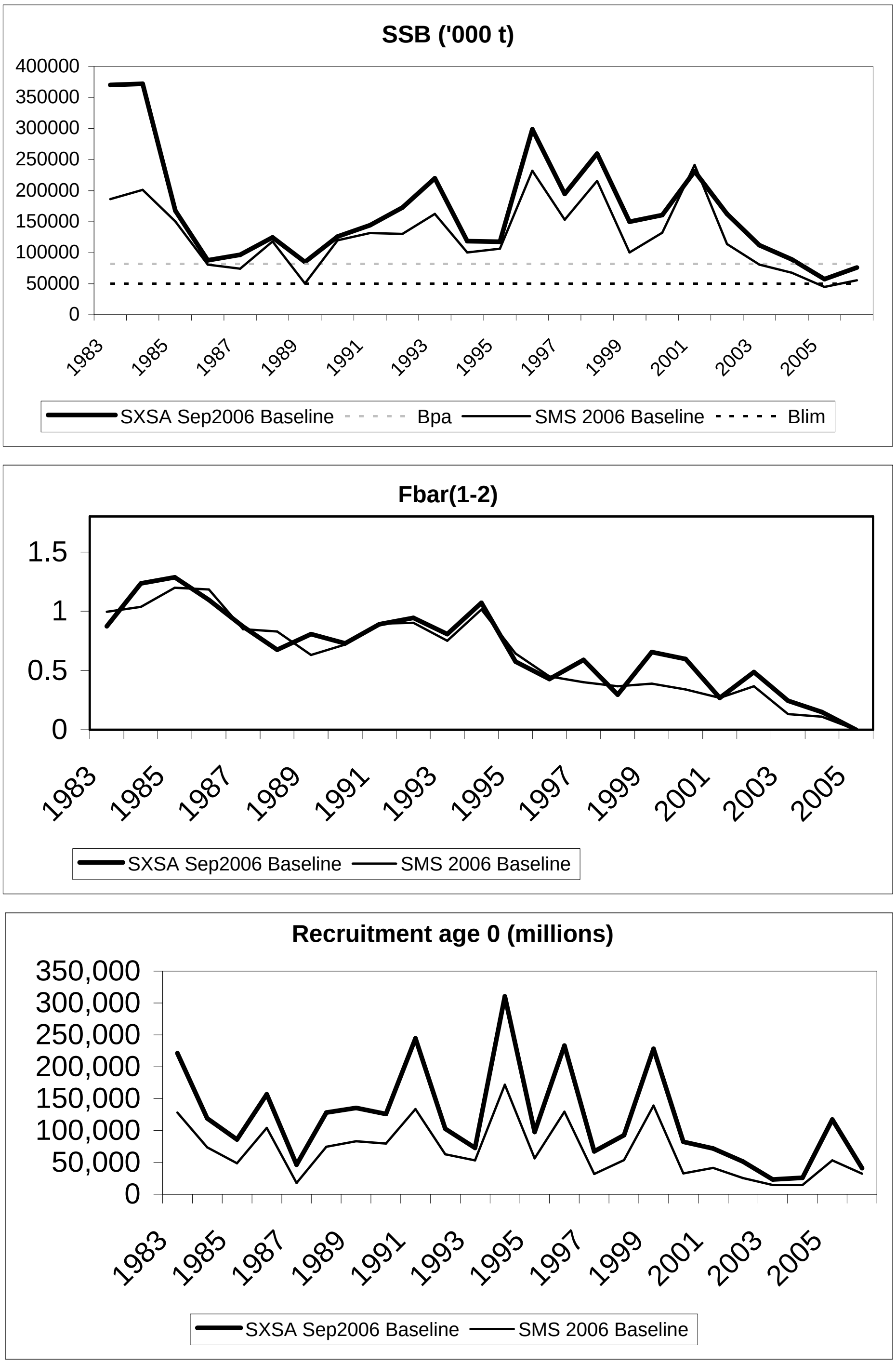


Figure 5.3.9 Norway pout IIIa and IV. Comparison of September 2006 SXSA baseline assessment with SMS September 2006 baseline assessment.

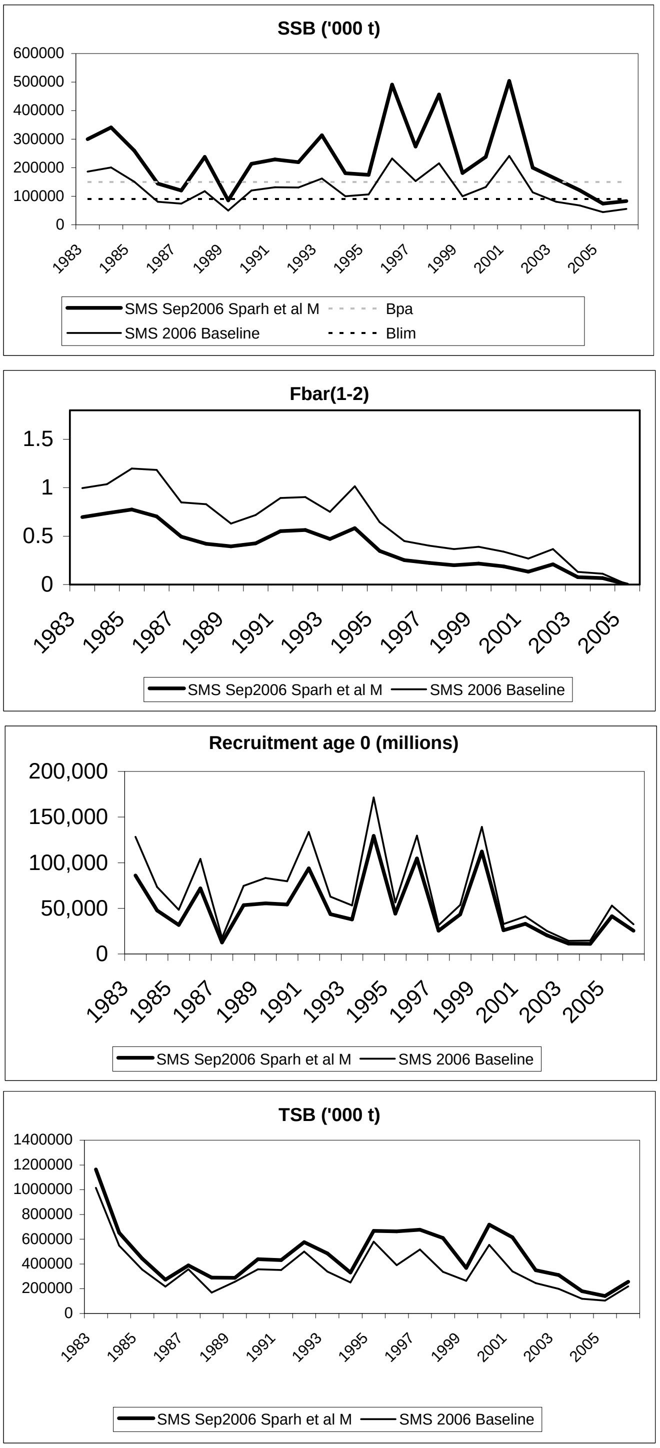


Figure 5.3.10 Norway pout IIIa and IV. Comparison of SMS baseline assessment (standard M) with SMS using M from Sparh et al M assessment. (September 2006 assessment).

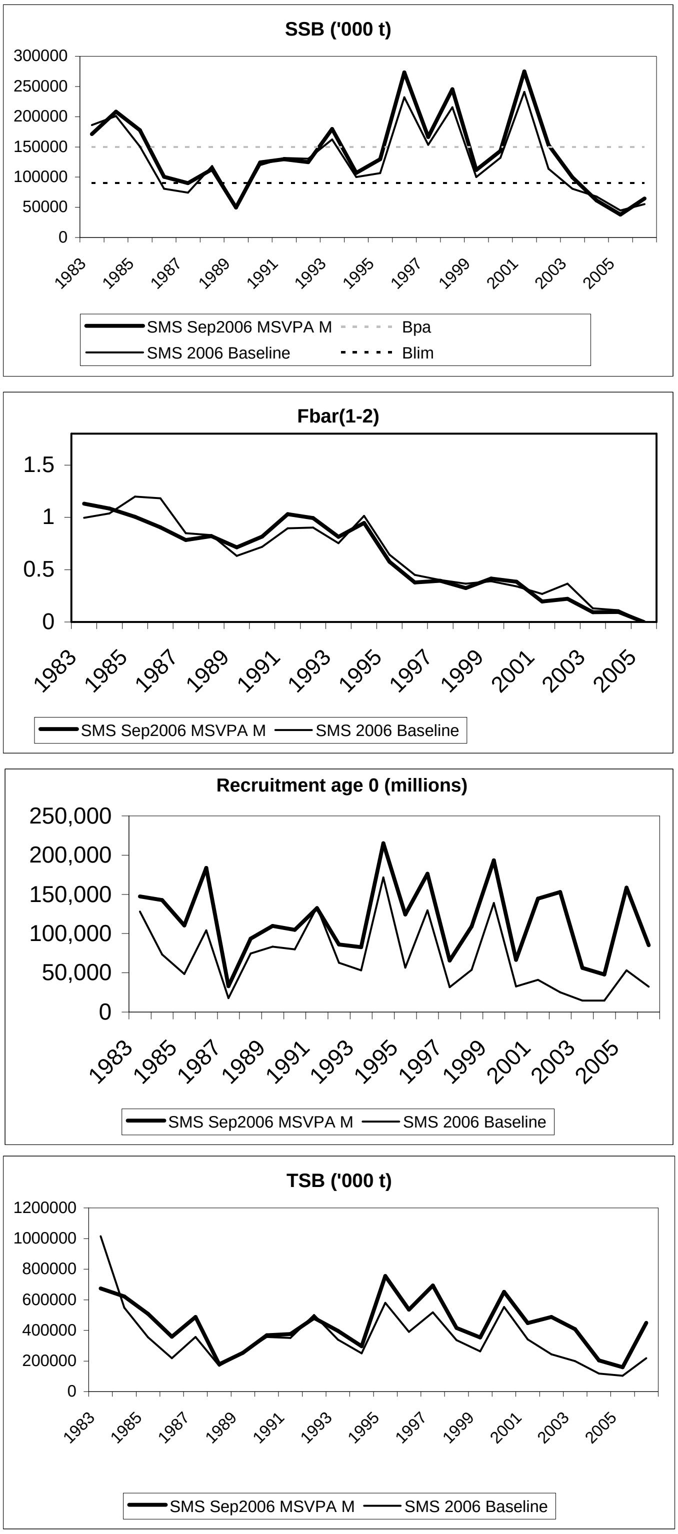


Figure 5.3.11 Norway pout IIIa and IV. Comparison of SMS baseline assessment (standard M) with SMS assessment using M from MSVPA. (September 2006 assessment).

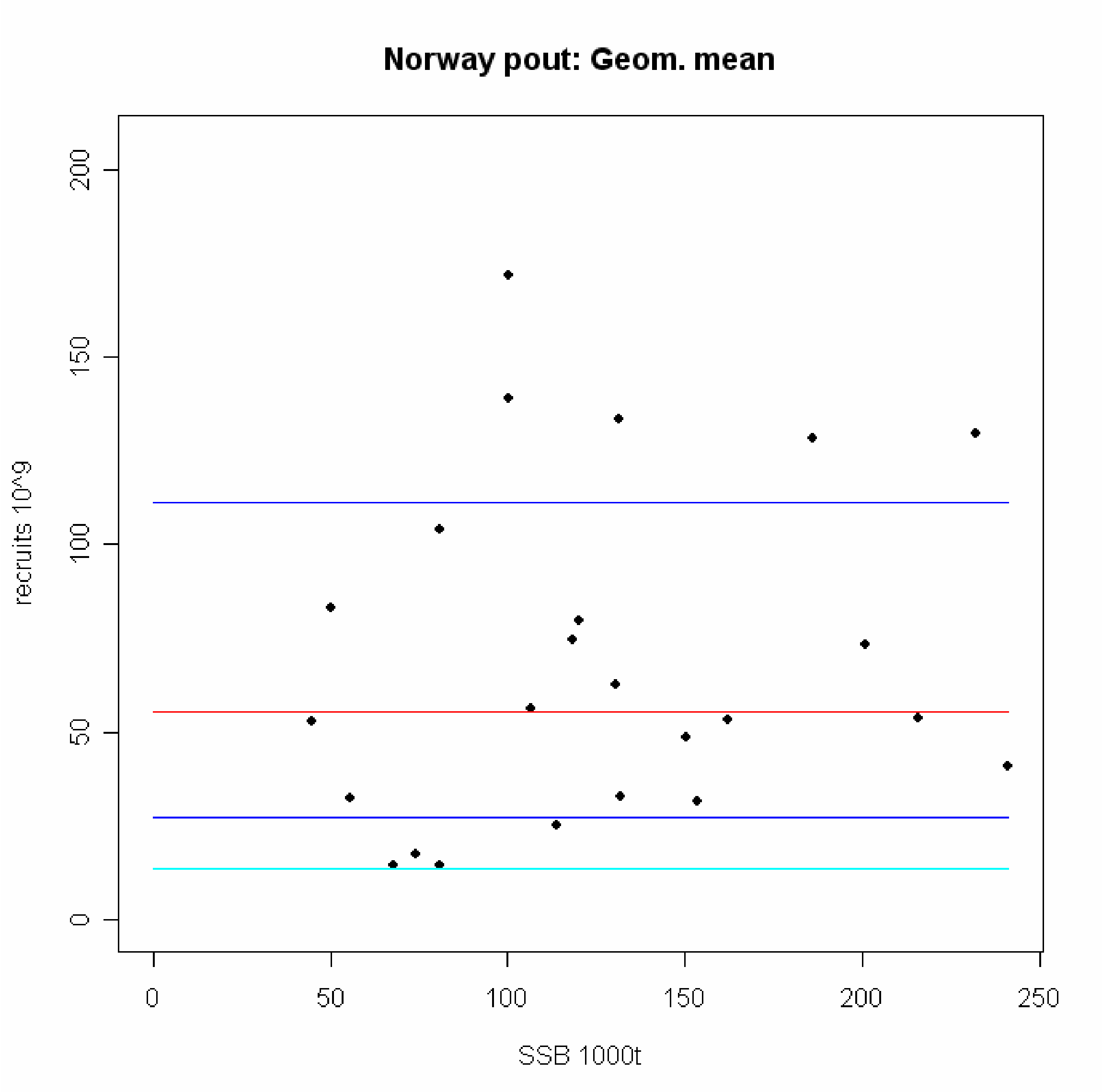


Figure 5.8.1 Plots of SSB versus Recruitment showing basis for using the geometric mean and periodical patterns in the relationship. (From the SMS assessment using Std M (baseline))

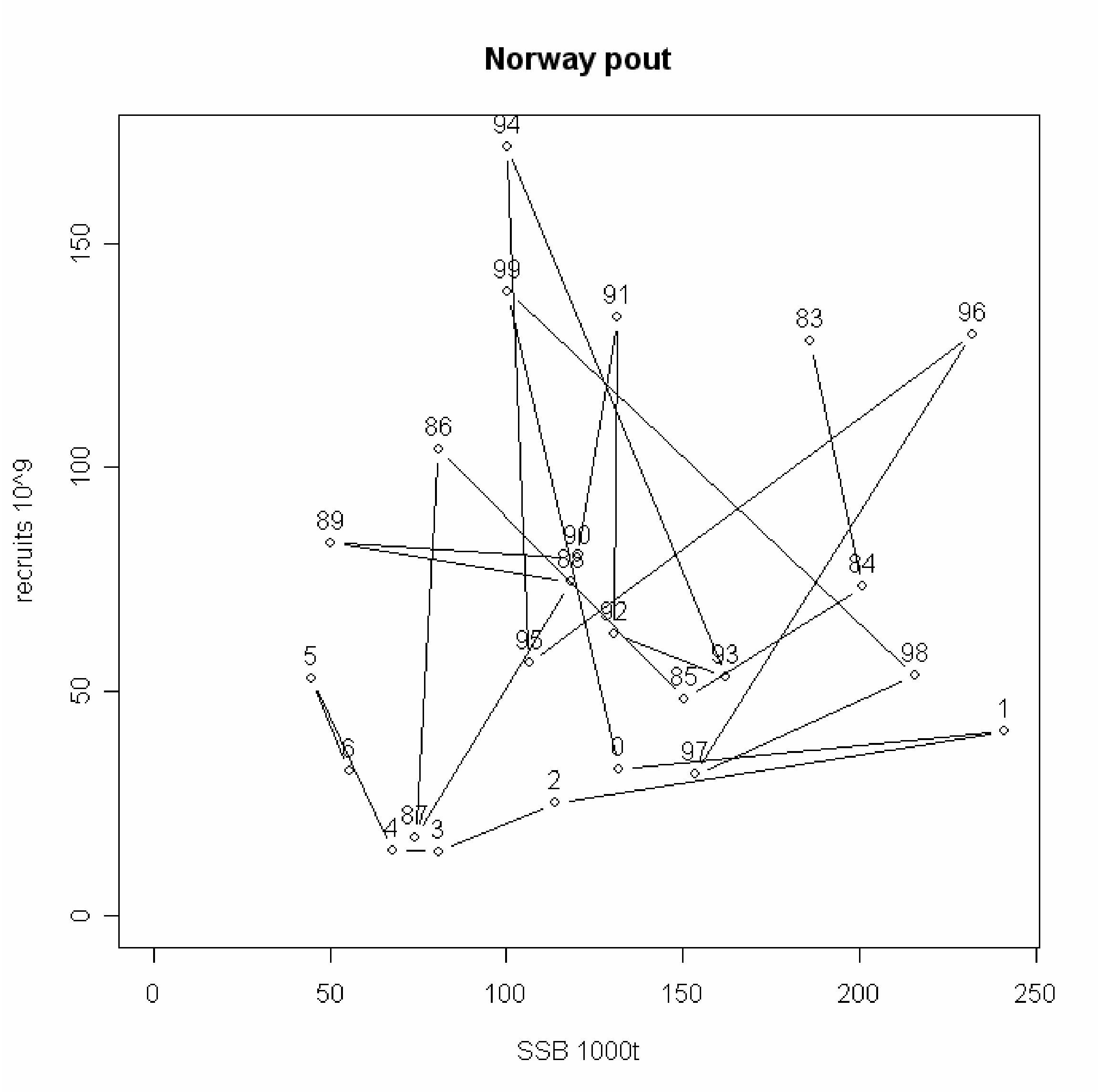


Figure 5.8.1 (Cont'd)

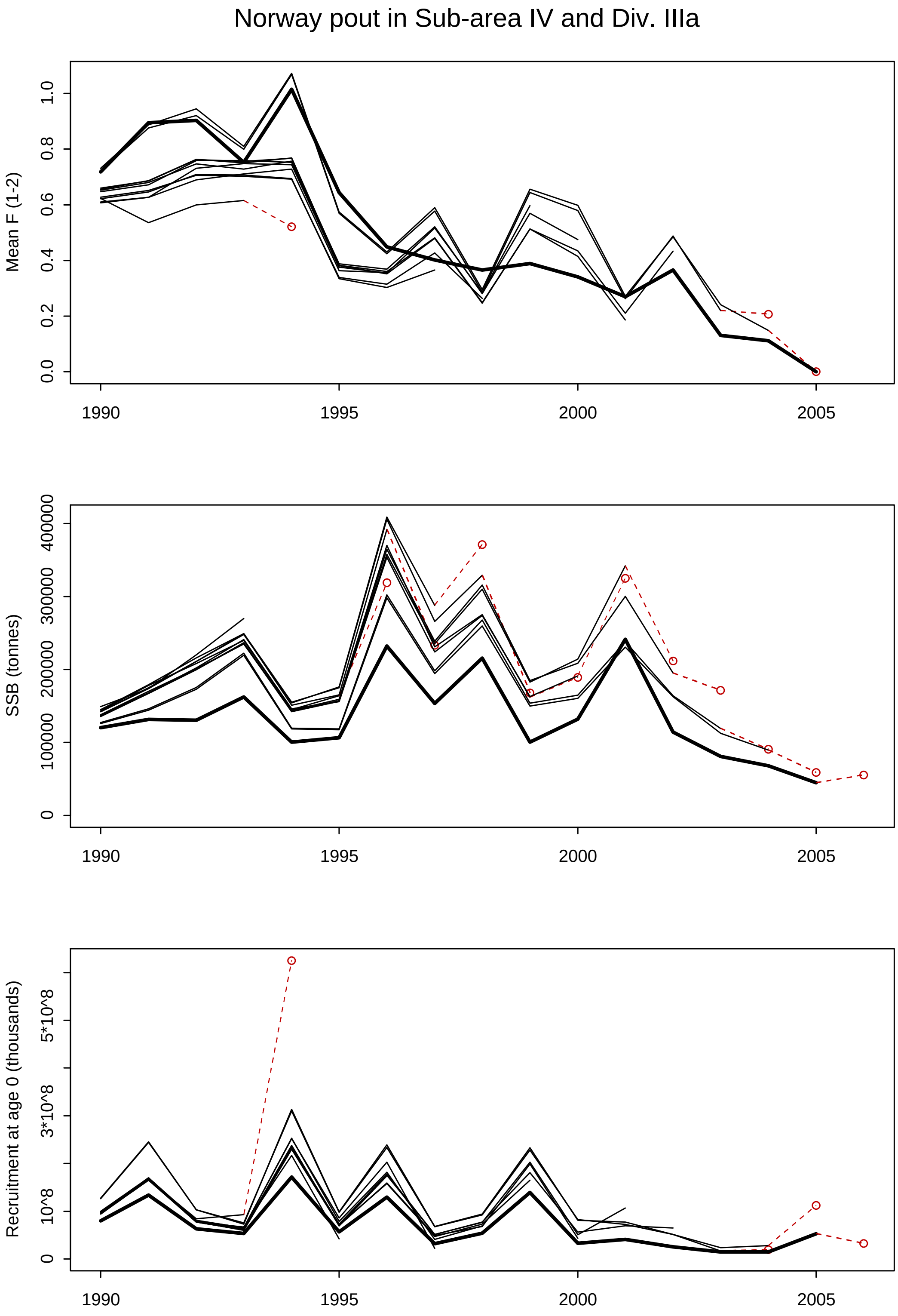


Figure 5.9.1 Norway pout. Historical performance of the assessment. Circles indicate forecasts.

6 PLAICE IN DIVISION VIId

This assessment of plaice in Division VIId is an update assessment. All the relevant biological and methodological information can be found in the Stock Annex dealing with this stock.

6.1 General

6.1.1 Ecosystem aspects

No information on ecosystem aspects was available to the Working Group. It may be appropriate to investigate whether and how the exchange of the Channel stock with the North Sea is driven by environmental factors, but this has not been done during this meeting.

6.1.2 Fisheries

Plaice is mainly caught in beam trawl fisheries for sole or in mixed demersal fisheries using otter trawls. There is also a directed fishery during parts of the year by inshore trawlers and netters on the English and French coasts, where the main fleet segments are the English and Belgian beam trawlers. The Belgian beam trawlers fish mainly in the 1st (targeting spawning concentrations in the central Eastern Channel) and 4th quarter and their area of activity covers almost the whole of Division VIId south of the 6 mile contour off the English coast. There is only light activity by this fleet between April and September. The second offshore fleet consists mainly of French large otter trawlers from Boulogne, Dieppe. The target species of these vessels are cod, whiting, plaice, mackerel, gurnards and cuttlefish and the fleet operates throughout Division VIId. The inshore trawlers and netters are mainly vessels <10m operating on a daily basis within 12 miles of the coast. There are a large number of these vessels (in excess of 400) operating from small ports along the French and English coast. These vessels target sole, plaice, cod and cuttlefish. The latter two groups are active when plaice is spread over Division VIId and IVc.

The first quarter is usually the most important for the fisheries but the share of the landings for this quarter has been decreasing from the early 1990s to a value around 30 – 35% of the total recently. In 2005, the beginning of the year still remains slightly predominant with the first semester corresponding to 56% of the total landings (see text table below).

QUARTER	LANDINGS	CUM. LANDINGS	CUM. %
I	1130.8	1130.8	33
II	814.9	1945.7	56
III	659.9	2605.6	76
IV	840.6	3446.2	100

Age distributions (exploitation pattern) may be quite different between quarters, as shown for 2005 in Figure 6.1.2.1, with older fish being caught in quarter I.

6.1.3 ICES advice

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

- No explicit management plans are settled for this stock.

ICES-ACFM (2005) stated:

No short-term forecasts can be provided. There is conflicting information, some information suggests that the stock is stable and some information suggests that the stock is declining.; as a minimum measure there should be no increase in effort.

The state of the stock cannot be assessed due to discrepancies in the data. The most recent estimates have shown a divergent perception of the historical trends between the catch-at-age based analyses and the survey-based analyses. This divergence seriously affects the trends of the last 5 years, leading to an uncertain assessment of the state of the stock. Possible stock identification problems may contribute to divergence between catch and survey data.

Mixed fisheries considerations

Fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel)

should in 2005 and 2006 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- *with minimal bycatch or discards of cod;*
- *Implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised;*
- *within the precautionary exploitation limits for all other stocks.*

6.1.4 Management

No explicit management plans are in force for this stock.

The TAC in both 2005 and 2006 was set to 5151 t for the combined ICES Divisions VIIde.

The minimum landing size for plaice is 27 cm, not in accordance with the minimum mesh size of 80 mm which is permitted to catch plaice in beam and otter trawling. Fixed nets are required to use 100-mm mesh since 2002 although an exemption to permit 90 mm has been in force since that time.

An EU regulation that was enforced in 2004 set a limit of 22 days at sea per month for trawlers with mesh size less than 99 mm, 14 days at sea for beam trawlers, and gillnetters have a derogation of 20 days at sea in the Eastern Channel provided that their mesh size is less than 110 mm (see Section 1.2.1). Days-at-sea restrictions for beam trawlers were lifted for 2006.

For 2006 Council Regulation (EC) N°51/2006 allocates different days at sea depending on gear, mesh size and catch composition. (see Section 1.2.1 for complete list). The days at sea limitations for the major fleets operating in sub-area VI can be summarised as follows: Trawls or Danish seines can fish between 103 days per year and a unlimited number of days per year. Beam trawlers have an unlimited number of days permit. Gillnets are allowed to fish 140 days per year and Trammel nets between 140 and 205 days (see Section 1.2.1).

6.2 Data available

6.2.1 Catch

Landings data as reported to ICES together with the total landings estimated by the Working Group are shown in Table 6.2.1.1. From 1992 to 2002, the landings have remained steady between 5100 t and 6300 t. The 2005 landings of 3446 t represent a third year of substantial decrease. As usual, France with roughly 60% contributed the largest share of the total landings in 2005, followed by Belgium and UK.

Routine discard monitoring has recently begun following the introduction of the EU data collection regulations. Discards data for 2005 are available from all the countries contributing to the landings (Tables 6.2.1.2 and 6.2.1.3, and Figure 6.2.1.1) though sampling levels are not high. The percentage discarded per period, metier and country (Table 6.2.1.3, Figure 6.2.1.1) is highly variable and in every case substantial. In a total number of trips sampled of 31 and 7 respectively, the trawlers have discarded 50% and the gillnetters 46% of their catch in numbers over the year. Where blinders are used, the amount of discards is elevated (Figure 6.2.1.2), as can be expected. However, nothing is known about the extent to which these (illegal) devices are being employed. The time series of dicards is not long enough to be used in analytical assessment.

6.2.2 Age compositions

Age compositions of the landings are presented in Table 6.2.2.1. The age distributions in landings per quarter are given in Figure 6.1.2.1. Sampling levels for those countries providing age compositions are given in the general section (Table 1.3.1).

6.2.3 Weight at age

Weight at age in the landings is presented in Table 6.2.3.1 and Figure 6.2.3.1a,b. Weight at age in the stock in Table 6.2.3.2 and Figure 6.2.3.2. The procedure for calculating mean weights is described in the Stock Annex (Q6).

6.2.4 Maturity and natural mortality

Information about maturity per age class is given with the table included in this section. With an age of three years more than 50 percent and with an age of four years 96 % of the plaice are mature. The natural mortality is assumed at a fixed value of 0.1 through all ages.

Age	1	2	3	4	5	6	7	8	9	10
Proportion of mature individuals	0	0.15	0.53	0.96	1	1	1	1	1	1

6.2.1 Catch, effort and research vessel data

Effort and CPUE data are available from three commercial fleets (Figure 6.2.5.1). These are:

- UK Inshore Trawlers
- Belgian Beam Trawlers
- French trawlers

The survey series consist of:

- UK Beam Trawlers
- French Gillnet fishers
- International Young fish survey.

All survey and commercial data available for calibration of the assessment are presented in Tables 6.2.5.1 and fully described in the Stock Annex (Q6). Effort of the UK inshore fleet has dropped sharply within the last decade. Commercial CPUEs remain fairly stable, only the French trawler CPUE appears to go down (see Figure 6.2.5.1).

Comparison of age-wise CPUEs through all tuning series (Figure 6.2.5.2) shows, in general, rather moderate agreement.

6.3 Data analyses

Although it is an update assessment, a series of exploratory analyses have been carried out to examine the effect of statistical shrinking and the respective performance of the various tuning fleets. In the following sections, the catch at age matrix and the tuning fleets are examined, plus an analysis of a survey-based assessment with SURBA which does not use commercial CPUE.

6.3.1 Reviews of last years assessment

In 2005, RGNSSK stated:

1. *Discards, though high (from 30 to 90%), are not included in the assessment. A catch-at-age model may not be appropriate in this case until discard information is taken into account for the time series. For tuning purposes, information from 3 commercial fleets and 3 surveys were available.*
2. *The RG noted that the SPALY shows residual patterns. In addition there is a retrospective bias pattern in SSB (upward revision) and F (downward revision). The SURBA exploratory analysis also highlights data problems (consistency within the surveys is only good for the UK GFS). The RG suggests that the WG explore information regarding the seasonal and spatial dynamics of plaice in relation to the timing of the survey.*
3. *The RG suggested the WG look at inconsistencies between the adopted maturity ogive for plaice in contiguous area (plaice NS and plaice VIId).*
4. *The RG agreed that there was no firm basis to provide a final assessment. The RG suggests that until discard data is available and stock ID is clarified (Report Sec 1.1.1), the WG could further explore survey-based assessment and ST forecasts from the output of this approach.*

These four issues were addressed by the working group in the following way.

1. Discards were examined but the time series is too short.
2. and 3. There was no direct French participation in the WG, thus no original data available.
4. Survey-based assessments have been explored in section 6.3.

6.3.2 Exploratory catch-at-age-based analyses

The level of shrinking does have a visible, though not drastic effect on retrospective performance (Figure 6.3.2.1). Single fleet retrospective analysis shows hardly any pattern for the UK inshore and Belgian BT commercial fleets, but considerable retrospective noise for the remaining tuning series. In the case of the UK BT Survey and the French GF survey, this reaches far back in time (Figure 6.3.2.2).

The log catch ratio residuals of the separable VPA (Figure 6.3.2.3) show no special pattern nor large values for the recent years of data, which suggests a relative consistency of the catch-at-age matrix.

The log catchability residuals from single fleet Laurec-Shepherd tuning model (with settings as in XSA, apart from shrinking at 2.0) are shown Figure 6.3.2.4a for the six fleets used for calibration. The residuals from the two surveys covering the entire geographical area of the stock (UK BTS and French GFS) are increasing from the mid 90’s, indicating a progressive divergence with the landings at age. While less clear-cut, the commercial series also show a concentration of positive residuals in the last decade.

The log q residuals from the joint fleets in XSA (shrinking at 0.5, default settings without tapered time weighting) are given in Figure 6.3.2.4b. They give practically the same impression. Figure 6.3.4.2 gives the contributions of the different fleets to the XSA estimates at age. Retrospective analyses are summarised in Figure 6.3.4.3, which shows considerable noise.

6.3.3 Exploratory survey-based analyses

The survey-based analysis was carried out with SURBA software, the results being shown in Figures 6.3.3.1 - 6 . The parameters used for this exercise are a smoothing coefficient lambda set to 1.0 and a reference age set to 4, the range of F values for calculating the mean being 2 to 6 like the XSA analysis. The SURBA analysis has been proven to be unsensitive to the choice of the initial parameters in the neighborhood of those chosen here (ICES-WGNSSK 2005). Figures 6.3.3.1 and 6.3.3.2 show a good performance of the UK beam trawl survey for tracking year classes through time and accordingly good internal consistency (Figure 6.3.3.4). This is very different from the French GFS, which exhibits rather erratic patterns and has a low internal consistency (Figures 6.3.3.4).

The retrospective analysis (Figure 6.3.3.6) does not show the tendency of underestimating F and overestimating SSB as seen in the outcome of the XSA model (Figure 6.3.4.3). The confidence interval around mean Z is relatively narrow, suggesting that the fishing mortalities perceived by the surveys are consistent throughout the time series. The retrospective SSB is very smooth. However, the retrospective recruitment gives no useful information at all due to very high uncertainty on the first estimate of the time series.

6.3.4 Conclusions

Both, the XSA analyses and the SURBA run (Figure 6.3.4.1) show a plateau for SSB since 1995. The SSB according to XSA was slightly decreasing while SURBA produced a rather increasing trend, which was also noted in last year’s analysis and was the reason for rejecting the final assessment. The parameters F and R showed erratic divergence between approaches. A number of other deficiencies or suspect features showed up in the analysis :

- Retrospective XSA shows noise or pattern, particularly for some single fleets
- There are trends in effort in a commercial tuning fleet
- One survey has very irregular age compositions.

Anecdotal evidence suggests that there is a decreasing trend in the contribution of the first quarter to the whole landings, where a fishery on the spawners takes place, yielding an age distribution different from the rest of the year. It is unknown whether there is major interannual variability in the immigration from the North Sea to these spawning grounds, which could distort any catch-based analysis. Any migration events taking place in the first quarter cannot be represented in the surveys in the second semester.

Discarding is known to take place and is substantial, but the year range of the data series is too short to make use of it in the analysis.

Both landings-at-age and tuning fleets information are highly dependent on the accuracy of the spatial declaration of the fishing activity as an important component of the fisheries operates on the borderline to ICES Division IVc.

At least some of these deficiencies should also affect the SURBA analysis; it is particularly the inability of the SURBA model to adequately estimate recruitment for this stock (Figures 6.3.3.6, 6.3.4.1) which makes the results doubtful.

6.3.5 Final assessment

No final assessment was carried out for this stock for the problems noted above. Survey-based analysis could not be shown to be a valid alternative to XSA. Problems with the French groundfish survey do affect both approaches and should be resolved.

6.4 Historic stock trends

The recent historic trends of the stock are diverging between methods, but recent trends are not strong. There is agreement between approaches that SSB was higher in the late 1980s, probably due to the strong 1985 year class. The 1996 year class, which was also a very strong one, did not really push up the SSB level in either approach, but only left a strong signal in survey indices.

6.5 Recruitment estimates

No recruitment estimates are available for this stock.

6.6 Short-term prognosis

No short-term prognosis is available for this stock.

6.7 Medium-term forcasts

No medium-term forecast is available for this stock.

6.8 Biological reference points

ICES CONSIDERS THAT:	**ICES PROPOSES THAT:**
B_{lim} = 5 600 t	B_{pa} = 8 000 t
F_{lim} = 0.54	F_{pa} = 0.45.
Technical basis	
B_{lim} ~ B_{loss} (= 5 584 t)	B_{pa} = 1.4 B_{lim}
F_{lim} = F_{loss}	F_{pa} = 5th percentile of F_{loss}; long-term SSB > B_{pa} and P (SSB_{MT} < B_{pa}) < 10 %

6.9 Quality of the assessment

The settings in the XSA assessment for the last two years are:

YEAR OF ASSESSMENT:	2005	2006
Assessment model:	XSA	XSA
Fleets:	UK Inshore Trawlers (age range: 2-10, 1985 onwards)	UK Inshore Trawlers (age range: 2-10, 1985 onwards)
	BEL Beam Trawlers (age range: 2-10, 1981 onwards)	BEL Beam Trawlers (age range: 2-10, 1981 onwards)
	FR Trawlers (age range: 2-10, 1989 onwards)	FR Trawlers (age range: 2-10, 1989 onwards)
	UK Beam Trawl Survey (age range: 1-6, 1988 onwards)	UK Beam Trawl Survey (age range: 1-6, 1988 onwards)
	French GFS (age range: 0-5, 1988 onwards)	French GFS (age range: 0-5, 1988 onwards)
	International YFS (age range: 0-1, 19887 onwards)	International YFS (age range: 0-1, 19887 onwards)
Age range:	1-10+	1-10+
Catch data:	1980-2004	1980-2005
Fbar:	3-6	3-6
Time series weights:	none	none
Power model for ages:	No	No
Catchability plateau:	Age 7	Age 7
Survivor est. shrunk towards the mean F:	5 years / 5 ages	5 years / 5 ages
S.e. of mean (F-shrinkage):	0.5	0.5
Min. s.e. of population estimates:	0.3	0.3
Prior weighting:	no	no

See also Sections 6.3.4 and 6.3.5.

For the historic performance of the assessment see Figure 6.9.1.

6.10 Status of the stock

The status of the stock is uncertain.

6.11 Management considerations

Managers should consider that stock identity of plaice in the Channel is unclear. The TAC is for Divisions VIId and VIIe combined. Plaice in VIIe is considered at risk of being harvested unsustainably and the current state of plaice VIId is unknown.

The plaice stock in VIId is mostly harvested in a mixed fishery with sole in VIId. Even if there exists a directed fishery on plaice that occurs in a limited period at the beginning of the year on the spawning grounds, plaice is mainly taken as by-catch by the demersal fisheries, especially targeting sole.

Due to the minimum mesh size (80 mm) in the mixed beam and otter trawl fisheries, a large number of undersized plaice are discarded. The 80 mm mesh size is not matched to the minimum landing size of plaice (27 cm). Measures taken specifically to sole fisheries will impact the plaice fisheries

A recommendation is made by the WG to study the stock identity of plaice in the North Sea and adjacent areas (see Section 1.7).

6.12 Comments

Suggested work plan for benchmark:

- Analyse the consistency and reliability of the tuning fleets (individual retrospective analysis, log catchabilities residuals, standardised CPUE, etc). Consider redefinition of the current tuning fleets (prior to the WG) and/or the integration of new ones. UK have provided beam-trawler data for this assessment but this new tuning fleet has not been used given that this was an update assessment.
- Integrate the ongoing discard estimation into the assessment.
- Investigate whether the problem of misreporting on sole could affect the reporting of plaice.
- Verify the consistency of the weights time series, with particular reference to the influence of an incorrect assumption about sex-ratios on mean weight calculations.
- Produce maps of catches per ICES rectangle for the recent years to investigate a possible shift in catch distribution.
- produce maps of distribution from the surveys
- Analyse the time series of quarterly landings for trend and interannual variation.

Review the French survey ageing information.

Table 6.2.1.1 Plaice in VIId. Nominal landings (tonnes) as officially reported to ICES, 1976-2004

Year	Belgium	Denmark	France	UK(E+W)	Others	Total reported	Un-allocated	Total as used by WG	Agreed TAC (5)
1976	147	1(1)	1439	376	-	1963	-	1963	
1977	149	81(2)	1714	302	-	2246	-	2246	
1978	161	156(2)	1810	349	-	2476	-	2476	
1979	217	28(2)	2094	278	-	2617	-	2617	
1980	435	112(2)	2905	304	-	3756	-1106	2650	
1981	815	-	3431	489	-	4735	34	4769	
1982	738	-	3504	541	22	4805	60	4865	
1983	1013	-	3119	548	-	4680	363	5043	
1984	947	-	2844	640	-	4431	730	5161	
1985	1148	-	3943	866	-	5957	65	6022	
1986	1158	-	3288	828	488 (2)	5762	1072	6834	
1987	1807	-	4768	1292	-	7867	499	8366	8.30
1988	2165	-	5688 (2)	1250	-	9103	1317	10420	9.96
1989	2019	+	3265 (1)	1383	-	6667	2091	8758	11.70
1990	2149	-	4170 (1)	1479	-	7798	1249	9047	10.70
1991	2265	-	3606 (1)	1566	-	7437	376	7813	10.70
1992	1560	1	3099	1553	19	6232	105	6337	9.60
1993	877	+(2)	2792	1075	27	4771	560	5331	8.50
1994	1418	+	3199	993	23	5633	488	6121	9.10
1995	1157	-	2598 (2)	796	18	4569	561	5130	8.00
1996	1112	-	2630 (2)	856	+	4598	795	5393	7.53
1997	1161	-	3077	1078	+	5316	991	6307	7.09
1998	854	-	3276 (23)	700	+	4830	932	5762	5.70
1999	1306	-	3388 (23)	743	+	5437	889	6326	7.40
2000	1298	-	3183	752	+	5233	781	6014	6.50
2001	1346	-	2962	655	+	4963	303	5266	6.00
2002	1204		3454	841		5499	278	5777	6.70
2003	995	-	2783 (3)	756		4536	-	4536	6.00
2004	987		2439 (4)	580		4007	-	4007	6.06
2005	830		1756	411	20	3018	428	3446	5.15

1 Estimated by the working group from combined Division VIId+e
2 Includes Division VIIe
3 Provisional
4 Data provided to the WG but not officially provided to ICES
5 TAC´s for Divisions VII d, e.

Table 6.2.1.2 Plaice VIId. Length structure of discards and landings collected by observations on board (numbers raised to sampled trips).

Lg	Fr trawl			Fr Gillnet		UK		Belgium
	Discards Q2	Discards Q3	Discards Q4	Discards Q2	Discards Q3	Discards Q1	Discards Q2	Discards Year
	2 trips 8 hauls	11 trips 85 hauls	8 trips 71 hauls	4 trips 24 hauls	2 trips 9 hauls	1 trips 28 hauls	1 trips 21 hauls	8 trips 62 hauls
10								
11								
12								
13								
14	6							
15	26		22					2
16	6		0					12
17		7	51			37		49
18	15	8		2				83
19	11	73		16			2	134
20	47	93	17	14	1	37	10	243
21	32	93	1	20	1	68	22	344
22	17	111	17	30		93	47	565
23	34	71	47	30		196	86	917
24	51	115	78	19		206	90	1241
25	10	89	131	11	1	308	119	1575
26	13	46	120	9		203	230	1507
27	6	38	97	2		319	214	864
28		43	120	3		334	186	259
29			55			325	273	71
30			89			324	100	23
31			8			276	30	12
32			6			177	4	8
33						227		4
34						210		1
35						117		5
36		9				67	4	2
37						11	4	2
38								3
39								2
40							4	0
41								
42							4	
43								
44								
45								
46								
47								
48								
49								
50								
51								
52								
53								
54								
55								
56								
57								
58								
59								
60								
61								
62								
63								

Table 6.2.1.2 (cont.)- Plaice VIId. Length structure of discards and landings collected by observations on board (numbers raised to sampled trips).

Lg	Fr trawl			Fr Gillnet		UK		Belgium
	Landings Q2	Landings Q3	Landings Q4	Landings Q2	Landings Q3	Landings Q1	Landings Q2	Landings Year
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22		13						
23		13						
24	1	28	3					
25	13	23	12					5
26	23	130	6	4	1		9	33
27	37	78	12	20		4	169	937
28	38	34	20	6	1	11	321	1399
29	35	99	32	16	2	24	340	1545
30	25	80	58	40	2	37	240	1563
31	21	16	108	5	1	62	230	1205
32	17	100	53	21		85	207	1065
33	10	17	24	5		109	157	874
34	5	14	27	8	2	98	108	650
35	3	68	23	2		72	103	575
36	4	7	30	3		57	69	424
37	6	7	12	8		53	70	407
38	1	16		5		35	41	328
39	2	5	15	6		43	42	218
40		27	3	6		32	25	173
41	2	45	12	3		22	15	150
42		82	6	2		18	13	112
43		4	15	2		24	8	86
44	1	1	6	1		15	16	74
45		40	6	1		15	16	69
46		2		3		6	2	55
47		2	3	2		12	4	46
48		6	3	2		6	4	32
49						5		27
50		4	3			1		35
51		7		1		4	1	15
52		4				2	4	19
53		4				1	3	9
54		2	3				5	10
55			3			2	6	10
56		2					1	1
57						1		4
58							2	1
59								1
60								2
61								
62		2						
63								

Table 6.2.1.3. - Plaice VIId. Landings (L), discards (D) and percentage discards (%D) per period, métier and country in numbers raised to the sampled trips.

Period	Métier	Country	Numbers				%D
			Trips sampled	Hauls sampled	Landed	Discarded	
Quarter 1	Beam Trawl	UK	1	28	856	3532	80%
Quarter 2	Gillnet	France	4	24	173	156	47%
Quarter 2	Trawl	France	2	8	244	272	53%
Quarter 2	Beam Trawl	UK	1	21	230	1427	86%
Quarter 3	Gillnet	France	2	9	9	3	25%
Quarter 3	Trawl	France	11	86	982	795	45%
Quarter 4	Gillnet	France	1	6	1	0	0%
Quarter 4	Trawl	France	8	71	498	859	63%
2005	Beam trawl without blinder	Belgium	4	28	8069	3803	32%
2005	Beam trawl with blinder	Belgium	4	30	4090	4125	50%
2005	Gillnet	France	7	39	183	159	46%
2005	Trawl	France	21	165	1724	1926	53%
2005	Beam Trawl	UK	2	49	1086	4959	82%

Table 6.2.2.1 - Plaice VIId. Landings in numbers (thousands).

	1	2	3	4	5	6	7	8	9	10+
1980	53	2644	1451	540	490	75	45	44	4	103
1981	16	2446	6795	2398	290	159	51	42	56	200
1982	265	1393	6909	3302	762	206	96	62	21	88
1983	92	3030	3199	5908	931	226	92	122	4	101
1984	350	1871	7310	2814	1874	533	236	101	34	100
1985	142	5714	6195	4883	413	612	164	99	139	50
1986	679	4884	7034	3663	1458	562	254	69	19	34
1987	25	8499	7508	3472	1257	430	442	154	105	77
1988	16	5011	18813	4900	1118	541	439	127	105	174
1989	826	3638	7227	9453	2672	588	288	179	81	197
1990	1632	2627	8746	5983	3603	801	243	203	178	231
1991	1542	5860	5445	4524	2437	1681	286	120	113	125
1992	1665	6193	4450	1725	1187	1044	698	200	116	118
1993	740	7606	3817	1259	542	468	334	287	102	152
1994	1242	3633	6968	3111	850	419	312	267	275	312
1995	2592	4340	2933	2928	922	228	277	225	122	258
1996	1119	4847	3606	1547	1436	488	179	176	165	347
1997	550	4246	7189	3434	1080	752	464	199	114	306
1998	464	4400	8629	3419	537	143	136	81	52	188
1999	741	1758	12104	6460	1043	171	86	81	38	111
2000	1383	6214	4284	7241	1652	307	82	27	42	98
2001	2682	4159	4380	2141	1985	310	87	22	13	78
2002	902	7204	5191	1907	1565	888	234	62	25	92
2003	646	4874	5668	1864	424	373	333	75	50	62
2004	967	4964	5471	894	389	152	133	133	38	48
2005	324	3080	3876	2282	461	195	107	88	68	48

Table 6.2.3.1 - Plaice in VIId. Weights in the landings.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
1980	0.309	0.312	0.499	0.627	0.787	1.139	1.179	1.293	1.475	1.557
1981	0.239	0.299	0.373	0.464	0.712	0.87	0.863	0.897	0.992	1.174
1982	0.245	0.271	0.353	0.431	0.64	0.795	1.153	1.067	1.504	1.355
1983	0.266	0.296	0.349	0.42	0.542	0.822	0.953	1.144	0.943	1.591
1984	0.233	0.295	0.336	0.402	0.508	0.689	0.703	0.945	1.028	1.427
1985	0.254	0.278	0.301	0.427	0.502	0.57	0.557	1.081	0.849	1.421
1986	0.226	0.306	0.331	0.406	0.546	0.486	0.629	0.871	1.446	1.579
1987	0.251	0.282	0.36	0.477	0.577	0.783	0.735	1.142	1.268	1.515
1988	0.292	0.268	0.321	0.432	0.56	0.657	0.77	0.908	1.218	1.328
1989	0.201	0.268	0.321	0.37	0.473	0.648	0.837	0.907	1.204	1.519
1990	0.201	0.256	0.326	0.378	0.483	0.61	0.781	0.963	1.159	1.31
1991	0.225	0.277	0.311	0.39	0.454	0.556	0.745	1.087	0.924	1.602
1992	0.182	0.277	0.352	0.429	0.509	0.585	0.701	0.837	0.85	1.195
1993	0.22	0.272	0.336	0.432	0.507	0.591	0.741	0.82	0.934	1.156
1994	0.243	0.27	0.288	0.356	0.466	0.576	0.686	0.928	0.969	1.287
1995	0.218	0.271	0.313	0.39	0.485	0.688	0.612	0.806	1.15	1.298
1996	0.221	0.3	0.29	0.396	0.475	0.643	0.764	0.934	1.057	1.312
1997	0.199	0.252	0.298	0.332	0.442	0.577	0.801	0.894	1.055	1.395
1998	0.159	0.244	0.267	0.381	0.502	0.762	0.839	0.981	0.986	1.379
1999	0.197	0.245	0.235	0.306	0.461	0.751	0.768	0.868	0.885	1.508
2000	0.182	0.256	0.314	0.37	0.44	0.607	0.768	0.972	0.975	1.193
2001	0.215	0.252	0.303	0.37	0.447	0.642	0.876	1.008	1.144	1.223
2002	0.254	0.256	0.309	0.376	0.438	0.562	0.627	0.880	0.909	1.330
2003	0.254	0.268	0.271	0.363	0.556	0.643	0.624	0.85	0.972	1.205
2004	0.217	0.243	0.295	0.421	0.483	0.61	0.636	0.933	1.093	1.348
2005	0.21	0.263	0.293	0.36	0.527	0.536	0.753	0.778	0.82	1.014

Table 6.2.3.2 -Plaice in VIId. Weight in the stock.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
1981	0.11	0.216	0.317	0.414	0.506	0.594	0.677	0.756	0.83	1.042
1982	0.105	0.208	0.308	0.406	0.502	0.596	0.687	0.776	0.862	1.118
1983	0.097	0.192	0.286	0.379	0.47	0.56	0.648	0.735	0.821	1.169
1984	0.082	0.164	0.248	0.333	0.42	0.507	0.596	0.686	0.777	1.086
1985	0.084	0.171	0.259	0.348	0.44	0.533	0.628	0.725	0.824	1.206
1986	0.101	0.205	0.311	0.42	0.532	0.646	0.763	0.882	1.004	1.313
1987	0.122	0.242	0.361	0.479	0.596	0.712	0.826	0.939	1.051	1.306
1988	0.084	0.168	0.254	0.34	0.427	0.514	0.603	0.692	0.783	0.952
1989	0.079	0.162	0.25	0.342	0.439	0.541	0.648	0.759	0.874	1.211
1990	0.085	0.23	0.322	0.346	0.465	0.549	0.748	0.899	0.979	1.766
1991	0.065	0.219	0.275	0.335	0.375	0.472	0.633	1.057	1.022	1.502
1992	0.088	0.241	0.336	0.421	0.477	0.521	0.634	0.713	0.741	1.229
1993	0.108	0.258	0.296	0.379	0.493	0.539	0.573	0.699	0.787	1.056
1994	0.165	0.198	0.276	0.331	0.383	0.493	0.603	0.903	0.781	1.15
1995	0.058	0.257	0.286	0.354	0.442	0.707	0.531	0.703	1.092	1.194
1996	0.178	0.229	0.263	0.347	0.354	0.474	0.536	0.907	0.958	1.126
1997	0.059	0.202	0.256	0.266	0.417	0.53	0.665	0.686	0.972	1.364
1998	0.072	0.203	0.273	0.361	0.53	0.67	0.629	0.656	0.915	1.107
1999	0.072	0.172	0.213	0.351	0.429	0.644	0.76	0.782	0.593	1.166
2000	0.068	0.184	0.204	0.246	0.355	0.554	0.693	0.817	0.89	1.131
2001	0.093	0.206	0.274	0.338	0.404	0.624	0.844	0.989	1.153	1.405
2002	0.102	0.206	0.281	0.379	0.467	0.558	0.610	0.759	1.053	1.250
2003	0.103	0.191	0.249	0.33	0.496	0.492	0.548	0.748	0.662	0.982
2004	0.172	0.183	0.268	0.408	0.471	0.521	0.616	0.892	1.102	1.287
2005	0.096	0.201	0.269	0.308	0.47	0.492	0.707	0.629	0.814	0.89

Table 6.2.5.1. - Plaice in VIId. Tuning fleets.

Plaice in Division VIId (Eastern English Channel) (run name: XSAAEDB01/X01)
FLT01: UK INSHORE TRAWL METIER <40 trawl lands all trawl age comps fleet (Catch: Unknown)
1985 2005, 1 1 0 1
2 10

2520	618.3	419.7	221.1	18.8	0	0	0	19	0
1804	237.9	300.2	132.9	51.6	6.5	4.7	2.9	0	0
2556	456	430.2	153.2	48	25.1	5	6.3	4.3	0
2500	382.4	856.1	141.7	57.8	30.1	14.1	2.8	4	5.2
2131	47.4	221.7	465.4	97.1	41.3	19	5.5	1.2	6.2
1094	34.3	92.1	52.6	56.9	18	7.5	5.5	3.6	3.1
2349	240.2	229.7	166.6	76.6	64.9	10.7	4.3	2.1	1.3
2527	298	225.5	140.4	77.8	55.3	44.2	14.6	2.9	2.4
2503	309.3	181.4	66.6	40.5	30.1	21.5	25.1	8.5	3.8
2635	176	240.2	99.7	37.8	21	17	8.9	17.9	3.5
1531	124.1	70.7	54.6	23.5	8.5	5	5.5	3.9	6.8
1659	274.4	63.8	16.9	19.1	10	2.5	3.1	2.5	2.5
2024	317.1	223.8	20.4	7.7	10.2	8	4.9	2.8	4
813	104.3	77.7	27.6	3.7	1.7	3.9	1.4	1.2	0.3
861	53.4	222.2	27	8.7	1.2	0.4	1.4	0.5	0.4
652	75	46	81.3	13.8	4.5	1.1	0.5	1	0.4
493	29.5	21.4	13.8	17.6	3.3	0.9	0.6	0.2	0.2
608	120.3	77.2	17.2	8.5	14.7	2.2	1.5	0.3	0.2
653	216.9	46.4	24.9	5.1	4.1	6.9	5.1	0.3	0.3
661	84.6	127.5	13.5	5.4	2.3	1.9	3.8	1.7	0.5
235	52.2	23.0	19.3	2.4	1.8	0.5	0.4	1.1	0.2

FLT02: BELGIAN BEAM TRAWL(HP corr) all gears age comp (Catch: Unknown)
1981 2005, 1 1 0.00 1.00
2 10

24.4	285.9	1126.5	593.3	67.3	21.6	8.3	7.1	13.3	14.1
29.8	147.8	1065.4	688.2	187.2	55.1	21.1	6.5	4.6	4.0
26.4	476.7	654.3	1384.5	165.0	52.2	23.0	31.6	1.3	1.4
35.4	92.0	1570.4	712.1	467.5	134.3	61.0	28.2	5.4	6.8
33.4	557.2	1125.3	1115.1	93.9	197.2	52.9	31.9	5.3	6.1
30.8	700.6	1141.8	667.8	269.9	145.9	60.3	11.3	5.6	6.4
49.3	1944.8	1639.7	889.0	343.1	92.7	154.5	41.1	28.0	14.1
48.9	773.0	4264.6	1301.8	237.1	109.9	113.2	35.8	25.4	24.0
43.8	73.6	1733.7	2950.5	973.4	212.8	113.1	61.1	21.7	0.1
38.5	372.1	2687.5	1942.8	1007.0	184.8	43.9	50.5	13.1	14.0
32.8	595.4	1689.2	1149.4	1089.5	698.4	86.9	36.0	58.9	1.7
30.9	889.8	1031.7	403.8	277.6	282.1	159.7	58.2	60.7	6.7
28.2	488.8	684.2	274.3	197.6	121.6	74.7	62.8	10.6	19.3
32.8	424.6	1259.2	1426.5	268.0	132.6	109.5	75.5	90.0	37.6
31.7	39.8	591.9	925.2	396.5	82.0	140.1	82.6	26.1	0.7
32.6	259.3	689.3	541.5	503.7	137.6	46.4	49.9	38.4	44.4
39.7	0.0	287.3	931.8	570.2	295.7	143.7	37.3	27.7	11.2
23.6	164.6	900.7	616.6	122.0	39.0	40.0	18.2	18.4	13.7
27.6	40.7	1687.7	1366.6	370.5	67.5	25.4	13.5	14.0	12.7
37.0	60.4	369.7	529.0	235.4	43.4	12.1	5.9	10.4	1.5
40.2	422.6	1759.9	1085.0	705.3	119.4	26.5	9.3	7.6	26.9
41.1	412.7	1361.3	641.0	578.0	138.7	62.7	9.6	5.0	26.4
40.0	407.2	1194.7	581.6	144.0	176.8	130.8	25.0	18.2	24.9
39.1	317.8	1329.4	313.9	154.7	48.8	68.3	51.5	13.3	23.4
44.0	299.6	737.6	708.8	239.5	73.6	39.8	35.3	21.3	1.1

FLT03: FRENCH TRAWLERS (EFFORT H*KW*10-4) 1989-90 DERAISED 1991> TRUE (Catch: Unknown)
1989 2005, 1 1 0.00 1.00
2 10

6983	1190.1	1635.9	1643.2	466.2	73.5	34.3	34.1	19.3	16.1
8395	698.2	1876.1	1289.5	728.3	153.7	42.6	33.1	46.5	14.4
10689	1938.7	1474.1	1430.0	399.5	255.2	41.0	17.6	11.9	9.9
10519	1802.9	1396.1	370.2	269.4	230.7	143.5	21.2	12.1	11.6
10217	2124.4	1118.2	268.4	56.0	73.4	48.7	32.3	14.3	4.6
10609	1034.2	2271.2	476.4	177.6	69.5	48.2	48.3	32.0	25.0
12384	1354.7	686.5	578.5	95.4	21.4	19.5	27.5	21.8	28.2
14476	1133.3	1283.9	352.7	317.5	98.8	43.6	33.3	34.6	36.9
10921	1396.2	3536.0	1155.4	139.0	170.7	88.3	50.8	22.4	28.2
11707	1446.0	3541.9	1534.4	205.4	29.8	20.2	17.8	6.9	8.2
10625	1139.1	5654.6	2456	254.4	36.1	24.8	23.5	4.4	16.6
13779	2757.4	1634	3110.4	781.5	130.9	21.2	6.1	12.9	19.9
11376	2113.6	1726.3	663.1	642.5	81.3	21.6	1.4	1.2	16.4
13489	3130.4	1134.9	336.6	230.9	186.2	36.7	9.5	2.9	13.1
12647	1984.9	2715.5	701.5	129.6	82.8	75.1	17.8	16.3	11.2
9613	3107.1	2308.6	284.8	110.4	50.1	22.3	24.4	5.9	6.7
10419	1131.3	1428.8	652.9	63.1	37.1	22.4	15.1	10.6	8.9

Table 6.2.5.1 (continued) - Plaice in VIId. Tuning fleets.

FLT04: UK BEAM TRAWL SURVEY true age 6 [rev: 15/08/04-RM] (Catch: Unknown) (Effort: Unknown)
1988 2005, 1 1 0.50 0.75
1 6

1	26.5	31.3	43.8	7.0	4.6	1.5
1	2.3	12.1	16.6	19.9	3.3	1.5
1	5.2	4.9	5.8	6.7	7.5	1.8
1	11.8	9.1	7.0	5.3	5.4	3.2
1	16.5	12.5	4.2	4.2	5.6	4.9
1	3.2	13.4	5.0	1.7	1.9	1.6
1	8.3	7.5	9.2	5.6	1.9	0.8
1	11.3	4.1	3.0	3.7	1.5	0.6
1	13.2	11.9	1.3	0.7	1.3	0.9
1	33.1	13.5	4.2	0.6	0.3	0.3
1	11.4	27.3	7.0	3.1	0.3	0.2
1	11.3	14.1	15.9	2.9	1.0	0.2
1	13.2	21.0	14.4	13.8	3.5	0.9
1	17.9	13.0	10.0	7.1	10.9	1.9
1	20.7	15.9	7.7	3.5	1.8	3.5
1	6.2	22.8	6.0	2.9	1.6	0.8
1	36.2	15.0	13.2	3.4	0.9	0.2
1	10.8	31.2	13.8	10.3	2.9	1.2

FLT05: French GFS [option 2] true age 5 [rev: 01/09/04-JV] (Catch: Unknown) (Effort: Unknown)
1988 2005, 1 1 0.75 1.00
0 5

1	1.9	8.0	17.6	9.9	1.7	0.6
1	1.6	3.5	7.4	2.7	1.1	0.1
1	0.1	3.9	1.2	2.7	1.9	1.6
1	0.1	2.5	2.1	0.8	0.6	0.4
1	0.9	34.4	3.6	1.9	0.3	0.2
1	6.6	28.7	13.4	6.3	1.4	0.6
1	5.3	6.5	3.0	1.1	0.2	0.1
1	2.1	7.9	4.4	1.1	0.7	0.2
1	30.5	6.6	3.1	0.3	0.1	0.2
1	10.2	40.9	10.9	3.8	0.3	0.1
1	10.0	16.4	18.4	4.1	0.5	0.1
1	1.0	10.3	5.6	8.0	1.3	0.2
1	19.3	12.5	15.6	4.3	3.1	0.8
1	6.0	9.7	4.6	1.6	0.8	0.3
1	0.5	11.2	9.4	4.4	0.4	0.2
1	11.1	3.2	10.8	5.0	4.1	2.1
1	2.4	10.4	10.0	4.9	1.0	0.1
1	1.6	7.44	16.3	8.9	2.7	0.8

FLT06: Intl YFS [rev: 01/09/04-JV] (Catch: Unknown) (Effort: Unknown)
1987 2005, 1 1 0.50 0.75
0 1

1	11.68	1.44
1	5.56	1.32
1	3.97	0.58
1	3.42	0.71
1	4.36	0.62
1	4.04	1.78
1	3.70	0.84
1	8.69	0.79
1	6.87	1.68
1	4.07	0.66
1	2.23	0.82
1	5.30	0.8
1	3.81	0.76
1	5.14	0.48
1	3.74	0.83
1	0.67	0.92
1	4.86	0.65
1	4.83	0.78
1	2.19	0.17

Table 6.2.5.2 - Plaice in VIId. Tuning diagnostic.

```
Lowestoft VPA Version 3.1

    8/09/2006  11:14

 Extended Survivors Analysis

 Plaice in VIId (run: XSAAEDB01/X01)

 CPUE data from file fleet.dat

 Catch data for  26 years. 1980 to 2005. Ages  1 to  10.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 FLT01: UK INSHORE TR,   1985, 2005,   2,     9,   .000,  1.000
 FLT02: BELGIAN BEAM ,   1981, 2005,   2,     9,   .000,  1.000
 FLT03: FR TRAWLERS  ,   1989, 2005,   2,     9,   .000,  1.000
 FLT04: UK BTS (Surve,   1988, 2005,   1,     6,   .500,   .750
 FLT05: FR GFS (Surve,   1988, 2005,   0,     5,   .750,  1.000
 FLT06: Intl YFS (Sur,   1987, 2005,   0,     1,   .500,   .750


 Time series weights :

      Tapered time weighting not applied


 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    7


 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   5 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =    .500

      Minimum standard error for population
      estimates derived from each fleet =    .300

      Prior weighting not applied


 Tuning converged after   29 iterations

1


 Regression weights
       , 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000



 Fishing mortalities
    Age,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005

      1,  .039,  .015,  .033,  .045,  .088,  .139,  .042,  .037,  .046,  .056
      2,  .289,  .185,  .148,  .152,  .551,  .363,  .582,  .300,  .388,  .180
      3,  .549,  .797,  .607,  .664,  .583,  .849,  .927, 1.160,  .569,  .525
      4,  .680, 1.472, 1.024, 1.176,  .976,  .574, 1.031,  .931,  .481,  .436
      5,  .757, 1.394,  .868,  .920, 1.002,  .695,  .985,  .585,  .438,  .433
      6,  .509, 1.065,  .587,  .666,  .675,  .443,  .685,  .583,  .379,  .363
      7,  .401, 1.198,  .478,  .756,  .697,  .360,  .625,  .524,  .374,  .443
      8,  .640,  .930,  .591,  .517,  .497,  .355,  .417,  .367,  .362,  .403
      9,  .667, 1.025,  .586,  .540,  .491,  .420,  .766,  .618,  .286,  .283
```

Table 6.2.5.2 (continued) – Plaice in VIId. Tuning diagnostic.

1

XSA population numbers (Thousands)

AGE

YEAR	1	2	3	4	5	6	7	8	9
1996	3.04E+04	2.03E+04	8.97E+03	3.29E+03	2.84E+03	1.29E+03	5.70E+02	3.92E+02	3.56E+02
1997	3.77E+04	2.65E+04	1.38E+04	4.69E+03	1.51E+03	1.21E+03	6.99E+02	3.45E+02	1.87E+02
1998	1.50E+04	3.36E+04	1.99E+04	5.61E+03	9.73E+02	3.39E+02	3.76E+02	1.91E+02	1.23E+02
1999	1.78E+04	1.31E+04	2.62E+04	9.82E+03	1.82E+03	3.70E+02	1.70E+02	2.11E+02	9.57E+01
2000	1.73E+04	1.54E+04	1.02E+04	1.22E+04	2.74E+03	6.57E+02	1.72E+02	7.24E+01	1.14E+02
2001	2.18E+04	1.44E+04	8.05E+03	5.15E+03	4.17E+03	9.11E+02	3.03E+02	7.74E+01	3.99E+01
2002	2.28E+04	1.72E+04	9.03E+03	3.12E+03	2.63E+03	1.88E+03	5.29E+02	1.91E+02	4.91E+01
2003	1.86E+04	1.98E+04	8.68E+03	3.23E+03	1.01E+03	8.88E+02	8.59E+02	2.56E+02	1.14E+02
2004	2.27E+04	1.62E+04	1.33E+04	2.46E+03	1.15E+03	5.07E+02	4.48E+02	4.60E+02	1.61E+02
2005	6.25E+03	1.97E+04	9.97E+03	6.79E+03	1.38E+03	6.74E+02	3.14E+02	2.79E+02	2.90E+02

Estimated population abundance at 1st Jan 2006

0.00E+00	5.34E+03	1.49E+04	5.33E+03	3.97E+03	8.09E+02	4.24E+02	1.83E+02	1.69E+02

Taper weighted geometric mean of the VPA populations:

2.15E+04	1.95E+04	1.29E+04	5.86E+03	2.27E+03	1.00E+03	5.17E+02	2.80E+02	1.30E+02

Standard error of the weighted Log(VPA populations) :

.4181	.3467	.4427	.5463	.5414	.6399	.6755	.7086	1.0184

1

Log catchability residuals.

Fleet : FLT01: UK INSHORE TR

Age	1981	1982	1983	1984	1985
1	No data for this fleet at this age				
2	99.99	99.99	99.99	99.99	.66
3	99.99	99.99	99.99	99.99	.34
4	99.99	99.99	99.99	99.99	.37
5	99.99	99.99	99.99	99.99	-.79
6	99.99	99.99	99.99	99.99	99.99
7	99.99	99.99	99.99	99.99	99.99
8	99.99	99.99	99.99	99.99	99.99
9	99.99	99.99	99.99	99.99	1.77

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	No data for this fleet at this age									
2	-.19	-.60	-.10	-1.88	-.97	.24	.19	-.04	.09	.02
3	.36	.02	.06	-.55	-.52	.27	.35	-.23	-.19	-.17
4	.36	.24	-.32	.48	-.58	.25	.61	-.02	-.09	-.25
5	.24	-.08	.22	.47	-.02	.01	.39	.11	.17	-.07
6	-1.07	-.27	.09	.69	.30	.06	.37	-.02	-.13	-.18
7	-.56	-.80	-.17	.46	.39	-.23	.39	.21	-.04	-.31
8	-.24	-.03	-.54	-.38	.46	-.43	.57	.35	-.16	-.10
9	99.99	.41	.22	-.51	.51	-.61	-.33	.62	.49	.18

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	No data for this fleet at this age									
2	.35	-.02	-.48	-.26	.38	-.29	.83	1.08	.36	.62
3	-.67	.07	-.53	.21	-.17	-.31	.68	.24	.56	.15
4	-.87	-.92	-.06	-.63	.45	-.36	.35	.57	.03	.38
5	-.43	-.65	-.24	-.05	.32	.29	-.06	.15	-.01	.03
6	-.41	-.29	-.10	-.56	.47	.01	.68	.04	-.09	.41
7	-.90	.20	.71	-.71	.55	-.09	.15	.70	-.02	.06
8	-.20	.31	.42	.23	.53	.86	.70	1.53	.64	-.06
9	-.31	.40	.70	.00	.77	.46	.60	-.38	.85	.86

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9
Mean Log q	-11.8781	-11.3856	-11.4489	-11.5893	-11.5732	-11.7060	-11.7060	-11.7060
S.E(Log q)	.6485	.3814	.4704	.3179	.4240	.4795	.5623	.6695

1

Table 6.2.5.2 continued) – Plaice in VIId. Tuning diagnostic.

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,	1.71,	-1.044,	13.28,	.10,	21,	1.10,	-11.88,
3,	1.10,	-.464,	11.57,	.54,	21,	.43,	-11.39,
4,	.95,	.251,	11.32,	.59,	21,	.46,	-11.45,
5,	.85,	1.391,	11.02,	.82,	21,	.26,	-11.59,
6,	.89,	.776,	11.07,	.73,	20,	.38,	-11.57,
7,	.95,	.308,	11.43,	.65,	20,	.47,	-11.71,
8,	1.42,	-1.762,	13.85,	.50,	20,	.69,	-11.48,
9,	1.04,	-.210,	11.64,	.57,	20,	.62,	-11.37,

1

Fleet : FLT02: BELGIAN BEAM

Age	1981,	1982,	1983,	1984,	1985
1	No data for this fleet at this age				
2	.09,	-.08,	.56,	-1.17,	.56
3	.37,	-.30,	.02,	.01,	-.07
4	.42,	.04,	.35,	.00,	.00
5	-.62,	.08,	-.31,	.06,	-1.21
6	-.65,	-.34,	-.14,	.20,	.34
7	-.21,	-.39,	-.71,	.42,	.01
8	.15,	.50,	.87,	-.44,	.82
9	.21,	.32,	.47,	-.23,	-1.37

Age	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995
1	No data for this fleet at this age									
2	.65,	.48,	.23,	-1.87,	.45,	1.11,	1.38,	.59,	1.04,	-1.56
3	.05,	-.41,	-.12,	-.33,	.48,	.82,	.56,	-.13,	.14,	.12
4	-.27,	-.37,	-.48,	-.10,	.07,	.14,	-.24,	-.43,	.64,	.14
5	-.38,	-.51,	-.79,	.31,	-.15,	.58,	-.29,	-.17,	.17,	.28
6	.05,	-1.08,	-.75,	.15,	-.09,	.64,	.34,	-.20,	.04,	-.10
7	-.12,	.39,	-.34,	-.05,	-.68,	-.05,	-.11,	-.25,	.03,	.71
8	-1.00,	-.39,	-.24,	-.28,	-.16,	-.22,	.17,	-.43,	.18,	.30
9	-.02,	.04,	-.18,	.09,	-1.04,	.81,	.93,	-.86,	.31,	-.22

Age	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005
1	No data for this fleet at this age									
2	-.09,	99.99,	-.80,	-1.41,	-1.28,	.57,	.44,	.19,	.20,	-.27
3	-.08,	-1.47,	-.26,	-.04,	-.94,	.89,	.53,	.56,	.02,	-.42
4	.21,	.52,	.28,	.42,	-1.12,	.20,	.35,	.20,	-.31,	-.65
5	.42,	1.24,	.45,	.80,	-.33,	.14,	.50,	-.07,	-.18,	-.04
6	.08,	.95,	.51,	.85,	-.45,	.05,	-.44,	.53,	-.26,	-.26
7	-.23,	.84,	.39,	.70,	-.37,	-.39,	.01,	.25,	.20,	-.07
8	.32,	.09,	.34,	-.25,	-.31,	-.07,	-.94,	-.27,	-.11,	-.09
9	.17,	.44,	.78,	.58,	-.20,	.42,	-.08,	.34,	-.45,	-.69

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age ,	2,	3,	4,	5,	6,	7,	8,	9
Mean Log q,	-7.5635,	-5.6670,	-5.1356,	-5.2399,	-5.5129,	-5.5211,	-5.5211,	-5.5211,
S.E(Log q),	.8921,	.5190,	.4084,	.5250,	.4909,	.4085,	.4542,	.5774,

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,	.89,	.234,	7.82,	.17,	24,	.81,	-7.56,
3,	1.56,	-1.481,	3.52,	.23,	25,	.79,	-5.67,
4,	1.21,	-1.048,	4.39,	.52,	25,	.49,	-5.14,
5,	1.02,	-.113,	5.18,	.49,	25,	.55,	-5.24,
6,	1.02,	-.114,	5.48,	.57,	25,	.51,	-5.51,
7,	1.00,	-.003,	5.52,	.71,	25,	.42,	-5.52,
8,	1.13,	-.870,	5.57,	.68,	25,	.51,	-5.58,
9,	1.21,	-1.373,	5.61,	.65,	25,	.69,	-5.50,

1

Table 6.2.5.2 (continued) – Plaice in VIId. Tuning diagnostic.

Fleet : FLT03: FR TRAWLERS

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	No data for this fleet at this age									
2	99.99	99.99	99.99	-.21	-.36	.45	.20	.11	.10	-.05
3	99.99	99.99	99.99	-.33	-.13	.03	.16	-.40	.08	-.57
4	99.99	99.99	99.99	.00	.03	.33	-.40	-.58	-.48	-.54
5	99.99	99.99	99.99	.53	.17	-.18	-.12	-1.29	.01	-1.08
6	99.99	99.99	99.99	.05	.37	-.12	.34	-.57	-.36	-1.39
7	99.99	99.99	99.99	-.10	.13	-.37	.17	-.35	-.35	-1.01
8	99.99	99.99	99.99	.29	.26	-.50	-.45	-.77	.18	-.55
9	99.99	99.99	99.99	1.12	1.06	-.36	-.29	-.23	-.28	-.15

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	No data for this fleet at this age									
2	-.77	-.59	-.88	-.08	.57	.48	.62	-.04	.92	-.46
3	-.42	.56	.03	.35	-.24	.36	-.32	.75	.19	-.10
4	-.56	.88	.74	.81	.48	-.18	-.33	.39	-.16	-.44
5	-.10	.24	.79	.50	.98	.43	-.18	.10	.01	-.81
6	-.32	.81	.06	.30	.76	.04	.08	.04	.28	-.39
7	-.17	.95	-.28	.94	.49	-.02	-.10	.15	-.20	.11
8	.04	1.00	.32	.57	.02	-1.39	-.52	-.15	-.15	-.19
9	.19	.83	-.19	-.31	.31	-.85	-.20	.69	-.55	-.63

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9
Mean Log q	-11.5105	-10.7975	-10.8939	-11.2694	-11.5389	-11.7398	-11.7398	-11.7398
S.E(Log q)	.5095	.3676	.5101	.6119	.5189	.4790	.5723	.5941

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	52.41	-2.502	99.74	.00	17	23.17	-11.51
3	.87	.636	10.61	.60	17	.32	-10.80
4	.77	1.329	10.39	.70	17	.39	-10.89
5	.93	.282	11.03	.53	17	.59	-11.27
6	1.07	-.301	11.84	.58	17	.57	-11.54
7	1.41	-1.669	13.95	.52	17	.64	-11.74
8	.92	.426	11.39	.67	17	.53	-11.86
9	.89	.581	11.04	.67	17	.54	-11.73

1

Fleet : FLT04: UK BTS (Surve

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	99.99	99.99	.50	-1.42	-.73	-.06	.01	-.88	-.19	-.23
2	99.99	99.99	.33	-.47	-.81	-.11	.00	-.21	-.05	-.93
3	99.99	99.99	.54	.11	-.66	.20	-.14	-.40	.06	-.38
4	99.99	99.99	-.10	.40	-.23	.00	.32	-.50	.32	-.22
5	99.99	99.99	.54	-.16	-.01	.17	.61	-.13	.11	-.47
6	99.99	99.99	.03	.17	.13	-.05	.93	-.03	-.41	-.41
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	-.31	.38	.25	.07	.28	.39	.43	-.58	.99	1.08
2	-.26	-.46	-.02	.27	.75	.23	.38	.43	.26	.67
3	-1.54	-.64	-.62	-.04	.76	.79	.46	.40	.40	.70
4	-1.25	-1.26	-.08	-.61	.61	.56	.63	.35	.50	.57
5	-.64	-1.08	-.96	-.36	.54	1.07	-.09	.50	-.30	.69
6	-.28	-.97	-.40	-.44	.49	.77	.81	.02	-.93	.56
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Table 6.2.5.2 (continued) – Plaice in VIId. Tuning diagnostic.

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age ,	1,	2,	3,	4,	5,	6
Mean Log q,	-7.3451,	-6.9437,	-6.8925,	-6.7229,	-6.5169,	-6.6053,
S.E(Log q),	.6361,	.4677,	.6182,	.5955,	.5863,	.5585,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
1,	1.08,	-.183,	7.14,	.24,	18,	.71,	-7.35,
2,	1.01,	-.017,	6.92,	.28,	18,	.49,	-6.94,
3,	1.01,	-.028,	6.87,	.37,	18,	.64,	-6.89,
4,	.92,	.338,	6.88,	.52,	18,	.56,	-6.72,
5,	.78,	1.181,	6.79,	.64,	18,	.45,	-6.52,
6,	.77,	1.462,	6.69,	.71,	18,	.42,	-6.61,

1

Fleet : FLT05: FR GFS (Surve

Age ,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995
1 ,	99.99,	99.99,	-.48,	-.78,	-.78,	-1.38,	.98,	1.54,	-.20,	-.35
2 ,	99.99,	99.99,	.42,	-.31,	-1.54,	-.84,	-.52,	.50,	-.24,	-.15
3 ,	99.99,	99.99,	.04,	-.77,	-.42,	-.94,	.09,	.77,	-1.06,	-.41
4 ,	99.99,	99.99,	.05,	-.90,	.10,	-.55,	-.76,	.84,	-1.40,	-.31
5 ,	99.99,	99.99,	.42,	-1.66,	.39,	-.48,	-.81,	.58,	-.89,	-.57
6 ,	No data for this fleet at this age									
7 ,	No data for this fleet at this age									
8 ,	No data for this fleet at this age									
9 ,	No data for this fleet at this age									

Age ,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005
1 ,	-.78,	.80,	.83,	.20,	.46,	.02,	.04,	-1.02,	-.03,	.93
2 ,	-.91,	-.01,	.24,	.00,	1.21,	-.11,	.62,	.37,	.57,	.68
3 ,	-2.05,	.28,	-.18,	.26,	.51,	-.01,	.96,	1.33,	.37,	1.21
4 ,	-1.62,	-.18,	-.24,	.29,	.76,	-.08,	.13,	2.33,	.80,	.74
5 ,	-.54,	-.05,	-.07,	.05,	1.09,	-.57,	-.26,	2.70,	-.61,	1.29
6 ,	No data for this fleet at this age									
7 ,	No data for this fleet at this age									
8 ,	No data for this fleet at this age									
9 ,	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age ,	1,	2,	3,	4,	5
Mean Log q,	-7.5308,	-7.5352,	-7.6895,	-8.1034,	-8.2729,
S.E(Log q),	.8027,	.6699,	.8566,	.9236,	.9898,

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,	2.53,	-1.229,	3.92,	.04,	18,	2.00,	-7.53,
2,	.65,	.975,	8.34,	.33,	18,	.44,	-7.54,
3,	1.22,	-.400,	7.30,	.17,	18,	1.07,	-7.69,
4,	1.44,	-.766,	7.85,	.16,	18,	1.35,	-8.10,
5,	3.10,	-1.738,	9.33,	.04,	18,	2.90,	-8.27,

1

Fleet : FLT06: Intl YFS (Sur

Age ,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995
1 ,	99.99,	.14,	.21,	-.09,	-.01,	-.30,	.50,	.49,	.17,	.58
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									
5 ,	No data for this fleet at this age									
6 ,	No data for this fleet at this age									
7 ,	No data for this fleet at this age									
8 ,	No data for this fleet at this age									
9 ,	No data for this fleet at this age									

Table 6.2.5.2 (continued) – Plaice in VIId. Tuning diagnostic.

```
  Age  ,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005
     1 ,  -.60,  -.61,   .30,   .08,  -.32,   .03,   .03,  -.12,  -.13,  -.36
     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
     5 , No data for this fleet at this age
     6 , No data for this fleet at this age
     7 , No data for this fleet at this age
     8 , No data for this fleet at this age
     9 , No data for this fleet at this age

 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

    Age ,        1
 Mean Log q,  -10.0559,
 S.E(Log q),     .3416,

 Regression statistics :

 Ages with q independent of year class strength and constant w.r.t. time.

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  1,    1.03,    -.153,     10.06,     .55,     19,     .36,  -10.06,
1

 Terminal year survivor and F summaries :

 Age  1   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
 FLT01: UK INSHORE TR,         1.,   .000,       .000,     .00,   0,  .000,     .000
 FLT02: BELGIAN BEAM ,         1.,   .000,       .000,     .00,   0,  .000,     .000
 FLT03: FR TRAWLERS  ,         1.,   .000,       .000,     .00,   0,  .000,     .000
 FLT04: UK BTS (Surve,     15772.,   .654,       .000,     .00,   1,  .145,     .019
 FLT05: FR GFS (Surve,     13603.,   .825,       .000,     .00,   1,  .091,     .022
 FLT06: Intl YFS (Sur,      3734.,   .350,       .000,     .00,   1,  .503,     .079

   F shrinkage mean  ,      4226.,    .50,,,,                         .261,     .070

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      5343.,       .25,      .33,    4,   1.334,   .056



1
 Age  2   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
 FLT01: UK INSHORE TR,     27732.,   .664,       .000,     .00,   1,  .076,     .100
 FLT02: BELGIAN BEAM ,     11368.,   .911,       .000,     .00,   1,  .041,     .229
 FLT03: FR TRAWLERS  ,      9386.,   .524,       .000,     .00,   1,  .122,     .272
 FLT04: UK BTS (Surve,     32472.,   .387,       .152,     .39,   2,  .221,     .086
 FLT05: FR GFS (Surve,     22133.,   .529,       .351,     .66,   2,  .118,     .124
 FLT06: Intl YFS (Sur,     13001.,   .350,       .000,     .00,   1,  .261,     .203

   F shrinkage mean  ,      5329.,    .50,,,,                         .161,     .438

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     14863.,       .18,      .24,    9,   1.276,   .1801
```

Table 6.2.5.2 (continued) – Plaice in VIId. Tuning diagnostic.

```
Age  3   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
 FLT01: UK INSHORE TR,      6455.,   .340,       .083,    .24,   2,  .181,     .452
 FLT02: BELGIAN BEAM ,      3918.,   .463,       .242,    .52,   2,  .098,     .663
 FLT03: FR TRAWLERS  ,      6298.,   .311,       .448,   1.44,   2,  .212,     .461
 FLT04: UK BTS (Surve,      6733.,   .337,       .334,    .99,   3,  .156,     .437
 FLT05: FR GFS (Surve,      7808.,   .461,       .620,   1.34,   3,  .082,     .387
 FLT06: Intl YFS (Sur,      4724.,   .350,       .000,    .00,   1,  .119,     .577

   F shrinkage mean  ,      2895.,    .50,,,,                        .151,     .821

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      5335.,       .15,      .14,   14,    .956,   .525

1
 Age  4   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
 FLT01: UK INSHORE TR,      6756.,   .291,       .146,    .50,   3,  .195,     .279
 FLT02: BELGIAN BEAM ,      2564.,   .322,       .230,    .72,   3,  .180,     .613
 FLT03: FR TRAWLERS  ,      3599.,   .280,       .206,    .74,   3,  .198,     .472
 FLT04: UK BTS (Surve,      6395.,   .314,       .042,    .13,   4,  .149,     .292
 FLT05: FR GFS (Surve,      6143.,   .440,       .143,    .33,   4,  .072,     .303
 FLT06: Intl YFS (Sur,      4081.,   .350,       .000,    .00,   1,  .071,     .426

   F shrinkage mean  ,      1764.,    .50,,,,                        .134,     .802

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      3973.,       .13,      .13,   19,    .951,   .436

 Age  5   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
 FLT01: UK INSHORE TR,       862.,   .247,       .069,    .28,   4,  .318,     .411
 FLT02: BELGIAN BEAM ,       729.,   .307,       .148,    .48,   4,  .184,     .471
 FLT03: FR TRAWLERS  ,       680.,   .315,       .353,   1.12,   4,  .152,     .498
 FLT04: UK BTS (Surve,      1428.,   .356,       .061,    .17,   5,  .130,     .268
 FLT05: FR GFS (Surve,      2199.,   .535,       .181,    .34,   5,  .053,     .182
 FLT06: Intl YFS (Sur,       832.,   .350,       .000,    .00,   1,  .018,     .423

   F shrinkage mean  ,       397.,    .50,,,,                        .144,     .744

 Weighted prediction :
 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       809.,       .14,      .11,   24,    .773,   .433
1
 Age  6   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
 FLT01: UK INSHORE TR,       537.,   .233,       .125,    .54,   5,  .315,     .297
 FLT02: BELGIAN BEAM ,       379.,   .297,       .115,    .39,   5,  .193,     .398
 FLT03: FR TRAWLERS  ,       363.,   .315,       .150,    .48,   5,  .166,     .413
 FLT04: UK BTS (Surve,       552.,   .339,       .167,    .49,   6,  .147,     .290
 FLT05: FR GFS (Surve,       594.,   .555,       .587,   1.06,   5,  .030,     .272
 FLT06: Intl YFS (Sur,       308.,   .350,       .000,    .00,   1,  .012,     .472

   F shrinkage mean  ,       250.,    .50,,,,                        .136,     .555
```

Table 6.2.5.2 (continued) – Plaice in VIId. Tuning diagnostic.

```
 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       424.,       .14,      .08,   28,    .613,   .363



 Age  7   Catchability constant w.r.t. time and dependent on age

 Year class = 1998

 Fleet,                 Estimated,    Int,       Ext,    Var,     N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,     , Weights,    F
 FLT01: UK INSHORE TR,       191.,   .229,       .058,     .25,   6,  .290,     .426
 FLT02: BELGIAN BEAM ,       169.,   .265,       .095,     .36,   6,  .253,     .471
 FLT03: FR TRAWLERS  ,       212.,   .293,       .069,     .24,   6,  .198,     .392
 FLT04: UK BTS (Surve,       142.,   .356,       .335,     .94,   6,  .090,     .539
 FLT05: FR GFS (Surve,       865.,   .577,       .612,    1.06,   5,  .017,     .111
 FLT06: Intl YFS (Sur,       198.,   .350,       .000,     .00,   1,  .006,     .414

   F shrinkage mean  ,       150.,    .50,,,,                         .145,     .518

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       183.,       .14,      .07,   31,    .526,   .443



1
 Age  8   Catchability constant w.r.t. time and age (fixed at the value for age)  7

 Year class = 1997

 Fleet,                 Estimated,    Int,       Ext,    Var,     N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,     , Weights,    F
 FLT01: UK INSHORE TR,       161.,   .245,       .031,     .13,   7,  .260,     .418
 FLT02: BELGIAN BEAM ,       190.,   .251,       .112,     .45,   7,  .296,     .365
 FLT03: FR TRAWLERS  ,       145.,   .285,       .037,     .13,   7,  .213,     .457
 FLT04: UK BTS (Surve,       190.,   .342,       .106,     .31,   6,  .056,     .365
 FLT05: FR GFS (Surve,       182.,   .442,       .190,     .43,   5,  .011,     .378
 FLT06: Intl YFS (Sur,       228.,   .350,       .000,     .00,   1,  .008,     .312

   F shrinkage mean  ,       170.,    .50,,,,                         .156,     .401

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       169.,       .14,      .04,   34,    .253,   .403

 Age  9   Catchability constant w.r.t. time and age (fixed at the value for age)  7

 Year class = 1996

 Fleet,                 Estimated,    Int,       Ext,    Var,     N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,     , Weights,    F
 FLT01: UK INSHORE TR,       380.,   .258,       .072,     .28,   8,  .253,     .157
 FLT02: BELGIAN BEAM ,       156.,   .251,       .145,     .58,   8,  .304,     .347
 FLT03: FR TRAWLERS  ,       163.,   .289,       .138,     .48,   8,  .234,     .335
 FLT04: UK BTS (Surve,       418.,   .345,       .138,     .40,   6,  .036,     .144
 FLT05: FR GFS (Surve,       208.,   .505,       .290,     .57,   5,  .007,     .271
 FLT06: Intl YFS (Sur,       108.,   .350,       .000,     .00,   1,  .004,     .471

   F shrinkage mean  ,       125.,    .50,,,,                         .161,     .417

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       198.,       .15,      .09,   37,    .612,   .2832
```

Table 6.3.3.1 - Plaice in VIId. Fishing mortality at age.

AGE / YEAR	1980	1981	1982	1983	1984	1985
1	0.0022	0.0013	0.0111	0.0049	0.0148	0.0051
2	0.1688	0.1186	0.1349	0.1526	0.1161	0.3132
3	0.2793	0.7385	0.4994	0.4565	0.5788	0.5989
4	0.3631	0.8878	0.8839	0.9471	0.8264	0.8645
5	0.6312	0.3009	0.6974	0.5845	0.8058	0.2338
6	0.4161	0.3791	0.3224	0.4013	0.6980	0.5924
7	0.3886	0.4907	0.3676	0.2080	0.8437	0.4206
8	0.2502	0.6732	1.9040	0.9780	0.3292	0.9525
9	0.4111	0.5107	0.7567	0.5231	0.7154	0.8987
+gp	0.4111	0.5107	0.7567	0.5231	0.7154	0.8987
0 FBAR 2- 6	0.3717	0.4850	0.5076	0.5084	0.6050	0.5206

AGE / YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.0119	0.0008	0.0006	0.0549	0.0957	0.0777	0.0647	0.0607	0.0785	0.1146
2	0.2139	0.1816	0.2067	0.1744	0.2211	0.5087	0.4438	0.4118	0.4147	0.3786
3	0.6939	0.5196	0.6675	0.4556	0.7054	0.8366	0.8131	0.4788	0.7254	0.6134
4	0.7676	0.7903	0.6762	0.7491	0.7508	0.8813	0.6127	0.4982	0.8057	0.6830
5	0.6040	0.5761	0.5595	0.8732	0.6344	0.7004	0.5277	0.3475	0.6574	0.5202
6	0.5042	0.3152	0.4630	0.5725	0.6200	0.6102	0.6546	0.3608	0.4386	0.3225
7	0.4633	0.8439	0.5414	0.4252	0.4352	0.4139	0.4875	0.3957	0.3858	0.5145
8	0.2786	0.5022	0.5462	0.3911	0.5325	0.3533	0.5045	0.3362	0.5602	0.4703
9	0.4120	0.7770	0.6765	0.7179	0.7467	0.5666	0.6027	0.4618	0.5502	0.4769
+gp	0.4120	0.7770	0.6765	0.7179	0.7467	0.5666	0.6027	0.4618	0.5502	0.4769
0 FBAR 2- 6	0.5567	0.4766	0.5146	0.5649	0.5863	0.7074	0.6104	0.4194	0.6084	0.5035

AGE / YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	FBAR 80-05
1	0.0394	0.0154	0.0331	0.0447	0.0877	0.1386	0.0425	0.0371	0.0457	0.0561	0.0463
2	0.2891	0.1846	0.1481	0.1518	0.5506	0.3633	0.5819	0.2999	0.3877	0.1799	0.2892
3	0.5493	0.7971	0.6074	0.6639	0.5827	0.8488	0.9269	1.1597	0.5690	0.5254	0.7514
4	0.6804	1.4718	1.0239	1.1755	0.9756	0.5741	1.0307	0.9311	0.4806	0.4359	0.6159
5	0.7572	1.3945	0.8680	0.9200	1.0024	0.6947	0.9847	0.5853	0.4378	0.4333	0.4855
6	0.5094	1.0653	0.5866	0.6664	0.6753	0.4427	0.6850	0.5830	0.3786	0.3629	0.4415
7	0.4007	1.1976	0.4782	0.7558	0.6971	0.3597	0.6248	0.5237	0.3737	0.4432	0.4469
8	0.6395	0.9304	0.5907	0.5168	0.4973	0.3550	0.4170	0.3673	0.3622	0.4025	0.3773
9	0.6668	1.0247	0.5859	0.5404	0.4907	0.4198	0.7663	0.6182	0.2857	0.2832	0.3957
+gp	0.6668	1.0247	0.5859	0.5404	0.4907	0.4198	0.7663	0.6182	0.2857	0.2832	
0 FBAR 2- 6	0.5571	0.9827	0.6468	0.7155	0.7573	0.5847	0.8418	0.7118	0.4507	0.3875	

Table 6.3.3.2 - Plaice in VIId. Stocks numbers at age.

AGE / YEAR	1980	1981	1982	1983	1984	1885
1	25465	12843	25158	19925	25057	29613
2	17899	22991	11606	22512	17941	22340
3	6260	13681	18476	9176	17487	14454
4	1864	4284	5915	10146	5260	8870
5	1101	1173	1595	2211	3561	2083
6	232	530	786	719	1115	1439
7	147	138	328	515	435	502
8	209	90	77	206	379	169
9	12	147	42	10	70	246
+gp	320	523	173	259	204	88
0 TOTAL	53509	56401	64156	65680	71510	79805

AGE / YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	60188	31207	26434	16255	18791	21697	27930	13212	17303	25158
2	26660	53815	28214	23903	13923	15451	18166	23689	11251	14475
3	14778	19477	40609	20762	18168	10099	8406	10546	14199	6725
4	7186	6681	10482	18849	11912	8119	3958	3373	5912	6220
5	3381	3018	2743	4823	8063	5087	3043	1941	1855	2390
6	1492	1672	1535	1418	1823	3869	2285	1625	1241	870
7	720	815	1104	874	724	887	1902	1074	1025	724
8	298	410	317	581	517	424	531	1057	654	630
9	59	204	225	166	356	275	269	290	683	338
+gp	105	149	370	402	459	302	273	430	771	712
0 TOTAL	114868	117448	112031	88034	74735	66210	66763	57237	54894	58242

AGE / YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	GMST 80-05	AMST 80-05
1	30449	37724	14987	17830	17317	21792	22801	18624	22748	6246	0	22603	24073
2	20299	26487	33611	13120	15428	14354	17167	19774	16237	19664	5343	19666	21045
3	8969	13756	19928	26227	10199	8049	9032	8681	13256	9970	14863	13030	14506
4	3295	4685	5609	9823	12218	5153	3117	3234	2463	6790	5335	6035	6924
5	2843	1510	973	1823	2744	4167	2626	1006	1153	1378	3973	2383	2740
6	1285	1206	339	370	657	911	1882	888	507	674	809	1051	1258
7	570	699	376	170	172	303	529	859	448	314	424	531	650
8	392	345	191	211	72	77	191	256	460	279	183	274	345
9	356	187	123	96	114	40	49	114	161	290	169	125	186
+gp	745	497	443	278	264	238	179	141	202	204	337		
0 TOTAL	69203	87098	76581	69948	59185	55084	57574	53576	57636	45809	31434		

Table 6.3.3.3 - Plaice in VIId. Stock summary.

	RECRUITS (Age 1)	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2- 6
1980	25465	16313	5443	2650	0.4869	0.3717
1981	12843	14227	6484	4769	0.7355	0.485
1982	25158	14931	7467	4865	0.6515	0.5076
1983	19925	14963	7969	5043	0.6328	0.5084
1984	25057	13942	7278	5161	0.7091	0.605
1985	29613	15569	7951	6022	0.7574	0.5206
1986	60188	22931	9926	6834	0.6885	0.5567
1987	31207	31519	13209	8366	0.6334	0.4766
1988	26434	24212	12972	10420	0.8033	0.5146
1989	16255	21317	14044	8758	0.6236	0.5649
1990	18791	21685	14452	9047	0.626	0.5863
1991	21697	17462	10069	7813	0.776	0.7074
1992	27930	16088	8514	6337	0.7443	0.6104
1993	13212	15808	7668	5331	0.6952	0.4194
1994	17303	14910	8241	6121	0.7427	0.6084
1995	25158	14683	7409	5130	0.6924	0.5035
1996	30449	17027	6502	5393	0.8295	0.5571
1997	37724	15175	6696	6307	0.9419	0.9827
1998	14987	17075	7559	5762	0.7623	0.6468
1999	17830	14270	8305	6326	0.7617	0.7155
2000	17317	11019	6331	6015	0.9501	0.7573
2001	21792	11896	6249	5266	0.8426	0.5847
2002	22801	12602	6030	5777	0.958	0.8418
2003	18624	10719	4532	4536	1.0008	0.7118
2004	22748	13373	5225	4007	0.7669	0.4507
2005	6246	11120	5816	3446	0.5925	0.3875
Arith. Mean	23337	16340	8167	5981	0.7463	0.5839
0 Units	(Thousands	(Tonnes)	(Tonnes)	(Tonnes)		

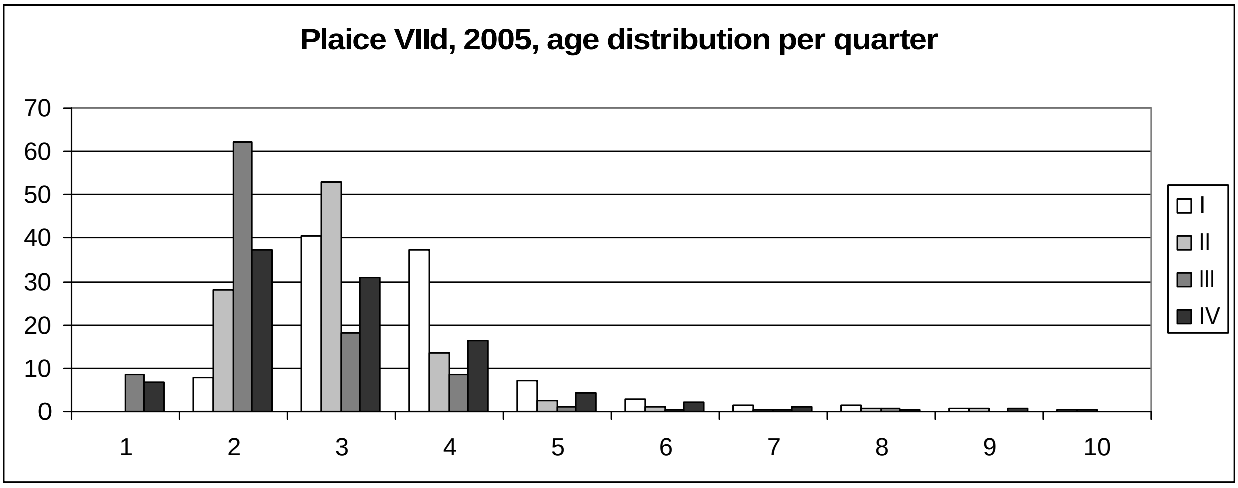


Figure 6.1.2.1 - Plaice VIId - Age distribution in the landings per quarter.

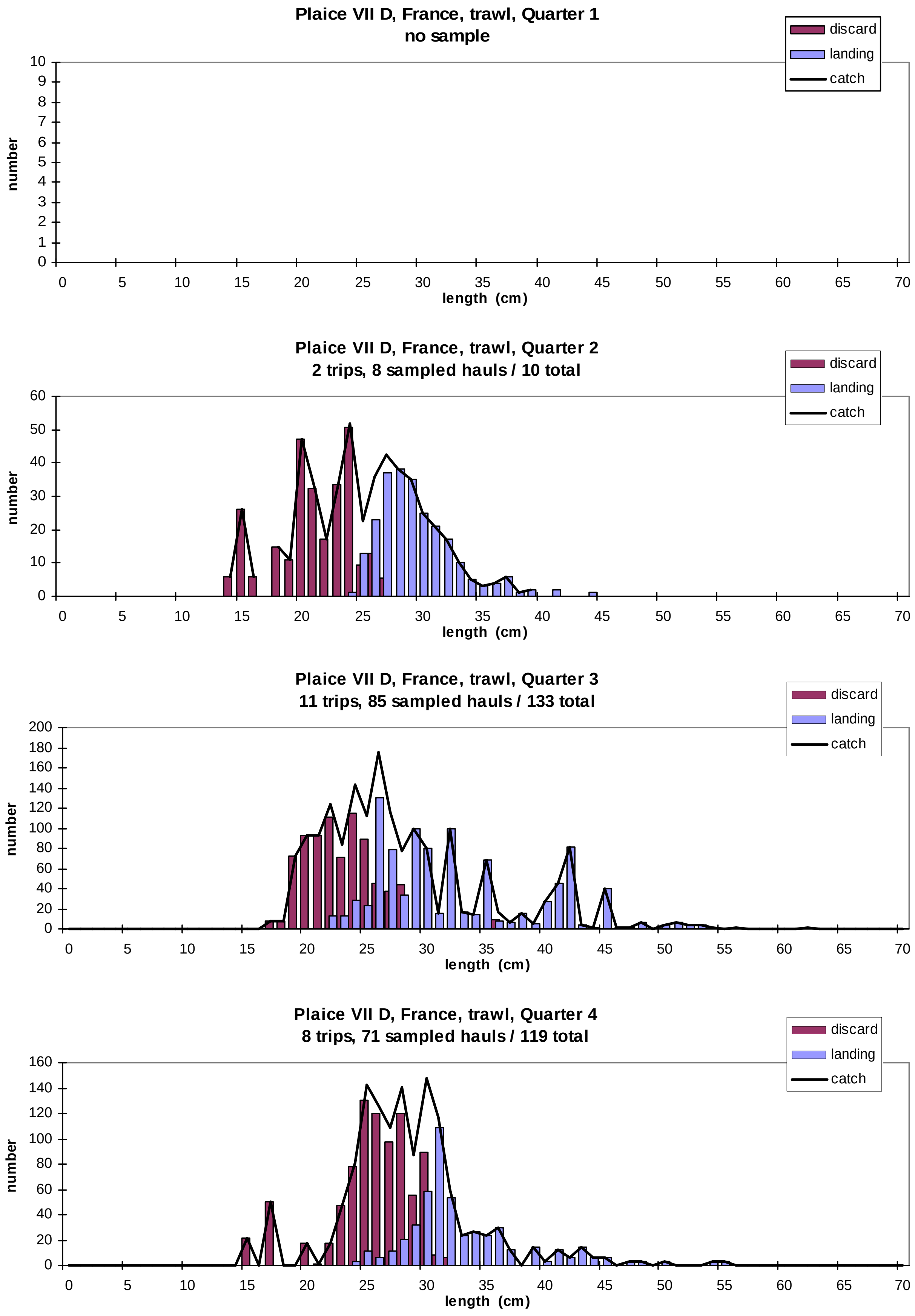


Figure 6.2.1.1 Plaice VIId - Length structure of discards and landings collected by observations on board (sum of number from sampled hauls).

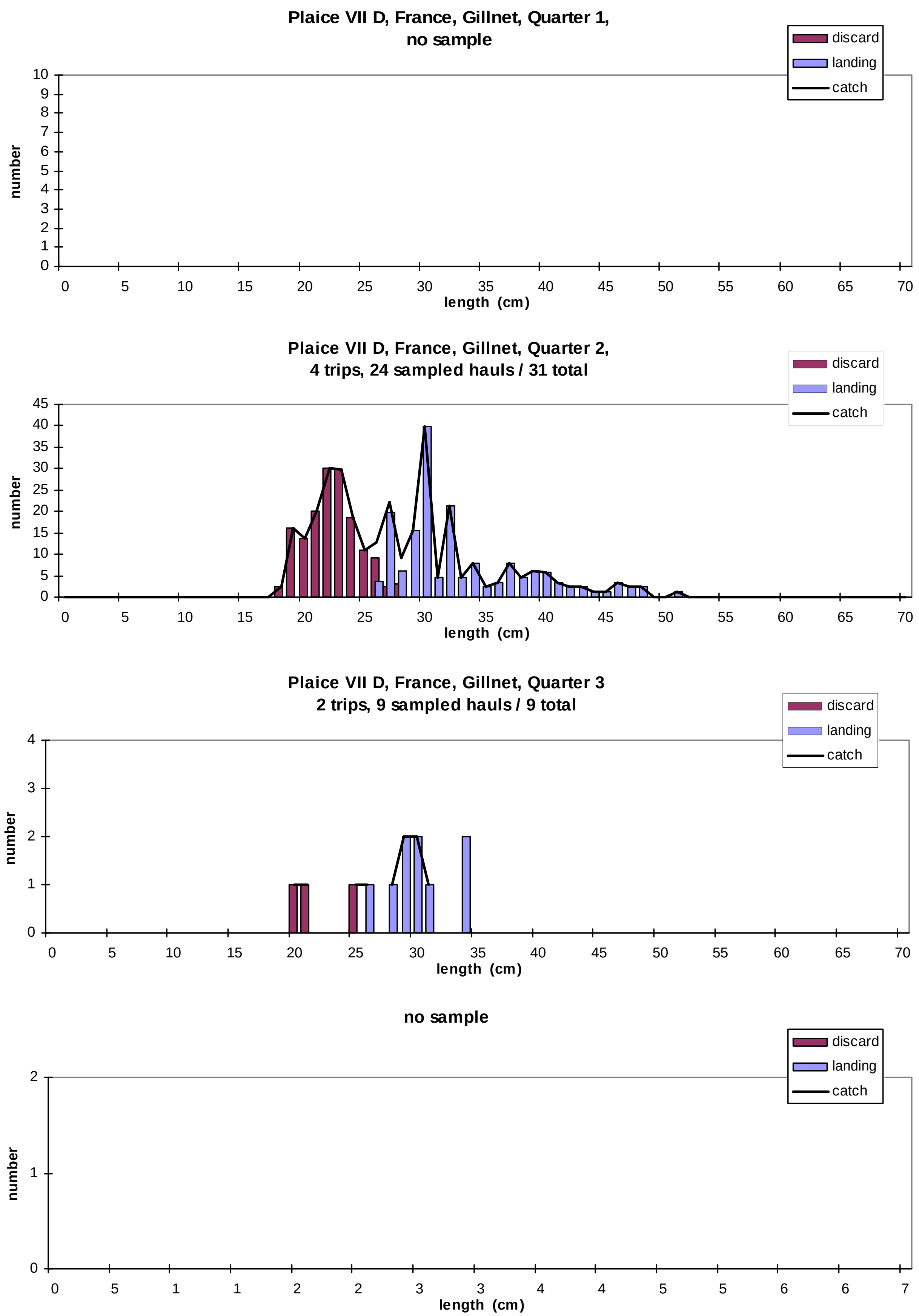
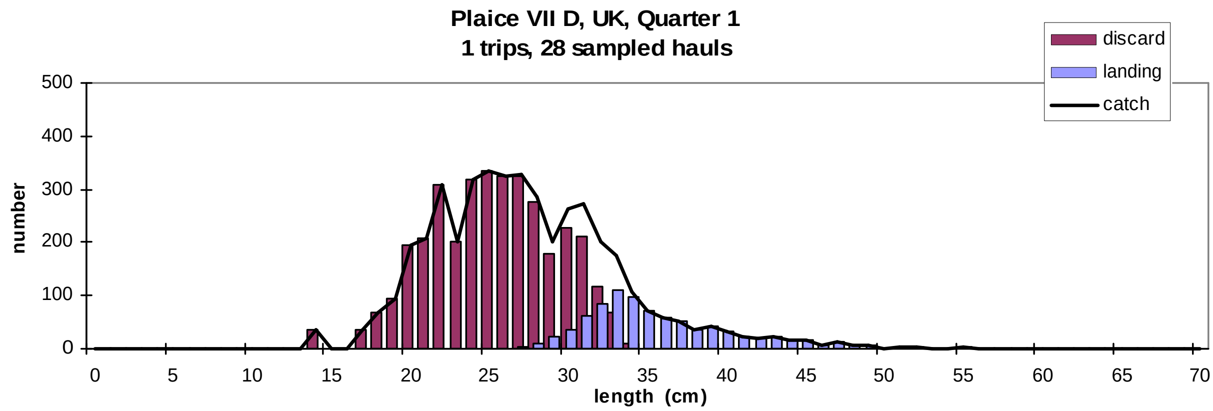
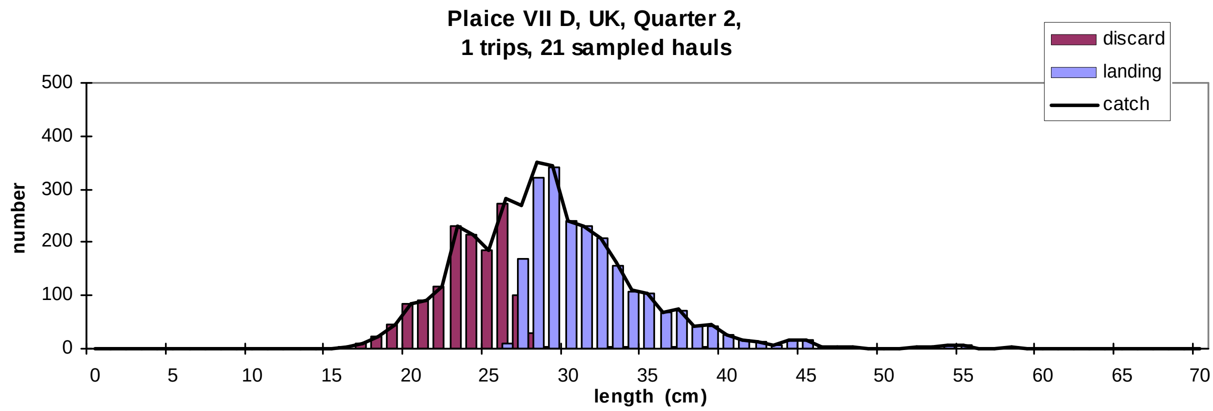
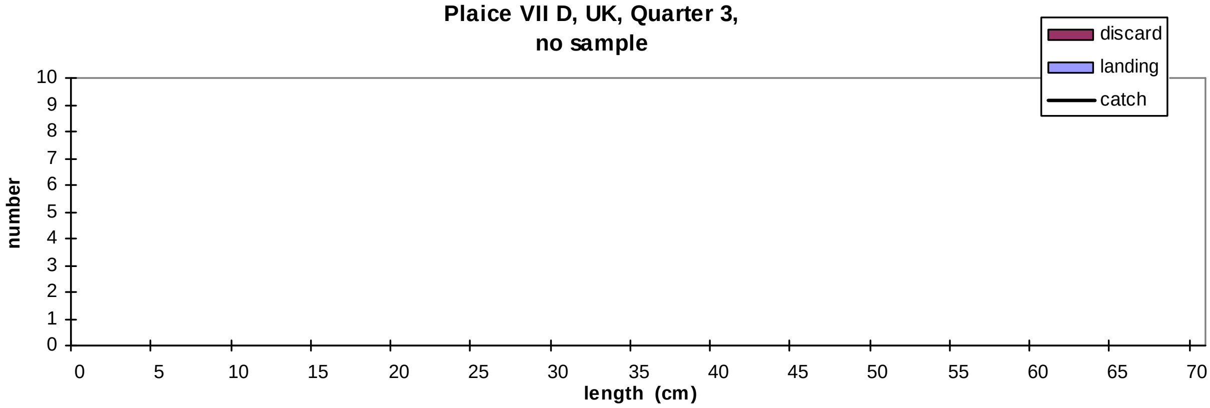


Figure 6.2.1.1 (cont) - Plaice VIId - Length structure of discards and landings collected by observations on board (sum of number from sampled hauls).







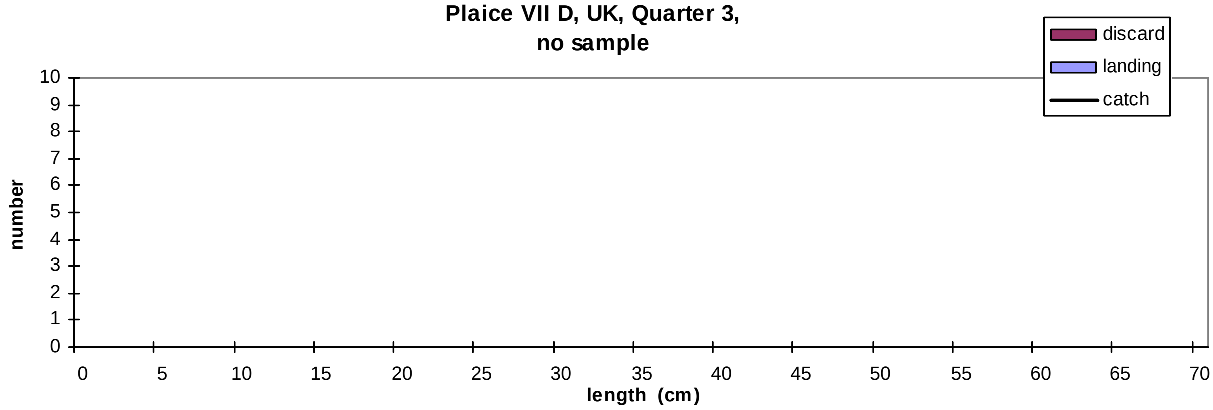


Figure 6.2.1.1 (cont) - Plaice VIId - Length structure of discards and landings collected by observations on board (sum of number from sampled hauls).

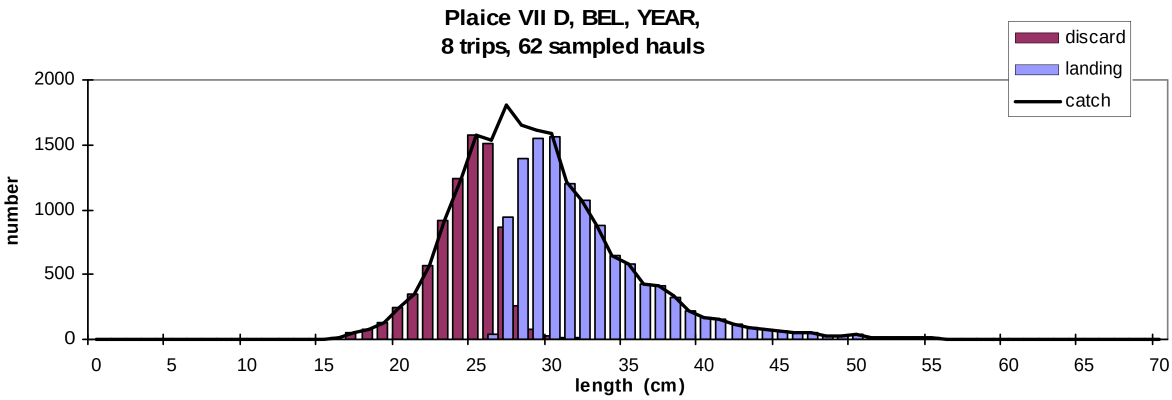
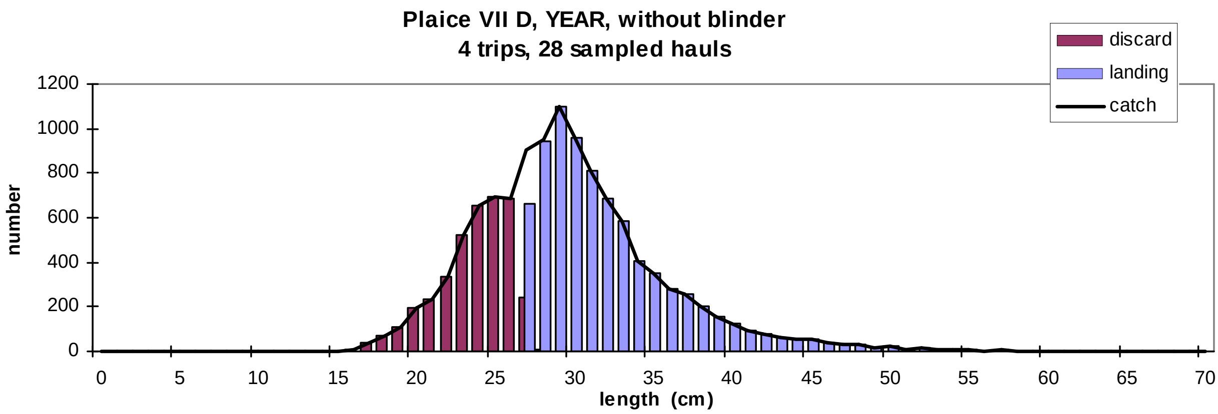


Figure 6.2.1.1 (cont) - Plaice VIId - Length structure of discards and landings collected by observations on board (sum of number from sampled hauls).



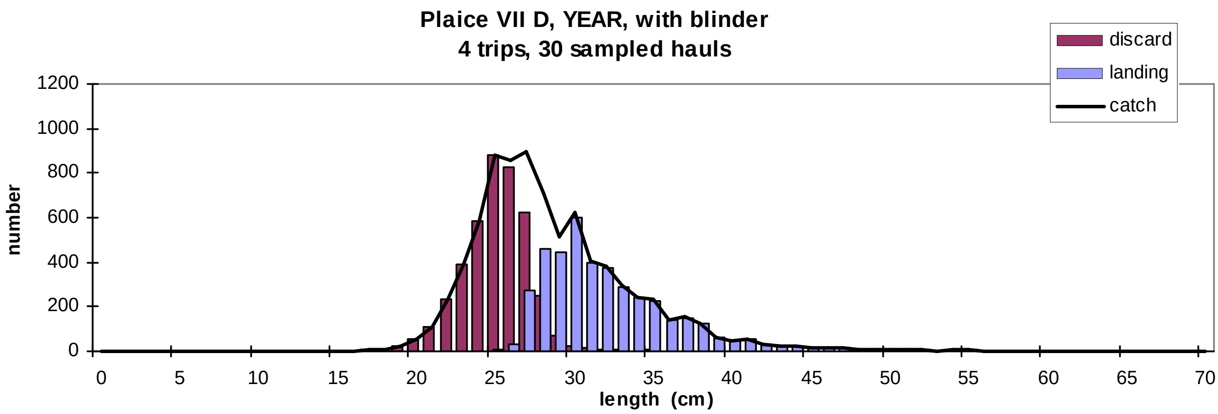


Figure 6.2.1.2 - Plaice VIId - Length structure of discards and landings collected by observations on board (sum of number from sampled hauls).

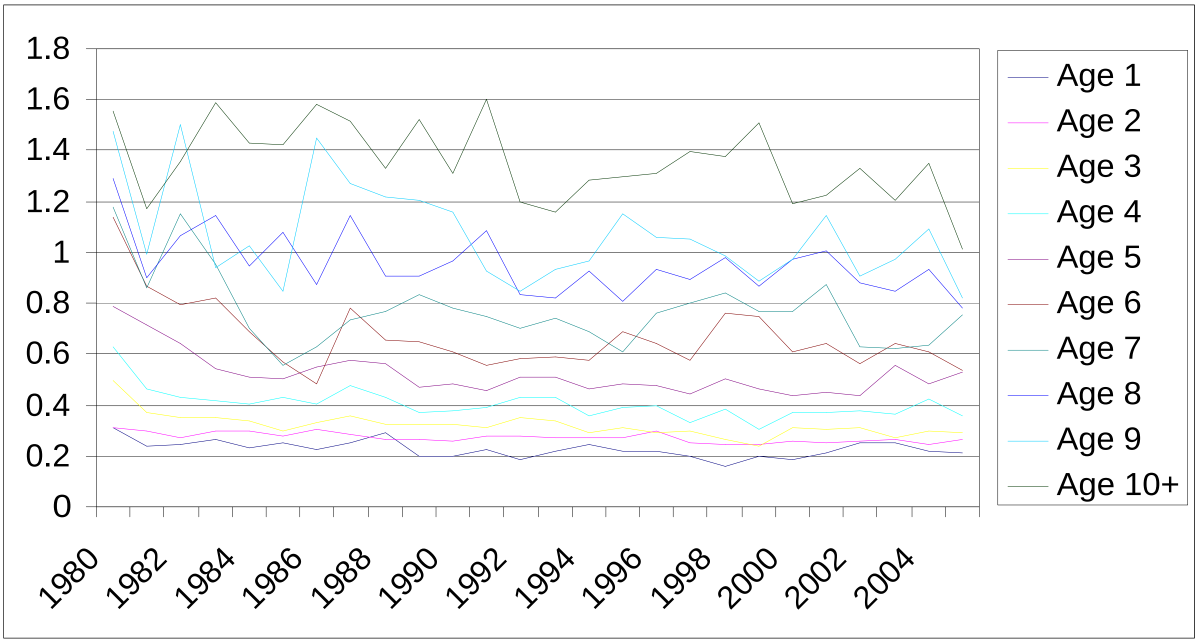


Figure 6.2.3.1a - Plaice VIId. Mean weights in the landings.

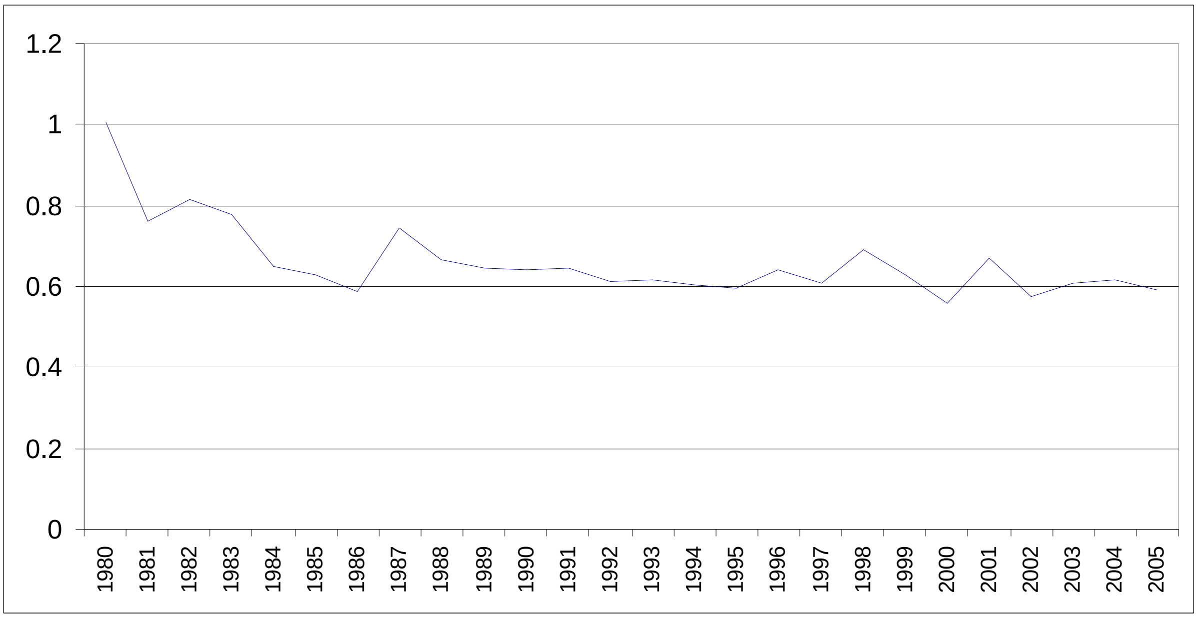


Figure 6.2.3.1b - Plaice VIId. Mean weights in the landings for ages 4 to 8, sexes combined.

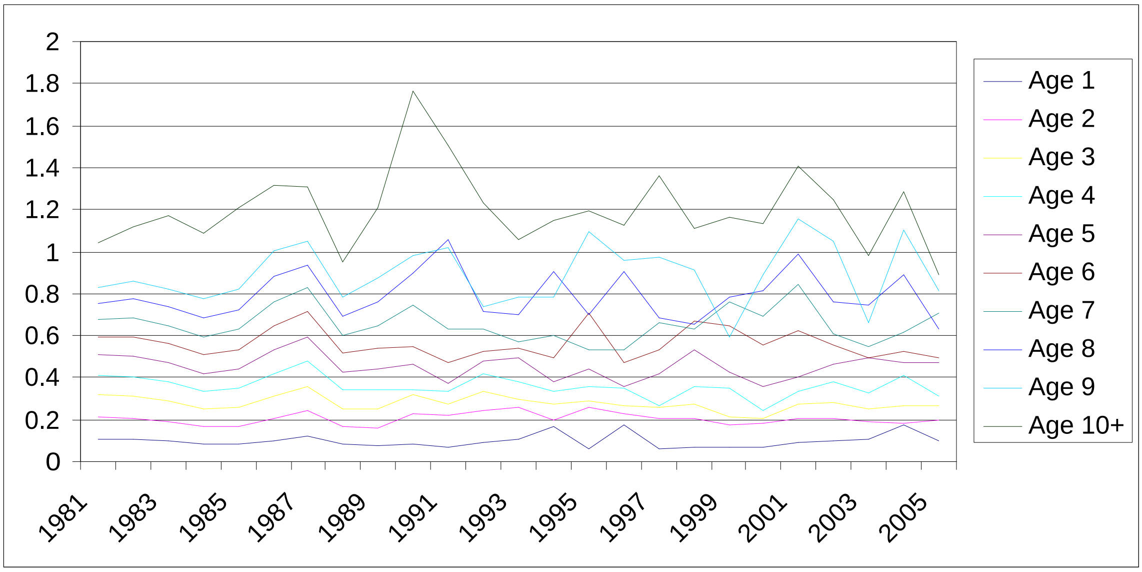


Figure 6.2.3.2 - Plaice VIId. Mean weights in the stock.

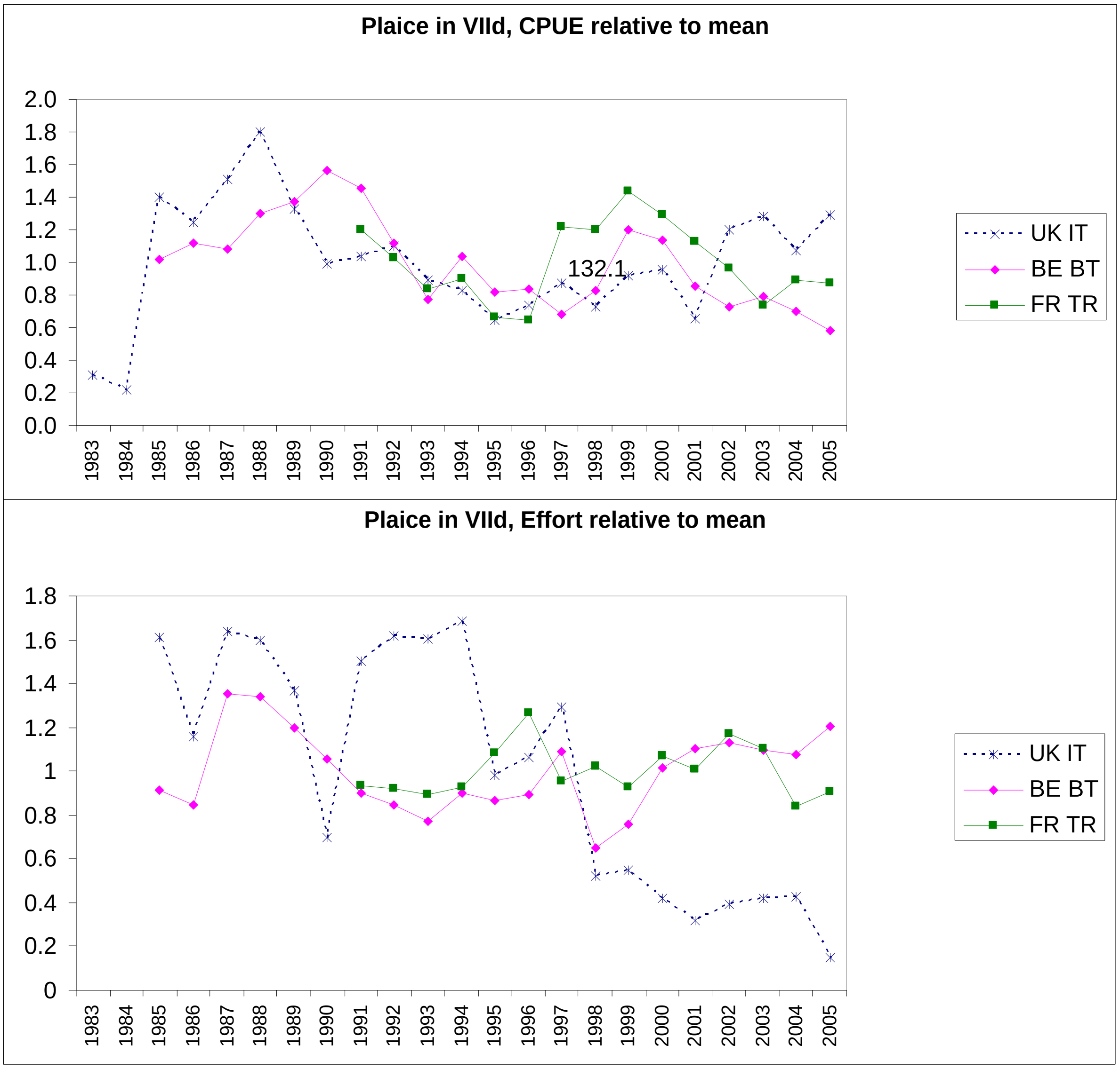


Figure 6.2.5.1 - Plaice in VIId. CPUE and effort.

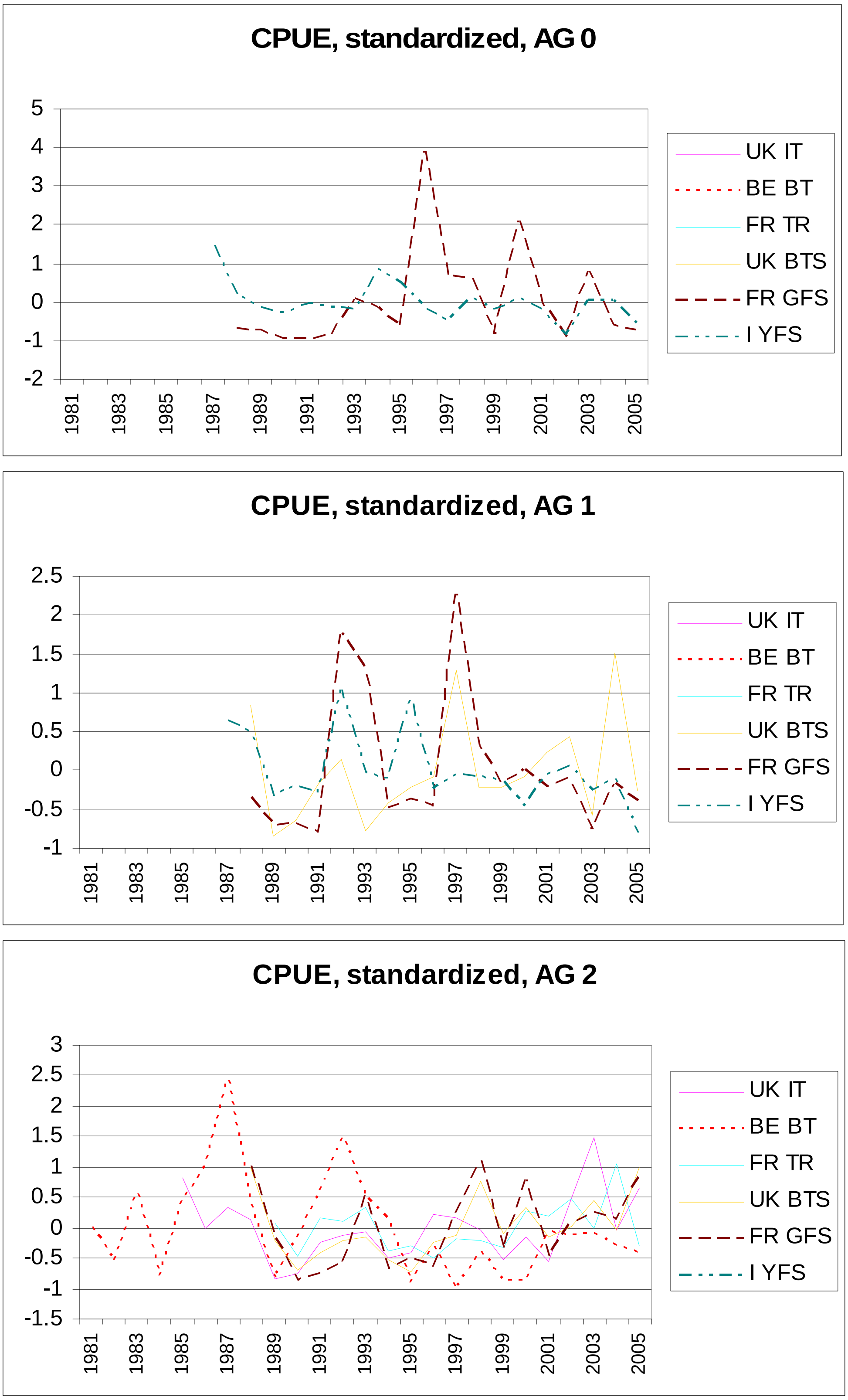
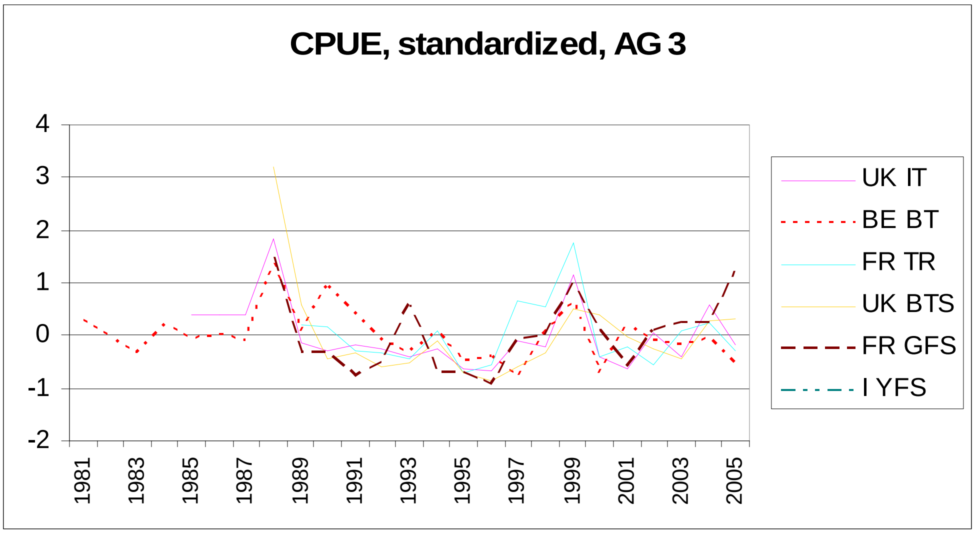
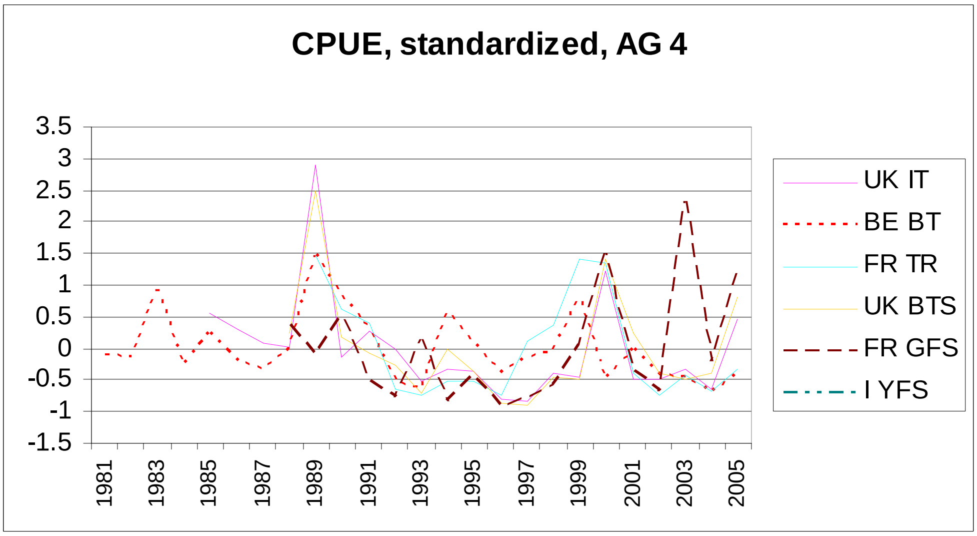


Figure 6.2.5.2 Plaice in VIId. CPUE standardized separated per fleet and age (age 0-age 2).





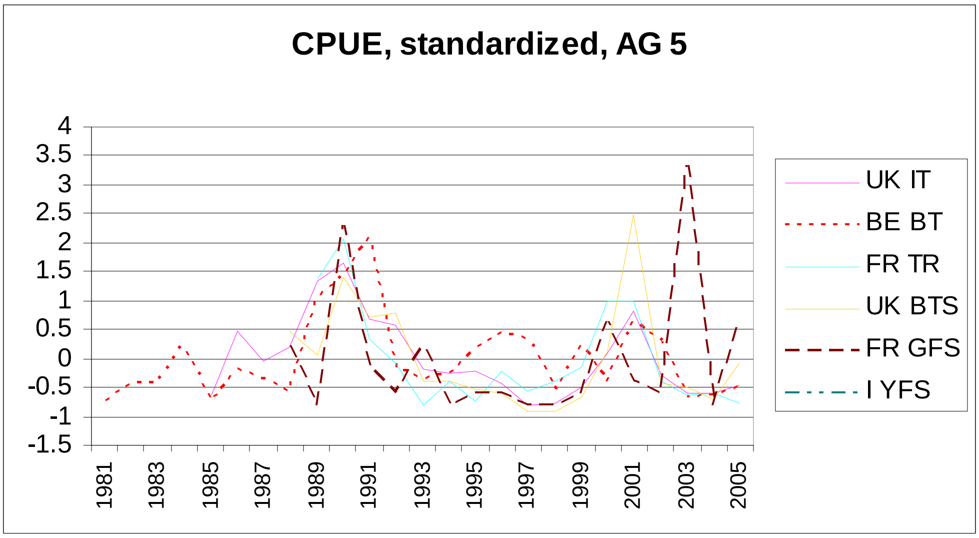
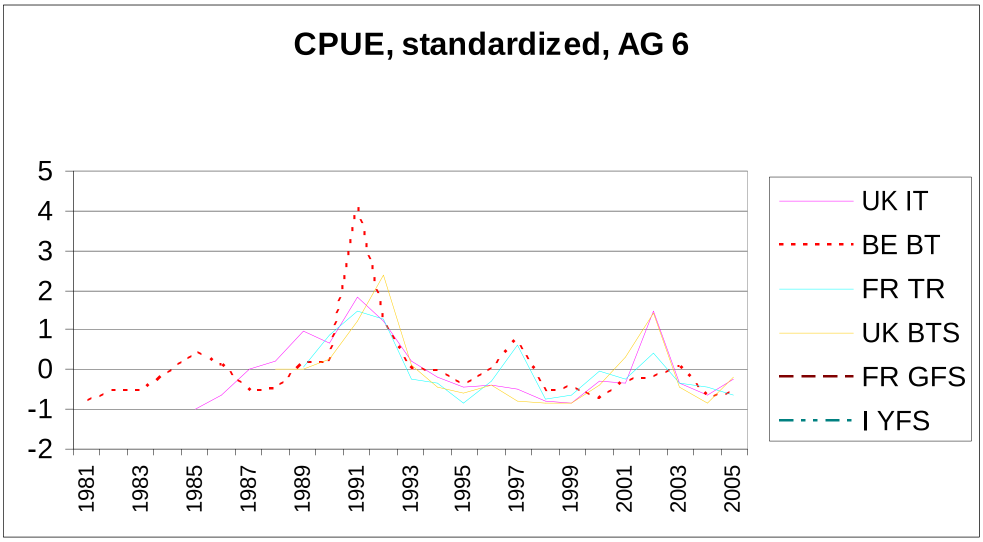
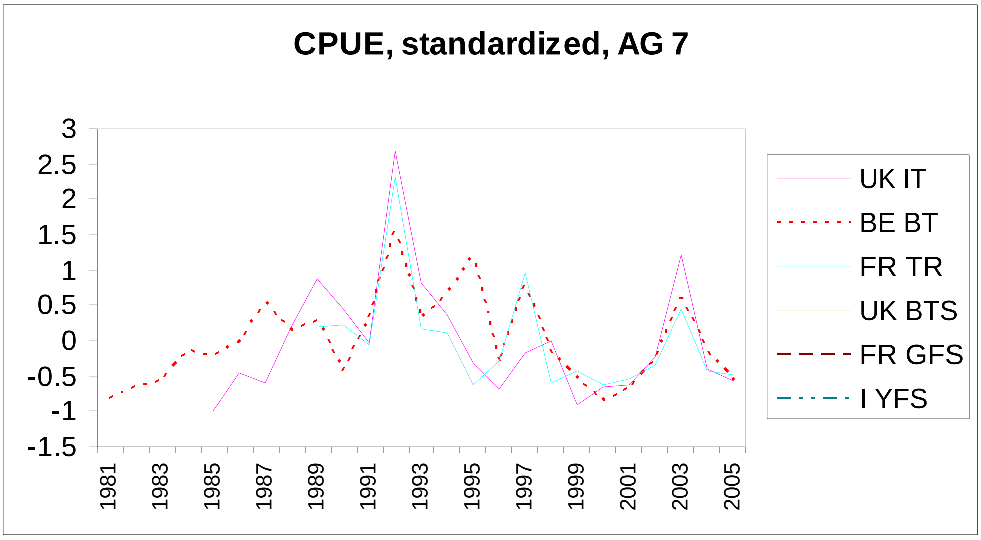


Figure 6.2.5.2 (cont.) - Plaice in VIId. CPUE standardized separated per fleet and age (age 3-age 5).





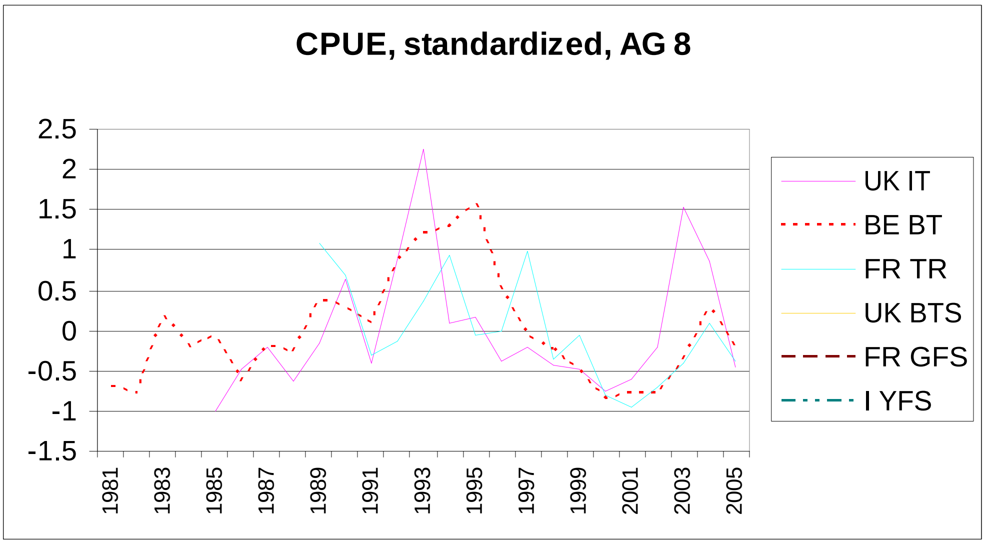
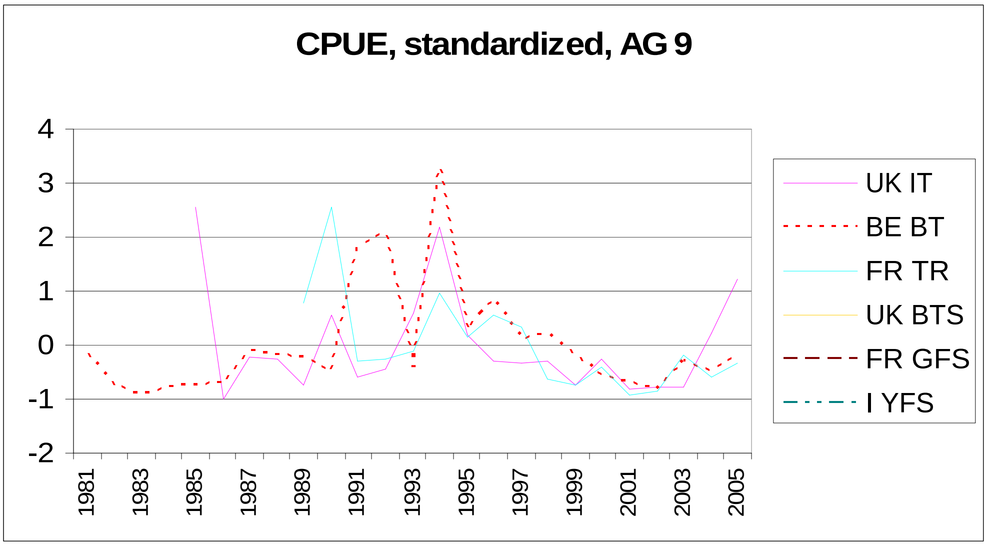


Figure 6.2.5.2 (cont.) - Plaice in VIId. CPUE standardized separated per fleet and age (age 6-age 8).



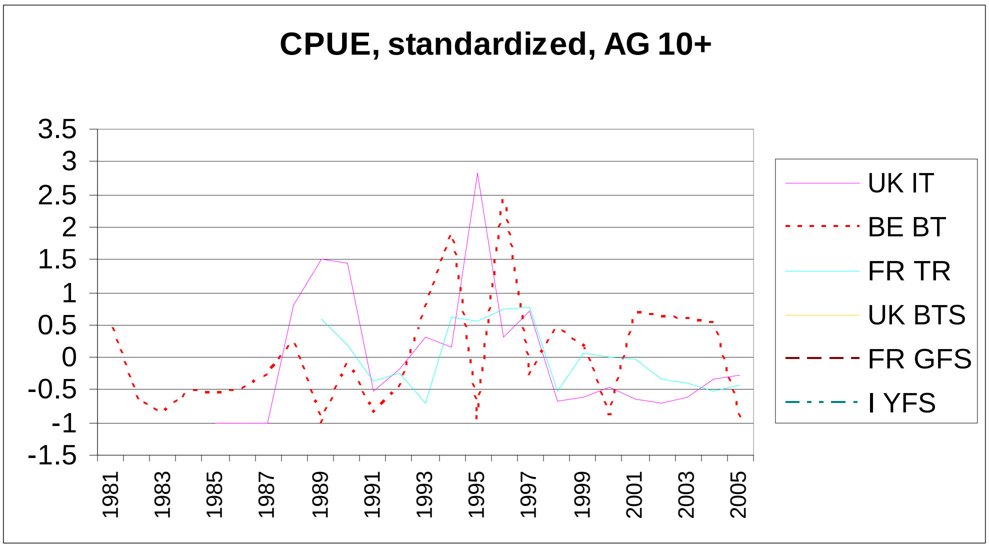


Figure 6.2.5.2 (cont.) - Plaice in VIId. CPUE standardized separated per fleet and age (age 9-age 10).

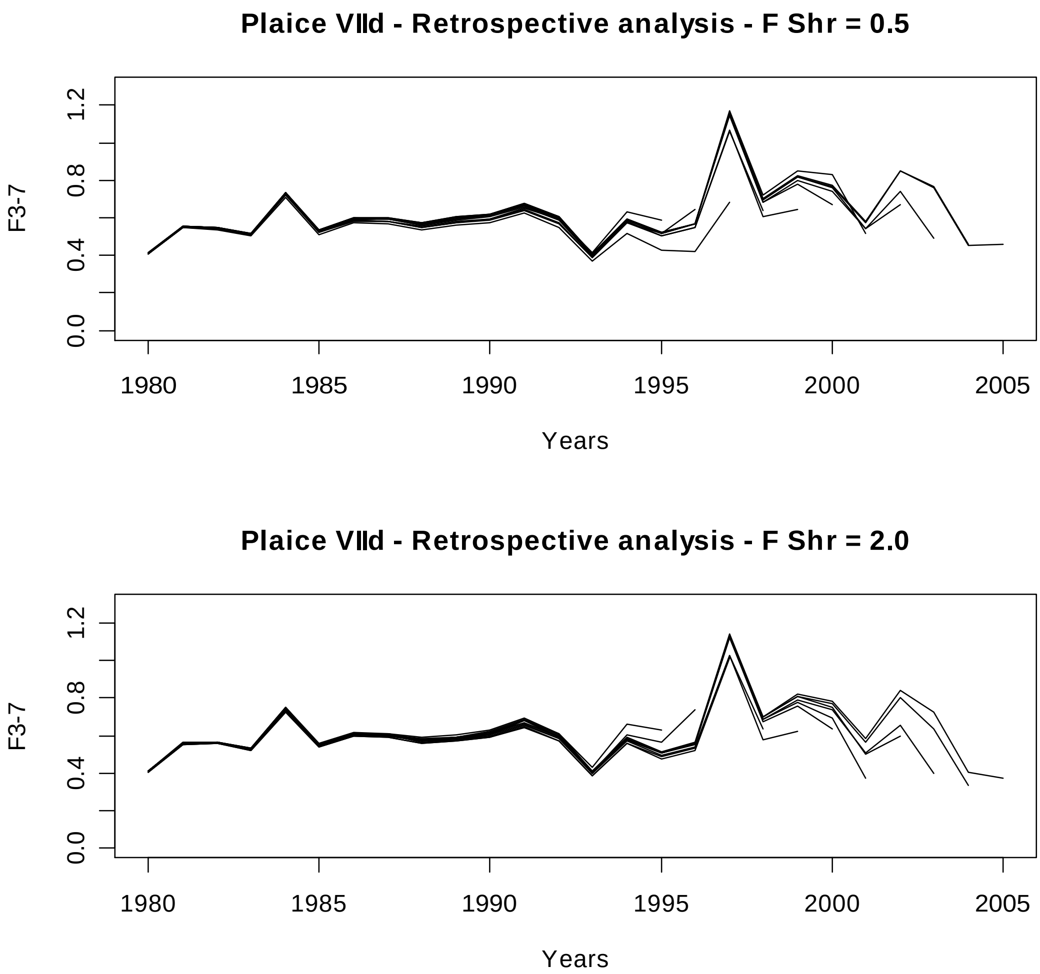


Figure 6.3.2.1: Retrospective analysis with F shrinkage = 0.5 and F shrinkage = 2.0.

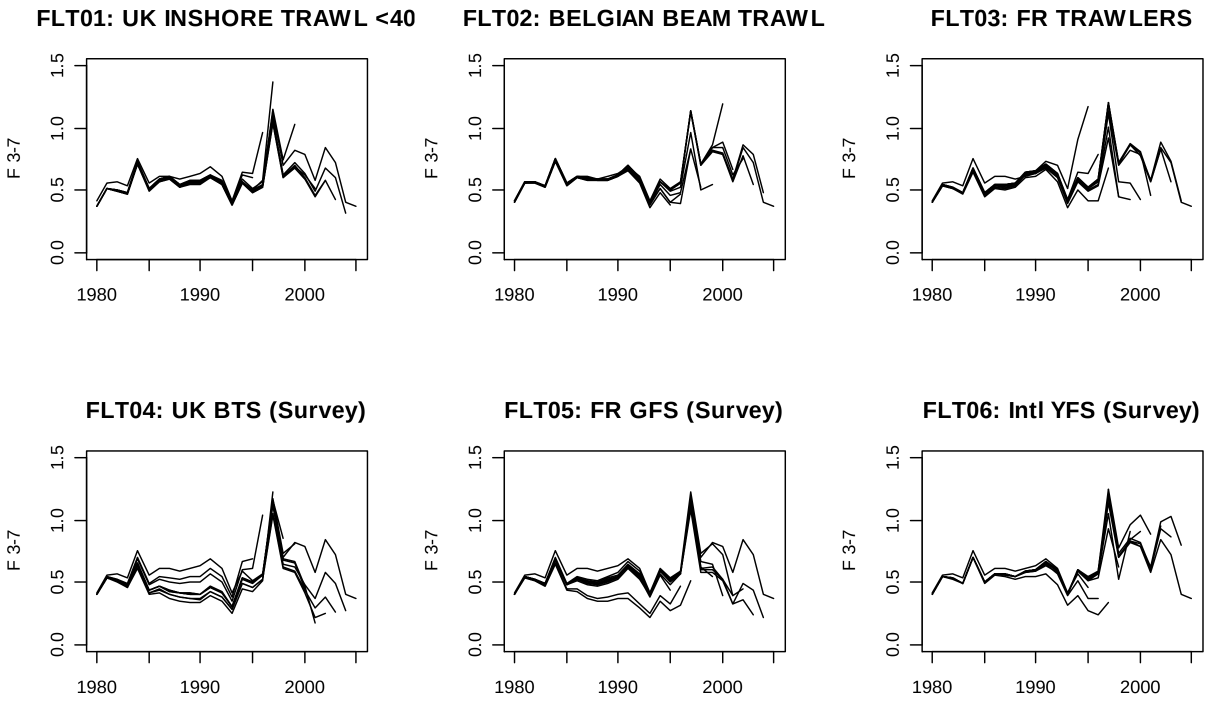
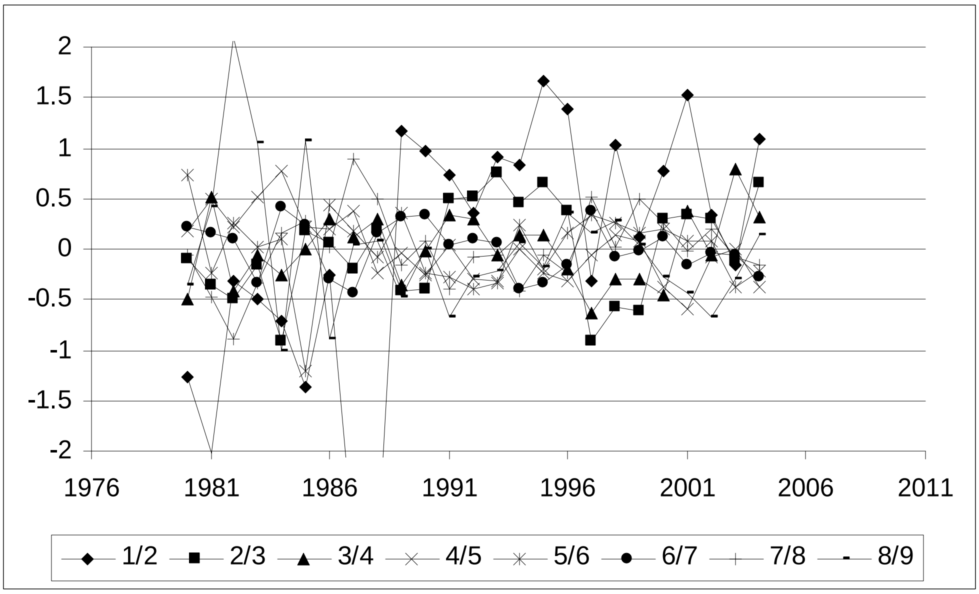


Figure 6.3.2.2 Single fleet Retrospective analysis (F Shr = 2.0).



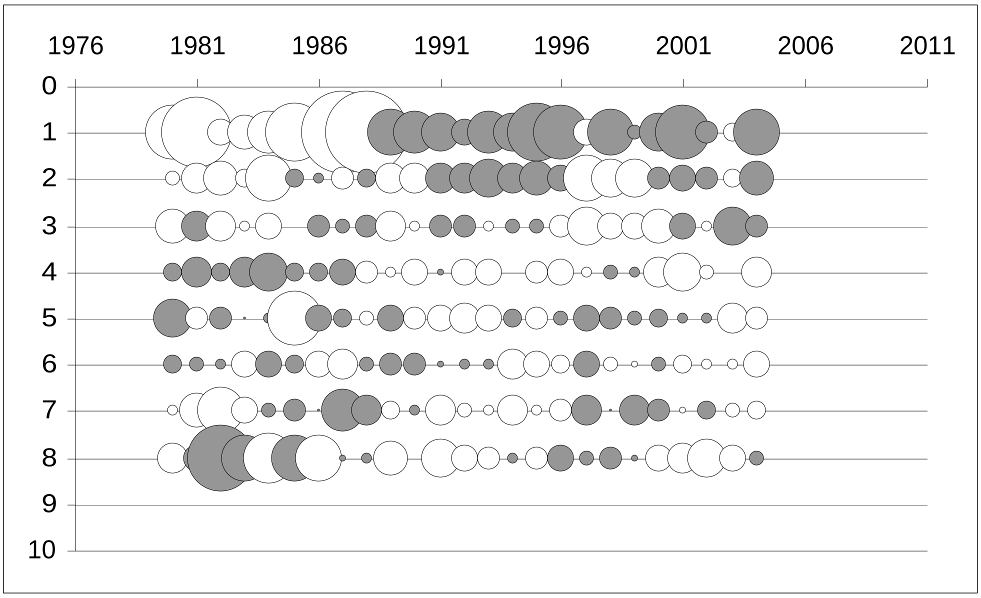


Figure 6.3.2.3. - Plaice in VIId. Separable VPA.

Figure 6.3.2.4a - Plaice in VIId. Log q residuals for the single fleet runs (Laurec-Shepherd tuning with shrinkage 2.0).

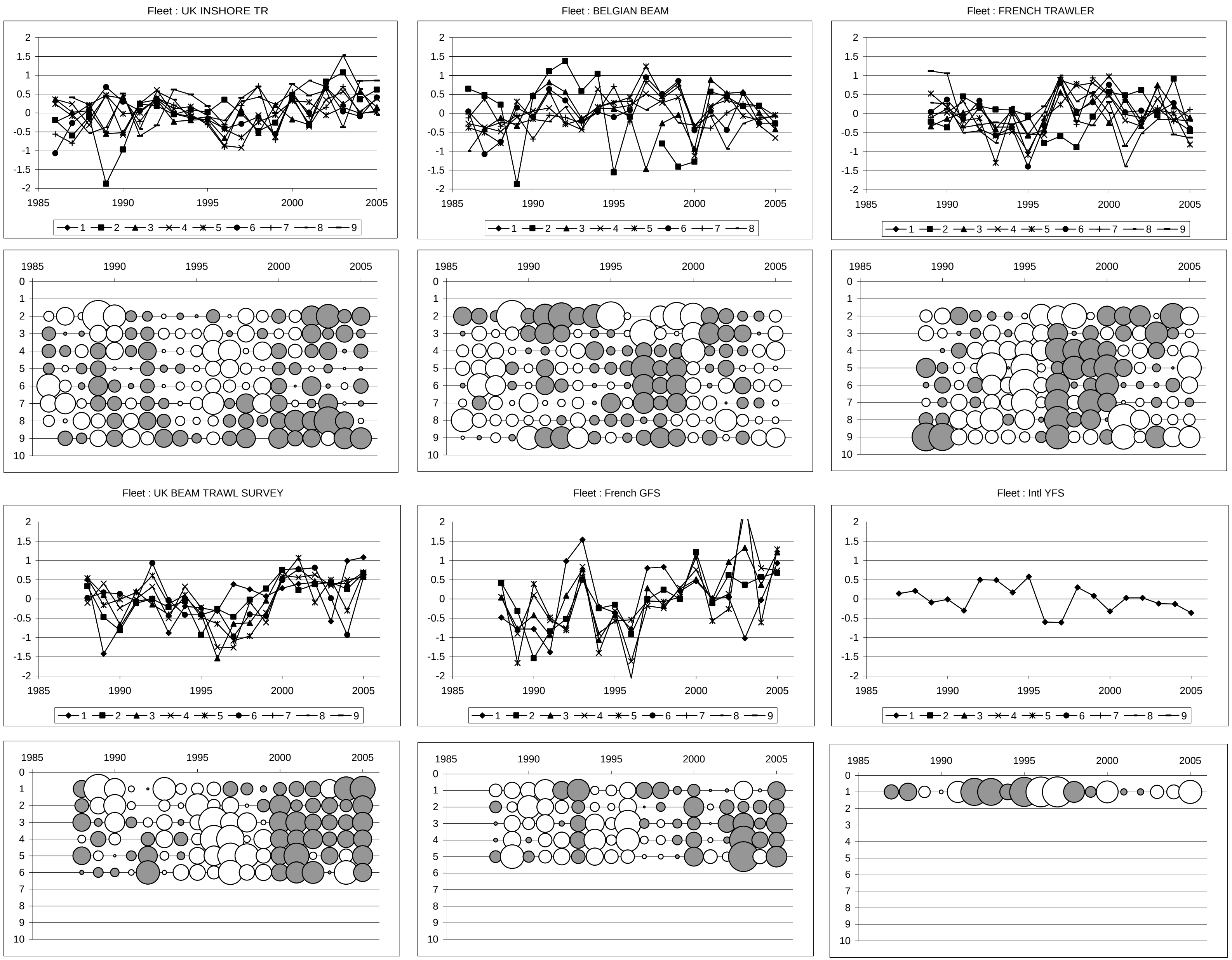


Figure 6.3.2.4b - Plaice in VIId. Log q residuals for the single fleet runs (XSA tuning with shrinkage 0.5.

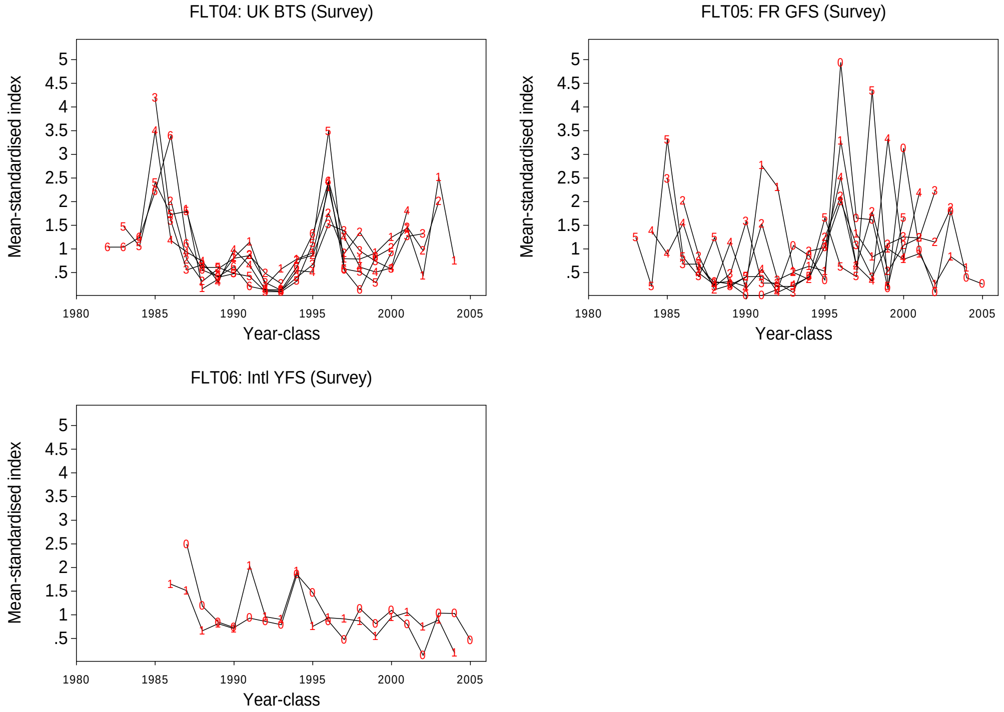


Figure 6.3.3.1. - Plaice VIId. Mean standardised indices by year class for each of the surveys.

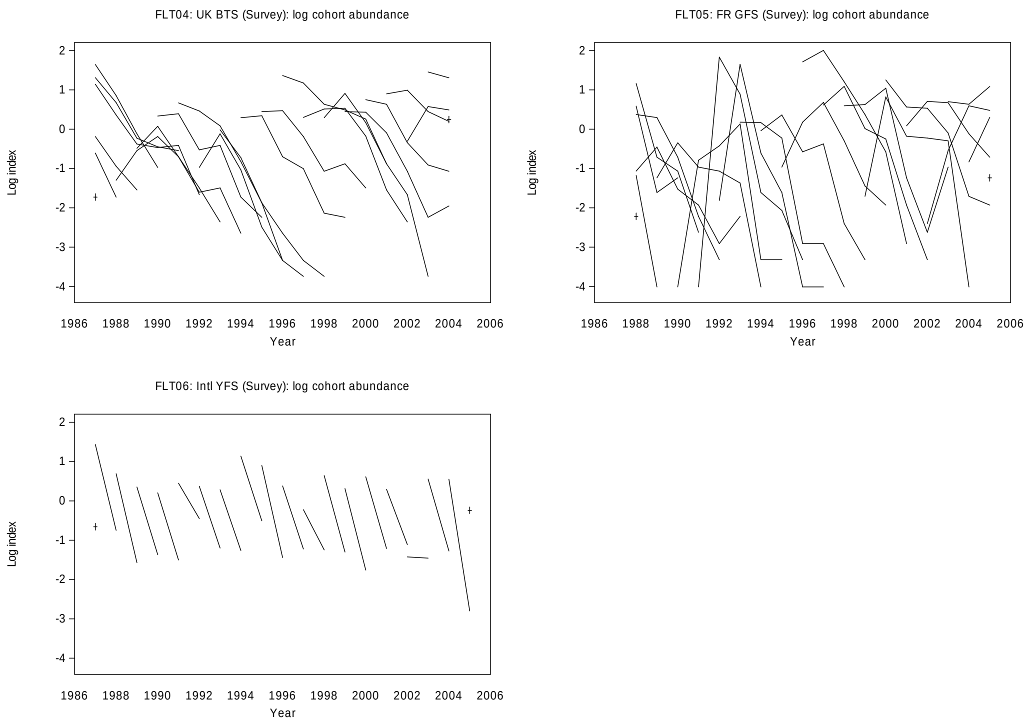


Figure 6.3.3.2 - Plaice VIID. Cohort curves for surveys.

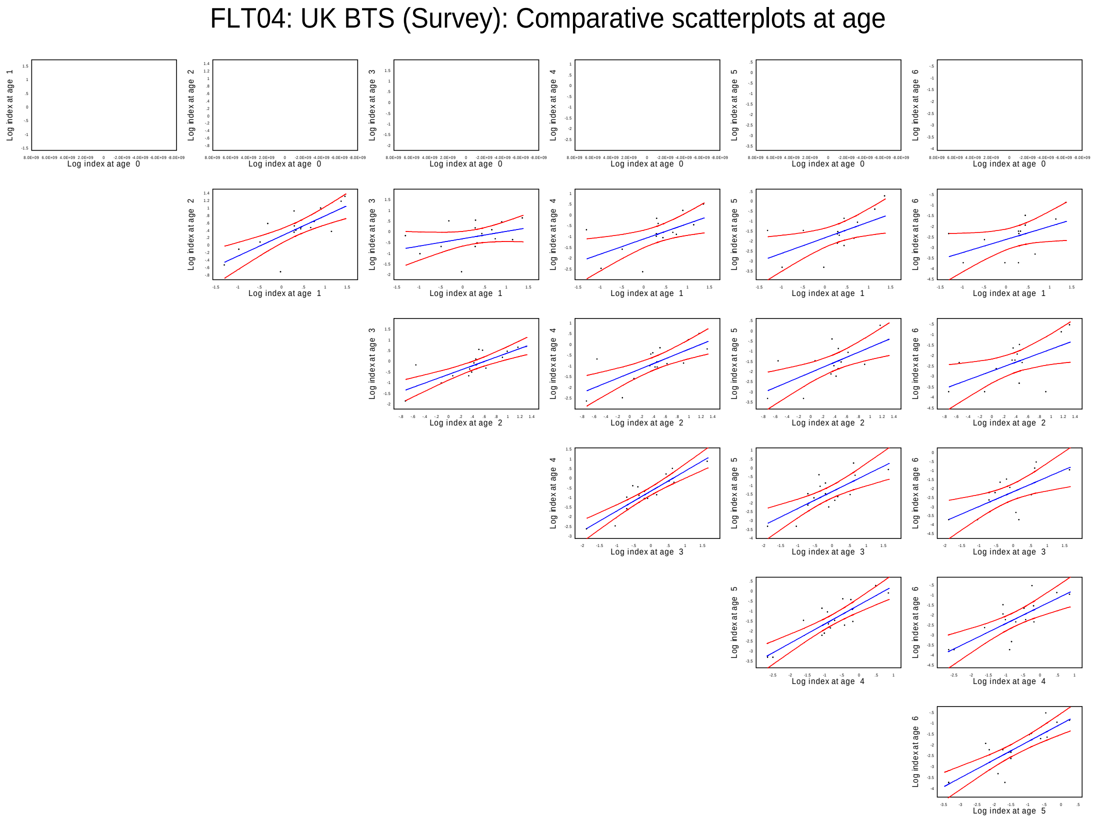


Figure 6.3.3.3 - Plaice 7d. Internal consistency of the UK Beam Trawl Survey.

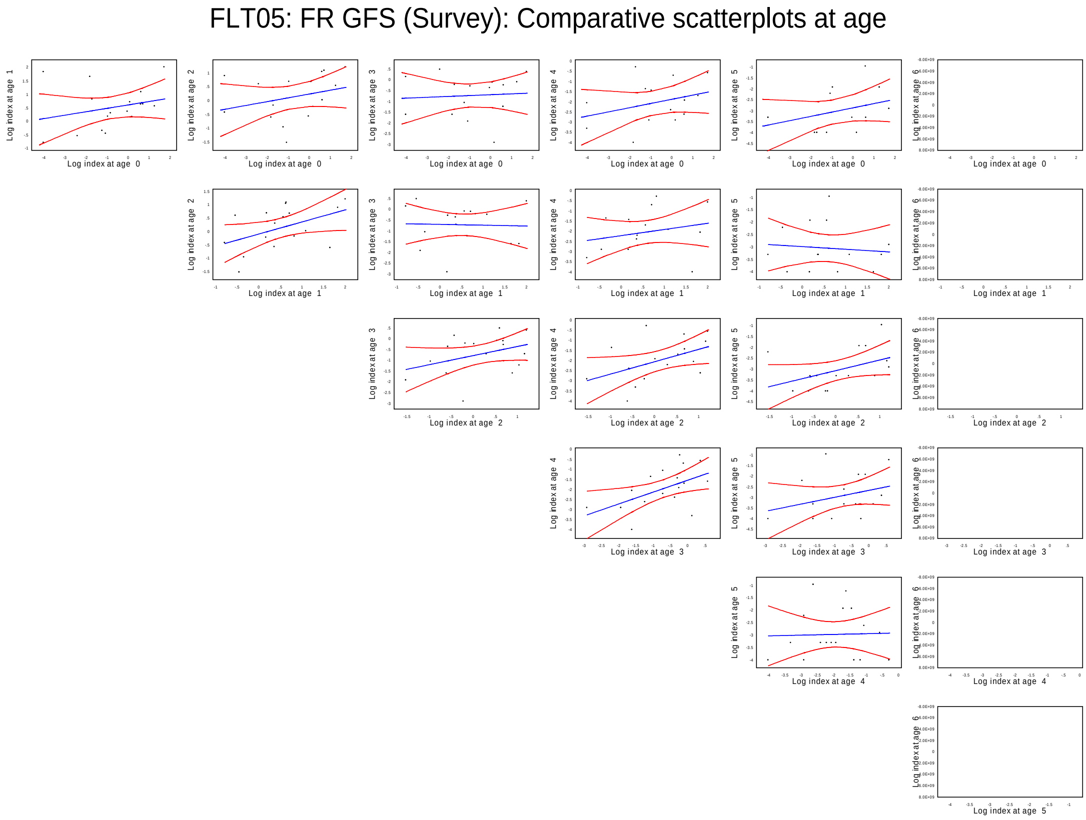


Figure 6.3.3.4 - Plaice 7d. Internal consistency of the French GFS.

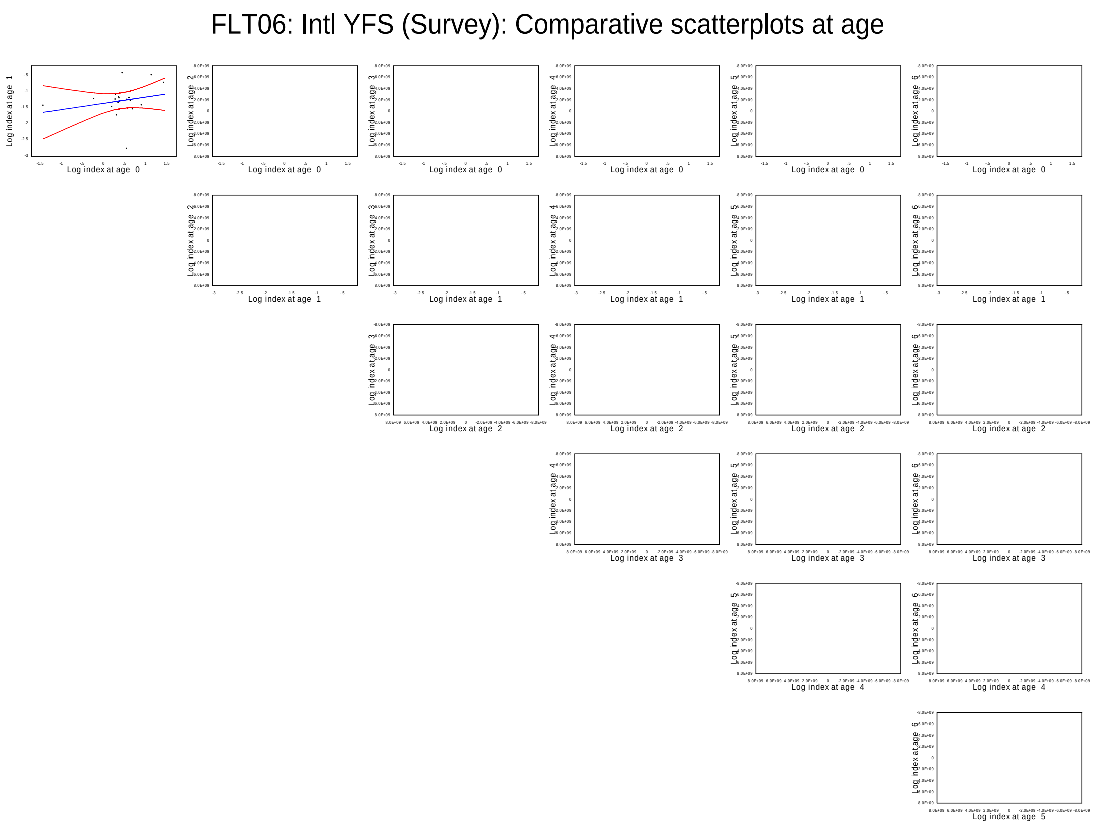


Figure 6.3.3.5 - Plaice 7d. Internal consistency of the International YFS.

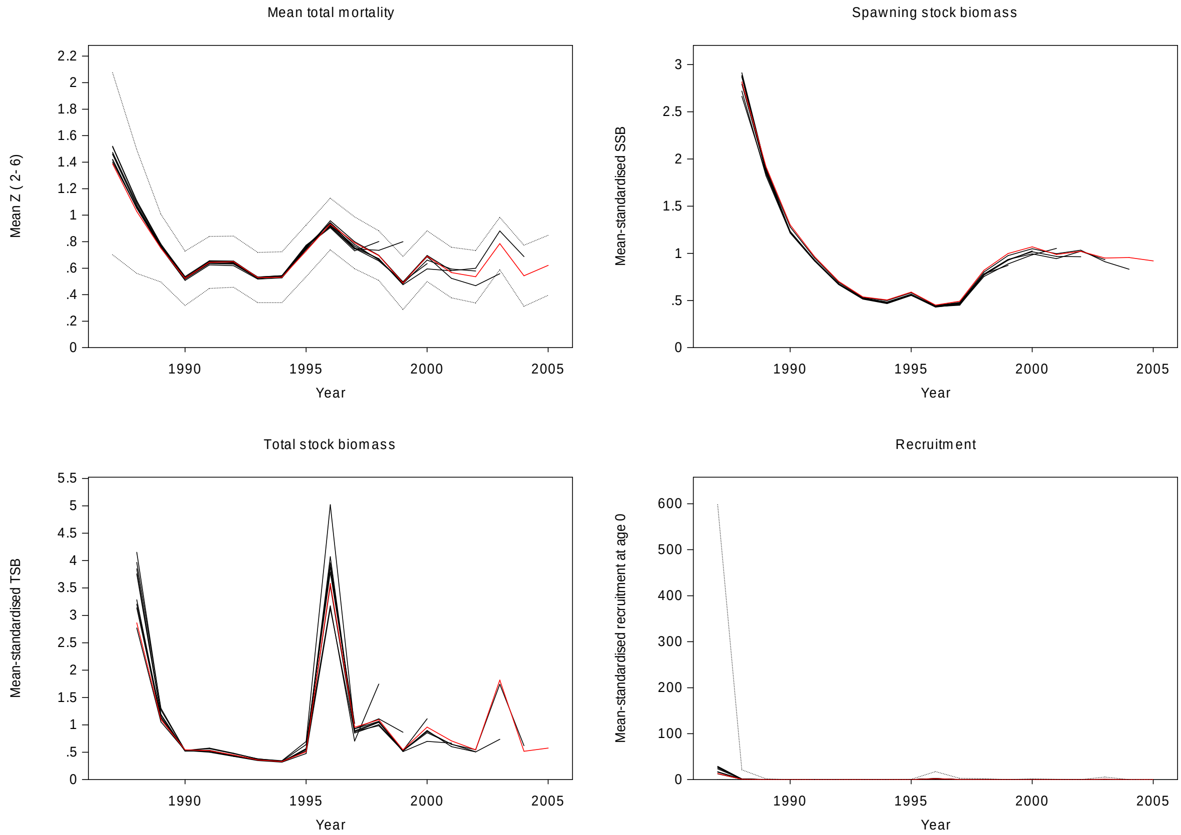


Figure 6.3.3.6 - Plaice VIId. Summary plots of the retrospective analysis from SURBA.

Figure 6.3.4.1 - Plaice VIID. Comparison of the mean standardised values of SSB, F and recruitment derived from XSA and SURBA models.

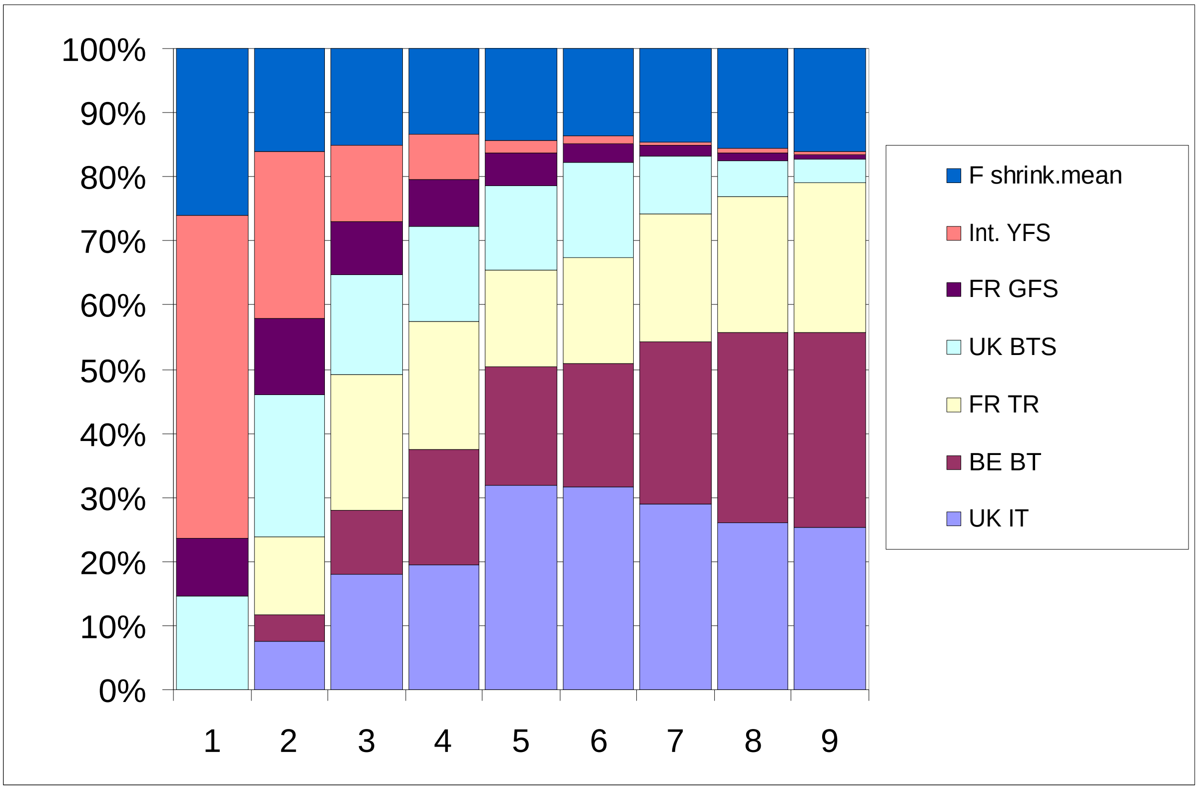


Figure 6.3.4.2. - Plaice VIId. Contributions of the different fleets to the estimators at age.

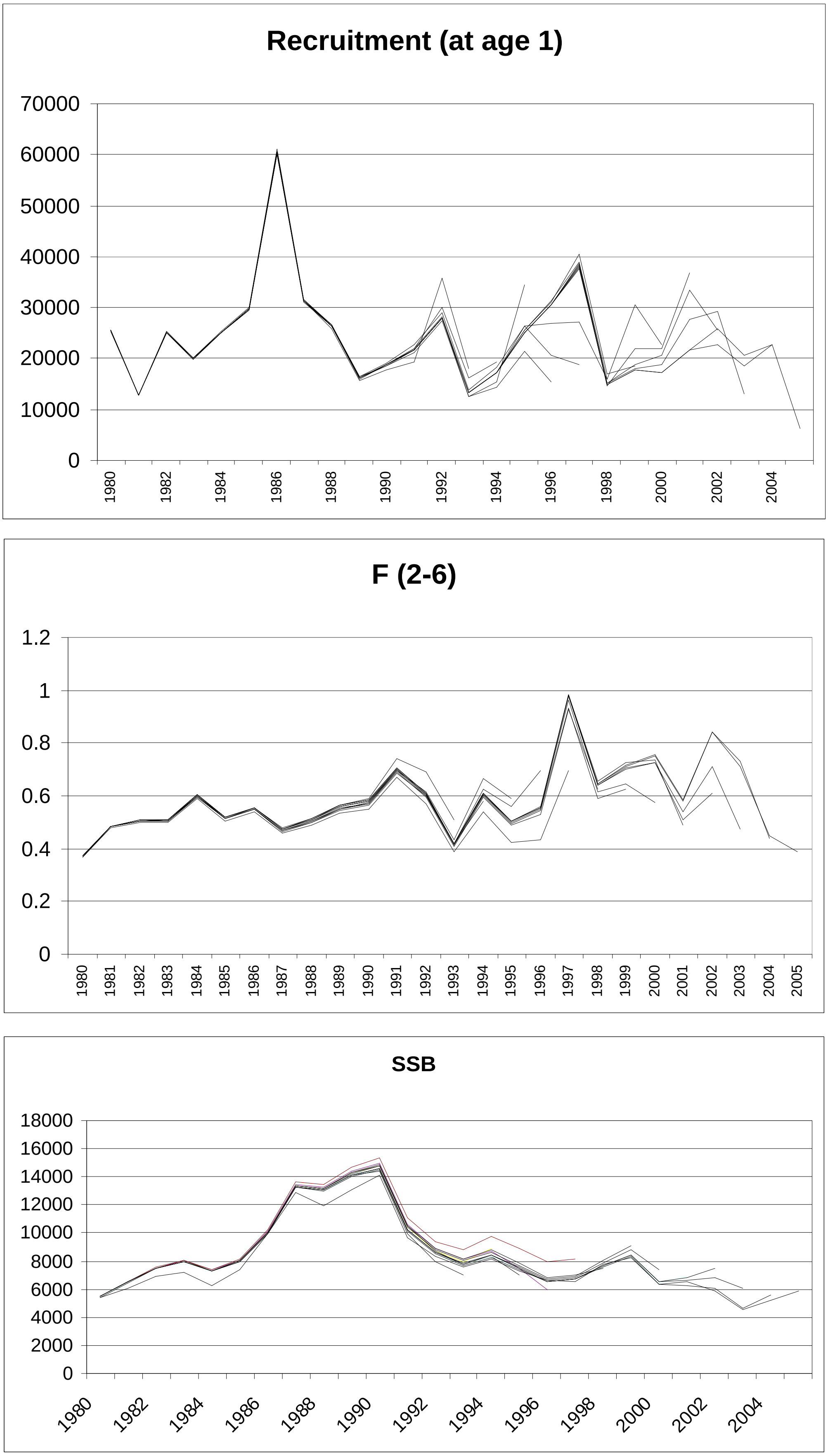


Figure 6.3.4.3 - Plaice in VIId. Retrospective analysis.

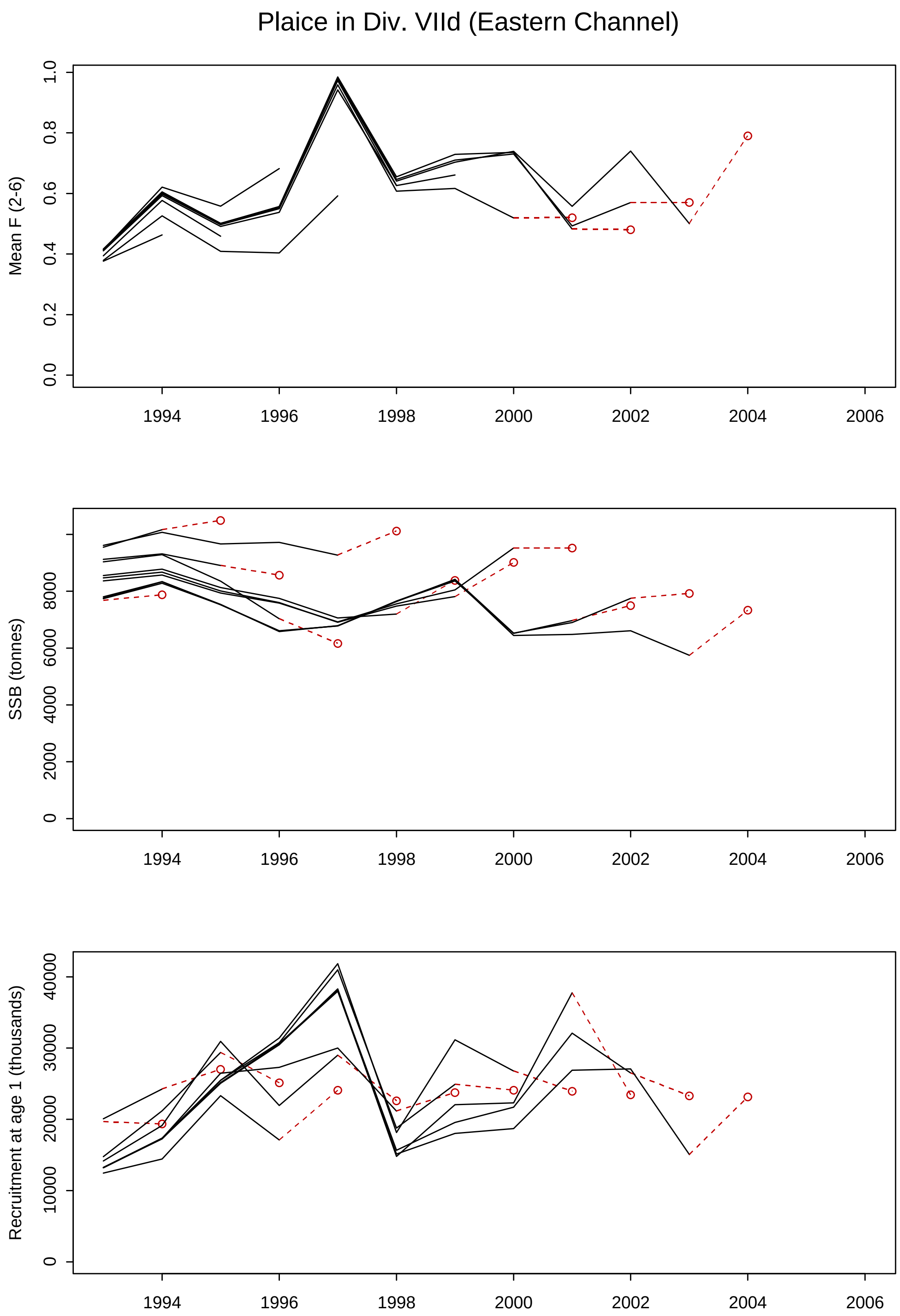


Figure 6.9.1. Plaice in VIId. Historical performance of the assessment. Circles indicate forecasts. Note that neither the 2005 nor 2006 WGNSSK meetings concluded a final assessment for this stock.

7 PLAICE IN DIVISION IIIa

This year plaice in IIIa is a benchmark assessment. A number of issues to be dealt with in this benchmark assessment have been summarised in previous WGNSSK reports. These issues focus mainly on addressing the high retrospective pattern in F and SSB and the high variation in F between recent years; issues that have caused the WG to reject the analytical assessment in 2004 and 2005.

A potential extension of the stock beyond its current assessment area, i.e. into the Belt Sea (Baltic Area 22) is examined in this assessment. If a relationship exists between the Kattegat and the Belt Sea, the variable F between years could be explained by a mix of the stock over the border to the Belt Sea and subsequent fishery on these components. Therefore, scenarios including catches of plaice in the Belt Sea have been included in this assessment, although not finally adopted by the WG. A summary of the biological knowledge for this potential stock structure is provided in section 7.1.5.

Other issues in the benchmark assessment have focused on selection of fleets and their effort standardisation, in order to achieve more accurate commercial tuning fleet definitions. Maturity at age and weight in stock have been established from surveys and used in assessment. Further, an 0-group survey index has been established primarily for strengthening the knowledge of recruitment in forecast.

7.1 General

7.1.1 Ecosystem aspects

Recent modeling results predicted a significant large impact of the increase of macro algal bed on plaice recruitment along the Skagerrak coasts due to eutrophication (Pihl et al., 2005). According to this study, up to 45 mill. individuals could be lost in years with large settlement due to algal blooms. However, those results were not supported by recent year classes, which are estimated to be the largest in the time series since 1978.

Also, there are no indications of major contracting/expanding of the distribution area of plaice in correspondence of high stock abundance in the Skagerrak-Kattegat (Casini et al., 2005). This would support the CPUE from survey as a reliable age class estimator.

7.1.2 The fishery in 2005

A general description of the fishery is given in the Stock Annex (Q7).

The fishery is conducted from spring to autumn by Danish seiners, flatfish gillnetters and beam trawlers with Danish landings usually accounting for more than 90% of the total catch (Figure 7.1.1). Plaice are also caught within a mixed cod-plaice fishery by otter trawlers, as by-catch of other gillnet fisheries and as by-catch in the directed Nephrops fishery.

7.1.3 ICES advice applicable to 2005 and 2006

In 2004, ICES recommended for 2005 that fishing mortality should be less than Fpa, which was to the current levels of exploitation. ICES noted that attention should be paid to the mixed fisheries context, where both North Sea and Kattegat cod stocks, which are caught together with plaice, are well below Blim.

There was no basis for an analytical forecast in 2005. Fishing mortality in 2006 should not be allowed to increase which may be achieved by allowing landings of less than 9 600 t in 2006, which is the average of landings of the last four years.

7.1.4 Management applicable in 2005 and 2006

TAC in 2006 was 9 600 t, a small increase compared to the TAC of 9 500 t in 2005. The TAC was split between Skagerrak and Kattegat, with 7 680 t and 1 920 t, respectively.

In February 2003 new regulations in the plaice fishery in IIIa were put in force in order to reduce by-catches of cod. If the mesh size was larger than or equal to 80 mm in the beam trawler and larger than or equal to 100 mm in the demersal trawls and seiners, fishing days were reduced from 25 to 9 per month (EU regulation L 97/12). Information from the net producers suggests that such a shift in mesh size have not been applied although logbook information shows a large decrease in vessels with mesh size greater than 100 mm

For 2006 Council Regulation (EC) N°51/2006 allocates different days at sea depending on gear, mesh size and catch composition. (see section 2.1.2 for complete list). The days at sea limitations for the major fleets operating in Div. IIIa could be summarised as follow: Trawlers or Danish Seiners can fish between 103 and unlimited days per year. Gillnets are allowed to fish between 140 and 162 days per year and Trammel nets are allowed to fish 140 days.

An effort management scheme for fisheries in Kattegat is presently under development and is proposed to be put in force by 1. January 2007. The effort measure will be kW-days. The Effort Management Scheme is expected to be constructed with a multi-annual perspective, but subject to possible annual adjustments/changes if and when needed.

The new scheme will in the longer term require separate catch projections for Kattegat. The scheme will be managed by a Kattegat Management Committee that will report regularly to the NSRAC (North Sea Regional Advisory Council).

7.1.5 Stock structure of plaice in Skagerrak, Kattegat and adjacent waters

Spawning has been observed in several places in the central part of Kattegat in late February and early March also in Skagerrak spawning has been observed although the extent seem insignificant (Poulsen 1939). Recent observations agree with previous records (Nielsen et al. 2003). Egg and larvae distribution supports such a perception, as the major part of observed drifting eggs are allocated in the southern Kattegat and only small numbers have been observed in northern Kattegat and Skagerrak. Eggs and larvae observed in Skagerrak are supposed to have their origin in the North Sea (Johansen ,1908). Migrations of adults as observed by tagging experiments suggest a small mixing of fish between Skagerrak and Kattegat, while most recaptures showed a resident behaviour in the Kattegat and Belt Sea areas. However, the material is not yet fully analysed, i.e. with regard to calibration of fishing effort and also seasonal patterns (Johansen 1908 and Blegvad 1934). Tagging information (Ulmestrand pers comm.) and studies on larvae distribution in SD 20 indicated that plaice in this area plausibly recruits from the North Sea and returns there for spawning. The suggested mixing of the stocks within Kattegat and the Belt Sea is also supported by meristic studies of anal fin rays (Jensen and Nielsen 2005). Within Kattegat a steady decrease in mean numbers of anal fin rays is observed in a southern direction, with no particular abrupt deviation from the continuum. This is interpreted as eggs and larvae are spread in the water masses from the same spawning area, but being exposed to slightly different temperature depending on drifting pattern for the single egg/larvae.

However, Swedish survey information (RV ANCYLUS) indicates spawning in SD 23 (The Sound) where the oceanographic and bottom features of the area are similar to SD 22.

In conclusion, plaice in Skagerrak and Kattegat intermingle, although Skagerrak plaice might be recruited partly from the North Sea. Kattegat plaice seem also connected to plaice in the Belt Sea, as Belt Sea plaice are probably recruited from Kattegat. Although few or no studies have focused on the affinity to plaice in the western Baltic, increasing catches in this area could be associated with favourable conditions that led the Kattegat/Belt Sea stock to expand into this area, as it is not assumed that spawning condition are suitable in the Baltic for plaice.

The WG did not consider the above information conclusive to make any decision on whether to expand the plaice IIIa assessment to include area 22. Therefore, the basis for advice on catches in 2007 is still based on a stock unit in IIIa.

7.2 Data available

The following text table indicates sampling levels for IIIaN, IIIaS and Baltic Area 22 (see also Section 1.2):

SAMPLING IN 2005					
lllaN	Skagerak				
Quarter	1	2	3	4	Total
Nos samples	3	4	7	1	15
Nos length meas	774	877	754	392	2797
Nos aged	743	866	737	381	2727
lllaS	Kattegat				
Quarter	1	2	3	4	Total
Nos samples	6	5	5	4	20
Nos length meas	459	481	481	487	1908
Nos aged	453	475	476	481	1885
Area 22	Belt Sea				
Quarter	1	2	3	4	Total
Nos samples	0	1	1	2	4
Nos length meas	0	227	206	184	617
Nos aged	0	224	204	184	612

7.2.1 Landings

The official landings reported to ICES are given in Table 7.1.1. The annual landings used by the Working Group, available since 1972, are given by country for Kattegat and Skagerrak separately in Tables 7.1.2 and 7.1.3. In the start of this period, landings were mostly taken in Kattegat but from the mid-1970s, the major proportion of the landings has been taken in Skagerrak and in 2005 more than 80%. Sampling from commercial fishery for plaice in IIIa in 2005 was conducted by Denmark, Sweden and Netherlands (Table 1.2.1). According to official tables (German landings) and national statistics (Danish, Swedish and Dutch landings) total landings in 2005 were estimated at 6905 t considerably lower than 2004 (Table 7.1.1). Danish landings from 2006 up to now, compared to those obtained at the same time last year is higher and quite consistent with previous landings (2003 and 2004) (Figure 7.1.1). Since 2003 a Dutch beam-trawl fishery began fishing in Skagerrak (IIIa), with annual catches of about 1500 tonnes in 2003 and 2004 and 1000 t in 2005.

Previously, potential misreporting has been considered to occur in the area between the North Sea and the Skagerrak, as ICES rectangles at the border distribute in both areas (rectangle nos..43F8,), and thus fishery in the rectangles can be reported in either of the areas. In recent years a substantial fishery has been reported in the rectangle as caught in Skagerrak. However, information from the fishery suggest that the fishery actually takes place in the Skagerrak part of the rectangle and further that there is no incentive for mis-reporting either from Div. IV to IIIa or visa versa.

Discard information has been sampled in 2005 but presently not available for the assessment.

7.2.2 Age compositions

Age compositions of the landings are presented in Table 7.2.1. Age-disaggregated Swedish and Danish samples were available for 2005 and used in the total landings for age estimation. These year classes do not show as clear a signal in the landings as in the surveys although the 1999, 2005 and 2003 are the 2^{nd}, 3^{rd} and 4^{th} strongest year class as age group 2 in the time series.

7.2.3 Weight at age

Weight at age in landings is presented in Table 7.2.2. The procedure for calculating mean weights is described in the Stock Annex (Q7).

Weight at age in the stock has previously been assumed equal to weight at age in the catch due to unavailable data on stock weights. This year data were made available from IBTS 1^{st} quarter (1991-2005) and KASU 1^{st} quarter (1997-2005) in IIIa (Table 7.2.3 and Figure 7.2.1.). Only 1^{st} quarter surveys were used to calculate mean weights in order to generate the stock at the beginning of the year. Only age groups 1-4 were used from surveys as ages 5 and 6 were contradictory and considered too noisy. For older age groups weight at age in 1^{st} quarter were computed from landings sampling in the time period 1995-2005. Before 1995 no information on weights per quarters was available. In summary compilation of stock at age are as follows:

- For age 1-4 (1997-2005) an average between the mean weight in the KASU and IBTS survey was used.
- Age 1-4 (1991-1996) mean weight from the IBTS survey was applied.
- Age 1-4 (1978-1991) an average from 1991-1995 (IBTS) was used as fixed value.
- Age 5-11 (1995-2005) mean weight from the commercial fleet.
- Age 5-11 (1978-1994) an average from (1995-1998) was used as fixed value.

7.2.4 Maturity and natural mortality

Natural mortality is assumed constant for all years and is set at 0.1 for all ages.

Previously, maturity was assumed knife-edge distributed: age group 2 was considered immature whereas age 3 and older plaice were considered fully mature. This year a maturity-at-age was established based on IBTS 1^{st} quarter data. Maturity data has been estimated in IBTS from 1991, but the first three years data were considered too noisy (Figure 7.2.2). As especially age group 2 shows a high variability between years and this age group to a large extent contributes to the stock numbers a fixed average value per age were applied. An average from the time period 1994-2005 were used for the entire timeframe (Table 7.2.4). In 2005 a decrease in maturity were seen for all age groups, the decrease could be caused by recruitment of the large 2003- year class, making maturity in the stock density depended. If the observed maturity-at-age values had been applied instead of a fixed value, SSB in 2005 had been downgraded by 30%.

7.2.5 Catch and effort data

7.2.5.1 Improvement of fisheries data

It has for several years been recognised that the categorisation of tuning fleets into trawlers, seiners and gillnetters are arbitrary units, which each include a wide range of subsets from targeting to by-catch fleets. Therefore it has also been recognised that more accurate commercial tuning fleet definitions and estimation should be considered for stock assessment.

Consequently, some intersessional work was conducted in 2006, to investigate the possibility of deriving and testing alternative commercial tuning fleets. The main purpose was to identify relatively simple datasets as reference fleets, and to compare various measures of effort and standardisation methods.

Ulrich and Hamon (WD 14) investigated the impact of using alternative commercial tuning series for the assessment of plaice IIIa. Extraction procedure for input data have been revised, and for each fleet three subsets of trips, two effort measures and 4 standardisation methods were tested (72 runs). Runs are compared through single fleets XSA using FLR, and their performance is evaluated with respect to the catch matrix by three objective synthetic indices. Main results are that the previous fleet series should not be kept because they are not consistently estimated, and that fishing days standardised by kW are performing best for all fleets. The study thus proposes a revision of the commercial tuning series to be used in the assessment of plaice in IIIa. The fleet revision is conducted in three steps: i) new definition of fleets, ii) new standardisation of effort and iii) objective choice of fleet/standardisation method by means of internal consistency analysis.

7.2.5.2 New fleet definitions

The new landings at age file was merged by trip with a Danish logbook database (EFLALO). From that, a number of subsets could be extracted, covering various definitions of tuning fleets. A similar methodology is also used for the Eastern Baltic cod assessment (ICES-WGBFAS 2005). The subsets are:

- GEAR subset. This subset is similar to SPALY, i.e. all trips having non-zero catches of plaice are retained, and are summed up by main gear (trawl, gillnet, Danish seine). This subset covers 75% of the landings and 95% of the nominal effort over 1995-2005.
- METIERS subset. This subset follows the work from Ulrich and Andersen (2004), where a number of fisheries were identified for each type of gear. These fisheries showed to target very different types of species, and the effort directed towards other species might bias the perception of the LPUE. On the contrary, retaining only the trips directly targeting plaice would also be misleading, as they would show higher LPUEs only. Furthermore, it is questionable whether the main species in the landings is necessarily the target species. Decision was made then to retain only the fisheries which are the most likely to catch plaice. This includes the fisheries (1) groundfish trawling (mesh size ≥105mm), (1) Danish seining (mesh size between 80 and 120 mm) and (3) flatfish gillnetting (mesh size ≥ 120 mm and catching flatfish mostly. For gillnets, it is considered that species assemblage is more representative of the actual target, because of the physical differences in net structure between roundfish and flatfish). This subset covers 54% of the landings and 23% of the nominal effort over 1995-2005, indicating a major removing of trips with low LPUE (72% of the effort covering 21% of the landings)
- LOCAL subset. As for the metiers subset, but limited to the vessels being actually registered in the IIIa area. The idea is to remove the opportunist vessels, which travels to the IIIa only when the LPUE are high. Smaller local vessels, which cannot travel to remote fishing grounds, might be more representative of the actual variation in abundance and could be candidate for reference fleet. This subset covers 45% of the catches and 18% of the effort over 1995-2005, indicating a removal of high LPUEs (5% of the effort covering 9% of the landings).

7.2.5.3 New procedures of effort standardisation

The Danish DFAD database includes both a measure for the total effort in days out of port (referred to as days at sea), and a species-specific measure of fishing time, calculated with regards to presence/absence of each species in the various rectangles visited during the trip (referred to as fishing days). Some years ago (ICES-WGNSSK 2000) the standardisation procedure was changed to using fishing days, and accounting for the effect of vessel length on LPUE. It was intended to test the importance of this standardisation procedure, and to evaluate the robustness of the assessment to this. Various standardisation methods were tested to each of the data sets:

- NOMINAL EFFORT – no standardisation, simple sum of days at sea and fishing days
- KWDAYS – nominal effort time vessel kW (Only the horse power class is available in DFAD, thus the kW is approximated by the middle HP of the class * 0,7355). This measure is often advocated as a simple and readily available candidate for effort measure
- GLM – similar to the current procedure. The effect of vessel length (compared to a 15m length vessel) is evaluated, through a GLM analysis of log CPUE is year, quarter and log(length /15).

7.2.5.4 Choice of fleet and standardization method

Management regulations were put in force in 2003 in order to reduce by-catches of cod in the trawl fishery: number of fishing days for trawlers operating small meshes (<100 mm) were favored by number of fishing days. This has created an incentive to misreport on the gear used and the reported landings composition has also changed dramatically after 2003, which is not considered a real change. Therefore, selection of trawlers by mesh-size (métier) is considered inappropriate.

The Danish seining is a rather homogenous fishery with respect to mesh size used and further selection by gear will not improve the fleet.

Gillnetters operate with a range of mesh sizes and in order to select the components of the fleet that target flatfishes, mesh sizes of more than 120 mm have been selected at the métier level.

The nominal effort time vessel kW (KWFISHDAYS) is suggested the best alternative to the previously used method of standardization by vessel length by means of a GLM. The remaining method of only nominal effort is not considered appropriate. Therefore, the WG selected 8 different fleet/standardization components for further comparison:

- Trawlers, Gillnetters and Seiners at the gear level standardized by KWFISHDAYS
- Trawlers, Gillnetters and Seiners at the gear level standardized by GLM (vessellength)
- Gillnetters at the métier level standardized by KWFISHDAYS
- Gillnetters at the métier level standardized by GLM (vessel length)

The internal consistency in the selected fleets is outlined in Figure 7.2.3 as matrix plots of cohorts between consecutive years. Generally ages 5-7 show poor internal consistency with correlations in many cases being negative. However, both younger and older fish seem consistently tracked from one year to the next. As the Danish seiners show equal performance both for KWDAYS and for GLM standardization, it was decided to use KWDAYS for the seiners. Trawlers was rejected as a tuning fleet, both due to this poor internal performance but also due to an assumed change in behaviour after the change in regulations on fishings days after 2003 (see section 7.1.4). For gillnetters the selection at the métier level improved their internal consistency for especially ages 5-7 (Figure 7.2.3) and it was therefore decided to use gillnetters at the metier level standardized by KWFISHDAYS.

The WG concluded that the following to fleets were used in the assessment

- Danish seiners at the Gear level - standardized by KWFISHDAYS
- Danish Gillnetters at the metier level - standardized by KWFISHDAYS

Log catch curves for the two selected fleets are shown in Figure 7.2.4

7.2.5.5 Trends in catch and effort

Effort, yield and LPUE are shown for the two commercial tuning fleets (Figure 7.2.5). Total effort by seiners constitute far the most by the two fleets. Since 2001 effort have lowered by both fleets, however, most by the seiners, a decrease of about 30%. LPUE is stable for the gillnetters, while LPUE increases slightly for the seiners for the entire period. LPUE by age only reveal a markedly signal on the strong 2001 year-class as age 3 in both fleets. This year-class is also recognized clearly in surveys (see Section 7.2.6).

No Danish discard information is presently available for 2005. The most recently available discard data are Swedish data from 2004 that suggest up to 50% discard by weight. This estimate is significantly higher than any previous estimates but could be due to the strong incoming year-classes as seen in the surveys since 1998.

7.2.6 Research vessel data

Two main surveys are available for the assessment: the Danish Kattegat survey KASU (RV Havfisken) being part of BITS and conducted in 1st and 4th quarter and the Swedish IBTS (RV Argos) survey both 1st and 3rd quarter.

The indices from the four surveys are given in Figure 7.2.6. At age 1 all surveys have tracked the strong year-classes 1998-99, 2001 and 2003. At older ages these strong year-classes are generaly tracked variable by the surveys, but even at age 6 the strong 1998 YC heavily influences the LPUEs in 3 of 4 surveys.

Internal consistency of the four surveys is illustrated in Figure 7.2.7 by means of catch curves and matrix scatterplots. In general, the survey series perform well with respect to tracking cohorts. The 1st quarter survey series perform better than the 3rd and 4th quarter survey series. A between survey consistency is given in Figure 7.2.9 (under section 7.2.6.2).

7.2.6.1 Data revision of Danish surveys

The Danish Institute for Fisheries Research (DIFRES) has since 1994 for KASU-2 and since 1996 for KASU-1 conducted two research surveys in Kattegat. The purpose of the two surveys is to produce abundance indices for cod, plaice and sole. In 2005 several changes where made to the KASU-1 and KASU-2 indices for plaice and a justification for the revision was then requested. In 2005 the DIFRES had introduced a new data base for storing survey data. In the process of transferring data from the old to the new data base and rewriting extraction programs several differences were introduced. A documentation of the revision is provided in detail by Folmer (WD 8). A comparison of the revised indices with the unrevised indices is given in Figure 7.2.8.

7.2.6.2 Establishment of 0-group index

Since 1985 the Danish R/V HAVKATTEN has surveyed fixed stations in the East Kattegat by use of a Petersen young-fish trawl at depths of 1 to 1.5 meter (Boje and Nielsen, WD #12). The trawl is small, vertical opening is approx. 65 cm and horizontal opening approx. 4 m. Hauling time is 10 min at a speed of 1.5 knots. The survey is conducted in July-August and on average 65 stations are conducted annually distributed on 5 areas in a north-south direction. In 1999 and 2002 no survey was conducted. All fish were length measured to the nearest mm. Ages were estimated by the Petersen method. Ages 0 and 1 were both well defined in the catch distributions and consequently 0-group was selected as fish below 105 mm. The remaining fish were all estimated to be 1 year olds. LPUE is calculated as numbers caught per 10 min haul.

The HAVKATTEN survey measures a high variability in year-class strength between the surveyed areas in Kattegat. This means that in some years strong year-classes are observed in certain areas, while not in other areas and vice versa. However, within the area covered by the survey, certain variability in recruitment strength must be expected due to environmental variability between localities. This is probably the case for changes in drift patterns of eggs and larvae caused by different wind and water current conditions between areas. As it is assumed that recruits in all the surveyed areas 1-7 have common origin, an appropriate index of 0-group is consequently to include all areas surveyed by HAVKATTEN. As the GLM standardised 0-group CPUE perform in agreement with both IBTS and KASU surveys (Figure 7.2.9), the WG suggest the use of the standardised CPUE series (Figure 7.2.10) as an index of 0-group abundance in Div. IIIa.

The tuning data (commercial fleets and research-vessel survey indices) used in the final assessment are given in Table 7.2.5.

7.3 Data analysis

7.3.1 Review of 2005 assessment

The RGNSSK listed in the 2005 review a number of issues to be dealt with for the plaice in IIIa assessment. The main issues are:

- Concern on the commercial tuning series, i.e. with respect to behaviour and standardisation,
- Concern on the high and variable F,
- Concern on the landings at age matrix, i.e. with respect to sampling, raising procedures and mix of the stock/fishery into SD 22.
- Discard need to be quantified and reflected in assessment,

The WG has in its present benchmark assessment dealt with most of the above issues as well as the issues listed in the section “Issues to be addressed in future assessments” in the previous two WG reports (ICES-WGNSSK 2004, 2005). The principal shortcoming was a lack of an examination of the landings at age matrix in detail (sampling effects and compilation procedure), which is an issue that the WG highlights as necessary prerequisite in order to improve the quality of the plaice IIIa assessment. In addition, the lack of discard data also hampers a proper assessment.

7.3.2 Exploratory landings at age analysis

A separable analysis was used to explore the consistency in the landings matrix. The analysis was run with a terminal F of 1.6 at age 6 and a terminal s of 1.0 (Table 7.3.1 and Figure 7.3.1). The residuals do not indicate any trends in catchability neither any extreme values.

Analysis setup 2004 and 2005

Year of assessment:	2004/2005	2006
Assessment model:	XSA	XSA
Fleets:	Danish Gillnetters(age range: 2-10, 1987 onwards)	Danish Gillnetters metier_kwfishdays (age range: 2-10, 1995 onwards)
	Danish Seiners_(age range: 2-10, 1987 onwards)	Danish Seiners _gear_kwfishdays (age range: 2-10, 1995 onwards)
	Danish Trawlers_(age range: 2-10, 1987 onwards)	
	KASU q4 (age range: 1-6, 1994 onwards)	KASU q4 (age range: 1-6, 1994 onwards), revised
	KASU_q1_backshifted (age range: 1-6, 1995 onwards)	KASU_q1_backshifted (age range: 1-6, 1995 onwards) revised
	IBTS_q1_backshifted (age range: 1-6, 1990 onwards)	IBTS_q1_backshifted (age range: 1-6, 1990 onwards)
	IBTS q3 (age range: 1-6, 1997 onwards)	IBTS q3 (age range: 1-6, 1997 onwards)
Age range:	2-10+	2-10+
Catch data:	1978-2004	1978-2005
Fbar:	age 4-8	age 4-8
Time series weights:	Tricubic over 20 years	Tricubic over 20 years
Power model for ages:	No	No
Catchability plateau:	Age 8	Age 8
Survivor est. shrunk towards the mean F:	5 years / 5 ages	5 years / 5 ages
S.e. of mean (F-shrinkage):	0.5	0.5
Min. s.e. of population estimates:	0.3	0.3
Prior weighting:	no	no
Number of iterations before convergence:	27	20

Landings at age analysis were carried out according to the specifications in the stock annex. The model used was XSA with the same settings as in the 2004/5 stock assessment as indicated in the text table. The XSA tuning diagnostics is given in Table 7.3.2 and plots of log q residuals is shown in Figure 7.3.2. The XSA tuning performed very poorly for all surveys with high s.e. of log q's (>0.5 for most abundant age groups) and missing (or negative) regressions between tuning fleets and catch for several ages. Further, for most surveys a considerable increase in catchability is observed over time from the plots of catch residuals (Figure 7.3.2.). In 2005, however, most residuals again turns negative, suggesting a new shift in relative catchability. For the commercial series the change occurs gradually over time while for the surveys the shift occurs over few years. There is, however, no information from the fishery or in the survey design that supports such a change.

The default setting of shrinkage (s.e. of 0.5 to the mean), has the effect that ages older than 7 are mainly estimated from the F shrinkage mean due to a higher weighing in the XSA. F shrinkage mean is considerably higher for nearly all ages, which means that the 2005 point estimate of F estimates are raised towards higher recent values than if no shrinkage is applied.

Fishing mortality and stock number at age is shown in Table 7.3.3.-4, and stock summary is provided in Table 7.3.5 and Figure 7.3.3. Historical performance of the assessment is shown in Figure 7.3.4 and retrospective analyses of the baseline assessment in Figure 7.3.5.

As in previous assessment a strong retrospective pattern is observed with a consistent overestimation of SSB and a consistent underestimation of F. In addition, F varies considerably from year to year in the recent period. Although the performance of the commercial tuning fleet improved considerably, the surveys fundamentally contradict the catch data as implied from the Log q residual plots (Figure 7.3.2).

The consistent retrospective pattern along with the variation in recent years F_{bar} and the poor tuning diagnostics, lead the group to conclude that the final point estimates of the population and fishing mortality were poorly estimated and therefore could not be applied to any projection of catch and population.

7.3.2.1 Improvement of XSA approach

In order to explore the single effects of the tuning fleets, **single XSA** runs were performed for the 2 commercial fleets and the 4 surveys (Figure 7.3.6). Depending on the tuning fleet used in the analysis, Fbar in the final year varies from approx. 0.2 to 0.9, while SSB varies from about 20 thou. t to 90 thou t. Highest F is generated by KASU Q4 survey and the commercial fleets and lowest estimate by the IBTS surveys. For SSB highest final estimates are by IBTS Q1 survey, while the remaining fleets estimate the SSB rather consistently in 2005. The overall SSB when using all fleets (SPALY run) is largely influenced by the high IBTS Q1 estimate.

The 2005 point estimates from the update XSA run (Section 7.3.2) were for the older ages mainly driven by the **shrinkage to the mean** (0.5) setting in the run. As the F pattern by age for the F shrinkage (increasing until age 6 and thereafter flat) differs considerably from the F pattern of the tuning fleets (flat until age 6 thereafter increases), this argues for using no shrinkage in the XSA tuning. Using less shrinkage (i.e. 2.0) result in lower F's in recent years (0.4 versus 0.8), but the strong retrospective pattern is still apparent for most years (Figure 7.3.7).

An examination of the landings at age matrix and the corresponding F at age, suggest that the high Fbar's in the recent period is primarily caused by the **older age groups** in which landings are rather variable from year to year. These age classes contribute therefore relatively much to the noise in recent years estimates of Fbar. Two exercises were therefore conducted to evaluate this problem: i) an XSA run with a changed Fbar range (ages 3-6) and ii) an XSA run with a reduced landings matrix of ages 2-8 only. However, none of the options did change the retrospective pattern in F and SSB (Figure 7.3.8).

In the present assessment of plaice in IIIa, particular attention has been to potential stock relations between the **IIIa stock and plaice in the Belt Sea**. Landings at age for the Belt Sea was therefore compiled, as well as weight in stock and landings for this area, and a compiled dataset for the entire area IIIa and the Belt Sea was established. Also tuning fleets was established for the entire area, which for the KASU surveys especially included a significant number of hauls in the Belt Sea. The examination of the catch matrix by means of catch curves (Figure 7.3.9) indicate that mortality at older ages decreased slightly, suggesting that older, probably migrating fish are not included in the catch matrix for IIIa alone. Separable analyses shows that the inclusion of area 22 improves the consistency in the catch matrix by reducing the total sum of squared residuals considerably (Figure 7.3.9). However, the inclusion of area 22 into the XSA assessment does not improve the retrospective pattern (Figure 7.3.10) and the WG was therefore not yet in a position to proceed with this attempt to include adjacent waters into the assessment.

7.3.2.2 SMS approach

The SMS model (for description see section 1.3.3) was used as an alternative approach. With the use of a separable model the F pattern over the years is expected to be less variable than in a VPA model. Outcome of the retrospective analyses is given in Figure 7.3.11. The trend and estimates of F and SSB are similar to those from the XSA with no shrinkage as is the retrospective pattern. The SMS model approach is therefore not considered an improvement given the present input data.

7.3.3 Exploratory survey based assessment

The survey based assessment tool, SURBA, was used to explore trends in F and SSB based on surveys only. Different combinations of the available surveys were tested and the results for SSB, R and F are shown in Figure 7.3.12. The indices were not back shifted and the 2006 estimates are thus only based on 1st quarter surveys. The rationale of choosing different combinations of surveys is explained by the different internal consistency of the surveys.

IBTS Q1 has a larger internal consistency compared to all other surveys (see section 7.2.6). As also observed last year, a SURBA run that included only Q1 surveys or IBTSQ1 alone improved the uncertainty estimates and the retrospective pattern of F considerably. However, while trend in F is similar for all surveys combinations, F seems to decrease in the latest years when only IBTSQ1 is used. Also for recruitment, while the general trend is similar between surveys, IBTSQ1 and Q1 surveys showed large year classes in 1998, 2001 and 2003. For SSB the situation is similar as for F and R, with a general increasing trend with a slightly smaller increase for IBTSQ1 and Q1 survey. Summary plots of the retrospective analyses are given in Figure 7.3.13.-14 .

In conclusion, the SURBA runs suggest an increasing SSB since 2000, while estimation of F is less robust, and variable, probably due to incoming strong year-classes.

7.3.4 General stock production model (ASPIC)

In order to eliminate errors in age reading and their associated problems in input data compilation and subsequent analytical assessment, a general stock production model was attempted as supportive information for the age disaggregated analyses. ASPIC is a computer program that fits a non-equilibrium logistic (Schaefer) production model to catch and effort data (see Section 1.3.3). ASPIC requires starting guesses for r, the intrinsic rate of increase, MSY, B1/Bmsy ratio and q, catchability coefficients. The 1st quarter survey LPUE's (KASU and IBTS) were used along with LPUE from the Danish seiners (ASPIC requires non-contrasting data – therefore gillnetters were omitted). Initially ASPIC was run with different starting guesses of these parameters to explore stability of parameter estimation. For an appropriate range of input values, ASPIC was stable in parameter estimation. MSY is estimated to 12 000 t and Bmsy to 65 000 t. Observed and estimated LPUE's for the three input series are given in Figure 7.3.15, and the estimated relative fishing mortality and biomass estimates is provided in Figure 7.3.16. Biomass in 2006 is estimated to be about 65% above Bmsy and fishing mortality in 2005 is estimated to be about 65% below Fmsy. Estimated trajectories from bootstrap of the ASPIC estimates are provided for scenarios of annual catches of 10 000 t and 12 000 t, respectively (catch in 2006 set at 9 000 t in both scenarios). The scenarios show that catches of 10 000 t will keep biomass well above Bmsy and F well below Fmsy, while catches of 12 000 t will imply a risk (80% C.I.) of falling below Bmsy and above Fmsy in the near future (Figure 7.3.17). However, the scenarios and the estimation of the MSY estimates are calculated under a regime (1995-2005) with high recruitment and consequent optimistic LPUE's from most input series to the model. Therefore, more robust estimates should be considered based on a longer time series.

7.3.5 Summary of the various observation data and analyses

Most indices suggest that recruitment in recent years are above average: LPUE from the two selected principal commercial fleets both suggest strong 2001 and 2003 year-classes, and port sampling (lanum) supports this. The same year classes are strong in the surveys along with a strong 1998 year-class.

The overall LPUE of the two commercial fleets are in contrast, i.e. the gillnetters have stable or slight decreasing LPUE since 1995, while the seiners have gradually increased LPUE since 1995. Thus the LPUE trend for the seiners is supported by the overall LPUE from the four surveys. It should be noted that effort measures from the gillnetters might not reflect real the fishing effort very precisely.

The landings at age data seem internally consistent, but are probably subject to an unknown proportion of misreporting from area 22 and also preliminary discard data indicate substantial discard. Exploratory XSA and SMS runs both show clear retrospective patterns of underestimating the fishing mortality and overestimating the biomass. This in combination with a highly variable F between years in the last 7-8 years leads to unreliable point estimates of the stock and F, and therefore a final assessment based on landings at age analysis is rejected.

An assessment based on surveys was run, using 2 of 4 available surveys (Q1) due to short time series and weak internal consistency in two survey series (Q3-4). Estimates of fishing mortality from the surveys are too imprecise an estimate for current exploitation and as basis for a final assessment. All approaches that use survey data show improved recruitment in recent 5-6 years and a corresponding increase in biomass.

An assessment based on a stock production model using LPUE's (non age disaggregated data) from the two Q1 surveys and the seiners, gave essentially the same results as the SURBA assessment, but estimated the fishing mortality far below Fmsy. MSY from the model was estimated to 12.000 t compared to recent catches of approx. 9500 t. A stochastic projection of F and biomass under assumed catch scenarios suggested that only small increases in catch (i.e. to 12 000 t) would imply a high risk of F and B to exceed their MSY levels.

7.3.6 Quality of assessment

The surveys in particular suggest that biomass is increasing in recent years probably due to improved recruitment in the years from 1998. The seiners only partly support this signal, while the gillnetters suggest a stable biomass. Effort measures from gillnetters are, however, dubious. There are no reliable estimates of trends in fishing mortality.

7.4 Management considerations

Plaice is taken both in a directed fishery and as an important by-catch in a mixed cod-Nephrops- plaice fishery fishery. North Sea cod, which is estimated to be well below $\mathbf{B}_{lim}$, has a stock area that includes the Skagerrak (Division IIIaN). Kattegat cod is also well below $\mathbf{B}_{lim}$ (Division IIIa South). Management of plaice in IIIa must therefore take account for state of the cod stocks.

The by-catch rules on cod in the plaice fishery in Kattegat probably create an incentive to misreport catches in the Belt Sea (area 22). Therefore, even though the TAC on plaice in IIIa is not fully utilized, this cannot be interpreted as indicative of low stock size because one of the neighboring fisheries does not have a limiting TAC.

A mismatch between the biological entity of the stock and the defined management area might exist for this stock and this will affect the quality of the assessment. It appears likely from the distribution of fisheries that the plaice stock in IIIa mix with those in subarea IV and the Western Baltic Sea.

7.5 Issues to be addressed in future assessments

A number of issues were investigated in the present benchmark assessment as described above. Some issues listed in previous report to be addressed under a forthcoming benchmark were however not addressed here, and will so remain as tasks for future assessment. During the exploration of data in present assessment, new problems were identified and will be listed here.

The information on catch and effort in the logbooks are provided by statistical square and fishing trip only. Consequently, fishing effort is defined as standardised days fishing calculated from duration of total trip which may not reflect accurately hours fished. Although fishing effort was thoroughly investigated before present assessment and that new effort measures and standardisation procedures are adopted, the problem still prevails.

Catch composition is based on market weight categories and a common ALK, obtained from the market sorting categories irrespective of gear type and fishing area, is applied to the catch by market categories of the fleets. This results in poor precision of fleet-specific age composition of catches and an auto-correlation between the commercial tuning fleets and the catch-at-age matrix. Onboard sampling data by fleet should be explored for potential improvement of age composition of the fleet-specific catches. Further, simulations of different sampling strategies should explore the effects on the resulting landings at age matrix and the tuning fleet age composition. Further, the landings at age matrix should be carefully checked for errors caused by ageing, typing or combinations thereof.

Some major technological developments have in recent decades affected the fisheries in the North Sea, the Kattegat and the Baltic such as the development of the beam trawl fishery for flatfish. In recent years multiple twin trawls have been introduced in the fishery for flatfish, roundfish, and the mixed fish/Nephrops fishery. Right up to the present time further development of electronic equipment such as satellite navigation, fish finders, and sonar as well as advances in vessel design has increased the fishing efficiency of the fleets. National studies to quantify this technological creep are presently ongoing and should enable us to improve effort estimation considerably.

Previous investigations on the biological link between the Kattegat and the Western Baltic (ICES SD 22), and the potential extension of the stock beyond its current assessment area has been summarized at this meeting. However, the WG concluded that the scientific evidence for such relationships were of a too historic and anecdotal character as to apply this past perception to the present. Therefore, the WG proposes that the work continues in the sense of reviewing historic material and re-analysing this. Further, **the WG recommends that an ICES Study Group be established with the main objective to examine the entity of the entire stock complex of plaice within its distribution area in the North sea, Skagerrak, Kattegat and western Baltic, in order to evaluate the appropriateness of the existing management areas for plaice and also to suggest protocols for studies that aim at clarifying the stock relationships.**

Available discard numbers for 2003 and 2004 in the plaice fishery in Division IIIa showed higher discarding rates than previously assumed, especially for younger ages. A significant higher effort should be made to establish discard at age by the national laboratories, than in the past. Further, work should be attempted to derive discard estimates for previous years to be included in the assessment.

Table 7.1.1 Plaice in IIIa. Official landings in tonnes as reported to ICES and WG estimates, 1972-2005

Year	Denmark		Sweden		Germany		Belgium		Norway		Netherlands		Total			
	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	Unalloc.	WG est.	TAC
1972		20,599		418		77				3					21,097	
1973		13,892		311		48				6					14,257	
1974		14,830		325		52				5					15,212	
1975		15,046		373		39				6					15,464	
1976		18,738		228		32		717		6					19,721	
1977		24,466		442		32		846		6					25,792	
1978		26,068		405		100		371		9					26,953	
1979		20,766		400		38		763		9					21,976	
1980		15,096		384		40		914		11					16,445	
1981		11,918		366		42		263		13					12,602	
1982		10,506		384		19		127		11					11,047	
1983		10,108		489		36		133		14					10,780	
1984		10,812		699		31		27		22					11,591	
1985		12,625		699		4		136		18					13,482	
1986		13,115		404		2		505		26					14,052	
1987		14,173		548		3		907		27					15,658	19,250
1988		11,602		491		0		716		41					12,850	19,750
1989		7,023		455		0		230		33					7,741	19,000
1990		10,559		981		2		471		69					12,082	13,000
1991		7,546		737		34		315		68					8,700	11,300
1992		10,582		589		117		537		106					11,931	14,000
1993		10,419		462		37		326		79					11,323	14,000
1994		10,330		542		37		325		91					11,325	14,000
1995	9,722	9,722	470	470	48	48	302	302	224	224			10,766	0	10,766	14,000
1996	9,593	9,641	465	465	31	11			428	428			10,517	28	10,545	14,000
1997	9,505	9,504	499	499	39	39			249	249			10,292	-1	10,291	14,000
1998	7,918	7,918	393	393	22	21			181	181			8,514	-1	8,513	14,000
1999	7,983	7,983	373	394	27	27			336	336			8,719	21	8,740	14,000
2000	8,324	8,324	401	414	15	15			163	163			8,789	127	8,916	14,000
2001	11,114	11,114	385	385	1	0			61	61			11,561	-1	11,560	11,750
2002	8,275	8,276	322	338	29	29			58	58			8,684	17	8,701	12,800
2003	6,884	6884	377	396	14	14			341	341	1494	1584	9,110	109	9,219	16,600
2004	7,135	7,135	317	244	77	77			106	106	1455	1511	9,090	-17	9,073	11,173
2005	5,605	5,619	244	244	21	47			80	80	808	915	6,758	147	6,905	9,500
2006																

Table 7.1.2 Plaice in Kattegat. Landings in tonnes Working Group estimates, 1972-2005

Year	Denmark	Sweden	Germany	Belgium	Norway	Total
1972	15,504	348	77			15,929
1973	10,021	231	48			10,300
1974	11,401	255	52			11,708
1975	10,158	296	39			10,493
1976	9,487	177	32			9,696
1977	11,611	300	32			11,943
1978	12,685	312	100			13,097
1979	9,721	333	38			10,092
1980	5,582	313	40			5,935
1981	3,803	256	42			4,101
1982	2,717	238	19			2,974
1983	3,280	334	36			3,650
1984	3,252	388	31			3,671
1985	2,979	403	4			3,386
1986	2,470	202	2			2,674
1987	2,846	307	3			3,156
1988	1,820	210	0			2,030
1989	1,609	135	0			1,744
1990	1,830	202	2			2,034
1991	1,737	265	19			2,021
1992	2,068	208	101			2,377
1993	1,294	175	0			1,469
1994	1,547	227	0			1,774
1995	1,254	133	0			1,387
1996	2,337	205	0			2,542
1997	2,198	255	25			2,478
1998	1,786	185	10			1,981
1999	1,510	161	20			1,691
2000	1,644	184	10			1,838
2001	2,069	260				2,329
2002	1,806	198	26			2,030
2003	2,037	253	6			2,296
2004	1,395	137	77			1,609
2005	1,104	100	47			1,251

* years 1972-1990 landings refers to IIIA

Table 7.1.3. Plaice in Skagerrak. Landings in tonnes. Working Group estimates, 1972-2005

Year	Denmark	Sweden	Germany	Belgium	Norway	Netherlands	Total
1972	5,095	70			3		5,168
1973	3,871	80			6		3,957
1974	3,429	70			5		3,504
1975	4,888	77			6		4,971
1976	9,251	51		717	6		10,025
1977	12,855	142		846	6		13,849
1978	13,383	94		371	9		13,857
1979	11,045	67		763	9		11,884
1980	9,514	71		914	11		10,510
1981	8,115	110		263	13		8,501
1982	7,789	146		127	11		8,073
1983	6,828	155		133	14		7,130
1984	7,560	311		27	22		7,920
1985	9,646	296		136	18		10,096
1986	10,645	202		505	26		11,378
1987	11,327	241		907	27		12,502
1988	9,782	281		716	41		10,820
1989	5,414	320		230	33		5,997
1990	8,729	779		471	69		10,048
1991	5,809	472	15	315	68		6,679
1992	8,514	381	16	537	106		9,554
1993	9,125	287	37	326	79		9,854
1994	8,783	315	37	325	91		9,551
1995	8,468	337	48	302	224		9,379
1996	7,304	260	11		428		8,003
1997	7,306	244	14		249		7,813
1998	6,132	208	11		98		6,449
1999	6,473	233	7		336		7,049
2000	6,680	230	5		67		6,982
2001	9,045	125			61		9,231
2002	6,470	140	3		58		6,671
2003	4,847	143	8		74	1,584	6,656
2004	5,717	179			106	1,511	7,513
2005	4,515	144			80	915	5,654

Table 7.2.1 Plaice in IIIa. Landing numbers at.age

AGE										
2	489	1105	362	190	526	1481	2154	1400		
3	15692	9789	4772	4048	2067	9715	12620	8641		
4	39531	29655	16353	13098	9204	8630	11140	21798		
5	24919	20807	12575	10970	10602	8026	4463	6232		
6	8011	7646	6033	4306	5554	2673	2183	1715		
7	620	2514	2393	1427	1851	925	985	698		
8	63	170	949	546	758	531	904	260		
9	63	75	203	213	301	257	695	197		
10	48	50	54	119	113	96	337	168		
11+	60	55	50	97	48	106	120	156		
TOTALNUM	89496	71866	43744	35014	31024	32440	35601	41265		
TONSLAND	26953	21976	16445	12602	11047	10780	11591	13482		
SOPCOF	%	102	104	106	103	102	101	100	100	

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
2	375	623	101	1012	3147	2309	904	1038	1411	446
3	4366	4227	3052	3844	8748	8611	3858	3505	6919	2277
4	14749	12400	12037	7102	8623	9583	11759	10088	8016	6606
5	19193	17710	13783	6255	9718	4663	17427	13233	9859	11530
6	4477	10205	6860	2708	3222	2893	4297	6891	8002	6622
7	633	2089	2745	1171	981	892	1033	1657	2780	4929
8	274	373	946	549	481	306	296	376	448	853
9	154	242	322	254	349	156	115	104	111	137
10	141	125	136	136	155	87	27	47	38	65
11+	98	190	156	236	273	137	115	69	55	51
TOTALNUM	44460	48184	40138	23267	35697	29637	39831	37008	37639	33516
TONSLAND	14052	15658	12850	7741	12082	8700	11931	11323	11325	10766
SOPCOF	%	100	100	100	100	100	100	100	100	100

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
2	4527	529	563	687	1223	3981	364	3481	1724	3755
3	5353	4733	6710	2704	3937	9172	5008	4686	17816	4828
4	7971	6379	8219	8432	8302	9399	8861	9098	4271	9638
5	5283	9465	6856	8520	11212	11001	7528	9279	4056	3371
6	4751	5104	2971	7419	3599	4744	4843	4330	1994	1745
7	1812	3072	791	1301	888	410	1766	969	265	764
8	1355	1369	385	380	139	102	448	138	97	168
9	151	849	234	77	17	19	51	19	11	63
10	23	114	170	106	7	14	17	11	11	8
11+	45	36	64	43	29	33	12	5	7	11
TOTALNUM	31271	31650	26963	29669	29353	38875	28898	32016	30252	24351
TONSLAND	10545	10291	8430	8740	8820	11560	8701	8952	9122	6880
SOPCOF	%	101	100	100	100	101	100	100	100	100

Table 7.2.2. Plaice in IIIa. Landings weight at age.

Catch weights at age (kg)

	YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
	AGE								
	2,	.2360,	.2220,	.2610,	.2300,	.2700,	.2850,	.2820,	.2780,
	3,	.2480,	.2550,	.2740,	.2630,	.3010,	.2740,	.2990,	.2820,
	4,	.2680,	.2670,	.3060,	.2960,	.2860,	.2930,	.3040,	.3080,
	5,	.3220,	.2970,	.3450,	.3570,	.3180,	.3560,	.3720,	.3540,
	6,	.4170,	.3780,	.4140,	.4320,	.3860,	.4230,	.4030,	.4370,
	7,	.5980,	.4510,	.5790,	.5370,	.5440,	.4830,	.4060,	.5440,
	8,	.7520,	.6550,	.6400,	.6710,	.7040,	.5310,	.3830,	.6800,
	9,	.8180,	.9220,	.7530,	.8130,	.8130,	.6470,	.3600,	.7370,
	10,	.9140,	1.0200,	.8110,	.9120,	.9120,	.9860,	.4430,	.7550,
	+gp,	.8430,	1.0440,	.9100,	.9990,	.9860,	1.1840,	1.0610,	.9140,
0	SOPCOFAC,	1.0159,	1.0390,	1.0625,	1.0268,	1.0184,	1.0060,	1.0009,	1.0012,

Catch weights at age (kg)

	YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
	AGE										
	2,	.2500,	.3220,	.2520,	.2740,	.2920,	.2630,	.3090,	.2670,	.2750,	.2630,
	3,	.2770,	.2800,	.2670,	.2630,	.2880,	.2700,	.3100,	.2720,	.2630,	.3010,
	4,	.2840,	.2810,	.2680,	.2820,	.2940,	.2590,	.2720,	.2710,	.2720,	.3030,
	5,	.3100,	.2920,	.2900,	.3200,	.3370,	.2740,	.2800,	.2950,	.2890,	.2890,
	6,	.3840,	.3630,	.3500,	.3760,	.3970,	.3650,	.3360,	.3380,	.3300,	.3280,
	7,	.5310,	.5270,	.4750,	.4660,	.4980,	.4920,	.5000,	.4410,	.3810,	.3680,
	8,	.7070,	.7110,	.5670,	.6350,	.6840,	.5840,	.6460,	.5660,	.5160,	.4990,
	9,	.8500,	.9040,	.7550,	.7410,	.7750,	.6700,	.8170,	.7120,	.6580,	.7360,
	10,	.9030,	1.0360,	.8330,	.8250,	.9510,	.8820,	.8040,	.8020,	.7660,	.7520,
	+gp,	1.0990,	1.0840,	1.1930,	1.0020,	1.1500,	1.0800,	.9760,	1.1680,	.9790,	1.0220,
0	SOPCOFAC,	.9997,	.9996,	1.0002,	.9999,	1.0004,	1.0006,	.9999,	.9991,	1.0001,	1.0015,

1

Catch weights at age (kg)

	YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,
	AGE										
	2,	.2660,	.3000,	.2600,	.2710,	.2570,	.2570,	.2460,	.2430,	.2400,	.2440,
	3,	.2680,	.2940,	.2500,	.2710,	.2620,	.2720,	.2710,	.2520,	.2760,	.2600,
	4,	.2940,	.2830,	.2800,	.2900,	.2760,	.2900,	.2700,	.2710,	.3200,	.2920,
	5,	.3840,	.2990,	.3270,	.2900,	.3020,	.3220,	.2870,	.2900,	.3470,	.3270,
	6,	.3990,	.3410,	.3980,	.2940,	.3550,	.3100,	.3380,	.2980,	.3780,	.3480,
	7,	.4360,	.4100,	.4640,	.3360,	.3880,	.4250,	.4020,	.4000,	.5230,	.3810,
	8,	.4300,	.4650,	.5150,	.3700,	.5170,	.5890,	.5950,	.4640,	.7860,	.5130,
	9,	.5610,	.4450,	.5870,	.6560,	.8570,	.8360,	.7940,	.6050,	.8440,	.6640,
	10,	.8700,	.5310,	.6410,	.5670,	.9700,	.6790,	1.1480,	.6420,	.5670,	.9520,
	+gp,	.9570,	.7600,	.8630,	.8310,	.9670,	.8180,	1.1500,	1.2900,	.8920,	1.1930,
0	SOPCOFAC,	1.0113,	1.0003,	1.0016,	1.0000,	1.0061,	1.0014,	1.0016,	1.0002,	1.0029,	.9642,

Table 7.2.3 Plaice in IIIa. Weight at age in stock derived from surveys (age 1-4) and landings (age 5-11)

An average is applied from 1978-1991 (Combined sex)											
	1	2	3	4	5	6	7	8	9	10	11
1988	0.014	0.085	0.178	0.241	0.295	0.341	0.399	0.426	0.509	0.635	1.028
1989	0.014	0.085	0.178	0.241	0.295	0.341	0.399	0.426	0.509	0.635	1.028
1990	0.014	0.085	0.178	0.241	0.295	0.341	0.399	0.426	0.509	0.635	1.028
1991	0.014	0.079	0.182	0.201	0.295	0.341	0.399	0.426	0.509	0.635	1.028
1992	0.009	0.092	0.171	0.223	0.295	0.341	0.399	0.426	0.509	0.635	1.028
1993	0.017	0.086	0.177	0.216	0.295	0.341	0.399	0.426	0.509	0.635	1.028
1994	0.012	0.089	0.166	0.258	0.295	0.341	0.399	0.426	0.509	0.635	1.028
1995	0.018	0.081	0.192	0.306	0.260	0.334	0.385	0.403	0.567	0.695	0.896
1996	0.015	0.099	0.170	0.287	0.327	0.312	0.317	0.311	0.424	0.443	1.435
1997	0.012	0.127	0.171	0.252	0.299	0.353	0.495	0.572	0.544	0.689	1.334
1998	0.008	0.035	0.219	0.230	0.297	0.386	0.451	0.430	0.392	0.501	0.875
1999	0.031	0.087	0.138	0.221	0.294	0.319	0.346	0.414	0.618	0.849	0.598
2000	0.032	0.066	0.131	0.200	0.295	0.318	0.316	0.845	0.800	0.926	1.111
2001	0.024	0.084	0.137	0.196	0.299	0.288	0.382	0.655	0.781	0.699	1.433
2002	0.022	0.061	0.125	0.166	0.304	0.328	0.372	0.389	0.769	0.932	2.058
2003	0.023	0.091	0.143	0.192	0.287	0.294	0.348	0.415	0.557	0.782	0.771
2004	0.020	0.063	0.128	0.175	0.340	0.368	0.473	0.680	0.809	0.969	1.022
2005	0.021	0.082	0.135	0.213	0.301	0.326	0.349	0.455	0.537	0.730	0.961

Table 7.2.4 Plaice in IIIa. Maturity at age derived from IBTS 1Q.

An average is compailed from 1994-2005 (Combined sex)											
	1	2	3	4	5	6	7	8	9	10	11
Average	0.042	0.543	0.743	0.878	0.922	0.935	1	1	1	1	1

Table 7.2.5. Plaice in Division IIIa. Tuning data used in assessment.

```
106
Danish Gillnetters kW_fishdays
1995    2005
1       1       0       1
2       11
261456  51342   204043  534615  1269921 690178  740275  139110  21895   10031   7579
236627  217166  411289  591754  547124  508125  209709  151691  15157   2045    5602
213357  43614   460311  411848  484080  329031  257940  145622  60399   11785   3634
183815  30748   300311  520524  589431  260112  77855   42616   27868   21760   9761
203436  51812   115085  518620  639050  782745  157307  50940   14463   8244    6414
179634  30711   162096  519573  646079  303293  85352   16764   2107    565     4035
267122  183337  276944  498192  1065032 633387  66383   19405   2949    2296    2793
203986  26244   327248  391379  370939  366056  225638  71003   11017   2878    5552
174243  151315  176215  447013  531001  305172  106104  19012   2361    1192    1321
162874  48559   809204  307406  295261  161659  31228   13408   1531    1728    1949
142537  129041  192017  595645  279067  150503  72673   19919   8669    804     1284
Danish Seiners kW_fishdays
1995    2005
1       1       0       1
2       11
850970  155813  484368  1239373 2104697 1538944 1041022 145780  22799   10884   8415
837608  674202  1151596 1653487 884863  825754  298720  211140  21074   2697    4770
768231  99404   1101380 1739961 2249798 1112023 748689  323652  253625  24865   4588
735004  113965  1887583 2087352 1789903 784812  209053  98007   57464   45444   13324
828763  197788  601914  2400904 2488466 2167244 319807  89222   19471   31692   7753
924357  291674  1239320 2884502 4221370 1229051 377813  53757   2640    770     3641
1036316 1546711 3607630 3079346 3354567 1339195 128125  30704   6704    4123    5329
932563  109602  1727207 3327015 2962315 1756223 569954  133012  11968   3485    3600
718124  992300  1663979 3202722 3075667 1244201 234818  40636   4434    1746    1507
649918  584230  5713912 1388886 1171581 589661  83370   14222   2065    1520    1499
552038  1514614 1701523 2954865 917270  455740  175968  34848   9062    1440    1424
KASU_q4
1994    2005
1       1       0.83    1
1       6
1       0.88    10.52   5.88    0.37    0.99    0.03
1       1.68    10.33   3.77    0.19    1.1     0.06
1       2.41    38.57   12.67   0.42    0.47    0.1
1       11.14   11.27   4.32    1.25    0.65    0.36
1       17.3    15.89   4.49    3.69    -9      0.11
1       102.2   38.57   6.33    0.99    0.75    0.5
1       103.04  129.66  16.75   -9      0.49    0.49
1       52.93   99.92   29.79   1.71    0.49    0.85
1       48.79   16.42   25.78   11.7    1.29    0.17
1       41.82   62.31   14.27   6.6     3.41    0.37
1       15.14   69.1    81.58   11.93   12.26   12.35
1       108.6   42.19   8.69    1.31    0.11    0.07
KASU_q1_backshifted
1995    2005
1       1       0.99    1
1       6
1       23.62   26.53   6.46    2.06    0.81    -9
1       11.45   19.32   4.39    1.75    0.67    0.19
1       -9      18.17   52.83   6       10.33   -9
1       26.72   23.79   2.55    1.08    -9      -9
1       204.24  48.8    9.34    1.84    2.22    -9
1       127.73  73.92   6.67    1.7     1.33    0.08
1       45.76   78.25   32.05   2.16    0.47    0.31
1       136.93  39.8    35.91   8.52    0.17    0.11
1       81.19   74.91   26.1    13.3    4.29    1.26
1       168.39  98.39   19.16   3.69    1.79    0.29
1       153.15  216.23  37.33   6.1     0.4     0.02
```

Table 7.2.5. cont. Plaice in Division IIIa. Tuning data used in assessment.

```
IBTSQ1_backshifted
1990    2005
1       1       0.99    1
1       6
1       9.55    21.07   11.16   3.75    0.29    0.09
1       9.21    18.67   12.31   2.86    0.39    0.11
1       14.57   13.39   13.48   12.1    4.56    0.54
1       19.29   13.76   3.92    2.36    2.54    0.57
1       10.12   21.41   8.91    2.44    1.74    0.79
1       47.74   30.49   9.77    3.33    0.74    0.35
1       20.89   46.75   9.57    3.34    0.18    0.07
1       15.73   17.19   9.5     3.27    0.78    0.24
1       44.6    19.46   5.92    5.68    0.31    0.19
1       131.44  72.73   14.98   5.36    3.37    0.31
1       55.16   91.76   20.41   3.22    2.09    0.79
1       15.57   66.06   44.18   10.8    1.93    1.62
1       95.55   50.85   46.2    33.62   6.34    1.05
1       40.79   116.25  33.62   27.51   25.39   1.61
1       117.05  85.37   51.22   21.28   31.61   9.21
1       37.98   97.57   22.76   13.04   4.17    13.96
IBTSQ3
1997    2005
1       1       0.83    1
1       6
1       16.39   17.39   8.42    2.23    0.79    0.45
1       27.92   19.96   5.26    3.68    0.41    -9
1       77.47   59.45   14.35   1.53    1.7     0.31
1       -9      -9      -9      -9      -9      -9
1       19.31   109.31  63.62   9.13    3.77    1.03
1       66.31   54.15   33.33   24.21   4.28    0.39
1       14.98   40.93   6.95    9.84    9.28    1.11
1       51.95   39.98   41.41   3.77    5.49    3.96
1       17.76   60.04   13.52   15.78   3.69    3.7
```

Table 7.3.1. Plaice in IIIa. Output from a separable analysis

At 9/09/2006 16:35

Separable analysis
from 1978 to 2005 on ages 2 to 10
with Terminal F of 1.600 on age 6 and Terminal S of 1.000

Initial sum of squared residuals was 681.815 and
final sum of squared residuals is 85.036 after 97 iterations
Matrix of Residuals

Age/ye	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
2/ 3	-1.407	0.041	-1.059	-0.675	-1.56	-0.438	-0.188
3/ 4	-0.319	-0.287	-0.917	-0.372	-1.338	0.303	-0.601
4/ 5	0.727	0.847	0.28	0.439	0.012	0.876	0.329
5/ 6	0.68	0.627	0.377	0.345	0.673	0.951	0.141
6/ 7	-0.02	-0.144	0.049	-0.143	0.388	-0.006	-0.383
7/ 8	0.301	-0.14	0.275	-0.178	0.035	-0.804	-0.001
8/ 9	-1.508	-1.634	-0.076	-0.556	-0.497	-1.436	-0.193
9/10	0.062	0.057	0.177	0.62	0.778	-0.299	0.944
TOT	0	0	0	0	0	0	0
WTS	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Age/ye	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
2/ 3	0.373	-0.571	0.112	-2.373	-0.352	0.246	0.989	0.179	-0.357	1.154
3/ 4	-0.251	-0.438	-0.631	-0.861	-0.287	-0.128	-0.072	-0.688	-0.549	0.408
4/ 5	0.248	0.224	0.056	0.4	-0.049	0.329	-0.573	-0.058	0.086	-0.235
5/ 6	-0.046	0.512	0.503	0.754	0.327	0.292	-0.463	0.423	-0.002	-0.057
6/ 7	-0.019	0.022	0.194	0.159	0.022	-0.384	-0.193	-0.224	-0.269	-0.641
7/ 8	0.086	-0.046	-0.14	0.205	0.078	-0.294	0.064	0.016	0.313	0.24
8/ 9	-0.716	-0.801	-1.104	-0.446	-0.671	-0.684	-0.417	-0.305	-0.129	-0.095
9/10	0.269	0.397	0.464	0.343	0.485	0.829	1.54	0.719	0.831	0.41
TOT	0	0	0	0	0	0	0	0	0	0
WTS	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Age/ye	1995/96	1996/97	1997/98	1998/99	1999/**	2000/**	2001/**	2002/**	2003/**	2004/**	TOT	WTS
2/ 3	-1.128	1.895	-1.273	0.304	-0.516	-0.645	1.622	-1.026	-0.636	0.691	0.001	0.278
3/ 4	-1.164	0.471	-0.6	0.312	-1.247	-0.81	0.549	-0.469	-0.273	1.013	0.001	0.476
4/ 5	0.092	0.202	-0.405	0.177	-0.75	-0.501	0.401	-0.331	0.1	0.328	0	0.678
5/ 6	0.169	-0.204	0.139	-0.55	-0.374	-0.03	0.305	-0.567	0.027	0.26	0	0.682
6/ 7	-0.126	-0.448	0.064	-0.333	0.042	0.527	-0.224	-0.346	0.374	-0.329	0	1
7/ 8	0.062	-0.424	0.499	-0.228	0.404	0.733	-1.099	0.846	0.15	-0.631	0	0.642
8/ 9	0.14	-0.529	-0.14	0.391	0.974	0.235	-0.572	1.226	0.059	-0.937	0	0.41
9/10	1.408	0.368	0.964	0.667	1.567	-0.33	-0.055	0.822	-0.536	0.086	0	0.511
TOT	0	0	0	0	0	0	0	0	0	0	-6.291	
WTS	0.001	0.001	0.001	0.001	0.001	1	1	1	1	1		

Fishing Mortalities (F)

	1978	1979	1980	1981	1982	1983	1984	1985
F-value	1.0508	1.129	1.1126	0.9302	1.1267	0.9435	1.1347	0.8041

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
F-value	0.7695	1.062	1.2934	0.9974	1.3533	1.0343	1.0066	1.0113	1.0229	1.1485

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
F-value	0.9654	1.52	1.1987	1.8188	1.4161	1.2406	1.849	2.0501	1.2503	1.6

Selection-at-age (S)

	2	3	4	5	6	7	8	9	10
S-value	0.0325	0.1847	0.3476	0.6667	1	0.887	0.8804	0.5209	1

1

Run title ANON COMBSE PLUSGROUP

At 9/09/2006 16:35

Traditional vpa Terminal populations from weighted Separable populations

Fishing mortality residuals

Age/ye	1978	1979	1980	1981	1982	1983	1984	1985
2	-0.0257	-0.0109	-0.025	-0.0224	-0.0251	-0.014	-0.0041	0.0045
3	0.0412	-0.0012	-0.0719	-0.0222	-0.1084	0.095	-0.0369	0.0113
4	0.3971	0.4091	0.1649	0.2418	0.126	0.3287	0.1012	0.165
5	0.3757	0.336	0.1156	0.1667	0.3776	0.423	-0.0012	-0.0308
6	-0.0305	-0.0627	-0.1132	-0.2086	-0.0247	-0.0664	-0.3111	-0.1511
7	-0.2618	-0.0454	0.0885	-0.2269	-0.3011	-0.3718	-0.1581	-0.1106
8	-0.6073	-0.6513	0.1212	-0.1486	-0.3371	-0.4432	0.0137	-0.2124
9	0.0194	0.0866	0.1915	0.2071	0.2827	-0.065	0.5491	0.1323
10	-0.0107	-0.0322	0.3235	0.4529	-0.2503	-0.2714	0.3115	0.039

Table 7.3.2. Plaice in IIIa. XSA diagnostics of SPALY run

Lowestoft VPA Version 3.1
8/09/2006 15:21
Extended Survivors Analysis
Plaice IIIa 2006 WGNSSK ANON COMBSE: PLUSGROUP
CPUE data from file ple3aFL30.txt
Catch data for 28 years. 1978 to 2005. Ages 2 to 11.

Fleet	I year	Last year	First age	Last age	Alpha	Beta
Danish Gillnetters k	1995	2005	2	10	0	1
Danish Seiners kW_fi	1995	2005	2	10	0	1
KASU_q4	1994	2005	1	6	0.83	1
KASU_q1_backshifted	1995	2005	1	6	0.99	1
IBTSQ1_backshifted	1990	2005	1	6	0.99	1
IBTSQ3	1997	2005	1	6	0.83	1

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 8

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 5 oldest ages.

S.E. of the mean to which the estimates are shrunk = .500

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 20 iterations

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	0.126	0.012	0.015	0.02	0.031	0.14	0.017	0.049	0.042	0.042
3	0.181	0.169	0.189	0.084	0.14	0.308	0.234	0.271	0.332	0.143
4	0.402	0.302	0.435	0.34	0.352	0.505	0.487	0.752	0.377	0.268
5	0.551	1.046	0.542	0.977	0.905	0.96	0.872	1.292	0.803	0.51
6	0.785	1.54	1.024	1.975	1.486	1.164	1.536	2.156	0.986	0.882
7	0.653	1.913	0.988	1.994	1.719	0.563	2.371	1.641	0.727	1.244
8	0.736	1.466	1.609	2.256	1.383	0.87	2.433	1.821	0.616	1.382
9	0.669	1.4	0.993	2.149	0.549	0.601	1.457	0.667	0.609	0.946
10	1.051	1.583	1.128	1.904	1.433	1.096	1.682	1.535	0.935	1.121

Table 7.3.2. Plaice in IIIa Cont.

YEAR	2	3	4	5	6	7	8	9	10
1996	4.02E+04	3.41E+04	2.53E+04	1.31E+04	9.18E+03	3.97E+03	2.73E+03	3.25E+02	3.72E+01
1997	4.59E+04	3.21E+04	2.57E+04	1.53E+04	6.83E+03	3.79E+03	1.87E+03	1.18E+03	1.51E+02
1998	3.97E+04	4.10E+04	2.45E+04	1.72E+04	4.87E+03	1.32E+03	5.06E+02	3.91E+02	2.64E+02
1999	3.57E+04	3.54E+04	3.07E+04	1.44E+04	9.06E+03	1.58E+03	4.46E+02	9.16E+01	1.31E+02
2000	4.15E+04	3.17E+04	2.94E+04	1.98E+04	4.89E+03	1.14E+03	1.95E+02	4.23E+01	9.66E+00
2001	3.21E+04	3.64E+04	2.49E+04	1.87E+04	7.25E+03	1.00E+03	1.84E+02	4.42E+01	2.21E+01
2002	2.33E+04	2.53E+04	2.42E+04	1.36E+04	6.49E+03	2.05E+03	5.16E+02	6.99E+01	2.20E+01
2003	7.69E+04	2.07E+04	1.81E+04	1.34E+04	5.15E+03	1.26E+03	1.73E+02	4.10E+01	1.47E+01
2004	4.38E+04	6.63E+04	1.43E+04	7.72E+03	3.34E+03	5.39E+02	2.22E+02	2.54E+01	1.90E+01
2005	9.71E+04	3.80E+04	4.30E+04	8.87E+03	3.13E+03	1.13E+03	2.36E+02	1.08E+02	1.25E+01

Estimated population abundance at 1st Jan 2006

	0.00E+00	8.43E+04	2.98E+04	2.98E+04	4.82E+03	1.17E+03	2.94E+02	5.36E+01	3.80E+01

Taper weighted geometric mean of the VPA populations:

	4.36E+04	3.53E+04	2.64E+04	1.53E+04	6.35E+03	1.74E+03	4.61E+02	1.20E+02	4.26E+01

Standard error of the weighted Log(VPA populations) :

	0.3852	0.3063	0.3215	0.3848	0.4662	0.702	0.8788	1.115	1.1276

Log catchability residuals.

Fleet : Danish Gillnetters k

Age	1990	1991	1992	1993	1994	1995
2	99.99	99.99	99.99	99.99	99.99	-0.42
3	99.99	99.99	99.99	99.99	99.99	-0.5
4	99.99	99.99	99.99	99.99	99.99	-0.03
5	99.99	99.99	99.99	99.99	99.99	0.09
6	99.99	99.99	99.99	99.99	99.99	-0.41
7	99.99	99.99	99.99	99.99	99.99	-0.21
8	99.99	99.99	99.99	99.99	99.99	-0.15
9	99.99	99.99	99.99	99.99	99.99	0.01
10	99.99	99.99	99.99	99.99	99.99	-0.23

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	1.12	-0.57	-0.62	-0.09	-0.63	1.06	-0.35	0.38	-0.13	0.19
3	0.24	0.51	-0.01	-0.97	-0.36	-0.28	0.48	0.24	0.69	-0.14
4	0	-0.32	0.18	-0.2	-0.02	-0.23	-0.18	0.52	0.28	-0.07
5	-0.22	-0.19	-0.17	0.18	-0.04	0.14	-0.36	0.34	0.17	-0.02
6	-0.47	-0.21	-0.16	0.58	0.2	0.02	-0.01	0.42	-0.15	-0.07
7	-0.79	0.05	-0.29	0.51	0.26	-0.73	0.73	0.37	-0.3	0.16
8	-0.96	-0.22	0.06	0.48	0.02	-0.38	0.72	0.45	-0.55	0.23
9	-1.16	-0.67	-0.34	0.77	-0.87	-0.95	0.53	-0.64	-0.55	0.01
10	-0.83	-0.17	-0.15	-0.23	-0.35	-0.3	0.42	0.05	-0.01	-0.14

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9	10
Mean Log	-11.7001	-9.9838	-8.9865	-8.1138	-7.4783	-7.2605	-7.013	-7.013	-7.013
S.E(Log q	0.6233	0.5042	0.2554	0.2162	0.3137	0.4925	0.4935	0.7193	0.3426

Table 7.3.2. Plaice in IIIa Cont.

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.83	0.382	11.53	0.39	11	0.54	-11.7
3	0.83	0.353	10.06	0.35	11	0.44	-9.98
4	2.06	-2.116	7.79	0.33	11	0.45	-8.99
5	1.08	-0.328	7.99	0.66	11	0.25	-8.11
6	1.05	-0.17	7.42	0.6	11	0.35	-7.48
7	1.02	-0.073	7.26	0.68	11	0.53	-7.26
8	1.22	-1.027	7.22	0.74	11	0.6	-7.01
9	1.01	-0.059	7.39	0.77	11	0.67	-7.36
10	1.04	-0.39	7.3	0.93	11	0.33	-7.17
1							

Fleet : Danish Seiners kW_fi

Age	1990	1991	1992	1993	1994	1995
2	99.99	99.99	99.99	99.99	99.99	-0.82
3	99.99	99.99	99.99	99.99	99.99	-1.2
4	99.99	99.99	99.99	99.99	99.99	-0.57
5	99.99	99.99	99.99	99.99	99.99	-0.54
6	99.99	99.99	99.99	99.99	99.99	-0.52
7	99.99	99.99	99.99	99.99	99.99	-0.52
8	99.99	99.99	99.99	99.99	99.99	-0.47
9	99.99	99.99	99.99	99.99	99.99	-0.32
10	99.99	99.99	99.99	99.99	99.99	-0.52

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	0.66	-1.35	-1.03	-0.49	-0.35	1.51	-0.77	0.52	0.65	0.97
3	-0.38	-0.29	0.06	-1.1	-0.35	0.54	0.24	0.68	0.88	0.3
4	-0.42	-0.35	-0.01	-0.26	-0.14	0.05	0.25	0.88	0.22	-0.02
5	-0.97	0.11	-0.41	0.17	0.24	-0.03	0.24	0.72	0.21	-0.14
6	-0.99	-0.01	-0.18	0.45	0.22	-0.33	0.3	0.67	0.02	-0.05
7	-1.17	0.37	-0.16	0.35	0.64	-0.89	0.67	0.28	-0.16	0.22
8	-1.08	0.11	0.32	0.45	0.36	-0.46	0.64	0.61	-1.06	0.25
9	-1.28	0.3	-0.19	0.48	-1.47	-0.67	-0.1	-0.62	-0.82	-0.49
10	-1.01	0.11	0.02	0.53	-0.86	-0.26	-0.09	-0.17	-0.7	-0.1

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9	10
Mean Log	-11.3704	-9.5989	-8.7946	-8.1507	-7.7407	-7.7945	-7.8269	-7.8269	-7.8269
S.E(Log q	0.9435	0.6724	0.3982	0.4438	0.4515	0.5995	0.6351	0.7783	0.5307

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.54	1.101	11.06	0.42	11	0.51	-11.37
3	0.71	0.538	9.84	0.3	11	0.5	-9.6
4	2.3	-1.317	7.07	0.11	11	0.88	-8.79
5	1.28	-0.453	7.77	0.25	11	0.59	-8.15
6	1.51	-0.9	7.27	0.28	11	0.69	-7.74
7	1.17	-0.496	7.86	0.53	11	0.73	-7.79
8	1.21	-0.765	8.2	0.62	11	0.79	-7.83
9	0.82	1.32	7.65	0.87	11	0.47	-8.3
10	0.83	1.68	7.34	0.93	11	0.34	-8.09

Table 7.3.2. Plaice in IIIa Cont.

Fleet : KASU_q4

Age	1990	1991	1992	1993	1994	1995
2	99.99	99.99	99.99	99.99	-1	-1.13
3	99.99	99.99	99.99	99.99	-0.59	-1.18
4	99.99	99.99	99.99	99.99	-2.09	-2.23
5	99.99	99.99	99.99	99.99	-0.65	-0.35
6	99.99	99.99	99.99	99.99	-3.91	-2.52
7	No data for this fleet at this age					
8	No data for this fleet at this age					
9	No data for this fleet at this age					
10	No data for this fleet at this age					

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	0.24	-1.22	-0.73	0.26	1.34	1.43	-0.17	0	0.66	-0.63
3	0.01	-1.02	-1.21	-0.81	0.32	0.91	1.06	0.7	1.34	-0.51
4	-1.6	-0.61	0.64	-0.99	99.99	-0.08	1.85	1.81	2.3	-1.11
5	-0.88	-0.26	99.99	-0.12	-0.93	-0.82	0.38	1.75	3.14	-1.98
6	-1.95	0.32	-1	0.76	0.91	0.77	-0.39	1.19	4.06	-1.14
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6
Mean Log	-6.9853	-7.6457	-8.9522	-8.7592	-8.6696
S.E(Log q	0.9044	0.9426	1.6212	1.4982	2.0014

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	1.87	-0.616	3.78	0.06	12	1.75	-6.99
3	0.84	0.171	8.08	0.12	12	0.84	-7.65
4	-0.4	-2.487	10.57	0.3	11	0.51	-8.95
5	-1.32	-1.243	10.62	0.04	11	1.92	-8.76
6	-0.64	-2.241	8.77	0.18	12	1.07	-8.67
1							

Fleet : KASU_q1_backshifted

Age	1990	1991	1992	1993	1994	1995
2	99.99	99.99	99.99	99.99	99.99	-0.58
3	99.99	99.99	99.99	99.99	99.99	-0.85
4	99.99	99.99	99.99	99.99	99.99	-0.38
5	99.99	99.99	99.99	99.99	99.99	-0.9
6	99.99	99.99	99.99	99.99	99.99	99.99
7	No data for this fleet at this age					
8	No data for this fleet at this age					
9	No data for this fleet at this age					
10	No data for this fleet at this age					

Table 7.3.2. Plaice in IIIa Cont.

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	-0.84	-1.14	-0.73	0.1	0.38	0.8	0.32	-0.21	0.62	0.61
3	-1.25	1.28	-1.97	-0.63	-0.8	0.8	1.2	1.12	-0.29	0.74
4	-0.7	0.42	-1.12	-0.9	-0.93	-0.37	1.01	2.01	0.59	-0.11
5	-0.8	2.27	99.99	0.73	-0.17	-1.1	-1.89	1.77	0.97	-0.96
6	-0.97	99.99	99.99	99.99	-0.5	0.14	-0.42	2.87	0.67	-2.04
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6
Mean Log	-6.5794	-7.4255	-8.3818	-8.4367	-8.9397
S.E(Log q	0.6656	1.1253	0.9931	1.3844	1.5698

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.99	0.016	6.62	0.28	11	0.7	-6.58
3	-2.01	-1.26	16.51	0.02	11	2.19	-7.43
4	-1.48	-1.639	12.68	0.05	11	1.35	-8.38
5	2.7	-0.412	6.58	0.01	10	3.94	-8.44
6	0.75	0.178	8.84	0.1	7	1.29	-8.94
1							

Fleet : IBTSQ1_backshifted

Age	1990	1991	1992	1993	1994	1995
2	-1.31	-1.06	-1.31	-1.02	-0.56	-0.32
3	-1	-0.99	-0.58	-1.73	-0.48	-0.56
4	-0.5	-1.66	-0.27	-1.53	-1.47	-0.63
5	-1.93	-2	-0.05	-1	-0.95	-1.59
6	-2.12	-2.09	-0.83	-1.32	-1.64	-1.73
7	No data for this fleet at this age					
8	No data for this fleet at this age					
9	No data for this fleet at this age					
10	No data for this fleet at this age					

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	0.17	-1.08	-0.81	0.62	0.72	0.75	0.69	0.35	0.6	-0.06
3	-0.59	-0.55	-1.25	-0.28	0.2	1	1.33	1.25	0.57	0.13
4	-0.78	-0.92	-0.19	-0.56	-1.02	0.51	1.66	2.01	1.62	-0.08
5	-2.71	-0.91	-2.45	0.55	-0.32	-0.29	1.13	2.95	3.24	0.78
6	-3.29	-1.01	-1.42	-0.6	0.46	0.47	0.51	1.79	2.8	3.18
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

Table 7.3.2. Plaice in IIIa Cont.

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6
Mean Log	-6.6983	-7.306	-7.6518	-7.8356	-7.6139
S.E(Log q	0.7401	0.9107	1.1973	1.8569	1.909

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	1.64	-0.653	4.15	0.1	16	1.25	-6.7
3	-8.15	-1.292	36.29	0	16	7.2	-7.31
4	-0.72	-2.657	12	0.19	16	0.69	-7.65
5	-0.63	-1.998	10.77	0.13	16	1.04	-7.84
6	-0.5	-3.433	9.32	0.35	16	0.67	-7.61
1							

Fleet : IBTSQ3

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	99.99	-0.99	-0.7	0.5	99.99	1.33	0.83	-0.61	-0.08	-0.47
3	99.99	-0.66	-1.36	-0.3	99.99	1.37	1.02	-0.32	0.36	-0.38
4	99.99	-1.2	-0.53	-1.72	99.99	0.42	1.41	1.04	-0.02	0.21
5	99.99	-1.23	-2.46	-0.46	99.99	0.05	0.42	1.59	1.17	0.37
6	99.99	-0.97	99.99	-1.23	99.99	-0.54	-1.06	0.78	1.42	1.32
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6
Mean Log	-6.7898	-7.3418	-7.7828	-7.596	-7.1616
S.E(Log q	0.8235	0.8946	1.0641	1.2902	1.1775

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	-6.48	-2.106	36.13	0.01	8	4.32	-6.79
3	1.07	-0.064	7.11	0.12	8	1.04	-7.34
4	5.26	-0.628	-2.1	0	8	5.87	-7.78
5	-0.79	-1.564	10.96	0.12	8	0.92	-7.6
6	-0.58	-5.86	9.44	0.75	7	0.26	-7.16

Table 7.3.2. Plaice in IIIa Cont.

Terminal year survivor and F summaries :

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2003

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Danish Gil	101622	0.654	0	0	1	0.171	0.035
Danish Se	221494	0.99	0	0	1	0.075	0.016
KASU_q4	45046	0.946	0	0	1	0.082	0.076
KASU_q1_	155594	0.698	0	0	1	0.15	0.023
IBTSQ1_t	79076	0.771	0	0	1	0.123	0.044
IBTSQ3	52721	0.876	0	0	1	0.095	0.066
F shrinka	62251	0.5				0.305	0.056

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
84282	0.27	0.2	7	0.721	0.042

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2002

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Danish Gil	25953	0.411	0.008	0.02	2	0.25	0.163
Danish Se	44995	0.575	0.163	0.28	2	0.128	0.097
KASU_q4	32467	0.683	0.589	0.86	2	0.09	0.132
KASU_q1_	57309	0.601	0.053	0.09	2	0.115	0.077
IBTSQ1_t	44748	0.598	0.232	0.39	2	0.117	0.098
IBTSQ3	23933	0.645	0.148	0.23	2	0.101	0.176
F shrinka	15628	0.5				0.198	0.258

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
29767	0.21	0.14	13	0.695	0.143

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2001

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Danish Gil	32966	0.245	0.212	0.86	3	0.401	0.245
Danish Se	36104	0.342	0.253	0.74	3	0.207	0.226
KASU_q4	41411	0.641	0.648	1.01	3	0.048	0.2
KASU_q1_	24567	0.529	0.045	0.08	3	0.074	0.317
IBTSQ1_t	40624	0.546	0.173	0.32	3	0.068	0.203
IBTSQ3	28618	0.568	0.308	0.54	3	0.065	0.278
F shrinka	14270	0.5				0.137	0.496

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
29770	0.16	0.11	19	0.727	0.268

Table 7.3.2. Plaice in IIIa Cont.

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2000

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Danish Gil	5286	0.194	0.102	0.52	4	0.461	0.474
Danish Se	5065	0.282	0.185	0.66	4	0.214	0.49
KASU_q4	4895	0.612	0.772	1.26	4	0.037	0.504
KASU_q1_	6310	0.508	0.373	0.74	4	0.053	0.411
IBTSQ1_b	13670	0.534	0.215	0.4	4	0.045	0.211
IBTSQ3	6127	0.538	0.257	0.48	4	0.049	0.421
F shrinka	1953	0.5				0.141	0.972

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
4819	0.14	0.12	25	0.858	0.51

1

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1999

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Danish Gil	1324	0.199	0.124	0.62	5	0.441	0.812
Danish Se	1420	0.291	0.182	0.62	5	0.207	0.774
KASU_q4	3336	0.757	0.776	1.02	5	0.02	0.404
KASU_q1_	1451	0.635	0.769	1.21	5	0.029	0.763
IBTSQ1_b	8912	0.68	0.515	0.76	5	0.023	0.171
IBTSQ3	3983	0.651	0.062	0.1	5	0.035	0.348
F shrinka	492	0.5				0.244	1.475

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
1173	0.17	0.15	31	0.885	0.882

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1998

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Danish Gil	302	0.246	0.089	0.36	6	0.314	1.227
Danish Se	361	0.348	0.089	0.25	6	0.174	1.102
KASU_q4	3023	0.843	0.654	0.78	5	0.008	0.215
KASU_q1_	664	0.703	0.214	0.3	5	0.012	0.739
IBTSQ1_b	1792	0.756	0.467	0.62	5	0.01	0.34
IBTSQ3	1234	0.81	0.037	0.05	4	0.013	0.463
F shrinka	234	0.5				0.469	1.413

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
294	0.25	0.09	32	0.337	1.244

Table 7.3.2. Plaice in IIIa Cont.

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Danish Gil	57	0.33	0.11	0.33	7	0.245	1.336
Danish Se	62	0.429	0.097	0.23	7	0.148	1.279
KASU_q4	88	0.702	0.207	0.3	5	0.002	1.035
KASU_q1_	77	0.588	0.817	1.39	5	0.003	1.124
IBTSQ1_b	124	0.624	0.29	0.46	5	0.002	0.829
IBTSQ3	99	0.7	0.095	0.14	4	0.003	0.963
F shrinka	50	0.5				0.597	1.434

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
54	0.32	0.04	34	0.13	1.382

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 8

Year class = 1996

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Danish Gil	31	0.373	0.123	0.33	8	0.251	1.081
Danish Se	21	0.467	0.162	0.35	8	0.175	1.363
KASU_q4	19	0.744	0.104	0.14	4	0.001	1.413
KASU_q1_	19	0.581	0.112	0.19	5	0.002	1.443
IBTSQ1_b	26	0.616	0.273	0.44	5	0.001	1.196
IBTSQ3	19	0.674	0.241	0.36	4	0.002	1.415
F shrinka	51	0.5				0.568	0.78

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
38	0.31	0.1	35	0.317	0.946
1					

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 8

Year class = 1995

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Danish Gil	3	0.316	0.064	0.2	9	0.355	1.23
Danish Se	3	0.449	0.121	0.27	9	0.167	1.26
KASU_q4	2	0.715	0.412	0.58	5	0	1.603
KASU_q1_	2	0.597	0.344	0.58	5	0	1.661
IBTSQ1_b	2	0.635	0.327	0.51	5	0	1.569
IBTSQ3	1	0.681	0.26	0.38	4	0	1.856
F shrinka	4	0.5				0.478	0.998

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
4	0.27	0.05	38	0.183	1.121

Table 7.3.3. Plaice in IIIa. Fishing mortality (F) at age

YEAR	1978	1979	1980	1981	1982	1983	1984	1985
AGE								
2	0.0084	0.0257	0.0111	0.0078	0.0115	0.0166	0.0326	0.0305
3	0.2335	0.2058	0.1326	0.1487	0.0986	0.2683	0.172	0.1591
4	0.7571	0.7968	0.5479	0.5624	0.5154	0.6505	0.4942	0.4437
5	1.0753	1.0745	0.8463	0.7785	1.1248	1.0494	0.7418	0.5028
6	1.0199	1.0635	0.9624	0.7005	1.0765	0.8662	0.8162	0.6294
7	0.595	0.9543	1.0671	0.5498	0.658	0.4401	0.8236	0.5905
8	0.2823	0.2829	1.0971	0.6556	0.5626	0.3497	0.9092	0.4669
9	0.4844	0.5607	0.5646	0.6831	0.831	0.3326	0.9305	0.4416
10	0.6944	0.791	0.9122	0.6764	0.8548	0.6101	0.8485	0.5282
+gp	0.6944	0.791	0.9122	0.6764	0.8548	0.6101	0.8485	0.5282
0 FBAR 4- 8	0.7459	0.8344	0.9042	0.6494	0.7875	0.6712	0.757	0.5266

Fishing mortality (F) at age

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
2	0.0107	0.0191	0.0032	0.0162	0.0462	0.049	0.0212	0.0314	0.0432	0.0124
3	0.1129	0.1433	0.1103	0.1454	0.1697	0.1543	0.0973	0.0961	0.2679	0.0821
4	0.3935	0.4702	0.6635	0.3565	0.4911	0.2535	0.2902	0.3498	0.2945	0.3918
5	0.7839	1.0212	1.3376	0.7781	1.0435	0.4764	0.8673	0.5424	0.6022	0.786
6	0.7312	1.2015	1.4295	0.9418	1.1093	0.9291	0.9717	0.9245	0.6565	0.95
7	0.4424	0.8112	1.1752	0.9144	0.9847	0.9724	0.9279	1.2039	1.133	0.9989
8	0.4295	0.45	0.9833	0.6829	1.1358	0.863	0.9239	0.9549	1.1945	1.2509
9	0.4935	0.7416	0.7812	0.6862	1.1653	1.4174	0.842	0.8912	0.7371	1.5051
10	0.5784	0.8493	1.148	0.8046	1.0939	0.9365	0.9112	0.908	0.8691	1.222
+gp	0.5784	0.8493	1.148	0.8046	1.0939	0.9365	0.9112	0.908	0.8691	1.222
0 FBAR 4- 8	0.5561	0.7908	1.1178	0.7348	0.9529	0.6989	0.7962	0.7951	0.7761	0.8755

Fishing mortality (F) at age

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	FBAR **-**
AGE											
2	0.126	0.0122	0.015	0.0204	0.0315	0.1396	0.0166	0.0487	0.0423	0.0415	0.0442
3	0.1805	0.1686	0.1886	0.0838	0.14	0.3081	0.2336	0.2715	0.332	0.1435	0.249
4	0.4017	0.3019	0.4346	0.3401	0.3517	0.5052	0.4865	0.7516	0.3771	0.2685	0.4657
5	0.5515	1.0465	0.5424	0.9773	0.9046	0.9605	0.8717	1.2919	0.803	0.5101	0.8684
6	0.7852	1.5401	1.0243	1.9747	1.4857	1.1643	1.536	2.1562	0.986	0.8817	1.3413
7	0.653	1.9132	0.9881	1.9941	1.7189	0.5627	2.3707	1.6408	0.727	1.2435	1.2038
8	0.7363	1.4663	1.6088	2.256	1.3835	0.8704	2.4327	1.8209	0.6165	1.3817	1.273
9	0.6691	1.4003	0.9933	2.1493	0.549	0.6006	1.4565	0.6675	0.6089	0.9463	0.7409
10	1.0506	1.5834	1.128	1.9043	1.4332	1.0958	1.6817	1.5346	0.9349	1.1207	1.1967
+gp	1.0506	1.5834	1.128	1.9043	1.4332	1.0958	1.6817	1.5346	0.9349	1.1207	
0 FBAR 4- 8	0.6255	1.2536	0.9196	1.5084	1.1689	0.8126	1.5395	1.5323	0.7019	0.8571	

Table 7.3.4. Plaice in IIIa. Stock number at age (start of year) Numbers *10**-3

Age/Year	1978	1979	1980	1981	1982	1983	1984	1985
2	61666	45803	34428	25774	48525	94332	70519	48986
3	79229	55332	40394	30807	23141	43407	83947	61759
4	78267	56763	40755	32010	24025	18973	30035	63954
5	39764	33215	23152	21321	16505	12984	8958	16580
6	13172	12276	10262	8988	8857	4849	4114	3860
7	1453	4298	3835	3547	4036	2731	1845	1646
8	269	725	1498	1194	1852	1891	1591	733
9	173	184	495	452	561	955	1206	580
10	101	96	95	254	207	221	619	430
+gp	125	105	87	206	87	243	219	398
TOTAL	274218	208799	155001	124555	127796	180586	203054	198926

Age/Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
2	37177	34609	33104	66177	73264	50789	45375	35298	35065	38119
3	42993	33282	30723	29857	58917	63299	43759	40197	30952	30386
4	47663	34749	26094	24896	23359	44989	49084	35925	33038	21425
5	37133	29097	19647	12161	15771	12934	31592	33227	22910	22269
6	9074	15342	9482	4666	5054	5026	7268	12009	17478	11352
7	1861	3952	4175	2054	1646	1508	1796	2489	4311	8203
8	825	1082	1589	1166	745	556	516	643	676	1256
9	416	486	624	538	533	216	212	185	224	185
10	338	230	209	259	245	150	47	83	69	97
+gp	233	346	238	446	428	235	201	121	99	75
TOTAL	177712	153175	125885	142221	179963	179703	179850	160176	144820	133366

Age/Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	GMST 78-	AMST 78-
2	40198	45906	39683	35728	41475	32112	23283	76919	43779	97094	0	44058	46704
3	34067	32066	41034	35371	31674	36365	25269	20721	66288	37973	84282	38913	41498
4	25328	25733	24512	30747	29433	24915	24180	18101	14292	43033	29767	31771	34190
5	13102	15336	17216	14362	19800	18735	13603	13450	7724	8869	29770	19080	20570
6	9182	6830	4873	9056	4890	7250	6488	5148	3344	3131	4819	7637	8340
7	3973	3789	1325	1583	1137	1002	2048	1264	539	1129	1173	2385	2750
8	2734	1871	506	446	195	184	516	173	222	236	294	767	978
9	325	1185	391	92	42	44	70	41	25	108	54	274	401
10	37	151	264	131	10	22	22	15	19	12	38	111	169
+gp	72	47	99	52	40	52	15	7	12	17	9		
TOTAL	129018	132913	129904	127568	128697	120682	95495	135838	136244	191602	150205		

Table 7.3.5. Plaice in IIIa . Summary (without SOP correction)

	RECRUITS (age 2)	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4-8
1978	61666	55202	45782	26953	0.5887	0.7459
1979	45803	43595	36643	21976	0.5997	0.8344
1980	34428	32762	27664	16445	0.5945	0.9042
1981	25774	27223	23216	12602	0.5428	0.6494
1982	48525	24967	20687	11047	0.534	0.7875
1983	94332	28534	21848	10780	0.4934	0.6712
1984	70519	34034	26453	11591	0.4382	0.757
1985	48986	38605	31606	13482	0.4266	0.5266
1986	37177	38089	32261	14052	0.4356	0.5561
1987	34609	33834	28954	15658	0.5408	0.7908
1988	33104	26563	22465	12850	0.572	1.1178
1989	66177	24457	19334	7741	0.4004	0.7348
1990	73264	30150	23503	12082	0.5141	0.9529
1991	50789	32872	26380	8700	0.3298	0.6989
1992	45375	36586	30509	11931	0.3911	0.7962
1993	35298	34127	28878	11323	0.3921	0.7951
1994	35065	31452	26796	11325	0.4226	0.7761
1995	38119	28953	24547	10766	0.4386	0.8755
1996	40198	26528	21825	10545	0.4832	0.6255
1997	45906	27944	22723	10291	0.4529	1.2536
1998	39683	21603	17870	8430	0.4717	0.9196
1999	35728	22328	18359	8740	0.4761	1.5084
2000	41475	20650	17093	8820	0.516	1.1689
2001	32112	22161	18270	11560	0.6327	0.8126
2002	23283	15822	13407	8701	0.649	1.5395
2003	76919	19013	14267	8952	0.6274	1.5323
2004	43779	17547	13615	9122	0.67	0.7019
2005	97094	26437	20096	6880	0.3424	0.8571
Arith. Mean	48400	29359	24109	11905	0.4992	0.8889
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

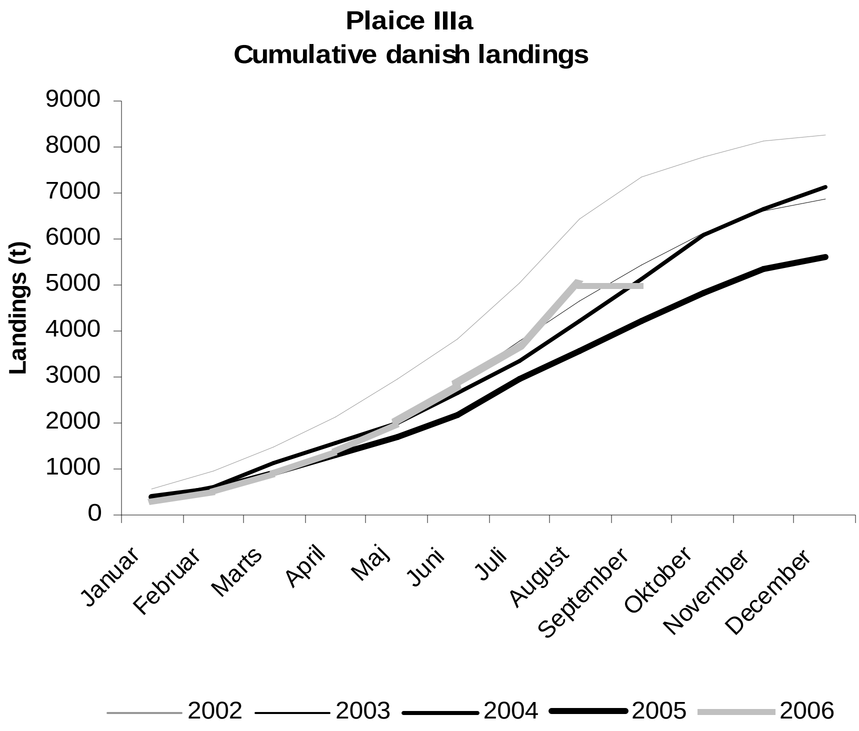


Fig. 7.1.1. Plaice in IIIa. Danish landings by month since 2002.

Figure 7.2.1 Mean weight at age in stock for age groups 1-6 upper figure and 7-11+ lower figure. Values 1978-1991 are fixed in age 1-4 and 1978-1995 are fixed for older age groups.

Fig. 7.2.2.. Plaice in IIIa. Observed maturity at age 1-6 compiled from IBTS 1st quarter.

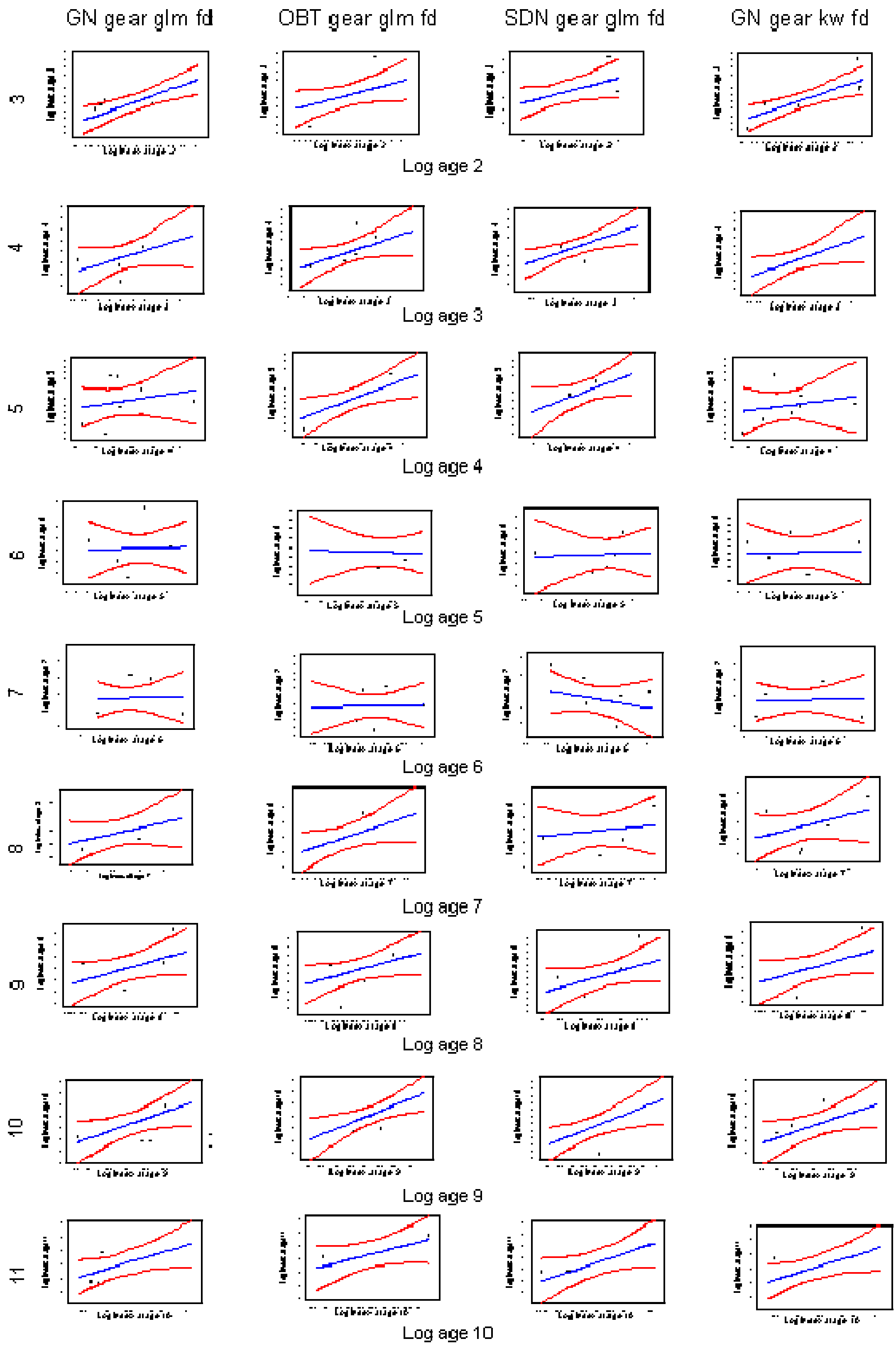


Figure 7.2.3. Plaice IIIa Internal consistency – year class matrix plots

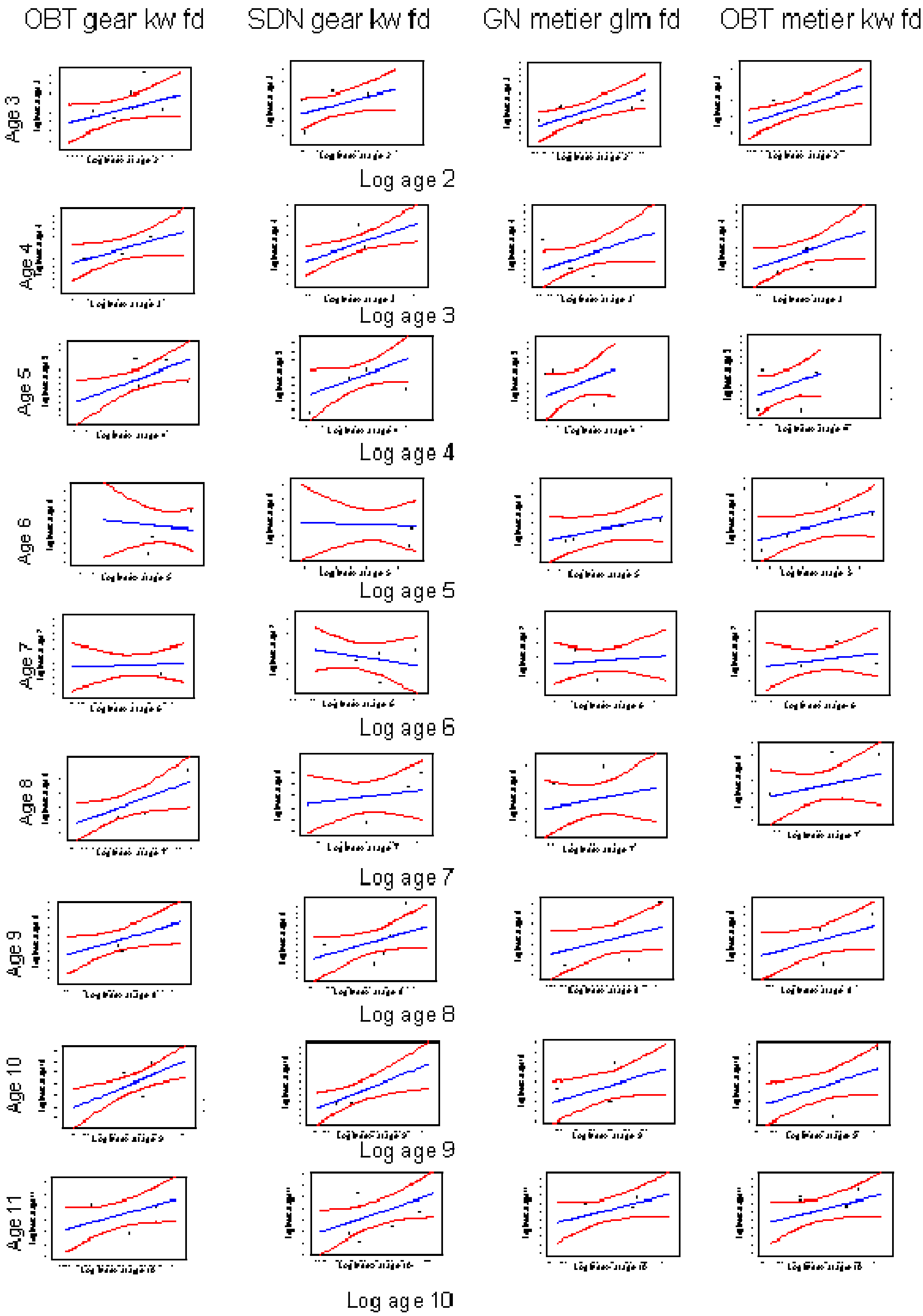


Figure 7.2.3 Continued. Plaice IIIa Internal consistency – year class matrix plots

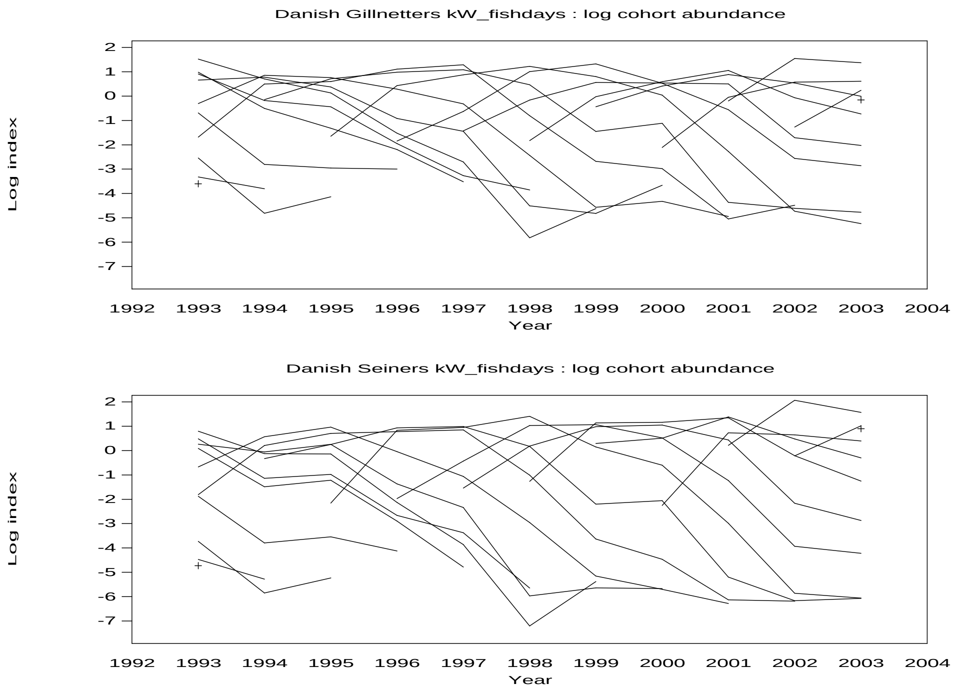


Fig. 7.2.4. Plaice in IIIa. Log catch curves for the two commercial fleets, Danish Gillnetters_Metier_kwFishdays and Danish seiners_Gear_kwFishdays.

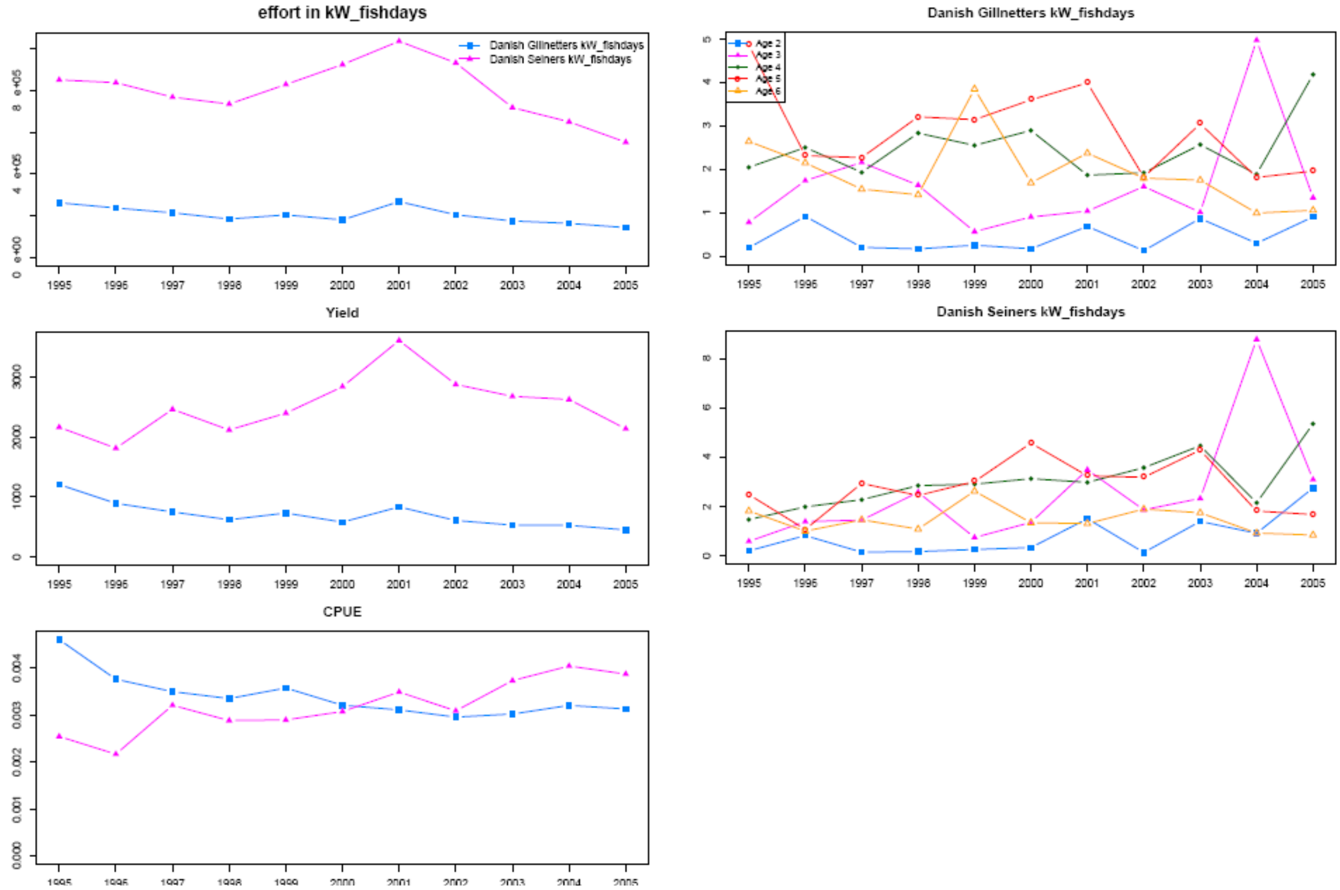


Figure 7.2.5. Plaice in IIIa. Effort, yield and CPUE (left) and CPUE by age for the two tuning fleets, Danish Gillnetters_metier_kwfishdays and Danish seiners_gear_kwfishdays. For fleet explanation see text.

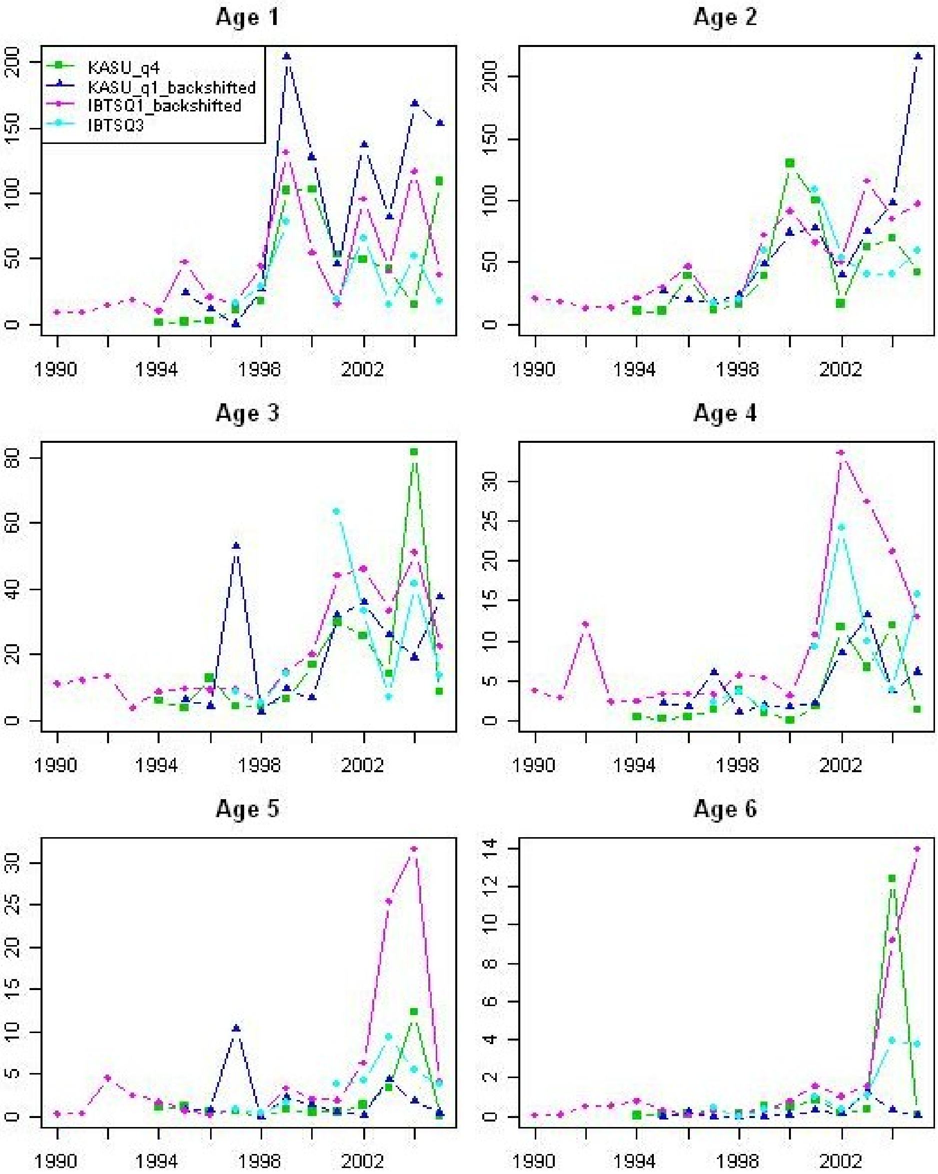


Fig. 7.2.6. Plaice in IIIa. CPUE by age for the four surveys, KASU 1st and 4th quarter, and IBTS 1st and 3rd quarter.

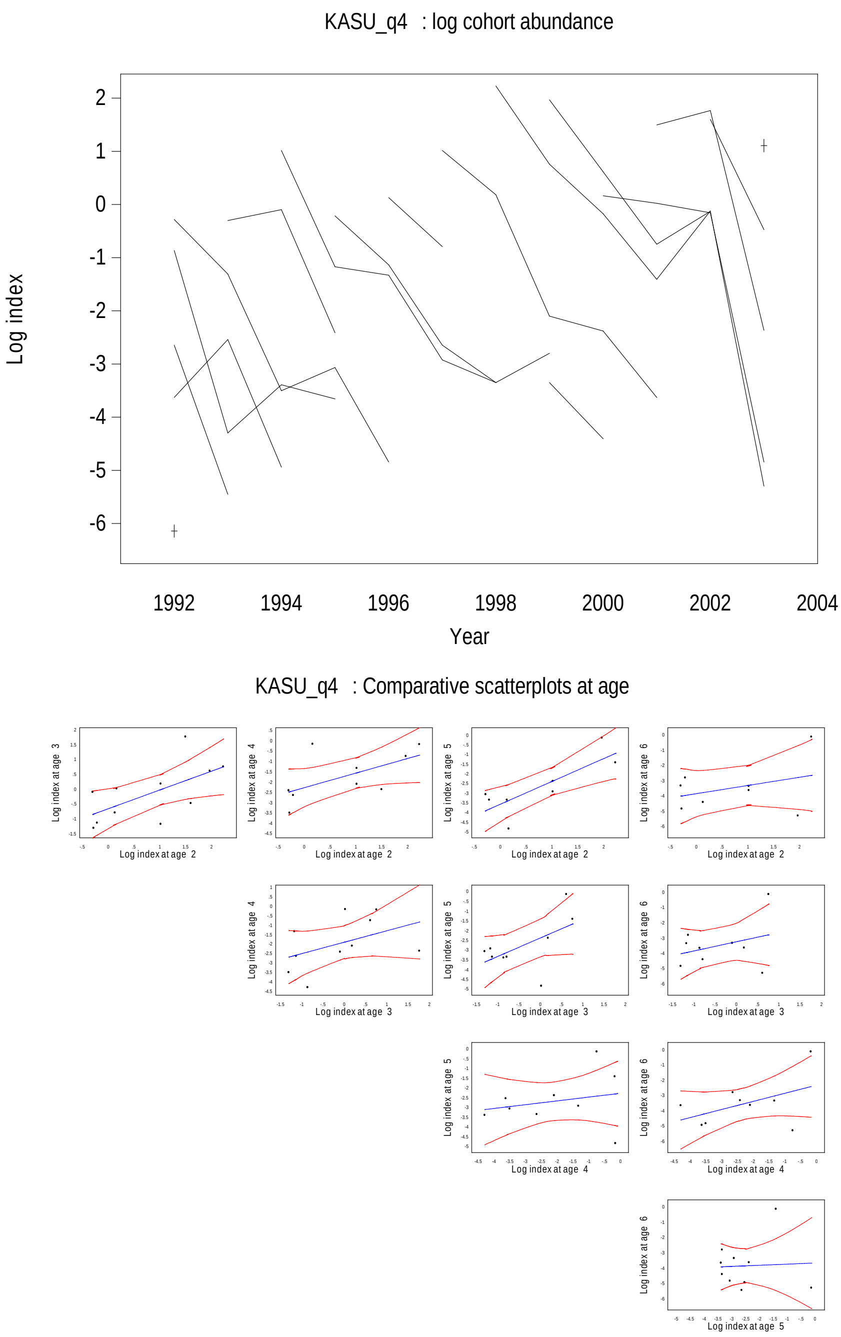
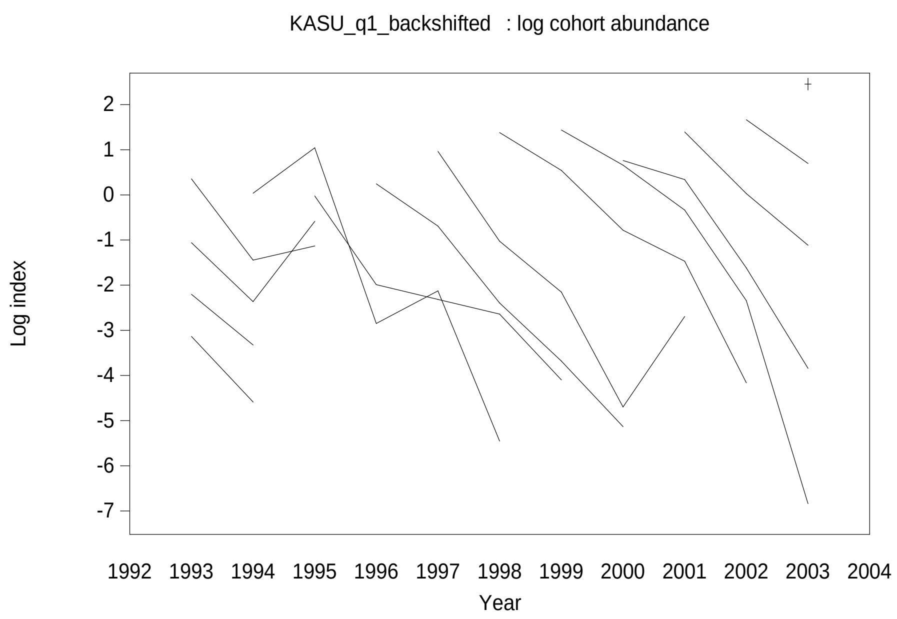


Fig. 7.2.7. Plaice in IIIa. Log catch curves and internal consistency matrix plot. KASU Q4 survey.



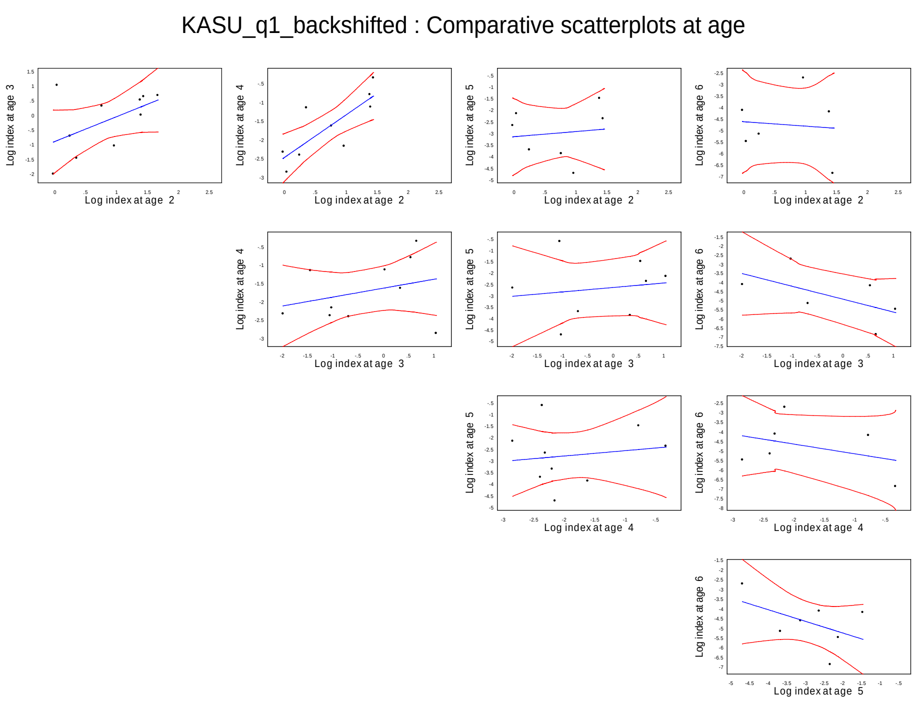
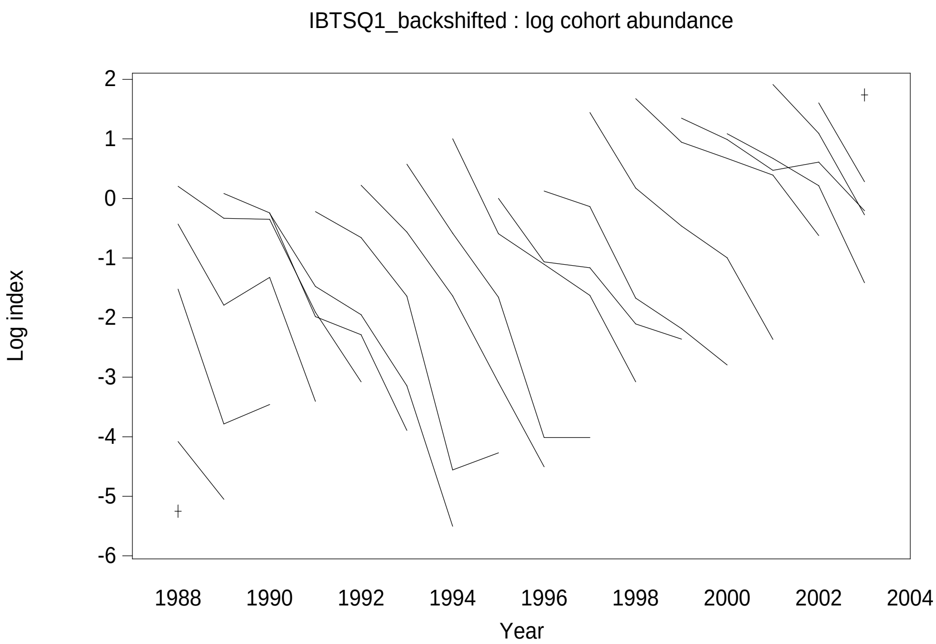


Fig. 7.2.7.Continued. Log catch curves and internal consistency matrix plot. KASU Q1 survey.



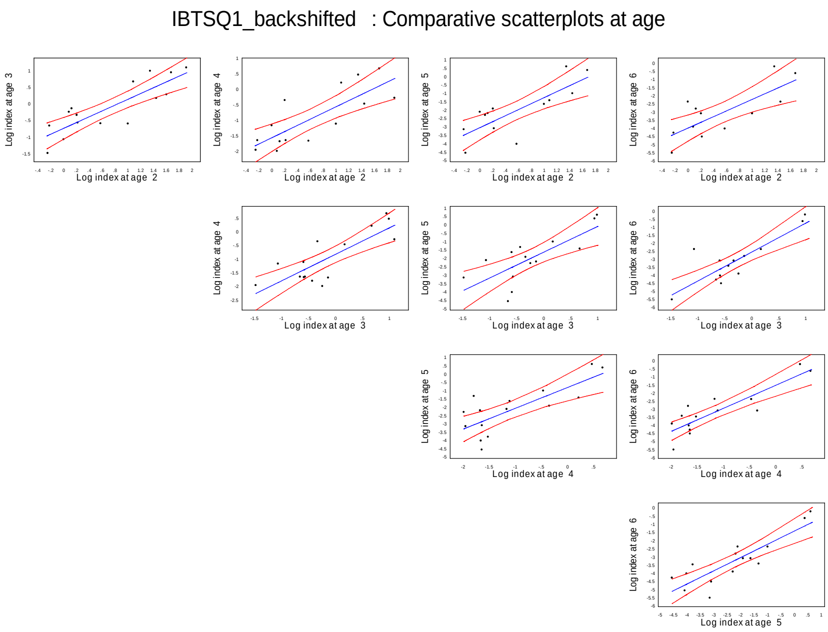
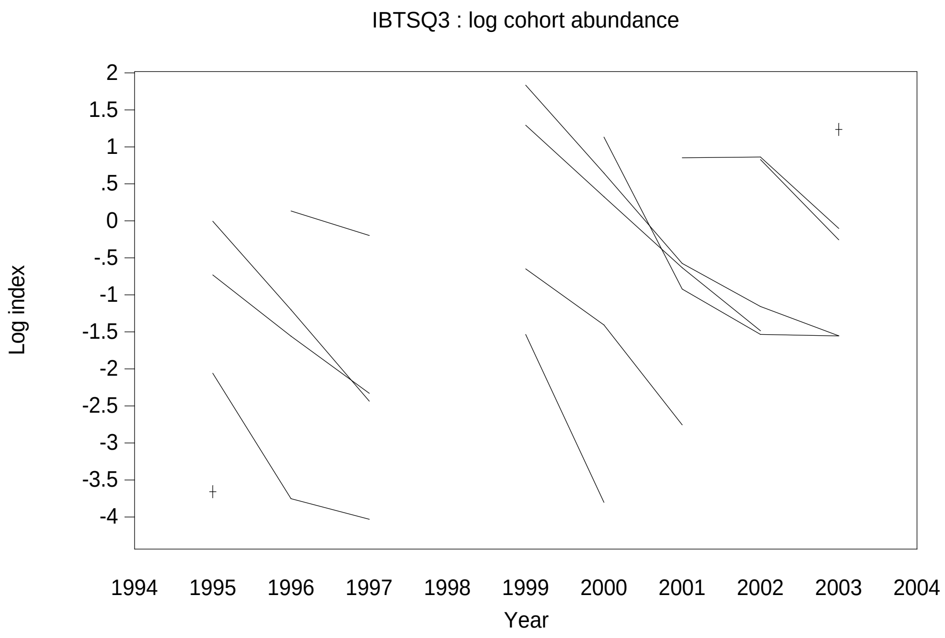


Fig. 7.2.7.Continued. Log catch curves and internal consistency matrix plot. IBTS Q1 survey.



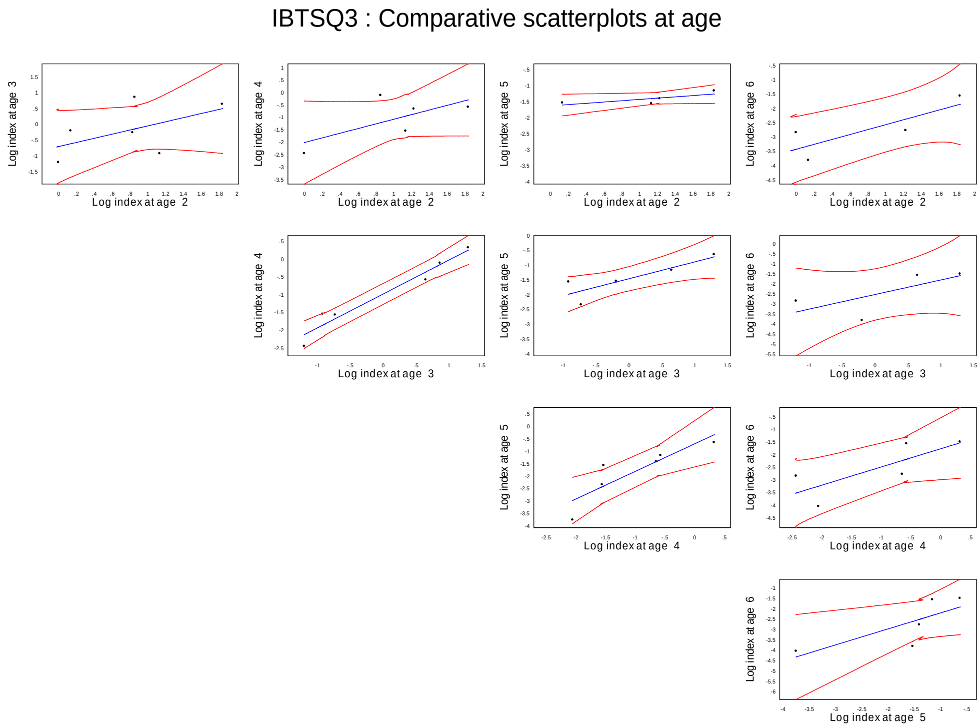


Fig. 7.2.7.Continued. Log catch curves and internal consistency matrix plot. IBTS Q3 survey.

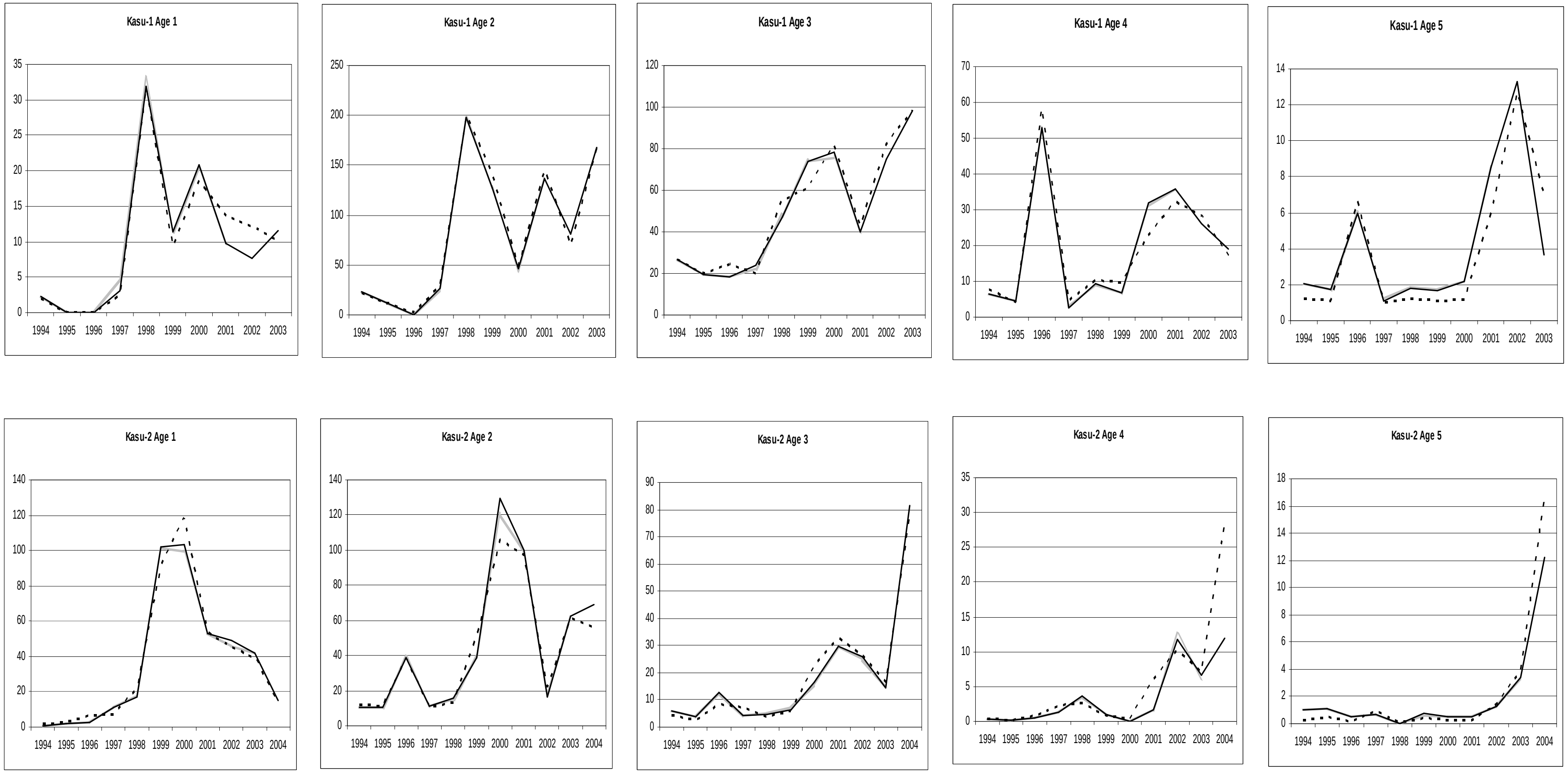
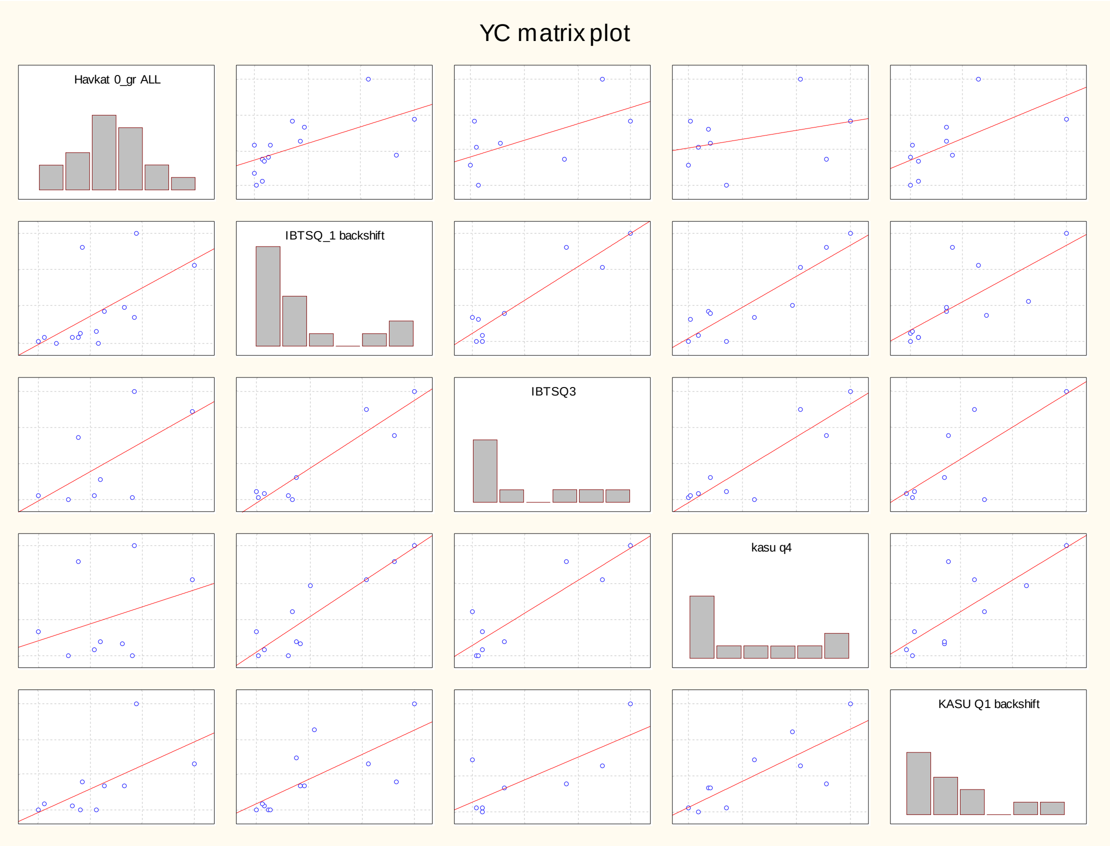


Figure 7.2.8. Plaice in IIIa. Comparison of the revised survey indices. The previous used index is marked gray, 2005 revised index is dashed line and the new revised index is solid line.



1.00	0.58	0.74	0.50	0.59
0.58	1.00	**0.95**	**0.97**	**0.83**
0.74	**0.95**	1.00	**0.94**	**0.90**
0.50	**0.97**	**0.94**	1.00	**0.82**
0.59	**0.83**	**0.90**	**0.82**	1.00

Fig. 7.2.9. Plaice in IIIa. YC matrix plot of HAVKATTEN survey 0-group versus ages 2 from KASU and IBTS surveys. Below is corresponding correlation coefficient matrix (significant correlations marked bold).

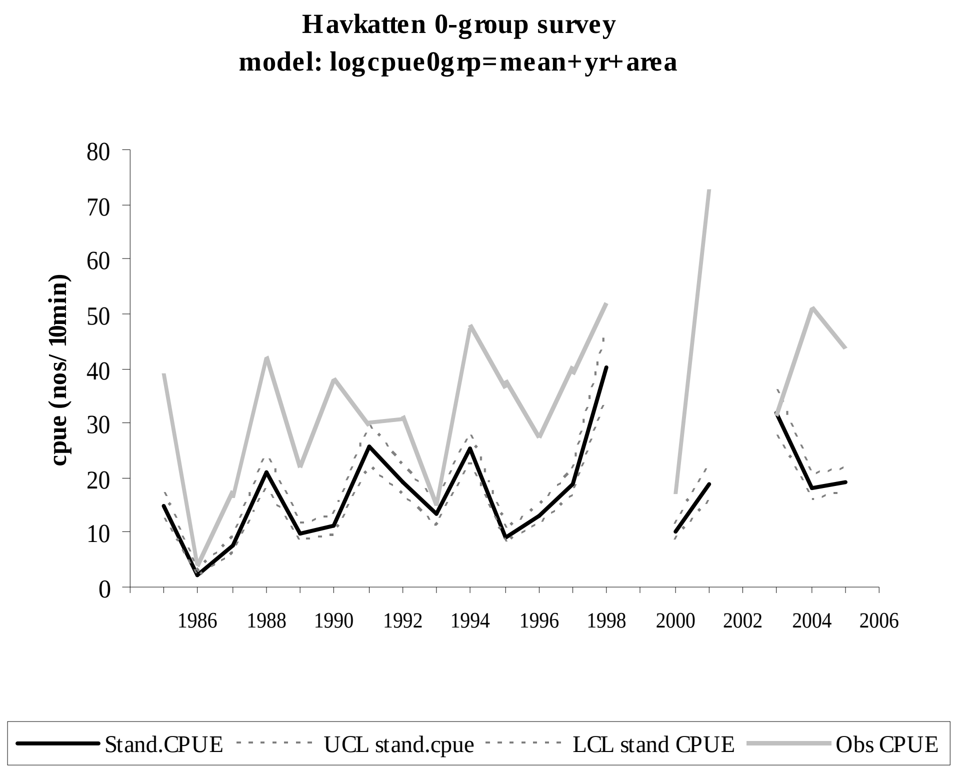


Fig. 7.2.10. Plaice in IIIa. Standardised CPUE versus observed CPUE (weighed mean) of 0-group plaice from the HAVKATTEN survey in Kattegat.

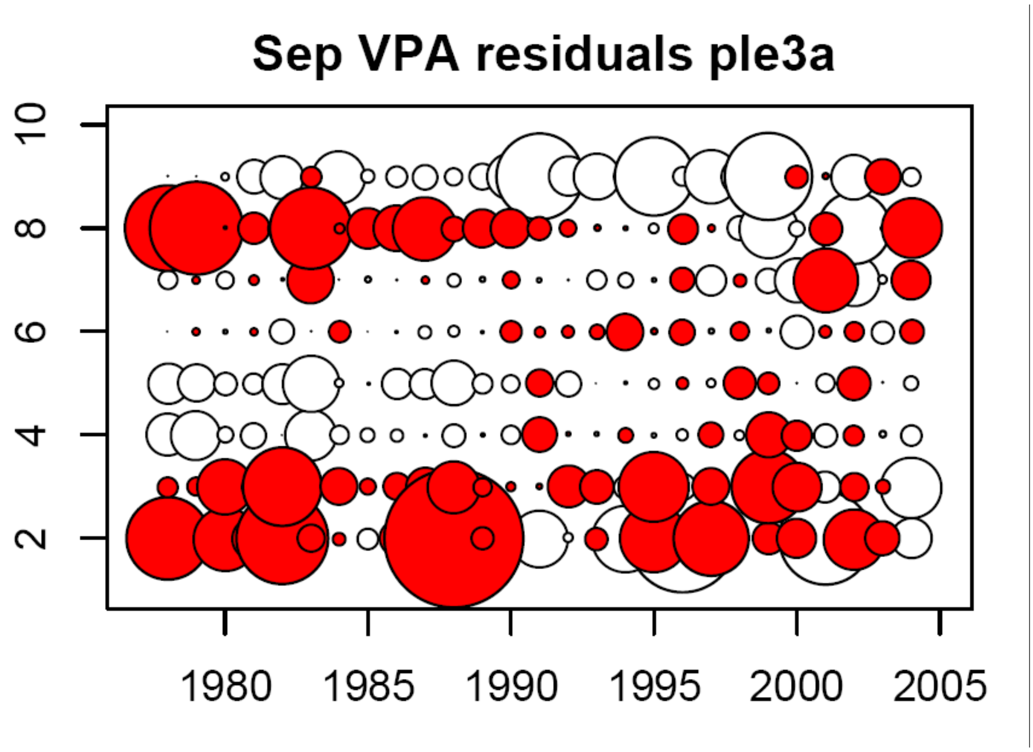


Fig. 7.3.1. Plaice in IIIa. Plot of residuals from a separable analysis (Table 7.3.).

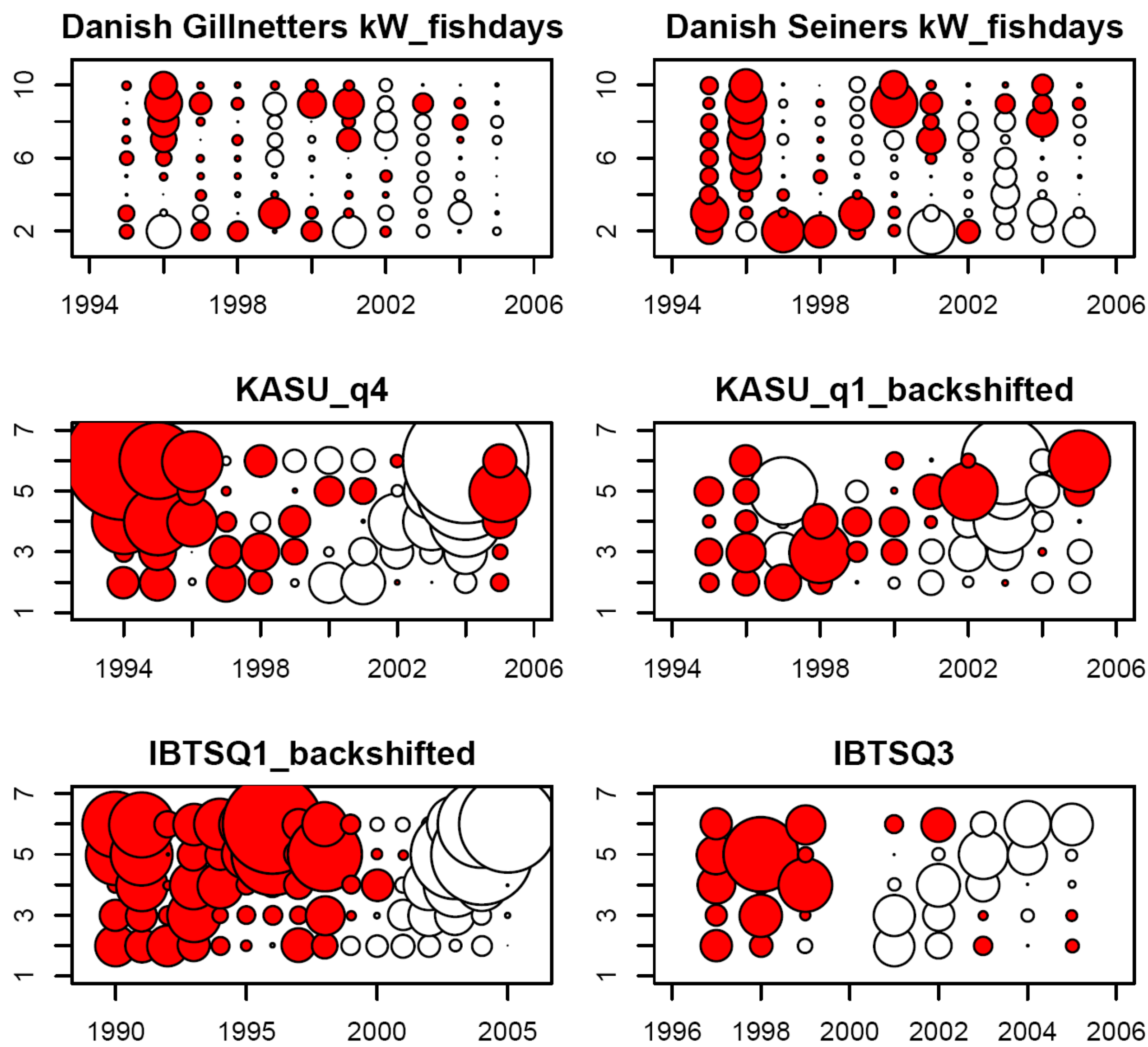


Fig. 7.3.2. Plaice in IIIa. Plots of log q residuals from a SPALY XSA run (Table 7.3.2.).

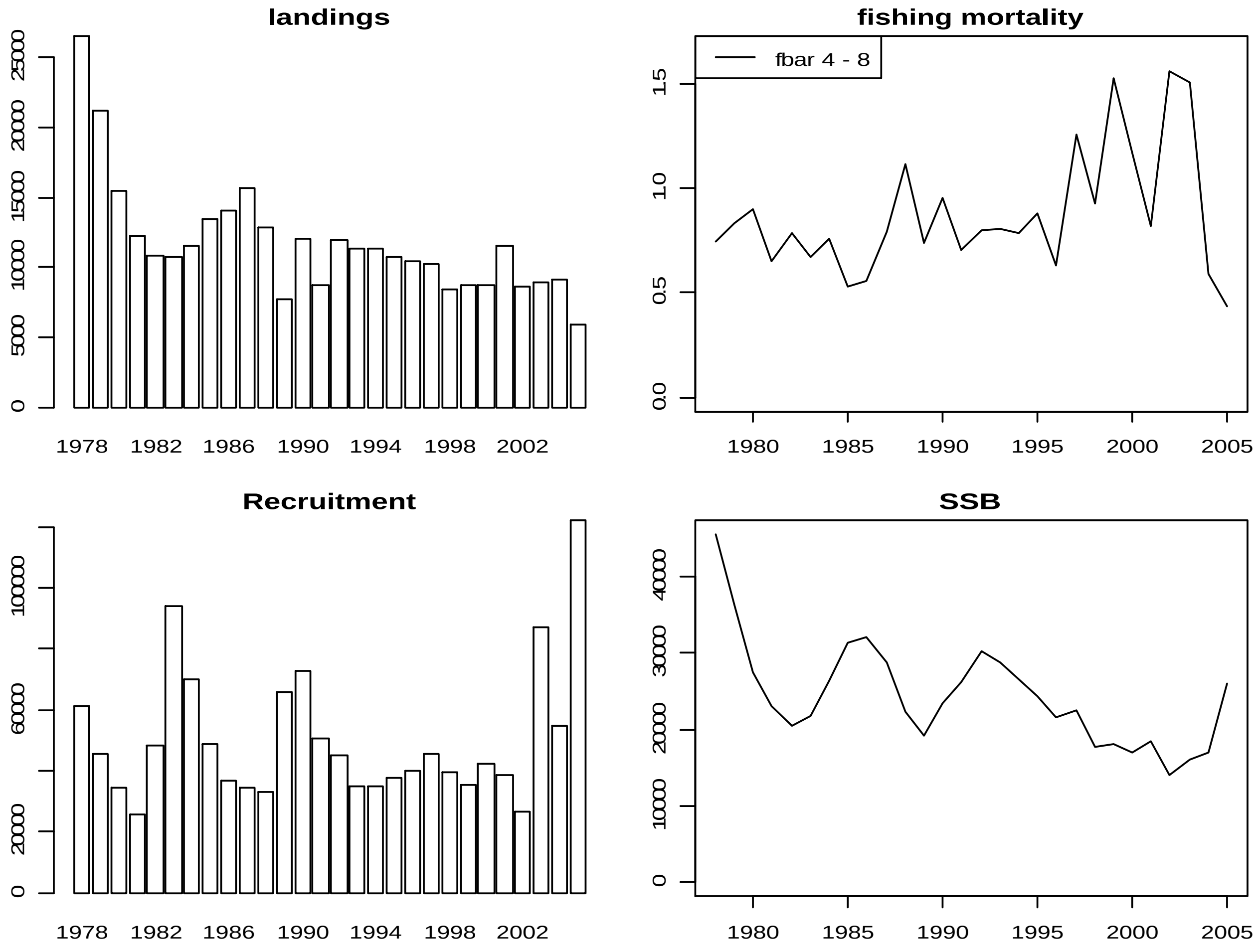


Fig. 7.3.3. Plaice in IIIa. Summary plots of SPALY XSA run, shr=0.5.

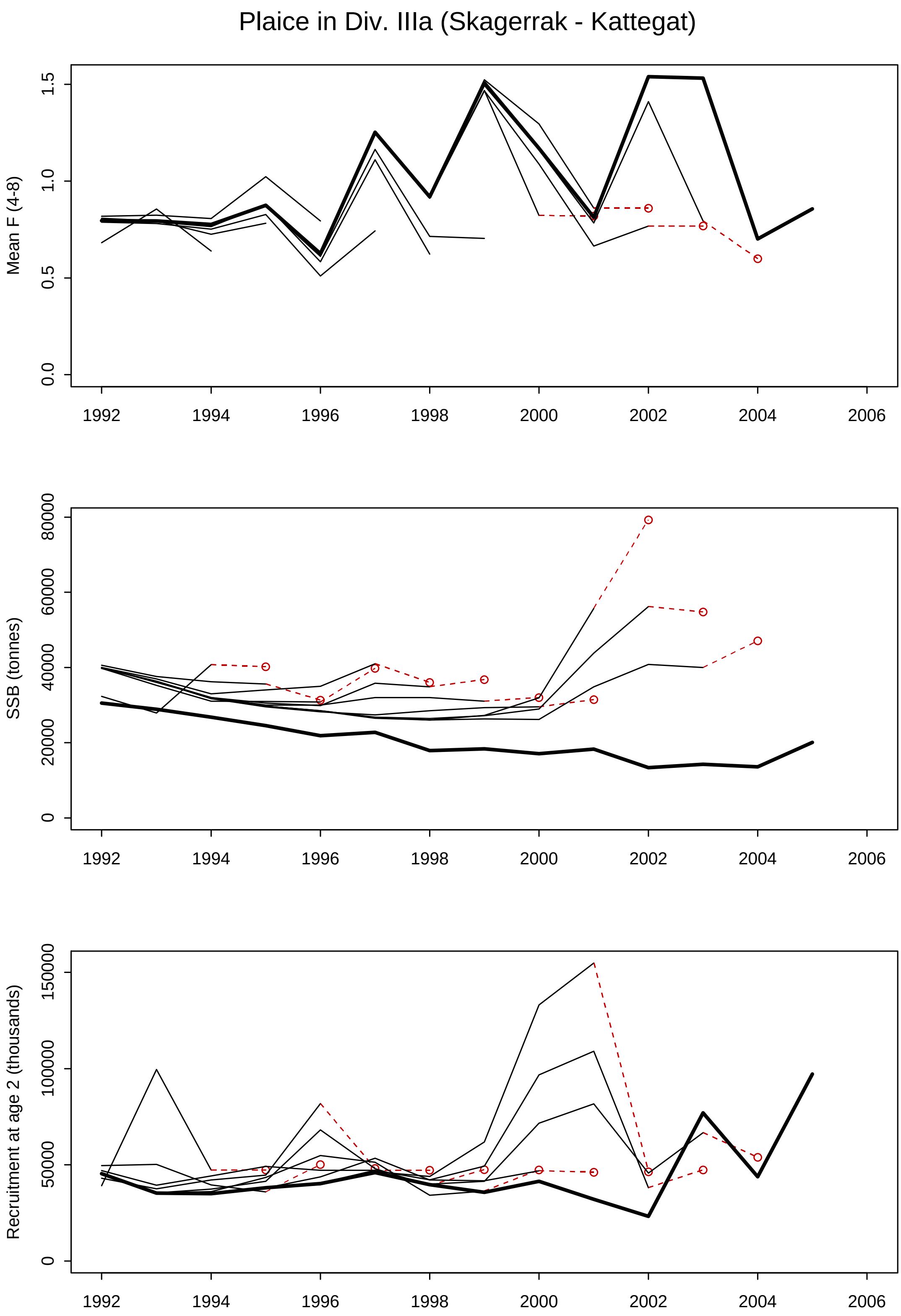


Fig. 7.3.4. Plaice in IIIa. Historical performance of assessment of plaice in IIIa. Circles indicate forecasts.

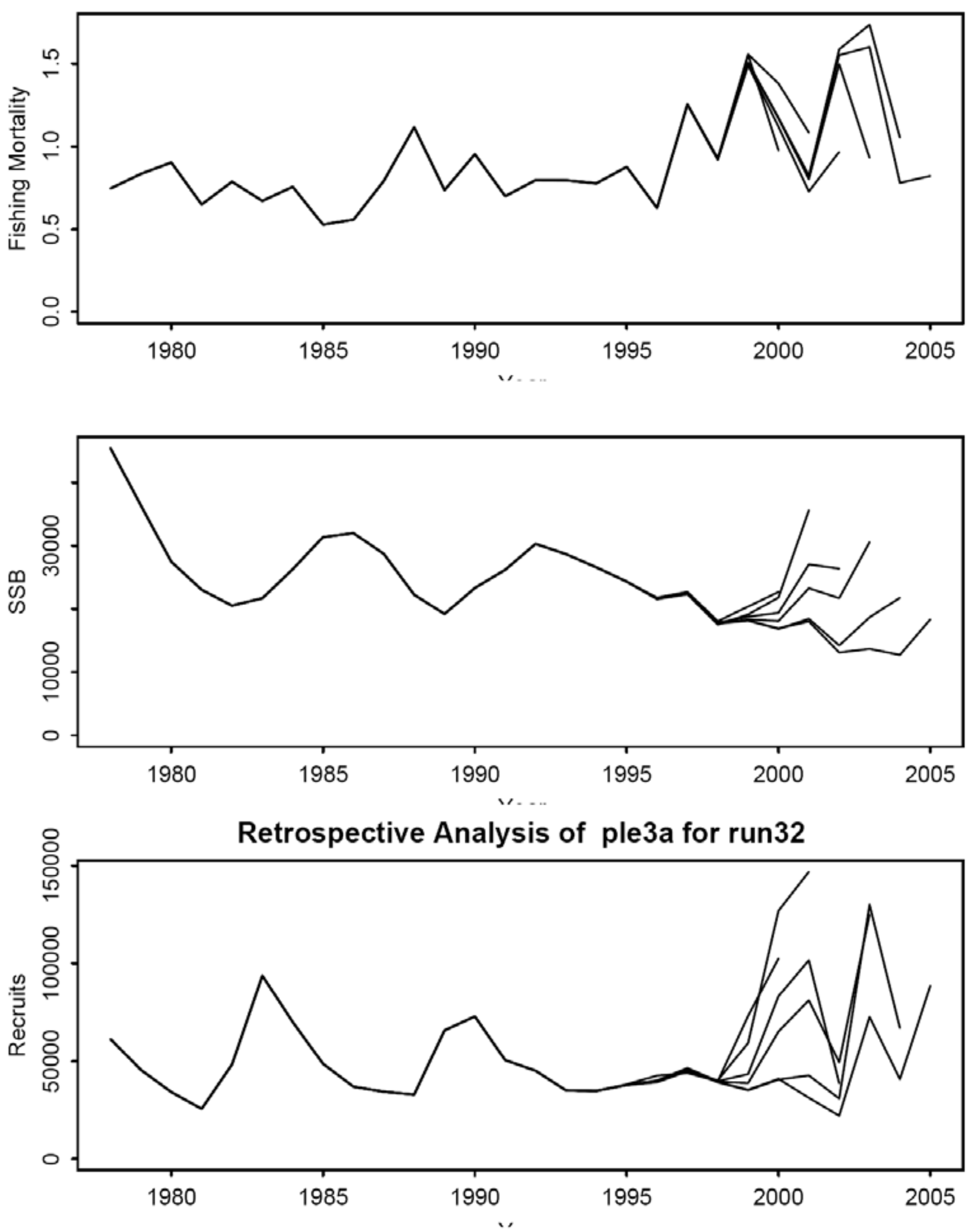


Fig. 7.3.5. Plaice in IIIa. Retrospective analysis of SPALY run (XSA). Shrinkage=0.5.

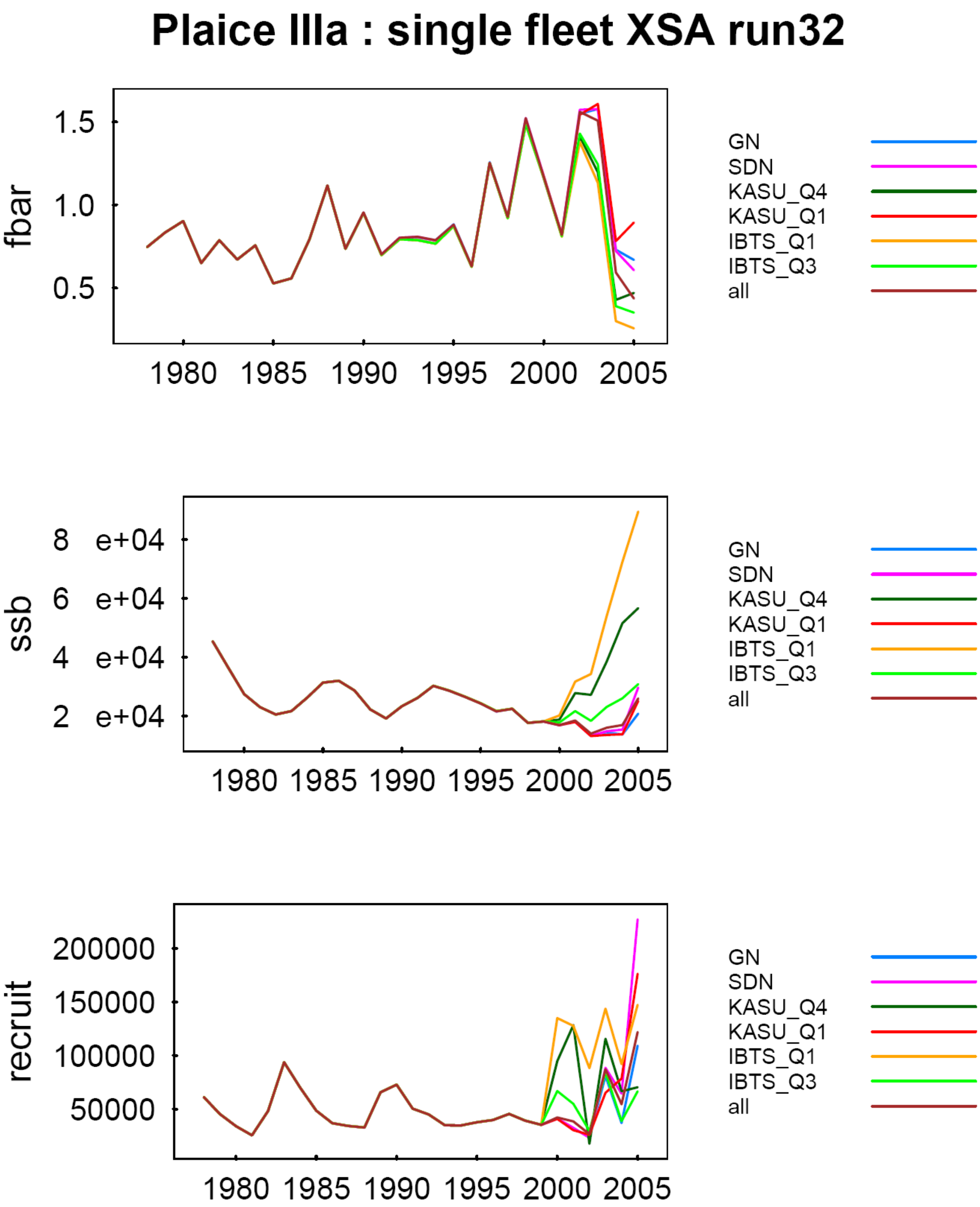


Fig. 7.3.6. Plaice in IIIa. Single fleet XSA runs, with shrinkage =2.0.

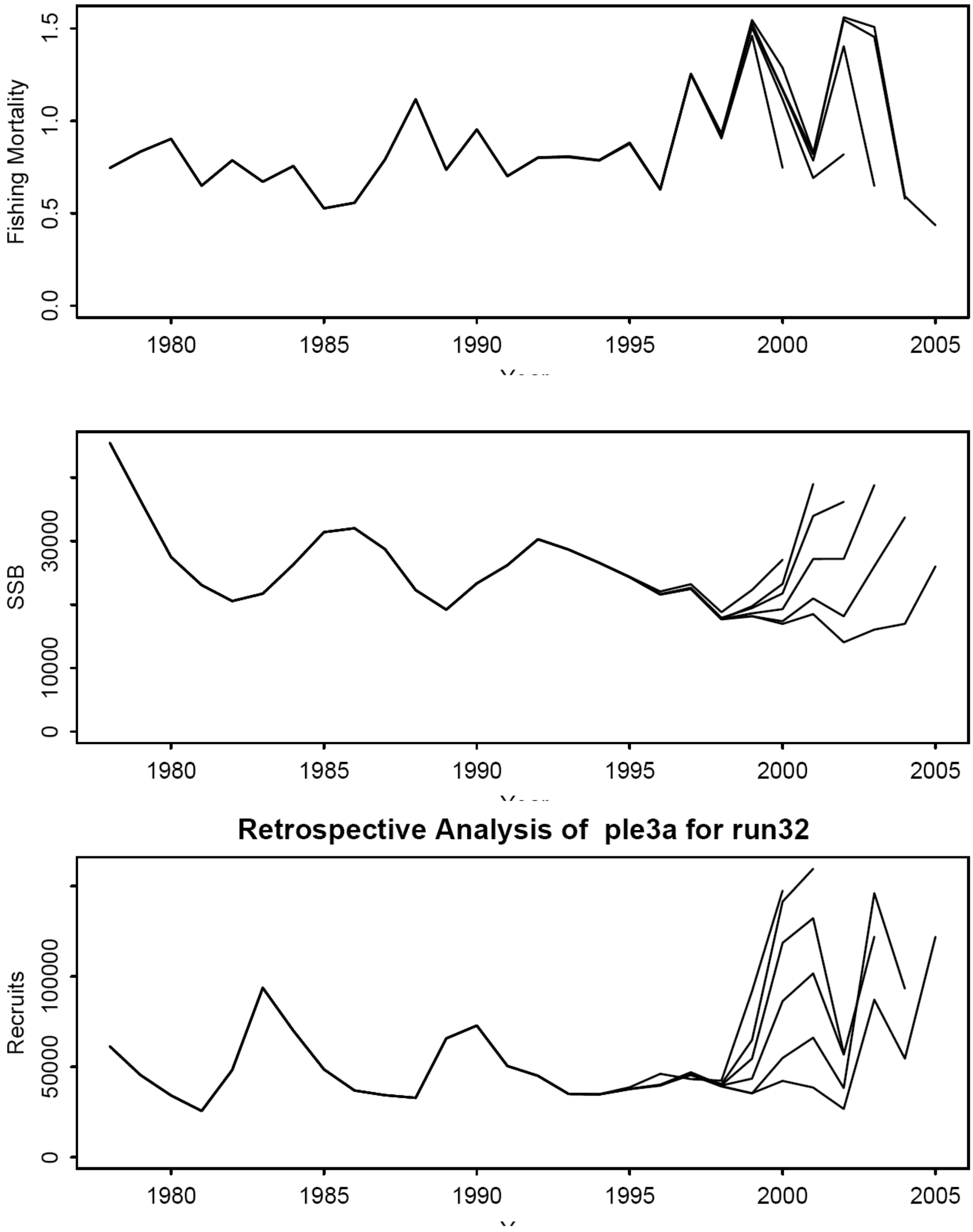


Fig. 7.3.7. Plaice in IIIa. Retrospective analysis using shrinkage=2.0.

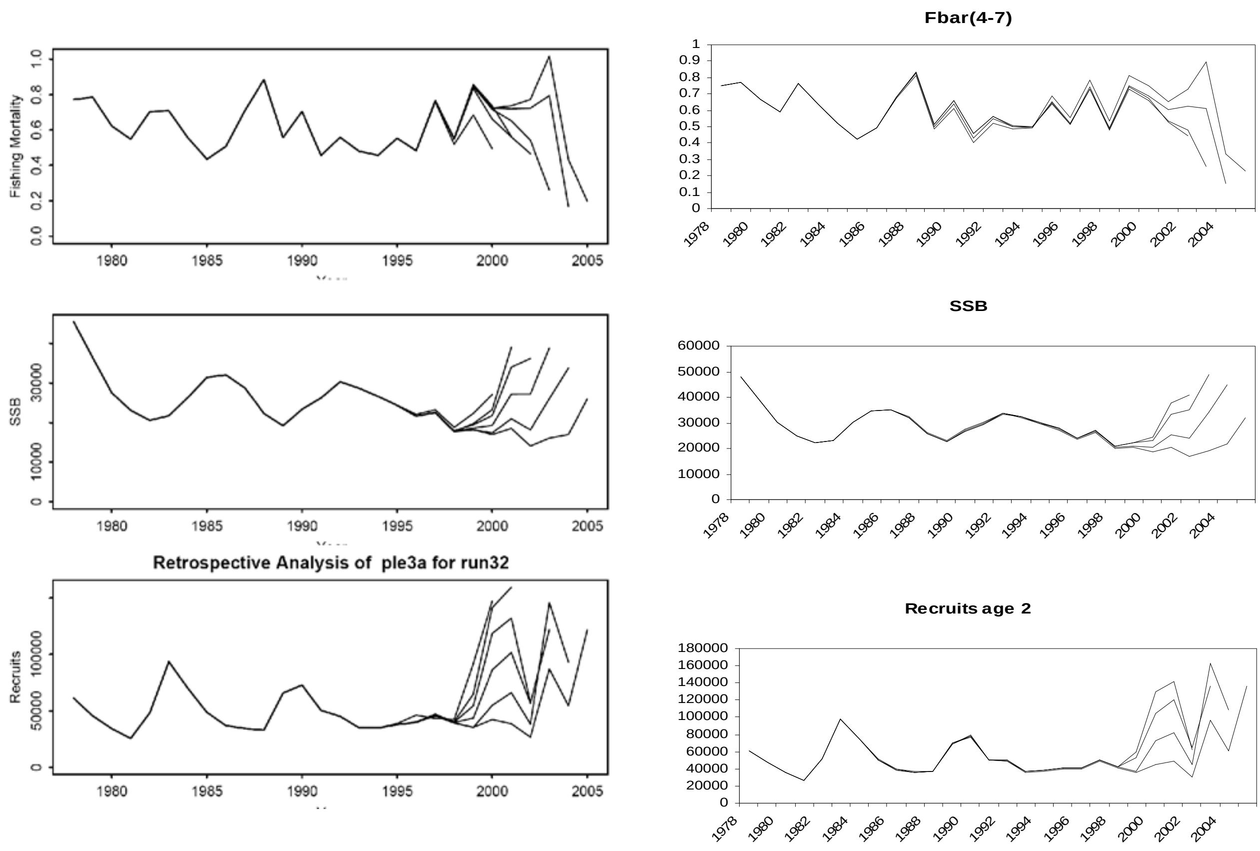


Fig. 7.3.8. Plaice in IIIa. Retrospective analyses of XSA runs. Left: Fbar(3-6), Right: LANUM (ages 2-8)

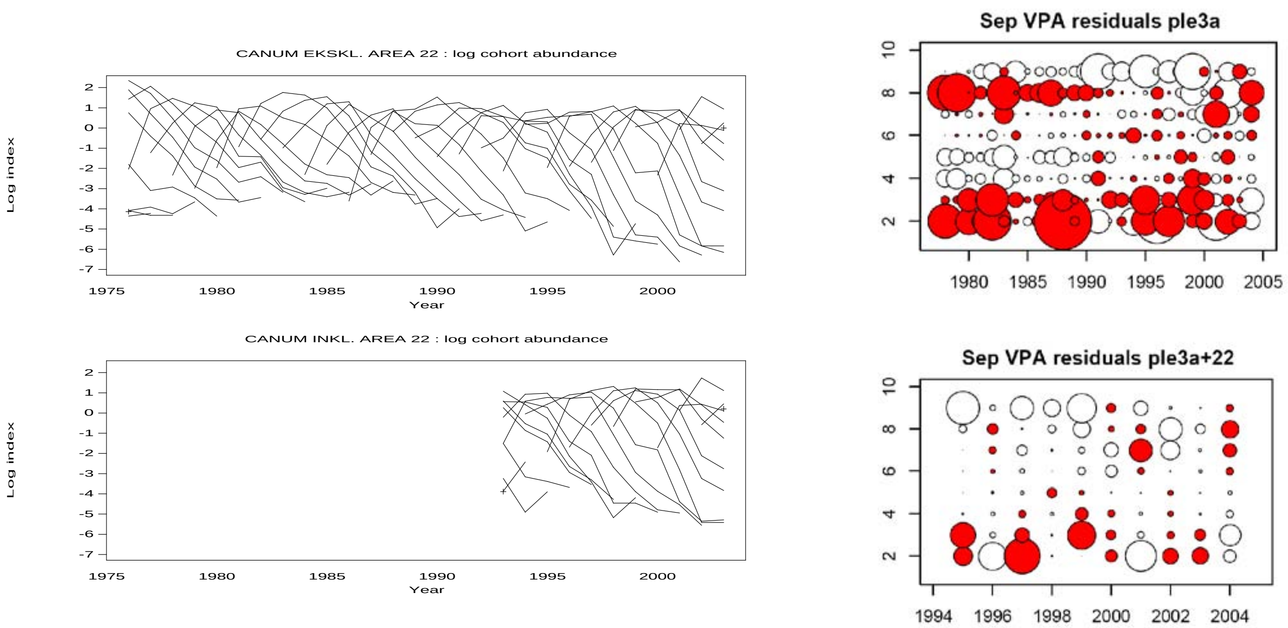


Fig. 10.3.9. Plaice in IIIa. Examination of landings at age for IIIa versus IIIa including area 22. Catch curves and separable VPA residuals for the two. Catch series for the entire area (incl 22) includes a shorter year range from 1994-2005.

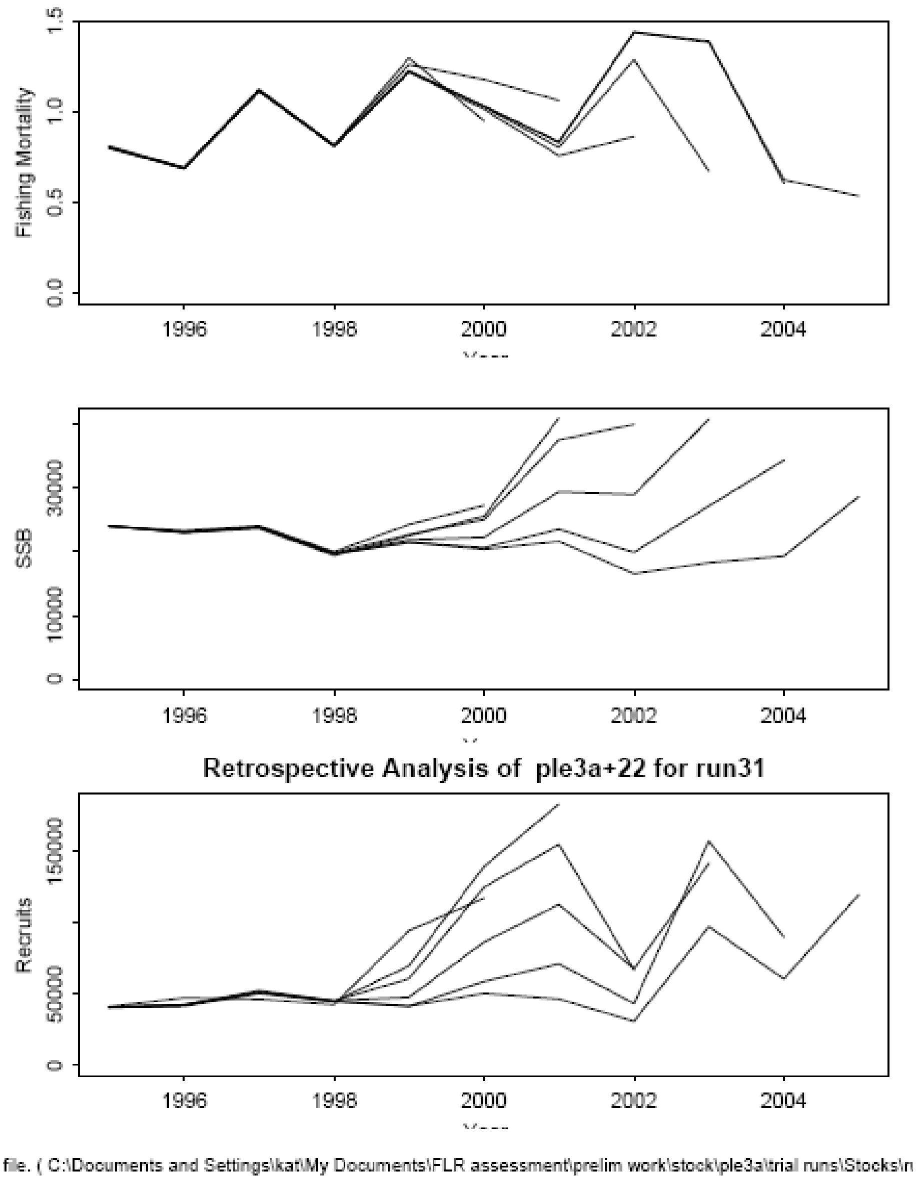


Fig. 7.3.10.Plaice in IIIa. Retrospective analyses of XSA runs including area 22.

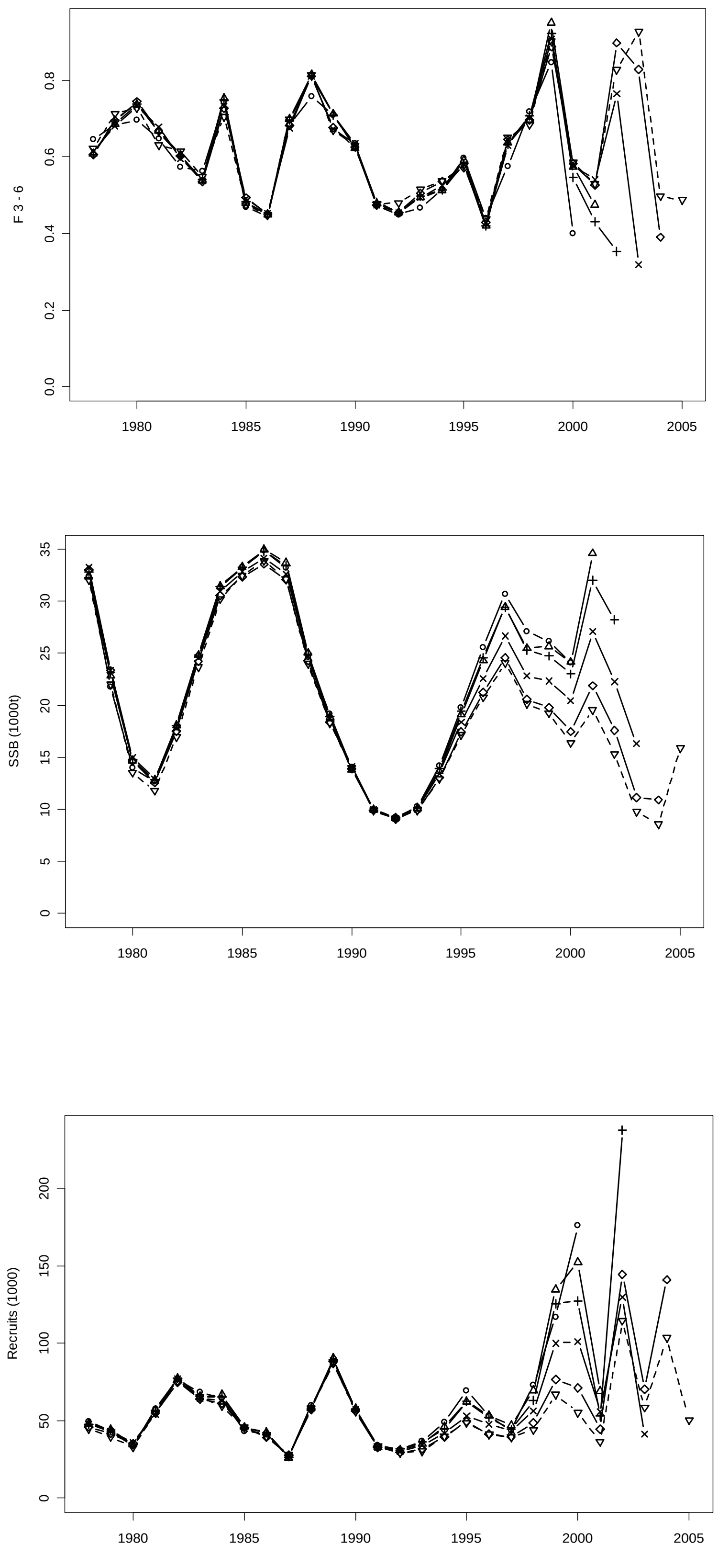


Fig. 7.3.11. Plaice in IIIa. Retrospective analysis from an SMS model.

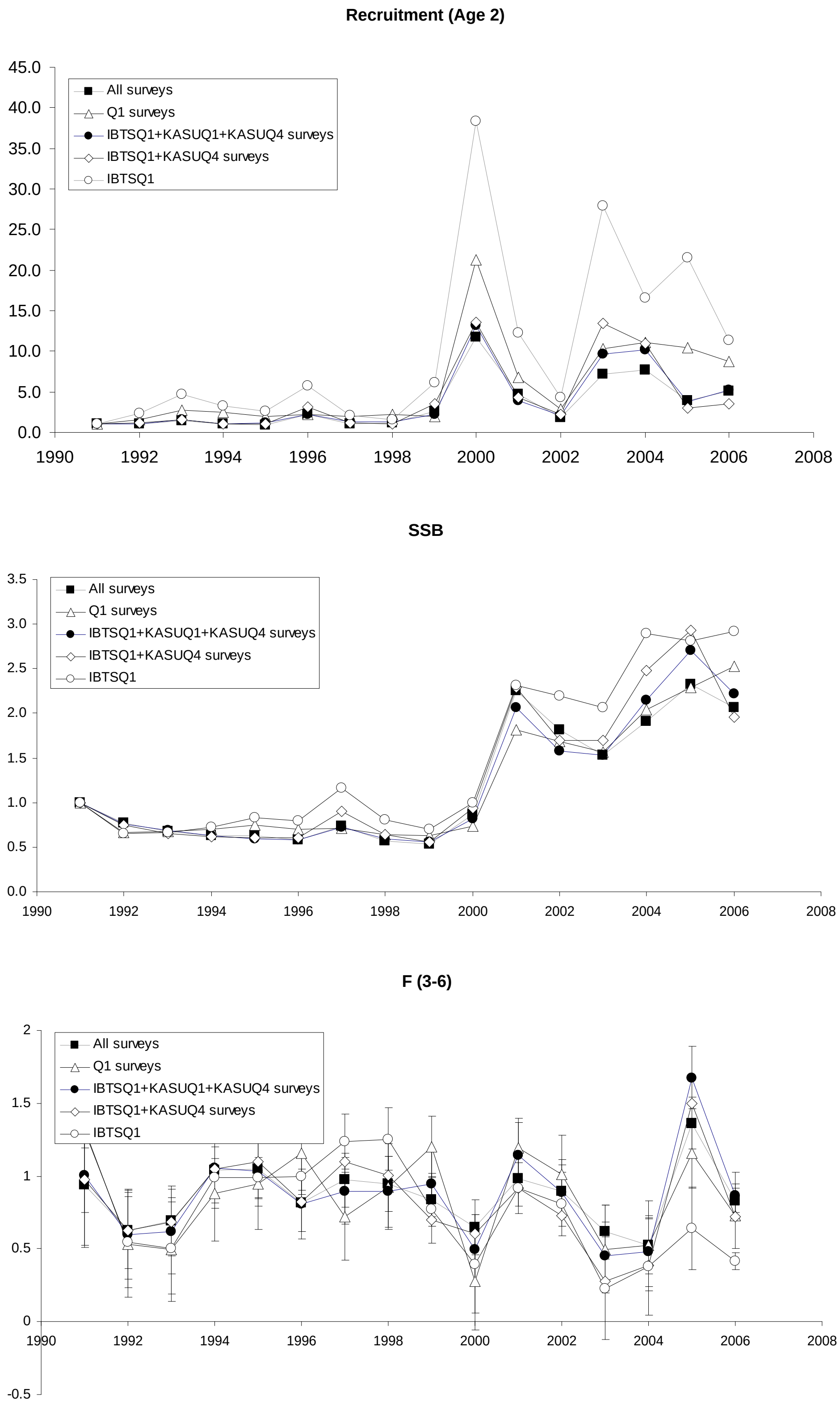


Fig. 7.3.12. Plaice in IIIa. Summary plot of survey based assessment approach SURBA for combinations of surveys.

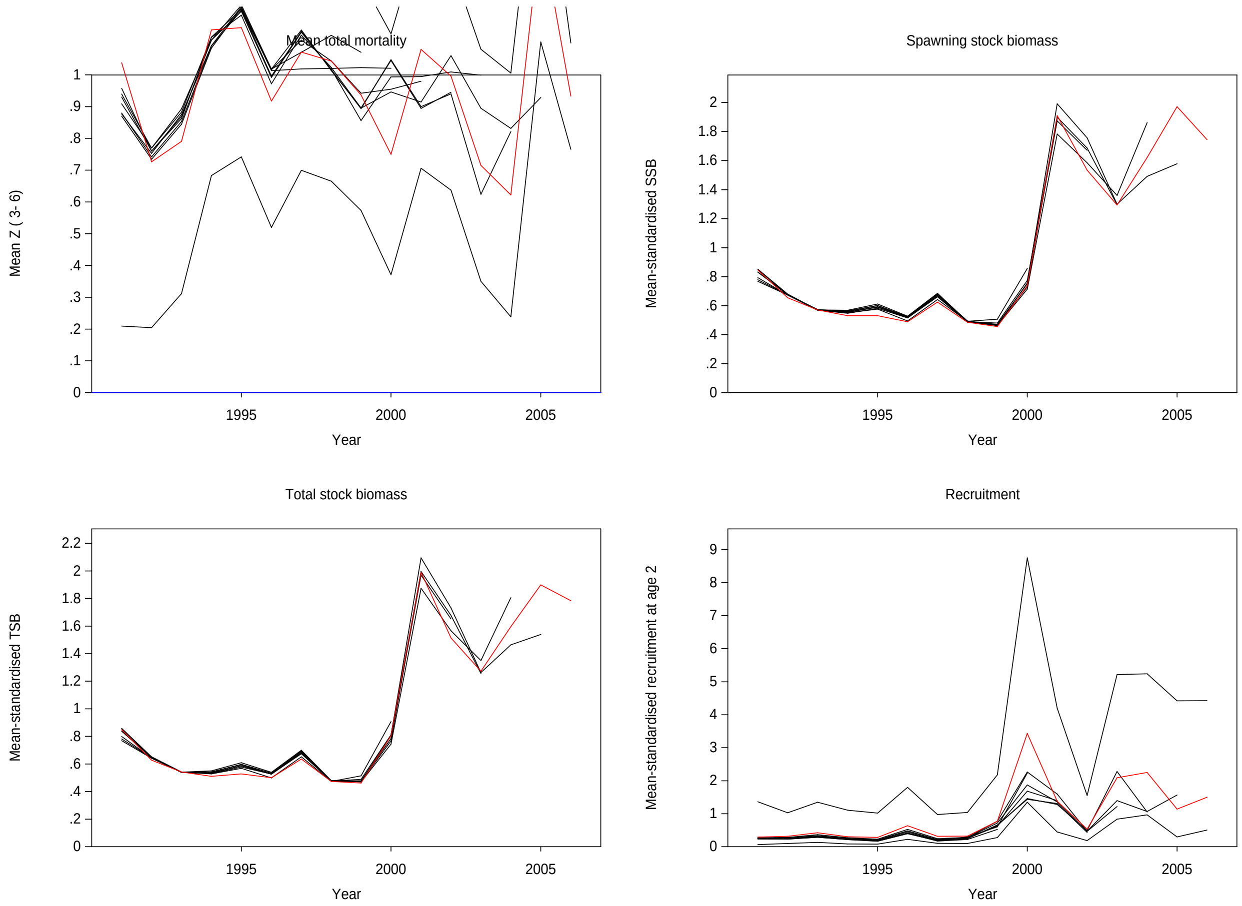


Fig. 7.3.13. Plaice in IIIa. Retrospective analysis of SURBA approach using all surveys.

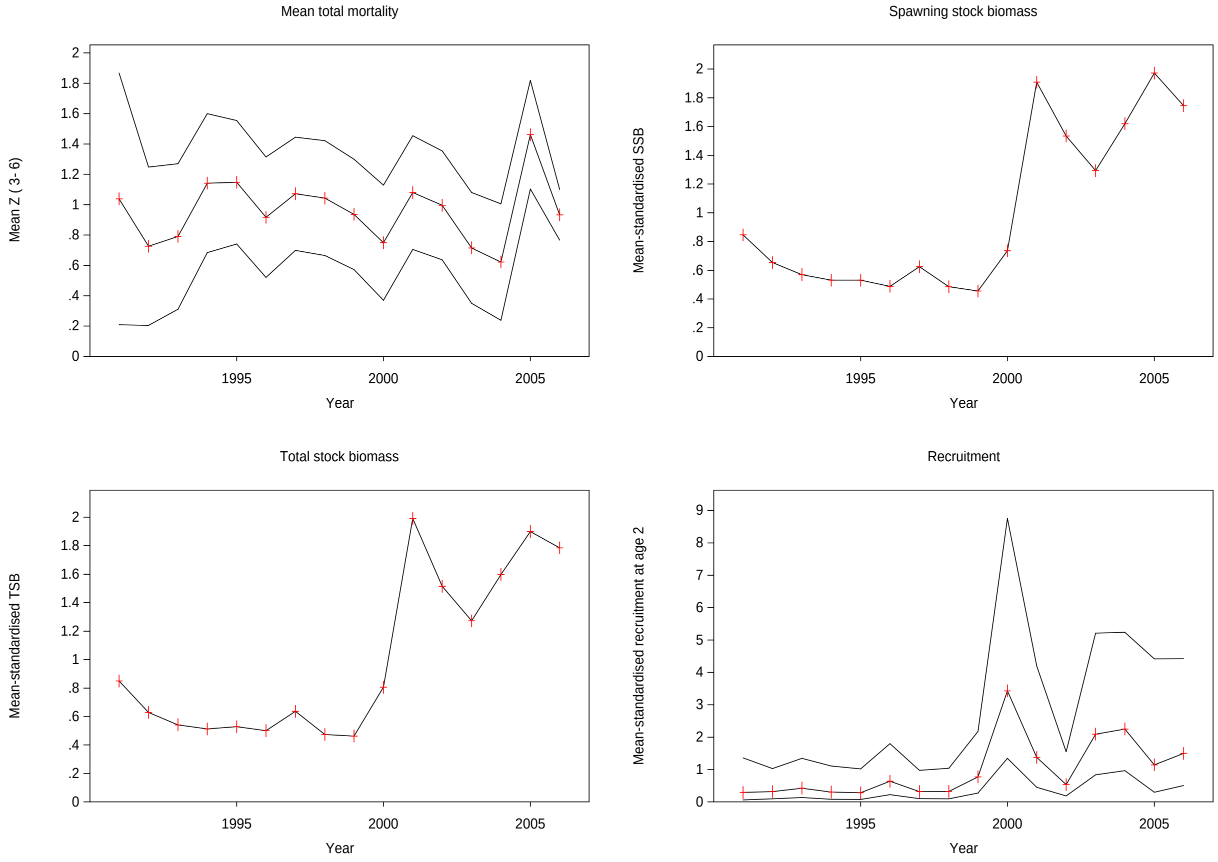
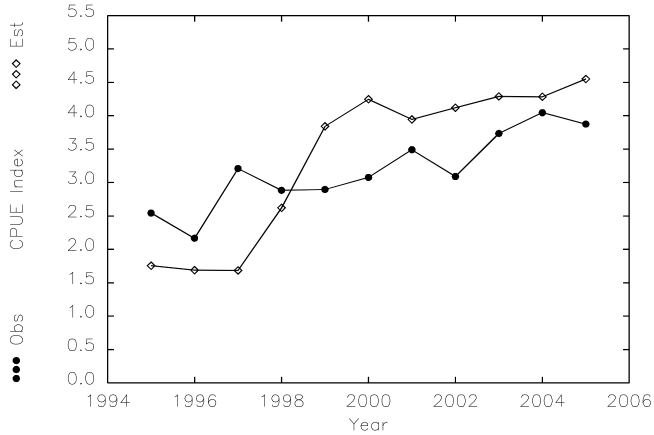
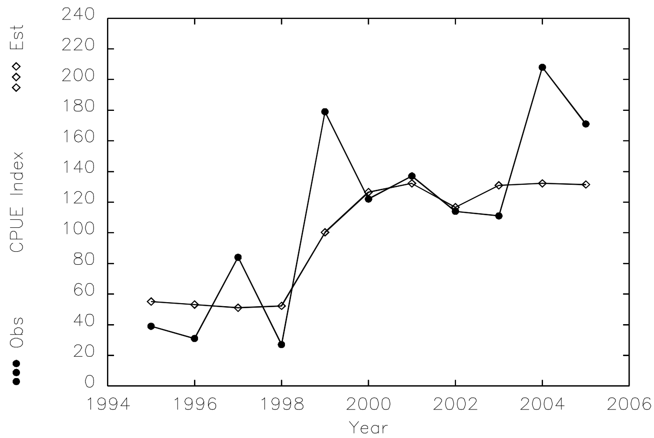


Fig. 7.3.14. Plaice in IIIa. Summary plot of SURBA run using all surveys.





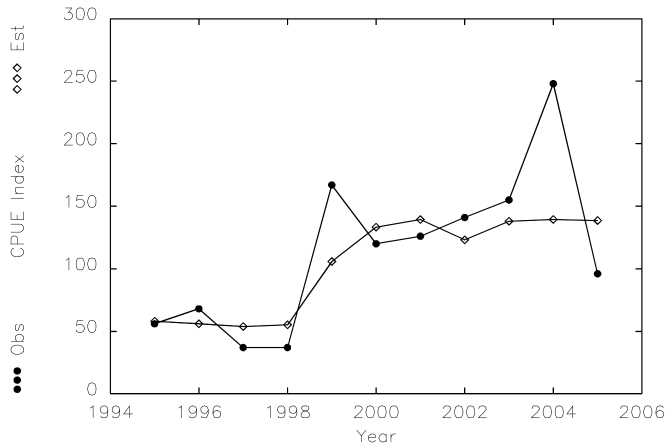


Fig. 7.3.15. Plaice in IIIa. Input LPUE series to the ASPIC model and the estimated index. Upper: Danish seiners, Middle: KASU Q1 survey and Lower: IBTS Q1 survey.

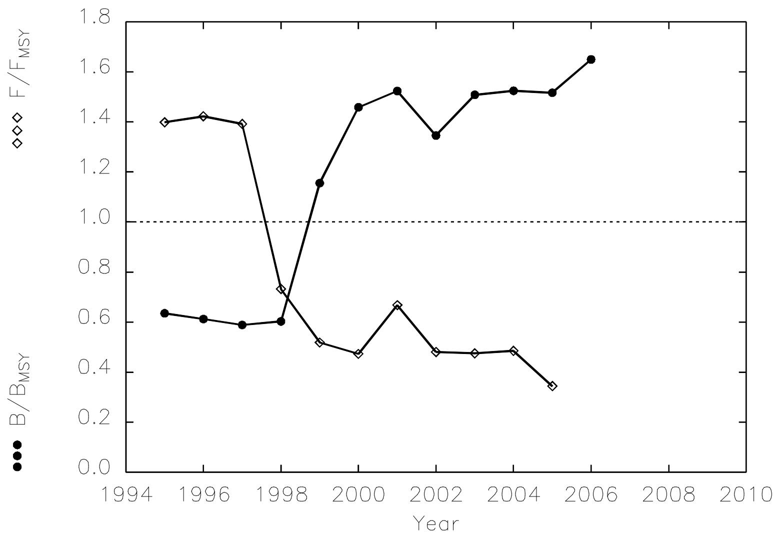


Fig. 7.3.16. Plaice in IIIa. Relative fishing mortality and biomass estimates by ASPIC.

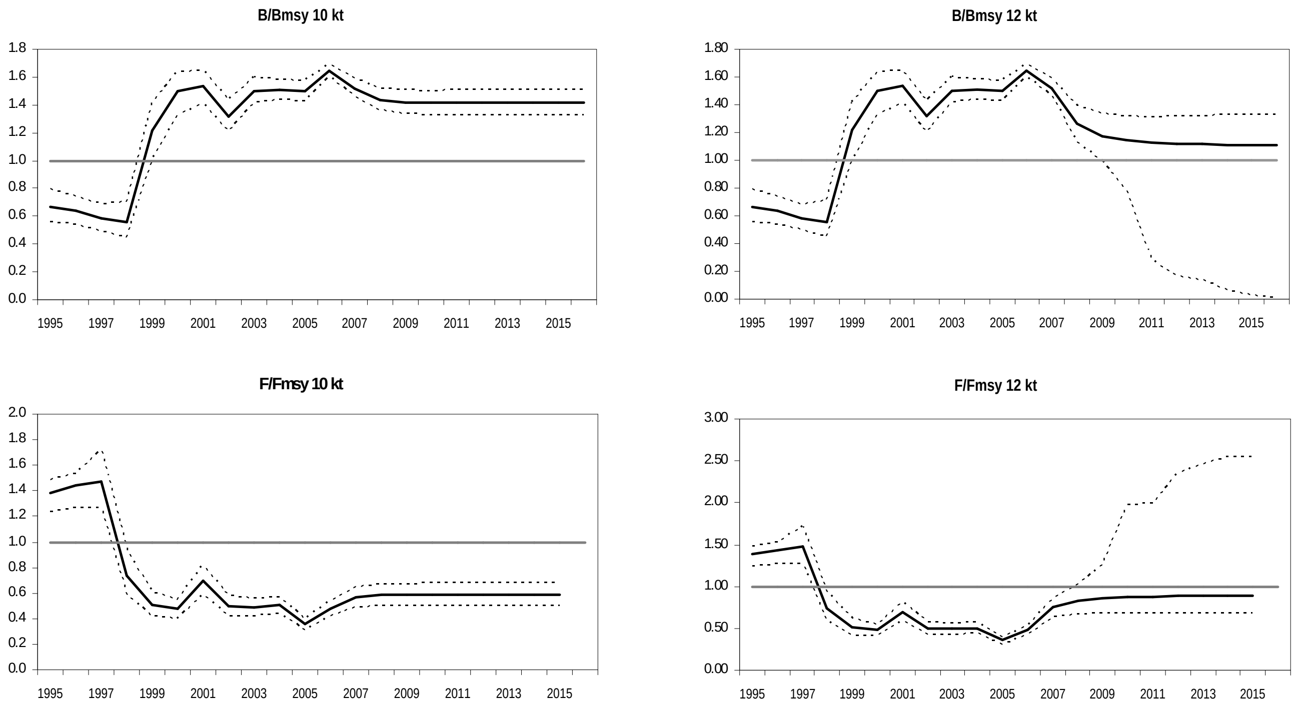


Fig. 7.3.17 Plaice in IIIa. Development of relative F and b from bootstraps of ASPIC results, assuming annual catches of 10 000 t (left) and 12 000 t (right).

8 Plaice in Sub-Area IV

The assessment of North Sea plaice is on the ACFM observation list, which means that a benchmark assessment is carried out every year. A Stock Annex is not yet available for North Sea plaice. Therefore information that should be given in the Stock Annex is currently still presented within this Section of the report.

8.1 General

8.1.1 Ecosystem aspects

Adult North Sea plaice have an annual migration cycle between spawning and feeding grounds. The spawning grounds are located in the central and Southern North Sea, overlapping with the distribution area of Sole. The feeding grounds are located more northerly than the sole distribution areas.

Juvenile stages are concentrated in shallow inshore waters and move gradually offshore as they become larger. The nursery areas on the eastern side of the North Sea contribute most of the total recruitment. Sub-populations have strong homing behaviour to specified spawning grounds and rather low mixing rate with other sub-populations during the feeding season (De Veen, 1978; Rijnsdorp and Pastoors, 1995). Genetically, North Sea and Irish Sea plaice are weakly distinguishable from Norway, Baltic and Bay of Biscay stocks using mitochondrial DNA (Hoarau et al., 2004).

Juvenile plaice were distributed more offshore in recent years. Surveys in the Wadden Sea have shown that 1-group plaice is almost absent from the area where it was very abundant in earlier years. The Wadden Sea Quality Status Report 2004 (Vorberg et al. 2005) notes that increased temperature, lower levels of eutrophication, and decline in turbidity have been suggested as causal factors, but that no conclusive evidence is available; taking into account the temperature tolerance of the species there is ground for the hypothesis that a temperature rise contributes to the shift in distribution.

A shift in the age and size at maturation of plaice has been observed (Grift et al. 2003): plaice become mature at younger ages and at smaller sizes in recent years than in the past. This shift is thought to be a genetic fisheries-induced change: Those fish that are genetically programmed to mature late at large sizes are likely to have been removed from the population before they have had a chance to reproduce and pass on their genes. This results in a population that consists ever more of fish that are genetically programmed to mature early at small sizes. Reversal of such a genetic shift may be difficult. This shift in maturation also leads to mature fish being of a smaller size at age, because growth rate diminishes after maturation.

8.1.2 Fisheries

North Sea plaice is taken mainly in a mixed flatfish fishery by beam trawlers in the southern and south-eastern North Sea. Directed fisheries are also carried out with seines, gill nets, and twin trawls, and by beam trawlers in the central North Sea. Due to the minimum mesh size enforced (80 mm in the mixed beam trawl fishery), large numbers of (undersized) plaice are discarded. Fleets exploiting North Sea plaice have generally decreased in number of vessels in the last 10 years. However, in some instances, reflagging vessels to other countries has partly compensated these reductions.

The Dutch beam trawl fleet, one of the major operators in the mixed flatfish fishery in the North Sea, has seen a shift towards more inshore fishing grounds. This shift may be caused by a number of factors, such as the implementation of fishing effort restrictions, the increase in fuel prices and changes in the TACs for the target species. However, the contribution of each of these factors is yet unknown.

The Dutch beam trawl fleet has reduced in number of vessels and shifted towards two categories of vessels: 2000HP (the maximum engine power allowed) and 300 HP (the maximum engine power for vessels that are allowed to fish within the 12 mile coastal zone and the plaice box). Approximately 85% of plaice landings from the UK (England and Scotland) is landed into the Netherlands by Dutch vessels fishing on the UK register. Vessels fishing under foreign registry are referred to as flag vessels. As described in the 2001 report of this WG (ICES-WGNSSK 2001), the fishing pattern of flag vessels can be very different from that of other fleet segments.

A study has been carried out into the increase in technical efficiency of the Dutch beam trawl fleet (Rijnsdorp et al 2006, BD 2). This study suggested an average increase in technical efficiency for plaice of around 1.65% by year (1990-2004). The results of the study are still being analysed and have not been used in this WG yet.

8.1.3 ICES Advice

The information in this section is taken from the ACFM summary sheet of October 2005 (ICES-ACFM 2005).

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

The management agreement had not been renewed for 2005. Therefore, advice was only presented in the context of precautionary boundaries. Note that for 2005 ICES advised that the stock assessment and projections results were not comparable to biomass reference values cited in the EU-Norway agreement because of the inclusion of discards in the 2004 assessment. The EU-Norway agreement refers to biomass values and equates these to the ICES PA reference points and cites the actual values as they were estimated at the time of adopting the EU-Norway agreement in 1999. ICES advised that managers should reconsider the role of 0.3 fishing mortality in the EU-Norway agreement, because this fishing mortality was only generated by the human consumption fishery.

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

The fishing mortality from all catch components in 2004 was estimated at 0.58, which was thought to be above the rate expected to lead to high long-term yields (in comparison, Fmax on human consumption=0.17).

Exploitation boundaries in relation to precautionary limits

The exploitation boundaries in relation to precautionary limits implied human consumption landings of less than 48 000 t in 2006, which was expected to rebuild SSB to the proposed Bpa (=230 000 t) in 2007.

Advice for mixed fisheries management

Demersal fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2006 be managed according to the following rules, which should be applied simultaneously:

- with minimal bycatch or discards of cod;
- Implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised;
- within the precautionary exploitation limits for all other stocks;
- Where stocks extend beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits.
- With minimum by-catch of spurdog, porbeagle and thornback ray and skate.

Mixed fisheries management options should be based on the expected catch in specific combinations of effort in the various fisheries taking into consideration the advice given above. The distributions of effort across fisheries should be responsive to objectives set by managers, which is also the basis for the scientific advice presented above.

Key points highlighted in the ACFM summary sheet

Based on the 2005 estimate of SSB and fishing mortality, ICES classified the stock as being at risk of reduced reproductive capacity and as being harvested sustainably. SSB in 2004 was estimated at around 170 000 t and was expected to have increased to just above 200 000 t in 2005. SSB was below the $\mathbf{B}_{pa}$ of 230 000 t and above the $\mathbf{B}_{lim}$ of 160 000 t. Fishing mortality in 2004 was estimated to be at or near the $\mathbf{F}_{pa}$ of 0.6 and above the target **F** 0.3. The stock was overexploited in terms of fishing mortality in relation to highest yield. Fishing mortality had been disaggregated into human consumption ($\mathbf{F}_{hc}$) and discards ($\mathbf{F}_{disc}$) components, and the former appeared to be decreasing while the latter was increasing. Recent recruitment had been below average.

The management agreement between the EU and Norway from 1999 (see section 8.1.4) was not renewed for 2005. A new management plan for North Sea plaice is under development (see section 16.3). The current plan does not refer to the reference points changed in 2004. Because the assessment now incorporates discards, ICES has proposed to change the value of Fpa so that it refers to the overall fishing mortality (landings and discards). Managers should reconsider the value of F=0.3 as it was stated in the management agreement between the EC and Norway. In response to a request from the European Community and Norway, ICES has evaluated a range of harvest rules for the North Sea plaice (from a starting point based on the ICES assessment made in 2004) with respect to medium- and long-term yields, stability of yield and effort, and stock status with respect to safe biological limits (see section 16 on evaluation of management plans).

Due to a range of factors such as TAC constraints on plaice, effort limitations and increases in fuel prices, the fishing effort of the major fleets has concentrated in the southern part of the North Sea. This is the area where a large part of the juvenile fish of e.g. plaice in the North Sea are found. In addition, juvenile plaice has shown a more offshore distribution in recent years. The combination of a change in fishing pattern and the spatial distribution of juvenile plaice has lead to an apparent increase in discarding of plaice. Technical measures applicable to the mixed flatfish fishery will affect both sole and plaice. The minimum mesh size of 80 mm in the beam trawl fishery selects sole at the minimum landing size. However, this mesh size generates catches of plaice from 17 cm, while the minimum landing size is 27 cm, leading to a high discard rate for this stock. Mesh enlargement would reduce the catch of undersized plaice, but would also result in short-term loss of marketable sole. An increase in the minimum landing size of sole could provide an incentive to fish with larger mesh sizes and therefore mean a reduction in the discarding of plaice.

Juvenile plaice have been distributed more offshore in recent years. Surveys in the Wadden Sea have shown that 1-group plaice is almost absent from the area where it was very abundant in earlier years. This could be linked to environmental changes in the productivity or changes in the temperature of the southern North Sea, but these links have not been shown conclusively.

The assessment was considered to be uncertain. Estimates of discards were based on a few observations of two dominant fleets since 1999, and by using a reconstruction model for the years prior to 1999. The inclusion of discard estimates appeared to contribute to a reduction in the retrospective bias that was previously observed in this assessment. However, the apparent reduction in bias had probably been accompanied by decreased precision. Different trends were observed in different areas of the North Sea. Commercial CPUE series and a survey in the central part of the North Sea appeared to indicate an increase in the plaice stock, whereas surveys in the southern North Sea indicated that the stock had remained at a low level.

8.1.4 Management

The TAC in 2005 was agreed at 59 000 tonnes. For 2006 the TAC was agreed at 57 441 tonnes.

In 1999, the EU and Norway agreed to implement a long-term management plan for the plaice stock, which is consistent with the precautionary approach and is intended to constrain harvesting within safe biological limits and designed to provide for sustainable fisheries and greater potential yield. The plan is re-instigated every year and consists of the following elements:

1. Every effort shall be made to maintain a minimum level of SSB greater than 210 000 tonnes (Blim)
2. For 2000 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality of 0.3 for appropriate age groups as defined by ICES.
3. Should the SSB fall below a reference point of 300 000 tonnes (Bpa), the fishing mortality referred to under paragraph 2, shall be adapted in the light of scientific estimates of the conditions then prevailing. Such adaptation shall ensure a safe and rapid recovery of SSB to a level in excess of 300 000 tonnes.
4. In order to reduce discarding and to enhance the spawning biomass of plaice, the Parties agreed that the exploitation pattern shall, while recalling that other demersal species are harvested in these fisheries, be improved in the light of new scientific advice from, inter alia, ICES.
5. The Parties shall, as appropriate, review and revise these management measures and strategies on the basis of any new advice provided by ICES.

The management plan is currently under revision.

Fishing effort has been restricted for demersal fleets as part of the cod recovery plan (EC Council Regulation No. 2056/2001; EC Council Regulation No 51/2006). For 2006, Council Regulation (EC) No 51/2006 allocates different days at sea depending on gear, mesh size, and catch composition (see section 2.1.2 for complete list). The days at sea limitations for the major fleets operating in sub-area IV could be summarized as follows: Beam Trawls can fish between 143 and 155 days per year. Trawls or Danish seines can fish between 103 and unlimited days per year. Gillnets are allowed to fish between 140 and 162 days per year. Trammel nets can fish between 140 and 205 days per year.

Several technical measures are applicable to the plaice fishery in the North Sea: mesh size regulations, minimum landing size, gear restrictions and a closed area (the plaice box).

Mesh size regulations for towed trawl gears require that vessels fishing North of 55 N (or 56°N east of 5°E, since January 2000) should have a minimum mesh size of 100 mm, while to the south of this limit, where the majority the plaice fishery takes place, an 80 mm mesh is allowed. In the fishery with fixed gears a minimum mesh size of 100mm is required. In addition to this, since 2002 a small part of North Sea plaice fishery is affected by the additional cod recovery plan (EU regulation 2056/2001) that prohibits trawl fisheries with a mesh size <120mm in the area to the north of 56°N.

The minimum landing size of North Sea plaice is 27 cm. The maximum aggregated beam length of beam trawlers is 24 m. In the 12 nautical mile zone and in the plaice box the maximum aggregated beam-length is 9m. A closed area has been in operation since 1989 (the plaice box). Since 1995 this area was closed in all quarters. The closed area applies to vessels using towed gears, but vessels smaller than 300 HP are exempted from the regulation. An evaluation of the plaice box (Grift et al, 2004) has indicated that: From trends observed it was inferred that the Plaice Box has likely had a positive effect on the recruitment of Plaice but that its overall effect has decreased since it was established. There are two reasons to assume that the Plaice Box has a positive effect on the recruitment of Plaice: 1) at present, the Plaice Box still protects the majority of undersized Plaice. Approximately 70 % of the undersized Plaice are found in the Plaice Box and Wadden Sea, and despite the changed distribution, densities of juvenile Plaice inside the Box are still higher than outside; 2) In the 80 mm fishery, discard percentages in the Box are higher than outside. Because more than 90 % of the Plaice caught in the 80 mm fishery in the Box are discarded, any reduction in this fishery would reduce discard mortality. There is, however, no proof of a direct relationship between total discard mortality and recruitment.

8.2 Data available

8.2.1 Catch

Total landings of North Sea plaice in 2005 (Table 8.2.1) were estimated by the WG at 55 700 t, which is 5736 t less than the 2004 landings. The TAC of 59 000 t was not taken in 2005. Discard sampling programmes started in the late 1990s to obtain discard estimates from several fleets fishing for flatfish. These sampling programmes give information on discard rates from 1999 but not for the historical time series. Observations indicate that the proportions of plaice catches discarded at present are high (80% in numbers and 50% in weight: Van Keeken et al. 2004) and have increased since the 1970s (51% in numbers and 27% in weight: Van Beek 1998).

In the WGNSSK 2005 assessment, the discards time series was derived from Dutch and UK discards observations for 1999-2004, while the discard time series for 1957-1998 was derived from a discard reconstruction (ICES-WGNSSK 2005, Section 9.2.3). To reconstruct the number of plaice discards at age, catch numbers at age are calculated from fishing mortality at age corrected for discard fractions, using a reconstructed population and selection and distribution ogives (ICES-WGNSSK 2005, Appendix 1).

Discard observations at age are available from the Dutch and the UK discard sampling programmes. The sampling effort in these programmes is given in Table 8.2.2 (see also Section 1.2.4). Discards data from Denmark were not available in an annual age-based manner, and could not be incorporated in the raising procedures described below. Discards data from other countries were not available at all.

The Dutch sampling programme mainly focuses on beam trawl vessels fishing with 80 mm mesh size, while the UK sampling programme includes different fleet segments fishing with different mesh sizes. However, annual sampling of each fleet segment did not take place and the patterns in discard rates within fleets could not be detected. Therefore the different fleet segments of the UK fleet were raised as one fleet.

The quality of the estimation of total discards numbers at age depends on the quality of the available discards data. The discards estimates are derived from scanty discards observations.

Discards at age were raised from the Dutch and UK sampling programmes by effort ratio (based on hp days at sea for the Dutch fleets, and on days at sea for the UK fleets). Discards at age for the other fleets were calculated as a weighted average of the Dutch and UK discards at age and raised to the proportion in landings (tonnes). This is the same method as used in the final assessment by WGNSSK 2005 (method B), except that for the UK fleets WGNSSK 2005 seems to have used effort in terms of trips instead of days at sea for raising. It also seems that last year discards for which no UK age information was available were left out of the raising procedure, whereas this year a combined Dutch-UK ALK was used for these fish. This resulted in higher discard estimates compared to the estimates presented in WGNSSK 2005.

8.2.2 Age compositions

Market sampling programmes (Table 1.2.1???) supplied age distributions for the official landings in 2005. Age compositions by sex and quarter were available for the Dutch landings. Combined age compositions by quarter were available from Germany, Belgium, Denmark and France. Landings from countries that do not provide age compositions were raised to the international age composition.

Until 2002 an age composition of the UK beam trawl fleet was provided, but since 2003 this fleet has ceased to exist. As the UK fleet historically fished further north than the other fleets, a larger proportion of their catches consisted of older animals.

From 2002 onwards, following EU regulation (1639/2001), each country is obliged to sample landings from foreign vessels that land in their country. Since many flag vessels still bring the catches to the Dutch auctions, a sizeable sampling of these vessels exists in the Netherlands. These samples have so far been included in the Dutch age composition. A separate age composition for foreign vessels could not be generated because the sampling programme is based on sampling by market category and category information for the foreign vessels is not available. The landing numbers at age are presented in Table 8.2.3.

The discard numbers at age were calculated using the discards raising procedures described above. The discard numbers at age are presented in Table 8.2.4. Because of the slightly different raising procedure compared to WGNSSK 2005 (see section 8.2.1.), the discard numbers at age are different from those presented in WGNSSK 2005. Catch numbers-at-age are presented as the sum of landings numbers at age and discards numbers at age in Table 8.2.5.

8.2.3 Weight at age

The stock weights of age groups 1-4 are calculated using modeled mean lengths from survey and back-calculation data (see ICES-WGNSSK 2005m Appendix 1) and converted to mean weight using a fixed length-weight relationship. Stock weights of the older ages are based on the market samples in the first quarter. Stock weights at age are presented in Table 8.2.6. and Figure 8.2.1. Stock weight at age has varied considerably over time. Discard weights at age are calculated the same way as the stock weights of age groups 1-4, after which a gear selection ogive is applied. Landing weights at age are derived from market sampling programmes. Catch weights at age are calculated as the weighted average of the discard and landing weights at age. Discard, landing, and catch weights at age are presented in Table 8.2.7, 8.2.8 and 8.2.9 respectively.

8.2.4 Maturity and natural mortality

Natural mortality is assumed to be 0.1 for all age groups and constant over time. A fixed maturity ogive (Table 8.2.10) is used for the estimation of SSB in North Sea plaice, but maturity at-age is not likely to be constant over time. However, a study of the effect of the fluctuations of natural mortality on the SSB by the WG in 2004 (ICES-WGNSSK 2004) showed that incorporating the historic fluctuations had little effect on SSB estimates in the last 5 years.

8.2.5 Catch, effort and research vessel data

Survey indices that can been used as tuning fleets are (Table 8.2.11 and Figure 8.2.2.):

- Beam Trawl Survey RV Isis (BTS-Isis)
- Beam Trawl Survey RV Tridens (BTS-Tridens)
- Sole Net Survey in September-Oktober (SNS)

Additional Survey indices that can be used for recruitment estimates are (Table 8.2.12):

- Demersal Fish Survey (DFS)

The Beam Trawl Survey (BTS-Isis & BTS-Tridens) was initiated in 1985 and was set up to obtain indices of the younger age groups of plaice and sole. However, due to its spatial distribution the BTS surveys also catches considerable numbers of older plaice and sole. Initially, the survey only covered the south-eastern part of the North Sea (RV Isis). Since 1996 the survey area of the BTS surveys has been extended. The RV Tridens now covers the central part of the North Sea. Both vessels use an 8-m beam trawl with 40 mm stretched mesh codend, but the Tridens beam trawl is rigged with a modified net. Previously age groups 1 to 4 were used for tuning the North Sea plaice assessment, but the age range has been extended to 1 to 9 in the revision done by ACFM in October 2001.

The Sole Net Survey (SNS & SNSQ2) was carried out with RV Tridens until 1995 and then continued with the RV Isis. Until 1990 this survey was carried out in both spring and autumn, but after that only in autumn. The gear used is a 6 m beam trawl with 40 mm stretched mesh cod-ends. The stations fished are on transects along or perpendicular to the coast. This survey is directed to juvenile plaice and sole. Ages 1 to 3 are used for tuning the North Sea plaice assessment; the 0-group index is used in the RCT3. In an attempt to solve the problem of not having the survey indices in time for the WG, the SNS was moved to spring in 2003. However, because of the gap in the spring series these data could not be used in the plaice assessment or in RCT3. In 2004, the SNS was moved back to autumn as before, based on the recommendation of the WGNSSK in 2004.

The research vessel survey time series have been revised in May 2006 by ICES-WGBEAM (2006), because of small corrections in data bases and new solutions for missing lengths in the age-length-keys.

Commercial LPUE series (consisting of an effort series and landings-at-age series) that can be used as tuning fleets are (Table 8.2.13 and Figure 8.2.3.):

- The Dutch beam trawl fleet
- The UK beam trawl fleet excluding all flag vessels

Effort has decreased in the Dutch beam trawl fleet since the early/mid 1990s. The age-classes available in both the Dutch and the UK fleets generally show equal trends in LPUE through time. The increase in LPUE in 2004 at age 3 suggests that the 2001 year-class is recruiting to this fleet as a relatively strong year-class.

The WG used both survey data and commercial LPUE data for tuning until the mid 1990s. The commercial LPUE was calculated as the ratio of the annual landings over the total number of fishing days of the fleet. At that time, however, it was realised that the commercial LPUE data of the Dutch beam trawl-fleet, which dominated the fishery, were likely to be biased due to quota restrictions. Vessels were reported to adjust their fishing patterns in accordance to the individual quota available for that year. Fishermen reported to leave productive fishing grounds because they lacked the fishing rights and moved to areas with lower catch rates of the restricted species with a bycatch of non-quota, or less restricted species. A method that corrects for this bias is to calculate LPUEs at a smaller spatial scale, e.g. ICES rectangles, and then calculate the average of these ICES rectangle-specific LPUEs (Quirijns 2006, WD 4). However, because age-information is not available at this spatial level, these LPUE series cannot be used for tuning in XSA (though age-aggregated tuning series could be used in other analytical assessment methods than XSA).

Age-aggregated LPUE series, corrected for directed fishing under a TAC-constraint (see Quirijns 2006, WD4), by area and fleet component, that can be used as indication of stock development are (Figure 8.2.4.):

The Dutch beam trawl fleet (only large cutters with engine powers above 221 kW)

The UK beam trawl flag vessels landing in the Netherlands (only large cutters with engine powers above 221 kW)

The same series for the Dutch beam trawl fleet, but corrected for technology creep (Quirijns 2006, WD4; Rijnsdorp et al. 2006, BD2; see also section 10.3.2.) is given in Figure 8.2.5. Effort of the Dutch beam trawl fleet and of the English beam trawl vessels landing in the Netherlands, by area and fleet component, are in Figure 8.2.6.

Plaice LPUE, corrected for directed fishing under a TAC constraint, of the Dutch fleet shows a substantial decrease in the years 1990-1997, after which overall LPUE remains more or less at the same level. The decline in the years 1990-1997 is even steeper when the data are corrected for technology creep. The LPUE of the UK vessels landing in the Netherlands and the Dutch fleet show different trends by area. In the southern North Sea, the UK fleet shows an increase in LPUE where the Dutch fleet shows a decrease in LPUE. Overall, the UK fleet appears to show a slight increase in LPUE where the Dutch fleet shows a rather stable LPUE pattern over recent years. For the northern and central North Sea LPUE appears to increase from 1999 onwards, but to decrease from 2002 onwards for the southern North Sea. The LPUE pattern of the Dutch fleet appears to correspond well with the stock dynamics of the XSA assessment. Taking technology creep into account, the LPUE in 2005 has decreased to about 44% of the level it had in 1990 (which percentage is 56% when LPUE is not corrected for technology creep).

8.3 Data analyses

The assessment of North Sea plaice by XSA was carried out in parallel by using the FLR version of XSA (as in ICES-WGNSSK 2005) and using the Fortran version of XSA (Darby and Flatman 1994), which were found to give nearly identical results. The development of the SSB estimates produced by XSA are compared with the development of the age-aggregated LPUE series and with some independent SSB estimates calculated from egg survey data. The Bayesian catch at age assessment model for North Sea plaice described in Borges et al. (2006, WD7) has not been used on the latest data for this year’s assessment.

8.3.1 Reviews of last year's assessment

In the following bullet points the comments made in 2005 by the RGNSSK (Technical Minutes) and the NSCFP that are relevant to this stock are summarised, and it is explained how this WG addressed the comments.

RGNSSK:

- "A number of assessments made use of shrinkage. This was often used to address retrospective bias. However, in many cases, there were also significant trends in F and use of shrinkage can impose strong artificial constraints on terminal F. Shrinkage is more appropriate in situations when F during the time period used in the shrinkage calculation has been relatively stable." The same warning against the use of shrinkage was issued in Kraak et al. (2004). In the current report the WG changed the shrinkage settings compared to previous years: s.e. at 2.0 instead of at 0.5.
- "It was noted that the Sum of Products (SOP) correction was applied to the roundfish but not flatfish assessments. This correction should be applied in all WG assessments." The WG applies the SOP correction in the current report.
- "The report did not contain XSA diagnostics, making it difficult to evaluate the assessment." The WG presents diagnostics in the current report.
- "The *q* plateau at age 6 may be forcing higher catchability at older ages than is appropriate." In preliminary explorations of the current assessment the WG investigated the influence of the choice of the age of the *q* plateau; the influence was negligible.
- "The summary table needs to include *F*(landings) and *F*(discards), as well as *F*(catches)." The WG presents the breaking up of *F* in the summary table in the current report.
- "The WG should look into some way of smoothing the transition between pre- and post-1999 discard estimates. […] The dip in fishing mortality in 1999 is likely due to low discard sampling. It is suggested that the modelling approach used prior to 1999 be extended to recent years for comparison to empirical observations. If appropriate, the 1999 dip maybe adjusted based on the relationship between observed and predicted discards in recent years." This transition has not been investigated owing to lack of time.
- "The method to estimate discards adopted by the WG (method B) was considered appropriate by the RG. NSCFP recommended that the growth-based discard model be reviewed and improved if necessary, as a matter of urgency." The WG itself is also concerned about the discard model. First of all, the method is very roundabout and its use implies a feedback from the XSA-estimated F based on catches without discards, via a subsequent adjustment of the catch numbers, back to XSA to estimate F including discards. IMARES is developing a catch-at-age-like assessment model in which the estimation of discards before 1999 based on survey data is integrated; the result will be available earliest next year.

NSCFP:

- "Fishers would like to see fuller use of commercial CPUE." The WG presents commercial LPUE data in the current report that are corrected for spatial effort allocation (partially taking care of the problem of directed fishing under a TAC-constraint, see section 8.2.5). Historic trends apparent from these data are compared with those from the analytical stock assessment.
- "The assessments appear focused on providing information on two indicators, F and SSB. […]The idea of simplifying a complex system into indicators and reference points is good, but the simplification can be overdone and a clear criticism from the fishing community and others is that these two variables do not capture adequately the state of the fishery. A simple step in expanding relevant performance indicators would be to report on catch rates. Catch rates (CPUE) are linked to stock size as well as an important measure of economic performance of

the fishery." In this light the commercial LPUE data that are presented in the current report (mentioned above, see section 8.2.5) should be viewed.

- "At the moment the choice of particular model could not always be justified. It would be better to provide a range of possibilities than to try to present an assessment that could be regarded as definite and incontrovertible." The WG in the current report emphasises that the results of the assessment by XSA should be compared with the trends in commercial LPUE (section 8.2.5), the results from the exploratory Bayesian catch-at-age assessment (section 8.3.2), and the independent SSB estimates from the Annual Egg Production (see section 8.3.2).

8.3.2 Exploratory catch-at-age-based analyses

In previous meetings of WGNSSK, age 1 of the BTS-Tridens tuning index was not included, because it was thought that this survey, covering the central North Sea, does not sample this age very well. However, it is argued in Kraak and Daan (2005, WD3) that XSA will not perform well in case the tuning series do not cover the whole distribution area of the stock (dynamic pool assumption) when exploitation rates have developed differently in different parts of the stock's distribution area. The latter is the case: due to a range of factors such as TAC constraints on plaice, effort limitations, and increases in fuel prices, the fishing effort of the major fleets has concentrated in the southern part of the North Sea (see sections 8.1.2 and 8.1.3.). Moreover, it is known that in recent years the 1-group plaice have been distributed more offshore than in the past (Grift et al. 2004, Figure 8.3.1.). This could result in that the SNS-survey, which covers the coastal region, samples the 1-group fish less well in recent years (a change in catchability of 1-group plaice by the SNS). Therefore, the following exploratory analysis haven been carried out:

1. using the ages 2-9 of the BTS-Tridens tuning index (as used in WGNSSK 2005);
2. using the ages 1-9 of the BTS-Tridens tuning index.

Both exploratory analyses were initially run with low shrinkage (shrinkage s.e. 2.0, over 5 years and 5 ages).

The resulting diagnostics (Table 8.3.1. for exploration 1 and Table 8.3.2. for exploration 2) indicate that the BTS-Isis estimates the number of group-1 plaice to be larger than the average based on F-shrinkage. The SNS estimates it to be smaller than the average. The BTS-Tridens gives a three times higher estimate than the BTS-Isis. In the second exploration, the BTS-Tridens gets a weight of 9% (BTS-Isis and SNS get weights of 42% and 46% respectively), resulting in a higher estimate for the survivors than in the first exploration. The situation is similar for the ages 2 and 3, although BTS-Tridens gets more weight while SNS gets less. At higher ages (except age 8) the estimates for BTS-Tridens and BTS-Isis are quite similar and the former gets more weight than the latter (up to 75% versus 25% approximately). Thus, for the younger ages the signals from the three surveys appear to be quite different, but it seems that all three signals are relevant because the differences probably reflect real differences that correspond with our understanding of the distribution of the fish and the fisheries, rather than noise.

The use of low shrinkage seems appropriate judging from the diagnostics (low shrinkage allows the surveys to determine the survivor estimates for the younger ages), and corresponds with the recommendation from the RGNSSK and Kraak et al. (2004).

As the use of 5 ages in shrinkage takes shrinkage down to age 5 (assessment plus group = 10+), which is not a recruiting age, the WG decided to divert from previous years' settings and use 5 ages instead of 2 for the XSA.

8.3.3 Exploratory survey-based analyses

Van Damme et al. (2006, WD5) describe how the annual egg production (AEP) method was applied to North Sea plaice, using the results of the ICES PGEGGS ichthyoplankton survey in 2004 and local sampling of plaice fecundity. The results of studies from the 1980s were also reworked using similar methods. The SSB estimates derived from this AEP method agree with those from the WGNSSK 2005 stock assessment, both in terms of the relative trend in SSB and the current absolute biomass (140 to 180 k tonnes in 2004) (Figure 8.3.2.). The decline in SSB from 1988 to 2004 was 50% as estimated by AEP.

8.3.4 Conclusions drawn from exploratory analyses

The use of age 1 in the BTS-Tridens tuning series was decided by the WG because the coverage of the whole stock's distribution area by the tuning fleets is necessary for XSA to perform correctly (dynamic pool assumption) (Kraak and Daan 2005, WD3). The exploration of the diagnostics of the two XSA runs (section 8.3.2.) justifies the conclusion that the second exploration can be used as final assessment. Although for the younger ages the signals from the three surveys appear to be quite different, all three signals are relevant because the differences seem to reflect real differences that correspond with our understanding of the distribution of the fish and the fisheries, rather than noise. The use of low shrinkage seems appropriate judging from the diagnostics, and corresponds with the recommendation from the RGNSSK and Kraak et al. (2004). This assessment estimates SSB in 1990 to be at 380 000 t, while the average over the period 1998-2005 is about 220 000 t; implying that the SSB has dropped to about 55% of the 1990-level. This corresponds to the pattern shown by the LPUE series corrected for spatial effort allocation and not corrected for technology creep (section 8.2.5., Figure 8.2.5.). Although the estimates from the AEP method (section 8.3.3., Figure 8.3.2.) are a bit lower than the estimates from this XSA assessment, they independently confirm a drop in SSB of about 50% in this period.

8.3.5 Final assessment

The settings for the final assessment, compared to the settings in earlier years is given below:

YEAR	2004	2005	2006
Catch at age	Landings + (reconstructed) discards based on NL beam trawl fleet	Landings + (reconstructed) discards based on NL + UK fleets	Landings + (reconstructed) discards based on NL + UK fleets
Fleets	BTS-Isis 1985-2003 1-9 BTS-Tridens 1996-2003 2-9 SNS 1982-2002 1-3	BTS-Isis 1985-2004 1-9 BTS-Tridens 1996-2004 2-9 SNS 1982-2004 1-3	BTS-Isis 1985-2005 1-9 BTS-Tridens 1996-2005 1-9 SNS 1982-2005 1-3
Plus group	10	10	10
First tuning year	1982	1982	1982
Last data year	2003	2004	2005
Time series weights	No taper	No taper	No taper
Catchability dependent on stock size for age <	1	1	1
Catchability independent of ages for ages >=	6	6	6
Survivor estimates shrunk towards the mean F	5 years / 2 ages	5 years / 2 ages	5 years / 5 ages
s.e. of the mean for shrinkage	0.5	0.5	2.0
Minimum standard error for population estimates	0.3	0.3	0.3
Prior weighting	Not applied	Not applied	Not applied

The full diagnostics are presented in Table 8.3.2. A summary of the input data is given in Figure 8.3.3. As in the previous two years, the 1997 survey results for the 1995 and 1996 year classes (at ages 1 and 2) in the BTS and SNS surveys were not used in the assessment, due to age reading problems in that year. Figure 8.3.4 shows the log catchability residuals for the tuning fleets in the final run. Figures 8.3.5 (a-c) show the time series of the estimated stock numbers at age in comparison to the tuning series. Fishing mortality and stock numbers are shown in Tables 8.3.3 and 8.3.4. respectively. The SSB in 2005 was estimated at 193 kt. Mean F(2-6) was estimated at 0.52. Recruitment of the 2004 year class, in 2005 at the age of 1, was estimated at 579 million in the XSA. Retrospective analysis is presented in Figure 8.3.6. Recent estimates are consistent.

8.4 Historic Stock Trends

Table 8.4.1. and Figure 8.4.1. present the trends in landings, mean F(2-6), F(human consumption, 2-6) and F(discards, 2-3), SSB, and recruitment since 1957. Reported landings gradually increased up to the late 1980s and then rapidly declined until 1996, in line with the decrease in TAC. The landings show a slow decline in the most recent years. Discards were particularly high in 1997, 1998, and in 2001-2003. Fishing mortality increased until the late 1990s and reached its highest observed level during 1997-1998, and, after a dip, showed another peak in 2001-2003. Overall F has been lower in 2004 and 2005. The peaks during 1997-1998 and 2001-2002 have been mainly caused by peaks in F(discards), which has decreased after 2002. The F(human consumption) dropped after 1997, showed a smaller peak around 2003, and has dropped since then. Current fishing mortality is estimated at 0.52 ($F_{hc,2-6}$ = 0.26, $F_{discards,2-3}$ = 0.55). The SSB increased to a peak in 1967 when the strong 1963 year-class became mature. Since then, SSB declined to a level of around 260 kt in the early 1980s. Due to the recruitment of the strong year-classes 1981 and 1985, SSB again

increased to a peak in 1987 of around 445 kt followed by a rapid decline (up to 1996). SSB has fluctuated around 200 kt in the last 10 years. In plaice the inter-annual variability in recruitment is relatively small, except for a limited number of strong year classes. Previously only year classes 1963, 1981, 1985 and 1996 were considered to be strong. Including discard data in the assessment alters the recruitment estimates and indicates that 1984, 1986 and 1987 were also relatively strong year classes and that the 1985 year class was by far the strongest year-class on record. Recruitment shows a periodic change with relatively poor recruitment in the 1960s and relatively strong recruitment in the 1980s. The recruitment level in the 1990s appears to be somewhat lower than in the 1980s. The 1996 and 2001 year classes are estimated to be relatively strong, while the 2002 year class is weak. The 2004 year class now appears quite weak as well.

8.5 Recruitment estimates

Input to the RCT3 analysis is presented in Table 8.5.1. Estimates from the RCT3 analysis of age 1 are presented in Table 8.5.2, and of age 2 in Table 8.5.3. For year class 2005 (age 1 in 2006) the values predicted by the two surveys (SNS and DFS) in RCT3 differ enormously (Table 8.5.2.), and therefore the geometric mean was accepted for the short-term forecasts (which happens to be quite similar to the RCT3 estimate). For year class 2004 (age 2 in 2006), the data coming from SNS 0-group and DFS 0-group are noisy (high s.e. of the predicted value, Table 8.5.3.). Otherwise the RCT3 is based on the same data as the XSA; the WG decided that it is not desirable to use the same data twice (the RCT3 uses the information from the XSA), and therefore decides to accept the XSA estimate.

The recruitment estimates from the different sources are summarized in the text table below.

YEAR CLASS	AT AGE IN 2006	XSA	RCT3	GM 1957-2003	ACCEPTED ESTIMATE
2004	2	**431 150**	520 173	681 256	XSA
2005	1		999 498	**911 711**	GM 1957-2003
2006	0			**911 711**	GM 1957-2003

8.6 Short-term forecasts

Short-term prognoses have been carried out in FLR and by MFDP in parallel; the results differed maximally 0.05%.

Weight-at-age in the stock and weight-at-age in the catch are taken to be the average over the last 3 years. The exploitation pattern was taken to be the mean value of the last three years, scaled to F in 2005. The proportion of landings to catches at age was taken to be the mean of the last three years. Population numbers at ages 2 and older are XSA survivor estimates. Numbers at age 1 and recruitment of the 2006 year-class are taken from the long-term geometric mean (1957-2003).

Input to the short term forecast is presented in table 8.6.1.The management options are given in Table 8.6.2. F in 2006 is set at the status quo level. The detailed table for a forecast based on Fsq is given in Table 8.6.3. At status quo fishing mortality in 2006 and 2007, SSB is expected to be at 198 kt in 2007 and 202 kt in 2008. The yield at Fsq is expected to be around 53 kt in 2006 (total catch 95 kt), which is below the predicted value for 2006 from last years status quo forecast (65 kt, total catch 112 kt). The landings in 2007 are predicted to be around 51 kt at Fsq (total catch 106 kt).

In order to bring SSB above Bpa in 2008, fishing in 2007 would have to be at 0.6 * Fsq, corresponding with a yield of around 33 kt (total catch 70 kt). The sensitivity plot in Figure 8.6.1. (left panel) shows that for a low probability (5%) of exceeding Fsq in 2007, a catch of around 60 kt, corresponding to landings of around 28 kt, should be taken. Figure 8.6.1. (right panel) also shows that fishing at Fsq in 2007 has a high probability (around 75%) that SSB will stay below Bpa (230 000 t) in 2008, whereas the probability that SSB will fall below Blim (160 000 t) is just above 15%.

Figure 8.6.2. shows the projected composition of the catch, landings and discards in 2007 and of the SSB in 2008, when fishing at Fsq in 2007. The catch in 2007 will consist for a major part of uncertain year classes (2002-2006), and for almost 50% of year classes for which the geometric mean was taken (2005-2006) while the other estimates come from XSA. The landings will consist for a much smaller part of these uncertain year classes, and for only 10% of year classes for which the geometric mean was taken. By contrast, the discards will consist almost entirely of uncertain year classes, and for 80% of those for which the geometric mean was taken. The SSB in 2008 will also consist for a major part of uncertain year classes.

8.7 Medium-term forecasts

No medium term projections were done for this stock. However, management simulations over the medium-term period have been performed for plaice, and these are discussed in section 16.3.

8.8 Biological reference points

The current reference points were established by the WGNSSK in 2004, when the discard estimates were included in the assessment for the first time. The stock-recruitment relationship for North Sea plaice did not show a clear breakpoint where recruitment is impaired at lower spawning stocks. Therefore, ICES considered that $\mathbf{B_{lim}}$ can be set at 160 000 t and that $\mathbf{B_{pa}}$ can then be set at 230 000 t using the default multiplier of 1.4 (although the WG acknowledges that, since the noisy discards estimates have been included, the uncertainty of the estimates of stock status is much greater than that, see Dickey-Collas et al. (2006, WD16). $\mathbf{F_{lim}}$ was set at $\mathbf{F_{loss}}$ (0.74). $\mathbf{F_{pa}}$ was proposed to be set at 0.6 which is the 5th percentile of $\mathbf{F_{loss}}$ and gave a 50% probability that SSB is around $\mathbf{B_{pa}}$ in the medium term. Equilibrium analysis suggests that F of 0.6 is consistent with an SSB of around 230 000 t.

	ICES considered that:	**ICES proposed that:**
Precautionary Approach Reference point	$\mathbf{B_{lim}}$ is 160 000 t	$\mathbf{B_{pa}}$ be set at 230 000 t
	$\mathbf{F_{lim}}$ is 0.74	$\mathbf{F_{pa}}$ be set at 0.60
Target reference points		$\mathbf{F_{y}}$ undefined

The management plan for North Sea plaice and sole that is proposed by the EC (5403/06 PECHE 14, see section 16.3 and Machiels et al. 2006, WD6) uses the target reference **F** of 0.3, implicitly equating it to $\mathbf{F_{MSY}}$.

8.9 Quality of the assessment

The assessment presented by the WG incorporates discards. WGNSSK noted in 2002 (ICES-WGNSSK 2003) that not considering discard catches in stock assessments could introduce bias and affect estimates of F and stock biomass, particularly when discard patterns vary over time. The discards estimates since 1999 have been derived under EC project 98/097 and under the EC data regulation (EC Commission Regulation No. 2056/2001). Because of the different sampling strategies by the different countries, only data from the UK and the Netherlands were used in this assessment. These countries contribute to approximately half of the landings. Total sampling effort of the discards is low, and data is scanty. The assessment is considered to be uncertain because discards form a substantial part of the total catch but cannot be well estimated from the scanty sampling trips. The WG also has concerns about the reconstruction of discards before 1999. The assessment is also considered to be uncertain because low shrinkage was used (to minimise bias), resulting in the estimates for the most recent years being determined mainly by the surveys, which show differing signals. However, the historic development of the stock abundance as estimated by XSA shows good correspondence with the development of commercial LPUE. Also some independent estimates of SSB from the annual egg production method correspond to the general pattern of a decrease in estimated SSB seen in the first half of the 1990s.

A retrospective analysis of the assessment shows no clear recurring bias (Figure 8.3.6.). An underestimation of the SSB is found in three of the five years, but this bias is far smaller than the variance in the SSB time series of the last assessment of those five years. For 2002, and to a lesser extent in 2001, overestimations of F are found (and a minor overestimation for 2003; the other two years show minor underestimations).

WGNSSK 2005 noted that the outcome of the XSA model used for the assessment is sensitive to the assumptions made in the model (parameter settings and choice of tuning series), and to the variance in the tuning series.

The historical performance of the North Sea plaice assessment is shown in Figure 8.9.1. The principal changes in the perceived levels of fishing mortality and recruitment were caused by the inclusion (ICES-WGNSSK 2004) of discard estimates. Estimates of SSB from recent meetings of WGNSSK have been noisy, but all indicate a stabilisation at a relatively low level.

8.10 Status of the Stock

SSB in 2006 is estimated around 194 thousand tonnes which is between Bpa (230 000 t) and Blim (160 000 t). Fishing mortality is estimated to have slightly decreased from 0.54 in 2004 to 0.52 in 2005 (both below Fpa = 0.60), after having been much higher in 2003 (0.80). Projected landings for 2007 at Fsq are slightly lower than projected landings for 2006 at Fsq which are lower than estimated landings of 2005. Projected discards for 2007 are quite higher than projected discards for 2006, but this is mainly based on the uncertain assumption of larger year classes 2005 and 2006 coming in (the geometric mean was chosen for these year classes in the projections, whereas recruitment of the 2004 year class is estimated to be low). Therefore, development of discarding in the next couple of years will depend on the true size of these year classes.

8.11 Management Considerations

Plaice is mainly taken by beam trawlers in a mixed fishery with sole in the southern and central part of the North Sea. In recent years, the bycatches of cod have been relatively low in the central North Sea. Some bycatches still occur in the chainmat beamtrawl fishery in the most southern part of the North Sea although the extent of these bycatches cannot be quantified due to the lack of gear resolution in the logbook database. Discards of cod in the beam trawl fishery are difficult to estimate due to the low catches in the sampled trips.

Fishing effort has been substantially reduced since 1995. The reduction in fishing effort appears to be reflected in recent estimates of fishing mortality. There are indications that technical efficiency has increased in this fishery, which can have counteracted the overall decrease in effort.

Technical measures applicable to the mixed flatfish fishery will affect both sole and plaice. The minimum mesh size of 80 mm in the beamtrawl fishery selects sole at the minimum landing size. However, this mesh size generates high discards of plaice which are selected from 17 cm with a minimum landing size of 27 cm. Recent discards estimates indicate fluctuations around 50% discards in weight. Mesh enlargement would reduce the catch of undersized plaice, but would also result in loss of marketable sole.

The combination of days-at-sea regulations, high oil prices, and the decreasing TAC for plaice and the relatively stable TAC for sole, appear to have induced a more coastal fishing pattern in the southern North Sea. This concentration of fishing effort could result in increased discarding of juvenile plaice that are mainly distributed in those areas. This process could be aggravated by the more off-shore distribution of the juvenile plaice in recent years where they become more susceptible to the fishery.

An evaluation of the plaice box has indicated that: “From trends observed it was inferred that the Plaice Box has likely had a positive effect on the recruitment of plaice but that its overall effect has decreased since it was established. There are two reasons to assume that the Plaice Box has a positive effect on the recruitment of plaice: 1) At present, the Plaice Box still protects the majority of undersized plaice. Approximately 70 % of the undersized plaice are found in the Plaice Box and Wadden Sea, and despite the changed distribution, densities of juvenile plaice inside the Box are still higher than outside; 2) In the 80 mm fishery, discard percentages in the Box are higher than outside. Because more than 90 % of the plaice caught in the 80 mm fishery in the Box are discarded, any reduction in this fishery would reduce discard mortality. There is, however, no proof of a direct relationship between total discard mortality and recruitment.” (Grift et al. 2004).

The stock dynamics are dependent on the occurrence of strong year classes. The mean age in the landings is currently just around age 4, but used to be around age 5 in the beginning of the time series. This change may be caused by the high exploitation levels, but also by the shift in the spatial distribution of fishing effort towards inshore waters and by the shift in the spatial distribution of the fish. A lower exploitation level is expected to improve the survival of plaice to the spawning population (plaice are known to mature from age 2 onwards), which could enhance the stability in the catches.

A shift in the age and size at maturation of plaice has been observed (Grift et al. 2003): plaice become mature at younger ages and at smaller sizes in recent years than in the past. This shift may be a genetic fisheries-induced change: Those fish that are genetically programmed to mature late at large sizes are likely to have been removed from the population before they have had a chance to reproduce and pass on their genes. This would result in a population that consists ever more of fish that are genetically programmed to mature early at small sizes. Reversal of such a genetic shift may be difficult. This shift in maturation also leads to mature fish being of a smaller size at age, because growth rate diminishes after maturation.

The Commission of the European Community has proposed a long-term management plan for the fisheries exploiting plaice and sole in the North Sea, which is designed to gradually adjust the level of fishing activity so as to achieve greater catches, larger and more stable stocks and more profitable fisheries (5403/06 PECHE 14). The plan defines target levels of annual fishing mortality of 0.3 for plaice and 0.2 for sole. These are values which, according to scientific advice, will allow higher yields for a given level of recruitment, reduce discarding, and allow a reduced biological risk to the fish stocks. The tools to achieve these objectives are the same as those in the other long-term plans already in place. Fishing mortality will be reduced by 10% year-on-year until the target levels have been reached, while annual variations in TACs will be kept within limits (15% up or down). Other measures will involve the regulation of fishing effort via fishing days at sea which are supposed to change in proportion with the intended change in sole fishing mortality (before the 15% TAC change limitation). This proposal has not yet been approved. An evaluation of this plan is provided in section 16.3.

The results from the North Sea Fishers' Survey (see Section 1 and Figure 8.11.1) comparing plaice abundance perceptions in 2006 with those in 2005 indicate that perceptions are significantly different in areas 6a, 6b and 8. Data for areas 1 and 3 have modal peaks indicating that the abundance of plaice had not changed. Areas 2, 6b and 7 showed a slight skewing towards an increase in abundance while the responses for an increase in abundance were strongest in areas 4, 6a, 8 and 9. Only in area 5 was there a substantial proportion of respondents (47%) who believed that plaice abundance had decreased. In this survey there are 7 areas where the “much less” option has not been selected, compared to 2 areas in 2005.

The assessment is considered to be uncertain mainly because discards form a substantial part of the total catch but cannot be well estimated from the scanty sampling trips.

Table 8.2.1. North Sea plaice. Nominal landings (tonnes) in Sub-Area IV as officially reported to ICES and WG estimates.

YEAR	Belgium	Denmark	France	Germany	Nether-lands	Norway	Sweden	UK E/W/NI	UK Scotland	Others	Total	Unallocated	WG estimate	TAC
1980	7005	27057	711	4319	39782	15	7	18687	4345		101928	38023	139951	
1981	6346	22026	586	3449	40049	18	3	17129	4390		93996	45701	139697	105000
1982	6755	24532	1046	3626	41208	17	6	16385	4355		97930	56616	154546	140000
1983	9716	18749	1185	2397	51328	15	22	13241	4159		100812	43218	144030	164000
1984	11393	22154	604	2485	61478	16	13	12681	4172		114996	41153	156149	182000
1985	9965	28236	1010	2197	90950	23	18	11335	4577		148311	11527	159838	200000
1986	7232	26332	751	1809	74447	21	16	12428	4866		127902	37445	165347	180000
1987	8554	21597	1580	1794	76612	12	7	14891	5747		130794	22876	153670	150000
1988	11527	20259	1773	2566	77724	21	2	17613	6884	43	138412	16063	154475	175000
1989	10939	23481	2037	5341	84173	321	12	20413	5691		152408	17410	169818	185000
1990	13940	26474	1339	8747	78204	1756	169	18810	6822		156261	-21	156240	180000
1991	14328	24356	508	7926	67945	560	103	18267	9572		143565	4438	148003	175000
1992	12006	20891	537	6818	51064	836	53	21049	10228		123482	1708	125190	175000
1993	10814	16452	603	6895	48552	827	7	20586	10542		115278	1835	117113	175000
1994	7951	17056	407	5697	50289	524	6	17806	9943		109679	713	110392	165000
1995	7093	13358	442	6329	44263	527	3	15801	8594		96410	1946	98356	115000
1996	5765	11776	379	4780	35419	917	5	13541	7451		80033	1640	81673	81000
1997	5223	13940	254	4159	34143	1620	10	13789	8345		81483	1565	83048	91000
1998	5592	10087	489	2773	30541	965	2	11473	8442	1	70365	1169	71534	87000
1999	6160	13468	624	3144	37513	643	4	9743	7318		78617	2045	80662	102000
2000	7260	13408	547	4310	35030	883	3	13131	7579		82151	-1001	81150	97000
2001	6369	13797	429	4739	33290	1926	3	11025	8122		79700	2147	81847	78000
2002	4859	12552	548	3927	29081	1996	2	8504	8236		69705	512	70217	77000
2003	4570	13742	343	3800	27353	1967	2	7135	6757		65669	820	66489	73250
2004	4314	12123	231*	3649	23662	1744	1	7542	7742		61008	428	61436	61000
2005	3396	11385	112	3379	22271	1660	0	7683	5022		54908	792	55700	59000

*WG estimate

Table 8.2.2. North Sea plaice. Sampling effort for the NL and UK discards sampling programmes used for estimating discards at age.

	NL	UK	sum
Year	hours	hours	hours
1999	178	605	783
2000	771	885	1656
2001	235	1120	1355
2002	342	492	834
2003	494	697	1191
2004	479	1167	1646
2005	514	287	801

Table 8.2.3. North Sea plaice. Landings numbers at age.

table 8.2.3 ple-nsea

[1] 2006-09-06 14:25:36 units= thousands

	age									
year	1	2	3	4	5	6	7	8	9	10
1957	0	4315	59818	44718	31771	8885	11029	9028	4973	10859
1958	0	7129	22205	62047	34112	19594	8178	8000	6110	13148
1959	0	16556	30427	25489	41099	22936	13873	6408	6596	16180
1960	0	5959	61876	51022	21321	27329	14186	9013	5087	15153
1961	0	2264	33392	67906	32699	12759	14680	9748	5996	14660
1962	0	2147	35876	66779	50060	20628	9060	9035	5257	12801
1963	0	4340	21471	76926	54364	31799	12848	6833	7047	16592
1964	0	14708	40486	64735	57408	37091	15819	6595	3980	16886
1965	0	9858	42202	53188	43674	30151	18361	8554	4213	17587
1966	0	4144	65009	51488	36667	27370	16500	10784	6467	14928
1967	0	5982	30304	112917	41383	22053	16175	8004	6728	11175
1968	0	9474	40698	38140	123619	17139	10341	10102	3925	13365
1969	3	15017	45187	36084	35585	102014	10410	6086	8192	16092
1970	76	17294	51174	56153	40686	35074	78886	6311	4185	14840
1971	19	29591	48282	33475	26059	22903	16913	29730	6414	16910
1972	2233	36528	62199	52906	23043	16998	14380	10903	18585	15651
1973	1268	31733	59099	73065	42255	13817	8885	9848	6084	23978
1974	2223	23120	55548	42125	41075	19666	8005	6321	5568	21980
1975	981	28124	61623	31262	25419	21188	11873	5923	4106	19695
1976	2820	33643	77649	96398	13779	9904	9120	6391	2947	12552
1977	3220	56969	43289	66013	83705	9142	5912	5022	4061	9191
1978	1143	60578	62343	54341	50102	35510	5940	3352	2419	7468
1979	1318	58031	118863	48962	47886	39932	24228	4161	2807	9288
1980	979	64904	133741	77523	24974	17982	13761	8458	1864	5377
1981	253	100927	122296	57604	35745	12414	9564	8092	4874	5903
1982	3334	47776	209007	69544	28655	16726	7589	5470	4482	8653
1983	1214	119695	115034	99076	29359	12906	8216	4193	3013	8287
1984	108	63252	274209	53549	37468	13661	6465	5544	2720	6565
1985	121	73552	144316	185203	32520	15544	6871	3650	2698	5798
1986	1674	67125	163717	93801	84479	24049	9299	4490	2733	6950
1987	0	85123	115951	111239	64758	34728	11452	4341	2154	5478
1988	0	15146	250675	74335	47380	25091	16774	5381	3162	6233
1989	1261	46757	105929	231414	52909	19247	10567	7561	2120	5580
1990	1550	32533	97766	110997	159814	26757	8129	4216	3451	3808
1991	1461	43266	83603	116155	72961	77557	14910	5233	3141	5591
1992	3410	43954	85120	72494	72703	33406	29547	6970	3200	6928
1993	3461	53949	98375	72286	51405	29001	13472	11272	3645	5883
1994	1394	45148	101617	80236	38542	20388	15323	6399	5368	5433
1995	7751	36575	81398	78370	36499	17953	9772	4366	2336	3753
1996	1104	42496	64382	46359	32130	14460	10605	4528	2624	4892
1997	892	42855	86948	43669	22541	13518	6362	3632	2179	4181
1998	196	30401	68920	56329	16713	6432	4986	2506	1761	3119
1999	549	8689	155971	39857	24112	6829	2783	2246	1521	3093
2000	2634	15819	39550	164330	14993	9343	2130	1030	940	2097
2001	4509	35886	52480	48238	89949	6836	4418	1127	637	2309
2002	1233	15596	58262	48361	36551	37877	4644	1788	742	1586
2003	694	42594	47802	48894	27126	15999	17069	1608	650	859
2004	543	10317	102332	35165	20527	11293	4787	4555	412	540
2005	2937	16685	26069	82278	17039	9533	5332	2614	2223	613

Table 8.2.4. North Sea plaice. Discards numbers at age. Raising based on NL and UK samples.

table 8.2.4 ple-nsea
[1] 2006-09-07 14:52:00 units= thousands

year \ age	1	2	3	4	5	6	7	8	9	10
1957	32356	45596	9220	909	961	25	0	0	0	0
1958	66199	73552	23655	2572	2137	65	0	0	0	0
1959	116086	127771	46402	11407	4737	106	0	0	0	0
1960	73939	167893	44948	997	1067	519	0	0	0	0
1961	75578	144609	89014	538	1612	130	0	0	0	0
1962	51265	181321	87599	21716	799	186	0	0	0	0
1963	90913	136183	129778	9964	2112	188	0	0	0	0
1964	66035	153274	64156	33825	3011	323	0	0	0	0
1965	43708	426021	59262	3404	923	267	0	0	0	0
1966	38496	163125	349358	14399	1402	125	0	0	0	0
1967	20199	133545	87532	152496	623	260	0	0	0	0
1968	73971	72192	46339	26530	22436	58	0	0	0	0
1969	85192	67378	16747	19334	773	2024	0	0	0	0
1970	123569	152480	27747	1287	5061	161	0	0	0	0
1971	69337	96968	42354	2675	426	81	0	0	0	0
1972	70002	55470	33899	5714	567	73	0	0	0	0
1973	132352	49815	4008	673	1289	67	0	0	0	0
1974	211139	308411	3652	285	611	109	0	0	0	0
1975	244969	280130	190536	4807	253	123	0	0	0	0
1976	183879	140921	71054	18013	174	41	0	0	0	0
1977	256628	103696	79317	33552	9317	129	0	0	0	0
1978	226872	154113	27257	10775	1244	570	0	0	0	0
1979	293166	215084	57578	18382	589	310	0	0	0	0
1980	226371	122561	932	687	193	86	0	0	0	0
1981	134142	193241	1850	373	431	55	0	0	0	0
1982	411307	204572	4624	1109	216	98	0	0	0	0
1983	261400	436331	30716	2235	804	72	0	0	0	0
1984	310675	313490	52651	24529	1492	69	0	0	0	0
1985	405385	229208	35566	2221	200	78	0	0	0	0
1986	1117345	490965	48510	26470	1451	146	0	0	0	0
1987	361519	1374202	180969	1427	1348	248	0	0	0	0
1988	348597	608109	459385	61167	882	177	0	0	0	0
1989	213291	485845	193176	85758	7224	115	0	0	0	0
1990	145314	279298	168674	28102	5011	177	0	0	0	0
1991	183126	301575	141567	40739	5528	939	0	0	0	0
1992	138755	219619	94581	34348	4307	880	0	0	0	0
1993	96371	154083	48088	11966	1635	216	0	0	0	0
1994	62122	95703	35703	1038	822	144	0	0	0	0
1995	118863	82676	15753	860	663	120	0	0	0	0
1996	111250	331065	27606	3930	451	116	0	0	0	0
1997	128653	510918	193828	588	271	108	0	0	0	0
1998	104538	646250	191631	53354	297	33	0	0	0	0
1999	28442	51985	49623	2952	227	18	0	5	0	9
2000	123198	204959	73709	70451	3133	86	31	13	9	36
2001	32086	379672	191174	64616	49703	64	29	0	0	0
2002	421199	365495	188049	34600	4125	17015	8	0	0	306
2003	70665	647148	62397	132331	4699	188	818	0	0	20
2004	219311	191410	114685	3703	2031	365	4	12	0	8
2005	94995	304707	31954	15422	3545	2659	30	7	31	0

Table 8.2.5. North Sea plaice. Catch numbers at age. (Landings + discards).

table 8.2.5 ple-nsea
[1] 2006-09-09 10:28:55 units= thousands

year \ age	1	2	3	4	5	6	7	8	9	10
1957	32356	49911	69038	45627	32732	8910	11029	9028	4973	10859
1958	66199	80681	45860	64619	36249	19659	8178	8000	6110	13148
1959	116086	144327	76829	36896	45836	23042	13873	6408	6596	16180
1960	73939	173852	106824	52019	22388	27848	14186	9013	5087	15153
1961	75578	146873	122406	68444	34311	12889	14680	9748	5996	14660
1962	51265	183468	123475	88495	50859	20814	9060	9035	5257	12801
1963	90913	140523	151249	86890	56476	31987	12848	6833	7047	16592
1964	66035	167982	104642	98560	60419	37414	15819	6595	3980	16886
1965	43708	435879	101464	56592	44597	30418	18361	8554	4213	17587
1966	38496	167269	414367	65887	38069	27495	16500	10784	6467	14928
1967	20199	139527	117836	265413	42006	22313	16175	8004	6728	11175
1968	73971	81666	87037	64670	146055	17197	10341	10102	3925	13365
1969	85195	82395	61934	55418	36358	104038	10410	6086	8192	16092
1970	123645	169774	78921	57440	45747	35235	78886	6311	4185	14840
1971	69356	126559	90636	36150	26485	22984	16913	29730	6414	16910
1972	72235	91998	96098	58620	23610	17071	14380	10903	18585	15651
1973	133620	81548	63107	73738	43544	13884	8885	9848	6084	23978
1974	213362	331531	59200	42410	41686	19775	8005	6321	5568	21980
1975	245950	308254	252159	36069	25672	21311	11873	5923	4106	19695
1976	186699	174564	148703	114411	13953	9945	9120	6391	2947	12552
1977	259848	160665	122606	99565	93022	9271	5912	5022	4061	9191
1978	228015	214691	89600	65116	51346	36080	5940	3352	2419	7468
1979	294484	273115	176441	67344	48475	40242	24228	4161	2807	9288
1980	227350	187465	134673	78210	25167	18068	13761	8458	1864	5377
1981	134395	294168	124146	57977	36176	12469	9564	8092	4874	5903
1982	414641	252348	213631	70653	28871	16824	7589	5470	4482	8653
1983	262614	556026	145750	101311	30163	12978	8216	4193	3013	8287
1984	310783	376742	326860	78078	38960	13730	6465	5544	2720	6565
1985	405506	302760	179882	187424	32720	15622	6871	3650	2698	5798
1986	1119019	558090	212227	120271	85930	24195	9299	4490	2733	6950
1987	361519	1459325	296920	112666	66106	34976	11452	4341	2154	5478
1988	348597	623255	710060	135502	48262	25268	16774	5381	3162	6233
1989	214552	532602	299105	317172	60133	19362	10567	7561	2120	5580
1990	146864	311831	266440	139099	164825	26934	8129	4216	3451	3808
1991	184587	344841	225170	156894	78489	78496	14910	5233	3141	5591
1992	142165	263573	179701	106842	77010	34286	29547	6970	3200	6928
1993	99832	208032	146463	84252	53040	29217	13472	11272	3645	5883
1994	63516	140851	137320	81274	39364	20532	15323	6399	5368	5433
1995	126614	119251	97151	79230	37162	18073	9772	4366	2336	3753
1996	112354	373561	91988	50289	32581	14576	10605	4528	2624	4892
1997	129545	553773	280776	44257	22812	13626	6362	3632	2179	4181
1998	104734	676651	260551	109683	17010	6465	4986	2506	1761	3119
1999	28991	60674	205594	42809	24339	6847	2783	2251	1521	3102
2000	125832	220778	113259	234781	18126	9429	2161	1043	949	2133
2001	36595	415558	243654	112854	139652	6900	4447	1127	637	2309
2002	422432	381091	246311	82961	40676	54892	4652	1788	742	1892
2003	71359	689742	110199	181225	31825	16187	17887	1608	650	879
2004	219854	201727	217017	38868	22558	11658	4791	4567	412	548
2005	97932	321392	58023	97700	20584	12192	5362	2621	2254	613

Table 8.2.6. North Sea plaice. Stock weights at age.

table 8.2.6 ple-nsea
[1] 2006-09-06 15:16:55 units= kg

year	age 1	2	3	4	5	6	7	8	9	10
1957	0.039	0.099	0.160	0.248	0.325	0.485	0.719	0.682	0.844	1.143
1958	0.042	0.091	0.183	0.279	0.303	0.442	0.577	0.778	0.793	1.112
1959	0.046	0.103	0.177	0.271	0.329	0.470	0.650	0.686	0.908	1.042
1960	0.039	0.108	0.185	0.279	0.364	0.469	0.633	0.726	0.845	1.090
1961	0.038	0.095	0.188	0.313	0.337	0.483	0.579	0.691	0.779	1.067
1962	0.036	0.093	0.176	0.308	0.424	0.573	0.684	0.806	0.873	1.303
1963	0.042	0.100	0.180	0.280	0.378	0.540	0.663	0.788	0.882	1.252
1964	0.025	0.110	0.187	0.304	0.373	0.477	0.645	0.673	0.845	1.232
1965	0.032	0.066	0.202	0.302	0.333	0.430	0.516	0.601	0.722	0.909
1966	0.032	0.097	0.129	0.313	0.403	0.455	0.503	0.565	0.581	0.984
1967	0.030	0.101	0.182	0.210	0.442	0.528	0.585	0.650	0.703	0.985
1968	0.056	0.091	0.178	0.294	0.344	0.532	0.592	0.362	0.667	0.887
1969	0.048	0.153	0.192	0.273	0.344	0.390	0.565	0.621	0.679	0.857
1970	0.044	0.110	0.243	0.281	0.369	0.410	0.468	0.636	0.732	0.896
1971	0.052	0.106	0.259	0.354	0.413	0.489	0.512	0.583	0.696	0.877
1972	0.057	0.154	0.225	0.418	0.473	0.534	0.579	0.606	0.655	0.929
1973	0.037	0.129	0.243	0.320	0.468	0.521	0.566	0.583	0.617	0.804
1974	0.050	0.102	0.224	0.427	0.437	0.524	0.570	0.629	0.652	0.852
1975	0.065	0.138	0.193	0.399	0.483	0.544	0.610	0.668	0.704	0.943
1976	0.083	0.165	0.233	0.316	0.484	0.550	0.593	0.658	0.694	0.931
1977	0.066	0.179	0.274	0.319	0.405	0.551	0.627	0.690	0.667	0.938
1978	0.066	0.148	0.329	0.383	0.411	0.467	0.547	0.630	0.704	0.943
1979	0.063	0.174	0.266	0.375	0.414	0.459	0.543	0.667	0.764	1.004
1980	0.050	0.159	0.299	0.440	0.444	0.524	0.582	0.651	0.778	1.058
1981	0.042	0.136	0.246	0.433	0.473	0.536	0.570	0.624	0.707	1.033
1982	0.049	0.125	0.258	0.361	0.490	0.589	0.631	0.679	0.726	0.981
1983	0.046	0.124	0.250	0.392	0.494	0.559	0.624	0.712	0.754	0.917
1984	0.049	0.126	0.223	0.425	0.464	0.571	0.649	0.692	0.787	1.029
1985	0.050	0.144	0.238	0.326	0.452	0.536	0.635	0.656	0.764	1.011
1986	0.044	0.124	0.252	0.317	0.440	0.533	0.692	0.779	0.888	1.092
1987	0.037	0.103	0.204	0.383	0.401	0.503	0.573	0.711	0.747	0.984
1988	0.037	0.096	0.176	0.269	0.426	0.467	0.547	0.644	0.706	0.973
1989	0.040	0.099	0.193	0.245	0.362	0.484	0.553	0.616	0.759	0.884
1990	0.045	0.109	0.184	0.270	0.343	0.422	0.555	0.647	0.701	0.972
1991	0.050	0.131	0.191	0.269	0.342	0.401	0.463	0.633	0.652	0.826
1992	0.047	0.123	0.204	0.275	0.318	0.403	0.500	0.573	0.683	0.834
1993	0.052	0.117	0.214	0.327	0.330	0.391	0.490	0.587	0.633	0.811
1994	0.054	0.143	0.220	0.297	0.360	0.404	0.462	0.533	0.653	0.798
1995	0.051	0.140	0.260	0.342	0.399	0.448	0.509	0.584	0.678	0.804
1996	0.044	0.116	0.234	0.375	0.390	0.462	0.488	0.554	0.660	0.815
1997	0.032	0.116	0.186	0.375	0.439	0.492	0.521	0.543	0.627	0.852
1998	0.039	0.080	0.208	0.339	0.474	0.577	0.581	0.648	0.656	0.812
1999	0.045	0.090	0.153	0.320	0.437	0.524	0.586	0.644	0.664	0.779
2000	0.052	0.105	0.169	0.224	0.408	0.467	0.649	0.695	0.656	0.787
2001	0.062	0.121	0.207	0.237	0.331	0.452	0.560	0.641	0.798	0.830
2002	0.049	0.117	0.218	0.306	0.319	0.403	0.446	0.612	0.685	0.873
2003	0.061	0.112	0.228	0.270	0.344	0.391	0.464	0.600	0.714	0.787
2004	0.048	0.116	0.206	0.313	0.384	0.430	0.489	0.495	0.780	0.875
2005	0.054	0.105	0.219	0.241	0.378	0.422	0.434	0.527	0.621	1.010

Table 8.2.7. North Sea plaice. Discards weights at age.

table 8.2.7 ple-nsea
[1] 2006-09-06 15:16:54 units= kg

year \ age	1	2	3	4	5	6	7	8	9	10
1957	0.046	0.102	0.146	0.178	0.202	0.231	0.231	0.231	0	0
1958	0.049	0.094	0.157	0.184	0.196	0.244	0.244	0.244	0	0
1959	0.053	0.105	0.154	0.183	0.191	0.231	0.244	0.000	0	0
1960	0.047	0.109	0.158	0.184	0.197	0.204	0.231	0.000	0	0
1961	0.046	0.098	0.159	0.190	0.198	0.210	0.210	0.244	0	0
1962	0.044	0.096	0.154	0.190	0.210	0.211	0.219	0.219	0	0
1963	0.049	0.102	0.156	0.185	0.199	0.220	0.219	0.231	0	0
1964	0.034	0.111	0.159	0.189	0.198	0.219	0.231	0.231	0	0
1965	0.040	0.071	0.164	0.189	0.203	0.219	0.219	0.244	0	0
1966	0.040	0.099	0.126	0.190	0.202	0.220	0.219	0.231	0	0
1967	0.038	0.103	0.157	0.167	0.210	0.211	0.231	0.231	0	0
1968	0.062	0.094	0.155	0.187	0.187	0.231	0.210	0.244	0	0
1969	0.055	0.142	0.161	0.183	0.203	0.204	0.244	0.220	0	0
1970	0.051	0.112	0.177	0.185	0.191	0.244	0.210	0.231	0	0
1971	0.059	0.108	0.181	0.196	0.209	0.244	0.000	0.231	0	0
1972	0.063	0.143	0.172	0.203	0.203	0.231	0.000	0.000	0	0
1973	0.045	0.127	0.177	0.191	0.203	0.231	0.244	0.000	0	0
1974	0.056	0.104	0.172	0.204	0.210	0.220	0.231	0.000	0	0
1975	0.070	0.133	0.161	0.202	0.219	0.231	0.231	0.000	0	0
1976	0.087	0.149	0.174	0.191	0.211	0.244	0.231	0.000	0	0
1977	0.071	0.155	0.184	0.191	0.192	0.210	0.000	0.000	0	0
1978	0.071	0.139	0.192	0.201	0.203	0.210	0.219	0.000	0	0
1979	0.068	0.153	0.182	0.198	0.211	0.220	0.219	0.231	0	0
1980	0.056	0.145	0.188	0.210	0.219	0.244	0.244	0.000	0	0
1981	0.049	0.131	0.177	0.209	0.211	0.244	0.244	0.000	0	0
1982	0.056	0.123	0.180	0.197	0.220	0.231	0.231	0.000	0	0
1983	0.053	0.123	0.178	0.202	0.203	0.231	0.244	0.000	0	0
1984	0.055	0.123	0.171	0.204	0.202	0.000	0.231	0.000	0	0
1985	0.056	0.136	0.175	0.192	0.219	0.231	0.000	0.000	0	0
1986	0.051	0.122	0.178	0.191	0.210	0.244	0.231	0.000	0	0
1987	0.044	0.104	0.164	0.201	0.209	0.219	0.244	0.000	0	0
1988	0.044	0.097	0.153	0.182	0.210	0.231	0.244	0.000	0	0
1989	0.048	0.100	0.160	0.177	0.190	0.244	0.244	0.000	0	0
1990	0.054	0.112	0.158	0.183	0.203	0.220	0.000	0.000	0	0
1991	0.058	0.129	0.161	0.183	0.197	0.211	0.219	0.220	0	0
1992	0.055	0.123	0.166	0.184	0.198	0.204	0.219	0.231	0	0
1993	0.059	0.119	0.170	0.193	0.203	0.220	0.231	0.244	0	0
1994	0.062	0.140	0.173	0.190	0.205	0.231	0.231	0.219	0	0
1995	0.060	0.139	0.184	0.197	0.211	0.231	0.220	0.244	0	0
1996	0.054	0.122	0.177	0.199	0.211	0.231	0.000	0.244	0	0
1997	0.042	0.118	0.159	0.198	0.219	0.231	0.000	0.000	0	0
1998	0.049	0.086	0.167	0.195	0.210	0.244	0.244	0.000	0	0
1999	0.055	0.096	0.144	0.191	0.210	0.244	0.000	0.000	0	0
2000	0.061	0.109	0.151	0.172	0.231	0.244	0.196	0.000	0	0
2001	0.070	0.121	0.166	0.175	0.192	0.231	0.000	0.231	0	0
2002	0.058	0.118	0.170	0.189	0.193	0.210	0.000	0.000	0	0
2003	0.069	0.114	0.173	0.183	0.196	0.203	0.219	0.000	0	0
2004	0.057	0.117	0.166	0.191	0.195	0.211	0.198	0.000	0	0
2005	0.063	0.108	0.171	0.177	0.211	0.202	0.219	0.220	0	0

Table 8.2.8. North Sea plaice. Landings weights at age.

table 8.2.8 ple-nsea
[1] 2006-09-08 16:44:59 units= kg

year	age 1	2	3	4	5	6	7	8	9	10
1957	0.000	0.183	0.223	0.287	0.392	0.506	0.592	0.654	0.440	1.108
1958	0.000	0.211	0.235	0.275	0.358	0.482	0.546	0.654	0.707	1.055
1959	0.000	0.223	0.251	0.299	0.370	0.483	0.605	0.637	0.766	1.021
1960	0.000	0.201	0.238	0.291	0.389	0.488	0.605	0.688	0.729	1.101
1961	0.000	0.194	0.237	0.307	0.418	0.517	0.613	0.681	0.825	1.088
1962	0.000	0.204	0.240	0.290	0.387	0.523	0.551	0.669	0.751	1.090
1963	0.000	0.258	0.292	0.325	0.407	0.543	0.636	0.680	0.729	1.048
1964	0.000	0.252	0.275	0.314	0.391	0.491	0.633	0.705	0.743	1.012
1965	0.000	0.243	0.284	0.323	0.387	0.474	0.542	0.667	0.730	0.892
1966	0.000	0.236	0.275	0.354	0.444	0.493	0.569	0.635	0.703	0.950
1967	0.000	0.237	0.285	0.328	0.433	0.558	0.609	0.675	0.753	0.998
1968	0.000	0.275	0.307	0.341	0.377	0.532	0.607	0.613	0.706	0.937
1969	0.230	0.311	0.328	0.352	0.380	0.436	0.606	0.693	0.696	0.945
1970	0.307	0.279	0.310	0.347	0.408	0.432	0.486	0.655	0.725	0.869
1971	0.264	0.329	0.368	0.416	0.463	0.531	0.560	0.627	0.722	0.920
1972	0.253	0.304	0.362	0.440	0.507	0.556	0.625	0.664	0.693	0.965
1973	0.286	0.332	0.361	0.426	0.511	0.566	0.636	0.659	0.711	0.884
1974	0.296	0.322	0.367	0.420	0.494	0.574	0.631	0.719	0.733	0.960
1975	0.265	0.319	0.351	0.446	0.526	0.624	0.676	0.747	0.832	1.082
1976	0.272	0.302	0.347	0.385	0.526	0.609	0.657	0.723	0.760	1.005
1977	0.254	0.324	0.354	0.381	0.419	0.557	0.648	0.722	0.716	0.980
1978	0.235	0.304	0.356	0.383	0.422	0.473	0.587	0.662	0.748	0.916
1979	0.235	0.310	0.348	0.387	0.428	0.473	0.549	0.674	0.795	0.959
1980	0.241	0.290	0.349	0.406	0.479	0.552	0.596	0.671	0.782	1.027
1981	0.241	0.279	0.335	0.423	0.514	0.568	0.615	0.653	0.738	1.025
1982	0.281	0.264	0.313	0.427	0.517	0.612	0.668	0.716	0.743	0.990
1983	0.199	0.248	0.298	0.381	0.512	0.600	0.673	0.766	0.810	0.978
1984	0.229	0.259	0.279	0.369	0.483	0.603	0.673	0.714	0.824	1.019
1985	0.242	0.259	0.284	0.330	0.453	0.565	0.664	0.714	0.788	1.001
1986	0.218	0.266	0.300	0.343	0.420	0.482	0.667	0.742	0.843	1.001
1987	0.218	0.246	0.296	0.347	0.397	0.498	0.576	0.719	0.819	0.978
1988	0.218	0.250	0.274	0.347	0.446	0.504	0.599	0.688	0.801	0.999
1989	0.233	0.276	0.305	0.327	0.386	0.525	0.594	0.660	0.780	0.929
1990	0.267	0.281	0.293	0.312	0.360	0.440	0.588	0.681	0.749	0.989
1991	0.219	0.276	0.283	0.295	0.352	0.438	0.509	0.646	0.720	0.887
1992	0.246	0.258	0.285	0.312	0.335	0.417	0.521	0.594	0.702	0.875
1993	0.243	0.267	0.282	0.318	0.348	0.413	0.506	0.616	0.704	0.836
1994	0.223	0.256	0.278	0.330	0.387	0.437	0.489	0.595	0.713	0.883
1995	0.270	0.275	0.299	0.336	0.399	0.451	0.525	0.607	0.729	0.902
1996	0.236	0.276	0.302	0.350	0.414	0.479	0.491	0.580	0.709	0.844
1997	0.206	0.269	0.310	0.361	0.453	0.520	0.598	0.611	0.678	0.917
1998	0.150	0.256	0.305	0.388	0.489	0.597	0.623	0.684	0.689	0.900
1999	0.242	0.249	0.276	0.350	0.449	0.539	0.621	0.672	0.742	0.802
2000	0.221	0.259	0.276	0.305	0.420	0.486	0.664	0.690	0.729	0.862
2001	0.236	0.264	0.289	0.306	0.361	0.477	0.586	0.701	0.787	0.793
2002	0.232	0.259	0.283	0.309	0.341	0.436	0.500	0.678	0.745	0.881
2003	0.227	0.248	0.281	0.319	0.363	0.406	0.477	0.641	0.750	0.837
2004	0.212	0.245	0.280	0.325	0.394	0.433	0.505	0.552	0.789	0.861
2005	0.267	0.262	0.277	0.327	0.385	0.427	0.463	0.545	0.603	0.888

Table 8.2.9. North Sea plaice. Catch weights at age.

table 8.2.9 ple-nsea
[1] 2006-09-08 16:44:59 units= thousands

year \ age	1	2	3	4	5	6	7	8	9	10
1957	0.046	0.109	0.213	0.284	0.386	0.506	0.592	0.654	0.440	1.108
1958	0.049	0.104	0.195	0.272	0.349	0.481	0.546	0.654	0.707	1.055
1959	0.053	0.119	0.193	0.263	0.351	0.482	0.605	0.637	0.766	1.021
1960	0.047	0.112	0.204	0.289	0.379	0.483	0.605	0.688	0.729	1.101
1961	0.046	0.099	0.180	0.306	0.408	0.514	0.613	0.681	0.825	1.088
1962	0.044	0.097	0.179	0.265	0.384	0.520	0.551	0.669	0.751	1.090
1963	0.049	0.107	0.175	0.309	0.399	0.541	0.636	0.680	0.729	1.048
1964	0.034	0.123	0.204	0.271	0.381	0.488	0.633	0.705	0.743	1.012
1965	0.040	0.075	0.214	0.315	0.383	0.471	0.542	0.667	0.730	0.892
1966	0.040	0.102	0.149	0.318	0.435	0.492	0.569	0.635	0.703	0.950
1967	0.038	0.109	0.190	0.236	0.430	0.554	0.609	0.675	0.753	0.998
1968	0.062	0.115	0.226	0.278	0.348	0.531	0.607	0.613	0.706	0.937
1969	0.055	0.173	0.283	0.293	0.376	0.431	0.606	0.693	0.696	0.945
1970	0.051	0.129	0.263	0.343	0.384	0.431	0.486	0.655	0.725	0.869
1971	0.059	0.160	0.280	0.400	0.459	0.530	0.560	0.627	0.722	0.920
1972	0.069	0.207	0.295	0.417	0.500	0.555	0.625	0.664	0.693	0.965
1973	0.047	0.207	0.350	0.423	0.502	0.565	0.636	0.659	0.711	0.884
1974	0.058	0.119	0.355	0.419	0.489	0.573	0.631	0.719	0.733	0.960
1975	0.071	0.150	0.207	0.414	0.523	0.621	0.676	0.747	0.832	1.082
1976	0.090	0.179	0.264	0.354	0.522	0.608	0.657	0.723	0.760	1.005
1977	0.073	0.215	0.244	0.317	0.396	0.552	0.648	0.722	0.716	0.980
1978	0.072	0.185	0.306	0.353	0.417	0.469	0.587	0.662	0.748	0.916
1979	0.069	0.186	0.294	0.336	0.426	0.471	0.549	0.674	0.795	0.959
1980	0.057	0.195	0.348	0.405	0.477	0.551	0.596	0.671	0.782	1.027
1981	0.049	0.182	0.332	0.422	0.510	0.566	0.615	0.653	0.738	1.025
1982	0.058	0.150	0.310	0.423	0.515	0.610	0.668	0.716	0.743	0.990
1983	0.054	0.150	0.273	0.377	0.504	0.598	0.673	0.766	0.810	0.978
1984	0.055	0.146	0.261	0.317	0.473	0.600	0.673	0.714	0.824	1.019
1985	0.056	0.166	0.263	0.329	0.451	0.564	0.664	0.714	0.788	1.001
1986	0.051	0.139	0.272	0.309	0.416	0.481	0.667	0.742	0.843	1.001
1987	0.044	0.112	0.216	0.345	0.393	0.496	0.576	0.719	0.819	0.978
1988	0.044	0.101	0.196	0.272	0.442	0.502	0.599	0.688	0.801	0.999
1989	0.049	0.115	0.211	0.287	0.363	0.524	0.594	0.660	0.780	0.929
1990	0.056	0.130	0.208	0.286	0.356	0.439	0.588	0.681	0.749	0.989
1991	0.059	0.147	0.206	0.266	0.341	0.436	0.509	0.646	0.720	0.887
1992	0.060	0.146	0.222	0.271	0.327	0.412	0.521	0.594	0.702	0.875
1993	0.065	0.157	0.245	0.301	0.343	0.412	0.506	0.616	0.704	0.836
1994	0.066	0.177	0.251	0.328	0.383	0.436	0.489	0.595	0.713	0.883
1995	0.073	0.181	0.280	0.334	0.396	0.450	0.525	0.607	0.729	0.902
1996	0.056	0.139	0.265	0.338	0.411	0.477	0.491	0.580	0.709	0.844
1997	0.043	0.130	0.206	0.359	0.451	0.518	0.598	0.611	0.678	0.917
1998	0.049	0.094	0.204	0.294	0.484	0.596	0.623	0.684	0.689	0.900
1999	0.059	0.118	0.244	0.339	0.446	0.539	0.621	0.671	0.742	0.799
2000	0.064	0.120	0.195	0.265	0.387	0.483	0.658	0.681	0.722	0.847
2001	0.090	0.133	0.193	0.231	0.301	0.475	0.582	0.701	0.787	0.793
2002	0.059	0.124	0.197	0.259	0.326	0.366	0.500	0.678	0.745	0.739
2003	0.071	0.122	0.220	0.220	0.339	0.403	0.465	0.641	0.750	0.818
2004	0.057	0.124	0.220	0.312	0.376	0.426	0.505	0.550	0.789	0.848
2005	0.069	0.116	0.219	0.303	0.355	0.378	0.462	0.544	0.595	0.888

Table 8.2.10. North Sea plaice. Natural mortality at age and maturity ate age vector used in assessments

2005-09-10 16:29:14

metric	1	2	3	4	5	6	7	8	9	10
natural mortality	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
maturity	0	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 8.2.11. North Sea plaice. Survey tuning fleets catches (numbers per hour)

table 8.2.11 ple-nsea
[1] 2006-09-09 09:42:29 W. Europe Daylight Time
[1] BTS-Isis units= NA

	Eff	1	2	3	4	5	6	7	8	9
1985	1	116	179.9	38.8	11.84	1.371	1.048	0.362	0.167	0.098
1986	1	667	131.8	51.0	8.89	3.285	0.428	0.338	0.129	0.038
1987	1	226	764.3	33.1	4.77	2.039	1.017	0.352	0.087	0.072
1988	1	680	147.0	182.3	9.99	2.810	0.814	0.458	0.036	0.112
1989	1	468	319.3	38.7	47.31	5.850	0.833	0.311	0.661	0.132
1990	1	115	102.6	55.7	22.78	5.572	0.801	0.205	0.374	0.259
1991	1	185	122.1	28.6	11.86	4.264	5.710	0.257	0.219	0.099
1992	1	177	125.9	27.3	5.62	3.184	2.662	1.136	0.259	0.053
1993	1	125	179.1	38.4	6.12	0.931	0.812	0.629	0.465	0.167
1994	1	145	64.2	35.2	10.88	2.857	0.638	0.861	0.957	0.401
1995	1	252	43.5	14.2	8.11	1.195	0.868	0.356	1.131	0.218
1996	1	218	212.3	23.0	4.83	3.404	0.917	0.047	0.173	0.131
1997	1	NA	NA	19.9	2.79	0.219	0.390	0.171	0.121	0.000
1998	1	343	431.9	47.4	8.91	1.440	0.755	0.145	0.078	0.105
1999	1	306	130.0	182.5	3.65	2.107	0.137	0.140	0.029	0.032
2000	1	278	74.4	31.4	24.00	0.613	0.175	0.540	0.029	0.013
2001	1	223	78.4	19.4	9.97	9.474	0.294	0.143	0.041	0.043
2002	1	541	47.7	16.0	5.38	2.734	1.422	0.091	0.138	0.000
2003	1	126	170.1	10.8	5.94	1.525	1.214	0.684	0.112	0.104
2004	1	226	41.8	66.6	6.62	2.650	1.603	1.021	3.054	0.000
2005	1	162	69.9	7.0	13.59	1.191	1.567	0.349	0.196	0.707

[1] BTS-Tridens units= NA

	Effort	1	2	3	4	5	6	7	8	9
1996	1	1.593	5.59	4.40	3.31	2.37	1.84	0.830	0.529	0.177
1997	1	NA	NA	10.41	3.95	2.84	1.93	0.471	1.102	0.424
1998	1	0.557	30.14	9.93	5.57	2.67	1.35	0.911	0.789	0.308
1999	1	2.387	8.29	36.93	6.47	2.65	2.13	0.600	0.771	0.326
2000	1	4.639	9.45	12.74	17.23	2.94	1.89	1.076	0.954	0.247
2001	1	0.672	6.93	9.05	7.23	7.67	1.21	0.691	0.480	0.603
2002	1	18.480	13.54	11.27	6.87	4.23	4.43	0.741	0.723	0.340
2003	1	4.108	34.84	11.91	8.57	4.75	2.72	3.973	0.699	0.703
2004	1	5.689	10.64	29.06	7.92	4.19	2.23	1.131	2.460	0.396
2005	1	6.930	22.58	11.41	15.69	2.81	5.61	1.533	0.576	3.502

Table 8.2.11. North Sea plaice Cont.

```
[1] SNS  units= NA
    Effort 1     2     3
1982 1 69993  8642  1261
1983 1 33974 13909   249
1984 1 44965 10413  2467
1985 1 28101 13848  1598
1986 1 93552  7580  1152
1987 1 33402 32991  1227
1988 1 36609 14421 13153
1989 1 34276 17810  4373
1990 1 25037  7496  3160
1991 1 57221 11247  1518
1992 1 46798 13842  2268
1993 1 22098  9686  1006
1994 1 19188  4977   856
1995 1 24767  2796   381
1996 1 23015 10268  1185
1997 1    NA    NA  1391
1998 1 33666 30242  5014
1999 1 32951 10272 13783
2000 1 22855  2493   891
2001 1 11511  2898   370
2002 1 30813  1103   265
2003 1    NA    NA    NA
2004 1 18202  1350  1081
2005 1 10118  1819   142
```

Table 8.2.12. North Sea plaice. DFS index catches (numbers per hour)

DFS

	effort	0	1
1981	1	605.96	169.78
1982	1	433.67	299.36
1983	1	431.72	163.53
1984	1	261.80	124.19
1985	1	716.29	103.27
1986	1	200.11	288.27
1987	1	516.84	195.87
1988	1	318.36	116.45
1989	1	435.70	125.72
1990	1	465.47	130.13
1991	1	498.49	152.35
1992	1	351.59	137.08
1993	1	262.26	75.16
1994	1	445.66	30.60
1995	1	184.51	37.74
1996	1	572.80	116.89
1997	1	149.19	209.92
1998	1	NA	NA
1999	1	NA	NA
2000	1	183.83	11.31
2001	1	499.05	5.00
2002	1	213.17	19.20
2003	1	361.14	11.08
2004	1	199.93	15.19
2005	1	132.18	8.74

Table 8.2.13. North Sea plaice. Commercial tuning fleets (not used in the final assessment)

table 8.2.13 ple-nsea
[1] 2006-09-07 18:30:14 W. Europe Daylight Time
[1] NL Beam Trawl units= NA

	Effort	2	3	4	5	6	7	8	9
1989	72.5	557.8	1016	1820	318.1	132.9	72.3	37.45	13.06
1990	71.1	308.8	844	701	1076.2	171.4	51.8	25.18	16.33
1991	68.5	401.5	619	776	448.1	497.7	100.4	28.53	16.60
1992	71.1	341.4	623	448	382.1	171.9	133.4	34.66	13.97
1993	76.9	358.3	605	407	256.2	142.8	78.5	46.96	13.33
1994	81.4	370.9	591	441	188.8	97.5	75.8	35.21	23.70
1995	81.2	277.3	536	417	178.0	81.0	42.1	19.08	11.47
1996	72.1	368.9	383	290	193.9	73.7	50.5	18.95	13.09
1997	72.0	320.8	634	252	95.6	60.2	28.0	13.54	6.39
1998	70.2	217.8	463	381	91.0	32.6	19.4	9.53	4.47
1999	67.3	64.5	1134	271	164.3	44.6	14.8	12.38	7.52
2000	67.7	132.5	251	1067	85.5	57.3	10.9	4.96	3.16
2001	61.4	264.3	367	321	664.6	44.7	28.6	6.35	3.19
2002	56.4	177.9	578	385	252.2	293.7	18.6	10.02	2.77
2003	51.6	372.8	387	406	186.4	103.8	129.1	6.03	5.02
2004	49.3	100.0	903	223	146.8	72.0	29.9	43.43	1.91
2005	49.9	151.8	219	715	94.6	58.2	33.5	14.57	23.17

[1] English Beam trawl excl Flag-vessels units= NA

	Effort	4	5	6	7	8	9	10	11	12
1990	102.3	27.0	92.7	17.46	11.08	7.06	8.23	2.45	1.662	0.958
1991	123.6	21.9	28.6	53.39	10.72	6.77	3.45	4.94	1.828	1.481
1992	151.5	19.2	29.3	18.40	24.25	6.39	3.68	3.20	3.281	1.096
1993	146.6	23.4	20.9	17.26	6.30	12.80	4.33	2.73	2.435	1.739
1994	131.4	23.1	22.0	13.49	9.53	4.51	6.47	3.28	1.438	1.218
1995	105.0	34.0	15.8	14.05	9.71	5.90	3.16	3.60	2.733	1.362
1996	82.9	13.3	19.0	10.74	10.08	6.55	4.68	2.50	3.305	1.966
1997	76.3	16.4	11.1	13.97	7.85	8.99	6.62	2.77	1.940	3.001
1998	68.8	23.6	13.0	8.97	8.69	5.04	6.03	4.61	1.948	1.599
1999	68.6	14.7	15.2	6.66	4.77	5.35	3.76	3.27	2.813	1.429
2000	57.8	63.2	15.0	9.95	4.41	2.44	3.48	1.87	1.782	2.526
2001	54.1	14.7	45.0	8.89	6.21	2.48	1.72	2.07	0.906	1.682
2002	30.6	23.4	20.8	29.61	5.13	4.12	1.41	1.73	1.503	1.340

Table 8.3.1. North Sea plaice. Diagnostics XSA run 1, with BTS-Tridens ages 2-9.

Lowestoft VPA Version 3.1

8/09/2006 11:43

Extended Survivors Analysis

Plaice in IV

CPUE data from file fleet.txt

Catch data for 49 years. 1957 to 2005. Ages 1 to 10.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
BTS-Isis	1985	2005	1	9	0.66	0.75
BTS-Tride	1996	2005	2	9	0.66	0.75
SNS	1982	2005	1	3	0.66	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 6

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 5 oldest ages.

S.E. of the mean to which the estimates are shrunk = 2.000

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 26 iterations

1

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.102	0.073	0.2	0.038	0.107	0.052	0.262	0.168	0.311	0.222
2	0.55	0.882	0.578	0.153	0.393	0.532	0.943	0.779	0.85	0.888
3	0.691	0.94	1.332	0.305	0.417	0.886	0.617	0.695	0.527	0.556
4	0.785	0.754	1.121	0.707	0.598	0.842	0.768	1.184	0.496	0.424
5	0.807	0.911	0.651	0.707	0.655	0.773	0.746	0.674	0.374	0.471
6	0.741	0.853	0.627	0.524	0.581	0.493	0.706	0.669	0.493	0.316
7	0.778	0.754	0.786	0.535	0.275	0.528	0.644	0.462	0.373	0.391
8	0.708	0.59	0.674	0.907	0.347	0.201	0.37	0.424	0.181	0.32
9	0.57	0.794	0.563	1.037	1.165	0.328	0.177	0.198	0.162	0.115

continued Table 8.3.1. North Sea plaice. Diagnostics XSA run 1, with BTS-Tridens ages 2-9.

1
XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
1996	1.22E+06	9.28E+05	1.94E+05	9.72E+04	6.18E+04	2.93E+04	2.06E+04	9.38E+03	6.35E+03
1997	1.93E+06	9.93E+05	4.84E+05	8.78E+04	4.01E+04	2.50E+04	1.26E+04	8.57E+03	4.18E+03
1998	6.07E+05	1.62E+06	3.72E+05	1.71E+05	3.74E+04	1.46E+04	9.63E+03	5.37E+03	4.30E+03
1999	8.19E+05	4.50E+05	8.22E+05	8.88E+04	5.05E+04	1.77E+04	7.06E+03	3.97E+03	2.48E+03
2000	1.30E+06	7.14E+05	3.49E+05	5.48E+05	3.96E+04	2.25E+04	9.46E+03	3.74E+03	1.45E+03
2001	7.64E+05	1.06E+06	4.36E+05	2.09E+05	2.73E+05	1.86E+04	1.14E+04	6.50E+03	2.39E+03
2002	1.93E+06	6.56E+05	5.62E+05	1.63E+05	8.13E+04	1.14E+05	1.03E+04	6.08E+03	4.81E+03
2003	4.84E+05	1.34E+06	2.31E+05	2.75E+05	6.83E+04	3.49E+04	5.09E+04	4.89E+03	3.80E+03
2004	8.66E+05	3.70E+05	5.57E+05	1.04E+05	7.60E+04	3.15E+04	1.62E+04	2.90E+04	2.90E+03
2005	5.16E+05	5.74E+05	1.43E+05	2.97E+05	5.76E+04	4.73E+04	1.74E+04	1.01E+04	2.19E+04

Estimated population abundance at 1st Jan 2006

0.00E+00	3.74E+05	2.14E+05	7.43E+04	1.76E+05	3.25E+04	3.12E+04	1.06E+04	6.62E+03

Taper weighted geometric mean of the VPA populations:

9.00E+05	6.70E+05	3.78E+05	2.03E+05	1.02E+05	5.26E+04	2.83E+04	1.59E+04	9.17E+03

Standard error of the weighted Log(VPA populations) :

0.5307	0.5344	0.4914	0.4868	0.5323	0.5743	0.6126	0.6694	0.7572

1

Log catchability residuals.

Fleet : BTS-Isis

Age	1982	1983	1984	1985
1	99.99	99.99	99.99	-1.26
2	99.99	99.99	99.99	0.25
3	99.99	99.99	99.99	-0.07
4	99.99	99.99	99.99	-0.32
5	99.99	99.99	99.99	-0.59
6	99.99	99.99	99.99	0.21
7	99.99	99.99	99.99	0.01
8	99.99	99.99	99.99	0.09
9	99.99	99.99	99.99	-0.01

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	-0.43	-0.66	0.53	0.55	-0.75	-0.09	0.01	0.05	0.33	-0.11
2	-0.39	0.47	-0.35	0.48	-0.34	0.01	0.21	0.66	0.03	-0.27
3	0.32	-0.38	0.44	-0.32	0.05	-0.27	-0.11	0.37	0.36	-0.12
4	-0.25	-0.64	-0.2	0.43	0.46	-0.14	-0.52	-0.25	0.5	0.34
5	-0.21	-0.28	0.26	0.6	-0.33	0.15	-0.01	-0.89	0.32	-0.24
6	-0.84	-0.43	-0.15	0.03	-0.49	0.75	0.68	-0.36	-0.26	0.07
7	-0.27	-0.28	-0.54	-0.34	-0.7	-0.92	-0.09	-0.07	0.57	-0.06
8	-0.27	-0.99	-1.79	0.46	0.5	0.14	-0.2	-0.35	0.95	1.54
9	-0.11	0	0.07	0.18	0.05	-0.01	-0.05	0.09	0.02	-0.08

continued Table 8.3.1. North Sea plaice. Diagnostics XSA run 1, with BTS-Tridens ages 2-9

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	-0.32	99.99	0.9	0.37	-0.14	0.13	0.25	0.1	0.21	0.33
2	0.37	99.99	0.54	0.32	-0.53	-0.77	-0.5	-0.06	-0.12	-0.02
3	0.46	-0.43	0.98	0.81	-0.02	-0.39	-1.02	-0.48	0.35	-0.53
4	0.25	-0.22	0.54	0.01	0	0.26	-0.17	-0.3	0.29	-0.08
5	0.97	-1.27	0.5	0.62	-0.41	0.48	0.43	-0.03	0.2	-0.25
6	0.57	-0.04	0.99	-0.98	-0.93	-0.29	-0.37	0.63	0.88	0.33
7	-2.02	-0.26	-0.13	-0.03	0.84	-0.49	-0.76	-0.47	1.02	-0.12
8	0.02	-0.33	-0.24	-0.77	-1.1	-1.41	-0.01	0.04	1.39	-0.2
9	0.04	99.99	0.2	-0.1	-0.38	-0.27	99.99	0.06	99.99	0.16

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6	7	8	9
Mean Log q	-8.1672	-8.2958	-8.9377	-9.5405	-10.1338	-10.3514	-10.3514	-10.3514	-10.3514
S.E(Log q)	0.5023	0.4066	0.4865	0.3467	0.5414	0.5947	0.6781	0.8406	0.1472

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.66	-2.242	4.43	0.39	20	0.76	-8.17
2	0.9	0.671	8.83	0.71	20	0.37	-8.3
3	0.88	0.694	9.44	0.62	21	0.43	-8.94
4	1.06	-0.398	9.38	0.71	21	0.38	-9.54
5	0.96	0.217	10.19	0.58	21	0.53	-10.13
6	0.97	0.115	10.36	0.52	21	0.59	-10.35
7	1.22	-0.738	10.75	0.37	21	0.78	-10.59
8	0.61	2.152	9.98	0.62	21	0.47	-10.47
9	0.88	3.282	10.15	0.98	18	0.1	-10.36
1							

Fleet : BTS-Tridens

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	No data for this fleet at this age									
2	-1.08	99.99	0.06	-0.25	-0.41	-1.01	0.42	0.54	0.69	1.03
3	-0.4	-0.28	0.21	0.01	-0.12	-0.35	-0.58	0.42	0.32	0.76
4	-0.22	0.04	-0.03	0.49	-0.43	-0.16	-0.01	-0.02	0.38	-0.03
5	-0.25	0.44	0.26	0	0.3	-0.58	0.01	0.25	-0.19	-0.24
6	-0.11	0.18	0.2	0.39	0.07	-0.25	-0.61	0.06	-0.16	0.23
7	-0.53	-0.62	0.33	0.05	0.16	-0.29	-0.04	-0.09	-0.26	-0.02
8	-0.24	0.5	0.69	1.14	1.02	-0.33	0.27	0.49	-0.2	-0.5
9	-1.04	0.41	-0.1	0.84	1.19	0.99	-0.39	0.59	0.26	0.39

continued Table 8.3.1. North Sea plaice. Diagnostics XSA run 1, with BTS-Tridens ages 2-9

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9
Mean Log q	-10.4781	-9.736	-9.4465	-9.2807	-8.9749	-8.9749	-8.9749	-8.9749
S.E(Log q)	0.7448	0.4231	0.2672	0.319	0.2904	0.3269	0.6522	0.751

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	1.85	-0.843	7.86	0.12	9	1.4	-10.48
3	1.51	-1.359	8.15	0.47	10	0.61	-9.74
4	1.4	-2.479	8.39	0.82	10	0.3	-9.45
5	1.78	-3.688	7.88	0.74	10	0.37	-9.28
6	1.46	-2.372	8.37	0.77	10	0.34	-8.97
7	1.19	-0.885	9.02	0.73	10	0.36	-9.1
8	3.06	-2.733	8.3	0.18	10	1.35	-8.69
9	1.82	-1.57	8.95	0.32	10	1.14	-8.66
1							

Fleet : SNS

Age	1982	1983	1984	1985
1	0.28	0	0.36	-0.52
2	0.34	0.04	0.21	0.54
3	-0.01	-1.5	0.03	0.01
4	No data for this fleet at this age			
5	No data for this fleet at this age			
6	No data for this fleet at this age			
7	No data for this fleet at this age			
8	No data for this fleet at this age			
9	No data for this fleet at this age			

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	-0.25	-0.42	-0.24	0.08	-0.13	0.88	0.83	0.47	0.46	-0.28
2	-0.39	0.19	0.18	0.46	-0.1	0.48	0.86	0.6	0.33	-0.16
3	-0.2	-0.4	1.08	0.78	0.45	0.07	0.68	0	-0.09	-0.47
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

continued Table 8.3.1. North Sea plaice. Diagnostics XSA run 1, with BTS-Tridens ages 2-9

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	-0.42	99.99	0.73	0.29	-0.49	-0.68	-0.47	99.99	-0.16	-0.3
2	0.2	99.99	0.74	0.65	-1.06	-1.21	-1.41	99.99	-0.7	-0.81
3	0.76	0.18	2.01	1.5	-0.3	-1.07	-1.85	99.99	-0.5	-1.15
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

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
Mean Log q	-3.4077	-4.2468	-5.3031
S.E(Log q)	0.4678	0.6583	0.911

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.58	-2.173	-2.72	0.41	22	0.68	-3.41
2	0.87	0.564	5.48	0.48	22	0.58	-4.25
3	0.65	1.476	8.03	0.45	23	0.57	-5.3
1							

Terminal year survivor and F summaries :

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 2004

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-Isis	517698	0.515	0	0	1	0.446	0.165
BTS-Tride	1	0	0	0	0	0	0
SNS	277784	0.478	0	0	1	0.517	0.289
F shrinkage m	471484	2				0.037	0.18

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
373991	0.35	0.22	3	0.631	0.222

continued Table 8.3.1. North Sea plaice. Diagnostics XSA run 1, with BTS-Tridens ages 2-9

1
Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-Isis	225242	0.327	0.107	0.33	2	0.527	0.858
BTS-Tride	599282	0.785	0	0	1	0.1	0.412
SNS	139266	0.394	0.318	0.81	2	0.335	1.162
F shrinkage m	300015	2				0.038	0.703

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
213839	0.24	0.21	6	0.851	0.888

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2002

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-Isis	55562	0.301	0.179	0.59	3	0.486	0.69
BTS-Tride	157692	0.402	0.023	0.06	2	0.357	0.3
SNS	28827	0.595	0.225	0.38	2	0.13	1.07
F shrinkage m	62770	2				0.027	0.631

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
74303	0.23	0.24	8	1.058	0.556

1
Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-Isis	179924	0.249	0.101	0.41	4	0.434	0.416
BTS-Tride	186214	0.248	0.117	0.47	3	0.498	0.405
SNS	108592	0.483	0.013	0.03	2	0.055	0.618
F shrinkage m	78468	2				0.013	0.781

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
176135	0.17	0.07	10	0.444	0.424

continued Table 8.3.1. North Sea plaice. Diagnostics XSA run 1, with BTS-Tridens ages 2-9

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-Isis	31722	0.248	0.16	0.64	5	0.359	0.481
BTS-Tride	34674	0.211	0.182	0.86	4	0.601	0.448
SNS	12793	0.39	0.346	0.89	2	0.026	0.928
F shrinkage m	21516	2				0.014	0.647

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
32511	0.16	0.11	12	0.682	0.471

1

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-Isis	31454	0.282	0.18	0.64	6	0.269	0.314
BTS-Tride	32465	0.198	0.115	0.58	5	0.7	0.305
SNS	11316	0.372	0.396	1.07	3	0.019	0.706
F shrinkage m	14397	2				0.012	0.591

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
31246	0.16	0.09	15	0.566	0.316

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-Isis	12093	0.292	0.187	0.64	7	0.24	0.352
BTS-Tride	10308	0.186	0.062	0.33	6	0.734	0.402
SNS	7398	0.365	0.48	1.32	3	0.012	0.524
F shrinkage m	8780	2				0.014	0.458

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
10645	0.16	0.07	17	0.444	0.391

continued Table 8.3.1. North Sea plaice. Diagnostics XSA run 1, with BTS-Tridens ages 2-9

1

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-Isis	10216	0.311	0.174	0.56	8	0.264	0.218
BTS-Tride	5558	0.194	0.078	0.4	7	0.705	0.371
SNS	10982	0.363	0.278	0.77	3	0.014	0.205
F shrinkage m	6980	2				0.017	0.305

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6618	0.16	0.09	19	0.575	0.32

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-Isis	21531	0.235	0.152	0.65	8	0.538	0.095
BTS-Tride	14226	0.198	0.12	0.61	8	0.448	0.14
SNS	53575	0.568	0.378	0.66	2	0.004	0.039
F shrinkage m	4558	2				0.01	0.386

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
17673	0.16	0.1	19	0.675	0.115

1
1

Table 8.3.2. North Sea plaice. Diagnostics XSA run 2 = final assessment, with BTS-Tridens ages 1-9

Lowestoft VPA Version 3.1

8/09/2006 12:32

Extended Survivors Analysis

Plaice in IV

CPUE data from file fleet.txt

Catch data for 49 years. 1957 to 2005. Ages 1 to 10.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
BTS-I:	1985	2005	1	9	0.66	0.75
BTS-T	1996	2005	1	9	0.66	0.75
SNS	1982	2005	1	3	0.66	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 6

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 5 oldest ages.

S.E. of the mean to which the estimates are shrunk = 2.000

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 26 iterations

1

Regression weights

1	1	1	1	1	1	1	1	1	1

Continued. Table 8.3.2. North Sea plaice. Diagnostics XSA run 2 = final assessment, with BTS-Tridens ages 1-9

Fishing mortalities

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.102	0.073	0.2	0.038	0.107	0.052	0.262	0.167	0.304	0.196
2	0.55	0.882	0.578	0.153	0.393	0.532	0.943	0.776	0.836	0.855
3	0.691	0.941	1.332	0.305	0.417	0.886	0.617	0.695	0.524	0.537
4	0.785	0.754	1.121	0.707	0.598	0.842	0.768	1.184	0.497	0.419
5	0.807	0.911	0.651	0.708	0.655	0.773	0.747	0.674	0.374	0.473
6	0.741	0.853	0.627	0.524	0.581	0.493	0.706	0.67	0.493	0.316
7	0.778	0.754	0.786	0.535	0.275	0.528	0.645	0.462	0.374	0.392
8	0.708	0.59	0.674	0.907	0.347	0.201	0.37	0.424	0.181	0.321
9	0.57	0.793	0.563	1.037	1.165	0.328	0.177	0.198	0.162	0.115

1

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
1996	1.22E+06	9.28E+05	1.94E+05	9.72E+04	6.18E+04	2.93E+04	2.06E+04	9.38E+03	6.35E+03
1997	1.93E+06	9.93E+05	4.84E+05	8.78E+04	4.01E+04	2.50E+04	1.26E+04	8.57E+03	4.18E+03
1998	6.07E+05	1.62E+06	3.72E+05	1.71E+05	3.74E+04	1.46E+04	9.63E+03	5.37E+03	4.30E+03
1999	8.19E+05	4.50E+05	8.22E+05	8.88E+04	5.05E+04	1.76E+04	7.06E+03	3.97E+03	2.48E+03
2000	1.30E+06	7.14E+05	3.49E+05	5.48E+05	3.96E+04	2.25E+04	9.46E+03	3.74E+03	1.45E+03
2001	7.64E+05	1.06E+06	4.36E+05	2.08E+05	2.73E+05	1.86E+04	1.14E+04	6.50E+03	2.39E+03
2002	1.93E+06	6.56E+05	5.62E+05	1.63E+05	8.13E+04	1.14E+05	1.03E+04	6.08E+03	4.81E+03
2003	4.89E+05	1.34E+06	2.31E+05	2.75E+05	6.82E+04	3.48E+04	5.09E+04	4.89E+03	3.80E+03
2004	8.81E+05	3.74E+05	5.60E+05	1.04E+05	7.60E+04	3.15E+04	1.61E+04	2.90E+04	2.89E+03
2005	5.79E+05	5.88E+05	1.47E+05	3.00E+05	5.74E+04	4.73E+04	1.74E+04	1.00E+04	2.19E+04

Estimated population abundance at 1st Jan 2006

0.00E+00	4.31E+05	2.26E+05	7.77E+04	1.79E+05	3.24E+04	3.12E+04	1.06E+04	6.59E+03

Taper weighted geometric mean of the VPA populations:

9.03E+05	6.71E+05	3.78E+05	2.03E+05	1.02E+05	5.26E+04	2.83E+04	1.59E+04	9.17E+03

Standard error of the weighted Log(VPA populations) :

0.5282	0.5341	0.4905	0.487	0.5323	0.5743	0.6126	0.6695	0.7572

1

Log catchability residuals.

Fleet : BTS-Isis

Age	1982	1983	1984	1985
1	99.99	99.99	99.99	-1.25
2	99.99	99.99	99.99	0.25
3	99.99	99.99	99.99	-0.07
4	99.99	99.99	99.99	-0.32
5	99.99	99.99	99.99	-0.59
6	99.99	99.99	99.99	0.21
7	99.99	99.99	99.99	0.01
8	99.99	99.99	99.99	0.09
9	99.99	99.99	99.99	-0.01

Continued. Table 8.3.2. North Sea plaice. Diagnostics XSA run 2 = final assessment, with BTS-Tridens ages 1-9

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	-0.42	-0.65	0.54	0.56	-0.74	-0.08	0.02	0.06	0.34	-0.1
2	-0.39	0.47	-0.35	0.49	-0.34	0.01	0.22	0.66	0.03	-0.27
3	0.32	-0.38	0.44	-0.32	0.05	-0.27	-0.11	0.37	0.36	-0.12
4	-0.25	-0.64	-0.2	0.43	0.46	-0.14	-0.52	-0.25	0.5	0.34
5	-0.21	-0.28	0.26	0.6	-0.34	0.15	-0.01	-0.89	0.32	-0.24
6	-0.84	-0.43	-0.15	0.03	-0.49	0.75	0.68	-0.36	-0.26	0.07
7	-0.27	-0.28	-0.54	-0.34	-0.7	-0.92	-0.09	-0.07	0.57	-0.06
8	-0.27	-0.99	-1.79	0.46	0.5	0.14	-0.2	-0.35	0.95	1.54
9	-0.11	0	0.07	0.18	0.05	-0.01	-0.05	0.09	0.02	-0.08

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	-0.31	99.99	0.91	0.38	-0.13	0.14	0.25	0.1	0.19	0.2
2	0.38	99.99	0.55	0.33	-0.52	-0.76	-0.49	-0.06	-0.14	-0.07
3	0.46	-0.43	0.98	0.81	-0.01	-0.39	-1.02	-0.47	0.34	-0.56
4	0.25	-0.22	0.54	0.01	0	0.26	-0.16	-0.3	0.3	-0.1
5	0.97	-1.27	0.5	0.62	-0.41	0.48	0.43	-0.03	0.2	-0.25
6	0.57	-0.04	0.99	-0.98	-0.93	-0.29	-0.37	0.63	0.88	0.33
7	-2.02	-0.26	-0.13	-0.03	0.84	-0.49	-0.76	-0.47	1.02	-0.12
8	0.02	-0.33	-0.24	-0.77	-1.1	-1.41	-0.01	0.04	1.39	-0.2
9	0.04	99.99	0.2	-0.1	-0.38	-0.27	99.99	0.06	99.99	0.16

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6	7	8	9
Mean Log q	-8.1756	-8.2994	-8.9398	-9.541	-10.1336	-10.3513	-10.3513	-10.3513	-10.3513
S.E(Log q)	0.498	0.4072	0.4884	0.347	0.5413	0.5948	0.6783	0.8405	0.1472

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.63	-2.16	4.6	0.39	20	0.74	-8.18
2	0.9	0.7	8.86	0.71	20	0.37	-8.3
3	0.87	0.718	9.46	0.62	21	0.43	-8.94
4	1.06	-0.405	9.38	0.71	21	0.38	-9.54
5	0.96	0.216	10.19	0.58	21	0.53	-10.13
6	0.97	0.114	10.36	0.52	21	0.59	-10.35
7	1.22	-0.74	10.75	0.37	21	0.78	-10.59
8	0.61	2.152	9.98	0.62	21	0.47	-10.47
9	0.88	3.281	10.15	0.98	18	0.1	-10.36
1							

Continued. Table 8.3.2. North Sea plaice. Diagnostics XSA run 2 = final assessment, with BTS-Tridens ages 1-9

Fleet : BTS-Tridens

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	-1.01	99.99	-1.3	-0.25	0.01	-1.44	1.09	0.9	0.73	1.27
2	-1.08	99.99	0.07	-0.24	-0.4	-1.01	0.43	0.54	0.68	0.99
3	-0.39	-0.27	0.22	0.02	-0.11	-0.35	-0.57	0.43	0.31	0.73
4	-0.22	0.04	-0.02	0.49	-0.43	-0.16	-0.01	-0.02	0.38	-0.05
5	-0.25	0.44	0.26	0	0.3	-0.58	0.01	0.25	-0.19	-0.24
6	-0.11	0.18	0.2	0.39	0.07	-0.25	-0.61	0.06	-0.16	0.23
7	-0.53	-0.62	0.33	0.05	0.16	-0.29	-0.04	-0.09	-0.26	-0.02
8	-0.24	0.5	0.69	1.14	1.02	-0.33	0.27	0.49	-0.2	-0.49
9	-1.04	0.41	-0.1	0.84	1.19	0.99	-0.39	0.59	0.26	0.39

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6	7	8	9
Mean Log q	-12.3952	-10.4861	-9.7406	-9.4475	-9.2803	-8.9747	-8.9747	-8.9747	-8.9747
S.E(Log q)	1.0595	0.734	0.4149	0.2677	0.3187	0.2905	0.3268	0.6519	0.7509

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	0.9	0.129	12.53	0.18	9	1.01	-12.4
2	1.77	-0.801	8.12	0.13	9	1.33	-10.49
3	1.48	-1.304	8.26	0.48	10	0.59	-9.74
4	1.41	-2.503	8.39	0.82	10	0.3	-9.45
5	1.78	-3.692	7.88	0.74	10	0.37	-9.28
6	1.46	-2.371	8.37	0.77	10	0.34	-8.97
7	1.19	-0.884	9.02	0.73	10	0.36	-9.1
8	3.06	-2.731	8.3	0.18	10	1.35	-8.69
9	1.82	-1.57	8.95	0.32	10	1.14	-8.66
1							

Fleet : SNS

Age	1982	1983	1984	1985
1	0.29	0	0.37	-0.52
2	0.35	0.04	0.22	0.55
3	-0.01	-1.5	0.03	0.01
4	No data for this fleet at this age			
5	No data for this fleet at this age			
6	No data for this fleet at this age			
7	No data for this fleet at this age			
8	No data for this fleet at this age			
9	No data for this fleet at this age			

Continued. Table 8.3.2. North Sea plaice. Diagnostics XSA run 2 = final assessment, with BTS-Tridens ages 1-9

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	-0.24	-0.42	-0.23	0.09	-0.12	0.89	0.83	0.48	0.46	-0.27
2	-0.39	0.19	0.19	0.46	-0.1	0.49	0.87	0.6	0.33	-0.15
3	-0.19	-0.4	1.08	0.78	0.46	0.07	0.68	0	-0.08	-0.46
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	-0.41	99.99	0.73	0.3	-0.48	-0.67	-0.47	99.99	-0.18	-0.42
2	0.2	99.99	0.75	0.65	-1.06	-1.2	-1.4	99.99	-0.72	-0.86
3	0.77	0.19	2.01	1.5	-0.3	-1.07	-1.85	99.99	-0.51	-1.19
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

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
Mean Log q	-3.4149	-4.2499	-5.3051
S.E(Log q)	0.4732	0.6621	0.9134

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.59	-2.117	-2.75	0.39	22	0.7	-3.41
2	0.87	0.566	5.49	0.48	22	0.58	-4.25
3	0.64	1.484	8.06	0.45	23	0.57	-5.31
1							

Continued. Table 8.3.2. North Sea plaice. Diagnostics XSA run 2 = final assessment, with BTS-Tridens ages 1-9

Terminal year survivor and F summaries :

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 2004

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-Is	526223	0.51	0	0	1	0.417	0.163
BTS-T	1534641	1.117	0	0	1	0.087	0.059
SNS	282007	0.484	0	0	1	0.463	0.285
F shrinkage m	476395	2				0.033	0.179

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
431150	0.33	0.28	4	0.857	0.196

1

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-Is	230806	0.326	0.122	0.37	2	0.512	0.844
BTS-T	569590	0.642	0.115	0.18	2	0.135	0.43
SNS	143371	0.398	0.332	0.83	2	0.318	1.142
F shrinkage m	302079	2				0.035	0.699

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
226199	0.24	0.2	7	0.823	0.855

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2002

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-Is	56892	0.299	0.189	0.63	3	0.472	0.678
BTS-T	161001	0.379	0.029	0.08	3	0.377	0.295
SNS	29317	0.596	0.235	0.39	2	0.125	1.059
F shrinkage m	62850	2				0.026	0.63

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
77677	0.22	0.23	9	1.023	0.537

Continued. Table 8.3.2. North Sea plaice. Diagnostics XSA run 2 = final assessment, with BTS-Tridens ages 1-9

1
Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-Is	180954	0.249	0.103	0.42	4	0.43	0.414
BTS-T	189836	0.244	0.117	0.48	4	0.504	0.398
SNS	110114	0.488	0.019	0.04	2	0.053	0.612
F shrinkage m	78435	2				0.013	0.782

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
178583	0.17	0.08	11	0.456	0.419

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-Is	31721	0.249	0.16	0.64	5	0.357	0.481
BTS-T	34430	0.209	0.167	0.8	5	0.604	0.45
SNS	12804	0.394	0.348	0.88	2	0.025	0.928
F shrinkage m	21510	2				0.014	0.647

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
32400	0.16	0.11	13	0.67	0.473

1
Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-Is	31490	0.282	0.179	0.63	6	0.269	0.314
BTS-T	32432	0.197	0.103	0.52	6	0.701	0.306
SNS	11323	0.375	0.399	1.06	3	0.019	0.705
F shrinkage m	14390	2				0.012	0.591

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
31246	0.16	0.09	16	0.546	0.316

Continued. Table 8.3.2. North Sea plaice. Diagnostics XSA run 2 = final assessment, with BTS-Tridens ages 1-9

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-I:	12100	0.292	0.187	0.64	7	0.24	0.352
BTS-T	10301	0.186	0.056	0.3	7	0.735	0.402
SNS	7396	0.368	0.482	1.31	3	0.012	0.524
F shrinkage m	8774	2				0.014	0.458

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
10641	0.16	0.07	18	0.431	0.392

1

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-I:	10202	0.312	0.174	0.56	8	0.264	0.219
BTS-T	5536	0.194	0.074	0.38	8	0.705	0.372
SNS	10972	0.366	0.28	0.76	3	0.014	0.205
F shrinkage m	6978	2				0.017	0.305

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6593	0.16	0.09	20	0.564	0.321

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-I:	21529	0.235	0.152	0.65	8	0.537	0.095
BTS-T	14228	0.198	0.12	0.61	8	0.449	0.14
SNS	53768	0.571	0.377	0.66	2	0.004	0.039
F shrinkage m	4564	2				0.01	0.385

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
17671	0.16	0.1	19	0.675	0.115

1
1

Table 8.3.3. North Sea plaice. Fishing mortality estimates in the final XSA run.

table 8.3.3 ple-nsea
[1] 2006-09-09 10:28:58 units= f

year	age 1	2	3	4	5	6	7	8	9	10
1957	0.077	0.229	0.255	0.304	0.347	0.208	0.274	0.314	0.290	0.290
1958	0.105	0.250	0.302	0.358	0.374	0.321	0.268	0.291	0.323	0.323
1959	0.152	0.310	0.355	0.376	0.412	0.383	0.350	0.309	0.367	0.367
1960	0.108	0.318	0.353	0.384	0.366	0.419	0.383	0.359	0.383	0.383
1961	0.097	0.289	0.344	0.357	0.417	0.330	0.361	0.437	0.381	0.381
1962	0.096	0.319	0.373	0.398	0.434	0.426	0.362	0.350	0.395	0.395
1963	0.149	0.364	0.418	0.434	0.423	0.474	0.450	0.452	0.448	0.448
1964	0.032	0.399	0.448	0.469	0.540	0.488	0.403	0.390	0.459	0.459
1965	0.068	0.267	0.397	0.412	0.355	0.508	0.417	0.352	0.410	0.410
1966	0.071	0.356	0.388	0.430	0.477	0.343	0.506	0.409	0.435	0.435
1967	0.054	0.352	0.405	0.408	0.476	0.504	0.310	0.436	0.428	0.428
1968	0.197	0.287	0.344	0.361	0.366	0.323	0.410	0.289	0.351	0.351
1969	0.149	0.313	0.327	0.341	0.315	0.428	0.295	0.399	0.356	0.356
1970	0.223	0.435	0.492	0.505	0.462	0.504	0.594	0.261	0.467	0.467
1971	0.196	0.332	0.388	0.388	0.407	0.395	0.428	0.412	0.407	0.407
1972	0.232	0.381	0.401	0.413	0.419	0.444	0.408	0.478	0.434	0.434
1973	0.113	0.395	0.433	0.542	0.545	0.413	0.387	0.480	0.475	0.475
1974	0.221	0.399	0.491	0.516	0.597	0.453	0.395	0.465	0.487	0.487
1975	0.355	0.502	0.531	0.557	0.600	0.618	0.478	0.503	0.553	0.553
1976	0.334	0.408	0.427	0.433	0.384	0.434	0.519	0.453	0.446	0.446
1977	0.324	0.472	0.496	0.501	0.667	0.421	0.442	0.534	0.515	0.515
1978	0.306	0.431	0.466	0.472	0.462	0.522	0.463	0.428	0.471	0.471
1979	0.427	0.643	0.672	0.678	0.687	0.712	0.709	0.609	0.682	0.682
1980	0.238	0.470	0.677	0.633	0.512	0.522	0.498	0.508	0.537	0.537
1981	0.177	0.485	0.579	0.617	0.600	0.456	0.512	0.544	0.548	0.548
1982	0.241	0.514	0.696	0.679	0.634	0.550	0.492	0.549	0.583	0.583
1983	0.238	0.517	0.560	0.750	0.614	0.580	0.503	0.492	0.590	0.590
1984	0.301	0.554	0.580	0.587	0.643	0.557	0.567	0.669	0.607	0.607
1985	0.262	0.475	0.495	0.689	0.462	0.511	0.531	0.647	0.718	0.718
1986	0.285	0.607	0.637	0.641	0.699	0.655	0.578	0.705	1.395	1.395
1987	0.219	0.644	0.676	0.739	0.790	0.607	0.661	0.516	0.782	0.782
1988	0.231	0.630	0.666	0.668	0.729	0.710	0.585	0.667	0.785	0.785
1989	0.211	0.579	0.627	0.629	0.628	0.646	0.649	0.504	0.533	0.533
1990	0.161	0.474	0.569	0.594	0.699	0.566	0.547	0.516	0.401	0.401
1991	0.240	0.606	0.662	0.690	0.704	0.761	0.627	0.729	0.812	0.812
1992	0.215	0.558	0.653	0.678	0.774	0.680	0.643	0.599	1.289	1.289
1993	0.223	0.491	0.614	0.650	0.759	0.673	0.550	0.479	0.642	0.642
1994	0.164	0.494	0.621	0.734	0.640	0.666	0.814	0.487	0.390	0.390
1995	0.122	0.461	0.668	0.797	0.792	0.606	0.688	0.503	0.292	0.292
1996	0.102	0.550	0.691	0.785	0.807	0.741	0.778	0.708	0.570	0.570
1997	0.073	0.882	0.941	0.754	0.911	0.853	0.754	0.590	0.793	0.793
1998	0.200	0.578	1.332	1.121	0.651	0.627	0.786	0.674	0.563	0.563
1999	0.038	0.153	0.305	0.707	0.708	0.524	0.535	0.907	1.037	1.037
2000	0.107	0.393	0.417	0.598	0.655	0.581	0.275	0.347	1.165	1.165
2001	0.052	0.532	0.886	0.842	0.773	0.493	0.528	0.201	0.328	0.328
2002	0.262	0.943	0.617	0.768	0.747	0.706	0.645	0.370	0.177	0.177
2003	0.167	0.776	0.695	1.184	0.674	0.670	0.462	0.424	0.198	0.198
2004	0.304	0.836	0.524	0.497	0.374	0.493	0.374	0.181	0.162	0.162
2005	0.196	0.855	0.537	0.419	0.473	0.316	0.392	0.321	0.115	0.115

Table 8.3.4. North Sea plaice. Stock number estimates in the final XSA run.

table 8.3.4. ple-nsea
[1] 2006-09-09 10:28:57 units= NA

year	age 1	2	3	4	5	6	7	8	9	10
1957	457973	256778	322069	182986	117504	49780	48438	35192	20763	45210
1958	698110	383613	184865	225749	122171	75186	36568	33338	23255	49887
1959	863385	568705	270362	123650	142799	76063	49331	25309	22555	55136
1960	757297	670798	377298	171551	76786	85609	46907	31440	16805	49877
1961	860573	614898	441590	239779	105744	48183	50972	28949	19875	48420
1962	589152	706787	416673	283131	151855	63043	31337	32158	16921	41052
1963	688361	484322	465007	259568	172009	89026	37245	19737	20503	48075
1964	2231479	536376	304563	276883	152215	101918	50127	21479	11359	47990
1965	694564	1956312	325543	176041	156781	80257	56630	30309	13162	54735
1966	586765	586891	1355523	198048	105457	99439	43685	33776	19288	44344
1967	401281	494308	371930	832370	116528	59209	63822	23833	20303	33590
1968	434257	343880	314546	224447	500691	65481	32350	42363	13951	47347
1969	648830	322568	233472	201821	141572	314112	42892	19435	28722	56230
1970	650536	506046	213495	152341	129900	93515	185256	28908	11796	41650
1971	410215	471015	296395	118107	83205	74022	51099	92588	20154	52932
1972	366523	305205	305805	181974	72480	50094	45115	30148	55497	46548
1973	1311561	262932	188650	185292	108896	43124	29088	27143	16908	66348
1974	1132162	1059647	160340	110668	97518	57113	25814	17869	15193	59707
1975	864263	821466	643446	88769	59795	48585	32867	15743	10155	48469
1976	692030	548063	450073	342353	46011	29685	23690	18445	8610	36523
1977	985840	448581	329857	265792	200943	28360	17400	12760	10611	23902
1978	908601	644850	253064	181841	145790	93335	16843	10120	6769	20807
1979	890114	605241	379264	143751	102596	83074	50133	9590	5969	19631
1980	1127636	525287	287850	175336	66012	46722	36889	22316	4719	13546
1981	871004	804066	296977	132353	84255	35791	25089	20289	12146	14638
1982	2035523	660276	447727	150625	64608	41825	20524	13604	10661	20474
1983	1305294	1447399	357402	201908	69084	30997	21842	11352	7106	19441
1984	1257091	931273	780752	184749	86324	33817	15702	11948	6283	15082
1985	1850544	841837	484282	395535	92898	41049	17539	8058	5537	11824
1986	4747578	1288712	473732	267088	179612	52933	22283	9334	3819	9600
1987	1929110	3231342	635203	226773	127266	80780	24881	11317	4175	10545
1988	1774162	1401643	1535686	292317	98022	52273	39823	11620	6111	11963
1989	1184971	1273733	675401	714117	135605	42786	23263	20077	5395	14132
1990	1035975	868118	645894	326611	344456	65501	20296	10997	10974	12064
1991	910226	797687	488883	330984	163214	154890	33647	10632	5940	10499
1992	772165	648022	393754	228171	150244	73021	65483	16262	4643	9943
1993	524548	563453	335636	185347	104827	62692	33459	31145	8085	12974
1994	442017	379668	311947	164376	87566	44398	28934	17460	17459	17606
1995	1158562	339535	209556	151638	71423	41789	20642	11605	9711	15558
1996	1215952	927871	193789	97201	61842	29277	20620	9383	6348	11774
1997	1926329	993364	484231	87846	40115	24965	12626	8570	4182	7970
1998	607418	1619788	372068	171068	37388	14598	9628	5372	4300	7577
1999	819387	449989	821994	88817	50455	17649	7059	3969	2477	5008
2000	1301974	713835	349452	548204	39644	22501	9457	3740	1450	3227
2001	763592	1058379	435894	208462	272705	18629	11391	6501	2392	8644
2002	1929171	656116	562370	162642	81274	113912	10293	6077	4811	12243
2003	488754	1343757	231174	274555	68250	34848	50857	4888	3798	5125
2004	880836	374364	559778	104350	76042	31482	16134	29003	2894	3842
2005	579514	587881	146850	300075	57447	47347	17397	10041	21899	5947

Table 8.4.1. North Sea plaice. Stock summary table.

table 8.4.1. ple-nsea
[1] 2006-09-09 11:17:39

	recruitment	ssb	catch	landings	discards	fbar2-6	fbar disc2-3	fbar hc2-6	Y/ssb
1957	457973	274205	78410	70563	7847	0.27	0.12	0.22	0.26
1958	698110	288540	88133	73354	14779	0.32	0.19	0.24	0.25
1959	863385	296824	109031	79300	29731	0.37	0.24	0.24	0.27
1960	757297	308163	116918	87541	29377	0.37	0.23	0.27	0.28
1961	860573	321353	118234	85984	32250	0.35	0.27	0.24	0.27
1962	589152	372862	124958	87472	37486	0.39	0.29	0.25	0.23
1963	688361	370371	148014	107118	40896	0.42	0.36	0.27	0.29
1964	2231479	363074	147059	110540	36519	0.47	0.32	0.30	0.30
1965	694564	344009	139747	97143	42604	0.39	0.25	0.28	0.28
1966	586765	361543	166589	101834	64755	0.40	0.34	0.24	0.28
1967	401281	416553	162737	108819	53918	0.43	0.32	0.25	0.26
1968	434257	402506	139259	111534	27725	0.34	0.22	0.21	0.28
1969	648830	377412	142708	121651	21057	0.34	0.17	0.25	0.32
1970	650536	333907	159877	130342	29535	0.48	0.28	0.35	0.39
1971	410215	316303	136807	113944	22863	0.38	0.22	0.29	0.36
1972	366523	319002	142308	122843	19465	0.41	0.19	0.33	0.39
1973	1311561	268640	143826	130429	13397	0.47	0.13	0.41	0.49
1974	1132162	278523	157277	112540	44737	0.49	0.20	0.41	0.40
1975	864263	292919	194672	108536	86136	0.56	0.43	0.37	0.37
1976	692030	310580	166515	113670	52845	0.42	0.27	0.30	0.37
1977	985840	316356	176300	119188	57112	0.51	0.31	0.34	0.38
1978	908601	302477	159285	113984	45301	0.47	0.23	0.36	0.38
1979	890114	295506	212501	145347	67154	0.68	0.36	0.49	0.49
1980	1127636	269737	170782	139951	30831	0.56	0.16	0.50	0.52
1981	871004	258216	172144	139747	32397	0.55	0.16	0.48	0.54
1982	2035523	259703	203863	154547	49316	0.61	0.22	0.52	0.60
1983	1305294	309919	217660	144038	73622	0.60	0.26	0.49	0.46
1984	1257091	322526	226102	156147	69955	0.58	0.28	0.43	0.48
1985	1850544	343791	220424	159838	60586	0.53	0.23	0.43	0.46
1986	4747578	368065	296260	165347	130913	0.65	0.34	0.48	0.45
1987	1929110	445526	342796	153670	189126	0.69	0.51	0.48	0.34
1988	1774162	392444	310444	154475	155969	0.68	0.52	0.41	0.39
1989	1184971	414796	276128	169818	106310	0.62	0.47	0.39	0.41
1990	1035975	378509	228218	156240	71978	0.58	0.39	0.39	0.41
1991	910226	340757	229063	148004	81059	0.68	0.47	0.45	0.43
1992	772165	273487	182887	125190	57697	0.67	0.40	0.45	0.46
1993	524548	238907	151999	117113	34886	0.64	0.28	0.50	0.49
1994	442017	207874	134218	110392	23826	0.63	0.25	0.53	0.53
1995	1158562	186469	120215	98356	21859	0.66	0.21	0.57	0.53
1996	1215952	179635	133861	81673	52188	0.71	0.35	0.56	0.45
1997	1926329	186132	179759	83048	96711	0.87	0.73	0.57	0.45
1998	607418	205668	174711	71534	103177	0.86	0.77	0.44	0.35
1999	819387	155093	94978	80662	14316	0.48	0.10	0.43	0.52
2000	1301974	228710	135002	81148	53854	0.53	0.32	0.34	0.35
2001	763592	276865	182750	81963	100787	0.71	0.59	0.32	0.30
2002	1929171	243394	180652	70217	110435	0.76	0.69	0.36	0.29
2003	488754	246132	181302	66502	114800	0.80	0.56	0.38	0.27
2004	880836	182637	116551	61436	55115	0.54	0.53	0.31	0.34
2005	579514	193408	104080	55700	48380	0.52	0.55	0.26	0.29

Table 8.5.1. North Sea plaice. Input to RCT3 analysis.

North Sea Plaice

year class	XSA age 1	XSA age 2	SNS0	SNS1	SNS2	SNS3	SNS4	BTS1	BTS2	BTS3	BTS4
1966	401281	343880	-11	-11	-11	-11	769.73	-11.00	-11.00	-11.00	-11.00
1967	434257	322569	-11	-11	-11	3273	100.83	-11.00	-11.00	-11.00	-11.00
1968	648830	506046	-11	-11	9732	1415	89.11	-11.00	-11.00	-11.00	-11.00
1969	650536	471015	-11	9311	28164	4472	488.31	-11.00	-11.00	-11.00	-11.00
1970	410216	305205	1200	13538	10785	1578	160.00	-11.00	-11.00	-11.00	-11.00
1971	366523	262932	4456	13207	5046	1129	65.24	-11.00	-11.00	-11.00	-11.00
1972	1311562	1059647	7757	65639	16509	9556	236.32	-11.00	-11.00	-11.00	-11.00
1973	1132162	821466	7183	15366	8168	868	589.95	-11.00	-11.00	-11.00	-11.00
1974	864263	548063	2568	11628	2403	1737	134.78	-11.00	-11.00	-11.00	-11.00
1975	692030	448581	1314	8537	3424	345	161.22	-11.00	-11.00	-11.00	-11.00
1976	985840	644850	11166	18537	12678	1575	180.43	-11.00	-11.00	-11.00	-11.00
1977	908601	605241	4373	14012	9829	491	38.32	-11.00	-11.00	-11.00	-11.00
1978	890114	525287	3267	21495	12882	834	87.86	-11.00	-11.00	-11.00	-11.00
1979	1127636	804066	29058	59174	18785	1261	70.97	-11.00	-11.00	-11.00	-11.00
1980	871004	660276	4210	24756	8642	249	41.67	-11.00	-11.00	-11.00	-11.00
1981	2035523	1447399	35506	69993	13909	2467	328.04	-11.00	-11.00	-11.00	11.84
1982	1305294	931273	24402	33974	10413	1598	144.87	-11.00	-11.00	38.81	8.89
1983	1257091	841837	32942	44965	13848	1152	199.58	-11.00	179.90	51.00	4.77
1984	1850544	1288712	7918	28101	7580	1227	1350.13	115.58	131.77	33.07	9.99
1985	4747579	3231343	47256	93552	32991	13153	7126.43	667.44	764.29	182.31	47.30
1986	1929110	1401643	8820	33402	14421	4373	816.14	225.82	146.99	38.66	22.78
1987	1774162	1273733	21335	36609	17810	3160	1076.83	680.17	319.27	55.67	11.86
1988	1184972	868118	15670	34276	7496	1518	612.98	467.88	102.64	28.55	5.62
1989	1035975	797687	24585	25037	11247	2268	97.78	115.31	122.05	27.31	6.12
1990	910226	648022	9368	57221	13842	1006	75.94	185.45	125.93	38.40	10.87
1991	772166	563453	17257	46798	9686	856	96.99	176.97	179.10	35.24	8.11
1992	524548	379668	6473	22098	4977	381	44.71	124.76	64.22	14.22	4.83
1993	442017	339535	9234	19188	2796	1185	45.00	145.21	43.55	23.02	2.79
1994	1158562	927871	26781	24767	10268	1391	49.67	252.16	212.32	19.91	8.91
1995	1215952	993364	12541	23015	-11	5014	1058.21	218.28	-11.00	47.40	3.65
1996	1926329	1619787	84042	-11	30242	13783	982.56	-11.00	431.90	182.52	23.99
1997	607418	449988	14328	33666	10272	891	175.83	342.51	130.00	31.38	9.97
1998	819386	713834	25522	32951	2493	370	65.24	305.90	74.40	19.39	5.37
1999	1301975	1058380	39262	22855	2898	265	-11.00	277.61	78.44	16.05	5.94
2000	763591	656115	24214	11511	1103	-11	111.00	222.71	47.74	10.78	6.62
2001	1929165	1343751	99628	30813	-11	1944	808.71	541.25	170.08	66.60	13.59
2002	-11	-11	31350	-11	2103	449	-11.00	126.11	41.75	7.00	-11.00
2003	-11	-11	-11	22507	3850	-11	-11.00	226.20	69.86	-11.00	-11.00
2004	-11	-11	16004	11874	-11	-11	-11.00	161.60	-11.00	-11.00	-11.00
2005	-11	-11	35656	-11	-11	-11	-11.00	-11.00	-11.00	-11.00	-11.00

Table 8.5.2. North Sea plaice. Results from RCT3 age 1 analysis.

Analysis by RCT3 ver3.1 of data from file :

ple_iv_1.txt

North Sea Plaice Age 1

Data for 10 surveys over 40 years : 1966 - 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 .00
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2003

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS0									
SNS1	1.39	-.31	.67	.390	32	10.02	13.62	.702	.170
SNS2	1.40	1.05	.98	.231	32	8.26	12.64	1.050	.076
SNS3									
SNS4									
BTS1	1.83	3.78	.91	.305	17	5.43	13.73	.995	.084
BTS2	1.00	9.05	.45	.636	18	4.26	13.29	.503	.329
BTS3									
BTS4									
DFS0	2.52	-.81	1.02	.247	19	5.89	14.01	1.109	.068
					VPA Mean =		13.79	.553	.273

Yearclass = 2004

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS0	.81	6.23	.71	.368	32	9.68	14.07	.743	.207
SNS1	1.39	-.31	.67	.390	32	9.38	12.74	.719	.221
SNS2									
SNS3									
SNS4									
BTS1	1.83	3.78	.91	.305	17	5.09	13.12	1.011	.112
BTS2									
BTS3									
BTS4									
DFS0	2.52	-.81	1.02	.247	19	5.30	12.53	1.158	.085
					VPA Mean =		13.79	.553	.374

Continued. Table 8.5.2. North Sea plaice. Results from RCT3 age 1 analysis.

Yearclass = 2005

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction			---------I
SNS0	.81	6.23	.71	.368	32	10.48	14.71	.753	.311
SNS1									
SNS2									
SNS3									
SNS4									
BTS1									
BTS2									
BTS3									
BTS4									
DFS0	2.52	-.81	1.02	.247	19	4.89	11.49	1.243	.114
					VPA Mean =		13.79	.553	.575

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2003	744171	13.52	.29	.15	.28		
2004	680480	13.43	.34	.28	.70		
2005	999498	13.82	.42	.66	2.45		

Table 8.5.3. North Sea plaice. Results from RCT3 age 2 analysis.

Analysis by RCT3 ver3.1 of data from file :

ple_iv_2.txt

North Sea Plaice Age 2

Data for 10 surveys over 40 years : 1966 - 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 .00
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2003

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS0									
SNS1	1.35	-.23	.64	.410	32	10.02	13.31	.670	.188
SNS2	1.53	-.43	1.10	.196	32	8.26	12.22	1.172	.062
SNS3									
SNS4									
BTS1	1.73	4.06	.85	.309	17	5.43	13.46	.937	.096
BTS2	.99	8.81	.47	.601	18	4.26	13.01	.522	.310
BTS3									
BTS4									
DFS0	2.59	-1.52	1.07	.218	19	5.89	13.71	1.161	.063
					VPA Mean =		13.48	.548	.282

Yearclass = 2004

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS0	.74	6.58	.60	.447	32	9.68	13.73	.635	.256
SNS1	1.35	-.23	.64	.410	32	9.38	12.45	.687	.218
SNS2									
SNS3									
SNS4									
BTS1	1.73	4.06	.85	.309	17	5.09	12.88	.953	.113
BTS2									
BTS3									
BTS4									
DFS0	2.59	-1.52	1.07	.218	19	5.30	12.19	1.212	.070
					VPA Mean =		13.48	.548	.343

Continued Table 8.5.3. North Sea plaice. Results from RCT3 age 2 analysis.

Yearclass = 2005

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
SNS0	.74	6.58	.60	.447	32	10.48	14.32	.643	.381
SNS1									
SNS2									
SNS3									
SNS4									
BTS1									
BTS2									
BTS3									
BTS4									
DFS0	2.59	-1.52	1.07	.218	19	4.89	11.12	1.302	.093
					VPA Mean =		13.48	.548	.526

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2003	561172	13.24	.29	.15	.28		
2004	520173	13.16	.32	.28	.74		
2005	793181	13.58	.40	.62	2.47		

Table 8.6.1. North Sea plaice. Input to the short term forecast.

2006

age	stock.n	catch.wt	landings.wt	discards.wt	mat	M	F	Fdisc	Fhc
1	911712	0.07	0.24	0.06	0	0.1	0.19	0.18	0.00
2	431211	0.12	0.25	0.11	0.5	0.1	0.69	0.65	0.04
3	226221	0.22	0.28	0.17	0.5	0.1	0.49	0.27	0.22
4	77683	0.28	0.32	0.18	1	0.1	0.59	0.19	0.39
5	178586	0.36	0.38	0.20	1	0.1	0.42	0.06	0.37
6	32401	0.40	0.42	0.21	1	0.1	0.41	0.04	0.38
7	31245	0.48	0.48	0.21	1	0.1	0.34	0.01	0.34
8	10641	0.58	0.58	0.07	1	0.1	0.26	0.00	0.26
9	6593	0.71	0.71	0.00	1	0.1	0.13	0.00	0.13
10	22470	0.85	0.86	0.00	1	0.1	0.13	0.00	0.13

2007

age	stock.n	catch.wt	landings.wt	discards.wt	mat	M	F	Fdisc	Fhc
1	911712	0.07	0.24	0.06	0	0.1	0.19	0.18	0.00
2		0.12	0.25	0.11	0.5	0.1	0.69	0.65	0.04
3		0.22	0.28	0.17	0.5	0.1	0.49	0.27	0.22
4		0.28	0.32	0.18	1	0.1	0.59	0.19	0.39
5		0.36	0.38	0.20	1	0.1	0.42	0.06	0.37
6		0.40	0.42	0.21	1	0.1	0.41	0.04	0.38
7		0.48	0.48	0.21	1	0.1	0.34	0.01	0.34
8		0.58	0.58	0.07	1	0.1	0.26	0.00	0.26
9		0.71	0.71	0.00	1	0.1	0.13	0.00	0.13
10		0.85	0.86	0.00	1	0.1	0.13	0.00	0.13

2008

age	stock.n	catch.wt	landings.wt	discards.wt	mat	M	F	Fdisc	Fhc
1	911712	0.07	0.24	0.06	0	0.1	0.19	0.18	0.00
2		0.12	0.25	0.11	0.5	0.1	0.69	0.65	0.04
3		0.22	0.28	0.17	0.5	0.1	0.49	0.27	0.22
4		0.28	0.32	0.18	1	0.1	0.59	0.19	0.39
5		0.36	0.38	0.20	1	0.1	0.42	0.06	0.37
6		0.40	0.42	0.21	1	0.1	0.41	0.04	0.38
7		0.48	0.48	0.21	1	0.1	0.34	0.01	0.34
8		0.58	0.58	0.07	1	0.1	0.26	0.00	0.26
9		0.71	0.71	0.00	1	0.1	0.13	0.00	0.13
10		0.85	0.86	0.00	1	0.1	0.13	0.00	0.13

Table 8.6.2. North Sea plaice. Results from the short term forecast.

2006 fmult	F2-6	Fdisc2-3	Fhc2-6	landings	discards	catch	SSB2006
1	0.52	0.46	0.28	52692	42691	95462	194051

2007 fmult	F2-6	Fdisc2-3	Fhc2-6	landings	discards	catch	SSB2007	SSB2008
0.3	0.16	0.14	0.08	17831	19804	37653	197699	271462
0.4	0.21	0.18	0.11	23251	25692	48967	197699	259992
0.5	0.26	0.23	0.14	28431	31259	59720	197699	249096
0.6	0.31	0.28	0.17	33382	36525	69942	197699	238743
0.7	0.36	0.32	0.20	38115	41508	79663	197699	228903
0.8	0.42	0.37	0.22	42641	46225	88910	197699	219549
0.9	0.47	0.41	0.25	46969	50691	97710	197699	210653
1	0.52	0.46	0.28	51110	54922	106087	197699	202191
1.1	0.57	0.51	0.31	55071	58932	114063	197699	194140
1.2	0.62	0.55	0.33	58863	62734	121660	197699	186477
1.3	0.68	0.60	0.36	62491	66340	128899	197699	179182
1.4	0.73	0.64	0.39	65966	69762	135800	197699	172234
1.5	0.78	0.69	0.42	69293	73010	142379	197699	165616
1.6	0.83	0.73	0.45	72479	76095	148655	197699	159310
1.7	0.88	0.78	0.47	75532	79027	154643	197699	153300
1.8	0.94	0.83	0.50	78457	81814	160359	197699	147569
1.9	0.99	0.87	0.53	81261	84464	165816	197699	142103
2	1.04	0.92	0.56	83948	86986	171029	197699	136889

Table 8.6.3. North Sea plaice. Detailed results from the short term forecast at Fsq.

2006 fmult	age	F	Fdisc	Fhc	disc.n	land.n	catch.n	discards	landings	catch	stock.n	TSB	SSB
1	1	0.19	0.18	0.00	145319	2073	147391	9155	488	9681	911712	49536	0
1	2	0.69	0.65	0.04	193959	11275	205234	21917	2834	24749	431211	47864	23932
1	3	0.49	0.27	0.22	45893	37783	83676	7802	10562	18367	226221	49241	24620
1	4	0.59	0.19	0.39	10791	22130	32921	1982	7165	9166	77683	21337	21337
1	5	0.42	0.06	0.37	8051	50875	58927	1616	19375	21016	178586	65839	65839
1	6	0.41	0.04	0.38	910	9546	10455	187	4026	4207	32401	13425	13425
1	7	0.34	0.01	0.34	150	8492	8643	32	4092	4125	31245	14446	14446
1	8	0.26	0.00	0.26	4	2305	2310	0	1335	1335	10641	5753	5753
1	9	0.13	0.00	0.13	4	776	779	0	554	554	6593	4648	4648
1	10	0.13	0.00	0.13	33	2623	2656	0	2261	2261	22470	20051	20051

2007 fmult	age	F	Fdisc	Fhc	disc.n	land.n	catch.n	discards	landings	catch	stock.n	TSB	SSB
1	1	0.19	0.18	0.00	145319	2073	147391	9155	488	9681	911712	49536	0
1	2	0.69	0.65	0.04	308123	17911	326035	34818	4502	39316	685023	76038	38019
1	3	0.49	0.27	0.22	39790	32758	72548	6764	9157	15924	196137	42693	21346
1	4	0.59	0.19	0.39	17426	35739	53165	3201	11571	14803	125454	34458	34458
1	5	0.42	0.06	0.37	1765	11150	12915	354	4246	4606	39140	14429	14429
1	6	0.41	0.04	0.38	2969	31157	34127	610	13142	13730	105759	43819	43819
1	7	0.34	0.01	0.34	93	5276	5369	20	2542	2563	19410	8974	8974
1	8	0.26	0.00	0.26	8	4350	4358	1	2518	2520	20077	10855	10855
1	9	0.13	0.00	0.13	4	875	879	0	625	625	7437	5243	5243
1	10	0.13	0.00	0.13	34	2689	2723	0	2317	2318	23035	20555	20555

2008 fmult	age	F	Fdisc	Fhc	disc.n	land.n	catch.n	discards	landings	catch	stock.n	TSB	SSB
1	1	0.19	0.18	0.00	145319	2073	147391	9155	488	9681	911712	49536	0
1	2	0.69	0.65	0.04	308123	17911	326035	34818	4502	39316	685023	76038	38019
1	3	0.49	0.27	0.22	63211	52040	115250	10746	14547	25298	311585	67822	33911
1	4	0.59	0.19	0.39	15109	30986	46095	2775	10033	12834	108771	29876	29876
1	5	0.42	0.06	0.37	2850	18007	20856	572	6858	7438	63208	23303	23303
1	6	0.41	0.04	0.38	651	6829	7479	134	2880	3009	23179	9604	9604
1	7	0.34	0.01	0.34	305	17220	17525	65	8297	8365	63357	29292	29292
1	8	0.26	0.00	0.26	5	2702	2707	0	1565	1565	12473	6744	6744
1	9	0.13	0.00	0.13	8	1651	1658	0	1179	1180	14032	9893	9893
1	10	0.13	0.00	0.13	36	2819	2854	0	2430	2430	24151	21551	21551

Figure 8.2.1. North Sea plaice. Stock weights at age

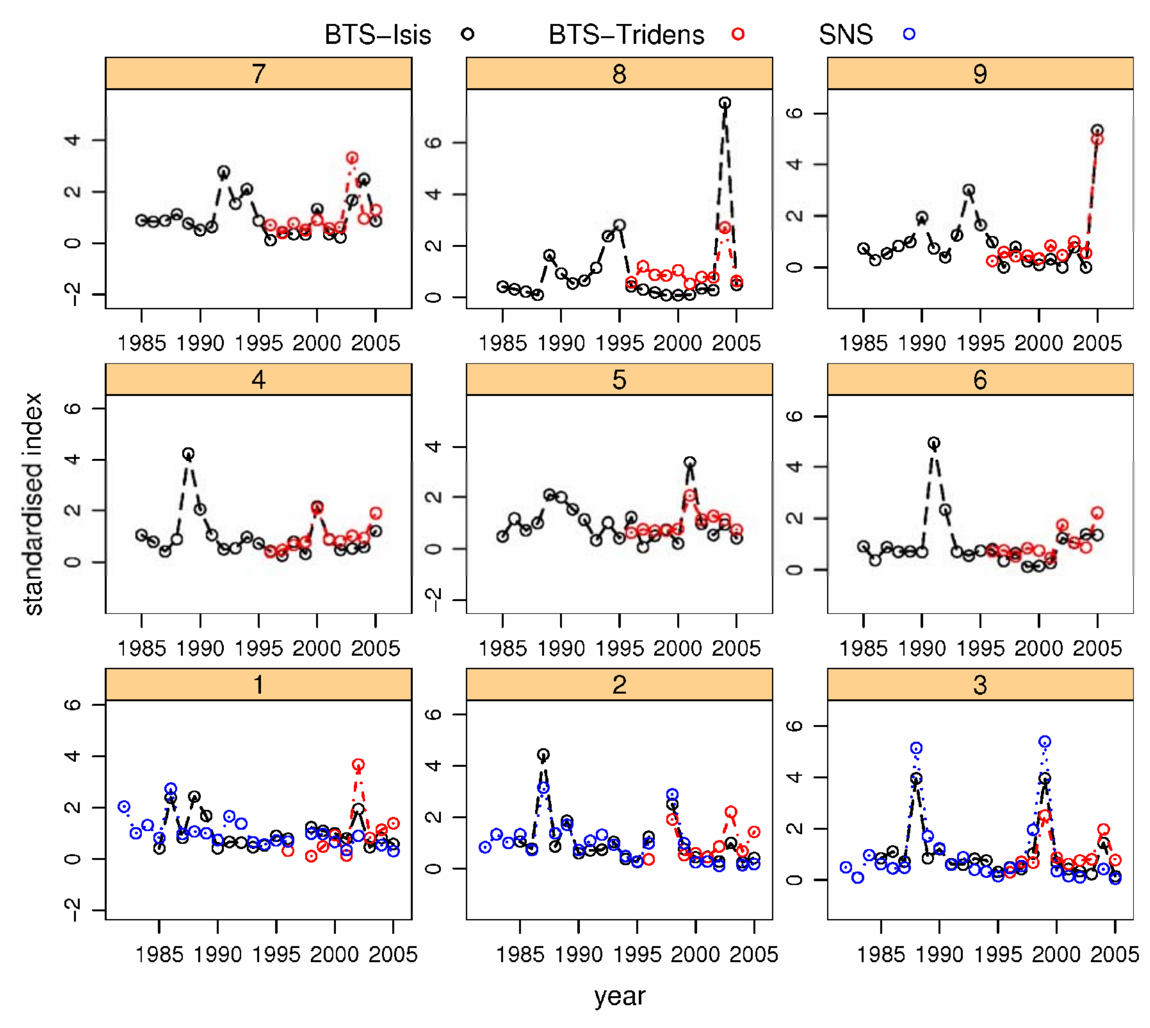


Figure 8.2.2. North Sea plaice. Standardised survey indices used for tuning.

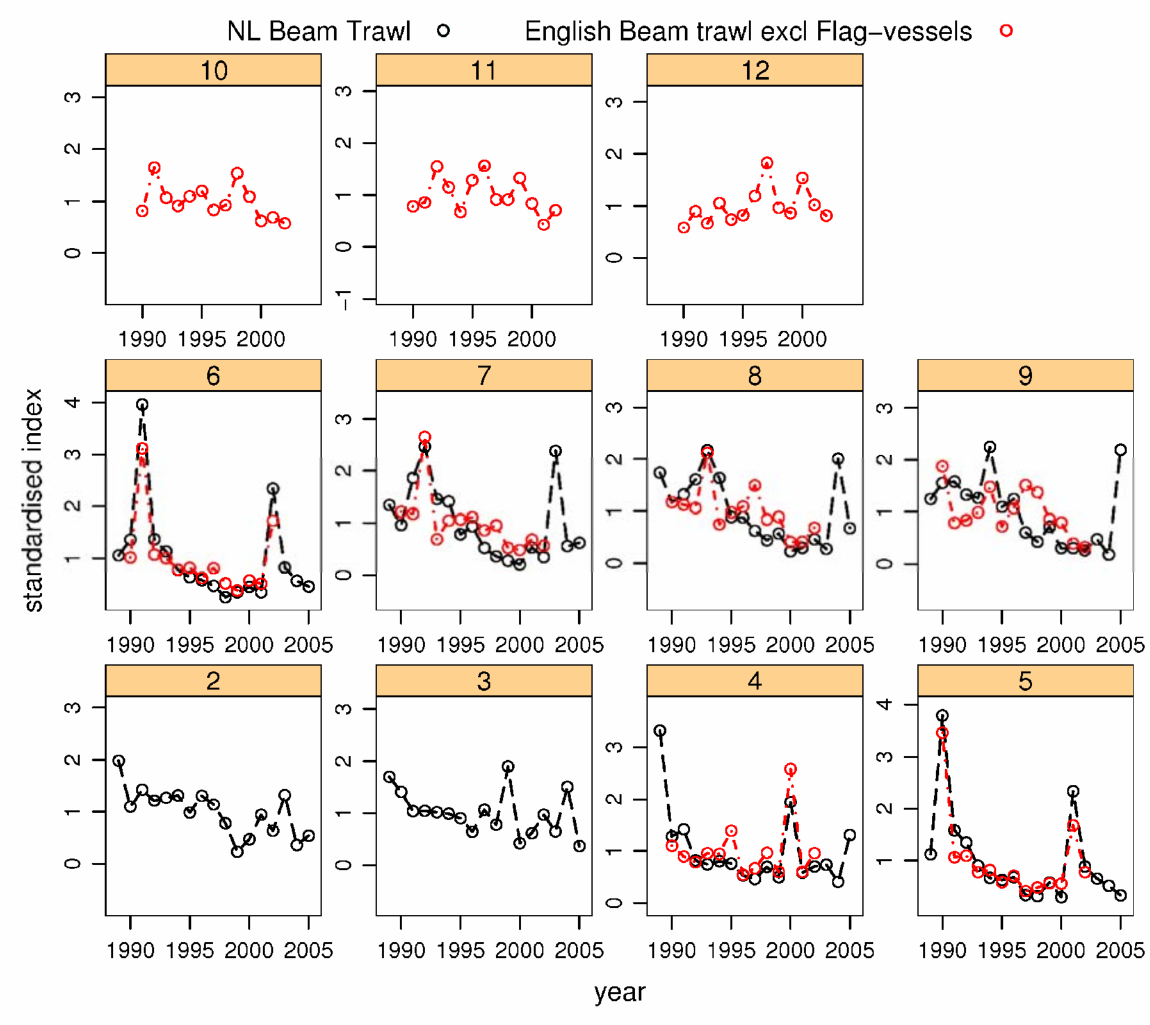
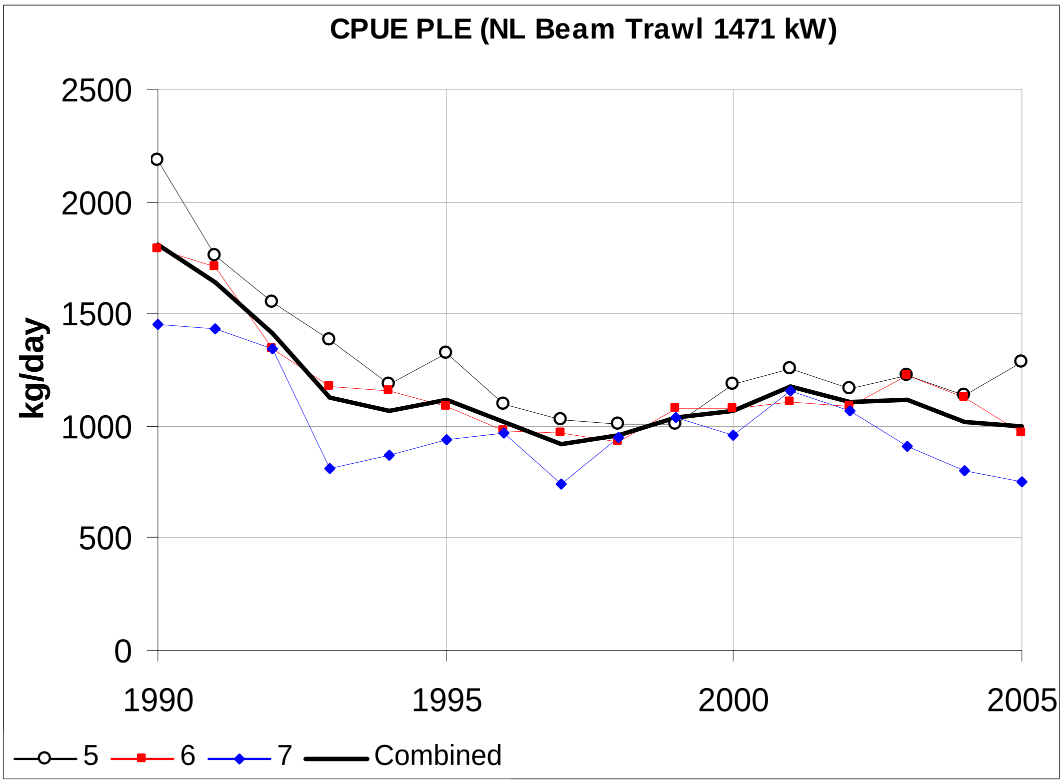


Figure 8.2.3. North Sea plaice. Standardised commercial indices available for tuning (not used in final assessment).



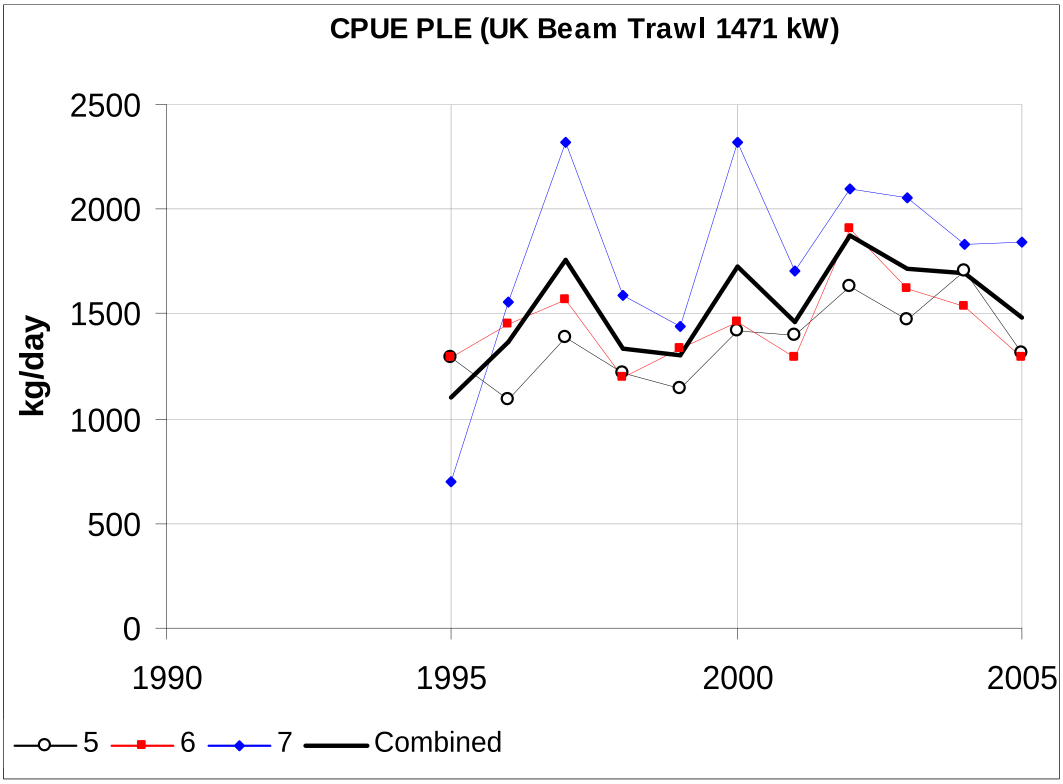


Figure 8.2.4. North Sea plaice. LPUE of the Dutch (top) and UK large trawler fleet (bottom), in areas 5 (north), 6 (central) and 7 (south) and the combined North Sea. Source: VIRIS Taken from Quirijns 2006, Working paper 4. Note that this figure represents LPUE(and not CPUE), in contrast to what the header in the pictures say.

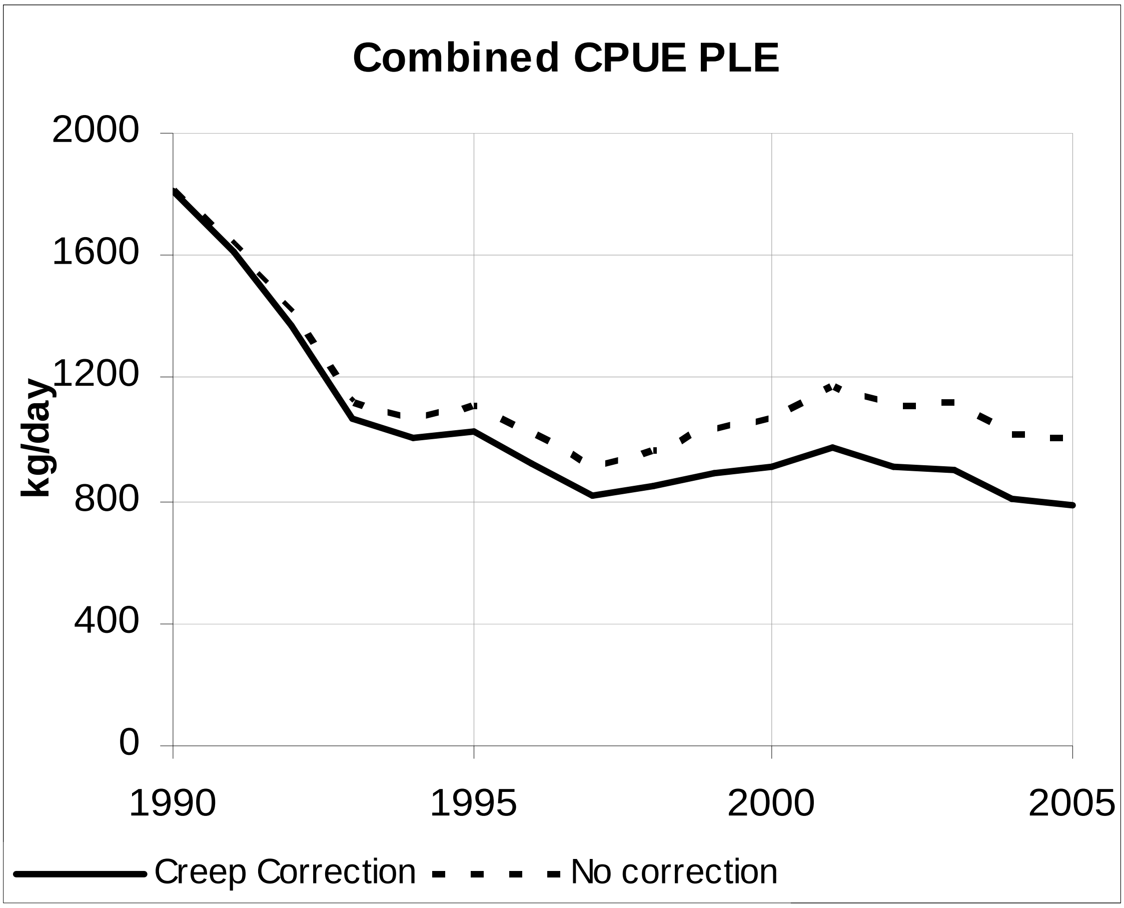
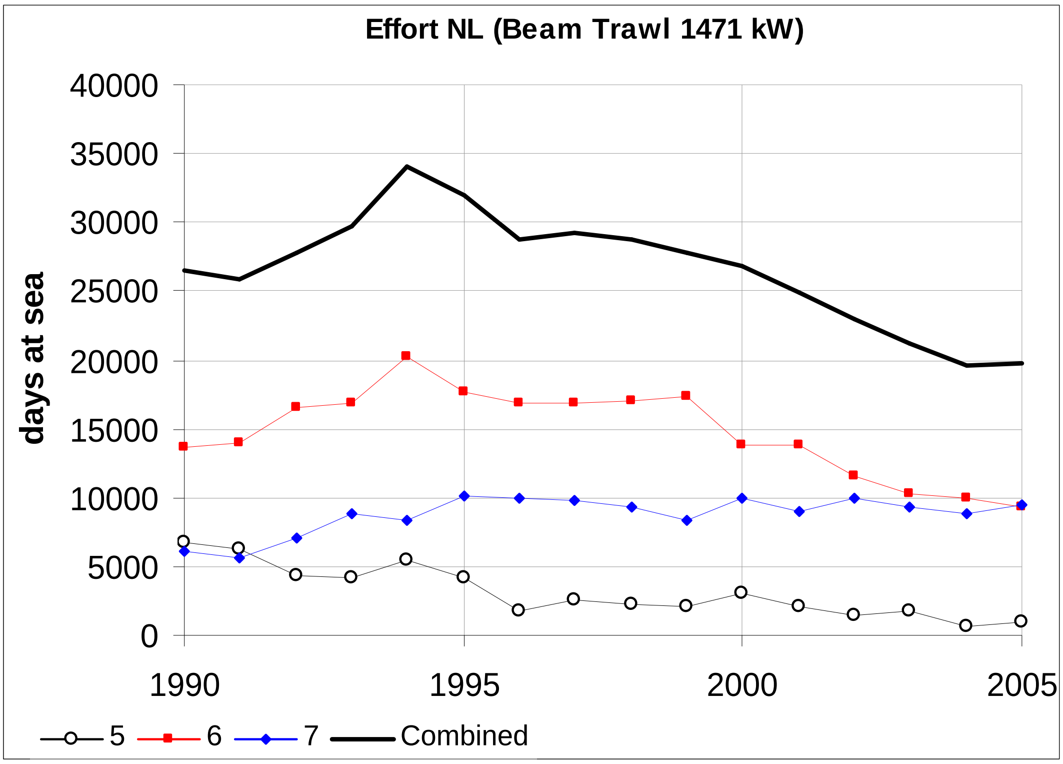


Figure 8.2.5. North Sea plaice. LPUE of the Dutch large trawler fleet with (solid line) and without (dashed line) correction for technological creep. Taken from Quirijns 2006, Working paper 4. Note that this figure represents LPUE (and not CPUE), in contrast to what the header in the picture says.



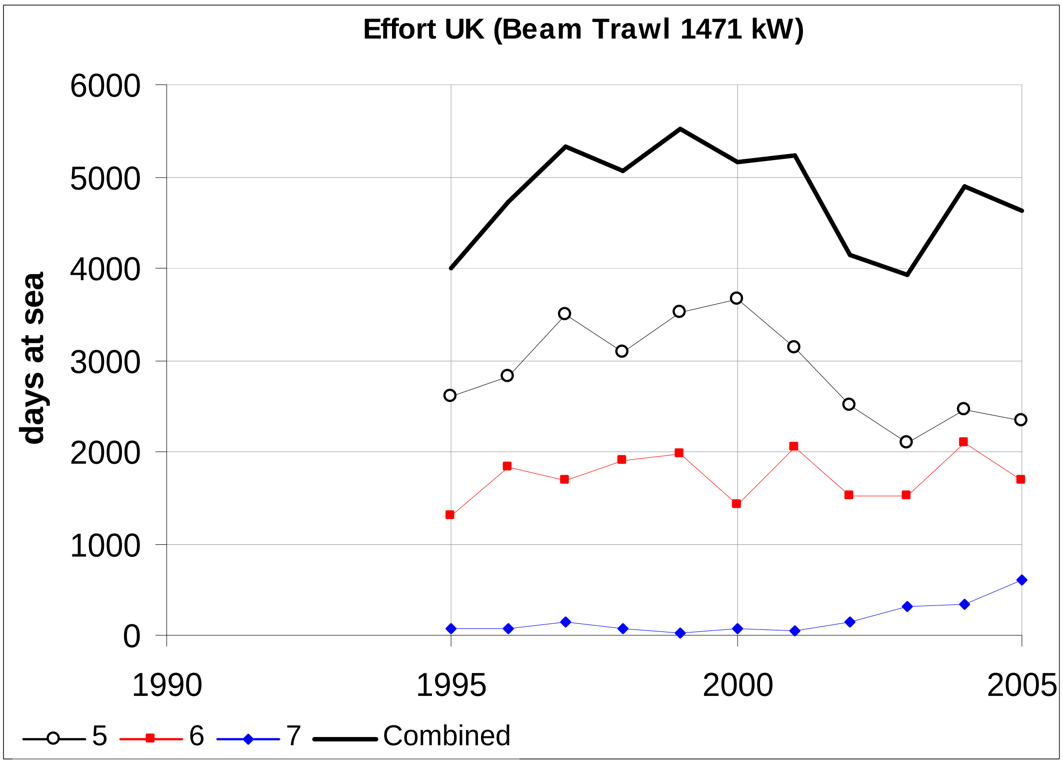


Figure 8.2.6. North Sea plaice. Effort (days at sea per 1471 kW vessel) linked to plaice catches for the Dutch fleet (top) and UK large trawler fleet (bottom), in areas 5 (north), 6 (central) and 7 (south) and the combined North Sea. Source: VIRIS. Taken from Quirijns 2006, Working paper 4.

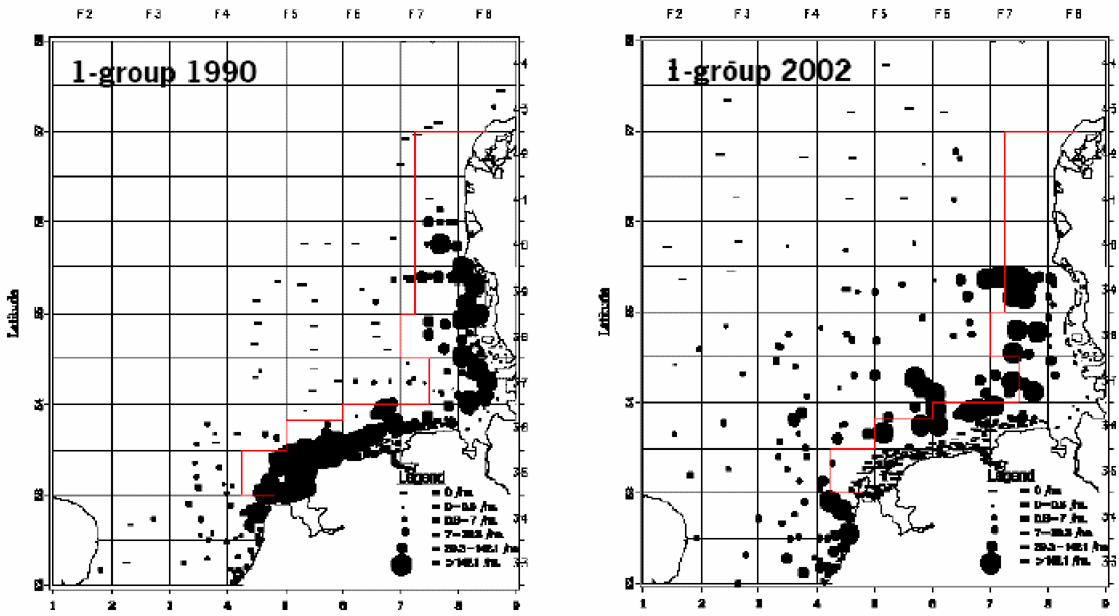


Figure 8.3.1. North Sea plaice. Spatial distribution of plaice age 1 (taken from Grift et al., 2004) in the DFS survey.

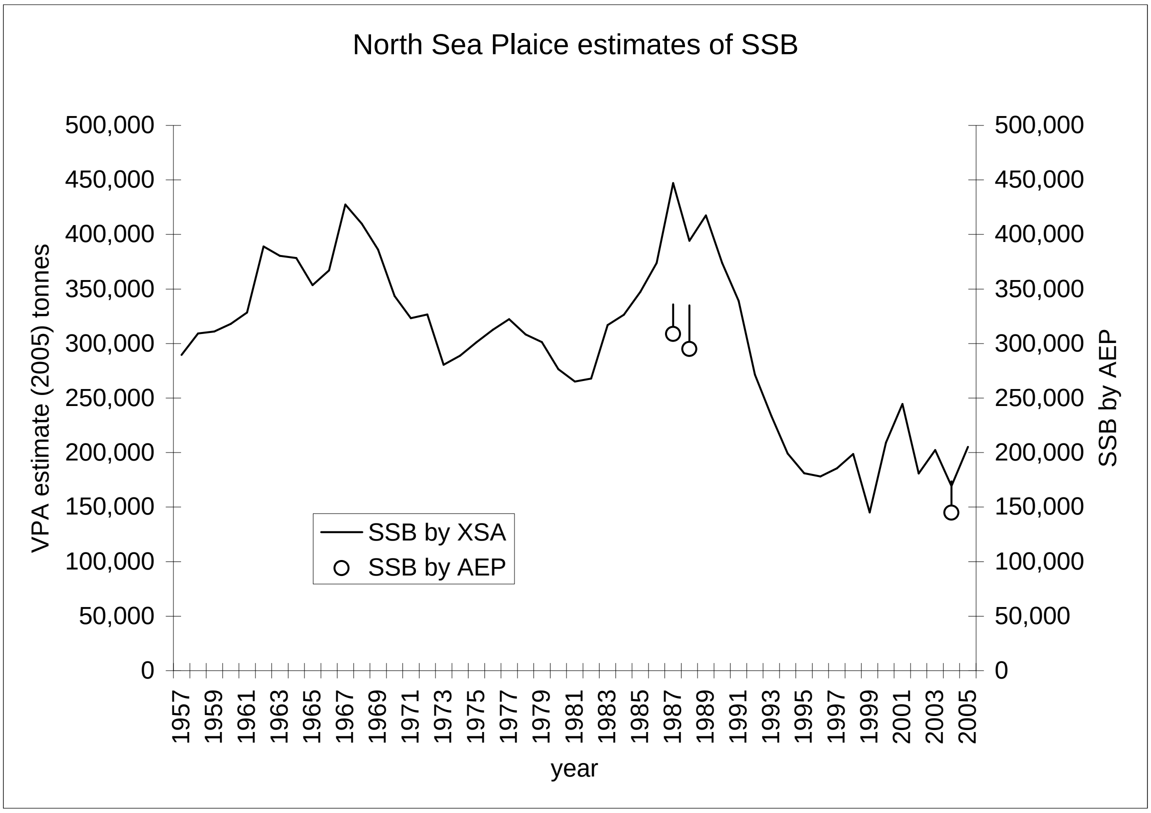


Figure 8.3.2. Comparison of AEP SSB with the ICES stock assessment using XSA (ICES, 2006a). Circles denote the AEP estimate of SSB using egg production at the median age of egg stage 1A, whilst the top of the linked vertical bars denote the AEP estimate of SSB using the egg production at spawning (derived by mortalities varying due to temperature, Dickey-Collas et al, 2003). Egg development rates were based on Fox et al. (2003). Taken from Van Damme et al. 2006, Working paper 5.

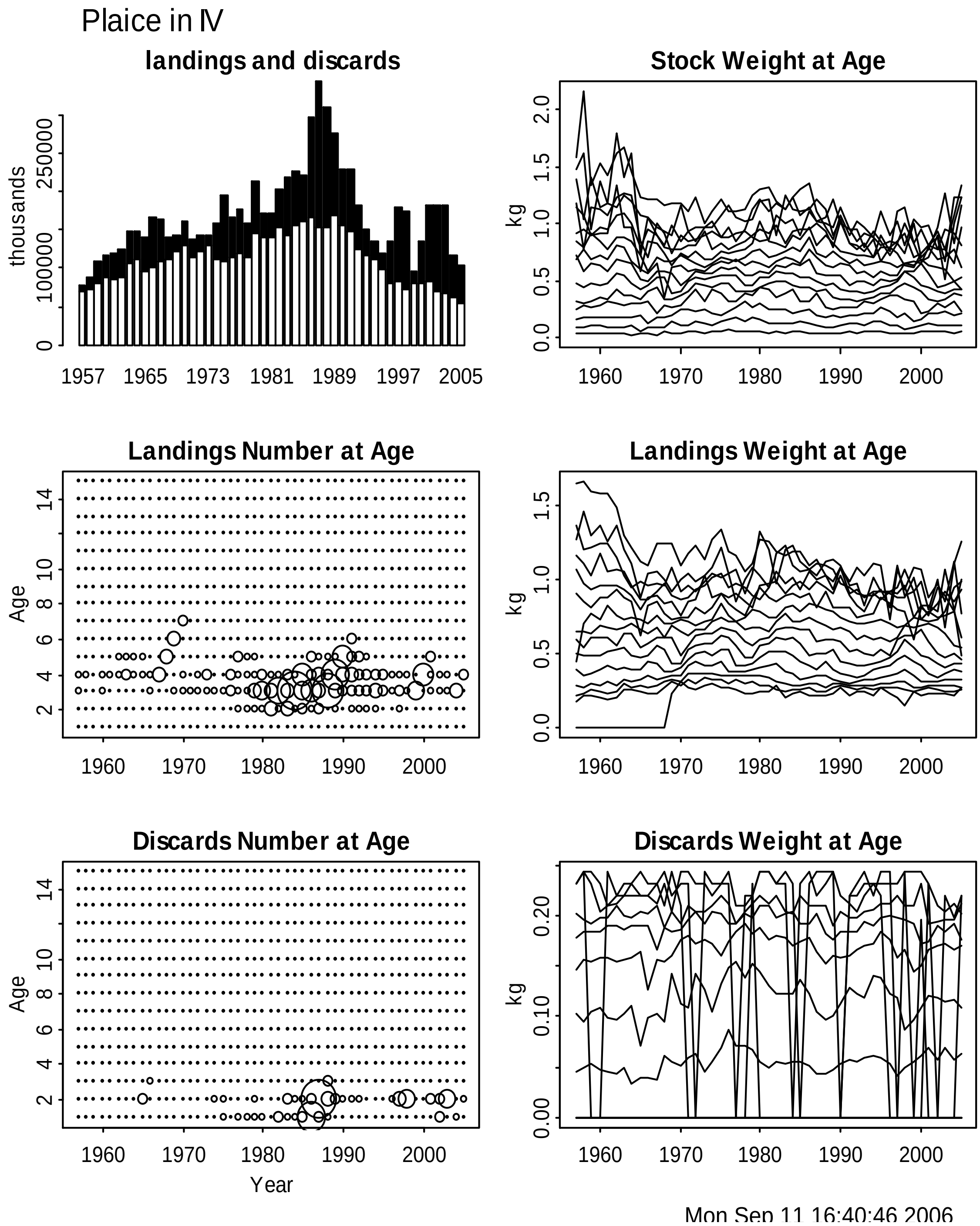


Figure 8.3.3. North Sea plaice. Summary of the catch input data. In the upper right panel black signified discards and white signifies landings.

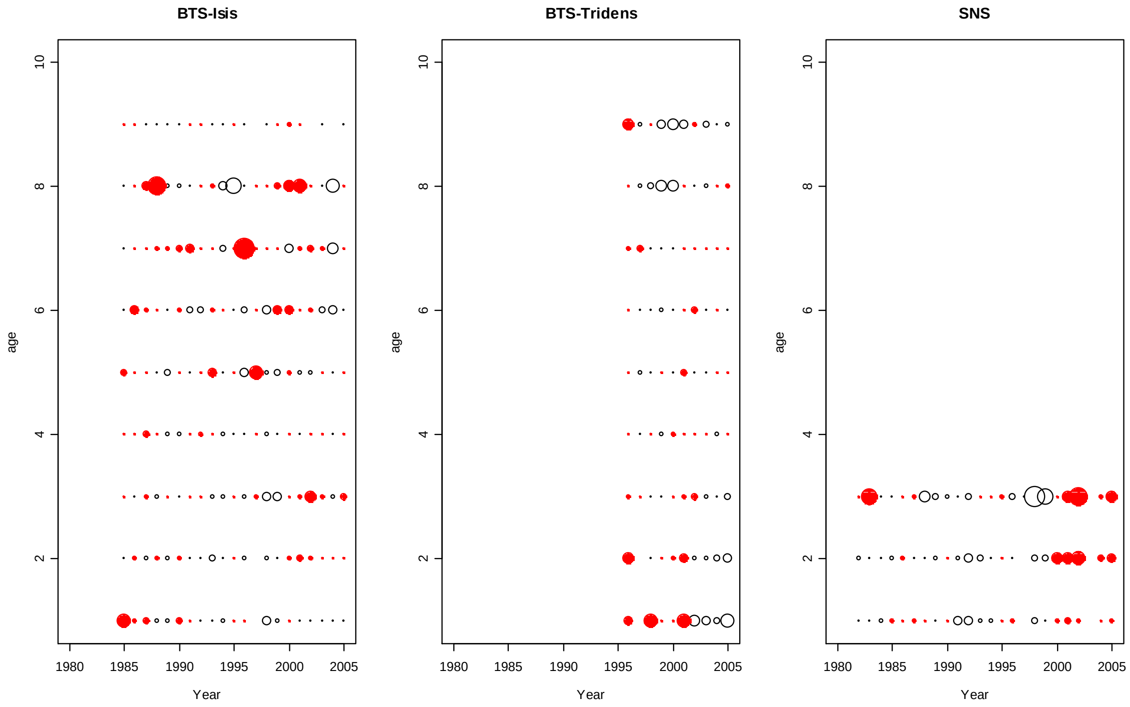


Figure 8.3.4. North Sea plaice. Log residual plots of final XSA run using all survey fleets.

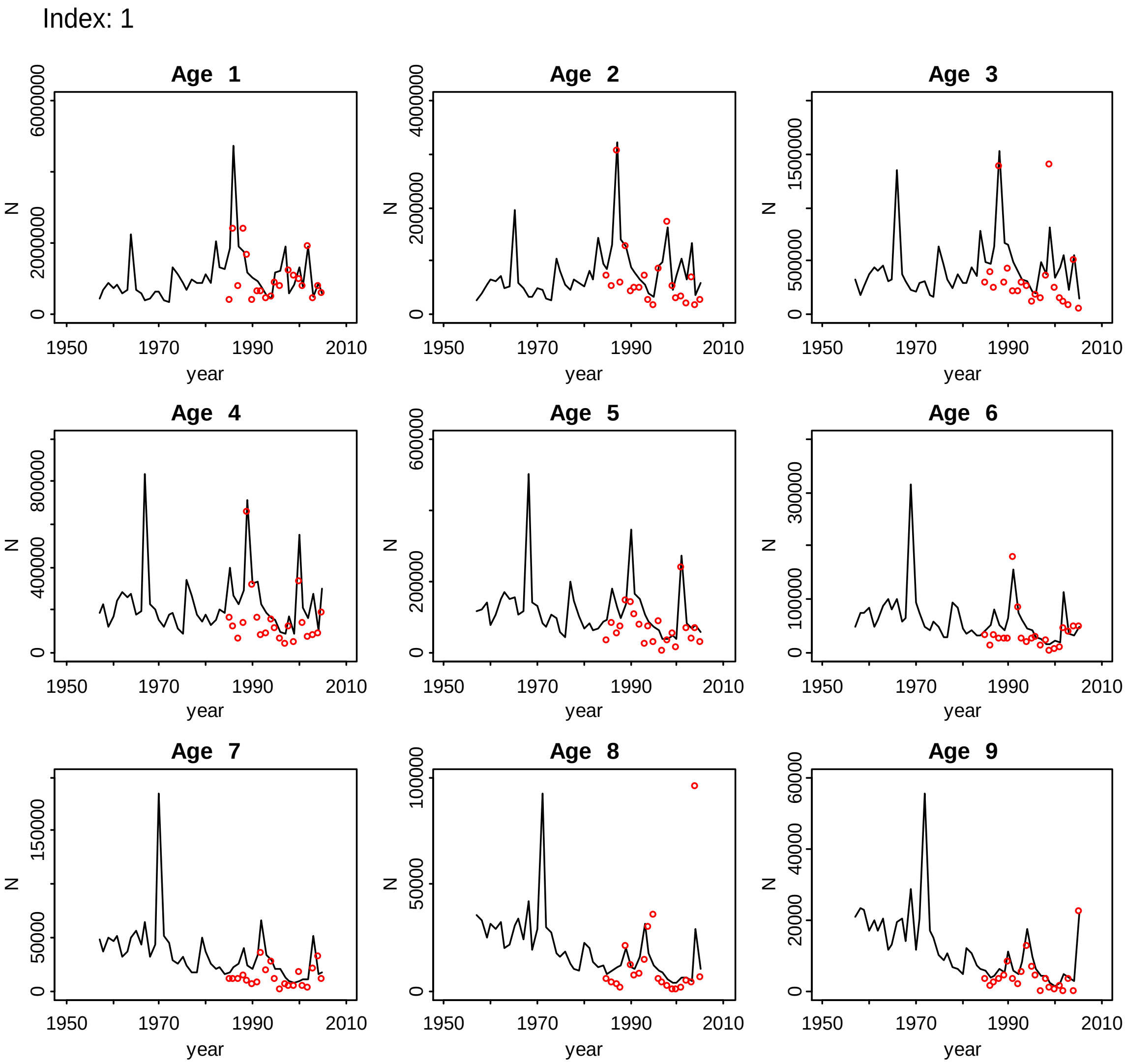


Figure 8.3.5.a. North Sea plaice. Time series of stock numbers from the XSA assessment (drawn line) and BTS-Isis survey data scaled to the population level (circles) by age.

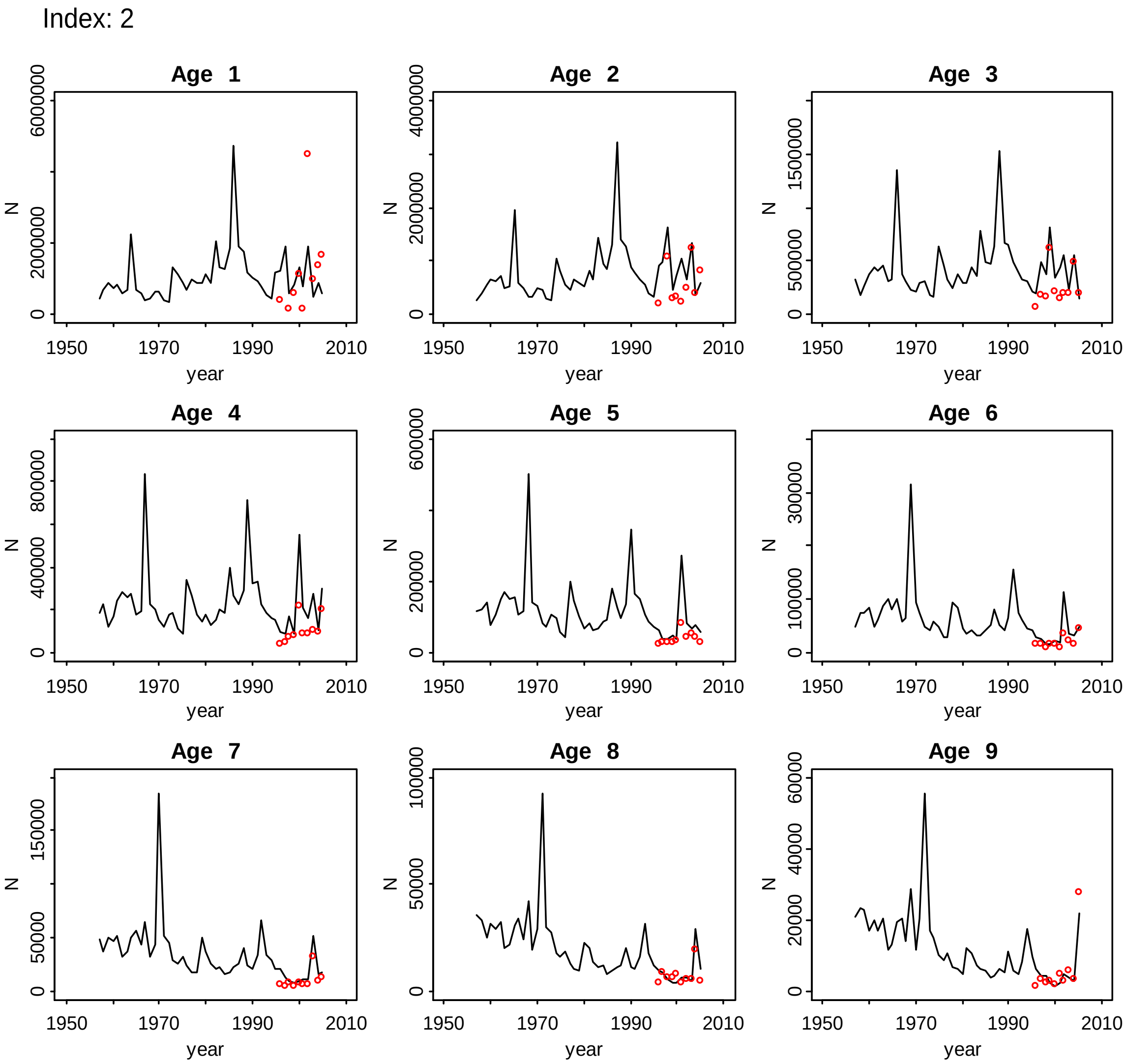


Figure 8.3.5.b. North Sea plaice. Time series of stock numbers from the XSA assessment (drawn line) and BTS-Tridens survey data scaled to the population level (circles) by age.

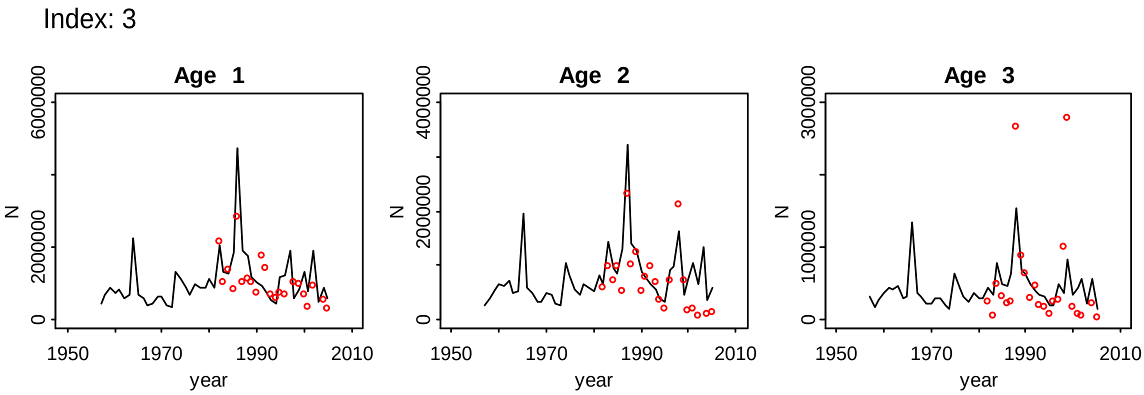


Figure 8.3.5.c. North Sea plaice. Time series of stock numbers from the XSA assessment (drawn line) and SNS survey data scaled to the population level (circles) by age.

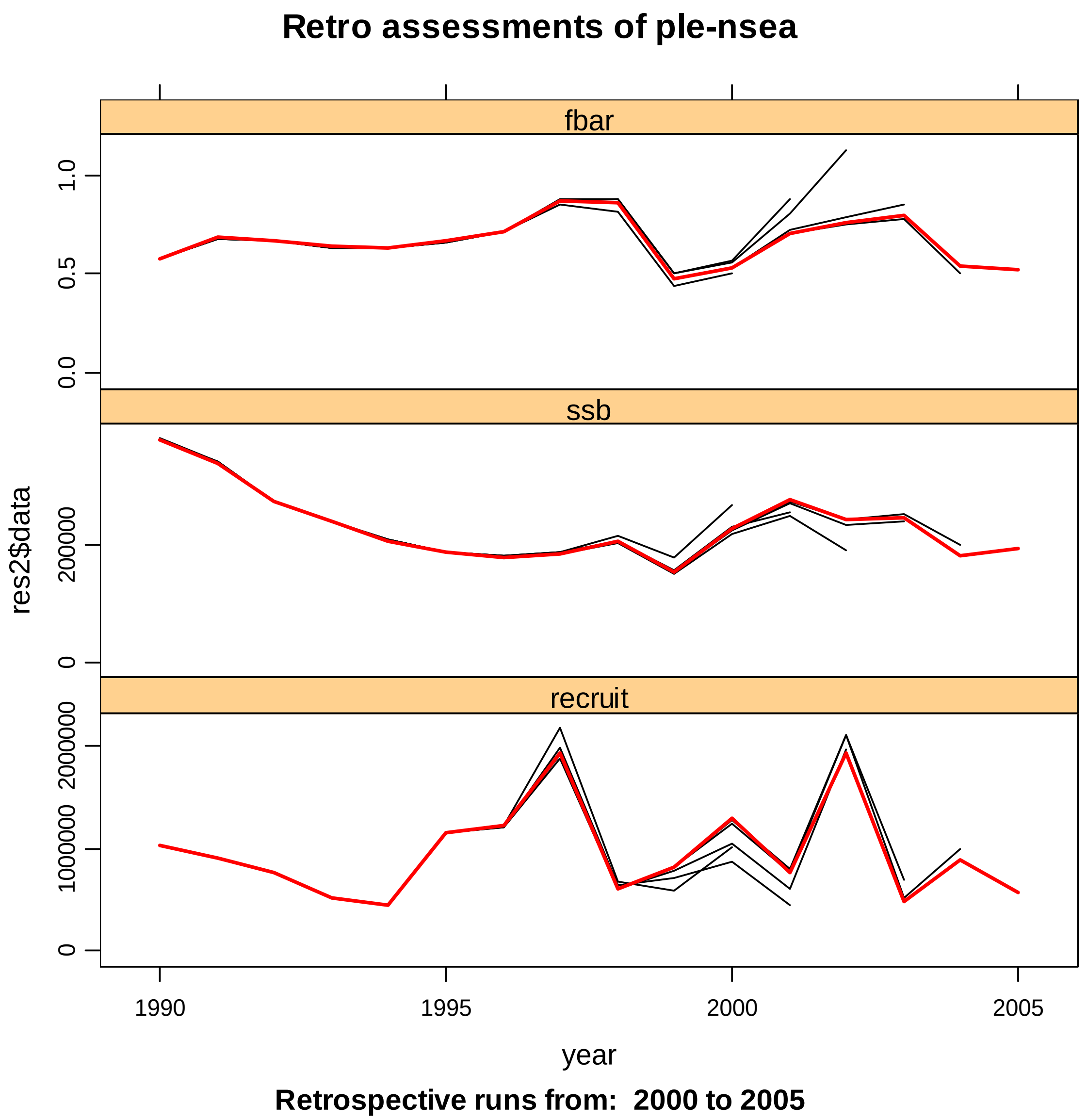


Figure 8.3.6. North Sea plaice. Retrospective analysis of the XSA model.

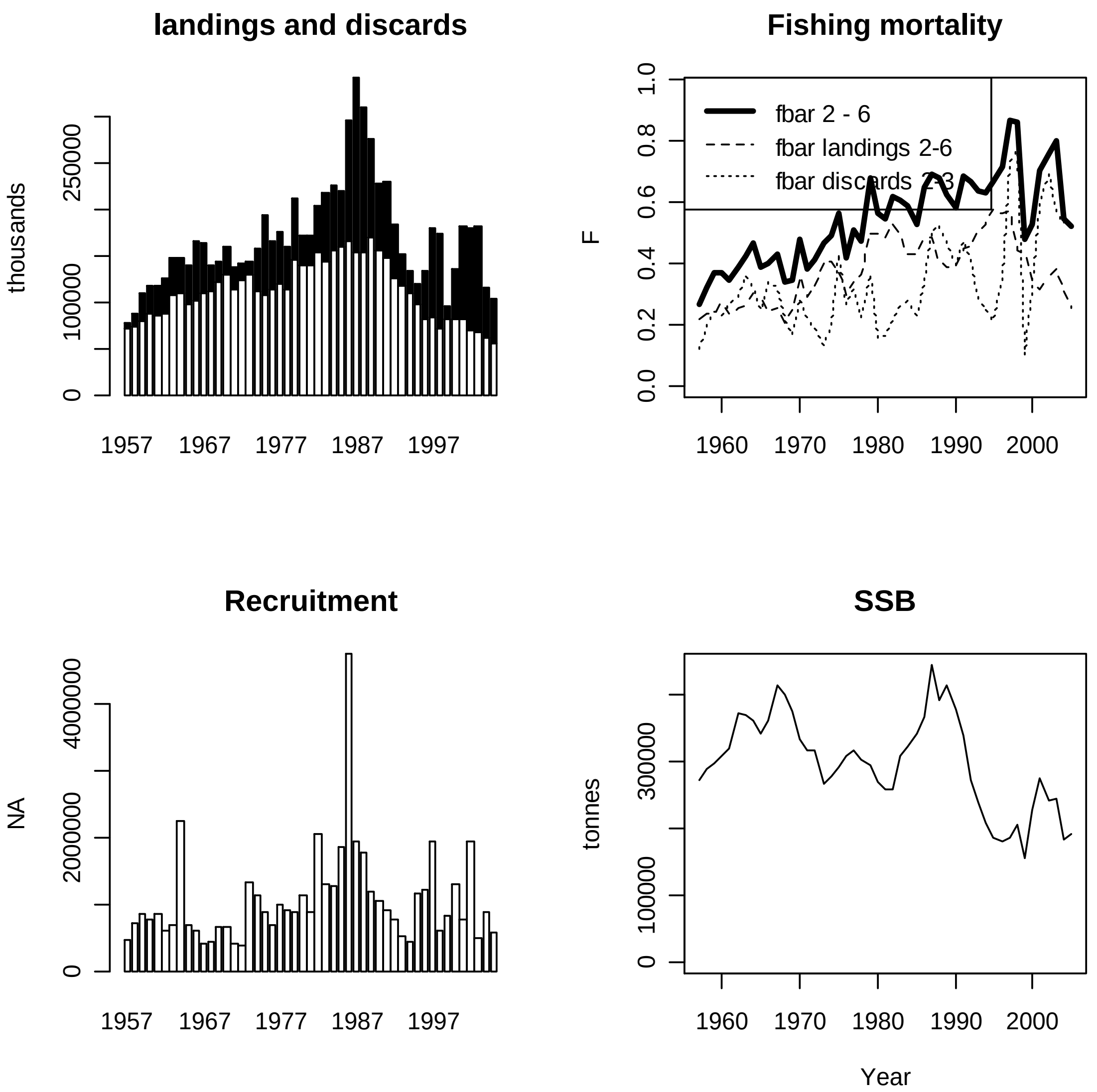


Figure 8.4.1. North Sea plaice. Stock summary of North Sea plaice. Recruitment is numbers at age 1.

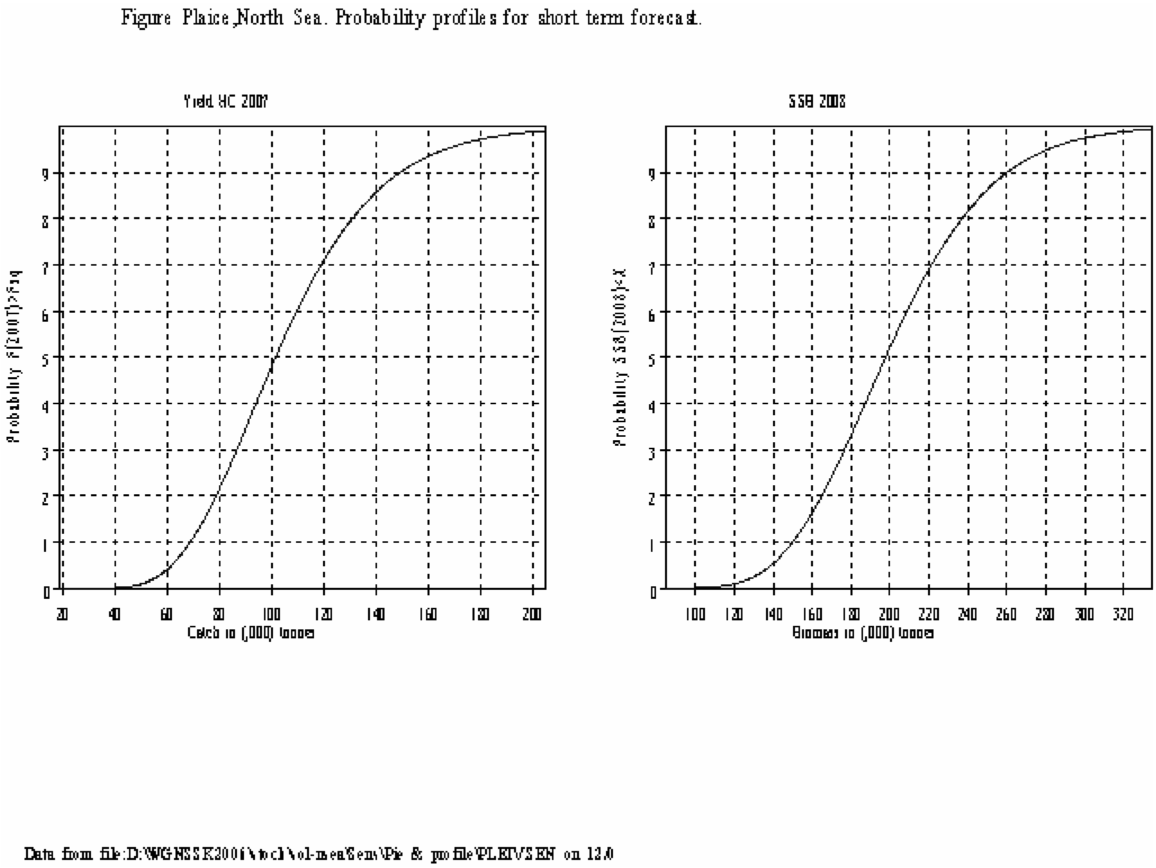


Figure 8.6.1. North Sea plaice. Sensitivity plot of the short-term forecast. Note that the in left panel on the x-axis is total catch and not landings as the heading suggests.

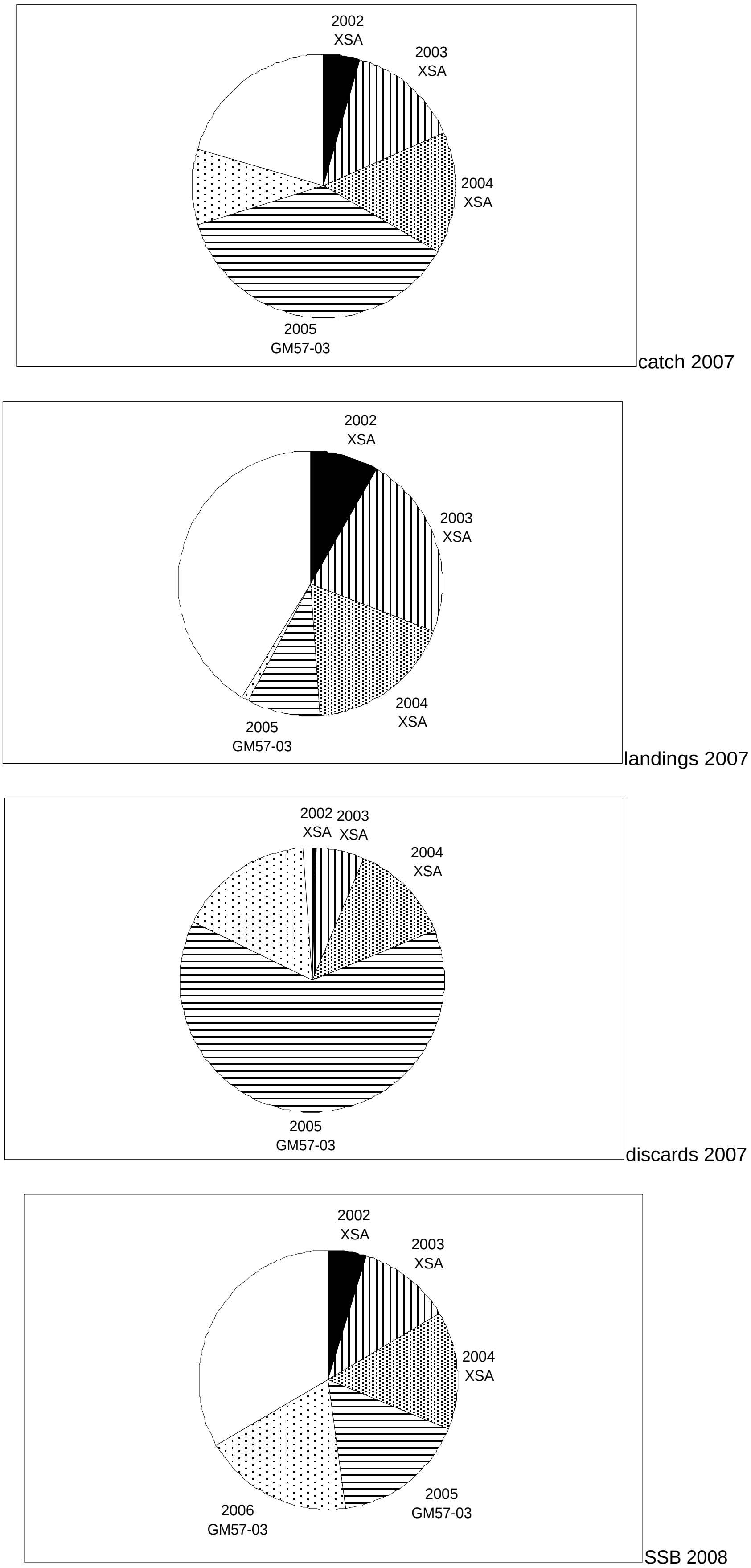


Figure 8.6.2. North Sea plaice. Projected composition of the catch (top), landings (second), and discards (third) in 2007 and the SSB (bottom) in 2008.

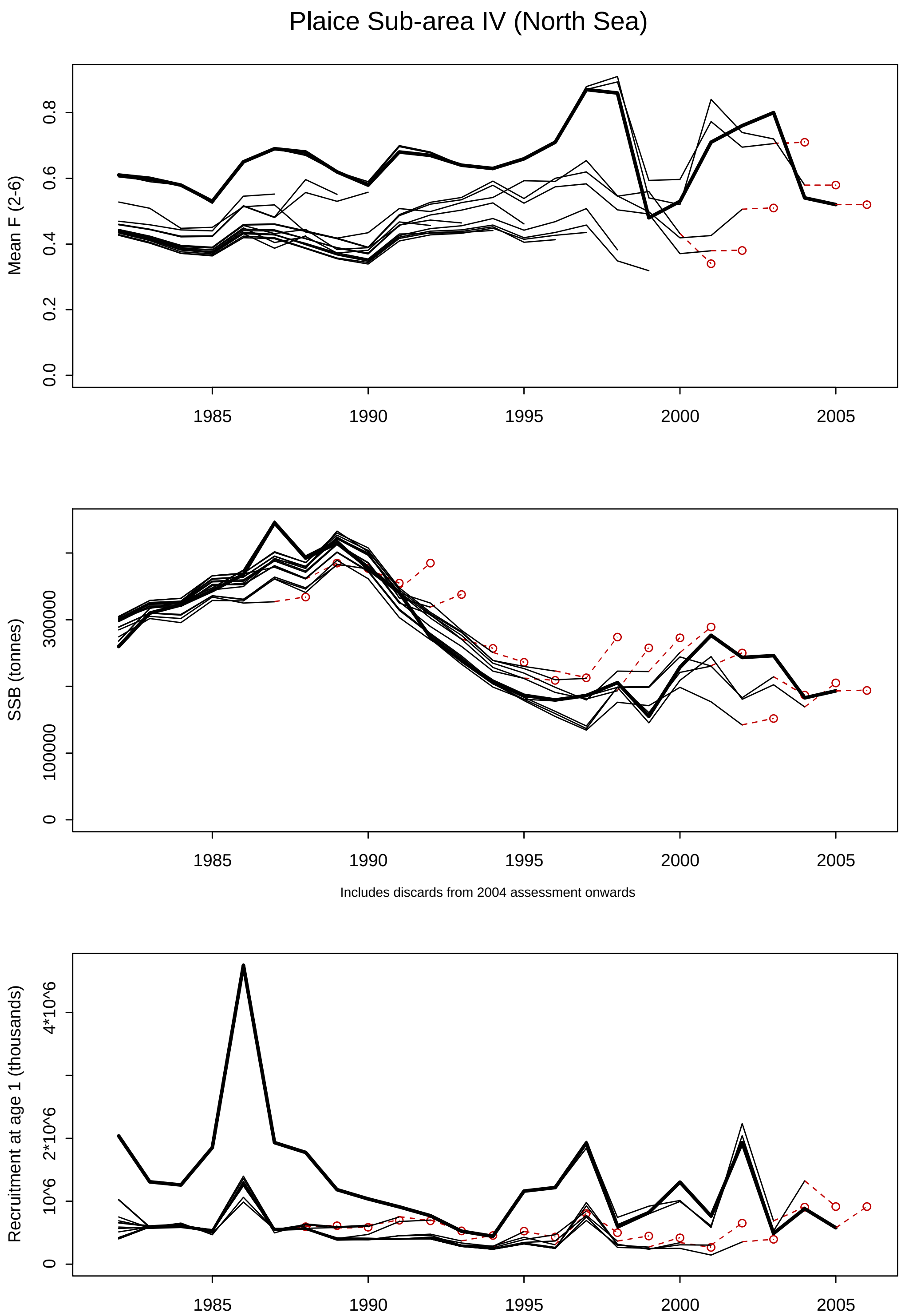


Figure 8.9.1. North Sea plaice. Historical performance of the assessment. Circles indicate forecasts.

Figure 8.11.1 North Sea plaice. Summary of the North Sea Fishers' Stock Survey results.

9 Sole in Sub-area VIId

The assessment of sole in sub-area VIId is presented here as an update assessment. Procedures and settings are the same as in last year's assessment. All the relevant biological and methodological information can be found in the Stock Annex (Q9) dealing with this stock. Here, only the basic input and output from the assessment model will be presented.

9.1 General

9.1.1 Ecosystem aspects

No information on ecosystem aspects was available to the Working Group.

9.1.2 Fisheries

A detailed description of the fishery can be found in the Stock Annex (Q9). It is likely that the high oil prices have had some impact on the fishing behavior of the Belgian and UK beam trawl fleets. For the French and UK inshore fleets however this will probably not be the case since they are constrained to the inshore areas. For the second consecutive year, neither France, Belgium nor UK was able to take up their 2005 quota (see section 9.2.1).

9.1.3 ICES advice

In the advice for both 2005 and 2006 ICES considered the stock as having full reproductive capacity and being harvested sustainably in 2005. For 2006 ICES classifies the stock at risk of being harvested unsustainably. ICES recommended that fishing mortality should be maintained below the proposed $F_{pa,}$ corresponding to landings of less than 5700t in 2005 and of less than 5720t in 2006.

Demersal fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2006 be managed according to the following rules, which should be applied simultaneously:

with minimal bycatch or discards of cod;

Implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised;

within the precautionary exploitation limits for all other stocks;

Where stocks extend beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits.

With minimum by-catch of spurdog, porbeagle and thornback ray and skate.

Mixed fisheries management options should be based on the expected catch in specific combinations of effort in the various fisheries taking into consideration the advice given above. The distributions of effort across fisheries should be responsive to objectives set by managers, which is also the basis for the scientific advice presented above.

9.1.4 Management

Management of sole in VIId is by TAC and technical measures. The agreed TACs in 2005 and 2006 are 5700t and 5720t respectively. Technical measures in force for this stock are minimum mesh sizes, minimum landing size. The minimum landing size for sole is 24cm. Demersal gears permitted to catch sole are 80mm for beam trawling and 80mm for otter trawlers. Fixed nets are required to use 100mm mesh since 2002 although an exemption to permit 90mm has been in force since that time.

EU regulation enforced in 2005 is a limitation of 22 days at sea per month for trawlers with mesh size less than 99 mm and 14 days at sea for beam trawlers. Gill-netters have a derogation of 20 days at sea in the Eastern Channel provided that their mesh size is less than 110 mm.

For 2006 Council Regulation (EC) N°51/2006 allocates different days at sea depending on gear, mesh size and catch composition. (see section 1.2.1 for complete list). The days at sea limitations for the major fleets operating in sub-area VIId could be summarised as follow: Trawls or Danish seines can fish between 103 and unlimited days per year. Beam trawlers have an unlimited number of days permit. Gillnets are allowed to fish 140 days per year and Trammel nets between 140 and 205 days.

9.2 Data available

9.2.1 Catch

The 2005 landings used by the Working Group were 4434t which is 22% below the agreed TAC of 5700t and 26% below the predicted landings at a status quo fishing mortality in 2005 (5992t). The contribution of France, Belgium and the UK to the landings in 2005 is 57%, 29% and 13% respectively. (Table 9.2.1).

Landing data reported to ICES are shown in Table 9.2.1 together with the total landings estimated by the Working Group. As in last year’s assessment, misreporting by UK beam trawlers from Division VIIe into VIId has been taken into account and corrected accordingly. It should be noted that there is also thought to be a considerable under-reporting by small vessels, which take up a substantial part of the landings in the eastern Channel. It has not been possible to quantify the level of these for inclusion in the assessment. However, misreporting is thought to be stable through time and will therefore not bias relative indicators of stock status.

Recent discard estimates are available for the UK static gear, several French inshore netting and trawl gear, and from the Belgian beam trawler fleet (Figure 9.2.1a-c). Numbers are raised to the sampled trips. In some trips, discarding up to 47% in numbers and 30% in weight has been measured, however, these high percentages depend on the fishing practice of certain vessels. There is some evidence that these high discarding percentages are attained when “blinders” are used. Average percentages drop to 5% in numbers and 4% in weight if no “blinders” are used (Figure 9.2.1d). The Working Group was not able to quantify the use of “blinders” in the different fisheries and therefore decided not to include discards in the assessment because in general discards for this high valued species are not substantial.

9.2.2 Age compositions

Quarterly data for 2005 were available for landing numbers and weight at age, for the French, Belgian, and UK fleets. These comprise around 99% of the international landings. Age compositions of the landings are presented in Table 9.2.2.

9.2.3 Weight at age

Weight at age in the landings is presented in Table 9.2.3 and weight at age in the stock in Table 9.2.4. The procedure for calculating mean weights is described in the Stock Annex (Q9).

Sampling levels for those countries providing age compositions are given in Table 1.3.1.

9.2.4 Maturity and natural mortality

As in previous assessments, a knife-edged maturity-ogive was used at age 3. Natural mortality are assumed at fixed values (0.1) for all ages and years.

9.2.5 Catch, effort and research vessel data

Available estimates of effort and LPUE are presented in Tables 9.2.5a,b and Figures 9.2.2a,b. Effort for the Belgian beam trawl fleet has increased to its highest level in 2003. Although it decreased in 2004 and 2005, it is still at one of the highest values in the time series. The UK (E&W) beam trawl fleet increased from the late 80's, reaching its peak in 1997. Since then, effort has decreased and fluctuated around 60% of its peak level. LPUE for both UK (E&W) and Belgian beam trawl fleets have been increasing gradually since the late 1990s (Figure 9.2.2b).

Survey and commercial data used for calibration of the assessment are presented in Table 9.2.6.

9.3 Data analyses

9.3.1 Reviews of last year's assessment

The ACFM Review Group noted that "recruitment estimates are quite inconsistent from one assessment to the next, but couldn't understand why as these are all driven by the YFS survey. Otherwise, the RG did not have time to carry out an in-depth review".

The Working Group agreed that the YFS survey is the main contributor to the survivor estimates (around 80% of age 1) and noted that this year's revision of the 2003 value for age 1 will revise the final recruitment estimate for that year (see retrospective plot: Figure 9.3.4).

9.3.2 Exploratory catch at age analysis

Catch at age analysis was carried out according to the specifications in the Stock Annex (Q9). The model used was XSA. The results of exploratory XSA runs, which are not included in this report, are available in ICES files.

A preliminary inspection of the quality of international catch-at-age data was carried out using separable VPA with a reference age of 4, terminal F=0.5 and terminal S=0.8. As last year, the log-catch ratios for the fully recruited ages (3-10) did not show any patterns or large residuals.

The tuning data were examined for trends in catchability by carrying out XSA tuning runs (lightly shrunk (se=2.0), mean q model for all ages, full time series and un-tapered), using data for each of the four fleets individually. Apart from the first few year's in the Belgian series (1982-1985, which were excluded from the analyses, as in previous assessments), there were no strong trends for any of the fleets. The Belgian beam trawl fleet had a somewhat noisier log catchability residual pattern, especially for age 2 and age 11. Year effects were noted for the UK(E&W) beam trawl fleet (UK-BT) and the UK(E&W) beam trawl survey (UK-BTS) in 1999 and 2000. The residuals of both commercial fleets (BEL-BT and UK-BT) also show a year effect in 2005 but in opposite directions.

The catchability residuals for the proposed final XSA are shown in Figure 9.3.1 and the XSA tuning diagnostics are given in Table 9.3.1. In general, estimates between fleets are consistent for ages 3 and above. The Belgian beam trawl fleet gave lower estimates for ages 3 to 7, compared to the other fleets. For age 1, 96% of the survivors estimates are coming from the surveys (Young fish survey (YFS) and UK(E&W) beam trawl survey giving 80% and 16% respectively of the weighting). F shrinkage gets low weights for all ages (< 4%).

9.3.3 Exploratory survey-based analyses

Last year, exploratory SURBA-runs (v3.0) were carried out on the UK(E&W) Beam-trawl Survey (UK-BTS) (1988-2004) and the International Young Fish Survey (1988-2004) to investigate whether the surveys-only analysis suggests different trends in Recruitment, SSB and fishing mortality. From the diagnostics on Mean Z, it was concluded that the surveys could not estimate any trend in fishing mortality. Given also that the SSB and recruitment trends from both XSA and SURBA runs showed similar patterns, the Working Group decided last year to accept the XSA as the final assessment.

Taken into account the above, the Working Group decided not to do a SURBA analyses this year.

9.3.4 Conclusion drawn from exploratory analyses

The XSA analyses was taken as the final assessment, giving consistent survivor estimates between fleets for ages 2 to 11. The estimates of recruiting age 1 (year class 2004) are for both surveys the highest values in the time series, indications of a strong 2004 year class (Figure 9.3.2).

9.3.5 Final assessment

The final settings used in this year's assessment are the same as in last year's assessment and are detailed below:

	2005 ASSESSMENT			**2006 ASSESSMENT**		
Fleets	Years	Ages	α-β	Years	Ages	α-β
BEL-BT commercial	86-04	2-10	0-1	86-05	2-10	0-1
UK-BT commercial	86-04	2-10	0-1	86-05	2-10	0-1
UK-BTS survey	88-04	1-6	0.5-0.75	88-05	1-6	0.5-0.75
YFS – survey	87-04	1-1	0.5-0.75	87-05	1-1	0.5-0.75
-First data year	1982			1982		
-Last data year	2004			2005		
-First age -Last age	1 11+			1 11+		
Time series weights	None			None		
-Model	No Power model			No Power model		
-Q plateau set at age	7			7		
-Survivors estimates shrunk towards mean F	5 years / 5 ages			5 years / 5 ages		
-s.e. of the means	2.0			2.0		
-Min s.e. for pop. Estimates	0.3			0.3		
-Prior weighting	None			None		

The final XSA output is given in Table 9.3.2 (fishing mortalities) and Table 9.3.3 (stock numbers). A summary of the XSA results is given in Table 9.3.4 and trends in yield, fishing mortality, recruitment and spawning stock biomass are shown in Figure 9.3.3.

Retrospective patterns for the final run are shown in Figure 9.3.4. There is a tendency to underestimate fishing mortality and overestimate SSB.

9.4 Historical Stock Trends

Trends in landings, SSB, F(3-8) and recruitment are presented Table 9.3.4 and Figure 9.3.3.

For most of the time series, fishing mortality has been fluctuating between Fpa (0.4) and Flim (0.57). In the early 1990s it dropped below Fpa. Since 1999 it has decreased steadily from 0.59 to around 0.4.

Recruitment has fluctuated around 26 million recruits with occasional strong year classes. The two highest values in the time series have been recorded in the last 4 years.

The spawning stock biomass has been stable for most of the time series. Since 2001 SSB has increased due to average and above average year classes to well above Bpa (8000 t).

9.5 Recruitment estimates

For this year's assessment the WG, as last year, did not use the RCT3 estimates for predictions, but the final XSA survivors-estimates.

The 2003 year class in 2004 was estimated by XSA to be around average with 26 million fish at age 1. 98% of the weight estimate comes from the tuning fleets, giving rather similar results. The XSA survivor estimates for this year class were used for further prediction.

The 2004 year class in 2005 was estimated by XSA to be 65 million one year olds, which is the highest in the time series. F shrinkage only gets 3% of the weight; the other 97% is coming from the surveys. The XSA survivor estimates for this year class were used for further prediction.

The long term GM recruitment (23 million, 1982-2003) was assumed for the 2005 and subsequent year classes.

For comparison, RCT3 runs were carried out. Input to the RCT3 model is given in Table 9.5.1 and results are presented in Table 9.5.2 and Table 9.5.3. However RCT3 estimates were not taken forward into predictions since they performed poorly in recent assessments and XSA estimates were not influenced by shrinkage. Although the RCT3 results are not used for prediction, it should be noted that the Young fish survey (YFS) at age 0 (not included in the XSA) confirms a strong 2004 year class.

The working group estimates of year class strength used for prediction can be summarised as follows:

YEAR CLASS	AT AGE IN 2006	XSA	GM 82-03	RCT3	ACCEPTED ESTIMATE
2003	3	17273	15273	-	XSA
2004	2	58953	20490	37588	XSA
2005	1	-	23000	23790	GM 1982-03
2006 & 2007	recruits	-	23000	-	GM 1982-03

9.6 Short term forecasts

The short term prognosis was carried out according to the specifications in the Stock Annex (Q9). As fishing mortality has stabilised in the last five years, the selection pattern for prediction has been taken as an unscaled 3-year average. Weights at age in the catch and in the stock are averages for the years 2003-2005.

Input to the short term predictions and the sensitivity analysis are presented in Table 9.6.1. Results are presented in Table 9.6.2 (management options) and Table 9.6.3 (detailed output).

Assuming *status quo* F, implies a catch in 2006 of 6060t (the agreed TAC is 5720t) and a catch of 6220t in 2007. Assuming *status quo* F will result in a SSB in 2007 and 2008 of 16830t and 14930t respectively.

Assuming *status quo* F, the proportional contributions of recent year classes to the landings in 2007 and SSB in 2008 are given in Table 9.6.4. The assumed GM recruitment accounts for 18 % of the landings in 2007 and 19 % of the 2008 SSB.

Results of a sensitivity analysis are presented in Figure 9.6.1 (probability profiles). The approximate 90% confidence intervals of the expected status quo yield in 2007 are 4500t and

8250t. There is a less than 5% probability that at current fishing mortality SSB will fall below the B_{pa} of 8000t in 2008.

9.7 Medium-term forecasts and Yield per recruit analyses

This year, no medium-term forecasts were carried out for this stock.

Yield-per-recruit results, long-term yield and SSB, conditional on the present exploitation pattern and assuming *status quo* F in 2006, are given in Table 9.7.1 and Figure 9.7.1 (program used: MFYPR). F_{max} is estimated to be 0.30 (0.38 = F_{sq}). Long term yield and SSB (using GM recruitment and F_{sq}) are estimated to be 3900t and 9900t respectively.

9.8 Biological reference points

		BASIS
Flim	0.55	Fishing mortality at or above which the stock has shown continued decline.
Fpa	0.40	F is considered to provide approximately 95% probability of avoiding Flim
Blim	-	Not defined
Bpa	8000	Lowest observed biomass at which there is no indication of impaired recruitment.
Fmax	0.30	
F2005	0.38	
Fsq	0.38	

9.9 Quality of the assessment

Sampling for sole in division VIId are considered to be at a reasonable level (Table 1.2.1).

In general discarding of sole is minor (5% in numbers and 4% in weight). It is unclear how the inclusion of discard data would affect the assessment results. There is some evidence that percentages up to 30% in weight have been measured is some observer trips when “blinders” were used.

The trends and estimates of fishing mortality, SSB and recruitment were consistent with last year’s assessment. The downward revision of the 2003 year class was mainly due to a revision of the Young Fish Survey index for that year class.

There is a tendency to underestimate fishing mortality and overestimate SSB.

Except year class 2002, all year classes from 1998 to 2004 are estimated to be at or above average which explains the increase in SSB since 1998. The 2004 year class is predicted to be the strongest in the time series by two survey indices in the assessment and confirmed by a third survey index (not used in XSA) as a strong year class.

There is no apparent stock/recruitment relationship for this stock and no evidence of reduced recruitment at low levels of SSB (Figure 9.9.1).

The historical performance of this assessment is rather noisy (Figure 9.9.2).

9.10 Status of the Stock

Fishing mortality has been stabilising for the last 5 years around Fpa. The spawning stock biomass has been stable for most of the time series and SSB is presently well above Bpa. The strong 2004 year class is predicted to increase SSB to a record high level of the time series in 2008.

9.11 Management Considerations

There is thought to be a significant misreporting into adjacent areas. The Working group has addressed this by modifying landings data.

Sole is taken in a beam-trawl fishery as part of a mixed demersal fishery. However, more than 50% of the reported landings come from small vessels (<10 m), using mainly fixed nets.

There is a high probability that SSB will remain above B_{pa} in the short term Figure 8.6.1 due to the strong 2004 year class.

EU Council Regulation (EC) N°51/2006 allocates different days at sea depending on gear, mesh size and catch composition. (see section 1.2.1 for complete list). The days at sea limitations for the major fleets operating in sub-area VIId could be summarised as follow: Trawls or Danish seines can fish between 103 and unlimited days per year. Beam trawlers have an unlimited number of days permit. Gillnets are allowed to fish 140 days per year and Trammel nets between 140 and 205 days. It is however unlikely that these effort limitations will restrict the effort on sole in sub-area VIId.

Table 9.2.1 Sole VIId. Nominal landings (tonnes) as officially reported to ICES and used by the Working Group

Year	Belgium	France		UK(E+W)	others	reported	Unallocated*	Total used by WG	TAC
1974	159	469		309	3	940	-56	884	
1975	132	464		244	1	841	41	882	
1976	203	599		404	.	1206	99	1305	
1977	225	737		315	.	1277	58	1335	
1978	241	782		366	.	1389	200	1589	
1979	311	1129		402	.	1842	373	2215	
1980	302	1075		159	.	1536	387	1923	
1981	464	1513		160	.	2137	340	2477	
1982	525	1828		317	4	2674	516	3190	
1983	502	1120		419	.	2041	1417	3458	
1984	592	1309		505	.	2406	1169	3575	
1985	568	2545		520	.	3633	204	3837	
1986	858	1528		551	.	2937	995	3932	
1987	1100	2086		655	.	3841	950	4791	3850
1988	667	2057		578	.	3302	551	3853	3850
1989	646	1610		689	.	2945	860	3805	3850
1990	996	1255		742	.	2993	654	3647	3850
1991	904	2054		825	.	3783	568	4351	3850
1992	891	2187		706	10	3794	278	4072	3500
1993	917	1907		610	13	3447	852	4299	3200
1994	940	2001		701	15	3657	726	4383	3800
1995	817	2248		669	9	3743	677	4420	3800
1996	899	2322		877	.	4098	699	4797	3500
1997	1306	1702		933	.	3941	823	4764	5230
1998	541	1703		803	.	3047	316	3363	5230
1999	880	2239		769	.	3888	247	4135	4700
2000	1021	2190		621	.	3832	-356	3476	4100
2001	1313	2482		822		4617	-592	4025	4600
2002	1643	2780		976		5399	-666	4733	5200
2003	1659	2898		1114	1	5672	-634	5038	5400
2004	1465	2734	***	1102		5300	-474	4826	5900
2005	1217	2365	**	558		4140	294	4434	5700

* Unallocated mainly due misreporting

** Preliminary

*** Data provided to the WG but not officially provided to ICES

Table 9.2.2 - Sole VIId - Landing numbers at age (kg)

Run title : Sole in VIId - 2006WG

At 5/09/2006 9:34

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1982	1983	1984	1985
AGE				
1	155	0	24	49
2	2625	852	1977	3693
3	5256	3452	3157	5211
4	1727	3930	2610	1646
5	570	897	1900	1027
6	653	735	742	1860
7	549	627	457	144
8	240	333	317	158
9	122	108	136	156
10	83	89	99	69
+gp	202	193	238	128
0 TOTALNUM	12182	11216	11657	14141
TONSLAND	3190	3458	3575	3837
SOPCOF %	97	99	99	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
1	49	9	95	163	1245	383	105	85	31	838
2	1251	3117	2162	3484	2851	7166	4046	5028	694	2977
3	5296	3730	7174	3220	5580	4105	8789	6442	6203	4375
4	3195	3271	1602	4399	1151	4160	1888	5444	5902	4765
5	904	2053	1159	1434	1496	604	1993	1008	3404	2968
6	768	1042	856	840	301	996	288	563	584	1980
7	1056	1090	388	571	390	257	368	162	567	375
8	155	784	255	201	260	247	135	188	109	278
9	190	111	256	166	129	258	171	116	147	88
10	212	163	83	224	126	92	95	62	93	106
+gp	372	459	275	282	489	382	231	129	258	241
0 TOTALNUM	13448	15829	14305	14984	14018	18650	18109	19227	17992	18991
TONSLAND	3932	4791	3853	3805	3647	4351	4072	4299	4383	4420
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
1	9	24	33	168	138	168	707	379	1030	195
2	1825	1489	1376	3268	3586	6042	7011	10957	4254	3398
3	7764	6068	5609	8506	4852	6194	7513	5086	8623	4088
4	3035	5008	2704	3307	4395	1595	3767	3178	2545	5533
5	3206	2082	1636	1311	1076	2491	1414	1805	2272	1576
6	1823	1670	609	869	505	728	655	671	1108	1145
7	1283	916	558	350	319	290	298	588	371	642
8	271	775	441	672	148	128	129	198	448	225
9	319	239	354	351	328	56	97	70	94	284
10	112	169	239	192	150	81	57	88	88	129
+gp	344	267	301	359	248	265	197	245	233	273
0 TOTALNUM	19991	18707	13860	19353	15745	18038	21845	23265	21066	17488
TONSLAND	4797	4764	3363	4135	3476	4025	4733	5038	4826	4434
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 9.2.3 - Sole VIId - Landings weights at age (kg)

Run title : Sole in VIId - 2006WG

At 5/09/2006 9:34

Table 2 Catch weights at age (kg)

YEAR	1982	1983	1984	1985
AGE				
1	0.102	0	0.1	0.09
2	0.171	0.173	0.178	0.182
3	0.225	0.23	0.234	0.23
4	0.312	0.302	0.314	0.281
5	0.386	0.404	0.38	0.368
6	0.428	0.436	0.436	0.394
7	0.439	0.435	0.417	0.516
8	0.509	0.524	0.538	0.543
9	0.502	0.537	0.529	0.594
10	0.463	0.583	0.565	0.595
+gp	0.6729	0.6283	0.7135	0.8005
0 SOPCOFAC	0.9713	0.991	0.9884	0.998

Table 2 Catch weights at age (kg)

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
1	0.135	0.095	0.102	0.106	0.12	0.114	0.103	0.085	0.099	0.129
2	0.18	0.175	0.152	0.154	0.178	0.161	0.153	0.147	0.15	0.176
3	0.212	0.236	0.226	0.192	0.238	0.208	0.203	0.197	0.186	0.179
4	0.306	0.295	0.278	0.271	0.289	0.266	0.267	0.247	0.235	0.23
5	0.363	0.353	0.36	0.293	0.349	0.354	0.29	0.335	0.288	0.255
6	0.387	0.407	0.409	0.358	0.339	0.394	0.403	0.384	0.355	0.333
7	0.437	0.411	0.459	0.388	0.47	0.421	0.391	0.537	0.381	0.357
8	0.52	0.482	0.514	0.472	0.465	0.43	0.462	0.553	0.505	0.385
9	0.502	0.465	0.553	0.515	0.487	0.434	0.459	0.515	0.484	0.49
10	0.523	0.538	0.563	0.547	0.518	0.478	0.463	0.766	0.496	0.494
+gp	0.6015	0.6176	0.6647	0.7014	0.5621	0.5656	0.5661	0.6666	0.6156	0.6536
0 SOPCOFAC	1.0006	1.0004	1.0001	0.9994	0.9995	1.0001	1.0001	1.0002	1.0001	0.9997

Table 2 Catch weights at age (kg)

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
1	0.142	0.139	0.132	0.13	0.145	0.108	0.12	0.114	0.12	0.136
2	0.165	0.153	0.159	0.151	0.142	0.152	0.162	0.17	0.179	0.173
3	0.178	0.188	0.172	0.189	0.176	0.211	0.204	0.208	0.205	0.209
4	0.229	0.233	0.235	0.215	0.223	0.283	0.253	0.257	0.255	0.254
5	0.269	0.292	0.286	0.26	0.332	0.288	0.316	0.277	0.296	0.304
6	0.324	0.343	0.343	0.28	0.377	0.334	0.375	0.357	0.304	0.338
7	0.361	0.39	0.383	0.29	0.424	0.367	0.376	0.381	0.348	0.369
8	0.405	0.404	0.417	0.341	0.427	0.374	0.393	0.438	0.403	0.419
9	0.435	0.503	0.484	0.358	0.384	0.493	0.469	0.482	0.492	0.559
10	0.465	0.474	0.435	0.374	0.459	0.511	0.42	0.494	0.509	0.439
+gp	0.5854	0.6509	0.6162	0.5354	0.68	0.5445	0.5308	0.5274	0.525	0.5323
0 SOPCOFAC	0.9999	1	1.0013	0.9992	1.0009	1.0005	0.9995	1.0002	0.9983	1.0004

Table 9.2.4 - Sole VIId - Stock weights at age (kg)

Run title : Sole in VIId - 2006WG

At 5/09/2006 9:34

Table 3 Stock weights at age (kg)

YEAR	1982	1983	1984	1985
AGE				
1	0.059	0.07	0.067	0.065
2	0.114	0.135	0.131	0.129
3	0.167	0.197	0.192	0.192
4	0.217	0.255	0.249	0.254
5	0.263	0.309	0.304	0.315
6	0.306	0.359	0.355	0.376
7	0.347	0.406	0.403	0.436
8	0.384	0.448	0.448	0.495
9	0.418	0.487	0.49	0.554
10	0.45	0.522	0.529	0.611
+gp	0.53	0.6008	0.6265	0.7798

Table 3 Stock weights at age (kg)

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
1	0.07	0.072	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
2	0.136	0.139	0.145	0.113	0.138	0.138	0.144	0.13	0.116	0.126
3	0.198	0.203	0.223	0.182	0.232	0.225	0.199	0.189	0.161	0.129
4	0.256	0.262	0.268	0.269	0.305	0.279	0.277	0.246	0.215	0.22
5	0.309	0.318	0.365	0.323	0.4	0.38	0.305	0.366	0.273	0.234
6	0.358	0.37	0.425	0.335	0.361	0.384	0.454	0.377	0.316	0.333
7	0.403	0.417	0.477	0.48	0.476	0.41	0.405	0.545	0.368	0.357
8	0.443	0.461	0.498	0.504	0.535	0.449	0.459	0.56	0.53	0.33
9	0.48	0.5	0.572	0.586	0.571	0.474	0.43	0.559	0.461	0.614
10	0.512	0.536	0.636	0.536	0.507	0.451	0.528	0.813	0.47	0.382
+gp	0.5761	0.6156	0.7498	0.7135	0.5765	0.6203	0.5269	0.5664	0.6122	0.6292

Table 3 Stock weights at age (kg)

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
2	0.155	0.139	0.14	0.128	0.122	0.127	0.136	0.151	0.137	0.16
3	0.176	0.165	0.158	0.18	0.148	0.157	0.179	0.207	0.185	0.206
4	0.258	0.22	0.233	0.205	0.208	0.216	0.209	0.249	0.236	0.247
5	0.286	0.264	0.299	0.253	0.402	0.226	0.258	0.314	0.265	0.274
6	0.308	0.317	0.374	0.277	0.44	0.223	0.254	0.376	0.267	0.313
7	0.366	0.376	0.363	0.298	0.395	0.231	0.301	0.399	0.273	0.356
8	0.391	0.404	0.357	0.324	0.554	0.253	0.234	0.418	0.331	0.403
9	0.438	0.563	0.45	0.336	0.443	0.256	0.326	0.446	0.504	0.608
10	0.466	0.494	0.372	0.323	0.42	0.301	0.404	0.444	0.409	0.425
+gp	0.6304	0.6536	0.5768	0.5118	0.6822	0.4204	0.417	0.5032	0.4501	0.5595

Table 9.2.5a **Sole in VIId. Indices of effort**

Year	France Beam trawl[1]	England & Wales Beam trawl[2]	Belgium Beam trawl[3]
1971			
1972			
1973			
1974			
1975			5.02
1976			6.56
1977			6.87
1978			8.22
1979			7.30
1980			12.81
1981			19.00
1982			23.94
1983			23.64
1984			28.00
1985			25.29
1986		2.79	23.54
1987		5.64	27.11
1988		5.09	38.52
1989		5.65	35.67
1990		7.27	30.33
1991	10.69	7.67	24.29
1992	10.52	8.78	21.99
1993	10.22	6.40	20.02
1994	10.61	5.43	25.17
1995	12.38	6.89	24.17
1996	14.09	10.31	25.00
1997	10.92	10.25	30.89
1998	11.71	7.31	18.12
1999	10.63	5.86	21.39
2000	13.78	5.65	30.54
2001	11.38	7.64	32.39
2002		7.90	33.68
2003		6.69	47.50
2004		4.90	41.60
2005		5.90	35.80

[1]in Kg/1000 h*KW-04

[1] Beam trawl >= 10m in millions hp hrs >10% sole

[3]Fishing hours (x 10^3) corrected for fishing power using P = 0.000204 BHP^1.23

Table 9.2.5b Sole in VIId. LPUE indices

Year	France[1] Beam trawl	England & Wales[2] Beam trawl	Belgium[3] Beam trawl
1971			
1972			
1973			
1974			
1975			24.09
1976			27.28
1977			29.99
1978			26.27
1979			37.42
1980			23.26
1981			24.52
1982			23.65
1983			22.37
1984			21.61
1985			22.90
1986		39.48	33.48
1987		32.82	36.56
1988		27.67	15.89
1989		26.59	16.82
1990		26.88	25.94
1991	18.52	22.09	22.56
1992	18.12	25.29	29.11
1993	21.60	23.75	34.77
1994	17.78	31.83	27.89
1995	18.46	28.39	24.70
1996	19.79	25.79	29.80
1997	14.41	25.40	32.57
1998	17.33	25.71	23.51
1999	30.4	27.29	26.41
2000	19.1	27.46	24.49
2001	46.1	26.58	24.58
2002		31.63	27.33
2003		32.81	33.13
2004		38.80	30.86
2005		41.30	31.97

[1] in h*KW-04

[2] in Kg/1000 HP*HRS >10% sole

[3] in Kg/hr corrected for fishing power using P = 0.000204 BHP^1.23

Table 9.2.6 - Sole VIId - tuning files

Bolded numbers = used in XSA

SOLE	7d,TUNING													
104	1													
BEL	BT													
1980	2005													
1	1	0	1											
2	15													
12.8	69.3	46.1	298.7	189.6	57.4	24.7	10.3	5.1	8.6	3.1	5.5	2.4	2.6	37.9
19.0	640.7	161.4	82.1	312.8	229.6	44.7	32.9	33.1	6.9	9.0	18.4	9.3	0.8	51.9
23.9	148.7	980.9	128.0	93.4	155.9	112.6	38.8	60.1	15.2	14.0	7.4	12.5	5.9	54.3
23.6	190.4	373.0	818.9	65.5	54.0	81.7	73.2	23.5	20.2	27.0	5.0	1.0	7.1	33.0
28.0	603.8	347.2	311.2	436.0	53.7	38.5	104.9	59.9	25.4	23.2	25.3	9.0	8.2	42.4
25.3	382.9	612.1	213.0	209.1	260.2	58.2	34.1	48.0	31.0	16.9	19.6	9.2	7.7	21.3
23.4	215.0	1522.3	675.0	233.7	170.6	194.0	30.1	53.1	64.2	32.6	12.7	2.6	43.0	29.3
27.1	843.6	451.0	739.3	724.4	344.5	232.4	152.7	25.3	86.5	56.0	56.1	54.5	9.3	109.0
38.5	131.6	990.4	243.3	362.9	216.7	111.8	41.8	73.8	47.0	9.8	22.3	35.8	8.6	25.3
35.7	47.5	512.6	543.6	748.0	276.6	225.0	53.1	36.4	12.7	4.7	0.0	0.0	4.7	27.0
30.3	1011.4	1375.2	218.1	366.2	85.3	198.2	65.5	39.0	22.4	22.2	25.4	2.8	24.0	18.2
24.3	320.2	1358.6	710.1	125.6	283.9	60.6	56.2	21.0	19.8	22.2	18.0	5.6	0.3	21.4
22.0	499.3	1613.7	523.3	477.7	36.9	67.9	28.2	31.7	11.2	11.4	6.0	5.7	3.2	16.7
20.0	1654.5	1520.4	889.5	215.5	78.5	38.9	40.8	37.8	11.3	8.7	13.3	1.5	3.0	22.4
22.2	196.9	1183.2	1598.5	912.9	201.0	160.0	39.5	33.8	46.2	16.0	10.2	14.9	8.8	18.6
24.2	206.2	542.7	671.3	590.9	409.4	100.6	40.3	25.4	14.2	9.3	5.0	11.9	3.4	8.0
25.0	284.1	975.5	628.7	560.1	354.3	316.8	68.3	77.6	34.2	26.2	15.8	10.8	1.1	4.2
30.9	196.0	1282.3	966.1	500.2	422.3	301.1	144.7	56.6	29.3	25.8	12.1	12.6	3.4	1.4
18.1	254.1	450.3	375.4	175.1	54.8	116.1	95.9	59.1	12.4	16.0	7.7	2.9	4.4	19.2
21.4	367.7	1043.6	640.2	308.3	94.6	48.7	90.6	68.3	28.2	44.7	22.9	4.7	8.5	11.3
30.5	569.1	1170.7	1225.1	239.1	139.4	68.4	66.6	74.4	46.0	26.9	7.6	6.6	0.3	1.9
32.4	1055.5	1385.4	375.0	617.9	351.1	105.4	31.6	15.2	18.7	35.5	11.6	6.9	12.3	4.6
33.7	1267.7	1612.6	804.3	286.3	122.4	95.7	45.2	24.8	28.6	15.8	13.8	8.0	6.0	2.6
47.5	2157.2	1848.1	1368.5	737.0	395.3	191.8	97.9	15.0	47.9	33.5	30.8	37.9	0.0	1.2
41.6	959.7	1846.2	778.1	1050.9	331.1	82.3	93.5	30.7	51.2	22	34.8	0.7	8.3	0.7
35.8	1150.8	1156.5	1259.7	309.1	201.7	156.5	74.2	37.9	16.4	44.8	1.3	6.2	0.8	3.3
UK	BT													
1986	2005													
1	1	0	1											
2	15													
2.8	30.0	144.8	100.5	28.0	28.8	39.4	1.2	2.4	5.2	2.5	2.8	1.5	1.7	5.3
5.6	251.8	106.0	143.5	99.2	18.6	14.6	37.6	1.4	0.4	3.3	1.1	1.5	3.3	2.4
5.1	112.3	281.3	56.4	62.9	39.6	9.0	11.5	16.2	2.0	0.2	4.6	4.9	0.0	0.2
5.7	162.3	78.1	144.2	18.2	31.7	23.1	5.1	4.2	16.3	1.0	0.6	2.2	2.7	12.9
7.3	112.6	327.4	47.7	66.1	14.1	15.1	15.1	4.1	7.4	22.2	1.9	0.4	3.4	7.6
7.7	349.0	139.2	195.2	8.4	30.7	5.1	7.4	10.9	2.7	1.9	8.4	0.3	0.0	5.0
8.8	240.1	516.6	81.3	167.5	11.1	20.3	6.4	14.6	4.9	2.2	1.5	3.3	0.1	2.5
6.4	174.9	222.5	218.9	34.6	52.7	5.2	10.7	4.5	3.0	3.3	1.1	1.3	2.1	2.8
5.4	33.6	260.9	144.1	113.3	27.5	45.5	4.4	10.5	3.2	4.1	3.7	2.4	1.6	9.3
6.9	181.1	106.9	220.4	107.6	94.6	18.3	37.5	5.4	9.4	2.0	4.3	4.4	0.9	7.7
10.3	295.8	251.3	79.5	169.0	84.6	67.4	17.5	33.2	4.1	8.8	4.2	5.4	3.6	11.9
10.3	268.5	331.1	158.5	42.4	125.2	50.8	48.7	11.6	23.0	2.7	7.1	1.1	3.8	7.6
7.3	252.6	169.4	97.5	65.2	22.1	51.7	28.8	22.4	5.8	12.5	2.0	5.3	1.5	9.0
5.9	170.0	300.0	105.6	43.6	31.8	12.3	26.3	12.9	7.3	3.4	3.8	0.7	2.5	4.1
5.7	152.1	178.8	171.4	54.7	25.8	18.2	6.9	21.6	9.7	5.7	2.3	4.2	0.6	7.9
7.6	284.3	268.0	101.0	111.9	44.0	19.0	19.6	5.8	14.7	12.1	5.0	1.4	3.0	4.7
7.9	314.6	449.0	222.2	71.7	54.9	22.9	18.6	6.0	3.1	5.2	2.3	2.4	0.4	2.9
6.7	386.0	220.8	149.5	64.8	27.2	32.0	15.0	5.6	5.8	0.9	4.2	2.8	1.9	5.1
4.9	119.6	470.6	110.3	66.5	34.9	10.3	19.4	4.6	3.4	3.1	0.6	3.5	1.3	4.5
5.9	171.4	178.9	377.9	69.7	72.5	35.5	17.5	15.6	11.3	4.3	7.9	2.7	3.2	11.0
UK	BTS													
1988	2005													
1	1	0.5	0.75											
1	6													
1	8.20	14.20	9.90	0.80	1.30	0.60								
1	2.60	15.40	3.40	1.70	0.60	0.20								
1	12.10	3.70	3.40	0.70	0.80	0.20								
1	8.90	22.80	2.20	2.30	0.30	0.50								
1	1.40	12.00	10.00	0.70	1.10	0.30								
1	0.50	17.50	8.40	7.00	0.80	1.00								
1	4.80	3.20	8.30	3.30	3.30	0.20								
1	3.50	10.60	1.50	2.30	1.20	1.50								
1	3.50	7.30	3.80	0.70	1.30	0.90								
1	19.00	7.30	3.20	1.30	0.20	0.50								
1	2.00	21.20	2.50	1.00	0.90	0.10								
1	28.10	9.40	13.20	2.50	1.70	1.30								
1	10.49	22.03	4.15	4.24	1.03	0.58								
1	9.09	21.01	8.36	1.20	1.91	0.54								
1	31.76	11.42	5.42	3.45	0.27	0.71								
1	6.47	28.48	4.13	2.46	1.58	0.30								
1	7.35	8.49	7.71	1.57	1.45	0.99								
1	25	5.04	2.86	3.47	1.63	1.02								
YFS														
1981	2005													
1	1	0.5	0.75											
0	**1**													
1	1.88	0.20												
1	2.66	0.70												
1	11.89	-11												
1	-11.00	-11												
1	-11.00	-11												
1	-11.00	**0.66**												
1	8.00	**0.94**												
1	1.19	**0.36**												
1	12.59	**1.15**												
1	3.33	**1.87**												
1	1.39	**0.80**												
1	1.28	**0.62**												
1	6.53	**1.59**												
1	8.10	**1.46**												
1	5.31	**0.34**												
1	0.99	**0.52**												
1	1.94	**0.56**												
1	9.37	**0.85**												
1	2.75	**1.28**												
1	1.85	**0.84**												
1	4.51	**1.93**												
1	2.52	**0.82**												
1	2.16	**1.30**												
1	7.15	**2.28**												
1	4.51	-11.00												

Table 9.3.1 - Sole VIId - XSA diagnostics

Lowestoft VPA Version 3.1

5/09/2006 9:33

Extended Survivors Analysis

Sole in VIId - 2006WG

CPUE data from file Tun7d.txt

Catch data for 24 years. 1982 to 2005. Ages 1 to 11.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
BEL BT	1986	2005	2	10	0	1
UK BT	1986	2005	2	10	0	1
UK BTS	1988	2005	1	6	0.5	0.75
YFS	1987	2005	1	1	0.5	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 5 oldest ages.

S.E. of the mean to which the estimates are shrunk = 2.000

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning had not converged after 30 iterations

Total absolute residual between iterations
29 and 30 = .00954

Final year F values

Age	1	2	3	4	5	6	7	8	9	10
Iteration 29	0.0031	0.1716	0.4	0.3672	0.4192	0.321	0.3799	0.3989	0.4072	0.3916
Iteration 30	0.0031	0.1716	0.3998	0.3669	0.4186	0.3204	0.3788	0.3972	0.4051	0.3887

1

Regression weights										
	1	1	1	1	1	1	1	1	1	1

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Fishing mortalities

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.001	0.001	0.002	0.007	0.005	0.007	0.015	0.019	0.042	0.003
2	0.121	0.096	0.059	0.239	0.174	0.248	0.385	0.298	0.27	0.172
3	0.567	0.643	0.547	0.537	0.587	0.45	0.489	0.472	0.36	0.4
4	0.543	0.786	0.588	0.644	0.521	0.342	0.481	0.349	0.405	0.367
5	0.486	0.792	0.565	0.56	0.393	0.56	0.511	0.396	0.4	0.419
6	0.472	0.447	0.495	0.589	0.385	0.446	0.246	0.43	0.4	0.32
7	0.437	0.408	0.233	0.523	0.394	0.353	0.293	0.324	0.398	0.379
8	0.334	0.455	0.312	0.43	0.387	0.241	0.234	0.288	0.389	0.397
9	0.301	0.488	0.344	0.389	0.343	0.22	0.259	0.172	0.193	0.405
10	0.886	0.231	1.186	0.282	0.255	0.118	0.324	0.352	0.302	0.389

1

XSA population numbers (Thousands)

YEAR \ AGE	1.00E+00	2.00E+00	3.00E+00	4.00E+00	5.00E+00	6.00E+00	7.00E+00	8.00E+00	9.00E+00	1.00E+01
1996	1.88E+04	1.68E+04	1.89E+04	7.61E+03	8.75E+03	5.09E+03	3.81E+03	1.00E+03	1.29E+03	2.00E+02
1997	2.79E+04	1.70E+04	1.34E+04	9.67E+03	4.00E+03	4.87E+03	2.87E+03	2.23E+03	6.51E+02	8.62E+02
1998	1.79E+04	2.52E+04	1.40E+04	6.40E+03	3.99E+03	1.64E+03	2.82E+03	1.73E+03	1.28E+03	3.62E+02
1999	2.63E+04	1.61E+04	2.15E+04	7.33E+03	3.22E+03	2.05E+03	9.04E+02	2.02E+03	1.14E+03	8.21E+02
2000	3.21E+04	2.36E+04	1.15E+04	1.14E+04	3.48E+03	1.66E+03	1.03E+03	4.85E+02	1.19E+03	7.01E+02
2001	2.57E+04	2.89E+04	1.80E+04	5.78E+03	6.11E+03	2.13E+03	1.02E+03	6.28E+02	2.98E+02	7.63E+02
2002	5.01E+04	2.31E+04	2.04E+04	1.04E+04	3.72E+03	3.16E+03	1.23E+03	6.51E+02	4.47E+02	2.16E+02
2003	21300	44700	14200	11300	5800	2020	2230	832	466	312
2004	26100	18900	30000	8030	7240	3530	1190	1460	564	355
2005	65300	22700	13000	18900	4840	4390	2140	722	896	421

Estimated population abundance at 1st Jan 2006

0	59000	17300	7920	11900	2890	2890	1330	441	544

Taper weighted geometric mean of the VPA populations:

24200	20500	15600	8650	4570	2660	1550	931	596	370

Standard error of the weighted Log(VPA populations) :

0.4279	0.373	0.3644	0.4456	0.4379	0.4751	0.5026	0.5094	0.5107	0.5547

Log catchability residuals.

Fleet : BEL BT

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	: at this age									
2	0.03	0.58	-0.73	-2.57	1.12	-0.77	-0.03	1.3	-0.3	-0.76
3	0.64	-0.28	-0.51	-0.07	0.01	0.76	0.02	0.18	-0.1	-0.36
4	0.15	0.32	-0.75	-0.43	-0.17	0.03	0.37	-0.08	0.54	-0.38
5	-0.15	0.51	-0.31	0.95	-0.15	-0.1	0.17	-0.09	0.2	-0.13
6	-0.11	0.92	-0.24	0.25	-0.17	0.64	-0.49	-0.86	0.42	0.07
7	-0.19	0.62	0.06	0.32	0.52	0.08	-0.23	0.02	0.02	-0.01
8	0.07	-0.09	-0.73	-0.05	-0.28	-0.08	-0.14	-0.26	0.31	-1.11
9	0.74	0.36	-0.73	-0.29	0.37	-0.7	-0.11	0.71	-0.19	0.2
10	0.1	2.15	1.51	-2.07	-0.04	0.6	-0.71	-0.66	1.43	-0.77

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	: at this age									
2	-0.12	-0.73	-0.35	0.39	0.06	0.45	0.88	0.37	0.54	0.64
3	-0.12	0.31	-0.28	-0.04	0.37	-0.03	-0.03	0.11	-0.55	-0.02
4	0.24	0.33	0.24	0.5	0.3	-0.35	-0.15	-0.11	-0.17	-0.42
5	-0.19	0.4	-0.21	0.4	-0.36	0.04	-0.29	-0.19	0.08	-0.58
6	0.13	0.13	-0.27	-0.07	0.08	0.73	-0.85	0.51	-0.11	-0.71
7	0.24	0.24	-0.24	0	-0.21	0.15	-0.2	-0.43	-0.47	-0.28
8	-0.01	-0.22	0.1	-0.23	0.52	-0.62	-0.34	-0.13	-0.56	0.07
9	-0.15	0.09	-0.07	0.04	-0.29	-0.61	-0.55	-1.48	-0.81	-0.81
10	1.15	-0.97	-0.01	-0.56	-0.28	-1.39	0.35	0.17	0.21	-0.9

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9	10
Mean Log q	-7.0683	-5.7436	-5.6489	-5.4973	-5.7461	-5.6854	-5.6854	-5.6854	-5.6854
S.E(Log q)	0.8679	0.3371	0.3554	0.3568	0.4976	0.2909	0.4138	0.5992	1.0446

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.86	0.309	7.48	0.21	20	0.76	-7.07
3	1.31	-1.162	4.51	0.43	20	0.44	-5.74
4	0.95	0.254	5.81	0.63	20	0.35	-5.65
5	1.06	-0.278	5.33	0.56	20	0.39	-5.5
6	1.11	-0.388	5.52	0.42	20	0.56	-5.75
7	0.97	0.188	5.73	0.76	20	0.29	-5.69
8	1.34	-1.704	5.54	0.58	20	0.47	-5.87
9	1.4	-1.202	5.7	0.33	20	0.77	-5.9
10	-2.62	-5.552	6.57	0.12	20	1.7	-5.72

Fleet : UK BT

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	: at this age									
2	-0.33	0.43	0.62	-0.02	-0.17	-0.05	-0.36	-0.32	-1.17	-0.14
3	0.54	-0.03	0.38	0	0.12	-0.25	-0.08	-0.48	-0.08	-0.61
4	0.54	0.42	-0.02	0.24	-0.1	0.06	-0.4	-0.17	-0.29	-0.07
5	0.3	0.55	0.41	-0.48	0.01	-1.21	0.49	-0.33	-0.02	-0.12
6	0.4	-0.26	0.25	0.08	-0.38	-0.27	-0.61	0.05	0.01	0.02
7	0.65	-0.26	-0.13	0.19	-0.32	-0.94	-0.21	-0.55	0.49	-0.15
8	-0.71	0.4	0.31	-0.25	-0.01	-0.65	-0.4	-0.14	-0.16	0.38
9	0.08	-0.65	0.09	-0.31	-0.15	0.11	0.34	0.04	0.36	0.22
10	0.02	-1.34	0.68	0.32	0.59	0.07	-0.31	-0.54	0.49	0.38

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	: at this age									
2	0.29	0.17	0.04	0.39	-0.1	0.07	0.43	0.09	0.08	0.03
3	-0.47	0.18	-0.23	0.12	0.29	-0.11	0.26	0.07	0.34	0.04
4	-0.77	-0.21	-0.03	0.15	0.18	-0.05	0.18	-0.2	0.18	0.35
5	-0.05	-0.52	0.16	0.18	0.29	0.23	0.22	-0.21	-0.09	0.18
6	-0.25	0.18	-0.1	0.29	0.24	0.26	-0.04	-0.04	-0.06	0.23
7	-0.12	-0.13	0.17	0.22	0.46	0.2	0.13	0.05	-0.1	0.35
8	-0.18	0.1	0.11	0.13	0.24	0.67	0.54	0.27	0.32	0.74
9	0.2	-0.08	0.18	-0.03	0.46	0.18	-0.21	-0.2	-0.26	0.41
10	0.23	0.2	0.45	-0.32	0.15	0.12	-0.11	0.33	-0.05	0.84

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9	10
Mean Log q	-6.5552	-5.8652	-5.8178	-5.9478	-5.9106	-5.9957	-5.9957	-5.9957	-5.9957
S.E(Log q)	0.384	0.3015	0.3039	0.4112	0.2582	0.3723	0.409	0.2812	0.5003

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.07	-0.274	6.32	0.46	20	0.42	-6.56
3	0.97	0.137	5.96	0.62	20	0.3	-5.87
4	0.92	0.552	6.08	0.72	20	0.28	-5.82
5	0.75	1.595	6.58	0.69	20	0.3	-5.95
6	0.83	1.708	6.25	0.85	20	0.2	-5.91
7	0.76	1.993	6.33	0.79	20	0.26	-6
8	0.83	1.182	6.06	0.74	20	0.33	-5.91
9	0.8	2.264	6.04	0.88	20	0.2	-5.96
10	1.01	-0.045	5.88	0.6	20	0.51	-5.89

Fleet : UK BTS

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	99.99	99.99	0.29	-0.42	0.16	0.08	-1.74	-2.07	-0.27	-0.25
2	99.99	99.99	1.07	0.24	-0.71	0.15	-0.31	0.12	-0.97	-0.18
3	99.99	99.99	0.67	0.65	-0.46	-0.34	0.14	0.08	0.14	-0.95
4	99.99	99.99	-0.25	-0.01	0.08	0.08	-0.58	0.64	0.04	-0.29
5	99.99	99.99	0.41	0.16	-0.16	-0.24	-0.1	0	0.38	-0.43
6	99.99	99.99	0.1	-0.83	-0.26	0.08	0.36	0.32	-0.83	0.22
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	-0.24	1.05	-0.75	1.51	0.32	0.4	0.99	0.26	0.2	0.48
2	-0.2	-0.23	0.42	0.16	0.59	0.39	0.09	0.29	-0.08	-0.84
3	-0.31	-0.1	-0.44	0.79	0.29	0.45	-0.08	0	-0.19	-0.33
4	-0.75	-0.22	-0.19	0.63	0.64	-0.06	0.5	-0.01	-0.08	-0.17
5	-0.32	-1.22	0.15	0.99	0.31	0.47	-1.02	0.23	-0.08	0.45
6	-0.04	-0.59	-1.09	1.31	0.59	0.31	0.06	-0.23	0.38	0.14
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6
Mean Log q	-8.2833	-7.398	-7.785	-8.1458	-8.1282	-8.2481
S.E(Log q)	0.8863	0.5099	0.4545	0.3942	0.5335	0.577

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

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	0.51	1.805	9.23	0.46	18	0.43	-8.28
2	0.9	0.328	7.66	0.4	18	0.47	-7.4
3	0.95	0.175	7.88	0.42	18	0.44	-7.78
4	0.82	1.056	8.32	0.69	18	0.32	-8.15
5	1	0	8.13	0.41	18	0.55	-8.13
6	0.99	0.03	8.24	0.42	18	0.59	-8.25

Fleet : YFS

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	99.99	0.52	0.02	-0.51	-0.3	0.41	-0.41	0.03	0.52	0.77
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									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	-0.68	-0.65	-0.13	-0.1	0.11	-0.09	0.08	0.09	0.36	-0.02
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									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1
Mean Log q	-10.1745
S.E(Log q)	0.4013

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.12	-0.459	10.18	0.48	19	0.46	-10.17

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Terminal year survivor and F summaries :

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 2004

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	1	0	0	0	0	0	0
UK BT	1	0	0	0	0	0	0
UK BTS	95175	0.911	0	0	1	0.164	0.002
YFS	57525	0.412	0	0	1	0.802	0.003
F shrinkage mean	10487	2				0.034	0.018

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
58953	0.37	0.27	3	0.726	0.003

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	32851	0.889	0	0	1	0.068	0.094
UK BT	17771	0.394	0	0	1	0.35	0.167
UK BTS	9545	0.454	0.445	0.98	2	0.26	0.292
YFS	24633	0.412	0	0	1	0.306	0.123
F shrinkage mean	10187	2				0.016	0.276

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
17273	0.23	0.21	6	0.896	0.172

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2002

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	8235	0.323	0.17	0.53	2	0.247	0.387
UK BT	8354	0.245	0.02	0.08	2	0.407	0.382
UK BTS	6609	0.329	0.136	0.41	3	0.219	0.463
YFS	8617	0.412	0	0	1	0.117	0.372
F shrinkage mean	6430	2				0.01	0.473

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7917	0.16	0.06	9	0.361	0.4

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	7684	0.246	0.134	0.55	3	0.28	0.522
UK BT	16155	0.197	0.066	0.33	3	0.418	0.282
UK BTS	11390	0.263	0.171	0.65	4	0.235	0.38
YFS	12886	0.412	0	0	1	0.06	0.342
F shrinkage mean	10049	2				0.007	0.421

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
11883	0.13	0.11	12	0.847	0.367

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	2188	0.215	0.19	0.88	4	0.342	0.522
UK BT	3450	0.189	0.054	0.28	4	0.391	0.361
UK BTS	3293	0.252	0.117	0.47	5	0.223	0.375
YFS	2643	0.412	0	0	1	0.035	0.449
F shrinkage mean	2612	2				0.008	0.454

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2888	0.12	0.08	15	0.686	0.419

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	2416	0.205	0.162	0.79	5	0.294	0.372
UK BT	3157	0.171	0.094	0.55	5	0.471	0.296
UK BTS	3027	0.242	0.063	0.26	6	0.202	0.307
YFS	3216	0.412	0	0	1	0.026	0.292
F shrinkage mean	2337	2				0.007	0.383

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2889	0.11	0.06	18	0.549	0.32

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	1076	0.187	0.038	0.2	6	0.406	0.45
UK BT	1430	0.168	0.093	0.56	6	0.44	0.356
UK BTS	2046	0.246	0.094	0.38	6	0.13	0.261
YFS	1202	0.412	0	0	1	0.017	0.411
F shrinkage mean	1440	2				0.007	0.354

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1330	0.11	0.06	20	0.553	0.379

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	375	0.183	0.137	0.75	7	0.431	0.452
UK BT	543	0.17	0.144	0.85	7	0.457	0.332
UK BTS	333	0.25	0.193	0.77	6	0.093	0.497
YFS	384	0.412	0	0	1	0.011	0.443
F shrinkage mean	592	2				0.008	0.308

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
441	0.11	0.09	22	0.766	0.397

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	344	0.18	0.12	0.67	8	0.353	0.579
UK BT	690	0.159	0.067	0.42	8	0.56	0.33
UK BTS	824	0.259	0.125	0.48	6	0.07	0.284
YFS	282	0.412	0	0	1	0.009	0.673
F shrinkage mean	1007	2				0.008	0.238

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
544	0.11	0.09	24	0.8	0.405

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	206	0.18	0.146	0.81	9	0.346	0.467
UK BT	295	0.155	0.13	0.84	9	0.579	0.348
UK BTS	333	0.258	0.147	0.57	6	0.06	0.314
YFS	130	0.412	0	0	1	0.007	0.664
F shrinkage mean	261	2				0.008	0.385

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
260	0.11	0.08	26	0.759	0.389

Table 9.3.2 - Sole VIId - Fishing mortality (F) at age

Run title : Sole in VIId - 2006WG

At 5/09/2006 9:34

Table 8 Fishing mortality (F) at age

YEAR	1982	1983	1984	1985
AGE				
1	0.0129	0.0000	0.0012	0.004
2	0.1868	0.0822	0.1136	0.2215
3	0.3109	0.3544	0.4321	0.4316
4	0.4889	0.3586	0.4392	0.3732
5	0.2292	0.4494	0.262	0.2742
6	0.2281	0.4574	0.7312	0.3916
7	0.4678	0.3173	0.5083	0.2628
8	0.4112	0.5106	0.234	0.2918
9	0.3467	0.2917	0.3577	0.1548
10	0.3376	0.4067	0.4202	0.2759
+gp	0.3376	0.4067	0.4202	0.2759
0 FBAR 3- 8	0.3560	0.4080	0.4345	0.3375

Table 8 Fishing mortality (F) at age

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
1	0.0020	0.0009	0.0039	0.0103	0.0299	0.0116	0.0033	0.0053	0.0012	0.0464
2	0.1201	0.1519	0.2601	0.1710	0.2226	0.2149	0.1470	0.1908	0.0495	0.1400
3	0.4993	0.5455	0.5400	0.6715	0.4005	0.5055	0.3930	0.3265	0.3378	0.4361
4	0.4553	0.5834	0.4221	0.6640	0.4750	0.5205	0.4070	0.3998	0.4958	0.4173
5	0.3209	0.5268	0.3713	0.7329	0.4373	0.4348	0.4488	0.3515	0.4150	0.4412
6	0.3021	0.6579	0.3850	0.4465	0.2888	0.5169	0.3383	0.1946	0.3143	0.4015
7	0.3578	0.8056	0.4829	0.4250	0.3408	0.3797	0.3235	0.2881	0.2733	0.3039
8	0.4425	0.4354	0.3858	0.4392	0.3099	0.3344	0.3121	0.2429	0.2854	0.1867
9	0.5986	0.5807	0.2192	0.4135	0.4962	0.5081	0.3622	0.4274	0.2712	0.3491
10	0.2896	1.5004	1.0517	0.2706	0.5615	0.7059	0.3140	0.1922	0.6397	0.2854
+gp	0.2896	1.5004	1.0517	0.2706	0.5615	0.7059	0.3140	0.1922	0.6397	0.2854
0 FBAR 3- 8	0.3963	0.5924	0.4312	0.5632	0.3754	0.4486	0.3704	0.3006	0.3536	0.3644

Run title : Sole in VIId - 2006WG

At 5/09/2006 9:34

Table 8 Fishing mortality (F) at age

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	FBAR 03-05
AGE											
1	0.0005	0.0009	0.0019	0.0067	0.0045	0.0069	0.0149	0.0189	0.0423	0.0031	0.0215
2	0.1214	0.0964	0.0591	0.2394	0.1738	0.2478	0.3846	0.2982	0.2702	0.1716	0.2467
3	0.5674	0.6431	0.5472	0.5374	0.5866	0.4499	0.4886	0.4716	0.3598	0.3998	0.4104
4	0.5433	0.7861	0.5877	0.6436	0.5215	0.3423	0.4811	0.3489	0.4053	0.3669	0.3737
5	0.4862	0.7921	0.5645	0.5596	0.3928	0.5600	0.5108	0.3963	0.4003	0.4186	0.4051
6	0.4723	0.4470	0.4952	0.5894	0.3846	0.4459	0.2461	0.4302	0.4004	0.3204	0.3837
7	0.4367	0.4083	0.2333	0.5226	0.3941	0.3533	0.2933	0.3240	0.3982	0.3788	0.3670
8	0.3336	0.4550	0.3124	0.4304	0.3868	0.2411	0.2336	0.2881	0.3890	0.3972	0.3581
9	0.3015	0.4877	0.3437	0.3894	0.3427	0.2200	0.2592	0.1718	0.1926	0.4051	0.2565
10	0.8858	0.2307	1.1863	0.2821	0.2547	0.1183	0.3240	0.3519	0.3016	0.3887	0.3474
+gp	0.8858	0.2307	1.1863	0.2821	0.2547	0.1183	0.3240	0.3519	0.3016	0.3887	
0 FBAR 3- 8	0.4732	0.5886	0.4567	0.5472	0.4444	0.3988	0.3756	0.3765	0.3922	0.3803	

Table 9.3.3 - Sole VIId - Stock numbers at age

Run title : Sole in VIId - 2006WG

At 5/09/2006 9:34

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1982	1983	1984	1985
AGE				
1	12706	21385	21618	12897
2	16199	11350	19350	19538
3	20676	12160	9459	15628
4	4695	13709	7719	5556
5	2926	2605	8666	4502
6	3366	2105	1504	6034
7	1545	2424	1206	655
8	748	875	1597	656
9	438	449	475	1144
10	305	280	303	301
+gp	739	605	726	557
0 TOTAL	64342	67948	72625	67467

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
1	25750	10976	25860	16768	44362	34799	33738	16788	26515	19428
2	11623	23253	9922	23308	15017	38956	31123	30427	15110	23962
3	14166	9327	18075	6922	17776	10876	28432	24313	22749	13012
4	9184	7780	4891	9531	3200	10777	5936	17366	15872	14684
5	3462	5271	3928	2902	4440	1801	5794	3575	10535	8747
6	3097	2272	2816	2452	1262	2594	1055	3347	2276	6294
7	3691	2071	1065	1734	1420	855	1400	680	2493	1504
8	456	2335	838	594	1026	914	529	917	462	1716
9	443	265	1367	515	347	681	592	351	651	314
10	886	221	134	993	308	191	371	373	207	449
+gp	1551	613	440	1247	1190	788	898	774	571	1018
0 TOTAL	74308	64384	69337	66967	90347	103232	109868	98911	97439	91128

Run title : Sole in VIId - 2006WG

At 5/09/2006 9:34

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	GMST 82-03	AMST 82-03
AGE													
1	18829	27894	17869	26293	32123	25690	50110	21271	26121	65340	0*	23000	24712
2	16782	17029	25217	16138	23631	28935	23086	44669	18886	22656	58953	20490	22028
3	18850	13449	13992	21508	11493	17971	20434	14220	29995	13042	17273	15273	16159
4	7612	9671	6397	7325	11370	5784	10369	11343	8029	18938	7917	8377	9126
5	8754	4001	3987	3216	3482	6108	3716	5799	7241	4844	11883	4461	4919
6	5091	4871	1639	2051	1663	2127	3157	2018	3530	4390	2888	2562	2868
7	3812	2873	2819	904	1030	1024	1232	2233	1187	2140	2889	1547	1758
8	1004	2229	1728	2020	485	628	651	832	1462	722	1330	922	1056
9	1289	651	1280	1144	1188	298	447	466	564	896	441	587	672
10	200	862	362	821	701	763	216	312	355	421	544	368	435
+gp	611	1359	451	1531	1157	2494	746	865	938	888	805		
0 TOTAL	82834	84889	75741	82952	88324	91823	114165	104027	98309	134277	104923		

* Replaced with GM in prediction

Table 9.3.4 - Sole VIId - Summary

Run title : Sole in VIId - 2006WG

At 5/09/2006 9:34

Table 16 Summary (without SOP correction)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 8
1982	12706	10402	7806	3190	0.4087	0.356
1983	21385	12586	9557	3458	0.3618	0.408
1984	21618	12940	8957	3575	0.3991	0.4345
1985	12897	13319	9961	3837	0.3852	0.3375
1986	25750	13967	10584	3932	0.3715	0.3963
1987	10976	13039	9017	4791	0.5313	0.5924
1988	25860	12827	10095	3853	0.3817	0.4312
1989	16768	11911	8439	3805	0.4509	0.5632
1990	44362	13887	9597	3647	0.38	0.3754
1991	34799	15909	8793	4351	0.4948	0.4486
1992	33738	17450	11282	4072	0.3609	0.3704
1993	16788	18054	13259	4299	0.3242	0.3006
1994	26515	15657	12579	4383	0.3484	0.3536
1995	19428	15150	11160	4420	0.3961	0.3644
1996	18829	15727	12184	4797	0.3937	0.4732
1997	27894	14370	10609	4764	0.4491	0.5886
1998	17869	12541	8117	3363	0.4143	0.4567
1999	26293	12492	9112	4135	0.4538	0.5472
2000	32123	12972	8483	3476	0.4098	0.4444
2001	25690	12635	7675	4025	0.5244	0.3988
2002	50110	14298	8653	4733	0.547	0.3756
2003	21271	18177	10368	5038	0.4859	0.3765
2004	26121	15859	11965	4826	0.4033	0.3922
2005	65340	25373	12339	4434	0.3593	0.3803
2006	23000[1]		12041[2]			0.3830[3]
Arith. Mean	26464	14648	10025	4134	0.4181	0.4236
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

[1] Geometric mean 1982-2003

[2] From forecast

[3] $F_{(03-05)}$ NOT rescaled to F_{2005}

Table 9.5.1 - Sole VIId – RCT3 input

Yearclass	XSA (Age 1)	XSA (Age 2)	yfs0	yfs1	bts1	bts2
1981	12706	11350	1.881	0.2005	-11	-11
1982	21385	19350	2.6555	0.695	-11	-11
1983	21618	19538	11.887	-11	-11	-11
1984	12897	11623	-11	-11	-11	-11
1985	25750	23253	-11	-11	-11	-11
1986	10976	9922	-11	0.6595	-11	14.2
1987	25860	23308	7.995	0.935	8.2	15.4
1988	16768	15017	1.1875	0.356	2.6	3.7
1989	44362	38956	12.588	1.152	12.1	22.8
1990	34799	31123	3.3285	1.8695	8.9	12
1991	33738	30427	1.3865	0.796	1.4	17.5
1992	16788	15110	1.281	0.615	0.5	3.2
1993	26515	23962	6.534	1.591	4.8	10.6
1994	19428	16782	8.1035	1.4635	3.5	7.4
1995	18829	17029	5.3135	0.339	3.5	7.3
1996	27894	25217	0.9865	0.5205	19	21.23
1997	17869	16138	1.942	0.559	2	9.44
1998	26293	23631	9.3725	0.854	28.14	22.03
1999	32123	28935	2.7455	1.282	10.49	21.01
2000	25690	23086	1.8475	0.8365	9.09	-11
2001	50110	44669	4.5135	1.93	31.76	28.48
2002	-11	-11	2.52	0.82	6.47	8.49
2003	-11	-11	2.16	1.3	7.35	5.04
2004	-11	-11	7.15	2.28	25.00	-11
2005	-11	-11	4.51	-11	-11	-11

Table 9.5.2 Sole VIId – RCT3 output (1 year olds)

Analysis by RCT3 ver3.1 of data from file : S7DREC1.txt

7D Sole (1year olds)

Data for 4 surveys over 25 years : 1981 - 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 .00
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2003

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
yfs0	1.91	7.16	1.21	.084	18	1.15	9.35	1.338	.028
yfs1	2.22	8.69	.43	.485	18	.83	10.55	.477	.221
bts1	.56	9.05	.39	.447	15	2.12	10.24	.437	.263
bts2	1.03	7.46	.46	.455	15	1.80	9.30	.546	.169
					VPA Mean =		10.05	.397	.319

Yearclass = 2004

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
yfs0	1.91	7.16	1.21	.084	18	2.10	11.16	1.350	.036
yfs1	2.22	8.69	.43	.485	18	1.19	11.33	.526	.238
bts1	.56	9.05	.39	.447	15	3.26	10.88	.464	.307
bts2									
					VPA Mean =		10.05	.397	.419

Yearclass = 2005

Survey/ Series	**Slope**	**Inter- cept**	**Std Error**	**Rsquare**	**No. Pts**	**Index Value**	**Predicted Value**	**Std Error**	**WAP Weights**
	I-----------Regression----------I					**I-----------Prediction---------I**			
yfs0	**1.91**	**7.16**	**1.21**	**.084**	**18**	**1.71**	**10.41**	**1.326**	**.082**
yfs1									
bts1									
bts2									
					VPA Mean =		**10.05**	**.397**	**.918**

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2003	23463	10.06	.22	.21	.85		
2004	42185	10.65	.26	.31	1.46		
2005	**23790**	**10.08**	**.38**	**.10**	**.07**		

Table 9.5.3 - Sole VIId – RCT3 output (2 year olds)

```
Analysis by RCT3 ver3.1 of data from file : S7DREC2.TXT

 7D Sole (2year olds)

 Data for    4 surveys over   25 years :  1981 - 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    .00
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Yearclass =   2003

          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 yfs0      1.97   6.95   1.26   .078     18   1.15     9.22    1.390     .026
 yfs1      2.24   8.58    .44   .474     18    .83    10.44     .485     .213
 bts1       .56   8.94    .39   .447     15   2.12    10.13     .435     .265
 bts2      1.01   7.38    .46   .462     15   1.80     9.21     .535     .175

                                         VPA Mean =    9.94     .395     .321
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

 yfs0      1.97   6.95   1.26   .078     18   2.10    11.09    1.403     .034
 yfs1      2.24   8.58    .44   .474     18   1.19    11.23     .535     .231
 bts1       .56   8.94    .39   .447     15   3.26    10.77     .462     .311
 bts2

                                         VPA Mean =    9.94     .395     .424

 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

 yfs0      1.97   6.95   1.26   .078     18   1.71    10.31    1.378     .076
 yfs1
 bts1
 bts2

                                         VPA Mean =    9.94     .395     .924


 Year     Weighted      Log     Int     Ext     Var     VPA      Log
 Class     Average      WAP     Std     Std    Ratio             VPA
          Prediction           Error   Error

 2003       20935      9.95     .22     .21      .85
 2004       37588     10.53     .26     .31     1.46
 2005       21320      9.97     .38     .10      .07
```

Table 9.6.1 - Sole in VIId
Input for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	23000	0.39	WS1	0.050	0
N2	58953	0.37	WS2	0.149	0.08
N3	17273	0.23	WS3	0.199	0.06
N4	7917	0.16	WS4	0.244	0.03
N5	11883	0.13	WS5	0.284	0.09
N6	2888	0.12	WS6	0.319	0.17
N7	2889	0.11	WS7	0.343	0.19
N8	1330	0.11	WS8	0.384	0.12
N9	441	0.11	WS9	0.519	0.16
N10	544	0.11	WS10	0.426	0.04
N11	805	0.11	WS11	0.504	0.11
H.cons selectivity			Weight in the HC catch		
sH1	0.0214	0.19	WH1	0.123	0.09
sH2	0.2467	0.27	WH2	0.174	0.03
sH3	0.4104	0.16	WH3	0.207	0.01
sH4	0.3737	0.06	WH4	0.255	0.01
sH5	0.4051	0.04	WH5	0.292	0.05
sH6	0.3837	0.15	WH6	0.333	0.08
sH7	0.3670	0.09	WH7	0.366	0.05
sH8	0.3581	0.16	WH8	0.420	0.04
sH9	0.2565	0.51	WH9	0.511	0.08
sH10	0.3474	0.14	WH10	0.481	0.08
sH11	0.3474	0.14	WH11	0.528	0.01
Natural mortality			Proportion mature		
M1	0.1	0.1	MT1	0	0
M2	0.1	0.1	MT2	0	0.1
M3	0.1	0.1	MT3	1	0.1
M4	0.1	0.1	MT4	1	0
M5	0.1	0.1	MT5	1	0
M6	0.1	0.1	MT6	1	0
M7	0.1	0.1	MT7	1	0
M8	0.1	0.1	MT8	1	0
M9	0.1	0.1	MT9	1	0
M10	0.1	0.1	MT10	1	0
M11	0.1	0.1	MT11	1	0
Relative effort in HC fihery			Year effect for natural mortality		
HF06	1	0.02	K06	1	0.1
HF07	1	0.02	K07	1	0.1
HF08	1	0.02	K08	1	0.1
Recruitment in 2006 and 2007					
R07	23000	0.39			
R08	23000	0.39			

Table 9.6.2 Sole in VIId - Management option table

MFDP version 1a
Run: Sol7d_fin
Sole in VIId
Time and date: 18:03 06/09/2006
Fbar age range: 3-8

2006 Biomass	SSB	FMult	FBar	Landings
21995	12041	1.0000	0.3830	6057

2007 Biomass	SSB	FMult	FBar	Landings	2008 Biomass	SSB
21026	16834	0.0000	0.0000	0	25775	21517
.	16834	0.1000	0.0383	729	24992	20741
.	16834	0.2000	0.0766	1432	24238	19994
.	16834	0.3000	0.1149	2109	23512	19274
.	16834	0.4000	0.1532	2762	22812	18581
.	16834	0.5000	0.1915	3392	22138	17913
.	16834	0.6000	0.2298	3999	21488	17270
.	16834	0.7000	0.2681	4585	20862	16651
.	16834	0.8000	0.3064	5149	20259	16054
.	16834	0.9000	0.3447	5693	19678	15480
.	16834	1.0000	0.3830	6218	19118	14926
.	16834	1.1000	0.4213	6724	18579	14393
.	16834	1.2000	0.4596	7212	18059	13880
.	16834	1.3000	0.4979	7683	17558	13385
.	16834	1.4000	0.5362	8138	17075	12909
.	16834	1.5000	0.5745	8576	16609	12450
.	16834	1.6000	0.6128	8998	16161	12008
.	16834	1.7000	0.6511	9406	15728	11582
.	16834	1.8000	0.6894	9800	15311	11171
.	16834	1.9000	0.7277	10179	14909	10776
.	16834	2.0000	0.7660	10545	14522	10395

Input units are thousands and kg - output in tonnes

Fmult corresponding to Fpa = 0.75

.	16834	1.05	0.4021	6473	18846	14657

Bpa = 8 000 t

Table 9.6.3 Sole in VIId. Detailed results

MFDP version 1a
Run: Sol7d_fin
Time and date: 18:03 06/09/2006
Fbar age range: 3-8

Year: 2006		F multiplier: 1		Fbar: 0.383					
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
1	0.0214	464	57	23000	1150	0	0	0	0
2	0.2467	12289	2138	58953	8804	0	0	0	0
3	0.4104	5552	1151	17273	3443	17273	3443	17273	3443
4	0.3737	2357	602	7917	1932	7917	1932	7917	1932
5	0.4051	3779	1105	11883	3379	11883	3379	11883	3379
6	0.3837	879	293	2888	920	2888	920	2888	920
7	0.3670	847	310	2889	990	2889	990	2889	990
8	0.3581	382	160	1330	511	1330	511	1330	511
9	0.2565	95	49	441	229	441	229	441	229
10	0.3474	152	73	544	232	544	232	544	232
11	0.3474	225	119	805	406	805	406	805	406
Total		27021	6057	127923	21995	45970	12041	45970	12041

Year: 2007		F multiplier: 1		Fbar: 0.383					
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0214	464	57	23000	1150	0	0	0	0
2	0.2467	4246	739	20370	3042	0	0	0	0
3	0.4104	13398	2778	41682	8309	41682	8309	41682	8309
4	0.3737	3086	788	10368	2530	10368	2530	10368	2530
5	0.4051	1568	458	4930	1402	4930	1402	4930	1402
6	0.3837	2181	726	7171	2285	7171	2285	7171	2285
7	0.3670	522	191	1781	610	1781	610	1781	610
8	0.3581	520	219	1811	695	1811	695	1811	695
9	0.2565	181	93	841	437	841	437	841	437
10	0.3474	86	42	309	132	309	132	309	132
11	0.3474	242	128	862	435	862	435	862	435
Total		26495	6218	113125	21026	69755	16834	69755	16834

Year: 2008		F multiplier: 1		Fbar: 0.383					
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
1	0.0214	464	57	23000	1150	0	0	0	0
2	0.2467	4246	739	20370	3042	0	0	0	0
3	0.4104	4629	960	14402	2871	14402	2871	14402	2871
4	0.3737	7447	1902	25020	6105	25020	6105	25020	6105
5	0.4051	2053	600	6456	1836	6456	1836	6456	1836
6	0.3837	905	301	2975	948	2975	948	2975	948
7	0.3670	1296	474	4421	1515	4421	1515	4421	1515
8	0.3581	321	135	1116	429	1116	429	1116	429
9	0.2565	247	126	1145	595	1145	595	1145	595
10	0.3474	165	79	589	251	589	251	589	251
11	0.3474	210	111	749	378	749	378	749	378
Total		21984	5485	100244	19118	56874	14926	56874	14926

Input units are thousands and kg - output in tonnes

Table 9.6.4 Sole VIId

Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class	2002	2003	2004	2005	2006
Stock No. (thousands) of 1 year-olds	21271	26121	65340	23000	23000
Source	XSA	XSA	XSA	GM82-03	GM82-03
Status Quo F:					
% in 2006 landings	9.9	19.0	35.3	0.9	-
% in 2007 landings	5.9	11.6	50.6	16.0	1.8
% in 2006 SSB	16.0	28.6	0.0	0.0	-
% in 2007 SSB	8.3	15.0	49.4	0.0	0.0
% in 2008 SSB	6.4	12.3	40.9	19.2	0.0

GM : geometric mean recruitment

Sole VIId : Year-class % contribution to

a) 2007 landings **b) 2008 SSB**

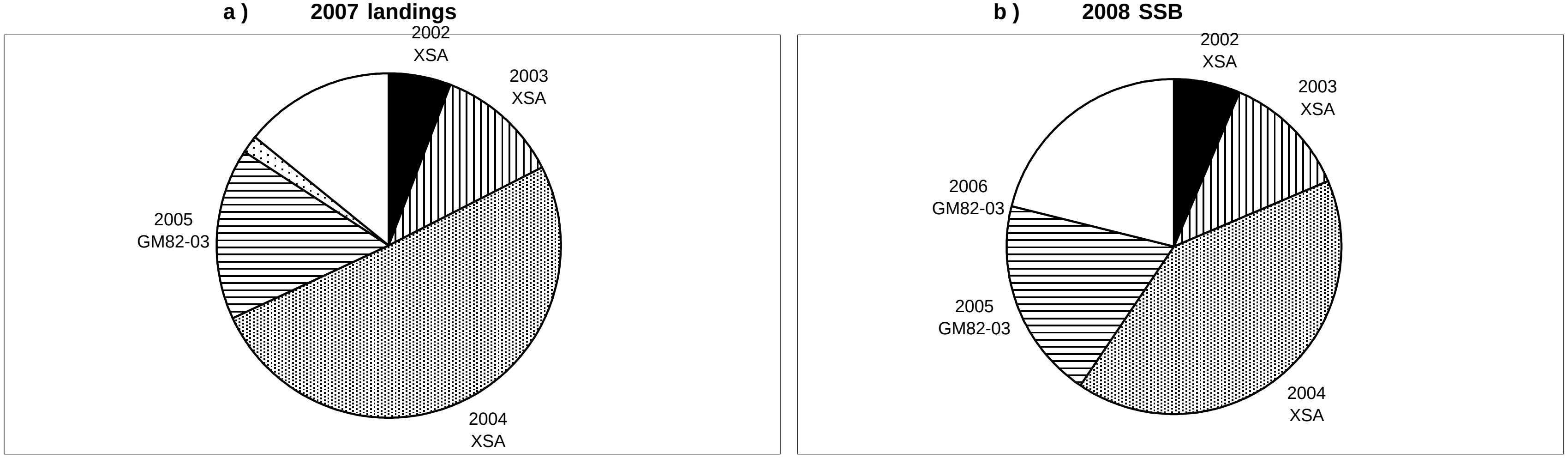


Table 9.7.1 - Sole in VIId Yield per recruit summary table

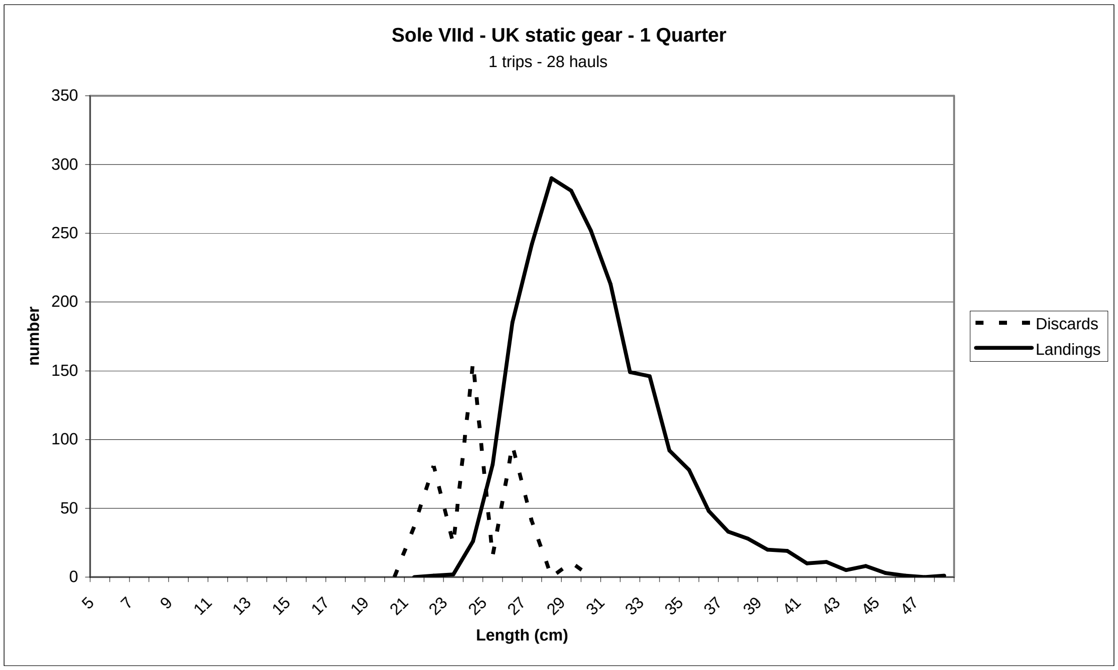
MFYPR version 2a
Run: S7d_y_fin
Time and date: 17:50 06/09/2006
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	10.5083	3.6477	8.6035	3.4626	8.6035	3.4626
0.1000	0.0383	0.2357	0.0862	8.1544	2.5436	6.2515	2.3588	6.2515	2.3588
0.2000	0.0766	0.3743	0.1276	6.7711	1.9181	4.8701	1.7335	4.8701	1.7335
0.3000	0.1149	0.4653	0.1490	5.8633	1.5231	3.9643	1.3388	3.9643	1.3388
0.4000	0.1532	0.5295	0.1604	5.2236	1.2555	3.3265	1.0715	3.3265	1.0715
0.5000	0.1915	0.5772	0.1665	4.7495	1.0649	2.8543	0.8812	2.8543	0.8812
0.6000	0.2298	0.6139	0.1695	4.3849	0.9239	2.4916	0.7405	2.4916	0.7405
0.7000	0.2681	0.6431	0.1709	4.0961	0.8164	2.2047	0.6333	2.2047	0.6333
0.8000	0.3064	0.6667	0.1712	3.8620	0.7324	1.9726	0.5496	1.9726	0.5496
0.9000	0.3447	0.6863	0.1709	3.6686	0.6654	1.7811	0.4829	1.7811	0.4829
1.0000	0.3830	0.7028	0.1703	3.5062	0.6110	1.6206	0.4287	1.6206	0.4287
1.1000	0.4213	0.7169	0.1695	3.3679	0.5661	1.4842	0.3841	1.4842	0.3841
1.2000	0.4596	0.7290	0.1686	3.2488	0.5286	1.3669	0.3469	1.3669	0.3469
1.3000	0.4979	0.7396	0.1677	3.1451	0.4968	1.2651	0.3154	1.2651	0.3154
1.4000	0.5362	0.7489	0.1668	3.0539	0.4696	1.1758	0.2885	1.1758	0.2885
1.5000	0.5745	0.7572	0.1659	2.9731	0.4462	1.0969	0.2653	1.0969	0.2653
1.6000	0.6128	0.7647	0.1651	2.9011	0.4257	1.0267	0.2451	1.0267	0.2451
1.7000	0.6511	0.7714	0.1643	2.8363	0.4077	0.9639	0.2274	0.9639	0.2274
1.8000	0.6894	0.7774	0.1635	2.7779	0.3917	0.9073	0.2117	0.9073	0.2117
1.9000	0.7277	0.7829	0.1628	2.7247	0.3775	0.8560	0.1978	0.8560	0.1978
2.0000	0.7660	0.7880	0.1621	2.6762	0.3648	0.8093	0.1853	0.8093	0.1853

Reference point	F multiplier	Absolute F
Fbar(3-8)	1.0000	0.383
FMax	0.7955	0.3047
F0.1	0.3318	0.1271
F35%SPR	0.343	0.1314
Fmed	1.0468	0.4009
Fhigh	1.7463	0.6688

Weights in kilograms

Figure 9.2.1a - Sole VIId - UK Length distributions of discarded and retained fish from discard sampling studies



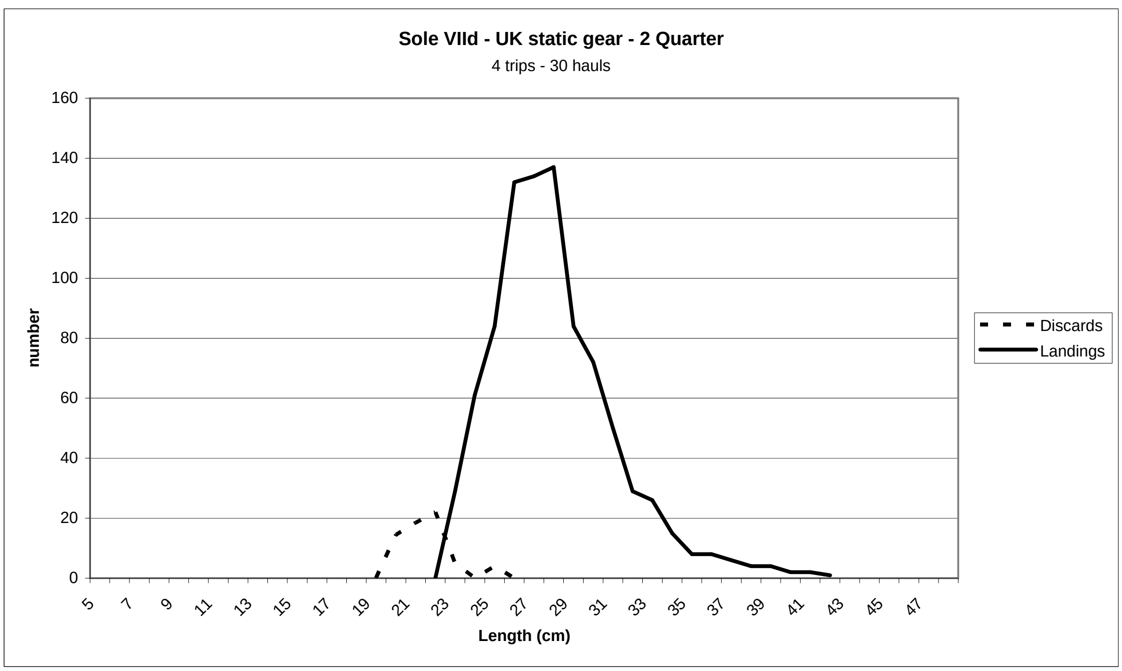


Figure 9.2.1b - Sole VIId - French Length distributions of discarded and retained fish from discard sampling studies

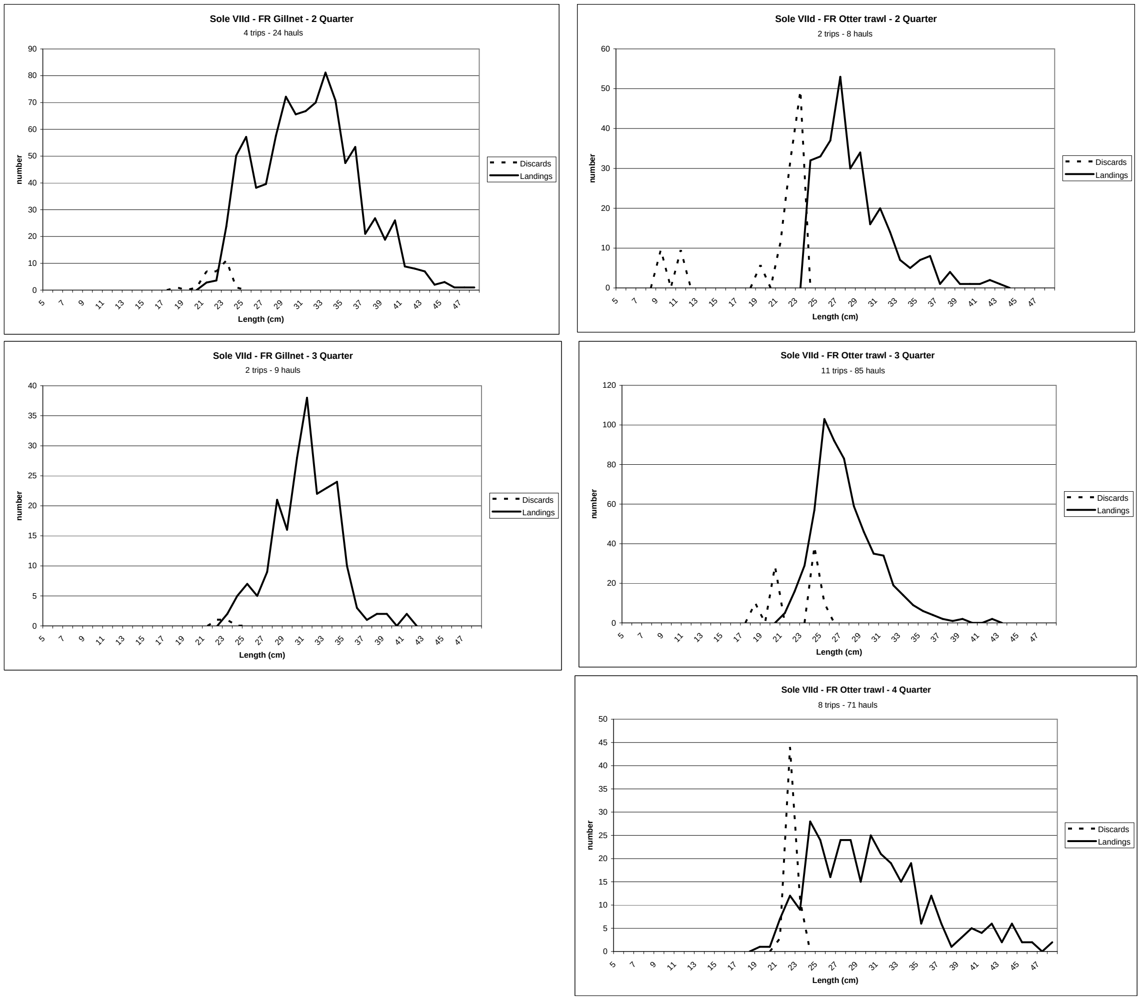


Figure 9.2.1c - Sole VIId - Belgium Length distributions of discarded and retained fish from discard sampling studies

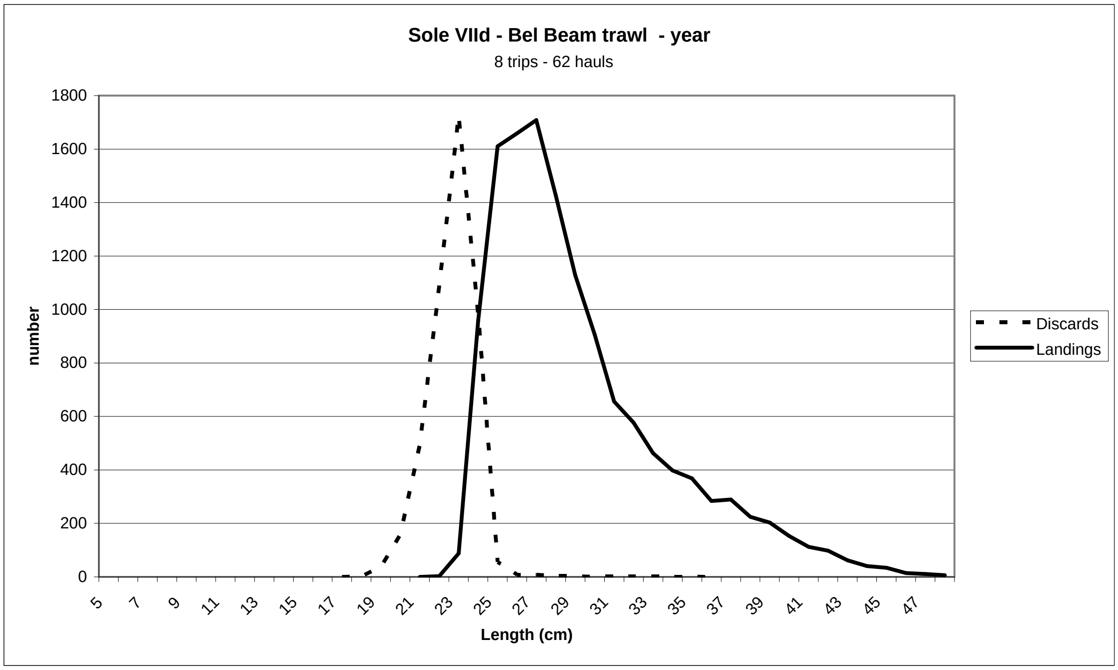
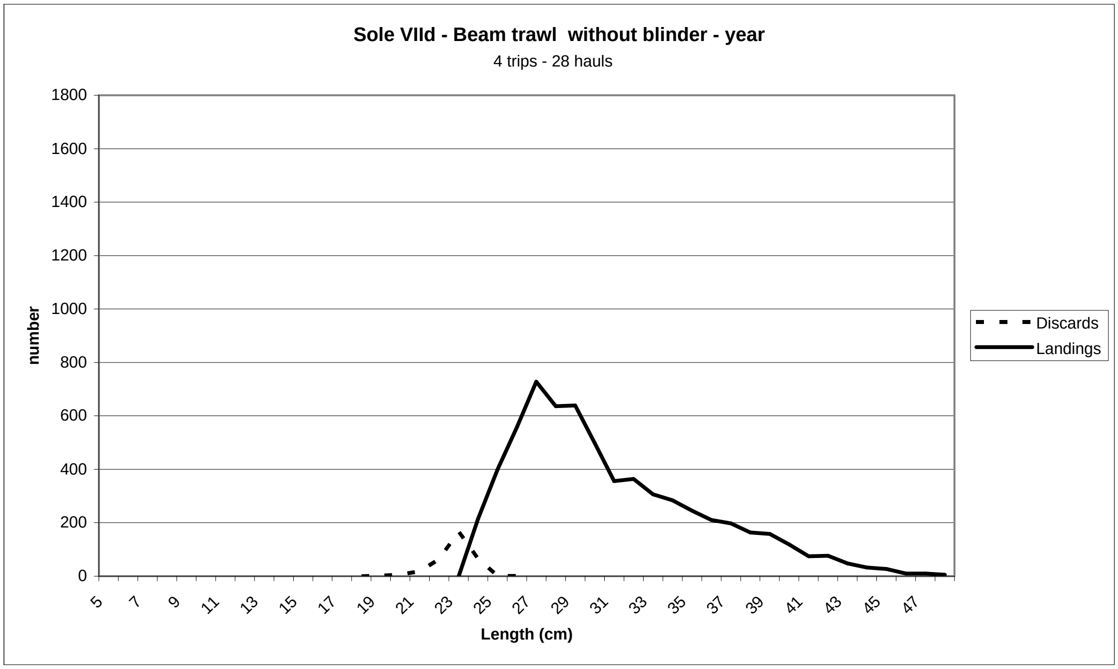


Figure 9.2.1d - Sole VIId - Length distributions of discarded and retained fish from discard sampling studies



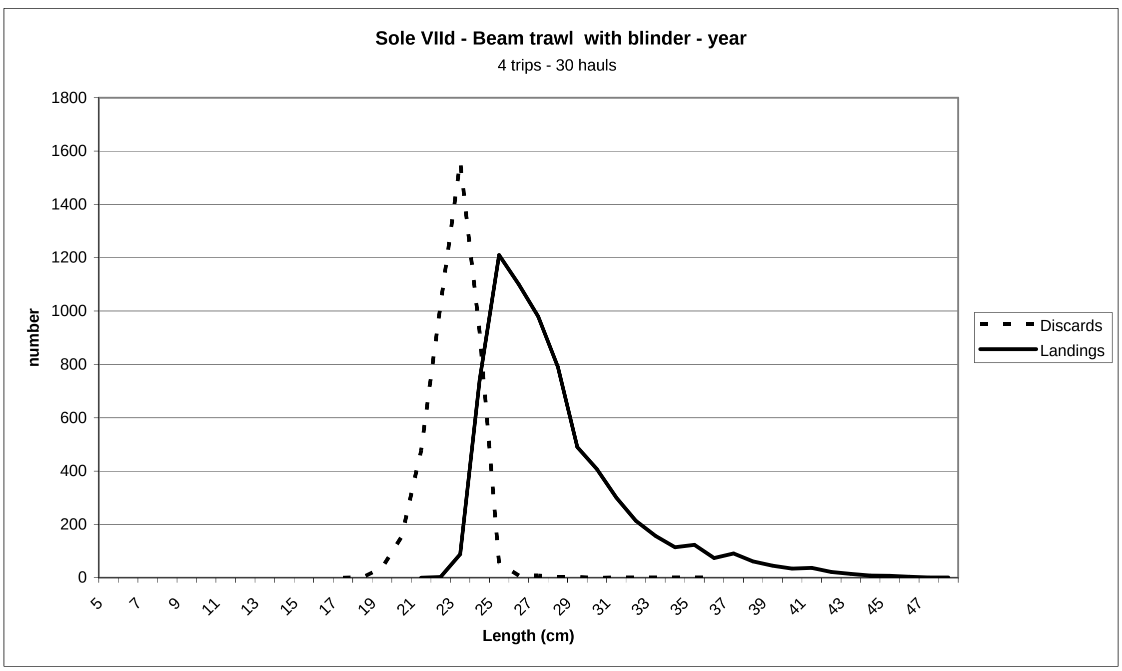


Figure 9.2.2a **Sole VIId - Effort series**

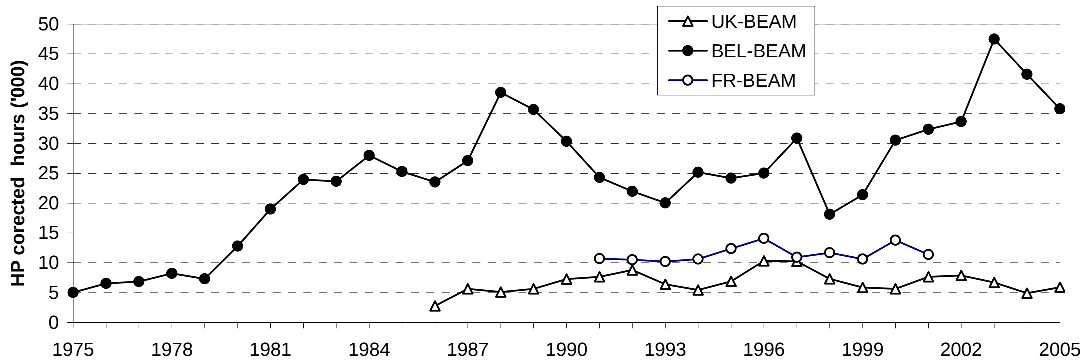


Figure 9.2.2b **Sole VIId - Relative LPUE series**

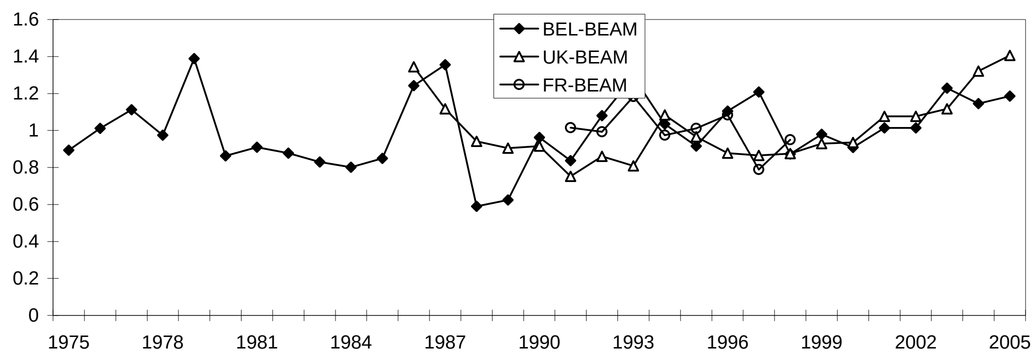


Figure 9.3.1 - VIId SOLE LOG CATCHABILITY RESIDUAL PLOTS - Final XSA

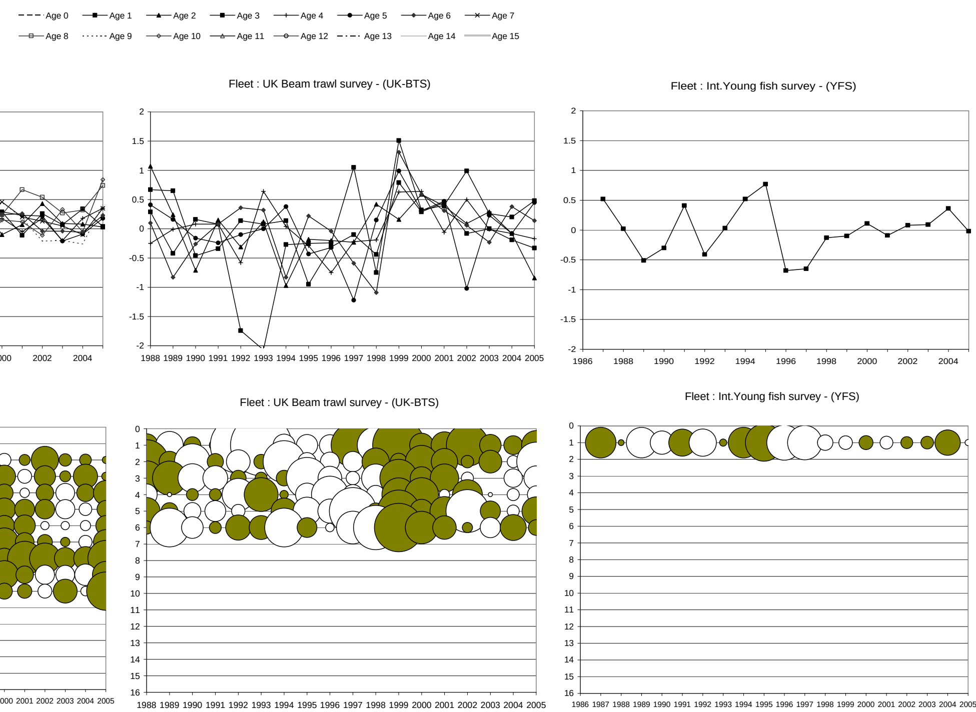
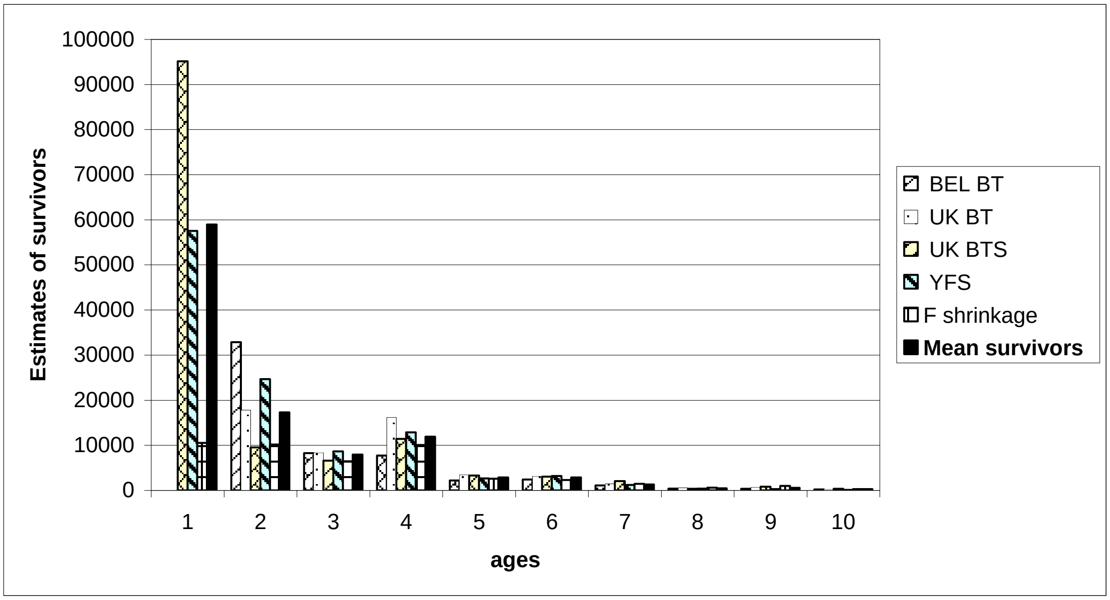


Figure 9.3.2 Sole in VIId. Estimates of survivors from different fleets and shrinkage, as well as their different weighting in the final XSA-run



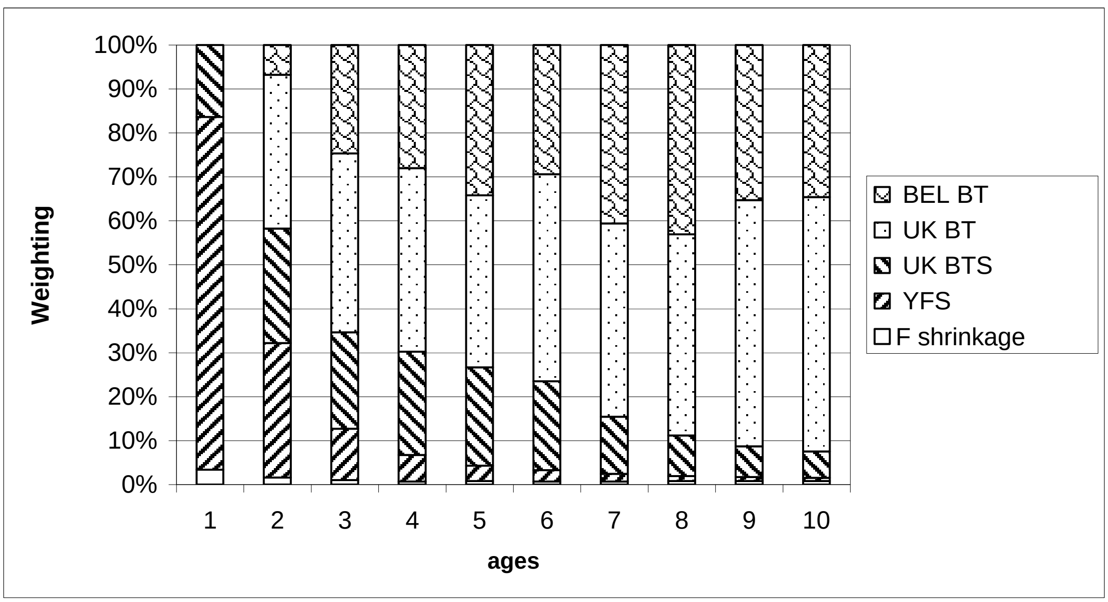


Figure 9.3.3 Sole in VIId. Summary plots

Recruitment in 2006 = GM 82-03 (shaded)
SSB in 2006 from forecast (square in graph)

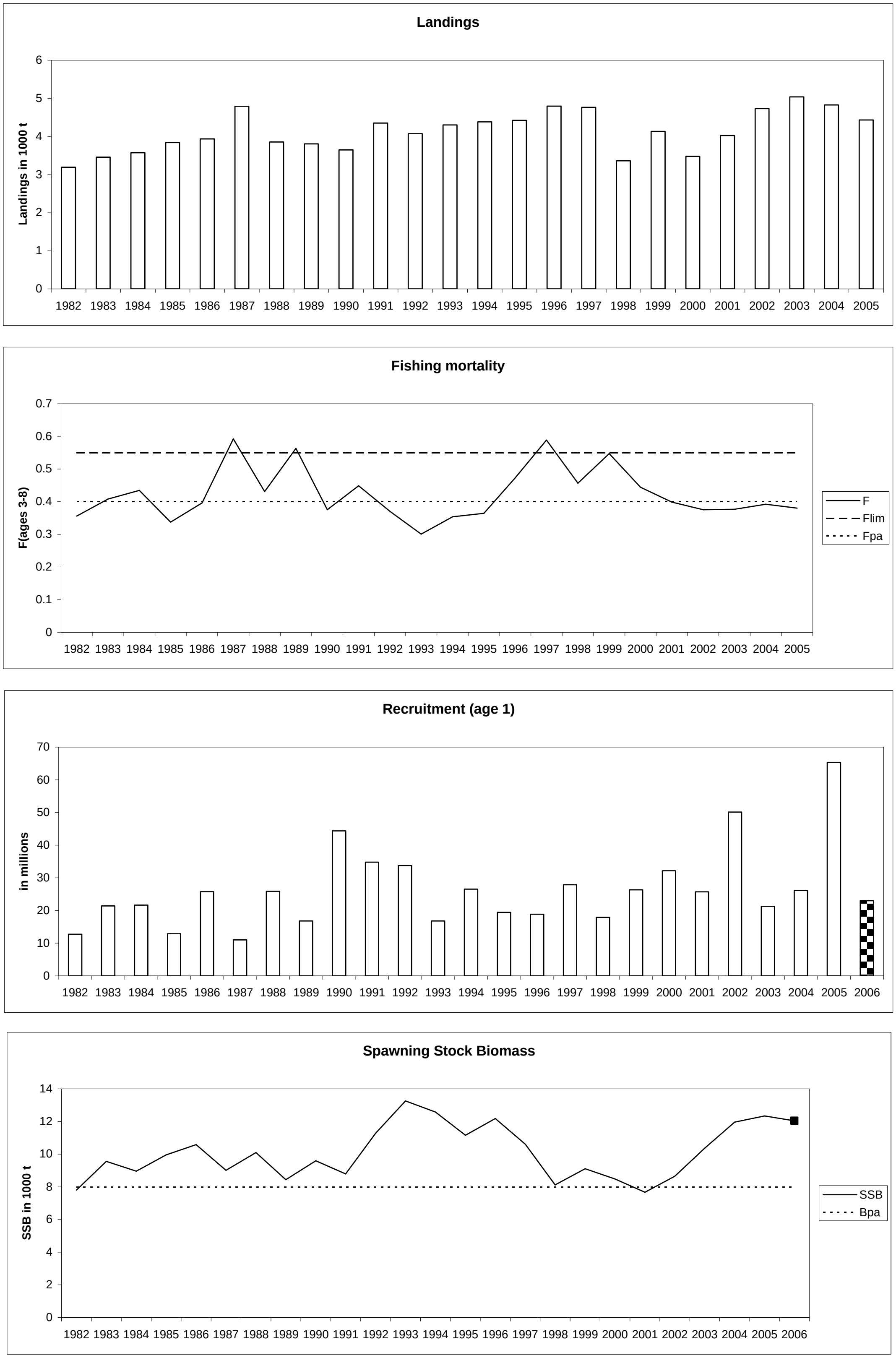


Figure 9.3.4 - Sole VIId retrospective XSA analysys (shinkage SE=2.0)

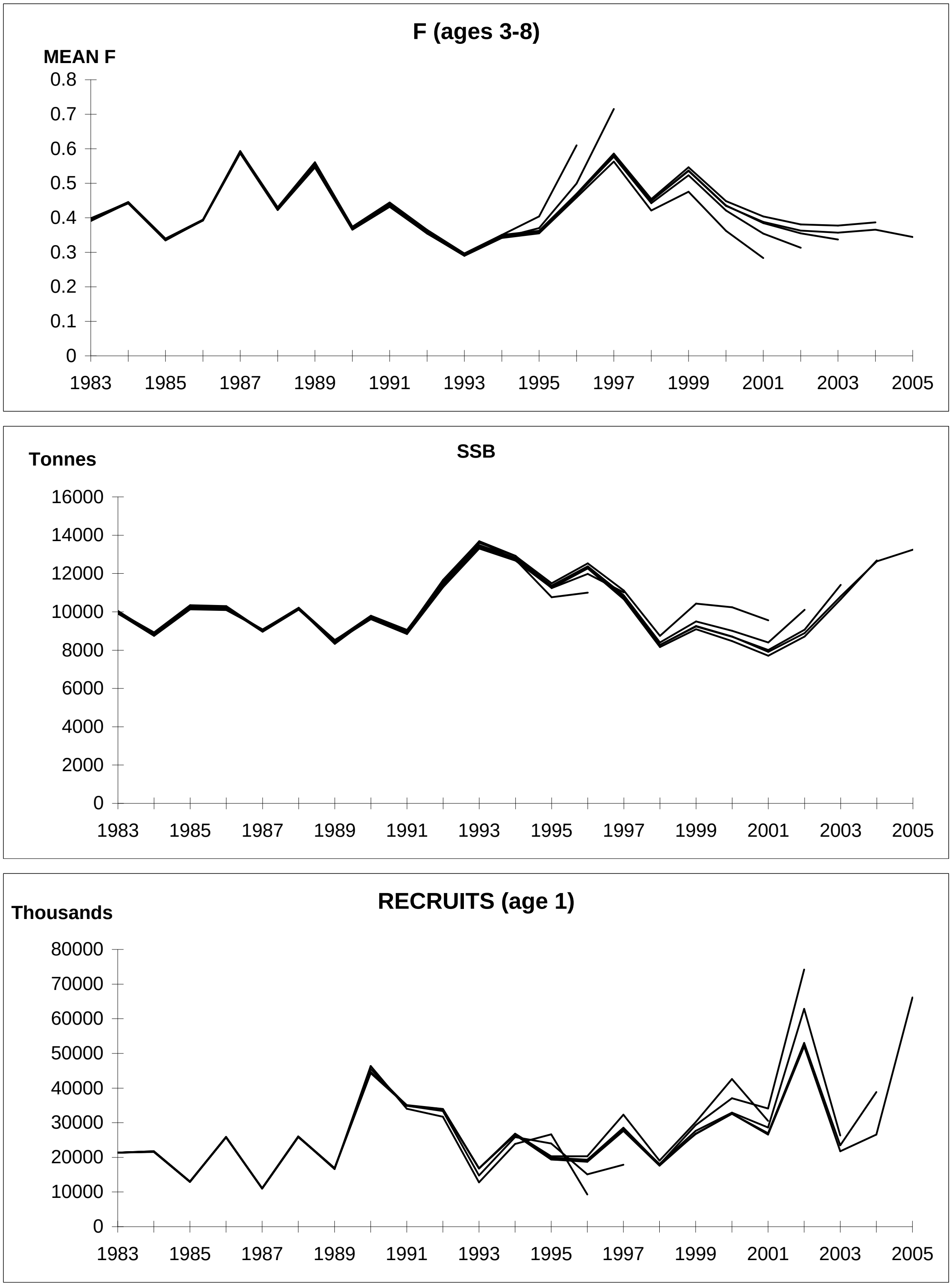
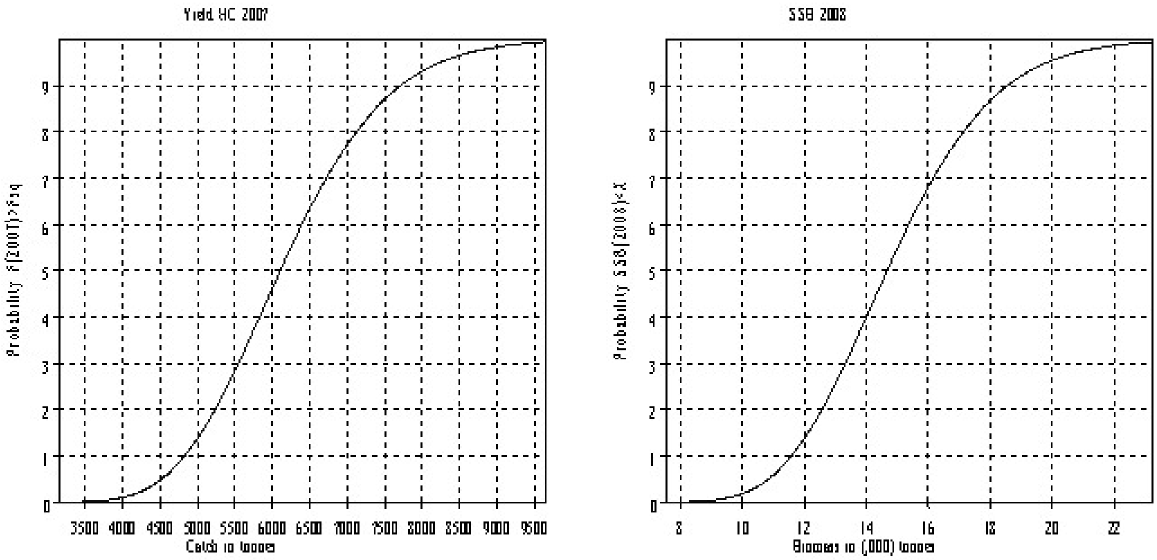
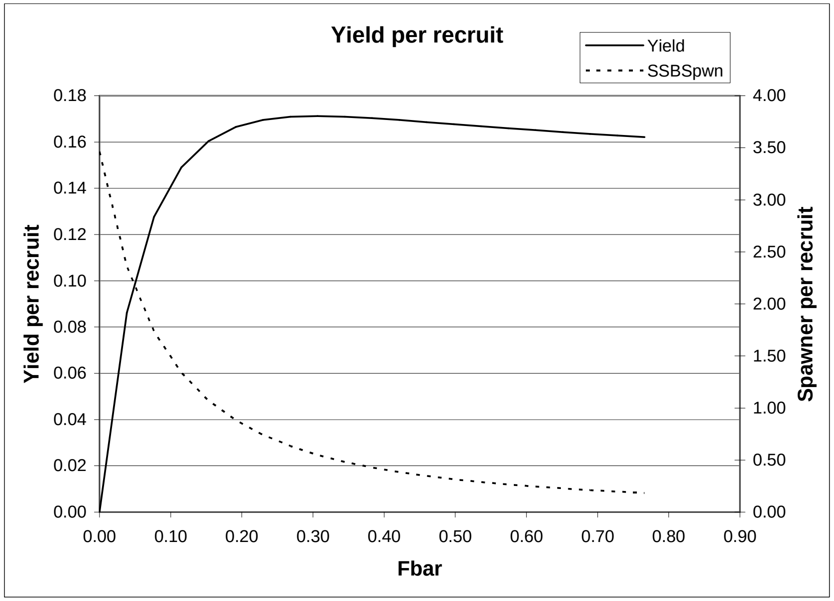


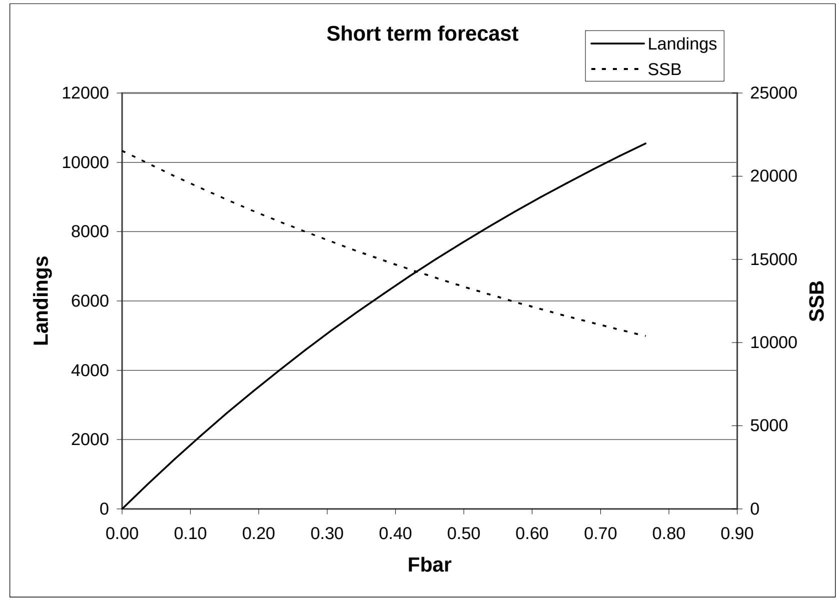
Figure 9.6.1 - Sole VIId - Probability profiles for short term forecast.



Data from file:E:\2006\WGNSSK_2006_pre\Sole7d\Prediction\Sensetivity_inven\Pie

Figure 9.7.1 - Sole in VIId Yield per recruit and short term forecast plots





MFYPR version 2a
Run: S7d_y_fin
Time and date: 17:50 06/09/2006

Reference point	F multiplier	Absolute F
Fbar(3-8)	1.0000	0.3830
FMax	0.7955	0.3047
F0.1	0.3318	0.1271
F35%SPR	0.3430	0.1314
Fmed	1.0468	0.4009
Fhigh	1.7463	0.6688

Weights in kilograms

MFDP version 1a
Run: Sol7d_fin
Sole in VIId
Time and date: 18:03 06/09/2006
Fbar age range: 3-8

Input units are thousands and kg - output in tonnes

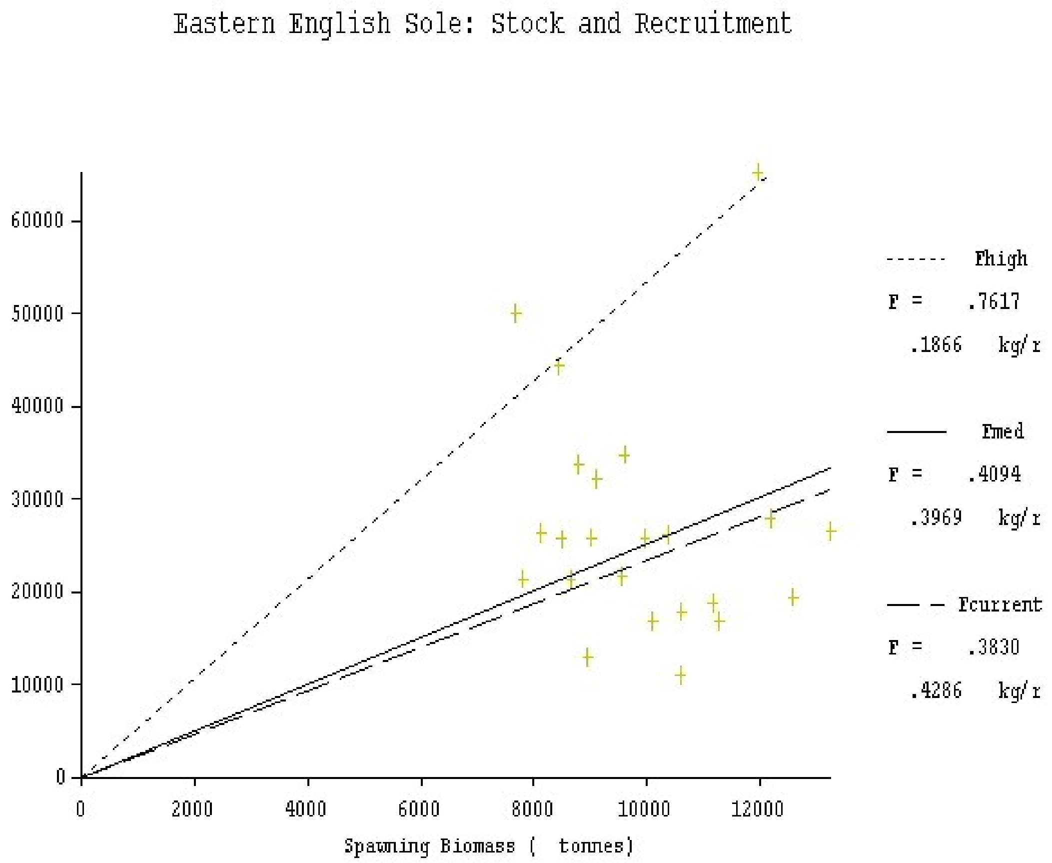


Figure 9.9.1 - Sole VIId Stock/recruitment plot

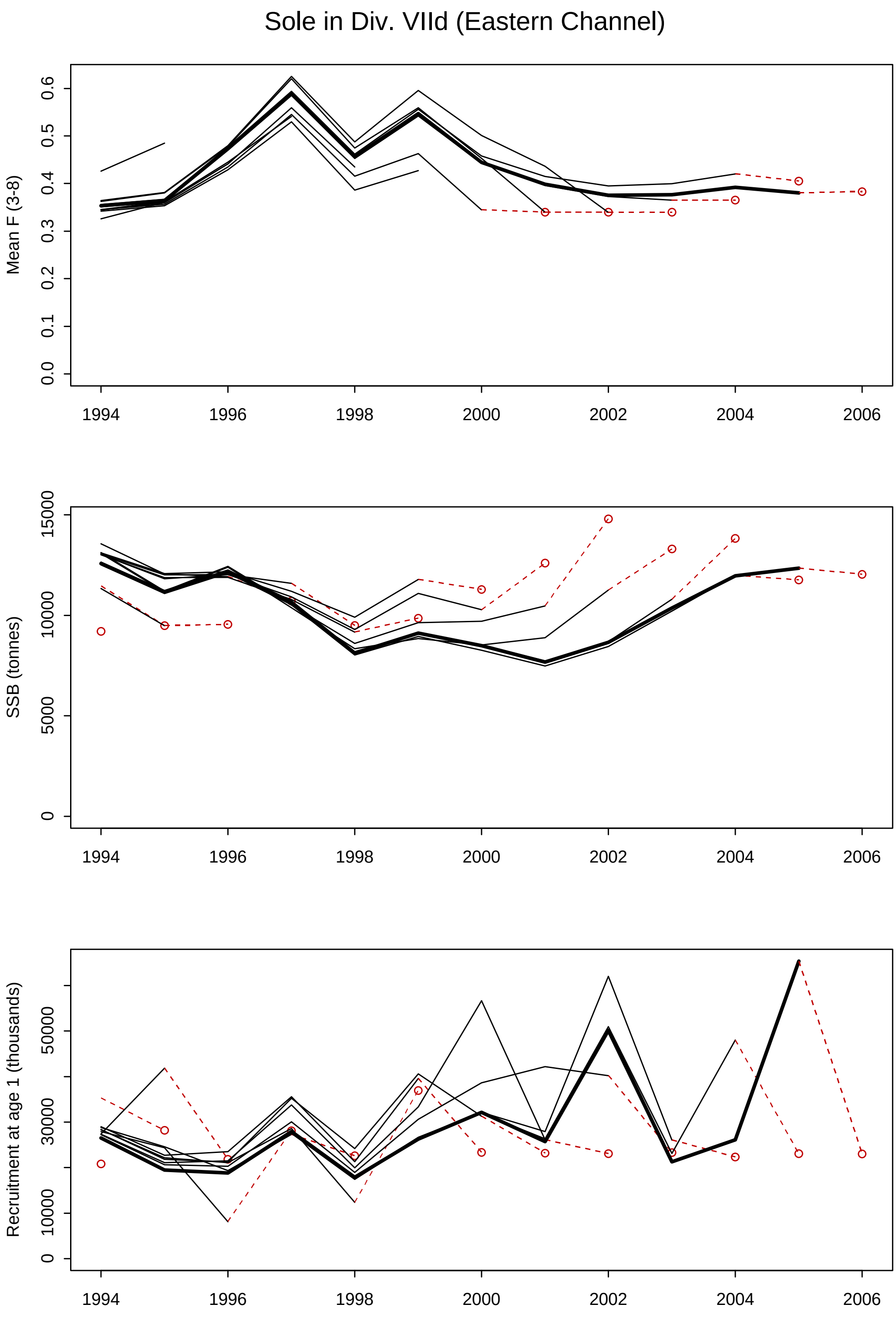


Figure 9.2.2. Sole in VIId. Historical performance of the assessment. Circles indicate forecasts.

10 Sole in Sub-Area IV

The assessment of sole in sub-area IV is presented as an update assessment. The most recent benchmark assessment was carried out in 2003.

10.1 General

10.1.1 Ecosystem aspects

Changes in growth of sole in relation to changes in environmental factors were analysed (Rijnsdorp et al., 2004) to explore changes in the productivity of the south-eastern North Sea. Based on market sampling data, Rijnsdorp et al. concluded that both length at age and condition factors of sole increased since the mid 1960s to a high point in the mid 1970s. Since the mid 1980s, length at age and condition have been intermediate between the low around 1960 and the high in the mid 1970s. Growth rate of the juvenile age groups was negatively affected by intra-specific competition. Length of 0-group fish in autumn showed a positive relationship with the temperature in the 2nd and 3rd quarter, but for the older fish no temperature effect could be detected. The overall pattern of the increase in growth and the later decline correlated with the temporal patterns in eutrophication, in particular the discharge of dissolved phosphates by the Rhine. Trends in the stock indicators e.g. SSB and recruitment did however not coincide with the observed patterns in eutrophication.

Mollet et al (2006) showed that age and size at first maturity shifted to younger ages and smaller sizes. These changes occurred from 1980 onwards.

In recent years no changes in the spatial distribution of juvenile and adult sole was observed (Grift et al. 2004, Verver et al, 2001) The proportion of undersized sole (<24 cm) inside the Plaice Box did not change after closure and remained stable at a level of 60-70% (Grift et al., 2004). The different length groups showed different patterns in abundance. Sole of around 5 cm showed a decrease in abundance from 2000 onwards, while the groups of 10 and 15 cm seemed rather stable. The largest groups showed a declining trend in abundance, which had already set in years before the closure.

10.1.2 Fisheries

Sole is mainly caught by beam trawlers. A large proportion of the fishing effort for sole is taken by the Dutch beam trawlers fishing for sole and plaice using 80 mm mesh size. The fishing effort of the Dutch fleet peaked mid 1990s and decreased thereafter to a level comparable to the 1980s. Apart from the Dutch fleet, Belgium and German beam trawlers, UK otter trawlers and a Danish fleet, fishing with fixed nets catch sole.

The effort restriction of days at sea regulation, currently high oil prices, and different changes in TAC between plaice and sole induced a more coastal fishing pattern in the southern North Sea, which is the area where sole and juvenile plaice are abundant. This could lead to increased discarding of plaice.

A change in efficiency of the commercial Dutch beam trawl fleet has been described by Rijnsdorp et al (2006).

In 2005 experimental fishing with an electric beam trawl using electric pulses instead of tickler chains to disturb sole from the sediment was explored. Because of the lighter gear, fuel consumption is lower and it is believed that this gear causes less physical damage on the bottom than a beam trawl with tickler chains, resulting in lower by-catches of benthic animals and better quality fish. The evaluation of the system has been hampered by lack of detailed information on the pulse characteristics used (pulse shape, height, frequency etc) all of which are known to affect fish in various ways. ICES advice on this issue is in preparation and will be released by ACFM after its October 2006 meeting.

10.1.3 ICES Advice

In 2005, based on the estimate of SSB and fishing mortality, ICES classifies the stock as having full reproductive capacity, and as being harvested sustainably. SSB in 2005 was estimated at 41 000 t which is above Bpa (35 000 t), while F in 2004 (0.35) is at or near Fpa. The 2002 year class is estimated to be relatively weak, similar to subsequent year classes.

Mixed fishery advice:

Demersal fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2006 be managed according to the following rules, which should be applied simultaneously:

- with minimal bycatch or discards of cod;
- Implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned for which reduction in fishing pressure is advised;
- within the precautionary exploitation limits for all other stocks;
- Where stocks extend beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits.
- With minimum by-catch of spurdog, porbeagle and thornback ray and skate.

Mixed fisheries management options should be based on the expected catch in specific combinations of effort in the various fisheries taking into consideration the advice given above. The distributions of effort across fisheries should be responsive to objectives set by managers, which is also the basis for the scientific advice presented above

10.1.4 Management

The TAC in 2006 was set at 17 670 tonnes, which is 930 tonnes lower then the agreed TAC of 2005 (Table 10.2.1).

The current Multi-annual guidance program (MAGP-IV) has defined national targets for EU fleet reductions in fleet capacity and/or days at sea. The minimum landing size of North Sea sole is 24 cm. A closed area has been in operation since 1989 (the plaice box) and since 1995 this area has been closed in all quarters. The closed area applies to vessels using towed gears, but vessels smaller than 300 HP are exempted from the regulation. An additional technical measure concerning the fishing gear is the restriction of the aggregated beam length of beam trawlers to 24 m. In the 12 nautical mile zone and in the plaice box the maximum aggregated beam-length is 9m.

Effort has been restricted because of implementation of days-at-sea regulation for the cod recovery plan (EC Council Regulation No. 2056/2001; EC Council Regulation 51/2006). For 2006 Council Regulation (EC) N°51/2006 allocates different days at sea depending on gear, mesh size and catch composition. (see section 2.1.2 for complete list). The days at sea limitations for the major fleets operating in sub-area IV could be summarised as follow: Beam trawlers can fish between 143-155 days per year. Trawls or Danish seines can fish between 103 and 280 days per year. Gillnets are allowed to fish between 140 and 162 days per year and Trammel nets between 140 and 205 days.

Technical measures applicable to the flatfish beam trawl fishery before 2000 were an exemption to use 80 mm mesh cod-end when fishing south of 55° North. From January 2000, the exemption area extends from 55° North to 56° North, east of 5° East latitude. Fishing with this mesh size is permitted within that area provided that the landings comprise at least 70% of a mix of species, which are defined in the technical measures of the EU (EC Council Reg. 1543/2000). From January 2002 the cod recovery plan was installed, allowing a maximum cod by-catch of 20% of the total catch. In the area extending from 55° North to 56° North, east of 5° East latitude, a maximum cod by-catch of 5% is allowed. Minimum cod-end mesh in this area is 100 mm, while above 56° North the minimum cod-end mesh is 120 mm (EC Council Reg. 2056/2001) .

10.2 Data available

10.2.1 Catch

Landings data by country and TACs are presented in Table 10.2.1 In 2005 88% of the TAC was taken, which is an unusually low percentage. The discards percentages observed in the Dutch discards sampling programme sampling beam trawl vessels fishing for sole with 80 mm mesh size were much lower for sole (for 2002-2005, between 13-17% in weight, see Table 10.2.2) than for plaice. No clear trends in discards percentages for North Sea sole were observed. Inclusion of a stable time series of discards in the assessment will have no major effect on the relative trends in stock indications (Kraak et al 2002; Van Keeken et al 2003). Also due to gaps in the discards sampling programs of North Sea sole, a complete time series of sole discards could not be obtained. No discards were included into the current assessment.

10.2.2 Age compositions

The age composition of the landings is presented in Table 10.2.3. The assessment has been carried out on the basis of landings rather than catches because discards at age are only partly available (see section 10.2.1). Age compositions and mean length at age in the landings were available on a quarterly basis from The Netherlands (by sex), UK and France (sexes combined). Age compositions on an annual basis were available from Belgium and Germany (sexes combined). Overall, the samples are thought to be representative for around 85 % of the total landings in 2005. The age compositions were combined separately by sex on a quarterly basis and then raised to the annual international total (see also section 1.2.4)

10.2.3 Weight at age

Weights at age in the landings (Table 10.2.4) are measured weights from the various national market sampling programs. Weights at age in the stock (Table 10.2.5) are the 2nd quarter landings weights. Over the entire time series, weights were higher during the 1980s compared to time periods before and after (Figure 10.4.1). Estimates of weights for older ages became more variable because of smaller samples sizes due to decreasing numbers of older fish in the stock.

10.2.4 Maturity and natural mortality

As in all previous assessments, a knife-edged maturity-ogive was used, assuming full maturation at age 3. The maturity-ogive is based on market samples of females from observations in the sixties and seventies. See Mollet et. al. (2006) for a description of the shift of the age at maturity towards younger ages.

Natural mortality in the period 1957-2005 has been assumed constant over all ages at 0.1, except for 1963 where a value of 0.9 was used to take into account the effect of the severe winter (1962-1963) (ICES-FWG 1979).

10.2.5 Catch, effort and research vessel data

One commercial and two survey series were used to tune the assessment. Effort for the Dutch commercial beam trawl is expressed as total HP effort days. Effort nearly doubled between

1978 and 1994 and declined since 1996. Effort is currently around the same level as it was in the early 1980s (Table 10.2.6 and 10.2.7, Figure 10.2.1).

Trends in commercial LPUE by area are shown in Figure 10.2.2. The data are based on landings into the Netherlands. There is a clear separation in LPUE between areas, with the southern area given a substantially higher LPUE than the Northern area. The overall pattern indicates a gradual decrease in LPUE over the time-series.

The BTS (Beam Trawl Survey) is carried out in the southern and south-eastern North Sea in August and September using an 8-m beam trawl. The SNS (Sole Net Survey) is a coastal survey with a 6-m beam trawl carried out in the 3rd quarter. In 2003 the SNS survey was carried out during the 2nd quarter and data from this year were omitted (Table 10.2.7 and Figure 10.2.3). The research vessel survey time series have been revised in May 2006 by WGBEAM (reference), because of small corrections in data bases and new solutions for missing lengths in the age-length-keys.

10.3 Data analyses

The assessment of North Sea sole by XSA was carried out in parallel, using the FLR version of XSA (FLXSA) and the Fortran version of XSA (Darby and Flatman 1994), which were found to give the same results (see also Section 1.3.3).

10.3.1 Reviews of last year's assessment

In the following bullet points the comments made in 2005 by the RGNSSK (Technical Minutes) that are relevant to this stock are summarised, and it is explained how this WG addressed the comments.

- "It was noted that the Sum of Products (SOP) correction was applied to the roundfish but not flatfish assessments. This correction should be applied in all WG assessments." The WG applies the SOP correction in the current report.
- "The issue of technological creep in this fishery featured strongly in the RG discussions, as did the use of commercial CPUE tuning at all". The technological creep will be discussed in section 10.3.2, using a recent publication of Rijnsdorp et. al. (2006).
- "The RG expressed concern about the strong retrospective pattern in mean F, which implies that the final-year decline may be artefactual." The updated assessment presented below confirms the decline in *F* in 2004 that was suggested by last year's assessment.

Apart from the issues above, The RG noted that the following should be addressed in the next benchmark: Sources of retrospective pattern: e.g. misreporting.; Value of Flim; Calculation of F on oldest age group; Trends in mean weights & maturity.

10.3.2 Exploratory catch-at-age-based analyses

Analysis of the change in efficiency of the commercial fleet (NL) used for tuning, was based on a paper of Rijnsdorp et. al. (2006). In the paper FpUEs for each week imposed by individual fishing vessels (beam trawlers) on North Sea plaice and sole stocks from 1990 to 2004 were estimated. FpUE was calculated as the multiplication of the ratio c:C with the ratio F:d, where c is the partial landing of an individual vessel; C is the total (quarterly) landings; F is the (quarterly) fishing mortality of the total fleet and d is the number of days fished by the vessel. This FpUE, fishing mortality induced per unit of effort per day at sea, can be interpreted directly as catchability (q). Overall the efficiency of the fleet increased with an average of 2.8%, but the actual average values per year showed discrepancies from this trend.

Yearly averages of the FpUE were analyzed by segmented linear regression to detect if this fits the trend better to the data points than the overall linear increasing trend.

The scatter of yearly average FpUE and the different trend lines are shown in Figure 10.3.1. Breakpoints in year 1994, 1995, 1996 and 1997 were set to explore the best fitted line. Overall regression (2.8% increase per year) showed an error sum of squares of 38.7. This residual sum of squares was reduced to 17.4, 4.2 and 10.1 when regression breaks were set in 1994, 1995 and 1996/1997 respectively. The resulting F^{1}_{11} values were 13, 90 and 31 respectively, all being highly significant. A break in 1994 resulted in a segmented linear regression increasing up to 1996 and decreasing thereafter. The linear increase was 9% per year, up to 1996 and the downward trend thereafter was 1% per year. To fit the line with a break in 1995, a step from 1995 to 1996 of 27 % efficiency increase had to be introduced to connect the two segments. The initial increase of the segmented line was 7 % per year. After the stepwise increase from 1995 to 1996 the decrease in efficiency was 3.5% per year. Breaks in 1996 or 1997 resulted in a segmented regression with a linear increase of 9% per year up to 1997 and decreasing by 3.5% per year thereafter (Figure 10.3.1).

A preliminary XSA for all these options were executed and compared with an XSA without technology creep and the one with an efficiency increase of 2.8% per year. The results are shown in Figures 10.3.2 & 10.3.3 for estimated fishing mortality and SSB respectively.

The resulting final F and SSB estimates cluster close above (F) and below (SSB) the estimate without inclusion of the technical creep. The XSA diagnostics showed that with the inclusion of the segmented creep, a better fit of the commercial index file with the catch matrix was achieved. The performance was specifically better for age 2 and 3. The diagnostics on terminal year survivors and F summaries showed an increase of the scaled weights from 0.157 to 0.247 for age 2 when corrected for technological creep. For age 3 the increase was from 0.401 to 0.442. It seems that including a (segmented) technology creep results in improved XSA results.

A constant increase of 2.8% results in an overestimate of the efficiency in the last period. Although a segmented trend improved the XSA performance it was concluded to continue with the final assessment omitting the creep effects, because the information on the efficiency development (catchability) was partly based on stock assessment results and put back in the model. In this way the data consistency relates back to earlier assessment results and will always result in a better fitting. Moreover the extrapolation of the trend found up to 2004 will increase the uncertainty on the development of fishing efficiency even more unless some external evidence can be found.

The low mean F for 2004 (0.35) found in the 2005 assessment was confirmed in the current assessment (0.36)

10.3.3 Exploratory survey-based analyses

No survey-based analysis was carried out in this year’s WG.

10.3.4 Conclusions drawn from exploratory analyses

The WG concluded to do the final assessment with the NL beam trawl as commercial tuning series, without correcting the effort for technology creep

10.3.5 Final assessment

Catch at age analysis was carried out with XSA using the settings given below.

YEAR	2004	2005	2006
Catch at age	Landings	Landings	Landings
Fleets	BTS-Isis1985-2003 SNS 1982-2002 Nl-BT 1990-2003	BTS-Isis 1985-2004 SNS 1982-2002 Nl-BT 1990-2004	BTS-Isis 1985-2005 SNS 1982-2005 Nl-BT 1990-2005
Plus group	10	10	10
First tuning year	1982	1982	1982
Last data year	2003	2004	2005
Time series weights	No taper	No taper	No taper
Catchability dependent on stock size for age <	2	2	2
Catchability independent of ages for ages >=	7	7	7
Survivor estimates shrunk towards the mean F	5 years / 5 ages	5 years / 5 ages	5 years / 5 ages
s.e. of the mean for shrinkage	2.0	2.0	2.0
Minimum standard error for population estimates	0.3	0.3	0.3
Prior weighting	Not applied	Not applied	Not applied

The full diagnostics are presented in Table 10.3.1 A summary of the input data is given in Figure 10.4.1. Figure 10.3.4 shows the log catchability residuals for the tuning fleets in the final run. Figures 10.3.5 show the time series of the estimated stock numbers at age in comparison to the tuning series. Fishing mortality and stock numbers per age group are shown in Tables 10.3.2 and 10.3.3 respectively. The SSB in 2005 was estimated at ~38 000 t. Mean F(2-6) was estimated at 0.45. Recruitment of the 2004 year class, in 2005 at the age of 1, was estimated at ~45 million. Retrospective analysis is presented in Figure 10.3.6. Downwards biases of mean *F* estimates from 1999 to 2003 were observed. In the same period upwards biases of the SSB estimates were found. Recruit estimates were relatively unbiased.

10.4 Historic Stock Trends

Table 10.4.1. and Figure 10.4.2 present the trends in landings, mean F(2-6), SSB, and recruitment since 1957.

Reported landings increased to the end of the 1960s, showed a period of lower landings until the end of the 1980s and a period of higher landings (30 000 t) again during the early 1990s. In 2005 landings were estimated to be around 16 000 t.

Recruitment was high in 1959 and 1964 and SSB increased from the end of the 1950s to a peak in early 1960s, followed by a period of declining SSB until the 1990s. Recruitment was high in 1988 and 1992. Between 1990-1995 a period of higher SSB was observed. The SSB in 2005 decreased compared to 2004. The SSB in 2005 is estimated at 38 000 t. The year-classes 2003 and 2004 show low recruitment level for 2 consecutive years. Recruitment in 2005 of the 2004 year class at the age of 1 was estimated at 45 million, the lowest observed since the late 1970s.

The mean fishery mortality on age 2-6 increased with large variation from circa 0.4-0.5 per year around 1970 to 0.5 to 0.6 per year at present. In recent years fishing mortality has decreased gradually. In 2005 fishing mortality increased compared to 2004 from 0.36 to 0.45 per year.

10.5 Recruitment estimates

Recruitment estimation was carried using RCT3. Input to the RCT3 model is presented in Table 10.5.1 for age-1 and Table 10.5.2 for age-2. Results are presented in Table 10.5.3 for age-1 and Table 10.5.4 for age-2. Average recruitment of 1-year-old-fish in the period 1957-2003 was around 97 million (geometric mean). For year class 2005 (age 1 in 2006) the value predicted by the RCT3 was similar as the geometric mean (Table 10.5.2.), and therefore the geometric mean was accepted for the short-term forecasts. For year class 2004 (age 2 in 2006), the data coming from DFS 1-group are noisy (high s.e. of the predicted value, Table 10.5.3.). Apart from DFS data the RCT3 estimate is based on the same data as the XSA; the WG finds it not desirable to use the same data twice and therefore accepts the XSA estimate. The year class strength estimates from the different sources are summarized in the text table below and the estimates used for the short-term forcast are underlined.

YEAR CLASS	AGE IN 2006	XSA THOUSANDS	RCT3 THOUSANDS	GM(1957-2003) THOUSANDS
2004	2	**39 898**	46 844	85 353
2005	1		82 611	**96 733**
2006	Recruit			**96 733**

10.6 Short-term forecasts and yield-per-recruit analyses

The short-term forecasts were carried out according to the specifications in the Stock Annex (Q10). The software used was WGFRANSW and FLR.

Weight-at-age in the stock and weight-at-age in the catch were taken to be the average over the last 3 years. The exploitation pattern was taken to be the mean value of the last three years, scaled to F in 2005. Population numbers at ages 2 and older are XSA survivor estimates. Numbers at age 1 and recruitment of the 2006 year-class are taken from the long-term geometric mean (1957-2003: 97 million).

Input to the short term forecast is presented in Table 10.6.1.The management options are given in Table 10.6.2. F in 2006 is set at the status quo level. The detailed table for a forecast based on Fsq is given in Table 10.6.3. At status quo fishing mortality in 2007 and 2008, SSB is expected to decrease from 30 100 t in 2006 to 24 400 t in 2007. The 2008 SSB is predicted to be 27 600 t. The landings at Fsq are expected to be around 13 400 t in 2006 which is below the 2006 TAC (17470) and slightly lower than last years status quo forecast (14 500 t). The landings in 2007 are predicted to be around 12 400 t at Fsq. In order to bring SSB above Bpa in 2008, fishing in 2007 would have to be around 0.3 * Fsq, corresponding with a yield of around 4 300 t.

The probability-profile plot in Figure 10.6.1 (top panel) shows that the 90% confidence interval for the 2007 yield is from 8 000 to 19 000 t . Figure 10.6.1 (lower panel) also shows that fishing at Fsq in 2007 has a high probability (around 80%) that SSB will stay below Bpa of 35 000 t in 2008, whereas the probability that SSB will fall below Blim (25 000 t) is around 45%.

Figure 10.6.2 shows the projected contribution of different sources of information to estimates of the landings in 2007 and of the SSB in 2008, when fishing at Fsq in 2007. The landings in 2007 will consist for a large part of uncertain year classes (2002-2006), and for almost 35% of year classes for which the geometric mean was taken (2004-2006). Other stock number estimates originate from XSA.

Yield and SSB, per recruit, under the condition of the current exploitation pattern and assuming Fsq as exploitation rate in 2006 are given in Table 10.6.4 and Figure 10.6.3. Fmax is estimated at 0.43.

10.7 Medium-term forecasts

No medium term projections were done this year.

10.8 Biological reference points

The current reference points are $\mathbf{B_{lim}}$= $\mathbf{B_{loss}}$= 25 000 t. and $\mathbf{B_{pa}}$ can then be set at 35 000 t using the default multiplier of 1.4. $\mathbf{F_{pa}}$ was proposed to be set at 0.4 which is the 5th percentile of $\mathbf{F_{loss}}$ and gave a 50% probability that SSB is around $\mathbf{B_{pa}}$ in the medium term. Equilibrium analysis suggests that F of 0.4 is consistent with an SSB of around 35 000 t.

	ICES CONSIDERED THAT:	ICES PROPOSED THAT:
Precautionary Approach Reference point	$\mathbf{B_{lim}}$ is 25 000 t	$\mathbf{B_{pa}}$ be set at 35 000 t
		$\mathbf{F_{pa}}$ be set at 0.40
Target reference points		$\mathbf{F_{y}}$ undefined

The management plan for North Sea plaice and sole that is proposed by the EC (5403/06 PECHE 14) uses the target reference **F** of 0.2, implicitly equating it to F_{MSY} (see section 16.3 and Machiels et al 2006, WD6).

10.9 Quality of the assessment

This year’s assessment of North Sea sole was carried out as an update assessment. Retrospective patterns from previous years suggested that F has been underestimated in previous years, and SSB overestimated. This was not confirmed in this year’s assessment results. The low terminal mean *F* (2005) estimate for 2004 of 0.35 was confirmed by the current assessment as 0.36. The (2005) SSB estimate for 2004 was 42 000 t and also confirmed in the current assessment being 40 000 t. The historic performance of the assessment is summarized in Figure 10.10.1.

The results from the North Sea Stock Survey (see Section 1 and Figure 10.10.2) indicate that perceptions of the sole abundance are significantly different in all areas. When comparing the results to last years, areas in the north and west of the North Sea (areas 1, 3 and 4) showed strong modal responses for the “same” abundance while areas in the east and southeast (areas 6a, 6b and 7) showed strong responses indicating a decline in abundance. In the north-east (areas 8 and 9) there majority indicated either no change or an increase in abundance. In area 5 perceptions were fairly evenly split between “less”, “same” and “more”. The XSA assessment showed a decrease in SSB in 2005 compared to 2004, caused by an average year class 2002 (90 000 thousand) and the strong 2001 year class being caught.

Rijnsdorp et al. (2006) show that the catch efficiency has increased for sole by on average 2.8 % annually from 1990 to 2004. This increase was related to 1) increase in efficiency during the time a vessel is in operation, 2) vessel replacement and 3) engine upgrading. The time series of the technological creep has been scrutinized during this assessment (see Section 10.3.2) and the effect of including it in the calibration of the assessment was quantified. The WG concluded not to correct the effort series of the Dutch beam trawl fleet that is used in the calibration of the assessment for the increase in technical efficiency because the overall trend of an increase of 2.8% per year was not constant over the time period studied. A steep positive trend was observed until 1997 and a negative trend thereafter. Because the results up to 2003 are extrapolated to 2005, the quantification of the change in efficiency is uncertain. It is necessary to find some external evidence before the change in technical efficiency is included in the calibration of the assessment.

During the next benchmark assessment for this stock, attention should be paid to the following issues:

- In 2003 the plus-group was set from age 15 to age 10. The choice to reduce the plusgroup to age 10 needs further analysis.
- Follow changes in technical efficiency in the commercial fleets and look for external evidence.
- Trends in mean weights and maturity and how that could affect the assessment and forecasts.

10.10 Status of the Stock

Fishing mortality was estimated at 0.45 in 2005, Fishing mortality appears to be above Fpa (=0.4). The SSB in 2005 was estimated at 38 000 t which is above Bpa (=35 000 t). The strong 2001 year class is succeeded by an average year class in 2002 and two weak year classes in 2003 and 2004. Projected landings for 2007 at Fsq are 12 500 t. lower than projected landings for 2006 (13 500)

10.11 Management Considerations

Sole is mainly taken by beam trawlers in a mixed fishery with plaice in the southern and central part of the North Sea. Fishing effort has been substantially reduced since 1995. The reduction in fishing effort appears not to be reflected in the most recent estimates in fishing mortality. It seems that technical efficiency has increased in this fishery up to mid 1990s, and decreased thereafter. The reason for this pattern is not clear. The overall increase of efficiency has partly counteracted the overall decrease in effort.

Technical measures applicable to the mixed flatfish fishery will affect both sole and plaice. The minimum mesh size of 80 mm in the beam trawl fishery selects sole at the minimum landing size. However, this mesh size generates high discards of plaice. Mesh enlargement would reduce the catch of undersized plaice, but would also result in loss of marketable sole. The combination of days-at-sea regulations, higher oil prices, and decreasing TAC for plaice and relatively stable TAC for sole, appear to have induced a shift in fishing effort towards the southern North Sea. This concentration of fishing effort result in higher plaice discards because juveniles are mainly distributed in this area.

The sole stock dynamics is heavily dependent on the occasional occurrence of strong year classes. The mean age in the landings is currently just above age 3, but used to be around age 6 in the beginning of the time series. A lower exploitation level is expected to improve the survival of sole to the spawning population, which could enhance the stability in the catches.

Table 10.2.1 Sole in Sub-Area IV: Nominal landings and landings as estimated by the Working Group (tonnes).

Year	Belgium	Denmark	France	Germany	Netherlands	UK (E/W/NI)	Other countries	Total reported	Unallocated landings	WG Total	TAC
1982	1900	524	686	266	17686	403	2	21467	112	21579	21000
1983	1740	730	332	619	16101	435		19957	4970	24927	20000
1984	1771	818	400	1034	14330	586	1	18940	7899	26839	20000
1985	2390	692	875	303	14897	774	3	19934	4314	24248	22000
1986	1833	443	296	155	9558	647	2	12934	5266	18200	20000
1987	1644	342	318	210	10635	676	4	13829	3539	17368	14000
1988	1199	616	487	452	9841	740	28	13363	8227	21590	14000
1989	1596	1020	312	864	9620	1033	50	14495	7311	21806	14000
1990	2389	1427	352	2296	18202	1614	263	26543	8577	35120	25000
1991	2977	1307	465	2107	18758	1723	271	27608	5905	33513	27000
1992	2058	1359	548	1880	18601	1281	277	26004	3337	29341	25000
1993	2783	1661	490	1379	22015	1149	298	29775	1716	31491	32000
1994	2935	1804	499	1744	22874	1137	298	31291	1711	33002	32000
1995	2624	1673	640	1564	20927	1040	312	28780	1687	30467	28000
1996	2555	1018	535	670	15344	848	229	21199	1452	22651	23000
1997	1519	689	99	510	10241	479	204	13741	1160	14901	18000
1998	1844	520	510	782	15198	549	339	19742	1126	20868	19100
1999	1919	828		1458	16283	645	501	21634	1841	23475	22000
2000	1806	1069	362	1280	15273	600	539	20929	1603	22532	22000
2001	1874	772	411	958	13345	597	394	18351	1593	19944	19000
2002	1437	644	266	759	12120	451	292	15969	976	16945	16000
2003	1605	703	728	749	12469	521	363	17138	782	17920	15850
2004	1477	808	655	949	12860	535	544	17828	-681	17147	17000
2005	1374	831	676	756	10917	667	357	15579	776	16355	18600

*

Table 10.2.2 Sole in sub-area IV: Overview of landings and discards numbers and weights (kg) per hour and there percentages in the Dutch discards

		Numbers			Weight		
Period	trips	Landings	Discards	%D	Landings	Discards	%D
	n	$n \cdot h^{-1}$	$n \cdot h^{-1}$		$kg \cdot h^{-1}$	$kg \cdot h^{-1}$	
1976-1979	21	116	8	6%	38	1	3%
1980-1983	22	84	23	21%	27	3	9%
1989-1990	6	286	83	22%	72	11	13%
1999-2001	20	92	21	19%	22	2	8%
2002	6	124	37	24%	18	3	13%
2003	9	95	32	25%	20	3	14%
2004	8	174	58	25%	28	5	17%
2005	9	99	29	23%	20	2	11%

Table 10.2.3 Sole in sub-area IV: Landings numbers at age (thousands)

[1] 2006-09-07 17:33:27 units= thousands

year	age 1	2	3	4	5	6	7	8	9	10
1957	0	1415	10148	12642	3762	2924	6518	1733	509	6288
1958	0	1854	8440	14169	9500	3484	3008	4439	2253	6557
1959	0	3659	12025	10401	8975	5768	1206	2025	2574	5615
1960	0	12042	14133	16798	9308	8367	4846	1593	1056	7901
1961	0	959	49786	19140	12404	4695	3944	4279	836	7254
1962	0	1594	6210	59191	15346	10541	4826	4112	2087	7494
1963	0	676	8339	8555	46201	8490	6658	2423	3393	8384
1964	55	155	2113	5712	3809	17337	3126	1810	818	3015
1965	0	47100	1089	1599	5002	2482	12500	1557	1525	3208
1966	0	12278	133617	990	1181	3689	744	6324	702	2450
1967	0	3686	25683	85127	1954	536	1919	760	5047	2913
1968	1037	17148	13896	24973	48571	462	245	1644	324	6523
1969	396	23922	21451	5326	12388	25139	331	244	1190	5272
1970	1299	6140	25993	8235	1784	3231	11960	246	140	5234
1971	420	33369	14425	12757	4485	1442	2327	7214	192	4594
1972	358	7594	36759	7075	4965	1565	523	1232	4706	2801
1973	703	12228	12783	16187	4025	2324	994	765	1218	5790
1974	101	15380	21540	5487	7061	1922	1585	658	401	4814
1975	264	22954	28535	11717	2088	3830	790	907	508	3445
1976	1041	3542	27966	14013	4819	966	1909	550	425	2663
1977	1747	22328	12073	15306	7440	1779	319	1112	256	2115
1978	27	25031	29292	6129	6639	4250	1738	611	646	1602
1979	9	8179	41170	16060	2996	3222	1747	816	241	1527
1980	637	1209	12511	17781	7297	1450	2197	1409	367	1203
1981	423	29217	3259	6866	8223	3661	948	886	766	908
1982	2660	26435	45746	1843	3535	4789	1678	615	605	1278
1983	389	34408	41386	21189	624	1378	1950	978	386	1176
1984	191	30734	43931	22554	8791	741	854	1043	524	894
1985	165	16618	43213	20286	9403	3556	209	379	637	975
1986	374	9363	18497	17702	7747	5515	2270	110	283	1682
1987	94	29053	22046	8899	6512	3119	1567	903	81	694
1988	10	13219	47182	15232	4381	3882	1551	891	524	317
1989	117	46387	18263	22654	4624	1653	1437	647	458	468
1990	863	11939	104454	9767	9194	3349	1043	1198	554	845
1991	120	13163	25420	77913	6724	3675	1736	719	730	1090
1992	980	6832	44378	16204	38319	2477	3041	741	399	1180
1993	54	50451	16768	31409	13869	24035	1489	1184	461	842
1994	718	7804	87403	13550	18739	5711	11310	464	916	908
1995	4801	12767	16822	68571	6308	7307	1995	6015	295	668
1996	172	18824	16190	16964	27257	3858	4780	943	3305	988
1997	1590	6047	23651	7325	5108	12793	1201	2326	333	1688
1998	244	56648	15141	14934	3496	1941	4768	794	1031	846
1999	287	15762	72470	8187	6111	1212	664	1984	331	812
2000	2351	15073	32738	42803	3288	2477	804	435	931	714
2001	884	25846	21595	19876	16730	1427	834	274	168	724
2002	1055	11053	32852	12290	8215	6448	673	597	89	364
2003	1048	32330	17498	16090	5820	3906	2430	400	128	451
2004	278	13972	46475	7033	6316	1486	799	677	169	154
2005	1027	6818	22622	29365	5543	3812	1772	477	884	455

Table 10.2.4 Sole in sub-area IV: Landing weights at age (kg)

[1] 2006-09-07 17:40:54 units= kg

year \ age	1	2	3	4	5	6	7	8	9	10
1957	0.000	0.154	0.177	0.204	0.248	0.279	0.290	0.335	0.436	0.408
1958	0.000	0.145	0.178	0.220	0.254	0.273	0.314	0.323	0.388	0.413
1959	0.000	0.162	0.188	0.228	0.261	0.301	0.328	0.321	0.373	0.426
1960	0.000	0.153	0.185	0.235	0.254	0.277	0.301	0.309	0.381	0.418
1961	0.000	0.146	0.174	0.211	0.255	0.288	0.319	0.304	0.346	0.419
1962	0.000	0.155	0.165	0.208	0.241	0.295	0.320	0.321	0.334	0.412
1963	0.000	0.163	0.171	0.219	0.258	0.309	0.323	0.387	0.376	0.485
1964	0.153	0.175	0.213	0.252	0.274	0.309	0.327	0.346	0.388	0.480
1965	0.000	0.169	0.209	0.246	0.286	0.282	0.345	0.378	0.404	0.480
1966	0.000	0.177	0.190	0.180	0.301	0.332	0.429	0.399	0.449	0.501
1967	0.000	0.192	0.201	0.252	0.277	0.389	0.419	0.339	0.424	0.491
1968	0.157	0.189	0.207	0.267	0.327	0.342	0.354	0.455	0.465	0.508
1969	0.152	0.191	0.196	0.255	0.311	0.373	0.553	0.398	0.468	0.523
1970	0.154	0.212	0.218	0.285	0.350	0.404	0.441	0.463	0.443	0.533
1971	0.145	0.193	0.237	0.322	0.358	0.425	0.420	0.490	0.534	0.547
1972	0.169	0.204	0.252	0.334	0.434	0.425	0.532	0.485	0.558	0.629
1973	0.146	0.208	0.238	0.346	0.404	0.448	0.552	0.567	0.509	0.586
1974	0.164	0.192	0.233	0.338	0.418	0.448	0.520	0.559	0.609	0.653
1975	0.129	0.182	0.225	0.320	0.406	0.456	0.529	0.595	0.629	0.669
1976	0.143	0.190	0.222	0.306	0.389	0.441	0.512	0.562	0.667	0.665
1977	0.147	0.188	0.236	0.307	0.369	0.424	0.430	0.520	0.562	0.619
1978	0.152	0.196	0.231	0.314	0.370	0.426	0.466	0.417	0.572	0.666
1979	0.137	0.208	0.246	0.323	0.391	0.448	0.534	0.544	0.609	0.763
1980	0.141	0.199	0.244	0.331	0.371	0.418	0.499	0.550	0.598	0.684
1981	0.143	0.187	0.226	0.324	0.378	0.424	0.442	0.516	0.542	0.630
1982	0.141	0.188	0.216	0.307	0.371	0.409	0.437	0.491	0.580	0.656
1983	0.134	0.182	0.217	0.301	0.389	0.416	0.467	0.489	0.505	0.642
1984	0.153	0.171	0.221	0.286	0.361	0.386	0.465	0.555	0.575	0.634
1985	0.122	0.187	0.216	0.288	0.357	0.427	0.447	0.544	0.612	0.645
1986	0.135	0.179	0.213	0.299	0.357	0.407	0.485	0.543	0.568	0.610
1987	0.139	0.185	0.205	0.277	0.356	0.378	0.428	0.481	0.393	0.657
1988	0.127	0.175	0.217	0.270	0.354	0.428	0.484	0.521	0.559	0.712
1989	0.118	0.173	0.216	0.288	0.336	0.375	0.456	0.492	0.470	0.611
1990	0.124	0.183	0.227	0.292	0.371	0.413	0.415	0.514	0.476	0.620
1991	0.127	0.186	0.210	0.263	0.315	0.436	0.443	0.467	0.507	0.558
1992	0.146	0.178	0.213	0.258	0.298	0.380	0.409	0.460	0.487	0.556
1993	0.097	0.167	0.196	0.239	0.264	0.300	0.338	0.441	0.496	0.603
1994	0.143	0.180	0.202	0.228	0.257	0.300	0.317	0.432	0.409	0.510
1995	0.151	0.186	0.196	0.247	0.265	0.319	0.344	0.356	0.444	0.591
1996	0.163	0.177	0.202	0.234	0.274	0.285	0.318	0.370	0.390	0.594
1997	0.151	0.180	0.206	0.236	0.267	0.296	0.323	0.306	0.384	0.440
1998	0.128	0.182	0.189	0.252	0.262	0.289	0.336	0.292	0.335	0.504
1999	0.163	0.179	0.212	0.229	0.287	0.324	0.354	0.372	0.372	0.453
2000	0.145	0.170	0.200	0.248	0.290	0.299	0.323	0.368	0.402	0.427
2001	0.143	0.185	0.202	0.270	0.275	0.333	0.391	0.414	0.433	0.493
2002	0.140	0.183	0.211	0.243	0.281	0.312	0.366	0.319	0.571	0.536
2003	0.136	0.182	0.214	0.256	0.273	0.317	0.340	0.344	0.503	0.431
2004	0.139	0.187	0.212	0.261	0.278	0.297	0.406	0.414	0.389	0.589
2005	0.172	0.185	0.207	0.243	0.241	0.282	0.265	0.377	0.318	0.391

Table 10.2.5 Sole in sub-area IV: Stock weights at age (kg)

year \ age	1	2	3	4	5	6	7	8	9	10
1957	0.025	0.070	0.147	0.187	0.208	0.253	0.262	0.355	0.390	0.365
1958	0.025	0.070	0.164	0.205	0.226	0.228	0.297	0.318	0.393	0.422
1959	0.025	0.070	0.159	0.198	0.239	0.271	0.292	0.276	0.303	0.426
1960	0.025	0.070	0.163	0.207	0.234	0.240	0.268	0.242	0.360	0.431
1961	0.025	0.070	0.148	0.206	0.235	0.232	0.259	0.274	0.281	0.396
1962	0.025	0.070	0.148	0.192	0.240	0.301	0.293	0.282	0.273	0.441
1963	0.025	0.070	0.148	0.193	0.243	0.275	0.311	0.363	0.329	0.465
1964	0.025	0.070	0.159	0.214	0.240	0.291	0.305	0.306	0.365	0.474
1965	0.025	0.140	0.198	0.223	0.251	0.297	0.337	0.358	0.526	0.460
1966	0.025	0.070	0.160	0.149	0.389	0.310	0.406	0.377	0.385	0.505
1967	0.025	0.177	0.164	0.235	0.242	0.399	0.362	0.283	0.381	0.459
1968	0.025	0.122	0.171	0.248	0.312	0.280	0.629	0.416	0.410	0.486
1969	0.025	0.137	0.174	0.252	0.324	0.364	0.579	0.415	0.469	0.521
1970	0.025	0.137	0.201	0.275	0.341	0.367	0.423	0.458	0.390	0.554
1971	0.034	0.148	0.213	0.313	0.361	0.410	0.432	0.474	0.483	0.533
1972	0.038	0.155	0.218	0.313	0.419	0.443	0.443	0.443	0.508	0.602
1973	0.039	0.149	0.226	0.322	0.371	0.433	0.452	0.472	0.446	0.536
1974	0.035	0.146	0.218	0.329	0.408	0.429	0.499	0.565	0.542	0.618
1975	0.035	0.148	0.206	0.311	0.403	0.446	0.508	0.582	0.580	0.650
1976	0.035	0.142	0.201	0.301	0.379	0.458	0.508	0.517	0.644	0.665
1977	0.035	0.147	0.202	0.291	0.365	0.409	0.478	0.487	0.531	0.644
1978	0.035	0.139	0.211	0.290	0.365	0.429	0.427	0.385	0.542	0.644
1979	0.045	0.148	0.211	0.300	0.352	0.429	0.521	0.562	0.567	0.743
1980	0.039	0.157	0.200	0.304	0.345	0.394	0.489	0.537	0.579	0.645
1981	0.050	0.137	0.200	0.305	0.364	0.402	0.454	0.522	0.561	0.622
1982	0.050	0.130	0.193	0.270	0.359	0.411	0.429	0.476	0.583	0.642
1983	0.050	0.140	0.200	0.285	0.329	0.435	0.464	0.483	0.510	0.636
1984	0.050	0.133	0.203	0.268	0.348	0.386	0.488	0.591	0.567	0.664
1985	0.050	0.127	0.185	0.267	0.324	0.381	0.380	0.626	0.554	0.642
1986	0.050	0.133	0.191	0.278	0.345	0.423	0.495	0.487	0.587	0.686
1987	0.050	0.154	0.191	0.262	0.357	0.381	0.406	0.454	0.332	0.620
1988	0.050	0.133	0.193	0.260	0.335	0.409	0.417	0.474	0.486	0.654
1989	0.050	0.133	0.195	0.290	0.350	0.340	0.411	0.475	0.419	0.595
1990	0.050	0.148	0.203	0.294	0.357	0.447	0.399	0.494	0.481	0.653
1991	0.050	0.139	0.184	0.254	0.301	0.413	0.447	0.522	0.548	0.573
1992	0.050	0.156	0.194	0.257	0.307	0.398	0.406	0.472	0.500	0.540
1993	0.050	0.128	0.184	0.229	0.265	0.293	0.344	0.482	0.437	0.583
1994	0.050	0.143	0.174	0.209	0.257	0.326	0.349	0.402	0.494	0.459
1995	0.050	0.151	0.179	0.240	0.253	0.321	0.365	0.357	0.545	0.545
1996	0.050	0.147	0.178	0.208	0.274	0.268	0.321	0.375	0.402	0.546
1997	0.050	0.150	0.190	0.225	0.252	0.303	0.319	0.325	0.360	0.424
1998	0.050	0.140	0.173	0.234	0.267	0.281	0.328	0.273	0.336	0.455
1999	0.050	0.131	0.187	0.216	0.259	0.296	0.340	0.322	0.369	0.464
2000	0.050	0.139	0.185	0.226	0.264	0.275	0.287	0.337	0.391	0.376
2001	0.050	0.144	0.185	0.223	0.263	0.319	0.327	0.421	0.410	0.530
2002	0.050	0.145	0.197	0.245	0.267	0.267	0.299	0.308	0.435	0.435
2003	0.050	0.146	0.194	0.240	0.256	0.288	0.330	0.312	0.509	0.470
2004	0.050	0.137	0.195	0.240	0.245	0.305	0.316	0.448	0.356	0.585
2005	0.050	0.150	0.189	0.234	0.237	0.258	0.276	0.396	0.369	0.413

Table 10.2.6 Sole in subarea IV: Effort and CpUE series

Note: only NL beam is used for tuning

year	NL beam	
	Effort HP days (·10^6)	CpUE kg· 1000HP $days^{-1}$
1978	44.3	375.8
1979	44.9	423.2
1980	45.0	282.1
1981	46.3	267.8
1982	57.3	309.8
1983	65.6	319.9
1984	70.8	307.3
1985	70.3	276.3
1986	68.2	213.4
1987	68.5	204.5
1988	76.3	235.9
1989	61.6	272.7
1990	71.4	378.1
1991	68.5	350.9
1992	71.1	307.1
1993	76.9	306.4
1994	81.4	295.6
1995	81.2	275.1
1996	72.1	227.1
1997	72.0	151.7
1998	70.2	230.7
1999	67.3	257.9
2000	67.7	240.6
2001	61.4	220.1
2002	56.6	229.0
2003	51.6	260.9
2004	49.3	278.5
2005	49.9	231.2

Table 10.2.7 Sole in subarea IV: Tuning data. BTS and SNS surveys and commercial serie from NL beam trawl

[1] BTS-ISIS

		1	2	3	4	5	6	7	8	9
1985	1	2.65	7.89	3.541	1.669	0.620	0.279	0.000	0.000	0.000
1986	1	7.88	4.49	1.726	0.826	0.590	0.221	0.108	0.000	0.018
1987	1	6.97	12.55	1.834	0.563	0.583	0.222	0.228	0.058	0.000
1988	1	83.11	12.51	2.684	1.032	0.123	0.149	0.132	0.103	0.014
1989	1	9.02	68.08	4.191	4.096	0.677	0.128	0.242	0.000	0.051
1990	1	22.60	22.36	20.090	0.611	0.682	0.511	0.078	0.055	0.013
1991	1	3.71	23.19	5.843	6.011	0.103	0.137	0.064	0.040	0.011
1992	1	74.44	23.20	9.879	2.332	2.903	0.061	0.142	0.065	0.016
1993	1	4.99	27.36	0.987	4.367	2.376	4.295	0.024	0.090	0.057
1994	1	5.88	4.99	15.422	0.133	1.412	0.095	1.006	0.010	0.000
1995	1	27.86	8.46	7.039	6.718	0.476	0.913	0.314	0.966	0.049
1996	1	3.51	6.17	1.909	1.488	2.493	0.308	0.406	0.051	0.299
1997	1	173.94	5.37	3.234	0.800	0.769	0.403	0.105	0.038	0.045
1998	1	14.12	29.21	1.998	1.346	0.079	0.016	0.424	0.000	0.000
1999	1	11.41	19.26	16.626	0.629	2.061	0.334	0.224	0.651	0.003
2000	1	14.46	6.53	4.207	1.587	0.283	0.153	0.064	0.008	0.162
2001	1	8.17	10.71	2.335	1.683	0.737	0.081	0.040	0.030	0.000
2002	1	21.90	4.17	3.431	0.906	0.356	0.359	0.022	0.060	0.000
2003	1	10.76	10.55	2.506	1.752	0.380	0.202	0.337	0.000	0.022
2004	1	3.65	4.40	3.618	0.630	0.650	0.122	0.072	0.075	0.000
2005	1	3.12	3.17	2.619	1.229	0.128	0.126	0.103	0.046	0.019

SNS

		1	2	3	4
1970	1	5410	734	238	35
1971	1	893	1844	110	3
1972	1	1455	272	149	0
1973	1	5587	935	84	37
1974	1	2348	361	65	0
1975	1	529	848	166	47
1976	1	1399	74	229	27
1977	1	3743	776	104	43
1978	1	1548	1355	294	28
1979	1	94	408	301	77
1980	1	4313	89	109	61
1981	1	3737	1413	50	20
1982	1	5856	1146	228	7
1983	1	2621	1123	121	40
1984	1	2493	1100	318	74
1985	1	3619	716	167	49
1986	1	3705	458	69	31
1987	1	1948	944	65	21
1988	1	11227	594	282	82
1989	1	2831	5005	208	53
1990	1	2856	1120	914	100
1991	1	1254	2529	514	624
1992	1	11114	144	360	195
1993	1	1291	3420	154	213
1994	1	652	498	934	10
1995	1	1362	224	143	411
1996	1	218	349	30	36
1997	1	10279	154	190	26
1998	1	4095	3126	142	99
1999	1	1649	972	456	10
2000	1	1639	126	166	118
2001	1	970	655	107	35
2002	1	7542	379	195	0
2003	1	NA	NA	NA	NA
2004	1	1367	623	396	69
2005	1	568	163	124	0

Table 10.2.7 cont.

NL Beam Trawl

		2	3	4	5	6	7	8	9
1990	71.1	127.6	1190	101.9	92.6	23.5	8.93	11.52	5.288
1991	68.5	107.1	251	872.3	67.7	31.2	9.97	4.55	5.723
1992	71.1	71.0	477	156.6	419.6	20.5	29.27	6.27	3.080
1993	76.9	510.9	142	313.8	125.2	242.2	11.53	10.56	3.069
1994	81.4	66.2	858	91.1	159.8	38.1	109.74	2.33	6.437
1995	81.2	120.4	140	658.7	35.0	63.2	11.05	57.66	1.810
1996	72.1	219.7	126	154.9	294.2	21.8	44.01	6.55	38.474
1997	72.0	62.6	256	62.6	46.2	135.7	6.90	25.00	1.319
1998	70.2	720.4	129	158.4	26.0	16.3	48.36	3.01	4.801
1999	67.3	175.6	820	61.7	66.3	10.8	4.99	22.69	1.976
2000	67.7	181.8	437	321.2	30.2	23.3	6.72	4.76	9.468
2001	61.4	305.0	222	243.8	213.0	11.7	8.24	2.21	1.515
2002	56.4	159.7	440	140.7	107.0	90.1	7.52	6.81	0.957
2003	51.6	502.8	224	241.1	65.8	54.7	38.02	4.36	1.202
2004	49.3	227.0	755	114.3	102.6	24.1	12.98	10.99	2.738
2005	49.9	101.4	328	421.4	76.1	40.1	18.46	5.79	12.405

Table 10.3.1. Sole in sub area IV: XSA diagnostics

```
Lowestoft VPA Version 3.1
   29/09/2006  20:54
 Extended Survivors Analysis
 Sole in IV

 CPUE data from file fleet.txt

 Catch data for  49 years. 1957 to 2005. Ages  1 to  10.

      Fl           Last      First     Last     Alpha     Beta
            year   year       age       age
 BTS-ISI      1985      2005         1        9     0.66     0.75
 SNS          1970      2005         1        4     0.66     0.75
 NL Beam      1990      2005         2        9        0        1

 Time series weights :

      Tapered time weighting not applied

 Catchability analysis :

      Catchability dependent on stock size for ages <    2

         Regression type = C
         Minimum of   5 points used for regression
         Survivor estimates shrunk to the population mean for ages <  2

      Catchability independent of age for ages >=    7

 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   5 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =   2.000

      Minimum standard error for population
      estimates derived from each fleet =    .300

      Prior weighting not applied

 Tuning converged after   24 iterations

       1

 Regression weights
               1         1         1        1        1        1        1       1       1       1

 Fishing mortalities
    Age      1996      1997      1998     1999     2000     2001     2002    2003    2004    2005

       1     0.004     0.006     0.002    0.004     0.02    0.014    0.006   0.012   0.006   0.024
       2     0.275     0.155     0.281    0.176    0.241    0.282    0.217   0.212     0.2   0.176
       3     0.696     0.578     0.621    0.612    0.585    0.565    0.613   0.552   0.469   0.503
       4      0.98     0.699      0.79    0.721    0.802    0.762     0.65   0.613   0.396   0.541
       5     0.701     0.808     0.762    0.786    0.633    0.758    0.737   0.652   0.458   0.551
       6     0.842     0.749     0.738    0.576    0.765    0.552    0.659   0.851   0.301   0.489
       7     0.719     0.606     0.615    0.532    0.847    0.558    0.484   0.492   0.362    0.62
       8     0.989     0.833     0.939    0.495     0.71    0.698    0.895   0.526   0.218   0.339
       9     0.503     1.075     1.014    1.264    0.404    0.582     0.45    0.42    0.39   0.433

       1
```

Table 10.3.1. Continued

population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
1996	49300	82400	33900	28500	56800	7130	9800	1580	8790
1997	271000	44400	56600	15300	9690	25500	2780	4320	531
1998	114000	243000	34400	28700	6890	3910	10900	1370	1700
1999	82000	102000	166000	16700	11800	2910	1690	5340	485
2000	124000	74000	77700	81600	7370	4870	1480	899	2940
2001	66700	110000	52600	39200	33100	3540	2050	574	400
2002	198000	59500	75300	27000	16600	14000	1840	1060	258
2003	90900	178000	43400	36900	12800	7170	6570	1030	392
2004	49400	81200	131000	22600	18100	6020	2770	3630	550
2005	45200	44400	60200	73900	13800	10400	4030	1740	2640

Estimated population abundance at 1st Jan 2006

	0	39900	33700	32900	38900	7170	5740	1960	1130

Taper weighted geometric mean of the VPA populations:

	93900	84100	63700	34900	17400	9140	5050	2910	1600

Standard error of the weighted Log(VPA populations) :

	0.7633	0.7974	0.8206	0.8577	0.8874	0.8923	0.9524	0.9925	1.0732
1									

Log catchability residuals.

Fleet : BTS-ISIS

Age	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.68
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.2
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.11
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.31
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.12
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.24
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	-0.66	0.05	-0.18	-0.18	-0.08	-0.33	0	-0.12	0.19	0.69
2	-0.62	-0.21	0.57	0.35	0.68	0.19	1.14	-0.27	-0.37	0.48
3	-0.18	-0.5	-0.61	0.53	0.07	0.29	0.28	-1.08	0.16	0.94
4	-0.4	-0.22	0.06	0.95	-0.4	-0.18	0.28	0.45	-2.05	0.47
5	0.16	0.01	-0.94	0.36	-0.04	-1.3	-0.22	1.21	0.15	0.03
6	-0.07	0.15	-0.42	-0.03	1.02	-0.81	-0.79	1.09	-0.77	0.66
7	-0.19	0.32	-0.01	0.34	-0.23	-0.57	-0.35	-1.09	-0.01	1.06
8	99.99	-0.01	0.06	99.99	-0.51	-0.18	0.18	-0.13	-1.15	0.56
9	-0.15	99.99	-0.43	-0.15	-1.14	-1.29	-0.18	0.93	99.99	1.45

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0	0.82	0.06	0.25	-0.01	0.24	-0.21	0.11	0.02	0.02
2	-0.34	0.06	0.14	0.51	-0.2	-0.07	-0.45	-0.62	-0.71	-0.46
3	0.18	0.11	0.16	0.7	0.07	-0.15	-0.09	0.11	-0.68	-0.21
4	0.67	0.47	0.43	0.16	-0.44	0.32	-0.01	0.31	-0.37	-0.79
5	0.39	1.05	-0.91	1.83	0.2	-0.25	-0.3	-0.04	0.01	-1.27
6	0.74	-0.33	-1.69	1.53	0.37	-0.1	0.09	0.32	-0.4	-0.78
7	0.33	0.16	0.2	1.37	0.47	-0.53	-1.08	0.39	-0.38	-0.22
8	0.28	-1.13	99.99	1.26	-1.21	0.55	0.77	99.99	-0.71	-0.38
9	-0.01	1.3	99.99	-1.18	0.4	99.99	99.99	0.43	99.99	-1.62

Table 10.3.1. Continued

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9
Mean Lo	-8.8978	-9.4077	-9.7673	-9.8553	-10.1248	-9.8496	-9.8496	-9.8496
S.E(Log	0.4949	0.464	0.6375	0.7591	0.7635	0.6124	0.7281	0.9713

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	0.65	2.863	9.94	0.78	21	0.36	-9.05

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	-0.009	8.89	0.62	21	0.51	-8.9
3	0.98	0.128	9.45	0.65	21	0.47	-9.41
4	0.98	0.072	9.78	0.52	21	0.64	-9.77
5	0.91	0.394	9.85	0.48	21	0.7	-9.86
6	0.87	0.607	9.98	0.52	21	0.67	-10.12
7	0.93	0.365	9.74	0.61	20	0.58	-9.85
8	0.86	0.696	9.64	0.64	16	0.63	-9.96
9	1.49	-1.081	11.44	0.28	14	1.43	-9.97
1							

Fleet : SNS

Age	1970	1971	1972	1973	1974	1975
1	0.34	0.21	-0.03	0.63	-0.05	-0.14
2	0.75	0.8	0.01	0.62	-0.66	0.2
3	0.47	0.13	-0.31	0.23	-0.74	-0.16
4	0.12	-2.54	99.99	-0.38	99.99	0.29
5	No data for this fleet at this age					
6	No data for this fleet at this age					
7	No data for this fleet at this age					
8	No data for this fleet at this age					
9	No data for this fleet at this age					

Age	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	-0.45	0.05	0.49	-0.16	0.07	-0.01	0.3	-0.23	0.44	0.57
2	-1.36	0.08	0.41	0.28	0.08	0.38	0.17	0.19	0.22	0.5
3	0.21	0.24	0.43	0.28	0.25	0.74	-0.04	-0.75	0.37	-0.23
4	-0.74	-0.16	0.17	0.41	0	-0.15	0.03	-0.36	0.12	-0.04
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	-0.09	0.23	-0.33	0.1	-0.39	-0.06	-0.08	-0.02	-0.32	-0.29
2	-0.2	-0.09	0.23	0.45	0.4	0.69	-1.24	0.36	0.03	-0.44
3	-0.47	-0.91	0.07	0.46	-0.09	0.79	-0.09	0	0.29	-0.02
4	-0.5	-0.33	0.7	-0.22	0.97	0.73	0.98	0.61	-1.46	0.85
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	-0.98	0.13	0.32	-0.01	-0.43	-0.19	0.21	99.99	0.36	-0.18
2	-0.5	-0.79	0.61	0.24	-1.44	-0.16	-0.13	99.99	0.04	-0.71
3	-1.04	0.22	0.45	0.04	-0.23	-0.29	-0.02	99.99	0.04	-0.33
4	0.12	0.22	1	-0.81	0.14	-0.37	99.99	99.99	0.6	99.99
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Table 10.3.1. Continued

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
Mean Lo	-4.6985	-5.4351	-6.0393
S.E(Log	0.5788	0.4286	0.7394

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	0.73	3.232	5.84	0.81	35	0.34	-3.76

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.76	2.309	6.31	0.73	35	0.41	-4.7
3	1.09	-0.761	4.91	0.67	35	0.47	-5.44
4	0.81	1.196	6.86	0.58	31	0.6	-6.04

1

Fleet : NL Beam Trawl

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	No data for this fleet at this age									
2	99.99	99.99	99.99	99.99	-0.4	-1.08	-0.56	-0.17	-0.6	0.28
3	99.99	99.99	99.99	99.99	-0.19	-0.29	-0.19	-0.45	-0.18	-0.42
4	99.99	99.99	99.99	99.99	-0.17	-0.09	-0.38	-0.17	-0.43	0.11
5	99.99	99.99	99.99	99.99	-0.15	0.12	-0.24	0.09	-0.17	-0.7
6	99.99	99.99	99.99	99.99	-0.28	-0.46	-0.1	0	0.02	-0.21
7	99.99	99.99	99.99	99.99	-0.25	-0.33	0.17	0.22	-0.08	-0.22
8	99.99	99.99	99.99	99.99	0.05	-0.25	-0.05	-0.14	-0.51	-0.12
9	99.99	99.99	99.99	99.99	0.08	0.12	0.21	0.06	0.16	0.15

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	No data for this fleet at this age									
2	0.39	-0.31	0.49	-0.1	0.29	0.42	0.36	0.41	0.4	0.18
3	-0.04	0.1	-0.07	0.21	0.32	0.03	0.38	0.22	0.3	0.26
4	0.31	-0.1	0.24	-0.19	-0.09	0.35	0.12	0.33	-0.02	0.17
5	0.11	0.07	-0.18	0.22	-0.16	0.35	0.34	0.08	0.09	0.11
6	-0.19	0.32	0.08	-0.11	0.23	-0.24	0.47	0.73	-0.16	-0.11
7	0.2	-0.44	0.14	-0.3	0.27	0.02	0	0.35	0.08	0.18
8	0.23	0.5	-0.42	0.05	0.36	0.04	0.63	0.06	-0.42	-0.27
9	0.08	-0.24	-0.14	0.33	-0.27	-0.03	-0.11	-0.32	0.16	0.12

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9
Mean Lo	-6.1307	-5.1837	-5.03	-4.9968	-5.165	-5.2234	-5.2234	-5.2234
S.E(Log	0.474	0.2689	0.2433	0.2592	0.3053	0.2424	0.3295	0.189

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.99	0.03	6.16	0.61	16	0.49	-6.13
3	1.01	-0.061	5.14	0.86	16	0.28	-5.18
4	0.99	0.102	5.08	0.9	16	0.25	-5.03
5	1	-0.019	4.99	0.89	16	0.27	-5
6	0.95	0.494	5.36	0.88	16	0.3	-5.16
7	0.94	0.738	5.39	0.93	16	0.23	-5.22
8	1.03	-0.304	5.16	0.86	16	0.35	-5.24
9	0.99	0.245	5.22	0.96	16	0.19	-5.2

1

Table 10.3.1. Continued

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2004

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-ISI	40574	0.379	0	0	1	0.409	0.024
SNS	33184	0.349	0	0	1	0.481	0.029
NL Beam	1	0	0	0	0	0	0
P shr	84137	0.8				0.095	0.012
F shr	83939	2				0.015	0.012

Weighted prediction :

Survivo at end	In s.e	Ext s.e	N	Var Ratio	F
39898	0.24	0.17	4	0.697	0.024

1

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2003

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-ISI	29018	0.302	0.229	0.76	2	0.408	0.202
SNS	36653	0.296	0.468	1.58	2	0.424	0.163
NL Beam	40484	0.489	0	0	1	0.157	0.149
F shr	24977	2				0.011	0.231

Weighted prediction :

Survivo at end	In s.e	Ext s.e	N	Var Ratio	F
33701	0.19	0.16	6	0.843	0.176

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2002

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-ISI	27333	0.253	0.229	0.9	3	0.376	0.581
SNS	26646	0.351	0.169	0.48	2	0.212	0.592
NL Beam	44052	0.257	0.059	0.23	2	0.401	0.398
F shr	28731	2				0.011	0.559

Weighted prediction :

Survivo at end	In s.e	Ext s.e	N	Var Ratio	F
32944	0.16	0.12	8	0.759	0.503

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2001

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-ISI	22850	0.245	0.137	0.56	4	0.277	0.799
SNS	44594	0.274	0.088	0.32	2	0.192	0.486
NL Beam	49443	0.201	0.061	0.3	3	0.52	0.448
F shr	30678	2				0.011	0.647

Table 10.3.1. Continued

Weighted prediction :

Survivo at end	In s.e	Ext s.e	N	Var Ratio	F
38928	0.14	0.12	10	0.888	0.541

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2000

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-ISI	5337	0.25	0.275	1.1	5	0.223	0.687
SNS	7329	0.293	0.239	0.82	3	0.124	0.542
NL Beam	7951	0.176	0.06	0.34	4	0.641	0.509
F shr	5754	2				0.011	0.65

Weighted prediction :

Survivo at end	In s.e	Ext s.e	N	Var Ratio	F
7174	0.13	0.1	13	0.737	0.551

1

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1999

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-ISI	4745	0.292	0.171	0.59	6	0.181	0.568
SNS	4574	0.247	0.134	0.54	3	0.079	0.584
NL Beam	6210	0.171	0.095	0.56	5	0.727	0.46
F shr	4148	2				0.013	0.628

Weighted prediction :

Survivo at end	In s.e	Ext s.e	N	Var Ratio	F
5744	0.14	0.07	15	0.517	0.489

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1998

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-ISI	1666	0.31	0.074	0.24	7	0.181	0.699
SNS	1389	0.246	0.348	1.41	3	0.046	0.795
NL Beam	2077	0.163	0.064	0.39	6	0.759	0.594
F shr	2295	2				0.013	0.551

Weighted prediction :

Survivo at end	In s.e	Ext s.e	N	Var Ratio	F
1962	0.14	0.05	17	0.385	0.62

1

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1997

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-ISI	893	0.363	0.105	0.29	8	0.175	0.411
SNS	1153	0.242	0.172	0.71	4	0.024	0.332
NL Beam	1197	0.175	0.138	0.78	7	0.789	0.321
F shr	538	2				0.012	0.612

Table 10.3.1. Continued

Weighted prediction :

Survivo at end	In s.e	Ext s.e	N	Var Ratio	F
1125	0.15	0.08	20	0.524	0.339

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1996

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BTS-ISI	1018	0.359	0.274	0.76	9	0.139	0.602
SNS	1829	0.249	0.103	0.41	4	0.014	0.378
NL Beam	1665	0.158	0.117	0.74	8	0.835	0.409
F shr	1264	2				0.011	0.51

Weighted prediction :

Survivo at end	In s.e	Ext s.e	N	Var Ratio	F
1552	0.14	0.1	22	0.671	0.433

Table 10.3.2. Sole in sub area IV: fishing mortality at age

2006-09-08 18:37:55 units= f

year	age 1	2	3	4	5	6	7	8	9	10
1957	0.000	0.021	0.127	0.255	0.259	0.228	0.292	0.167	0.241	0.241
1958	0.000	0.017	0.149	0.235	0.276	0.361	0.345	0.295	0.303	0.303
1959	0.000	0.034	0.130	0.246	0.205	0.239	0.182	0.366	0.248	0.248
1960	0.000	0.029	0.158	0.241	0.323	0.267	0.289	0.344	0.294	0.294
1961	0.000	0.018	0.145	0.295	0.252	0.239	0.174	0.397	0.272	0.272
1962	0.000	0.019	0.141	0.229	0.363	0.313	0.367	0.247	0.304	0.304
1963	0.000	0.053	0.179	0.422	0.402	0.509	0.482	0.457	0.479	0.479
1964	0.000	0.020	0.326	0.250	0.486	0.365	0.516	0.325	0.390	0.390
1965	0.000	0.107	0.169	0.389	0.321	0.600	0.432	0.465	0.443	0.443
1966	0.000	0.124	0.437	0.205	0.490	0.369	0.318	0.360	0.349	0.349
1967	0.000	0.114	0.366	0.488	0.683	0.382	0.296	0.549	0.481	0.481
1968	0.011	0.308	0.695	0.643	0.506	0.296	0.268	0.395	0.423	0.423
1969	0.008	0.333	0.691	0.554	0.683	0.473	0.318	0.413	0.490	0.490
1970	0.010	0.153	0.643	0.548	0.320	0.332	0.382	0.368	0.391	0.391
1971	0.011	0.335	0.562	0.672	0.579	0.412	0.376	0.372	0.484	0.484
1972	0.005	0.238	0.661	0.525	0.531	0.361	0.228	0.311	0.392	0.392
1973	0.007	0.207	0.694	0.609	0.569	0.451	0.364	0.535	0.507	0.507
1974	0.001	0.188	0.592	0.644	0.518	0.519	0.561	0.387	0.528	0.528
1975	0.007	0.278	0.554	0.665	0.478	0.523	0.370	0.646	0.516	0.516
1976	0.010	0.107	0.566	0.513	0.560	0.376	0.475	0.422	0.634	0.634
1977	0.013	0.263	0.554	0.616	0.500	0.366	0.182	0.497	0.315	0.315
1978	0.001	0.236	0.573	0.537	0.525	0.527	0.649	0.551	0.534	0.534
1979	0.001	0.225	0.661	0.632	0.485	0.463	0.378	0.642	0.386	0.386
1980	0.004	0.128	0.557	0.592	0.585	0.406	0.586	0.528	0.594	0.594
1981	0.003	0.255	0.521	0.601	0.532	0.581	0.450	0.439	0.541	0.541
1982	0.018	0.232	0.697	0.557	0.633	0.602	0.510	0.523	0.537	0.537
1983	0.003	0.310	0.600	0.726	0.327	0.478	0.465	0.559	0.647	0.647
1984	0.003	0.290	0.720	0.683	0.672	0.709	0.545	0.431	0.585	0.585
1985	0.002	0.320	0.741	0.772	0.600	0.560	0.388	0.439	0.451	0.451
1986	0.002	0.145	0.623	0.688	0.676	0.761	0.753	0.322	0.606	0.606
1987	0.001	0.238	0.521	0.615	0.515	0.562	0.444	0.682	0.370	0.370
1988	0.000	0.238	0.660	0.738	0.620	0.587	0.535	0.432	0.985	0.985
1989	0.001	0.126	0.529	0.684	0.456	0.444	0.395	0.395	0.367	0.367
1990	0.005	0.137	0.408	0.532	0.581	0.620	0.494	0.591	0.613	0.613
1991	0.002	0.090	0.425	0.536	0.764	0.428	0.677	0.667	0.783	0.783
1992	0.003	0.120	0.435	0.467	0.488	0.629	0.670	0.611	0.870	0.870
1993	0.001	0.182	0.423	0.556	0.827	0.572	0.871	0.528	0.864	0.864
1994	0.013	0.140	0.480	0.636	0.674	0.881	0.513	0.650	0.904	0.904
1995	0.054	0.306	0.445	0.764	0.611	0.536	0.789	0.501	1.032	1.032
1996	0.004	0.275	0.696	0.980	0.701	0.842	0.719	0.989	0.503	0.503
1997	0.006	0.155	0.578	0.699	0.808	0.749	0.606	0.833	1.075	1.075
1998	0.002	0.281	0.621	0.790	0.762	0.738	0.615	0.939	1.015	1.015
1999	0.004	0.176	0.612	0.721	0.786	0.576	0.532	0.495	1.264	1.264
2000	0.020	0.241	0.585	0.802	0.633	0.765	0.847	0.710	0.404	0.404
2001	0.014	0.282	0.565	0.762	0.758	0.552	0.558	0.698	0.582	0.582
2002	0.006	0.217	0.613	0.650	0.737	0.659	0.484	0.895	0.450	0.450
2003	0.012	0.212	0.552	0.613	0.652	0.851	0.492	0.526	0.420	0.420
2004	0.006	0.200	0.469	0.396	0.458	0.301	0.362	0.218	0.390	0.390
2005	0.024	0.176	0.503	0.541	0.551	0.489	0.620	0.339	0.433	0.433

Table 10.3.3 Sole in sub area IV: stock numbers at age

2006-09-08 18:37:55 units= NA

year \ age	1	2	3	4	5	6	7	8	9	10
1957	128907	72453	89306	59105	17318	15057	27046	11836	2500	30811
1958	128641	116640	64213	71154	41455	12092	10843	18272	9061	26295
1959	488743	116399	103777	50074	50905	28474	7627	6950	12311	26788
1960	61712	442233	101842	82463	35415	37524	20277	5754	4362	32546
1961	99479	55840	388695	78707	58637	23190	25994	13738	3691	31943
1962	22894	90012	49613	304348	53010	41258	16518	19769	8360	29932
1963	20418	20716	79930	38985	219081	33368	27304	10355	13976	32248
1964	539002	8301	7991	27180	10395	59613	8153	6856	2665	9787
1965	121935	487657	7364	5221	19160	5783	37448	4404	4482	9389
1966	39890	110332	396447	5627	3203	12579	2871	21994	2503	8708
1967	75147	36094	88153	231620	4150	1775	7873	1891	13886	7979
1968	99250	67996	29153	55334	128603	1896	1096	5298	988	19807
1969	50652	88819	45213	13160	26313	70163	1276	759	3230	14246
1970	137683	45455	57611	20506	6842	12025	39573	840	454	16926
1971	42079	123345	35289	27403	10721	4494	7807	24430	526	12535
1972	76484	37675	79865	18209	12661	5435	2694	4851	15243	9039
1973	104789	68865	26866	37299	9746	6733	3429	1940	3217	15223
1974	109891	94148	50680	12150	18352	4990	3882	2157	1028	12283
1975	40817	99337	70559	25368	5774	9889	2687	2005	1326	8949
1976	113279	36682	68050	36701	11808	3239	5305	1680	951	5926
1977	140256	101509	29822	34972	19879	6100	2012	2984	997	8210
1978	47166	125247	70610	15500	17084	10910	3828	1517	1642	4053
1979	11723	42652	89518	36027	8195	9143	5829	1810	791	4995
1980	151590	10598	30813	41837	17322	4565	5208	3613	862	2810
1981	148986	136558	8440	15980	20942	8732	2751	2623	1929	2275
1982	152693	134406	95771	4537	7928	11127	4419	1588	1530	3217
1983	142098	135632	96470	43142	2352	3811	5513	2402	852	2580
1984	70749	128206	89995	47922	18881	1534	2137	3134	1243	2110
1985	80790	63835	86770	39642	21907	8722	684	1122	1843	2809
1986	159600	72944	41953	37408	16573	10878	4510	420	654	3868
1987	72513	144056	57097	20366	17009	7627	4597	1921	275	2349
1988	454313	65523	102711	30692	9963	9196	3934	2669	879	527
1989	108279	411070	46713	48056	13282	4847	4628	2084	1567	1596
1990	177673	97863	327827	24896	21934	7620	2814	2821	1271	1927
1991	70463	159944	77194	197270	13236	11101	3709	1554	1413	2095
1992	353986	63644	132202	45667	104384	5580	6549	1705	722	2119
1993	69255	319367	51088	77408	25908	58001	2693	3033	838	1519
1994	57050	62613	240985	30276	40164	10250	29618	1020	1618	1591
1995	96090	50938	49231	134912	14506	18517	3842	16041	482	1082
1996	49257	82379	33946	28545	56847	7125	9804	1579	8793	2617
1997	270668	44406	56633	15315	9692	25509	2777	4324	531	2669
1998	113509	243398	34428	28747	6890	3911	10913	1371	1700	1383
1999	82031	102475	166350	16749	11805	2909	1692	5339	485	1177
2000	124495	73951	77730	81584	7367	4869	1479	899	2943	2249
2001	66740	110412	52576	39192	33105	3539	2049	574	400	1715
2002	198090	59548	75319	27031	16556	14041	1844	1061	258	1052
2003	90852	178236	43367	36902	12768	7166	6571	1029	392	1376
2004	49375	81209	130521	22595	18085	6017	2768	3634	550	500
2005	45173	44412	60191	73892	13755	10356	4031	1745	2644	1356

Table 10.4.1. Sole in sub area IV: XSA summary

[1] 2006-09-12 22:00:03

	recruitment	ssb	catch	landings	discards	fbar2-6	Y/ssb
1957	128907	55147	12067	12067	0	0.18	0.22
1958	128641	60967	14287	14287	0	0.21	0.23
1959	488743	65550	13832	13832	0	0.17	0.21
1960	61712	73578	18620	18620	0	0.20	0.25
1961	99479	117015	23566	23566	0	0.19	0.20
1962	22894	116453	26877	26877	0	0.21	0.23
1963	20418	113380	26164	26164	0	0.31	0.23
1964	539002	37061	11342	11342	0	0.29	0.31
1965	121935	30036	17043	17043	0	0.32	0.57
1966	39890	84156	33340	33340	0	0.33	0.40
1967	75147	82920	33439	33439	0	0.41	0.40
1968	99250	72788	33179	33179	0	0.49	0.46
1969	50652	55305	27559	27559	0	0.55	0.50
1970	137683	50750	19685	19685	0	0.40	0.39
1971	42079	43721	23652	23652	0	0.51	0.54
1972	76484	47311	21086	21086	0	0.46	0.45
1973	104789	36493	19309	19309	0	0.51	0.53
1974	109891	36012	17989	17989	0	0.49	0.50
1975	40817	38279	20773	20773	0	0.50	0.54
1976	113279	38799	17326	17326	0	0.42	0.45
1977	140256	34190	18003	18003	0	0.46	0.53
1978	47166	36034	20280	20280	0	0.48	0.56
1979	11723	44609	22598	22598	0	0.49	0.51
1980	151590	33445	15807	15807	0	0.45	0.47
1981	148986	22852	15403	15403	0	0.50	0.67
1982	152693	32784	21579	21579	0	0.54	0.66
1983	142098	39837	24927	24927	0	0.49	0.63
1984	70749	43284	26839	26839	0	0.61	0.62
1985	80790	40831	24248	24248	0	0.60	0.59
1986	159600	34221	18201	18201	0	0.58	0.53
1987	72513	29502	17368	17368	0	0.49	0.59
1988	454313	38576	21590	21590	0	0.57	0.56
1989	108279	33784	21805	21805	0	0.45	0.65
1990	177673	89462	35120	35120	0	0.46	0.39
1991	70463	77323	33513	33513	0	0.45	0.43
1992	353986	76630	29341	29341	0	0.43	0.38
1993	69255	54621	31491	31491	0	0.51	0.58
1994	57050	74198	33002	33002	0	0.56	0.44
1995	96090	58780	30467	30467	0	0.53	0.52
1996	49257	38140	22651	22651	0	0.70	0.59
1997	270668	27972	14901	14901	0	0.60	0.53
1998	113509	20804	20868	20868	0	0.64	1.00
1999	82031	41684	23475	23475	0	0.57	0.56
2000	124495	39187	22641	22641	0	0.61	0.58
2001	66740	30424	19944	19944	0	0.58	0.66
2002	198090	31094	16945	16945	0	0.58	0.54
2003	90852	25863	17920	17920	0	0.58	0.69
2004	49375	40155	17147	17147	0	0.36	0.43
2005	45173	38011	16355	16355	0	0.45	0.43

Table 10.5.1. Sole in sub area IV: Input RCT3 – age 1

Sole North Sea Age 1

8 38 2

Year	VPA1	DFS0	DFS1	SNS1	SNS2	SNS3	BTS1	BTS2	Sol3
1968	50652	-11.00	-11.00	-11.00	734.38	110.35	-11.00	-11.00	-11.00
1969	137683	-11.00	-11.00	5410.28	1843.79	148.55	-11.00	-11.00	-11.00
1970	42080	-11.00	-11.00	893.00	272.27	83.81	-11.00	-11.00	-11.00
1971	76484	-11.00	-11.00	1454.69	935.26	65.16	-11.00	-11.00	-11.00
1972	104789	-11.00	-11.00	5587.15	361.43	165.84	-11.00	-11.00	-11.00
1973	109891	-11.00	-11.00	2347.93	848.13	229.11	-11.00	-11.00	31.50
1974	40817	-11.00	2.86	528.85	73.56	103.84	-11.00	-11.00	16.30
1975	113279	168.84	6.95	1399.43	776.10	294.07	-11.00	-11.00	34.40
1976	140258	82.28	9.69	3742.94	1354.66	300.84	-11.00	-11.00	-11.00
1977	47166	33.80	2.13	1547.71	408.27	109.33	-11.00	-11.00	41.50
1978	11724	96.87	2.27	93.78	88.89	49.97	-11.00	-11.00	1.90
1979	151590	392.08	48.21	4312.89	1413.05	227.78	-11.00	-11.00	76.10
1980	148986	404.00	13.39	3737.20	1146.20	120.58	-11.00	-11.00	77.10
1981	152693	293.93	14.28	5856.46	1123.33	318.32	-11.00	-11.00	147.10
1982	142098	328.52	20.32	2621.14	1099.91	167.07	-11.00	-11.00	77.80
1983	70750	104.38	11.89	2493.11	715.60	69.24	-11.00	7.89	10.80
1984	80790	186.53	3.43	3619.44	457.61	64.82	2.65	4.49	29.80
1985	159600	315.03	10.47	3705.06	943.70	281.61	7.88	12.55	24.60
1986	72513	73.22	6.43	1947.85	593.83	207.56	6.97	12.51	20.30
1987	454313	523.86	35.04	11226.67	5005.00	914.25	83.11	68.08	66.90
1988	108279	50.07	11.59	2830.74	1119.50	513.84	9.02	22.36	86.40
1989	177673	77.80	11.25	2856.17	2529.10	360.41	22.60	23.19	54.10
1990	70463	21.09	8.26	1253.62	144.40	153.78	3.71	23.20	11.30
1991	353986	391.93	17.90	11114.01	3419.57	934.10	74.44	27.36	180.70
1992	69255	25.30	10.67	1290.78	498.25	142.85	4.99	4.99	-11.00
1993	57050	25.13	6.18	651.78	223.67	29.60	5.88	8.46	-11.00
1994	96090	69.11	9.82	1362.10	349.09	189.82	27.86	6.17	12.90
1995	49257	19.07	3.99	218.36	153.63	141.71	3.51	5.37	0.90
1996	270668	59.62	19.02	10279.33	3126.37	455.61	173.94	29.21	45.70
1997	113509	44.08	-11.00	4094.61	971.78	166.28	14.12	19.26	13.80
1998	82031	-11.00	-11.00	1648.85	125.88	106.67	11.41	6.53	-11.00
1999	124495	-11.00	4.53	1639.17	655.36	195.30	14.46	10.71	-11.00
2000	66740	15.51	3.40	970.31	379.04	-11.00	8.17	4.17	-11.00
2001	198090	84.62	18.36	7541.56	-11.00	393.00	21.90	10.55	-11.00
2002	-11	65.38	5.34	-11.00	624.40	124.00	10.76	4.40	-11.00
2003	-11	18.47	8.95	1369.00	162.90	-11.00	3.65	3.16	-11.00
2004	-11	54.51	8.85	563.40	-11.00	-11.00	3.12	-11.00	-11.00
2005	-11	48.76	-11.00	-11.00	-11.00	-11.00	-11.00	-11.00	-11.00

Table 10.5.2. Sole in sub area IV: Input RCT3 – age 2

Sole North Sea Age 2
8 38 2

Year	VPA2	DFS0	DFS1	SNS1	SNS2	SNS3	BTS1	BTS2	Sol3
1968	45455	-11.00	-11.00	-11.00	734.38	110.35	-11.00	-11.00	-11.00
1969	123345	-11.00	-11.00	5410.28	1843.79	148.55	-11.00	-11.00	-11.00
1970	37676	-11.00	-11.00	893.00	272.27	83.81	-11.00	-11.00	-11.00
1971	68865	-11.00	-11.00	1454.69	935.26	65.16	-11.00	-11.00	-11.00
1972	94149	-11.00	-11.00	5587.15	361.43	165.84	-11.00	-11.00	-11.00
1973	99338	-11.00	-11.00	2347.93	848.13	229.11	-11.00	-11.00	31.50
1974	36682	-11.00	2.86	528.85	73.56	103.84	-11.00	-11.00	16.30
1975	101509	168.84	6.95	1399.43	776.10	294.07	-11.00	-11.00	34.40
1976	125249	82.28	9.69	3742.94	1354.66	300.84	-11.00	-11.00	-11.00
1977	42652	33.80	2.13	1547.71	408.27	109.33	-11.00	-11.00	41.50
1978	10599	96.87	2.27	93.78	88.89	49.97	-11.00	-11.00	1.90
1979	136558	392.08	48.21	4312.89	1413.05	227.78	-11.00	-11.00	76.10
1980	134406	404.00	13.39	3737.20	1146.20	120.58	-11.00	-11.00	77.10
1981	135632	293.93	14.28	5856.46	1123.33	318.32	-11.00	-11.00	147.10
1982	128206	328.52	20.32	2621.14	1099.91	167.07	-11.00	-11.00	77.80
1983	63835	104.38	11.89	2493.11	715.60	69.24	-11.00	7.89	10.80
1984	72944	186.53	3.43	3619.44	457.61	64.82	2.65	4.49	29.80
1985	144056	315.03	10.47	3705.06	943.70	281.61	7.88	12.55	24.60
1986	65523	73.22	6.43	1947.85	593.83	207.56	6.97	12.51	20.30
1987	411070	523.86	35.04	11226.67	5005.00	914.25	83.11	68.08	66.90
1988	97863	50.07	11.59	2830.74	1119.50	513.84	9.02	22.36	86.40
1989	159944	77.80	11.25	2856.17	2529.10	360.41	22.60	23.19	54.10
1990	63644	21.09	8.26	1253.62	144.40	153.78	3.71	23.20	11.30
1991	319367	391.93	17.90	11114.01	3419.57	934.10	74.44	27.36	180.70
1992	62613	25.30	10.67	1290.78	498.25	142.85	4.99	4.99	-11.00
1993	50938	25.13	6.18	651.78	223.67	29.60	5.88	8.46	-11.00
1994	82379	69.11	9.82	1362.10	349.09	189.82	27.86	6.17	12.90
1995	44406	19.07	3.99	218.36	153.63	141.71	3.51	5.37	0.90
1996	243398	59.62	19.02	10279.33	3126.37	455.61	173.94	29.21	45.70
1997	102475	44.08	-11.00	4094.61	971.78	166.28	14.12	19.26	13.80
1998	73952	-11.00	-11.00	1648.85	125.88	106.67	11.41	6.53	-11.00
1999	110412	-11.00	4.53	1639.17	655.36	195.30	14.46	10.71	-11.00
2000	59548	15.51	3.40	970.31	379.04	-11.00	8.17	4.17	-11.00
2001	178236	84.62	18.36	7541.56	-11.00	393.00	21.90	10.55	-11.00
2002	-11	65.38	5.34	-11.00	624.40	124.00	10.76	4.40	-11.00
2003	-11	18.47	8.95	1369.00	162.90	-11.00	3.65	3.16	-11.00
2004	-11	54.51	8.85	563.40	-11.00	-11.00	3.12	-11.00	-11.00
2005	-11	48.76	-11.00	-11.00	-11.00	-11.00	-11.00	-11.00	-11.00

Table 10.5.3. Sole in sub area IV: Output RCT3 – age 1

```
Analysis by RCT3 ver3.1 of data from file :
Sole North Sea Age 1
Data for    8 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    .00
Minimum of   3 points used for regression

Forecast/Hindcast variance correction used.
Yearclass =   2003

         I-----------Regression----------I  I-----------Prediction---------I
Survey/       Slope  Inter-    Std  Rsquare  No.  Index Predicted   Std     WAP
Series                cept   Error           Pts  Value   Value    Error   Weights

DFS0              1.27   5.79   1.16   .298     25   2.97    9.57    1.291     .023
DFS1              1.35   8.40    .60   .618     26   2.30   11.51     .641     .094
SNS1               .73   5.93    .34   .810     33   7.22   11.17     .356     .305
SNS2               .78   6.41    .43   .725     33   5.10   10.40     .463     .181
SNS3
BTS1               .68   9.82    .38   .752     18   1.54   10.88     .427     .213
BTS2              1.15   8.66    .53   .599     19   1.43   10.31     .617     .102
Sol3
                                       VPA Mean =   11.49     .688     .082
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

DFS0              1.27   5.79   1.16   .298     25   4.02   10.90    1.244     .036
DFS1              1.35   8.40    .60   .618     26   2.29   11.50     .641     .134
SNS1               .73   5.93    .34   .810     33   6.34   10.53     .364     .416
SNS2
SNS3
BTS1               .68   9.82    .38   .752     18   1.42   10.79     .429     .299
BTS2
Sol3
                                       VPA Mean =   11.49     .688     .116

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

DFS0              1.27   5.79   1.16   .298     25   3.91   10.76    1.247     .233
DFS1
SNS1
SNS2
SNS3
BTS1
BTS2
Sol3

                                       VPA Mean =   11.49     .688     .767

Year     Weighted      Log     Int      Ext      Var      VPA      Log
Class     Average      WAP     Std      Std     Ratio              VPA
         Prediction           Error    Error
2003      54379       10.90     .20      .19      .90
2004      52252       10.86     .23      .19      .67

2005           82611           11.32          .60          .31           .26
```

Table 10.5.4. Sole in sub area IV: Output RCT3 – age 2

Analysis by RCT3 ver3.1 of data from file :
Sole North Sea-Age 2

Data for 8 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 .00
Minimum of 3 points used for regression
Forecast/Hindcast variance correction used.

Yearclass = 2003

Survey/ Series	Slope (Regression)	Inter- cept	Std Error	Rsquare	No. Pts	Index Value (Prediction)	Predicted Value	Std Error	WAP Weights
DFS0	1.27	5.70	1.16	.300	25	2.97	9.46	1.286	.023
DFS1	1.35	8.30	.60	.620	26	2.30	11.40	.638	.095
SNS1	.72	5.84	.34	.812	33	7.22	11.07	.354	.310
SNS2	.78	6.31	.43	.727	33	5.10	10.30	.460	.184
SNS3									
BTS1	.69	9.70	.39	.742	18	1.54	10.76	.438	.202
BTS2	1.15	8.56	.53	.605	19	1.43	10.20	.611	.104
Sol3									
					VPA Mean =		11.39	.688	.082

Yearclass = 2004

Survey/ Series	Slope (Regression)	Inter- cept	Std Error	Rsquare	No. Pts	Index Value (Prediction)	Predicted Value	Std Error	WAP Weights
DFS0	1.27	5.70	1.16	.300	25	4.02	10.79	1.239	.036
DFS1	1.35	8.30	.60	.620	26	2.29	11.39	.638	.136
SNS1	.72	5.84	.34	.812	33	6.34	10.42	.361	.425
SNS2									
SNS3									
BTS1	.69	9.70	.39	.742	18	1.42	10.68	.441	.285
BTS2									
Sol3									
					VPA Mean =		11.39	.688	.117

Yearclass = 2005

Survey/ Series	Slope (Regression)	Inter- cept	Std Error	Rsquare	No. Pts	Index Value (Prediction)	Predicted Value	Std Error	WAP Weights
DFS0	1.27	5.70	1.16	.300	25	3.91	10.66	1.242	.235
DFS1									
SNS1									
SNS2									
SNS3									
BTS1									
BTS2									
Sol3									
					VPA Mean =		11.39	.688	.765

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2003	48778	10.80	.20	.19	.90		
2004	46844	10.75	.24	.19	.68		
2005	74185	11.21	.60	.31	.26		

Table 10.6.1. Sole in sub area IV: Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	96733	0.77	WS1	0.05	0
N2	39898	0.24	WS2	0.144	0.05
N3	33700	0.19	WS3	0.193	0.02
N4	32943	0.16	WS4	0.238	0.01
N5	38927	0.14	WS5	0.246	0.04
N6	7173	0.13	WS6	0.284	0.08
N7	5744	0.14	WS7	0.307	0.09
N8	1962	0.15	WS8	0.385	0.18
N9	1124	0.14	WS9	0.411	0.21
N10	2347	0.14	WS10	0.489	0.18
H.cons selectivity			Natural Mortality		
sH1	0.014	0.67	M1	0.1	0.1
sH2	0.191	0.23	M2	0.1	0.1
sH3	0.494	0.15	M3	0.1	0.1
sH4	0.503	0.06	M4	0.1	0.1
sH5	0.539	0.05	M5	0.1	0.1
sH6	0.533	0.29	M6	0.1	0.1
sH7	0.478	0.25	M7	0.1	0.1
sH8	0.351	0.21	M8	0.1	0.1
sH9	0.403	0.19	M9	0.1	0.1
sH10	0.403	0.19	M10	0.1	0.1
Weight in the catch			Proportion mature		
WH1	0.147	0.12	MT1	0	0
WH2	0.182	0.01	MT2	0	0.1
WH3	0.209	0.03	MT3	1	0.1
WH4	0.251	0.05	MT4	1	0
WH5	0.261	0.09	MT5	1	0
WH6	0.295	0.07	MT6	1	0
WH7	0.333	0.22	MT7	1	0
WH8	0.374	0.09	MT8	1	0
WH9	0.399	0.24	MT9	1	0
WH10	0.465	0.23	MT10	1	0
Relative effort in HC fishery			Year effect for natural mortality		
HF06	1	0.23	K06	1	0.1
HF07	1	0.23	K07	1	0.1
HF08	1	0.23	K08	1	0.1
Recruitment in 2006 and 2007					
R07	96733	0.77			
R08	96733	0.77			

Table 10.6.2. Sole in sub area IV: Catch forecast table.

2006

SSB	Fmult	Fbar	Landings
30077	1	0.45	13403

2007

SSB	Fmult	Fbar (2-6)	landings	SSB 2008
24389	0	0.00	0	39964
24389	0.1	0.05	1491	38466
24389	0.2	0.09	2920	37033
24389	0.3	0.14	4289	35661
24389	0.4	0.18	5600	34349
24389	0.5	0.23	6857	33093
24389	0.6	0.27	8062	31891
24389	0.7	0.32	9218	30740
24389	0.8	0.36	10326	29637
24389	0.9	0.41	11389	28582
24389	1	0.45	12409	27570
24389	1.1	0.50	13388	26601
24389	1.2	0.54	14328	25673
24389	1.3	0.59	15230	24783
24389	1.4	0.63	16097	23929
24389	1.5	0.68	16929	23111
24389	1.6	0.72	17729	22326
24389	1.7	0.77	18498	21573
24389	1.8	0.81	19237	20851
24389	1.9	0.86	19948	20158
24389	2	0.90	20631	19493

Table 10.6.3. Sole in sub area IV: Detailed forecast table.

year: 2006 Fmult.: 1 Fbar: 0.45

age	F	catch.n	landings	stock.n	biomass	SSB
1	0.01	1256	185	96733	4837	0
2	0.19	6598	1204	39898	5759	0
3	0.49	12563	2620	33701	6493	6493
4	0.50	12448	3118	32944	7841	7841
5	0.54	15506	4048	38928	9576	9576
6	0.53	2831	836	7174	2035	2035
7	0.48	2087	696	5744	1765	1765
8	0.35	555	207	1962	756	756
9	0.40	357	142	1125	463	463
10	0.40	744	346	2347	1148	1148
Total:		54945	13403	260556	40673	30077

year: 2007 Fmult.: 1 Fbar: 0.45

age	F	catch.n	landings	stock.n	biomass	SSB
1	0.01	1256	185	96733	4837	0
2	0.19	14277	2606	86333	12461	0
3	0.49	11123	2320	29838	5749	5749
4	0.50	7027	1760	18597	4426	4426
5	0.54	7179	1874	18022	4433	4433
6	0.53	8109	2395	20545	5828	5828
7	0.48	1384	462	3811	1171	1171
8	0.35	911	340	3221	1241	1241
9	0.40	396	158	1249	514	514
10	0.40	665	309	2099	1027	1027
Total:		52327	12409	280449	41687	24389

year: 2008 Fmult.: 1 Fbar: 0.45

age	F	catch.n	landings	stock.n	biomass	SSB
1	0.01	1256	185	96733	4837	0
2	0.19	14277	2606	86333	12461	0
3	0.49	24068	5020	64564	12439	12439
4	0.50	6222	1558	16465	3919	3919
5	0.54	4052	1058	10174	2503	2503
6	0.53	3754	1109	9512	2698	2698
7	0.48	3965	1322	10914	3354	3354
8	0.35	604	226	2137	823	823
9	0.40	650	260	2051	844	844
10	0.40	642	298	2024	990	990
Total:		59490	13641	300907	44868	27570

Table 10.6.4. Sole in sub area IV: Yield per recruit summary table

MFYPR version 2a
Run: SOLE SEPTEMBER
Time and date: 10:42 28/09/2006
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.000	10.5083	3.8487	8.6035	3.6915	8.6035	3.6915
0.1000	0.0452	0.2681	0.096	7.8310	2.4999	5.9274	2.3429	5.9274	2.3429
0.2000	0.0904	0.4131	0.139	6.3837	1.8006	4.4813	1.6437	4.4813	1.6437
0.3000	0.1356	0.5031	0.160	5.4870	1.3863	3.5859	1.2296	3.5859	1.2296
0.4000	0.1808	0.5639	0.171	4.8820	1.1193	2.9821	0.9628	2.9821	0.9628
0.5000	0.2260	0.6076	0.176	4.4487	0.9369	2.5500	0.7805	2.5500	0.7805
0.6000	0.2712	0.6403	0.179	4.1245	0.8064	2.2270	0.6502	2.2270	0.6502
0.7000	0.3164	0.6658	0.179	3.8734	0.7098	1.9771	0.5537	1.9771	0.5537
0.8000	0.3616	0.6861	0.179	3.6734	0.6361	1.7784	0.4802	1.7784	0.4802
0.9000	0.4068	0.7026	0.179	3.5105	0.5784	1.6167	0.4227	1.6167	0.4227
1.0000	0.4520	0.7164	0.178	3.3752	0.5324	1.4826	0.3767	1.4826	0.3767
1.1000	0.4972	0.7281	0.177	3.2609	0.4948	1.3696	0.3394	1.3696	0.3394
1.2000	0.5424	0.7382	0.176	3.1631	0.4638	1.2729	0.3085	1.2729	0.3085
1.3000	0.5876	0.7469	0.174	3.0783	0.4377	1.1893	0.2825	1.1893	0.2825
1.4000	0.6328	0.7546	0.173	3.0040	0.4155	1.1162	0.2605	1.1162	0.2605
1.5000	0.6780	0.7614	0.172	2.9382	0.3964	1.0517	0.2416	1.0517	0.2416
1.6000	0.7232	0.7675	0.171	2.8796	0.3798	0.9942	0.2251	0.9942	0.2251
1.7000	0.7684	0.7730	0.170	2.8268	0.3652	0.9427	0.2107	0.9427	0.2107
1.8000	0.8136	0.7780	0.170	2.7792	0.3523	0.8963	0.1979	0.8963	0.1979
1.9000	0.8588	0.7826	0.169	2.7358	0.3408	0.8541	0.1866	0.8541	0.1866
2.0000	0.9040	0.7868	0.168	2.6961	0.3305	0.8155	0.1764	0.8155	0.1764

Reference point	F multipli	Absolute F
Fbar(2-6)	1.0000	0.452
FMax	0.7296	0.3298
F0.1	0.3024	0.1367
F35%SPR	0.2816	0.1273

Weights in kilograms

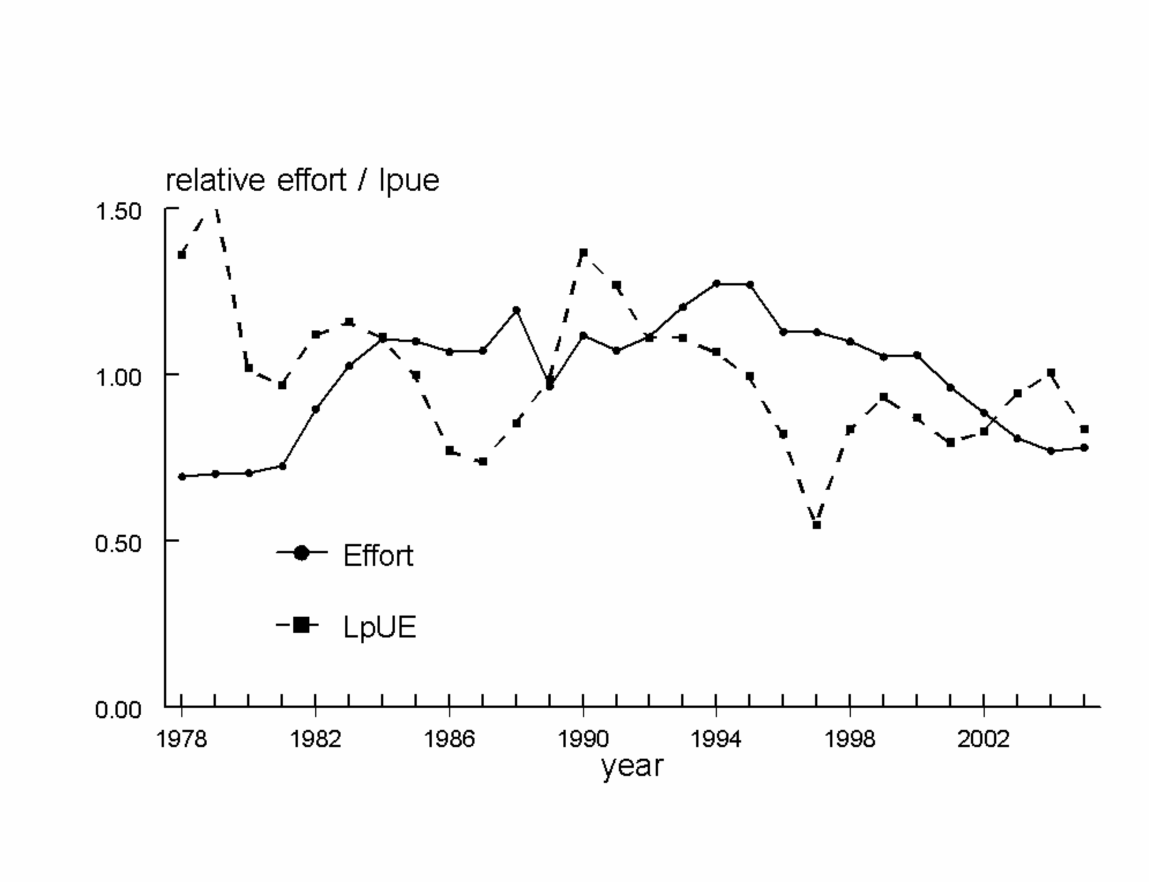


Figure 10.2.1. North Sea sole: trends in relative effort (solid line) and lpue (dashed line)

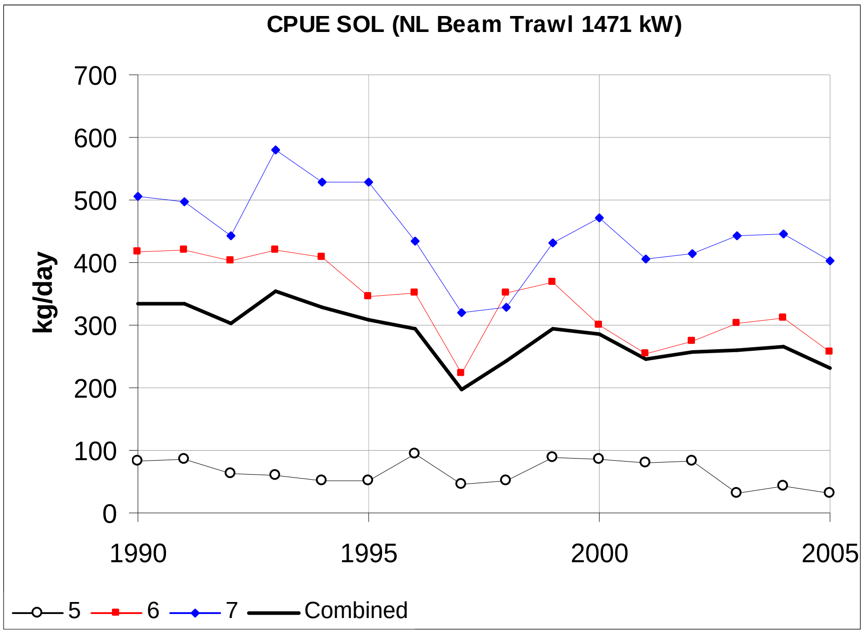


Figure 10.2.2. North Sea sole: LPUE trends in the Dutch beam trawl fleet (only large vessels, 2000 HP, 1471 kW) based on landings and effort records in the Dutch logbook database from vessels landings into the Netherlands. Three (North Sea) areas are considered: 5 (north, open circles), 6 (central, red squares) and 7 (south, diamond blue). Black line indicates the overall trend in LPUE)

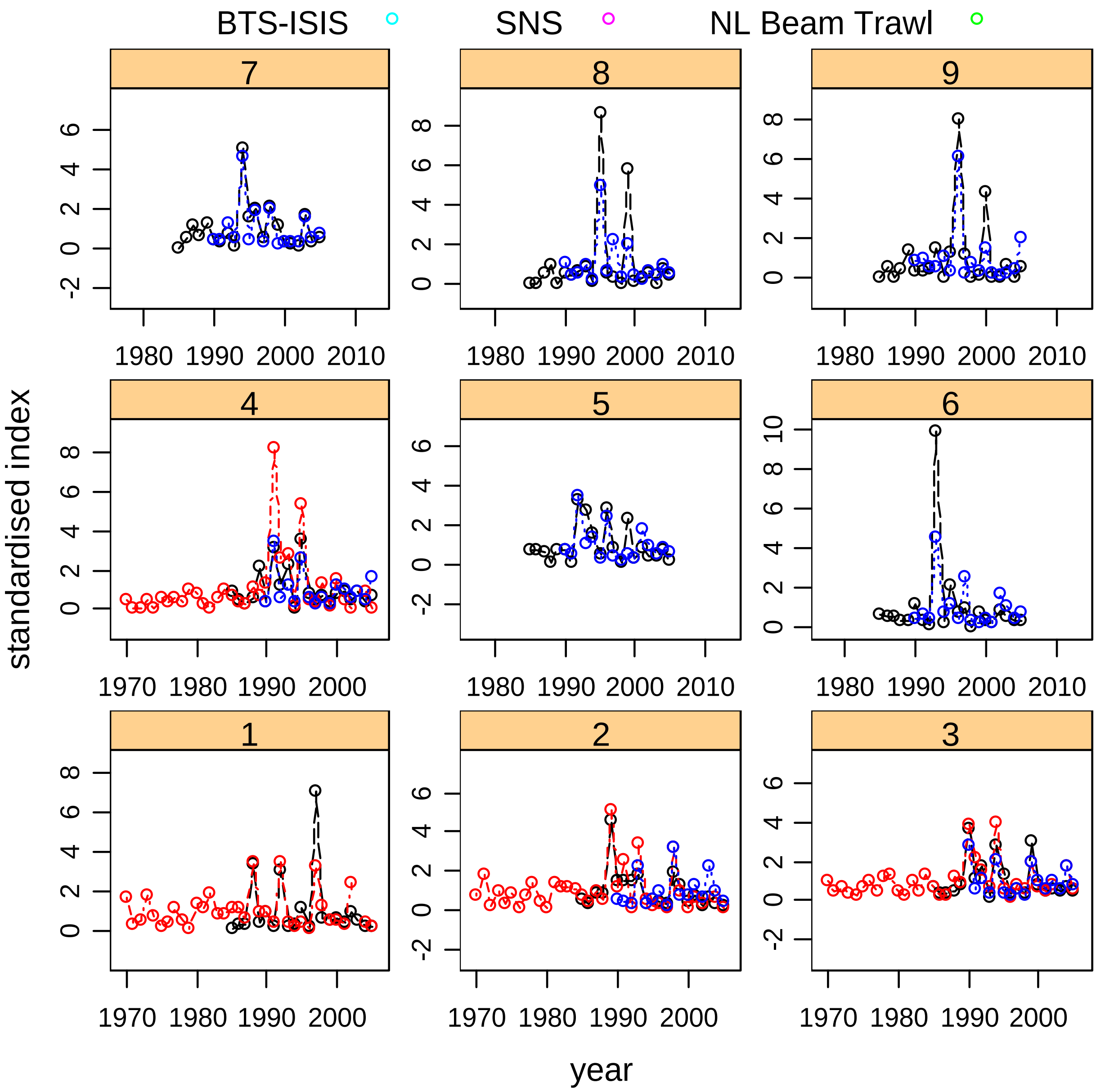


Figure 10.2.3 Sole in sub-area IV. Time series of the estimated stock numbers at age in comparison to the tuning series

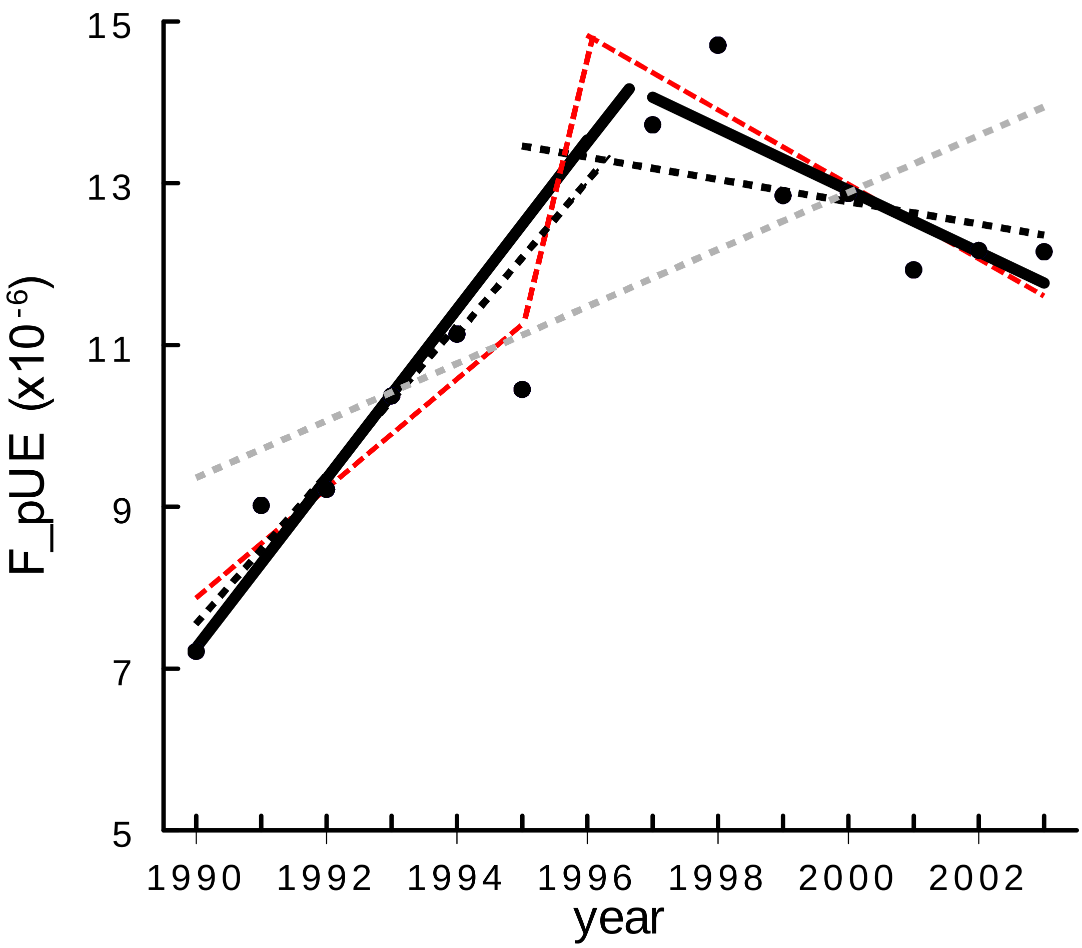


Figure 10.3.1. North Sea sole: Time series of F_pUE in the Dutch beam trawl . Grey dotted line is the linear trend line with 2.8 % increase per year. The thick black line represents segmented trend with a regression break in 1996 or 1997. The black dashed line shows segmented trend with a regression break in 1994. A regression break in 1995 is shown as thin dashed line. Please note the 2 regression line are connected by a step line from 1995 to 1996.

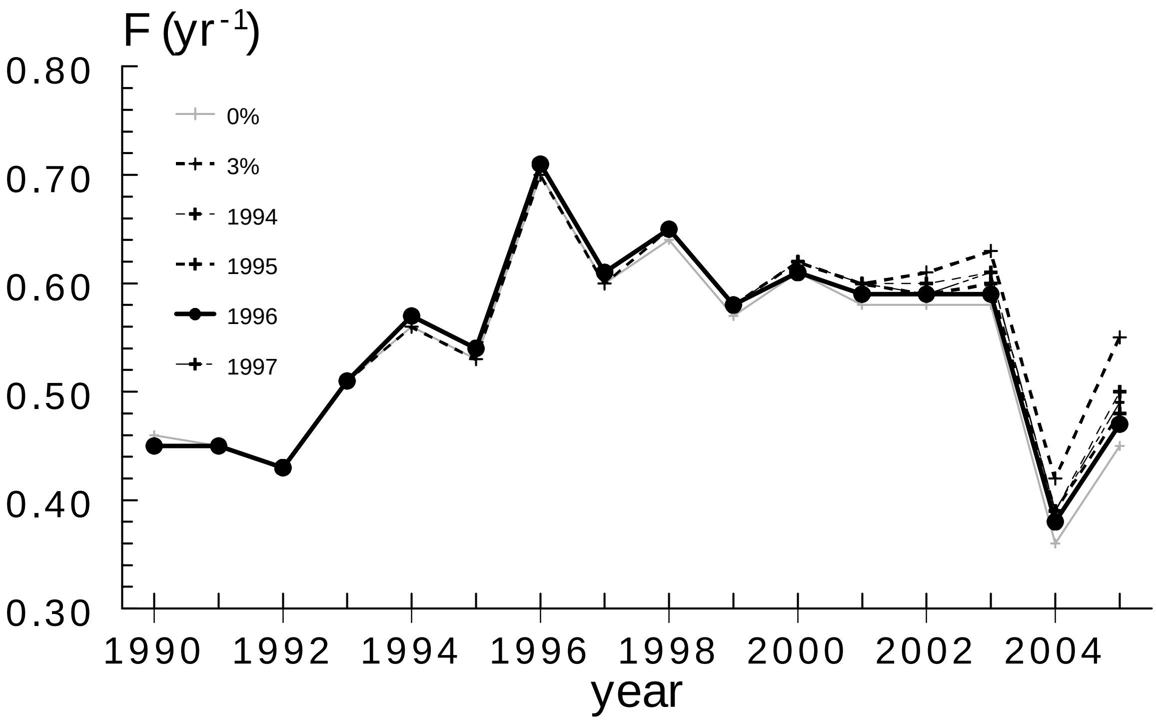


Figure 10.3.2 Sole in sub-area IV. XSA summary plot for fishery mortality (per year), without (0%) technology creep (grey line), with 2.8 % increase per year (dashed –top– line). Segmented regressions: see legend.

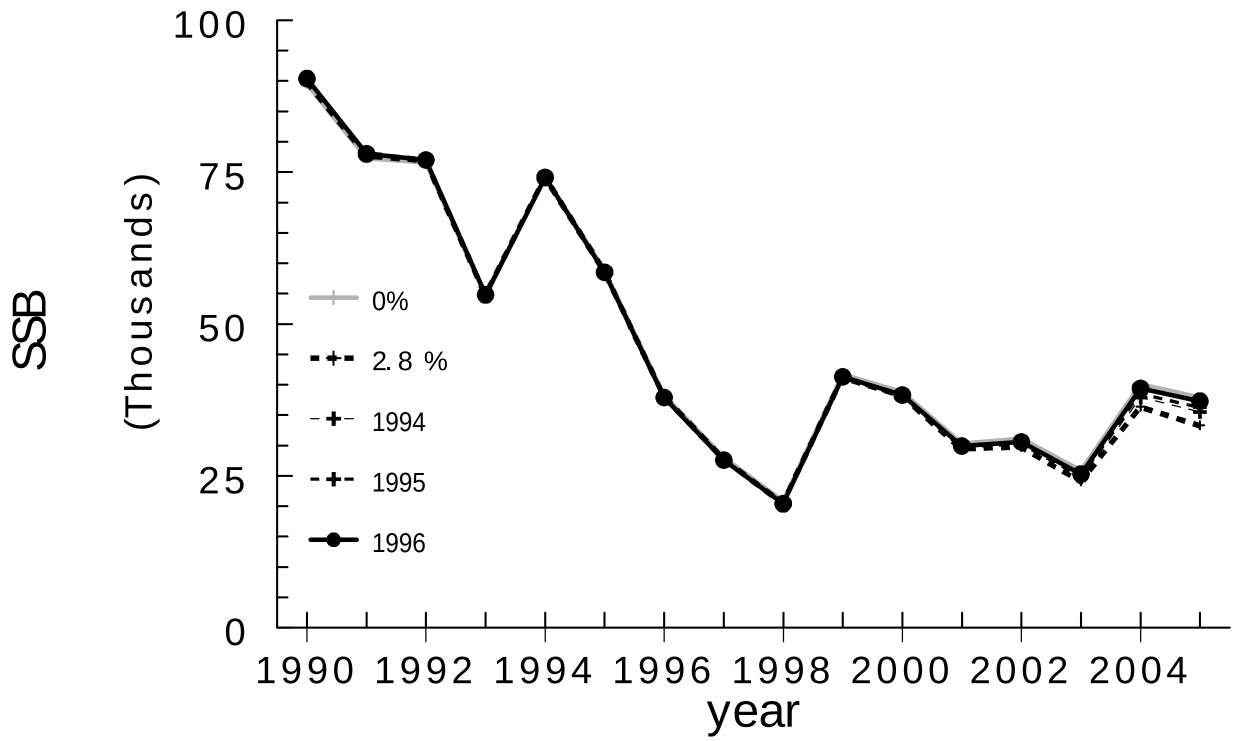


Figure 10.3.3 Sole in sub-area IV. XSA summary plot for SSB (thousand tonnes), without (0%) technology creep (grey line), with 2.8 % increase per year (dashed –top– line). Segmented regressions: see legend.

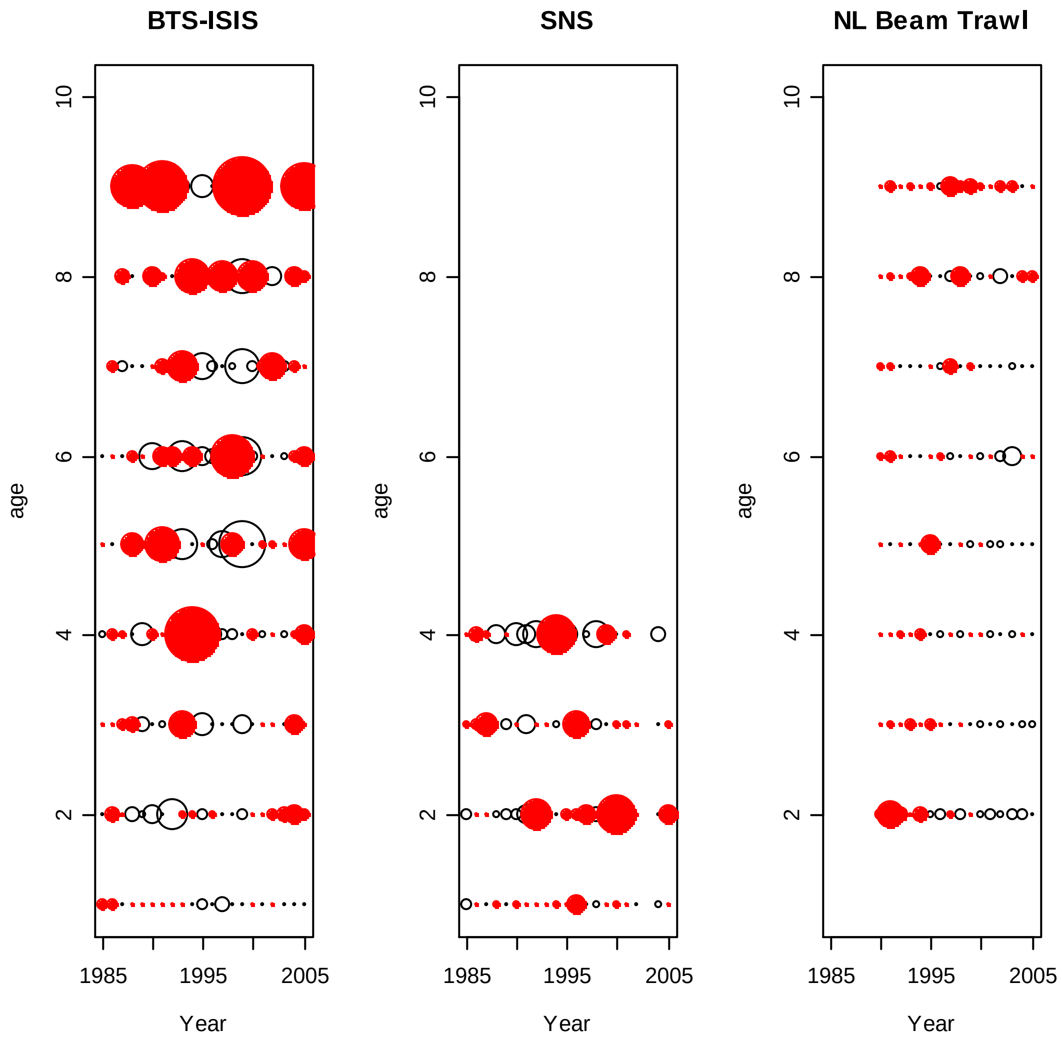


Figure 10.3.4 Sole in sub-area IV. log catchability residuals for the tuning fleets, BTS, SNS and NL beam trawl, in the final run. Open circles indicate positive residuals, Closed –dark- circles indicate negative residuals

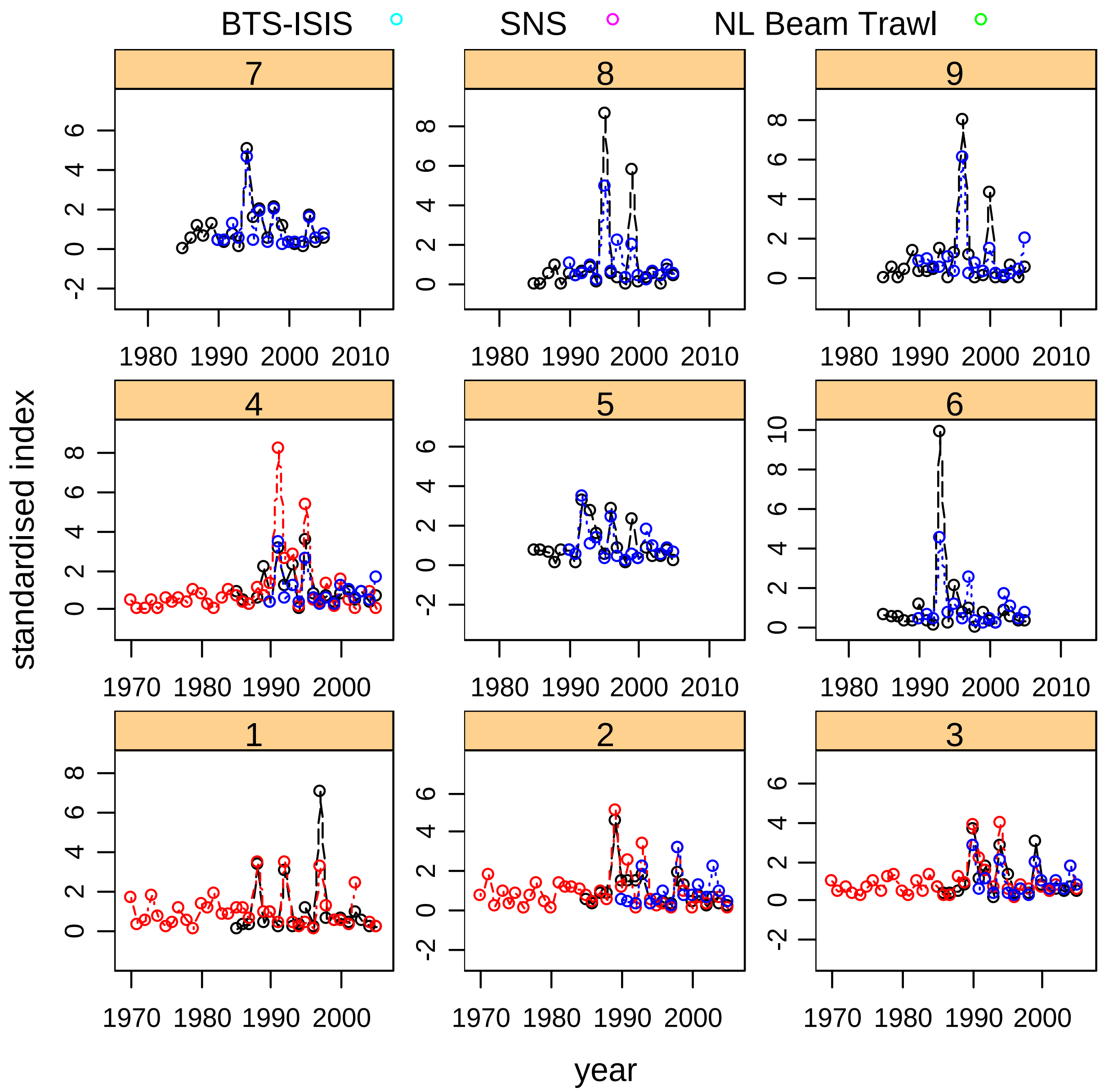


Figure 10.3.5 Sole in sub-area IV. Time series of the estimated stock numbers at age in comparison to the tuning series

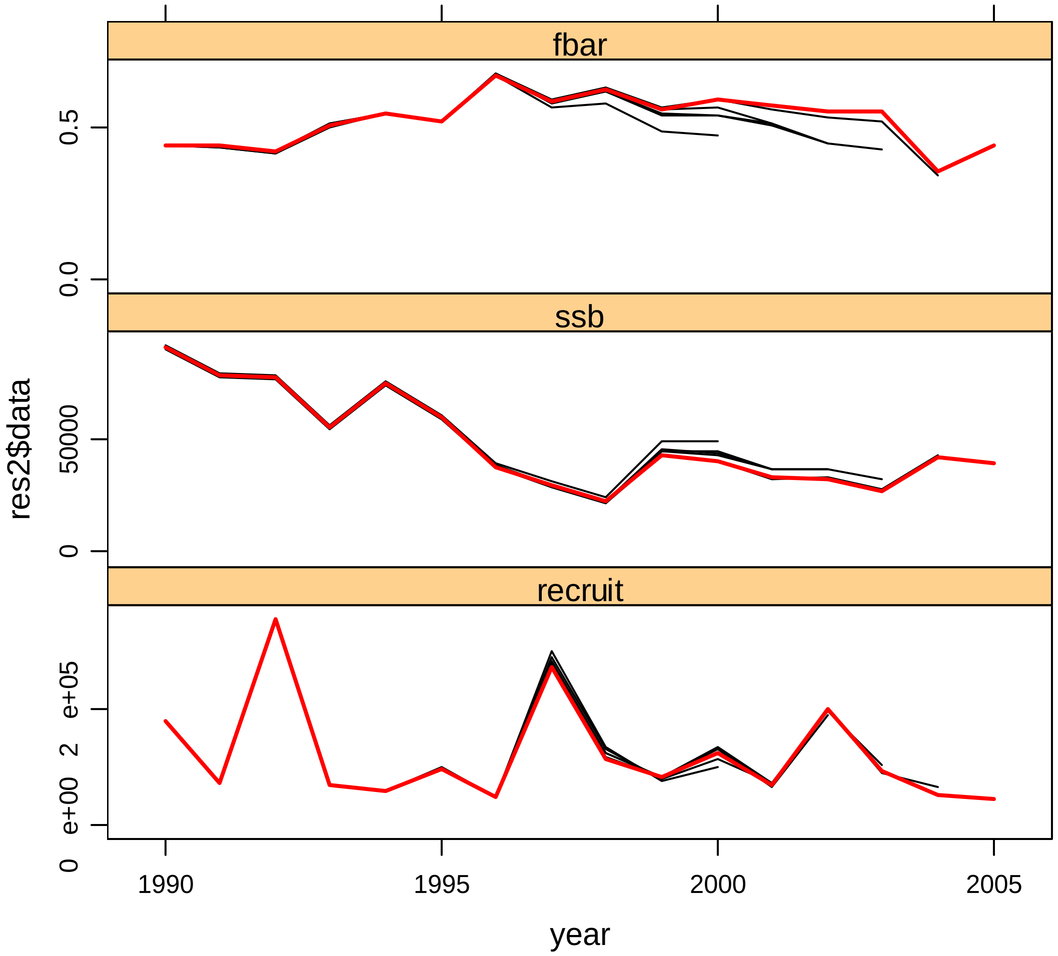


Figure 10.3.6 Sole in sub-area IV. Retrospective analysis of F, SSB and recruitment for 1990-2005

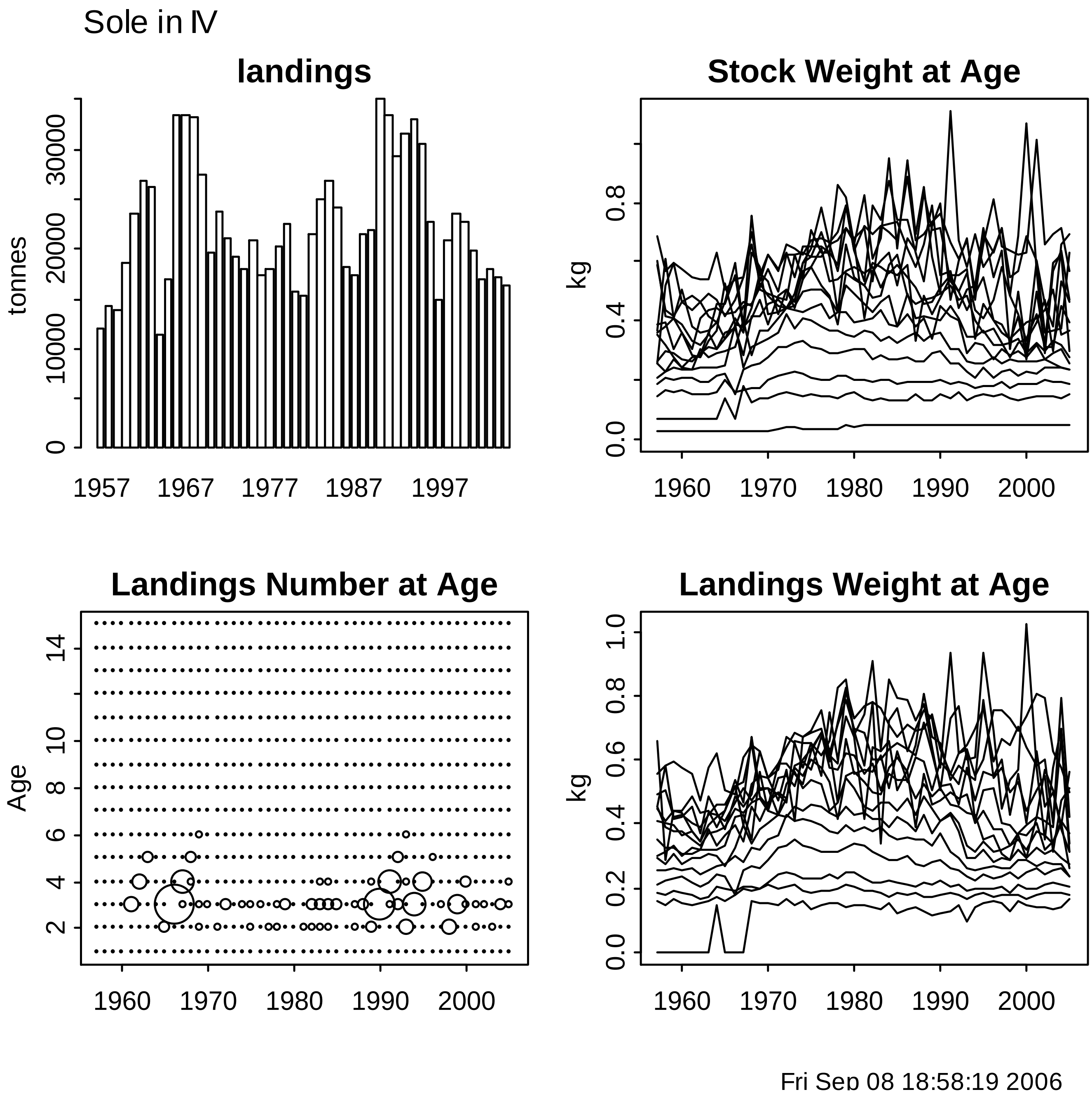


Figure 10.4.1 Sole in sub-area IV. Stock summary plots

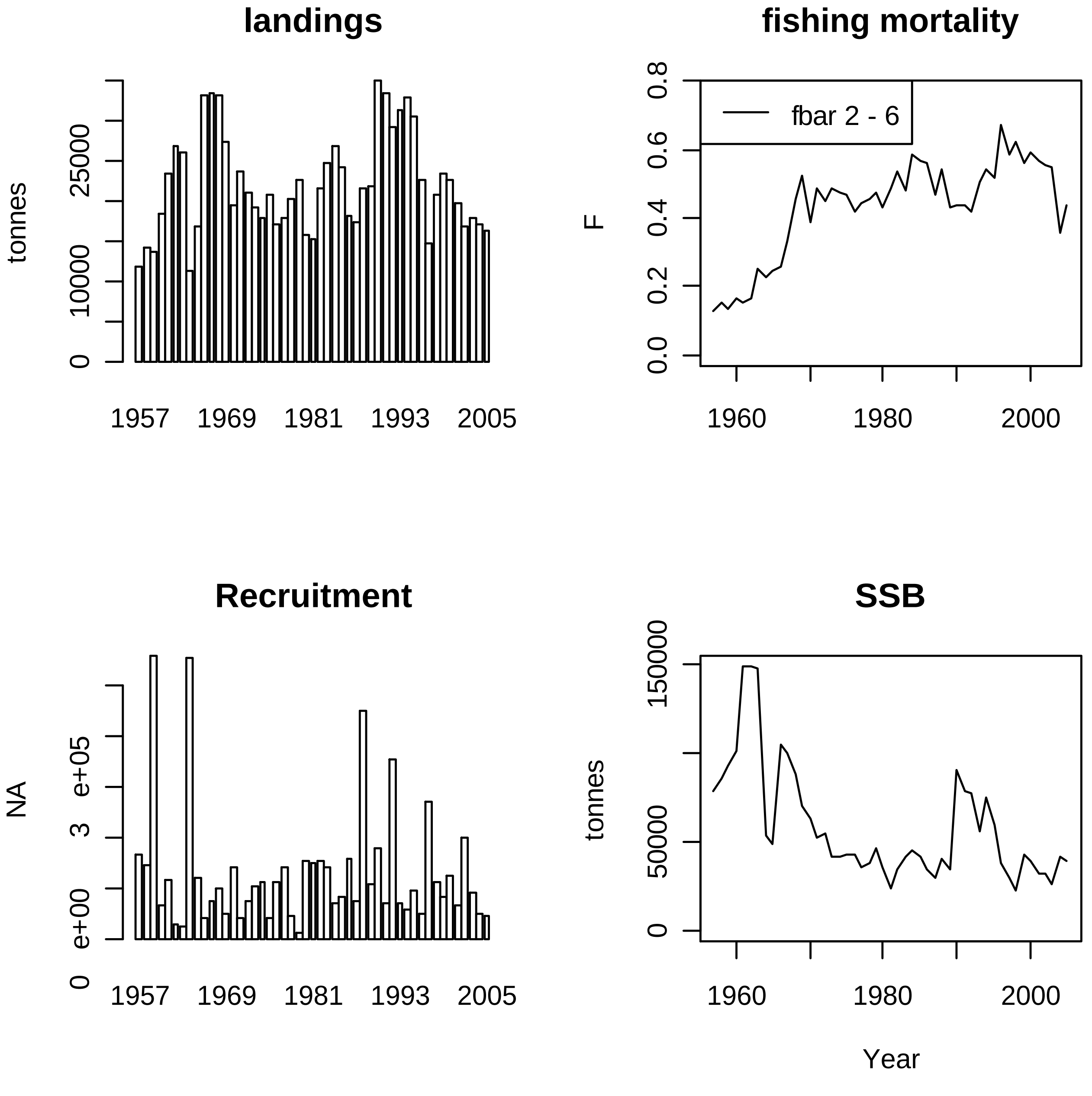
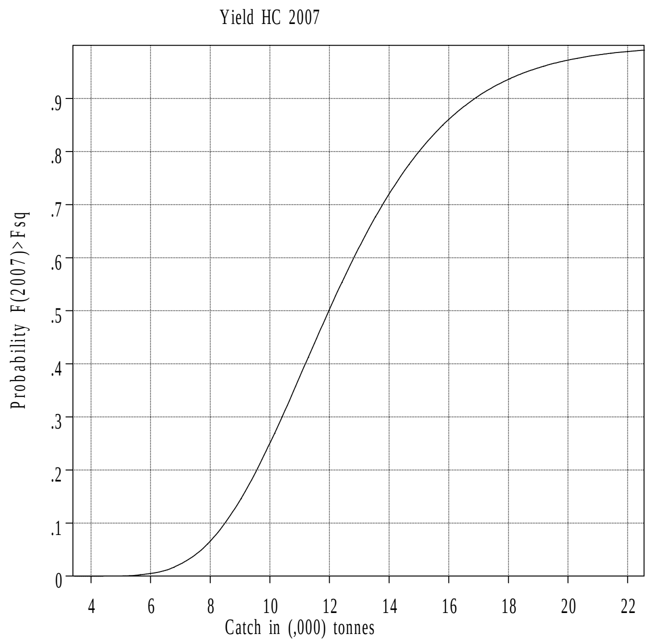


Figure 10.4.2 Sole in sub-area IV. XSA summary plots



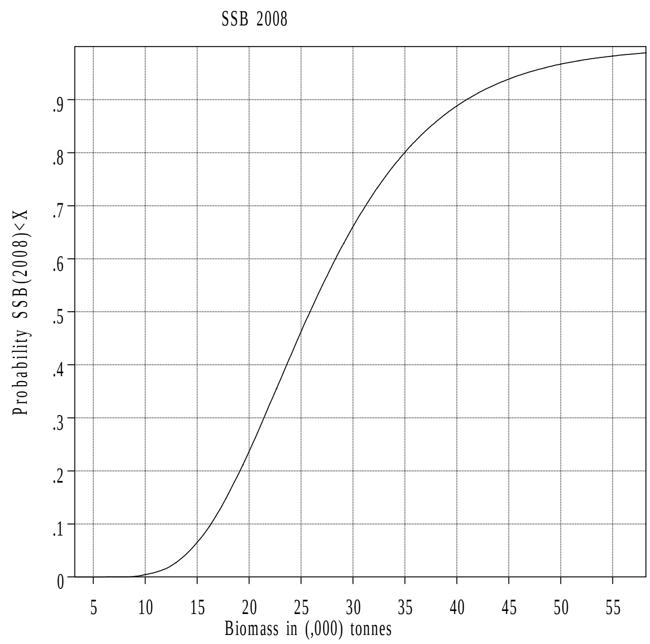
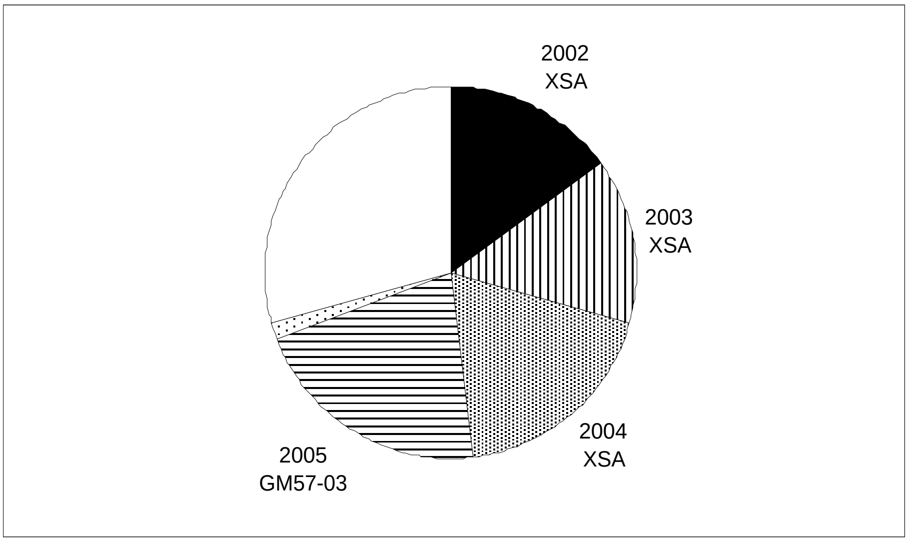


Figure 10.6.1. Sole in sub-area IV. Probability plots for short-term forecasts. Top, probability plot for Fsq and below a probability plot for SSB.



Landings

SSB

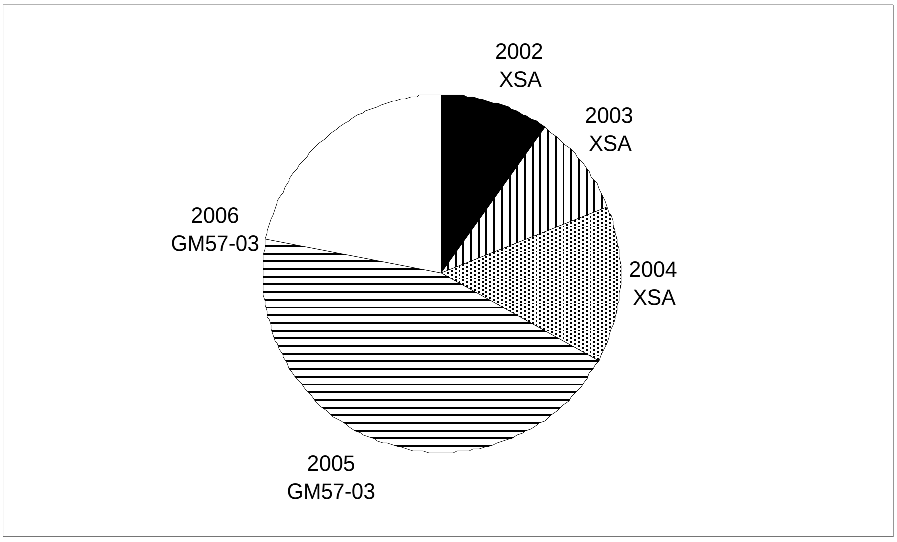
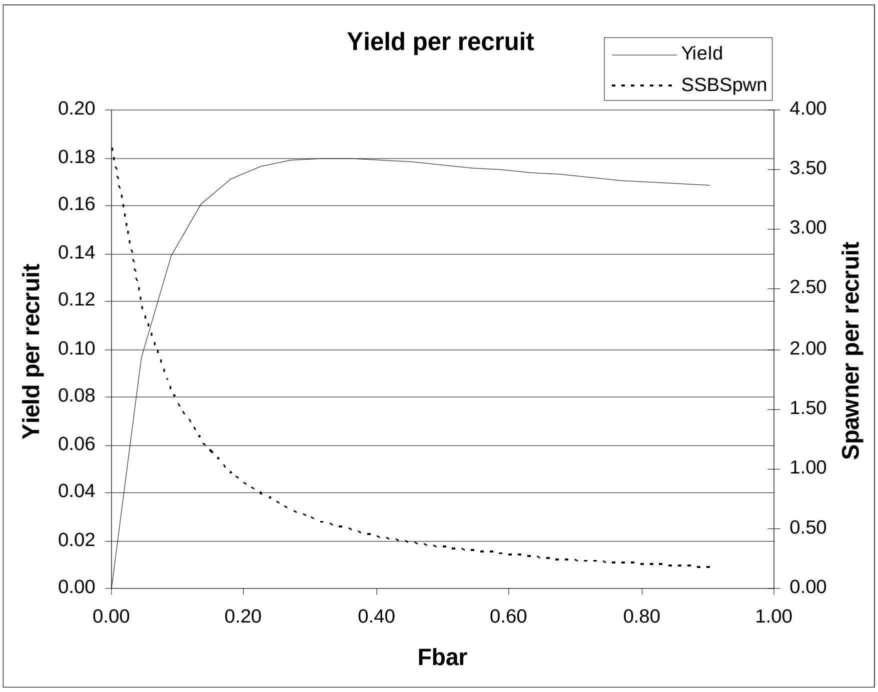


Figure 10.6.2 Sole in sub-area IV. Relative year class contribution to 2007 predicted landings (top) and 2008 SSB (below)



MFYPR version 2a
Run: SOLE SEPTEMBER
Time and date: 10:42 28/09/2006

Reference point	F multiplier	Absolute F
Fbar(2-6)	1.0000	0.4520
FMax	0.7296	0.3298
F0.1	0.3024	0.1367
F35%SPR	0.2816	0.1273

Weights in kilograms

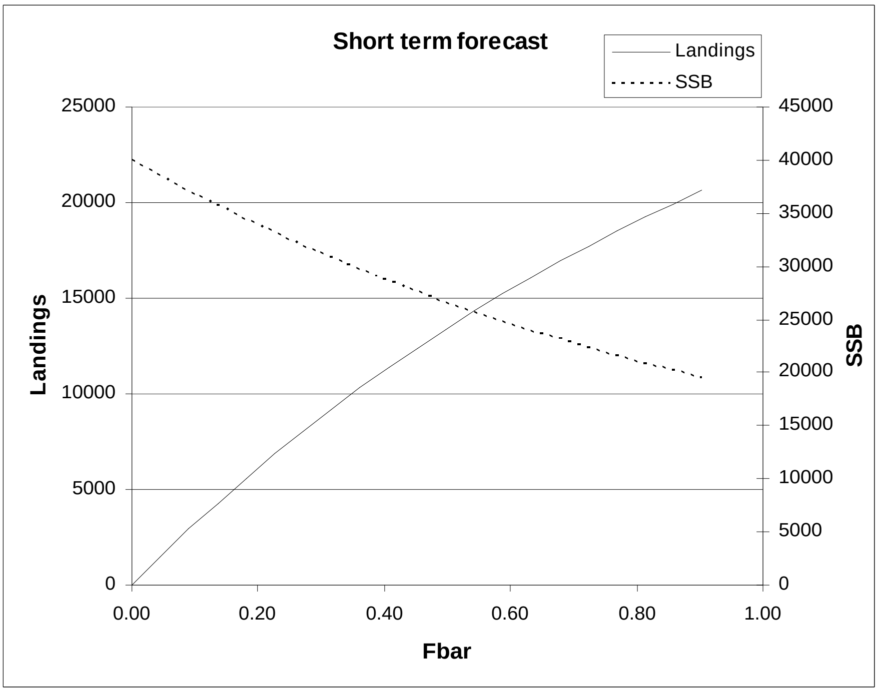


Figure 10.6.4 Sole in sub-area IV. XSA YPR results (top) and short-term forecast (bottom).

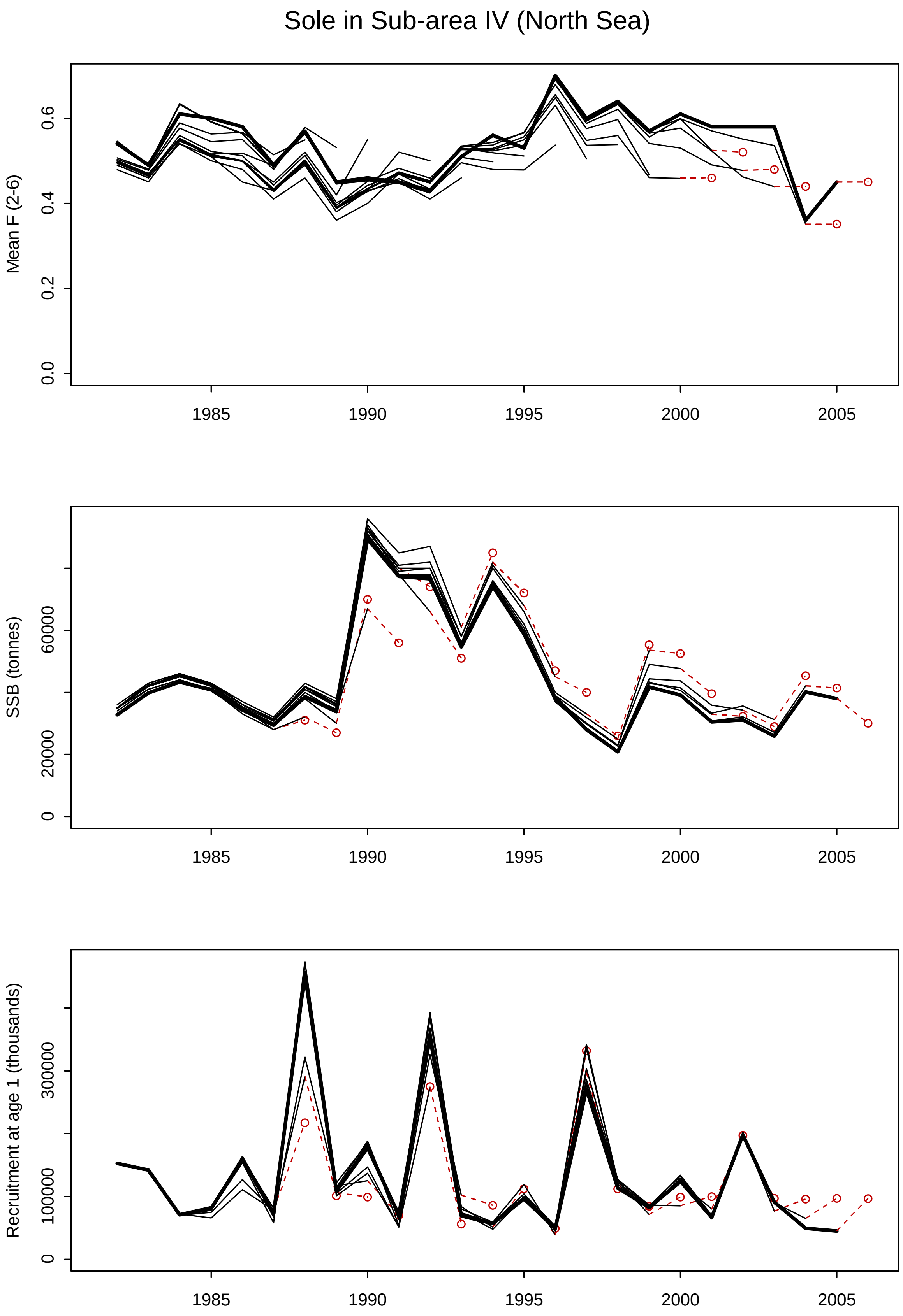


Figure 10.10.1. Sole in sub-area IV. Historic performance (F, SSB & recruitment) of the assessments. Circles indicate forecast values

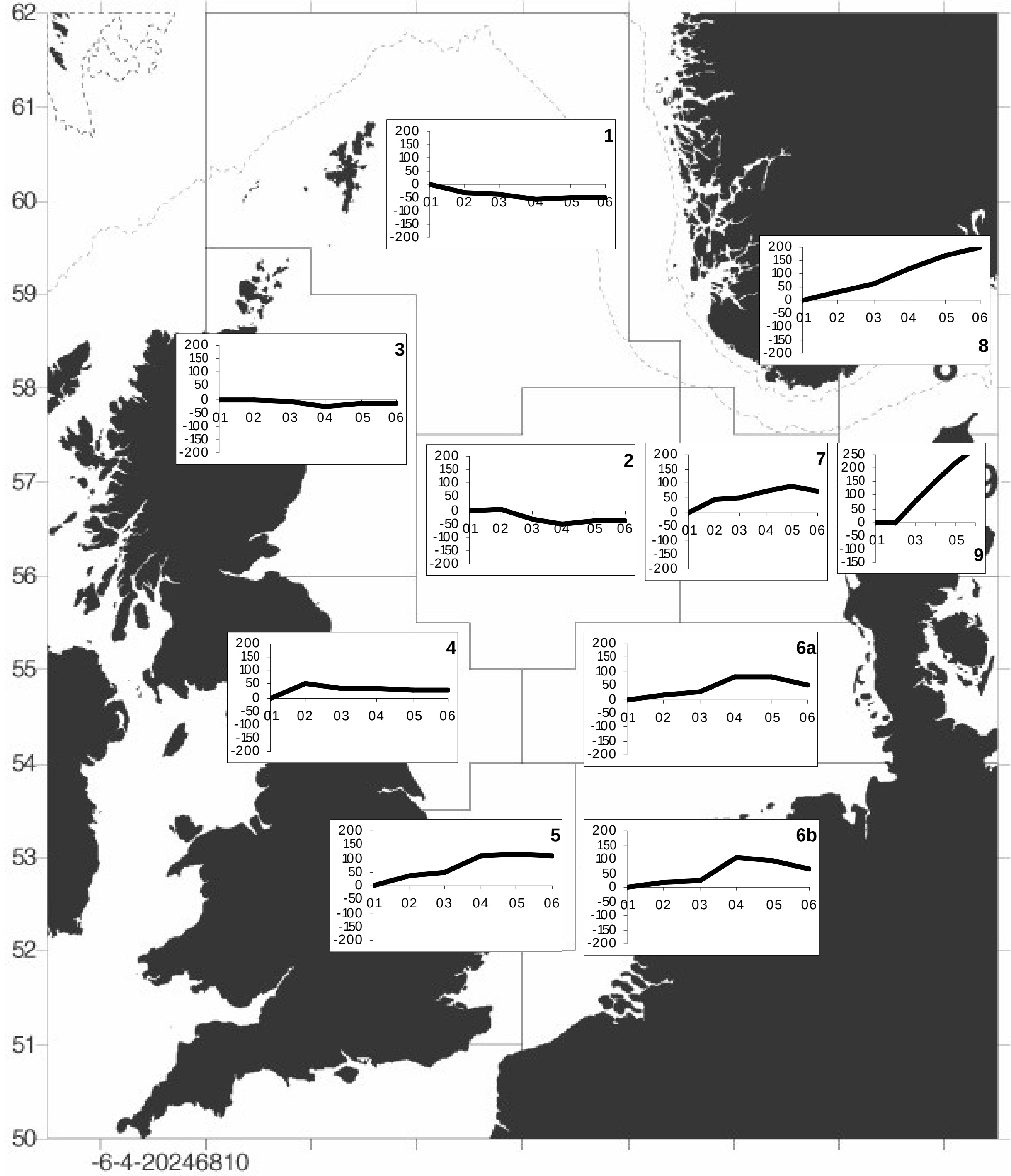


Figure 10.10.2. Sole in sub-area IV. Fishermen survey

11 SAITHE IN SUB-AREA IV, VI AND DIVISION IIIa

The 2006 assessment of saithe in Sub-areas IV and VI and Division IIIa is classified as an update assessment. Detailed biological and methodological information can be found in the Stock Annex (Q11).

11.1 General

11.1.1 Ecosystem aspects

The geographical distributions of juvenile (< age 3) and adults saithe differ. Typical for all saithe stocks are the inshore nursery grounds. Juvenile saithe in the North Sea are therefore mainly distributed along the west and south coast of Norway, the coast of Shetland and the coast of Scotland. At around age 3 the individuals gradually migrate from the costal areas to the northern part of the North Sea (57°N - 62°N). The age at maturity is between 4 and 6 years, and spawning takes place in January-March at about 200 m depth along the Northern Shelf edge and the western edge of the Norwegian Deeps. Larvae and post-larvae are widely distributed in Atlantic water masses across the northern part of the North Sea, and around May the 0-group appears along the coasts (of Norway, Shetland and Scotland). The west coast of Norway is probably the most important nursery ground for saithe in the North Sea.

When saithe exceeds 60-70 cm in length the diet changes from plankton (krill, copepods) to fish (mainly Norway pout, blue whiting, haddock and herring). Large saithe (>70 cm) has a highly migratory behaviour and the feeding migrations extend from far into the Norwegian Sea to across the Norwegian Deeps to the Norwegian coast.

Tagging experiments by various countries have shown that exchange between all saithe stock components in the northeast Atlantic takes place. In particular, exchange between the saithe stock north of 62°N (northeast Arctic saithe) and saithe in the North Sea has been observed (this probably also includes drift of larva and 0-group).

11.1.2 Fisheries

A general description of the fishery is given in the Stock Annex (Q11).

In 2005 the landings were estimated to be around 110 000 t in Sub-area IV and Division IIIa, and around 5 000 t in Sub-Area VI, which is well below the TAC. Significant discards appear only in Scottish trawlers (mainly due to TAC regulations). However, as Scottish discarding rates are not representative of the majority of the saithe fishery, these have not been used in the assessment. Ages 1 and 2 are mainly distributed close to the shores and are very scarce in the main fishing areas for saithe. These ages are therefore little related to discarding practices.

11.1.3 ICES Advice

For 2005 ICES considered the stock to be inside safe biological limits, however, the ICES advice for the stock was presented in the context of mixed fisheries.

Exploitation boundaries in relation to existing managent plans

Following the agreed management plan, landings in 2005 should be 150 000 t (137 000 t in IV and IIIa and 14 000 t in VI) which is expected to allow an increase in SSB to 241 000 t in 2006.

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. The current fishing mortality (F_{sq}) is estimated as 0.29, which is above rates that would lead to high long-term yields ($F_{0.1}$=0.13 and F_{max}=0.25). Fishing at $F_{0.1}$ is expected to lead to landings in 2005 of 56 000 t and SSB in 2006 of around 330 000 t.

For all demersal fisheries in the North Sea, ICES advice was based on mixed-fishery considerations and it advised the following:

Fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2004 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- *with minimal bycatch or discards of cod;*
- *Implement TACs or other restrictions that will curtail fishing mortality for those stocks ... for which reduction in fishing pressure is advised;*
- *within the precautionary exploitation limits for all other stocks.*
- *Where stocks extent beyond this area, e.g. into Division VI (saithe and anglerfish) or is widely migratory (Northern hake) taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;*

In 2006 ICES classified the stock as having full reproductive capacity and being harvested sustainably.

Expoitation boundaries in relation to existing management plans.

A catch of 136 000 t in 2006 is a 15 % reduction in TAC from 2005 to 2006 and corresponds to an F value of 0.40.

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

A catch of 109 000 t in 2006 corresponds to an F of 0.30, which is the target F according to the management plan when SSB is above 200 000 t.

Exploitation boundaries in relation to precautionary limits

A catch of 136 000 t in 2006 corresponds to an F value of 0.40 (F_{pa}) and an SSB(2007) of 200 000 t equal to B_{pa}.

11.1.4 Management

Management of saithe is by TAC and technical measures. The fishery is not regulated by days at sea for vessels that have less bycatch than 5% of each cod, plaice and sole. The agreed TAC for saithe in Sub-Area IV and Division IIIa for 2005 was 145 000 t. In Division Vb and Sub-Areas VI, XII, and XIV the TAC for 2004 was 15 044 t. For 2006 the TACs were 123 250 t and 12 787 t, respectively. Current technical measures are described in Section 2.1.2.

In 2004 EU and Norway *"agreed to implement a long-term plan for the saithe stock in the Skagerrak, the North Sea and west of Scotland, which is consistent with a precautionary approach and designed to provide for sustainable fisheries and high yields. The plan shall consist of the following elements:*

1. *Every effort shall be made to maintain a minimum level of Spawning biomass (SSB) greater than 106 000 tonnes (B_{lim}).*

2. *Where the SSB is estimated to be above 200 000 tonnes the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.30 for appropriate age groups.*

3. *Where the SSB is estimated to be below 200 000 tonnes but above 106 000 tonnes The TAC shall not exceed a level which, on the basis of a scientific evaluation by ICES, will result in a fishing mortality rate equal to 0.30-0.20*(200 000-SSB)/94 000.*

4. *Where the SSB is estimated by the ICES to be below the minimum level of SSB of 106 000 tonnes the TAC shall be set at a level corresponding to a fishing mortality rate of no more than 0.1.*

5. *Where the rules in paragraphs 2 and 3 would lead to a TAC which deviates by more than 15% from the TAC the preceding year the Parties shall fix aTAC that is no more tha 15% greater or 15% less than the TAC of the preceding year.*

6. *Notwithstanding paragraph 5 the Parties may where considered appropriate reduce the TAC by more than 15% compared to the TAC of the preceding year.*

7. *A review of this arrangement shall take place no later than 31 December 2007.*

This arrangement enters into force on 1 January 2005."

11.2 Data available

11.2.1 Catch

Landings data by country and TACs are presented in Table 11.2.1.

11.2.2 Age compositions

Age compositions of the landings are presented in Table 11.2.2. Landings-at-age data by fleet are supplied by Denmark, Germany, France, Norway, UK (England), and UK (Scotland) for Area IV and only UK (Scotland) for Area VI. Sum-of-products (SOP) discrepancies are observed from 2000 onwards.

11.2.3 Weight at age

Weight at age in the catch is presented in Table 11.2.3 and Figure 11.2.1. These are also used as stock weights. There has been a decreasing trend in mean weights from the mid-1990s for ages 5 and older.

11.2.4 Maturity and natural mortality

A natural mortality rate of 0.2 is used for all ages and years, and the following maturity ogive is used for all years:

AGE	1	2	3	4	5	6	7+
Proportion mature	0.0	0.0	0.0	0.15	0.7	0.9	1.0

11.2.5 Catch, effort and research vessel data

Fleet data used for calibration of the assessment are presented in Table 11.2.4. Trends in relative LPUE and effort for the commercial fleets are shown in Figure 11.2.2. The LPUE shows an increasing trend in all fleets and ages (Figure 11.2.3). Three commercial series of effort and catch at age and two series of survey indices were used:

Commercial fleets:

- French fresh fish trawl, age range: 3-9 (“FRAtrb”)
- German bottom trawl, age range: 3-9 (“GERotb”)
- Norwegian bottom trawl, age range: 3-9 (“NORtrl”)

Surveys:

- Norwegian acoustic survey, age range 3-6 (“NORacu”)
- IBTS quarter 3, age range: 3-5 (“IBTSq3”)

A more detailed description of the series is given in the Stock Annex (Q11)

11.3 Data analyses

The methods used for analyzing the data was FLXSA and XSA. Results from these were very nearly identical; XSA was used for the final run in order to generate diagnostics (see Section 1.3.3).

11.3.1 Reviews of last year’s assessment

The Review Group in ACFM had several comments to the assessment.

1. The RG considered that there were not strong reasons to exclude ages 1 and 2 from the Catch at Age and thus the assessment. Catch of these age groups is related to discarding practices and may be able to be modeled in relation to TAC, price and so on.

2. The age range adopted for Fbar was 3 – 6 but the assessment implies that saithe are not fully exploited until age 5. The RG considered the trend of F ages 6 – 8, which is a better reflection of the fully recruited F, given recent trends in the age based exploitation pattern, and compared this to the Fbar trend. The RG felt that the age range used in the F indicator should be reconsidered by the WG. This has implications for revision of the PA reference points.

3. Tuning data did not provide good signal for recruitment at age 3. Recruitment estimates are noisy.

4. Trends in survey Q’s with time were noted.

5. There was no explanation for the decrease in F since the late 1980s.

The Working Group has the following responses:

1. Ages 1 and 2 are mainly distributed close to the shores and are very scarce in the main fishing areas for saithe. These ages are therefore very little related to discarding practices. The discarding in the saithe fishery is mainly over quota fish or price related. Some fishermen are not willing to fill up their boat with low priced fish.

2. There are no signals in the catch data for ages 1 and 2. When used in single fleet runs these ages must always be excluded because of very bad diagnostics. The Working Group will therefore continue to make the assessment for ages 3+.

3. Figure 11.3.1 shows the F trends for F(3-6), F(4-7) and F(6-8). The F(6-8) shows the same trends as the other two except that it has an increasing trend since 2000 and that this series is much more variable. This variability may be explained by the fact that the catches of ages 6 to 8 represents from 3 % to 40 % of the total catches in numbers, while the catches of ages 3 to 6 represents around 80 % of total catches for all years.

4. The Management Plan agreed by EU and Norway is based on F(3-6) and the corresponding PA reference points. This management plan will be reviewed at the negotiations in 2007. The Working Group therefore decided to do a thorough analysis of Fbar at the Working Group Meeting in 2007, and if necessary change the PA reference points.

5. This year, the Working Group has an index for age 3 from the acoustic survey in July.

6. This point was not addressed by the Working Group.

7. Since 1990 the saithe stock has shown an increasing trend. In the same period the outtake has been almost constant around 100 000 t. This will evidently result in a decreasing trend in fishing mortality.

11.3.2 Exploratory catch-at-age-based analyses

Exploratory runs were done with FLXSA with different choices of plus group (age 9 and 10), F-shrinkage (0.5, 1.0 and 2.0), q-plateau (age 6, 7 and 8) and tuning fleet combinations. Black line represents SPALY. The assessment is very sensitive to different combinations of the tuning series (Figure 11.3.2), but relatively unsensitive to the other settings. As this assessment is an update the final assessment is run with the same settings as last year except that age 6 in IBTSq3 is excluded because this age is a plus group (this was accidentally retained last year). The retrospective analysis (Fig. 11.3.3) shows that there is a tendency to overestimate fishing mortality and underestimate SSB.

11.3.3 Exploratory Survey-based analysis

The surveys available to the Working Group have indices only for young fish (age 3 to 6). These series are not giving good signals for the SSB, and therefore the Working Group has not done any survey-based analysis for exploring trends in SSB.

11.3.4 Final assessment

The settings in the final XSA assessment for the last three years are:

YEAR OF ASSESSMENT:	2004	2005	2006
Assessment model:	XSA	XSA	XSA
Fleets:	FRAtrb (age range: 3-9, 1990 onwards)	FRAtrb (age range: 3-9, 1990 onwards)	FRAtrb (age range: 3-9, 1990 onwards)
	GERotb (age range: 3-9, 1995 onwards)	GERotb (age range: 3-9, 1995 onwards)	GERotb (age range: 3-9, 1995 onwards)
	NORtrl (age range: 3-9, 1980 onwards)	NORtrl (age range: 3-9, 1980 onwards)	NORtrl (age range: 3-9, 1980 onwards)
	NORacu (age range: 3-7, 1995 onwards)	NORacu (age range: 3-6, 1995 onwards)	NORacu (age range: 3-6, 1995 onwards)
		IBTSq3 (age range: 3-6, 1991 onwards)	IBTSq3 (age range: 3-5, 1991 onwards)
Age range:	1-10+	3-10+	3-10+
Catch data:	1967-2003	1967-2004	1967-2005
Fbar:	3-6	3-6	3-6
Time series weights:	Tricubic over 20 years	Tricubic over 20 years	Tricubic over 20 years
Power model for ages:	No	No	No
Catchability plateau:	Age 7	Age 7	Age 7
Survivor est. shrunk towards the mean F:	5 years / 3 ages	5 years / 3 ages	5 years / 3 ages
S.e. of mean (F-shrinkage):	1.0	1.0	1.0
Min. s.e. of population estimates:	0.3	0.3	0.3
Prior weighting:	no	No	no
Number of iterations before convergence:	37	39	40

Outputs from the final run are given in Table 11.3.1 (diagnostics), Table 11.3.2 (fishing mortality at age), Table 11.3.3 (population numbers at age), and Table 11.3.4 (stock summary). The XSA log catchability residuals are shown in Figure 11.3.4, the relative weights of F-shrinkage and tuning fleets are shown in Figure 11.3.5 and historical performance of the assessment is shown in Figure 11.3.6.

11.4 Historic Stock Trends

The historic stock and fishery trends are presented in Figure 11.4.1 (and Table 11.3.4). The reported landing increased from 1967 to the highest observed landing levels in the mid-1970ties. After 1976 the landings decreased rapidly to a stable level in 1979-1981 and increased again from 1981 to 1985. From 1985 the reported landings decreased and levelled of in 1989 to a fairly stable level where they have stayed since. The last four years (2002-2005) TAC levels have been far higher than the reported landings. The set TAC and the forecasted landing for 2006 indicate that this will also be the case in 2006. Estimated fishing mortality show the same trends as landings in the period 1967-1985 while it has decreased continuously since 1985 till present (except some small jumps), reaching below F_{lim} in 1993 and below F_{pa} in 1997. Estimated SSB increased from 1967 reaching the highest observed level in 1974 where after it decreased to below B_{lim} in 1990. After 1991 SSB increased to above B_{pa} in 1999. SSB is estimated to have been slightly above B_{pa} since 2001. The mean and variance in estimated recruitment (measured at age 3) are higher before around 1985 than after, e.g., the six strongest year classes observed all occurred in the earliest period. Estimated recruitment has decreased after the strong 1998 year class.

11.5 Recruitment estimates

This year an index of the 2003 year class from the acoustic survey in July was made available. RCT3 inputs and outputs are given in Tables 11.5.1 and 11.5.2 respectively. The text table below shows the recruitment estimated by RCT3 and the geometric mean from the period 1988 to 2003. The reason for only using this period is that the recruitment level and variance seem to be on different levels before and after around 1988. In a new survey along the Norwegian coast age 3 was less abundant than age 2 and age 4. The Working Group decided to use the RCT3 estimate for the 2003 year class.

YEAR CLASS	AGE IN 2006	XSA	GM(88-02)	RCT3
2002	4	107801		
2003	3		126845	111864

11.6 Short-term forecasts

The short-term prognosis was performed using the same method and settings as last year. Inputs are presented in Table 11.6.1. The average over the last three years are used for weight at age in the stock and catch. Fishing mortalities at age are also estimated to be an arithmetic average over the last three years. Number at age 3 (recruitment) is taken from a RCT3 run with input of an index of age 3 in July 2006. Population numbers at age 4 and older are the XSA survivor estimates. The management option table are given in Table 11.6.2 and the forecast is summarised in Table 11.6.3 and Figure 11.6.1. Status quo fishing mortality (F_{sq}) in 2006 and 2007 is expected to lead to landings of about 110 000 tonnes in 2007 and a slight decrease in the expected spawning stock biomass in 2008. A fishing mortality higher than F_{pa} in 2007 (and F_{sq} in 2006) is expected to lead to a spawning stock biomass in 2008 which is close to B_{pa}. The forecasted contribution of the most recent year classes in landings and SSB are shown in Table 11.6.4. The probability profiles for the short term forecast are shown in Figure 11.6.2. A sensitivity analysis identifying some of the sources of uncertainty underlying the prediction is presented in Figure 11.6.3.

11.7 Medium-term forecasts and yield-per-recruit

No medium-term forecasts were done. Results of yield-per-recruit analyses (using the same inputs as short-term forecasts) are given in Figure 11.7.1.

11.8 Biological reference points

Figure 11.8.1 shows the yield per recruit. The biological reference points are:

$\mathbf{F}_{0.1}$	0.10	$\mathbf{F}_{lim}$	0.60
$\mathbf{F}_{max}$	0.22	$\mathbf{F}_{pa}$	0.40
$\mathbf{F}_{med}$	0.35	$\mathbf{B}_{lim}$	106 000 t
$\mathbf{F}_{high}$	>0.49	$\mathbf{B}_{pa}$	200 000 t

11.9 Quality of the assessment

This assessment agrees well with the fishermen's perception of the stock in the main distributional area of saithe (Fig. 11.9.1). Compared to last year's assessment, the changes in estimated SSB and F(3-6) for 2003 and backwards are very small. For 2004 SSB is revised upwards with about 15 % and F is down with about 5 % (Fig. 11.3.6).

A problem with this assessment is the required use of commercial CPUE for tuning (the survey series which are used only contain usable information for age 3-6). There are many reasons for why commercial CPUE may fail to track changes in relative abundance. The most serious reason is so-called hyperstability; that is commercial catch rates remaining high while population abundance drops, which may occur when vessels are able to locate fish concentration independently of population size. Hyperstability can be discovered in time if the degree of the fleet's spatial concentration is monitored. Norway and Germany have now permitted the use of data from their satellite based vessel monitoring systems for research purposes, which makes it possible to perform such monitoring of the German and Norwegian tuning fleets. This needs to be addressed in future Working Group meetings.

The most serious problem with stock forecasts for saithe is the lack of reliable information about year class strength before age 3. An annual 0-group survey has been conducted by IMR (Norway) since 1999 in the northern North Sea, but this will not be continued due to lack of relationship between the 0-group index and later XSA population estimates for the year classes 1999-2001 (the 0-group index for the 2000 year class is extremely high, while this year class is estimated to be around average for age 4 in this year's assessment). IMR have started a new survey along the west coast of Norway to measure the relative abundance of saithe between 2 and 4 years old (when the saithe is distributed along the coast).

11.10 Status of the Stock

The general perception of the status of the saithe stock remains unchanged from last year's assessment. Fishing mortality appears to be below F_{pa} and the spawning stock biomass appears to be above B_{pa}.

11.11 Management Considerations

The ICES advice applies to the combined areas IIIa, IV, and VI.

The reported landings have been much lower than the TAC the last three years. Information from fishermen indicates that very low prices on saithe combined with high fuel prices are causing these reductions.

Bycatch of other demersal fish species occurs in the trawl fishery for saithe. Saithe is also taken as unintentional by-catch in other fisheries.

The stock of saithe in the North Sea is expected to remain within safe biological limits if the TAC for 2007 is set according to the agreed management plan. However, the estimated recruitment has declined rapidly the last four years. Thus, even with the current situation with low fishing mortality the spawning stock biomass is expected to decrease in the medium-term.

Table 11.2.1 Nominal landings (in tonnes) of Saithe in Subarea IV and Division IIIa and Subarea VI, 1998-2005, as officially reported to ICES.

SAITHE IV and IIIa

Country	1999	2000	2001	2002	2003	2004*	2005*
Belgium	200	122	24	107	45	22	28
Denmark	4494	3529	3575	5668	6954	7991	7498
Faroe Islands	1101		289	872	495	558	184
France	24305[1*]	19200	20472	25441	18001	13628	10768
Germany	10481	9273	9479	10999	8956	9589	12401
Greenland	-	601[2*]	1526[2*]	62	1616	403	
Ireland	-	1	-	-		1	
Netherlands	7	11	20	6	11*	3	40
Norway	56150	43665	44397	60013	61735	662783	67365
Poland	862	747	727	752	734*	0	1100
Russia	-	67	-	-	-		35
Sweden	1929	1468	1627	1863	1876	2249	2114
UK (E/W/NI)	2874	1227	1186	2521	1215	457	1190
UK (Scotland)	5420	5484	5219	6596	5829	5924	7703
Total reported	107823	85395	88541	114900	107467	103608	110575
Unallocated	-509	2281	1030	1291	-5809	-3646	968
W. G. Estimate	107314	87676	89571	116191	101658	99962	111543
TAC	110000	85000	87000	135000	165000	190000	145000

*Preliminary, [1]reported by TAC area, Iia(EC), IIIa-d(EC), and IV, [2]Preliminary data reported in IVa

Table 11.2.1 continued

SAITHE VI

Country	1999	2000	2001	2002	2003	2004*	2005*
Belgium	-	-	-	-	-		
Denmark	-	-	-	-	-		
Faroe Islands	2			2		34	21
France	3467[1*]	3310	5157	3062	3499	3053	3452
Germany	250	305	466	467	54	4	373
Ireland	320	410	399	91	170	95	168
Norway	126	58	31	12	28	16	20
Portugal	-	-	-	-	-		
Russia	3	25	1	1	6	6	25
Spain	23	3	15	4	6	2	3
UK (E/W/NI)	503	276	273	307	263	37	203
UK (Scotland)	2084	2463	2246	1567	1189	1563	4433
Total reported	6778	6850	8588	5513	5215	4810	8699
Unallocated	564	-960	-1770	-327	35	-296	-2960
W. G. Estimate	7342	5890	6818	5186	5250	4514	5739
TAC	7500	7000	9000	14000	17119	20000	15044

*Preliminary, [1]reported by TAC area, Iia(EC), IIIa-d(EC), and IV,

SAITHE IV and IIIa + VI

	1999	2000	2001	2002	2003	2004	2005
WG estimate	114656	93566	96389	121377	106908	104476	117282

Table 11.2.2 Saithe in Sub-Areas IV and VI and Division IIIa. Landed numbers at age.

Catch numbers at age Numbers*10**-3

YEAR	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE									
3	17330	23223	30235	37249	69809	48075	54332	66938	56987
4	16220	21231	17681	76661	57792	66095	37698	33740	25864
5	15531	13184	11057	15000	32737	25317	26849	14123	10319
6	2303	6023	7609	12128	4736	21207	16061	20688	7566
7	1594	429	5738	3894	4248	3672	8428	14666	13657
8	292	242	791	1792	2843	2944	2000	5199	9357
9	198	123	626	318	1874	1641	1357	1477	3501
+gp	183	145	150	267	774	1607	2381	1955	2687
SOPCOF %	100	100	100	100	100	100	100	100	100

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	207823	27461	35059	16332	17494	26178	31895	28242	80933	134024
4	53060	54967	27269	14216	12341	8339	40587	20604	32172	55605
5	11696	14755	18062	11182	9015	6739	9174	26013	12957	13281
6	6253	5490	3312	8699	6718	3675	5978	5678	13011	4765
7	3976	3777	1138	2805	5658	3335	2145	4893	1657	3005
8	5362	3447	1033	733	1150	3396	1454	1494	1252	682
9	3586	3812	768	540	509	657	982	1036	335	399
+gp	3490	4701	3484	2089	2302	2536	1254	1327	646	742
SOPCOF %	100	100	100	100	100	100	100	100	100	100

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	55435	31220	32578	22128	40808	46117	18404	37823	19958	26664
4	91223	97470	26408	30752	19583	29871	33614	20828	40194	26034
5	15186	13990	35323	13187	11322	7467	12753	11845	13034	14797
6	5381	3158	3828	10951	4714	3583	3193	3125	4297	3774
7	2603	1811	1908	1557	2776	1716	1524	1568	947	3494
8	1456	1240	1104	739	745	953	696	1511	346	674
9	445	910	776	419	281	367	518	814	427	552
+gp	900	700	680	488	364	458	422	1026	794	800
SOPCOF %	100	100	100	100	100	100	100	100	100	100

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
3	11066	15036	10363	9429	7064	16052	19914	11661	5315	13122
4	38861	19299	31017	13872	17295	17646	42331	20209	14987	11780
5	11786	30177	16367	26684	8940	22421	8871	25759	17696	15879
6	7731	3676	16077	8389	12339	3349	8899	6269	13412	16760
7	3163	2640	2231	10070	3159	3586	2437	7061	3820	10910
8	808	1012	1206	2346	3226	1772	2976	1512	4104	2673
9	210	291	567	891	641	1614	1865	1979	1118	2117
+gp	491	288	277	657	441	245	1623	1039	806	433
SOPCOF	100	100	100	100	106	104	107	107	110	107

Table 11.2.3 Saithe in Sub-Areas IV and VI and Division IIIa. Landings weights at age (kg).

YEAR	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE									
3	0.9305	1.2784	0.9663	0.9414	0.8399	0.8082	0.8212	0.8608	0.8928
4	1.362	1.6521	1.5568	1.4408	1.348	1.1958	1.4061	1.5606	1.4977
5	2.1035	1.9886	2.2614	2.0587	2.1775	1.961	1.641	2.3834	2.4904
6	3.1858	3.0093	2.7133	2.718	2.936	2.3687	2.5709	2.7527	3.3002
7	3.7541	4.0404	3.5588	3.5995	3.7657	3.7941	3.3571	3.4286	3.7647
8	5.3162	4.4278	4.4063	4.4632	4.6339	4.2276	4.6844	4.4977	4.2957
9	5.8905	6.1355	5.2203	5.6871	5.1725	4.6304	4.8138	5.7128	5.5396
+gp	7.719	7.4055	6.7675	6.8452	6.163	6.3263	6.4449	7.857	7.562

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	0.7024	0.7598	0.8215	1.1072	0.9546	0.9608	1.0857	1.0276	0.7948	0.6632
4	1.3092	1.256	1.3267	1.6228	1.8212	1.8211	1.5746	1.7178	1.6139	1.2654
5	2.2604	1.9348	2.1545	2.2381	2.3911	2.7175	2.5293	2.1493	2.2966	1.9505
6	3.0706	3.1107	3.3401	3.095	3.03	3.5868	3.2202	3.1377	2.6899	2.7715
7	4.0347	4.1618	4.5221	4.0504	4.0895	4.536	4.2069	3.6906	3.8959	3.4067
8	4.3833	4.6045	4.9005	5.2742	5.1262	5.4776	5.1251	4.6317	4.6647	4.9499
9	5.1117	4.8589	5.4494	6.3077	5.9393	6.9804	5.9049	5.5053	6.183	5.8649
+gp	7.147	6.5419	7.4	7.9551	8.1476	8.7237	8.8232	8.4529	8.4735	8.8543

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	0.6943	0.6739	0.7787	0.8954	0.8441	0.7913	0.9641	0.8994	0.9439	1.0022
4	1.0353	0.8763	0.981	1.0362	1.1958	1.1579	1.1893	1.2603	1.1188	1.2937
5	1.7944	1.8236	1.3859	1.4196	1.5828	1.7523	1.6066	1.7544	1.601	1.8159
6	2.4316	3.0747	2.7907	1.9984	2.2472	2.3646	2.2417	2.6363	2.4337	2.5619
7	3.5717	4.2098	4.0238	3.9139	3.2419	3.1653	3.6677	3.1851	3.6175	3.5549
8	4.2094	5.33	5.2544	5.0175	4.8583	4.2221	4.3296	3.9798	4.7869	4.767
9	5.6506	6.1284	6.3221	6.4298	6.3149	6.0661	5.4125	5.0802	6.5479	5.2674
+gp	8.2184	8.6026	8.6489	8.4308	8.4162	8.1914	7.0455	6.8909	8.3256	7.8907

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
3	0.9668	0.9047	0.8917	0.8808	1.0274	0.8023	0.8057	0.718	0.8766	0.6664
4	1.1873	1.1448	0.966	1.0605	1.1266	1.0717	0.8594	0.9543	1.0154	1.0735
5	1.8068	1.4522	1.3925	1.2112	1.5389	1.313	1.3243	1.0829	1.2574	1.3015
6	2.3678	2.5867	1.744	1.7537	1.6843	2.095	1.7524	1.6609	1.5822	1.6007
7	2.9518	3.5556	2.9486	2.3374	2.5936	2.5461	2.2885	2.2484	2.4753	1.9977
8	4.7053	4.5251	3.8829	3.4934	3.0842	3.4848	3.1089	3.348	3.1027	3.0085
9	6.0922	6.1575	4.9955	4.8438	4.7733	4.141	3.9206	3.7733	4.2858	3.7959
+gp	8.3821	8.8663	7.2273	6.7452	7.4615	6.141	3.7472	4.2936	5.5559	4.8845

Table 11.2.4 Saithe in Sub-Areas IV and VI and Division IIIa. Tuning data. All data used in assessment.

105										
FRATRB_IV										
1990	2005									
1	1	0	1							
3	9									
21758	3379.574	2471.553	1405.54	304.063	290.298	32.728		14.813		
15248	1381.383	2538.766	731.379	372.239	130.79		67.67		11.93	
7902	717.161	1480.817	498.716	73.572		24.402		7.133		5.741
13527	3917.8		2253.44	1162.23	103.625	8.299		8.648		6.183
14417	1770.754	3652.84	1381.104	434.086	38.895		5.317		2.71	
14632	3151.807	1682.869	921.653	225.695	70.393		24.088		13.317	
16241	895.031	4286.247	1053.226	535.95		107.63		24.634		15.158
12903	1087.28	1914.745	3175.192	190.091	83.908		16.535		13.738	
13559	799.753	2538.413	1870.453	1480.902	52.256		23.023		10.381	
14588	852.467	1233.817	2666.699	620.174	399.661	24.212		13.688		
8695	889.314	1993.229	1038.898	1195.148	214.774	180.514	31.751			
6366	724.1021	1339.454	2372.881	269.951	144.906	25.554		29.28		
11022	3275.662	7576.645	1220.435	1242.118	175.302	151.434	40.935			
10536	1516.931	3235.528	2354.784	264.339	325.113	80.521		112.88		
5234	447.218	977.66		1020.943	494.617	92.582		35.628		19.772
3015	406.936	660.534	643.107	428.406	209.713	15.685		14.262		

NORTRL_IV							
1980	2005						
1	1	0	1				
3	9						
18317	186	1290	658	980	797	261	60
28229	88	844	1345	492	670	699	119
47412	6624	12016	2737	2112	341	234	19
43099	4401	4963	8176	1950	2367	481	357
47803	20576	7328	2207	3358	433	444	106
66607	27088	21401	5307	1569	637	56	46
57468	5297	29612	3589	818	393	122	25
30008	2645	18454	2217	290	235	201	198
18402	3132	2042	2214	141	157	74	134
17781	649	2126	835	694	309	154	65
10249	804	781	924	519	203	63	12
28768	14348	4968	1194	518	203	51	56
35621	3447	9532	4031	1087	465	165	109
24572	7635	4028	2878	1018	526	365	252
30628	3939	16098	4276	926	251	72	203
32489	4347	9366	5412	833	1644	273	203
40400	3790	14429	4414	2765	1144	189	16
36026	2894	5266	9837	1419	892	299	72
24510	1376	8279	5454	5662	977	489	243
21513	813	2595	6869	2368	3602	1168	346
15520	284	1628	2054	4261	1066	1203	221
23106	4808	5228	6513	935	1235	509	390
38114	4015	12063	3474	3775	981	1632	1050
41645	1630	5451	10452	3602	4432	792	1004
32726	663	2677	5709	6578	2256	2640	656
34964	1200	3073	5169	9195	6948	1727	1432

Table 11.2.4 (Cont'd) Saithe in Sub-Areas IV and VI and Division IIIa. Tuning data. All data used in assessment.

GER_OTB_IV

1995	2005						
1	1	0	1				
3	9						
21167	1158	2359	1350	589	152	30	16
19064	510	3167	1081	517	257	148	41
21707	816	2475	3636	292	163	70	24
20153	591	2744	1395	1776	238	100	39
18596	284	1065	2264	943	1015	77	36
12223	542	2185	823	1216	242	325	38
11008	892	1329	2317	372	532	249	155
12789	650	3658	1230	1100	99	140	69
14560	500	1399	2630	438	392	58	72
13708	334	2040	1928	1079	200	235	47
11700	434	510	1623	1543	787	205	119

NORACU

1995	2005				
1	1	0.5	0.75		
3	6				
1	56244	4756		1214	174
1	21480	29698		6125	4593
1	22585	16188		24939	3002
1	15180	48295		13540	11194
1	16933	21109		27036	4399
1	34551	82338		14213	13842
1	72108	28764		17405	3870
1	82501	163524	17479	4475	
1	67774	107730	41675	4581	
1	34153	43811		31636	6413
1	48446	36560		27859	10174

IBTSq3

1991	2005		
1	1	0.5	0.75
3	5		
1	1.946	0.402	0.064
1	1.077	2.760	0.516
1	7.965	2.781	1.129
1	1.117	1.615	0.893
1	13.959	2.501	1.559
1	3.825	6.533	1.112
1	3.756	3.351	7.461
1	1.027	3.921	1.333
1	2.100	2.019	2.949
1	3.479	8.836	1.081
1	21.496	6.173	3.937
1	10.748	18.974	1.327
1	19.272	23.802	13.402
1	4.979	6.896	3.158
1	8.893	6.870	4.994

Table 11.3.1 Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

```
 Lowestoft VPA Version 3.1

    7/09/2006  12:32

 Extended Survivors Analysis

 SAITHE IN IV, VI and IIIa : 1967 - 2005

 CPUE data from file c:\wgnssk06\sei05\tun06.txt

 Catch data for  39 years. 1967 to 2005. Ages  3 to  10.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                  ,     year, year,  age ,  age
 FRATRB_IV        ,    1990, 2005,   3,     9,   .000,  1.000
 NORTRL_IV        ,    1980, 2005,   3,     9,   .000,  1.000
 GER_OTB_IV       ,    1995, 2005,   3,     9,   .000,  1.000
 NORACU           ,    1995, 2005,   3,     6,   .500,   .750
 IBTSq3           ,    1991, 2005,   3,     5,   .500,   .750


 Time series weights :

      Tapered time weighting applied
      Power =    3 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 =   1.000

      Minimum standard error for population
      estimates derived from each fleet =    .300

      Prior weighting not applied


 Tuning converged after   40 iterations

1


 Regression weights
       ,  .751,  .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000



 Fishing mortalities
    Age,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005

      3,  .117,  .106,  .174,  .077,  .090,  .079,  .132,  .102,  .071,  .104
      4,  .310,  .307,  .333,  .372,  .197,  .338,  .307,  .192,  .185,  .222
      5,  .548,  .422,  .465,  .536,  .438,  .424,  .283,  .310,  .257,  .304
      6,  .687,  .326,  .418,  .464,  .512,  .290,  .296,  .332,  .263,  .413
      7,  .709,  .531,  .336,  .507,  .316,  .271,  .355,  .405,  .347,  .356
      8,  .599,  .517,  .495,  .720,  .299,  .294,  .379,  .390,  .438,  .439
      9,  .325,  .448,  .621,  .864,  .434,  .239,  .580,  .469,  .563,  .425
```

Table 11.3.1(cont'd). Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

XSA population numbers (Thousands)

YEAR	AGE 3	4	5	6	7	8	9
1996	1.11E+05	1.61E+05	3.09E+04	1.72E+04	6.88E+03	1.98E+03	8.35E+02
1997	1.64E+05	8.07E+04	9.68E+04	1.46E+04	7.09E+03	2.77E+03	8.92E+02
1998	7.17E+04	1.21E+05	4.86E+04	5.20E+04	8.64E+03	3.41E+03	1.35E+03
1999	1.41E+05	4.93E+04	7.11E+04	2.50E+04	2.80E+04	5.05E+03	1.70E+03
2000	9.09E+04	1.07E+05	2.78E+04	3.40E+04	1.29E+04	1.38E+04	2.01E+03
2001	2.34E+05	6.80E+04	7.17E+04	1.47E+04	1.67E+04	7.68E+03	8.39E+03
2002	1.78E+05	1.77E+05	3.97E+04	3.84E+04	9.01E+03	1.04E+04	4.68E+03
2003	1.33E+05	1.28E+05	1.07E+05	2.45E+04	2.34E+04	5.18E+03	5.84E+03
2004	8.58E+04	9.82E+04	8.64E+04	6.40E+04	1.44E+04	1.28E+04	2.87E+03
2005	1.46E+05	6.54E+04	6.69E+04	5.47E+04	4.03E+04	8.32E+03	6.75E+03

Estimated population abundance at 1st Jan 2006

	0.00E+00	1.08E+05	4.29E+04	4.04E+04	2.97E+04	2.31E+04	4.39E+03

Taper weighted geometric mean of the VPA populations:

	1.30E+05	8.96E+04	5.03E+04	2.38E+04	1.11E+04	4.80E+03	2.18E+03

Standard error of the weighted Log(VPA populations) :

	.3624	.4038	.5338	.6801	.7457	.7609	.8666

1

Log catchability residuals.

Fleet : FRATRB_IV

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
3	99.99	99.99	99.99	99.99	.57	-.12	.18	.89	.38	.11
4	99.99	99.99	99.99	99.99	.28	.35	.29	.26	.34	-.19
5	99.99	99.99	99.99	99.99	.04	.04	.18	.16	.23	-.45
6	99.99	99.99	99.99	99.99	-.30	.30	-.37	-.50	.28	-.43
7	99.99	99.99	99.99	99.99	.85	.55	-.55	-1.70	-.26	-.11
8	99.99	99.99	99.99	99.99	-.23	.59	-1.05	-1.27	-1.50	-.09
9	99.99	99.99	99.99	99.99	.11	-.09	-.39	-.81	-1.37	.28

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3	-.55	-.53	-.02	-.75	.25	-.60	.66	.22	.12	.06
4	-.36	-.25	-.41	-.29	-.14	.29	.50	-.03	-.27	.31
5	-.25	-.11	.02	-.05	.42	.60	-.08	-.36	-.31	.06
6	.14	-.66	.11	-.08	.81	.37	.39	-.64	-.31	.32
7	.02	-.11	-.92	-.06	.53	.17	.46	.20	.10	.44
8	-.26	-.80	-.74	-1.06	.28	-.78	.18	.30	-.70	-.53
9	-.01	.12	-.55	-.48	.53	-.76	-.23	.55	.27	-.43

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	3	4	5	6	7	8	9
Mean Log q	-13.8055	-12.7156	-12.4764	-12.8930	-13.4480	-13.4480	-13.4480
S.E(Log q)	.4732	.3177	.3042	.4600	.5502	.7584	.5633

Table 11.3.1(cont'd). Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3,	1.29,	-.540,	14.38,	.27,	16,	.63,	-13.81,
4,	1.06,	-.226,	12.79,	.59,	16,	.35,	-12.72,
5,	1.19,	-.927,	12.79,	.70,	16,	.36,	-12.48,
6,	.83,	.989,	12.42,	.78,	16,	.38,	-12.89,
7,	.74,	1.681,	12.38,	.81,	16,	.38,	-13.45,
8,	.80,	1.088,	12.82,	.75,	16,	.46,	-13.91,
9,	.99,	.058,	13.55,	.73,	16,	.55,	-13.62,

1

Fleet : NORTRL_IV

Age	1980	1981	1982	1983	1984	1985
3	99.99	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99	99.99
5	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
7	99.99	99.99	99.99	99.99	99.99	99.99
8	99.99	99.99	99.99	99.99	99.99	99.99
9	99.99	99.99	99.99	99.99	99.99	99.99

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
3	-.42	.53	1.17	.02	.39	2.09	.76	1.47	.93	.14
4	1.11	.75	-.01	.12	.03	.54	.80	.40	1.23	.88
5	-.13	.01	-.32	-.55	.22	-.27	.61	.31	.45	.36
6	-.96	-1.08	-1.36	-.34	.35	-.65	.17	.55	-.35	-.56
7	-1.43	-.90	-.56	.08	-.13	-1.02	-.48	.48	-.52	.87
8	-2.20	-.73	-.72	.38	-.20	-1.70	-.78	.50	-1.02	.17
9	-2.35	-.39	.16	.15	-.72	-.55	-.32	.93	.82	.84

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3	.49	-.07	.44	-.68	-.96	.52	.14	-.57	-.81	-.80
4	.09	-.11	.34	.22	-.77	.51	-.12	-.73	-.94	-.45
5	.12	-.16	.34	.35	.36	.17	-.43	-.40	-.57	-.46
6	.23	-.32	.22	.23	.86	-.32	-.38	-.05	-.20	.30
7	.10	-.14	.05	.38	.18	-.35	-.43	.06	.09	.12
8	-.51	-.31	.35	1.06	.22	-.45	-.05	-.16	.41	.34
9	-2.23	-.63	.63	.99	.52	-.83	.40	-.01	.56	.36

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	3	4	5	6	7	8	9
Mean Log q	-14.3169	-12.8707	-12.3196	-12.2523	-12.0762	-12.0762	-12.0762
S.E(Log q)	.7775	.6326	.3976	.4272	.3934	.5889	.8700

Table 11.3.1(cont'd). Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3,	.74,	.525,	13.66,	.29,	20,	.60,	-14.32,
4,	2.02,	-1.080,	14.37,	.10,	20,	1.27,	-12.87,
5,	1.62,	-1.902,	13.25,	.48,	20,	.58,	-12.32,
6,	.87,	.762,	11.97,	.78,	20,	.38,	-12.25,
7,	.89,	.760,	11.77,	.83,	20,	.36,	-12.08,
8,	.76,	1.384,	11.23,	.77,	20,	.43,	-12.08,
9,	.94,	.186,	11.73,	.53,	20,	.85,	-11.96,

1

Fleet : GER_OTB_IV

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.10
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.42
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.05
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.21
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.00
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.52
9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.19

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3	-.11	-.17	.44	-.93	.58	.23	.06	-.05	.03	-.07
4	-.18	.14	-.08	-.03	.26	.38	.27	-.55	.15	-.65
5	.01	-.10	-.28	-.06	.24	.42	.17	-.18	-.24	.02
6	.00	-.70	-.05	.15	.54	.20	.17	-.41	-.44	.30
7	.44	-.25	-.08	.35	.02	.64	-.54	-.23	-.38	.12
8	1.09	-.17	.05	-.43	.24	.66	-.33	-.63	-.06	.39
9	.54	-.13	.09	-.04	.08	.08	-.15	-.50	-.12	.05

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	3	4	5	6	7	8	9
Mean Log q	-14.9719	-13.3642	-12.8678	-12.9469	-13.1622	-13.1622	-13.1622
S.E(Log q)	.3944	.3647	.2193	.3738	.3673	.5190	.2527

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3,	1.47,	-.922,	16.45,	.33,	11,	.58,	-14.97,
4,	1.02,	-.065,	13.40,	.55,	11,	.39,	-13.36,
5,	1.21,	-1.140,	13.27,	.78,	11,	.26,	-12.87,
6,	.95,	.209,	12.82,	.72,	11,	.38,	-12.95,
7,	.87,	.729,	12.69,	.80,	11,	.33,	-13.16,
8,	.99,	.029,	13.11,	.65,	11,	.55,	-13.14,
9,	1.11,	-.991,	13.77,	.91,	11,	.28,	-13.20,

1

Table 11.3.1(cont'd). Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

Fleet : NORACU

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.10
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-1.60
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-2.09
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-2.46
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3	-.36	-.72	-.24	-.87	.29	.07	.51	.59	.33	.16
4	-.81	-.73	-.02	.07	.55	.04	.80	.64	.00	.24
5	-.29	-.11	-.01	.35	.58	-.17	.34	.24	.14	.30
6	.67	.19	.29	.12	.99	.41	-.40	.10	-.57	.14
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	3	4	5	6
Mean Log q	-1.0778	-.5632	-.8573	-1.4429
S.E(Log q)	.4848	.6706	.6454	.8271

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	1.06	-.118	.48	.36	11	.54	-1.08
4	.67	.903	4.19	.48	11	.45	-.56
5	.82	.470	2.73	.45	11	.55	-.86
6	.85	.352	2.77	.41	11	.74	-1.44

1

Fleet : IBTSq3

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
3	99.99	99.99	99.99	99.99	99.99	-.82	-1.15	.41	-1.22	.46
4	99.99	99.99	99.99	99.99	99.99	-1.92	-.18	-.13	-.98	-.31
5	99.99	99.99	99.99	99.99	99.99	-2.38	-.35	.03	-.23	.04
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3	-.14	-.56	-.98	-1.00	-.05	.82	.43	1.29	.35	.42
4	-.39	-.37	-.60	-.34	.25	.43	.58	1.06	.08	.51
5	-.12	.56	-.44	.01	-.11	.22	-.36	.98	-.29	.46
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Table 11.3.1(cont'd). Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

```
 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time


    Age ,         3,         4,         5
 Mean Log q,   -9.9373,   -9.4051,   -9.6454,
 S.E(Log q),     .7868,     .6340,     .5780,




 Regression statistics :


 Ages with q independent of year class strength and constant w.r.t. time.

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  3,     .50,    1.592,     10.85,     .52,     15,     .37,   -9.94,
  4,     .69,     .892,     10.02,     .47,     15,     .44,   -9.41,
  5,     .58,    2.731,     10.15,     .81,     15,     .27,   -9.65,
1

 Terminal year survivor and F summaries :

 Age  3   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
 FRATRB_IV         ,    114314.,   .493,       .000,    .00,   1,  .229,     .099
 NORTRL_IV         ,     48473.,   .809,       .000,    .00,   1,  .085,     .219
 GER_OTB_IV        ,    100857.,   .414,       .000,    .00,   1,  .325,     .111
 NORACU            ,    126951.,   .509,       .000,    .00,   1,  .215,     .089
 IBTSq3            ,    164093.,   .820,       .000,    .00,   1,  .083,     .070

 F shrinkage mean  ,    119166.,   1.00,,,,                        .062,     .095

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    107801.,       .24,      .12,    6,    .526,   .104



 Age  4   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
 FRATRB_IV         ,     55366.,   .275,       .088,    .32,   2,  .328,     .176
 NORTRL_IV         ,     23911.,   .511,       .176,    .35,   2,  .094,     .369
 GER_OTB_IV        ,     30216.,   .281,       .340,   1.21,   2,  .310,     .302
 NORACU            ,     57725.,   .412,       .039,    .09,   2,  .142,     .169
 IBTSq3            ,     67192.,   .515,       .075,    .15,   2,  .093,     .147

 F shrinkage mean  ,     38398.,   1.00,,,,                        .032,     .245

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     42909.,       .16,      .13,   11,    .817,   .222
```

Table 11.3.1(cont'd). Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

```
 Age  5   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
 FRATRB_IV         ,     38906.,   .209,       .132,    .63,   3,  .320,     .314
 NORTRL_IV         ,     22631.,   .323,       .137,    .42,   3,  .138,     .492
 GER_OTB_IV        ,     42129.,   .207,       .050,    .24,   3,  .328,     .293
 NORACU            ,     57224.,   .355,       .169,    .48,   3,  .105,     .224
 IBTSq3            ,     66138.,   .394,       .299,    .76,   3,  .089,     .197

 F shrinkage mean  ,     34919.,   1.00,,,,                          .021,     .345

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     40368.,       .12,      .09,   16,    .760,   .304


1
 Age  6   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
 FRATRB_IV         ,     30194.,   .194,       .190,    .98,   4,  .301,     .407
 NORTRL_IV         ,     24962.,   .265,       .259,    .97,   4,  .177,     .475
 GER_OTB_IV        ,     26811.,   .186,       .179,    .96,   4,  .338,     .448
 NORACU            ,     42649.,   .335,       .124,    .37,   4,  .096,     .304
 IBTSq3            ,     39710.,   .395,       .424,   1.07,   3,  .066,     .323

 F shrinkage mean  ,     37354.,   1.00,,,,                          .023,     .341

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     29658.,       .11,      .09,   20,    .837,   .413


 Age  7   Catchability constant w.r.t. time and dependent on age

 Year class = 1998

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FRATRB_IV         ,     22167.,   .191,       .211,   1.10,   5,  .271,     .368
 NORTRL_IV         ,     21359.,   .231,       .119,    .52,   5,  .229,     .380
 GER_OTB_IV        ,     21940.,   .175,       .129,    .74,   5,  .359,     .372
 NORACU            ,     25694.,   .341,       .256,    .75,   4,  .071,     .325
 IBTSq3            ,     52860.,   .399,       .125,    .31,   3,  .048,     .171

 F shrinkage mean  ,     24283.,   1.00,,,,                          .022,     .341

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     23110.,       .10,      .08,   23,    .757,   .356
```

Table 11.3.1(cont'd). Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

```
Age  8   Catchability constant w.r.t. time and age (fixed at the value for age)  7

Year class = 1997

Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FRATRB_IV          ,      3940.,   .195,       .152,    .78,   6,  .257,     .479
NORTRL_IV          ,      4457.,   .225,       .141,    .63,   6,  .247,     .434
GER_OTB_IV         ,      4485.,   .175,       .166,    .95,   6,  .368,     .431
NORACU             ,      5443.,   .344,       .070,    .20,   4,  .058,     .368
IBTSq3             ,      4118.,   .403,       .246,    .61,   3,  .039,     .462

F shrinkage mean  ,      5539.,   1.00,,,,                          .030,     .362

Weighted prediction :

Survivors,         Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     4393.,       .11,      .07,   26,    .647,   .439


Age  9   Catchability constant w.r.t. time and age (fixed at the value for age)  7

Year class = 1996

Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FRATRB_IV          ,      3417.,   .215,       .192,    .89,   7,  .231,     .445
NORTRL_IV          ,      3798.,   .233,       .138,    .59,   7,  .191,     .408
GER_OTB_IV         ,      3715.,   .173,       .104,    .60,   7,  .482,     .416
NORACU             ,      2643.,   .347,       .286,    .83,   4,  .038,     .545
IBTSq3             ,      3623.,   .403,       .343,    .85,   3,  .025,     .424

F shrinkage mean  ,      3833.,   1.00,,,,                          .033,     .405

Weighted prediction :

Survivors,         Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     3614.,       .11,      .07,   29,    .590,   .425
```

Table 11.3.2 Saithe in Sub-Areas IV and VI and Division IIIa. Fishing mortality (F) at age.

Fishing mortality (F) at age

YEAR	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
AGE										
3	0.1628	0.2548	0.1178	0.1521	0.2682	0.3711	0.4990	0.6879	0.4270	0.9112
4	0.2632	0.3074	0.3145	0.4897	0.3728	0.4397	0.5628	0.6748	0.6292	0.9306
5	0.3781	0.3551	0.2599	0.4828	0.3998	0.2768	0.3202	0.4242	0.4462	0.6615
6	0.4836	0.2455	0.3574	0.5070	0.2735	0.4925	0.2838	0.4388	0.4243	0.5383
7	0.4161	0.1524	0.3913	0.3127	0.3319	0.3538	0.3695	0.4556	0.5872	0.4143
8	0.2603	0.1004	0.4639	0.2016	0.3965	0.4054	0.3317	0.4106	0.5974	0.4831
9	0.3893	0.1668	0.4070	0.3426	0.3360	0.4201	0.3303	0.4381	0.5407	0.4823
+gp	0.3893	0.1668	0.4070	0.3426	0.3360	0.4201	0.3303	0.4381	0.5407	0.4823
FBAR 3- 6	0.3219	0.2907	0.2624	0.4079	0.3286	0.3950	0.4164	0.5564	0.4817	0.7604

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
3	0.2973	0.5433	0.2647	0.3400	0.1835	0.3876	0.3072	0.5736	0.6468	0.2405
4	0.6549	0.5447	0.4422	0.3281	0.2689	0.4803	0.4677	0.6939	1.0498	1.4108
5	0.7375	0.4639	0.4504	0.5635	0.2998	0.5354	0.6590	0.6127	0.7032	0.9663
6	0.7714	0.3552	0.4266	0.5404	0.4729	0.4760	0.7662	0.8437	0.4775	0.7029
7	0.7468	0.3486	0.5821	0.5493	0.5701	0.5638	0.9402	0.5284	0.4680	0.5250
8	0.7841	0.4634	0.3978	0.5030	0.7693	0.5265	1.0340	0.6685	0.4305	0.4358
9	0.7751	0.3917	0.4724	0.5352	0.6094	0.5263	0.9235	0.6866	0.4621	0.5612
+gp	0.7751	0.3917	0.4724	0.5352	0.6094	0.5263	0.9235	0.6866	0.4621	0.5612
FBAR 3- 6	0.6153	0.4768	0.3960	0.4430	0.3063	0.4698	0.5500	0.6810	0.7193	0.8301

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
3	0.3681	0.3778	0.3795	0.4720	0.4588	0.2472	0.3221	0.2403	0.1395	0.1170
4	0.8770	0.6158	0.7535	0.6909	0.7750	0.7305	0.4905	0.6798	0.5670	0.3098
5	0.8688	0.9712	0.7322	0.7045	0.6230	0.9426	0.6221	0.6615	0.5758	0.5481
6	0.5336	0.6209	0.9713	0.6374	0.5032	0.6006	0.6327	0.4817	0.4030	0.6868
7	0.5432	0.7348	0.5577	0.7095	0.5051	0.4151	0.6808	0.3958	0.9537	0.7091
8	0.5138	0.7703	0.7202	0.5733	0.5679	0.3936	0.9759	0.3049	0.5486	0.5986
9	0.5394	0.7206	0.7719	0.6734	0.6262	0.7083	1.1692	0.8460	1.1863	0.3252
+gp	0.5394	0.7206	0.7719	0.6734	0.6262	0.7083	1.1692	0.8460	1.1863	0.3252
FBAR 3- 6	0.6619	0.6464	0.7091	0.6262	0.5900	0.6302	0.5169	0.5158	0.4213	0.4154

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	FBAR 67-0
AGE										
3	0.1065	0.1740	0.0769	0.0898	0.0788	0.1318	0.1020	0.0709	0.1045	0.0925
4	0.3069	0.3329	0.3721	0.1974	0.3379	0.3068	0.1919	0.1847	0.2219	0.1995
5	0.4223	0.4654	0.5362	0.4381	0.4238	0.2834	0.3105	0.2566	0.3045	0.2905
6	0.3258	0.4184	0.4637	0.5120	0.2898	0.2955	0.3325	0.2633	0.4130	0.3363
7	0.5307	0.3361	0.5066	0.3165	0.2709	0.3550	0.4053	0.3474	0.3557	0.3695
8	0.5167	0.4952	0.7199	0.2986	0.2945	0.3789	0.3900	0.4382	0.4386	0.4223
9	0.4479	0.6212	0.8636	0.4336	0.2390	0.5802	0.4688	0.5633	0.4253	0.4858
+gp	0.4479	0.6212	0.8636	0.4336	0.2390	0.5802	0.4688	0.5633	0.4253	
FBAR 3- 6	0.2904	0.3477	0.3622	0.3093	0.2826	0.2544	0.2342	0.1939	0.2610	

Table 11.3.3 Saithe in Sub-Areas IV and VI and Division IIIa. Stock number at age

Stock number at age (start of year) Numbers ('000)

YEAR	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
AGE										
3	127456	114114	300688	291834	327929	171371	152851	148738	181235	384100
4	77470	88671	72416	218824	205229	205321	96807	75982	61208	96819
5	54512	48750	53387	43290	109792	115735	108297	45148	31680	26710
6	6638	30578	27984	33705	21871	60268	71848	64372	24185	16601
7	5177	3351	19585	16026	16621	13622	30154	44291	33984	12955
8	1407	2796	2356	10843	9597	9765	7829	17062	22993	15466
9	680	888	2070	1213	7256	5286	5330	4601	9265	10358
+gp	621	1041	490	1008	2974	5132	9288	6037	7036	9984
TOTAL	273960	290188	478976	616744	701271	586499	482404	406232	371587	572993

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
3	118001	92439	77606	67077	172580	109696	117999	204920	310988	286563
4	126429	71763	43960	48761	39089	117610	60952	71054	94543	133346
5	31258	53775	34080	23128	28756	24458	59566	31260	29064	27092
6	11286	12241	27684	17784	10779	17445	11723	25231	13870	11779
7	7934	4272	7025	14795	8482	5499	8873	4461	8885	7044
8	7009	3078	2468	3214	6993	3927	2562	2837	2153	4556
9	7811	2620	1585	1358	1591	2653	1899	746	1190	1146
+gp	9495	11783	6073	6074	6071	3353	2393	1419	2194	2290
TOTAL	319221	251970	200483	182190	274340	284641	265968	341929	462888	473816

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
3	112029	114431	77440	119870	138504	92858	151791	103255	226373	110797
4	184459	63473	64211	43380	61217	71669	59374	90053	66480	161212
5	26632	62827	28072	24746	17798	23091	28263	29766	37360	30873
6	8440	9146	19477	11052	10015	7815	7366	12422	12577	17199
7	4775	4053	4025	6037	4784	4957	3509	3203	6282	6882
8	3411	2271	1591	1886	2431	2363	2680	1454	1765	1982
9	2412	1671	861	634	871	1128	1305	827	878	835
+gp	1835	1443	988	810	1074	906	1611	1514	1246	1940
TOTAL	343993	259314	196665	208416	236694	204789	255899	242493	352960	331719

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	GMST 88-
AGE											
3	164489	71724	140766	90889	234014	178215	132852	85786	146169	0	126845
4	80700	121067	49346	106718	68021	177069	127891	98219	65427	107801	81130
5	96826	48609	71056	27849	71724	39724	106669	86423	66854	42909	40344
6	14612	51970	24988	34032	14712	38436	24497	64025	54745	40368	16396
7	7086	8637	28002	12868	16698	9014	23417	14383	40284	29658	7440
8	2773	3412	5052	13814	7677	10427	5175	12783	8320	23110	3238
9	892	1354	1703	2014	8391	4682	5844	2869	6753	4393	1502
+gp	875	654	1236	1375	1269	4028	3038	2046	1370	4347	
TOTAL	368252	307427	322151	289558	422506	461596	429384	366535	389922	252587	

Table 11.3.4 Saithe in Sub-Areas IV and VI and Division IIIa. Summary (without SOP correction).

	RECRUITS Age 3	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 6
1967	127456	395634	150838	88326	0.5856	0.3219
1968	114114	520414	211723	113751	0.5373	0.2907
1969	300688	694140	263959	130588	0.4947	0.2624
1970	291834	890603	312006	234962	0.7531	0.4079
1971	327929	1018299	429567	265381	0.6178	0.3286
1972	171371	903650	474089	261877	0.5524	0.395
1973	152851	847482	534480	242499	0.4537	0.4164
1974	148738	833727	554897	298351	0.5377	0.5564
1975	181235	743424	472054	271584	0.5753	0.4817
1976	384100	752244	351517	343967	0.9785	0.7604
1977	118001	509393	263103	216395	0.8225	0.6153
1978	92439	463758	268051	155141	0.5788	0.4768
1979	77606	419009	240997	128360	0.5326	0.396
1980	67077	396547	235057	131908	0.5612	0.443
1981	172580	494643	241021	132278	0.5488	0.3063
1982	109696	510838	210149	174351	0.8297	0.4698
1983	117999	466067	213726	180044	0.8424	0.55
1984	204920	464460	175785	200834	1.1425	0.681
1985	310988	488339	159562	220869	1.3842	0.7193
1986	286563	483914	150148	198596	1.3227	0.8301
1987	112029	380508	150451	167514	1.1134	0.6619
1988	114431	315256	144548	135172	0.9351	0.6464
1989	77440	252256	110511	108877	0.9852	0.7091
1990	119870	256617	97113	103800	1.0689	0.6262
1991	138504	274838	93264	108048	1.1585	0.59
1992	92858	270285	95428	99742	1.0452	0.6302
1993	151791	319921	102985	111491	1.0826	0.5169
1994	103255	312660	112241	109622	0.9767	0.5158
1995	226373	458138	134592	121810	0.905	0.4213
1996	110797	446029	155402	114997	0.74	0.4154
1997	164489	470595	197292	107327	0.544	0.2904
1998	71724	389441	196704	106123	0.5395	0.3477
1999	140766	405895	207222	110716	0.5343	0.3622
2000	90889	409633	195470	91322	0.4672	0.3093
2001	234014	497450	216400	95042	0.4392	0.2826
2002	178215	502206	206766	115395	0.5581	0.2544
2003	132852	478702	240858	105569	0.4383	0.2342
2004	85786	483837	281130	104237	0.3708	0.1939
2005	146169	480124	288144	116343	0.4038	0.261
2006	111845*		290000			
Arith. Mean	160268	505153	234340	157005	0.7425	0.461
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		
*RCT3						

Table 11.5.1 Saithe in Sub-Areas IV and VI and Division IIIa. Recruitment indices.

```
NORTH SEA SAITHE AS 3-GROUP
1     12    2
'Year'       'VPA'        'NORACU'
1995         226373       56244
1996         110797       21480
1997         164489       22585
1998         71724        15180
1999         140766       16933
2000         90889        34551
2001         234014       72108
2002         178215       82501
2003         132852       67774
2004         85786        34153
2005         146169       48446
2006         -11          18909
```

Table 11.5.2 Saithe in Sub-Areas IV and VI and Division IIIa. RCT3 run.

```
NORTH SEA SAITHE AS 3-GROUP

 Data for    1 surveys over   12 years :  1995 - 2006

 Regression type = C
 Tapered time weighting applied
 power =    3 over  20 years
 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 =   2006

          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 NORACU    1.05    .76     .54   .364     11   9.85   11.08     .673     .246

                                        VPA Mean =   11.80     .385     .754




 Year     Weighted      Log      Int      Ext      Var      VPA       Log
 Class     Average      WAP      Std      Std     Ratio               VPA
          Prediction           Error    Error

 2006      111864     11.63      .33      .31      .86
```

Table 11.6.1 Saithe in Sub-Areas IV and VI and Division IIIa. Input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N3	111864	0.33	WS3	0.75	0.15
N4	107800	0.20	WS4	1.01	0.06
N5	42908	0.20	WS5	1.21	0.10
N6	40367	0.20	WS6	1.62	0.03
N7	29657	0.20	WS7	2.24	0.11
N8	23109	0.20	WS8	3.15	0.06
N9	4392	0.20	WS9	3.95	0.07
N10	4346	0.20	WS10	4.91	0.13
H.cons selectivity			Weight in the HC catch		
sH3	0.09	0.09	WH3	0.75	0.15
sH4	0.20	0.08	WH4	1.01	0.06
sH5	0.29	0.07	WH5	1.21	0.10
sH6	0.34	0.08	WH6	1.62	0.03
sH7	0.37	0.14	WH7	2.24	0.11
sH8	0.42	0.18	WH8	3.15	0.06
sH9	0.49	0.30	WH9	3.95	0.07
sH10	0.49	0.30	WH10	4.91	0.13
Natural mortality			Proportion mature		
M3	0.20	0.10	MT3	0.00	0.10
M4	0.20	0.10	MT4	0.15	0.10
M5	0.20	0.10	MT5	0.70	0.10
M6	0.20	0.10	MT6	0.90	0.10
M7	0.20	0.10	MT7	1.00	0.10
M8	0.20	0.10	MT8	1.00	0.00
M9	0.20	0.10	MT9	1.00	0.00
M10	0.20	0.10	MT10	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF06	1.00	0.15	K06	1.00	0.10
HF07	1.00	0.15	K07	1.00	0.10
HF08	1.00	0.15	K08	1.00	0.10
Recruitment in 2007 and 2008					
R07	126845	0.35			
R08	126845	0.35			

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

Stock numbers in 2006 are VPA survivors.
These are overwritten at Age 3

Table 11.6.2 Saithe in Sub-Areas IV and VI and Division IIIa. Management option table.

	Year							
	2006	2007						
Mean F Ages								
H.cons 3 to 6	0.23	0.00	0.09	0.18	0.23	0.30	0.40	0.46
Effort relative to 2005								
H.cons	1.00	0.00	0.40	0.80	1.00	1.30	1.74	2.00
Biomass								
Total 1 January	489	487	487	487	487	487	487	487
SSB at spawning time	290	289	289	289	289	289	289	289
Catch weight (,000t)								
H.cons	109	0	48	90	109	136	170	188
Biomass in year.... 2008								
Total 1 January		611	555	507	485	455	416	395
SSB at spawning time		391	342	299	280	254	220	203

	Year							
	2006	2007						
Effort relative to 2005								
H.cons	1.00	0.00	0.40	0.80	1.00	1.30	1.74	2.00
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.10	0.12	0.12	0.12	0.12	0.12	0.12	0.12
SSB at spawning time	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Catch weight								
H.cons	0.16	0.00	0.37	0.20	0.17	0.14	0.12	0.12
Biomass in year.... 2008								
Total 1 January		0.12	0.13	0.13	0.13	0.14	0.14	0.14
SSB at spawning time		0.11	0.12	0.13	0.13	0.13	0.13	0.14

Table 11.6.3. Saithe in Sub-Areas IV and VI and Division IIIa. Detailed forecast tables.

Forecast for year 2006
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
3	111864	8925	8925
4	107800	17770	17770
5	42908	9867	9867
6	40367	10499	10499
7	29657	8345	8345
8	23109	7261	7261
9	4392	1545	1545
10	4346	1528	1528
Wt	489	109	109

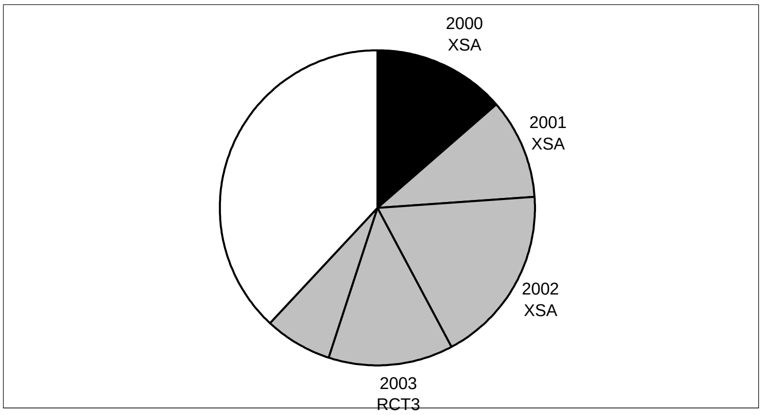
Forecast for year 2007
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
3	126845	10120	10120
4	83537	13770	13770
5	72261	16616	16616
6	26260	6830	6830
7	23618	6646	6646
8	16789	5275	5275
9	12407	4363	4363
10	4400	1548	1548
Wt	487	109	109

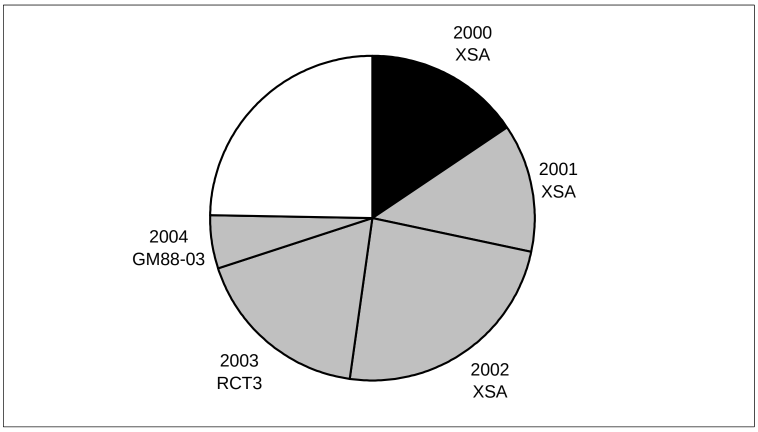
Table 11.6.4 Saithe in Sub-Areas IV and VI and Division IIIa. Stock numbers of recruits and their source for recent year classes used in predictions, and relative (%) contributions to landings and SSB (by weight) of these year classes.

Year-class	2000	2001	2002	2003	2004
Stock No. (thousands) of 3 year-olds	132852	85786	146169	111845	126845
Source	XSA	XSA	XSA	RCT3	GM88-03
Status Quo F:					
% in 2006 landings	15.6	11.0	16.5	6.2	-
% in 2007 landings	13.7	10.1	18.4	12.8	7.0
% in 2006 SSB	20.3	12.6	5.6	0.0	-
% in 2007 SSB	18.3	13.3	21.2	4.4	0.0
% in 2008 SSB	15.6	12.7	24.0	17.6	5.3

a) 2007 landings



b) 2008 SSB



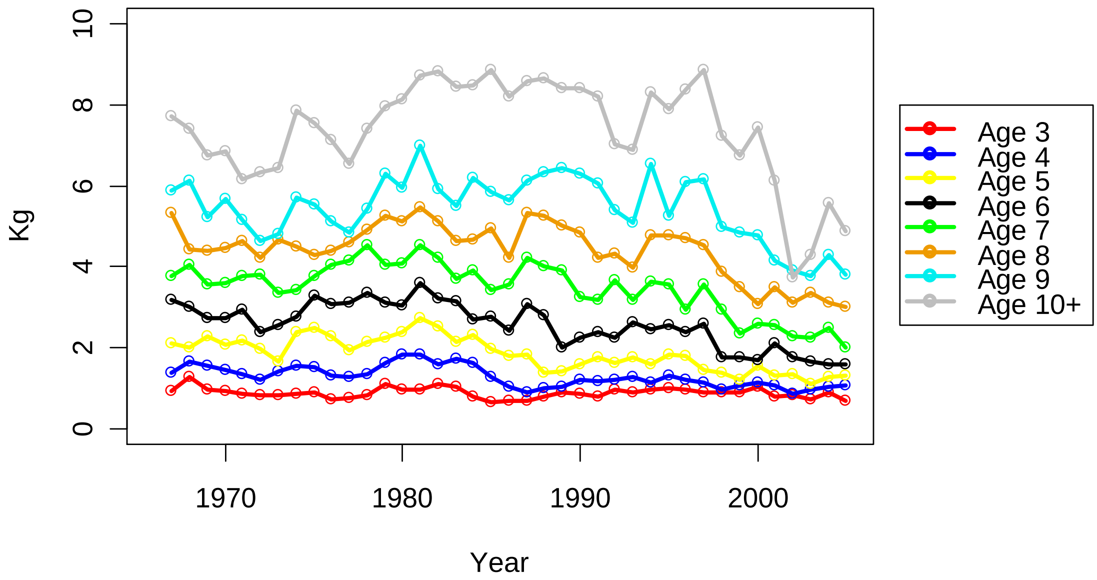
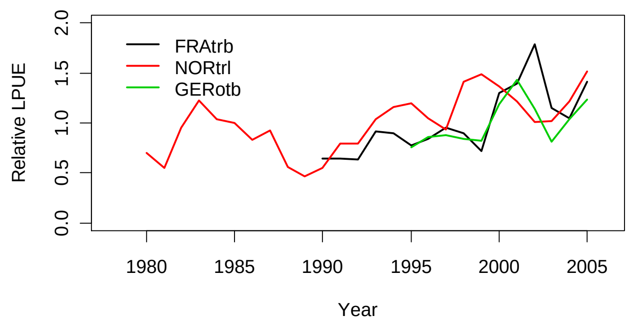


Figure 11.2.1 Saithe in Sub-Areas IV and VI and Division IIIa. Trends in mean weights at age.



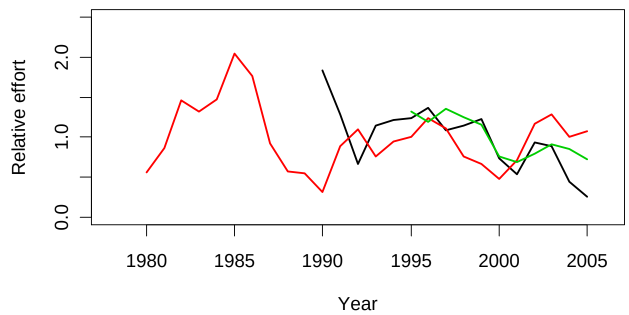


Figure 11.2.2 Saithe in Sub-Areas IV and VI and Division IIIa. Relative trends in effort and landings per unit effort for the commercial fleets.

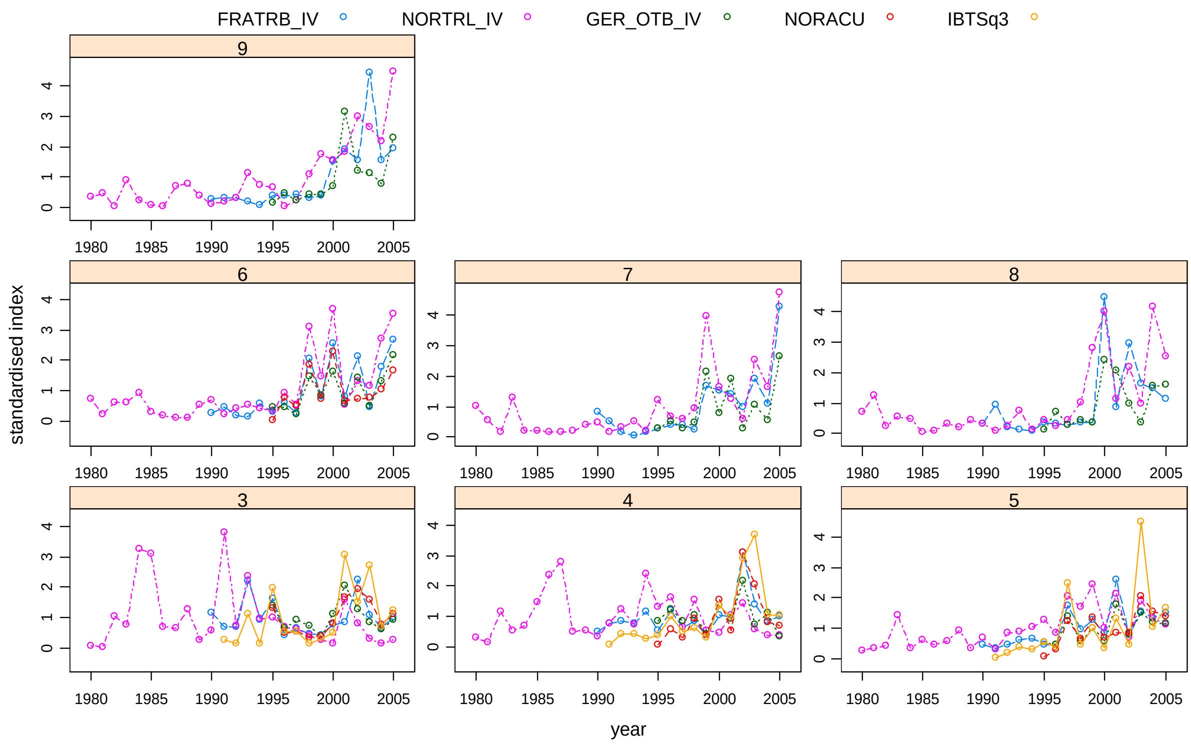


Figure 11.2.3. Saithe in Sub-Areas IV and VI and Division IIIa. Mean standardised CPUE series by age.

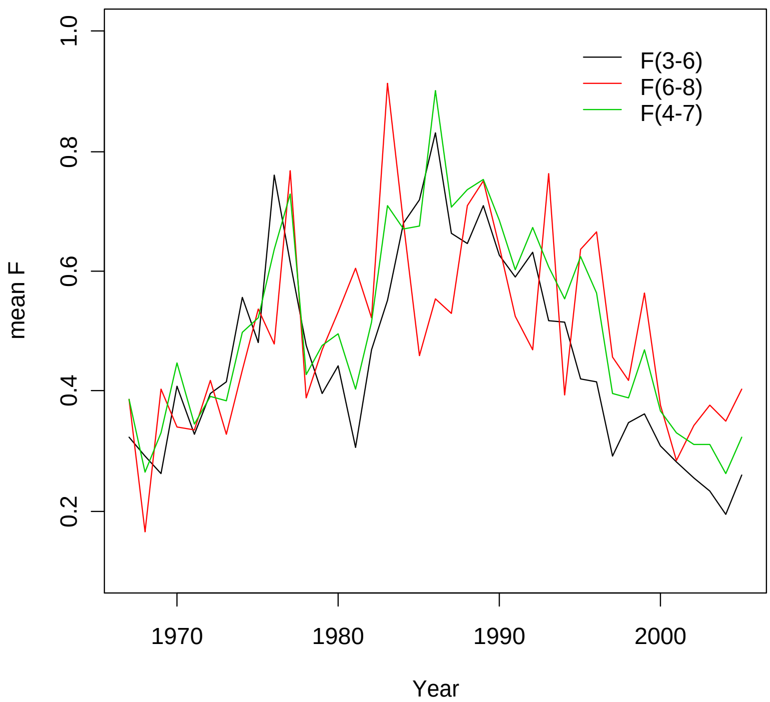


Figure 11.3.1 Saithe in Sub-Areas IV and VI and Division IIIa. Trends in Fbar using different age range.

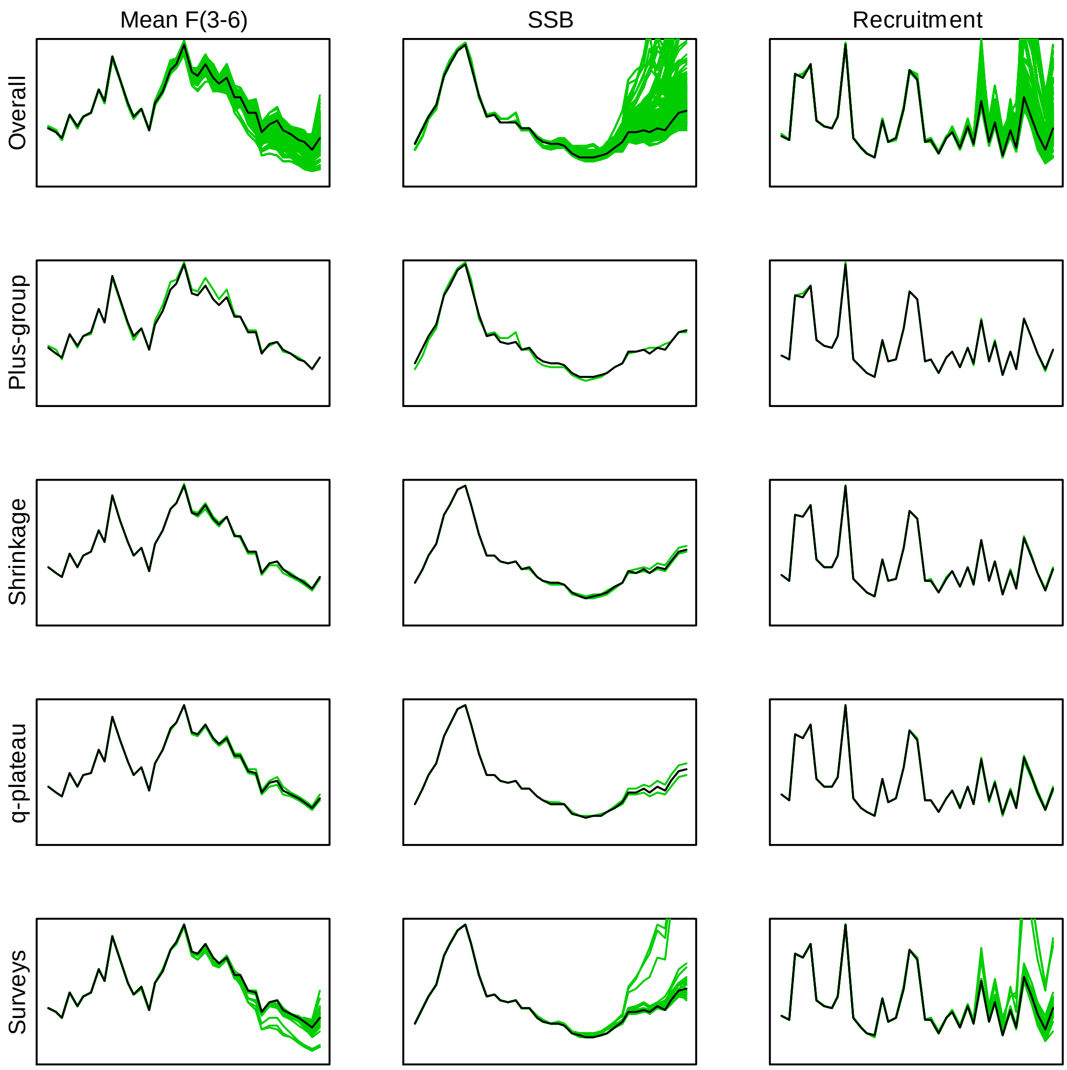


Figure 11.3.2 Saithe in Sub-Areas IV and VI and Division IIIa. FLXSA assessments with different choices of plus group (age 9 and 10), F-shrinkage (0.5, 1.0 and 2.0), q-plateau (age 6, 7 and 8) and tuning fleet combinations. Black line represents SPALY.

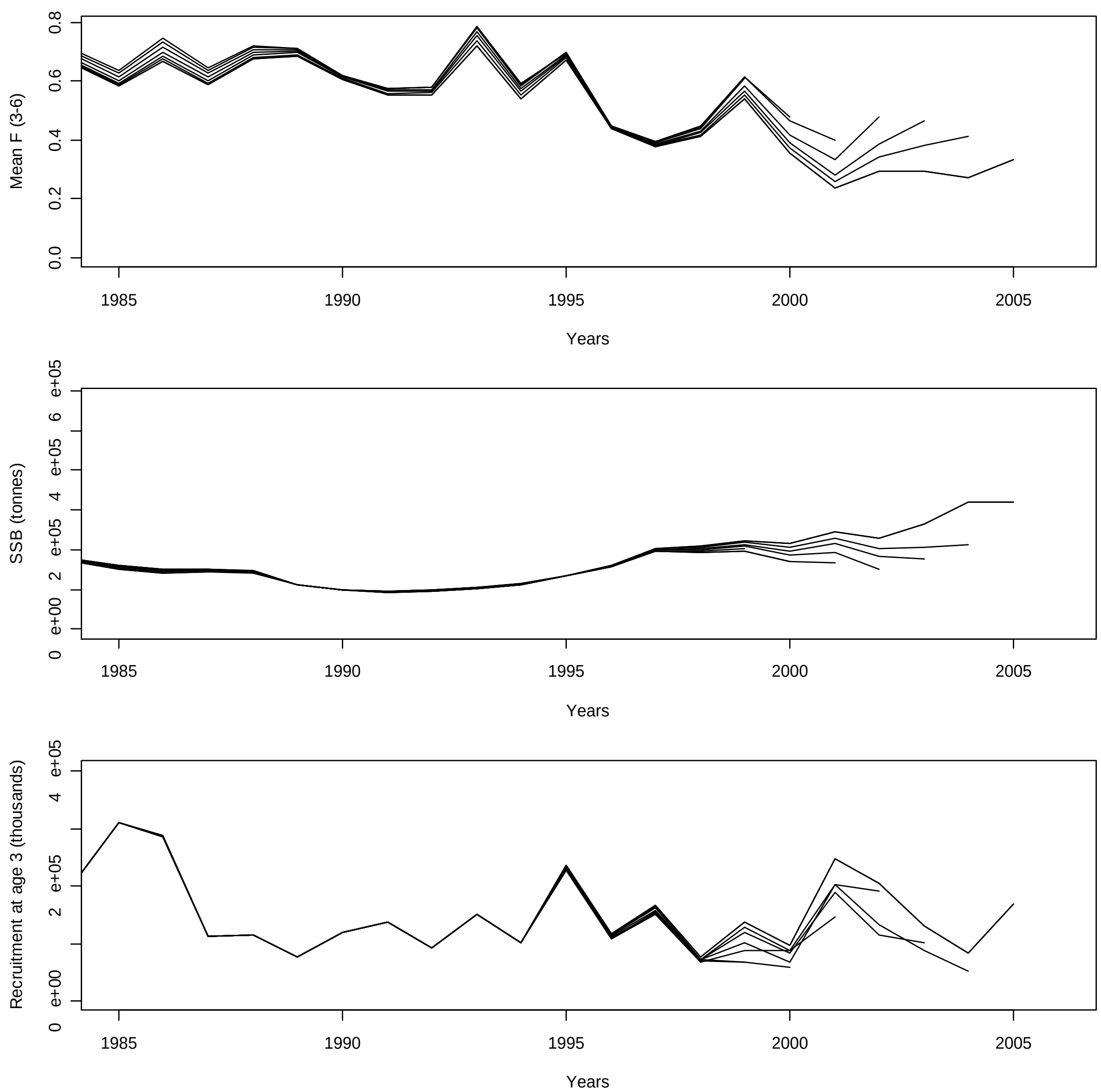


Figure 11.3.3 Saithe in Sub-Areas IV and VI and Division IIIa. Retrospective analysis.

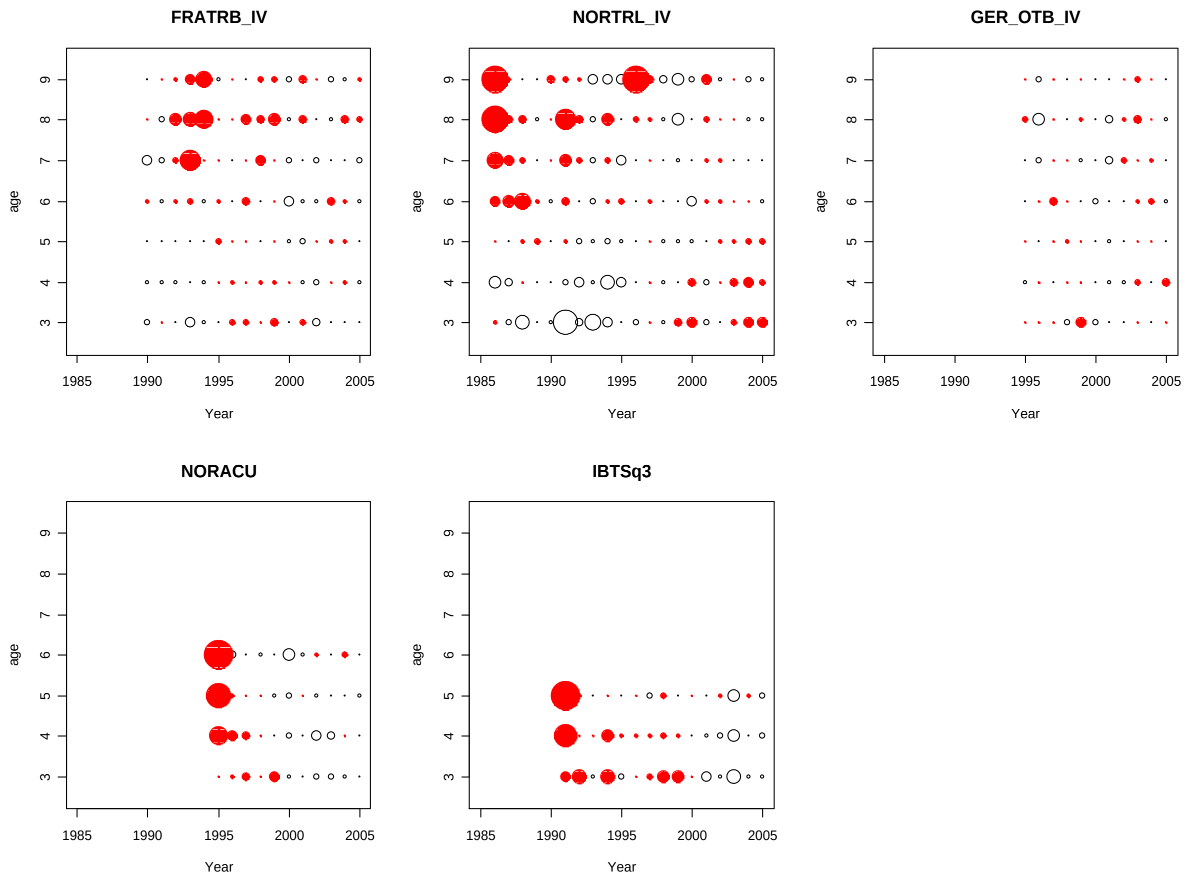


Figure 11.3.4 Saithe in Sub-Areas IV and VI and Division IIIa. Log catchability residuals from the final run.

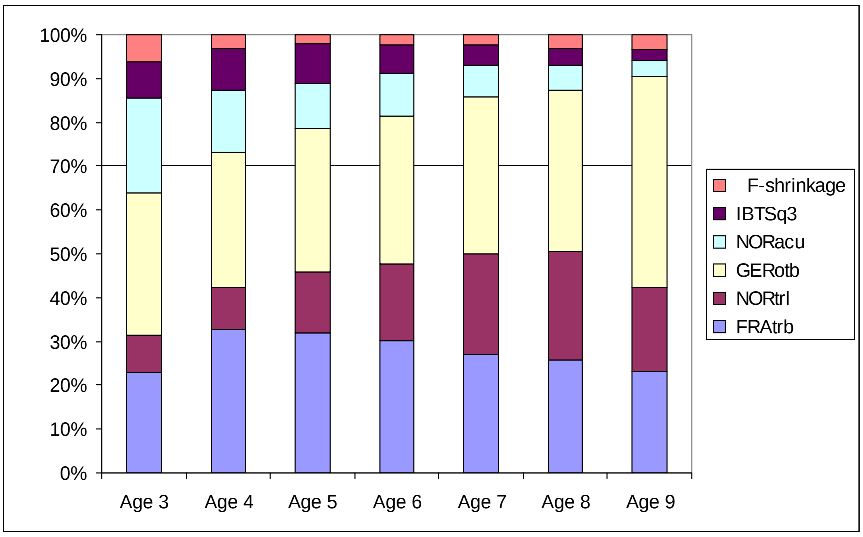


Figure 11.3.5. Saithe in Sub-Areas IV and VI and Division IIIa. Relative weights of F-shrinkage and tuning fleets in the final XSA run.

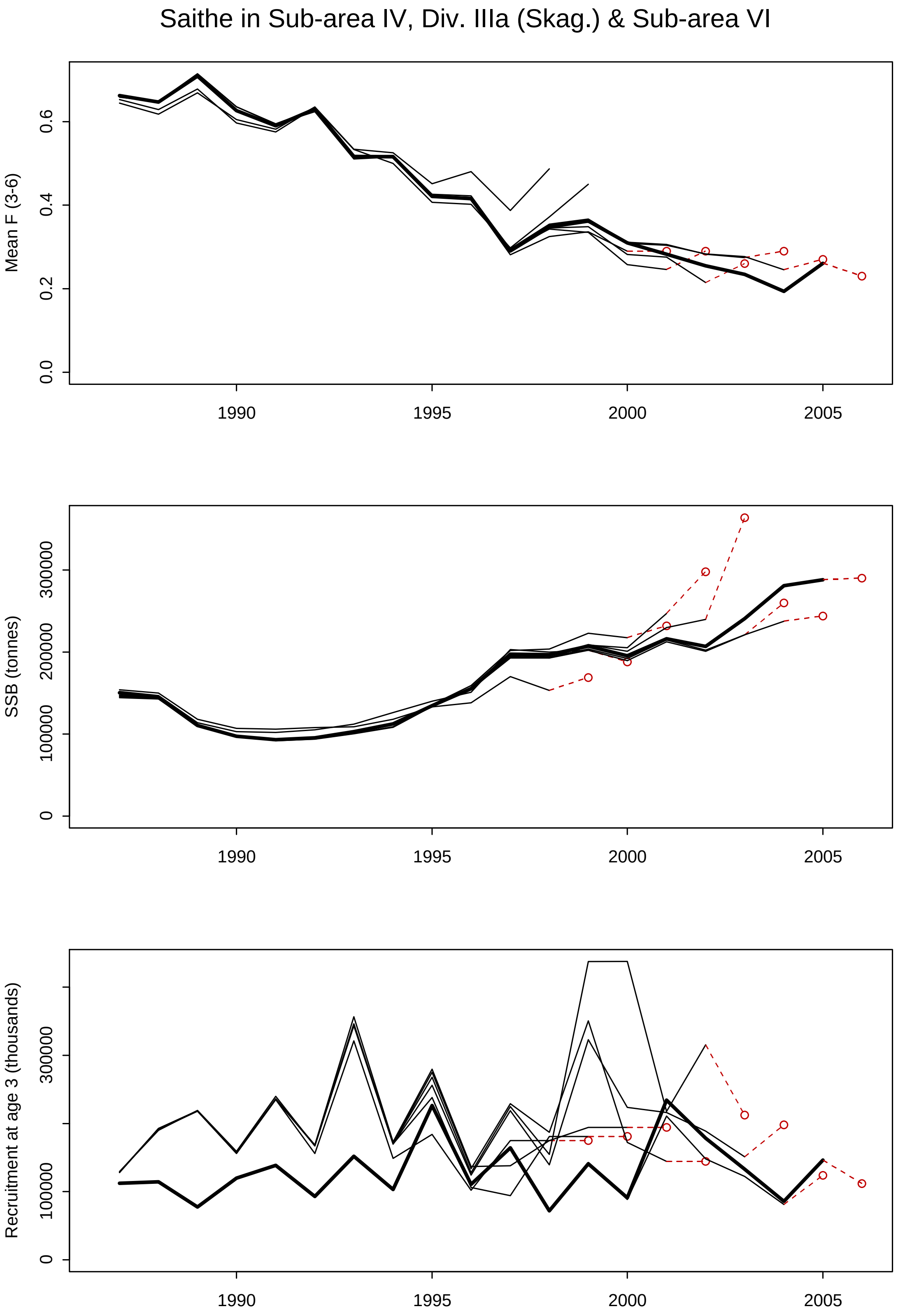


Figure 11.3 6 Saithe in Sub-Areas IV and VI and Division IIIa. Assessments generated in successive working groups. Circles represent forecasts.

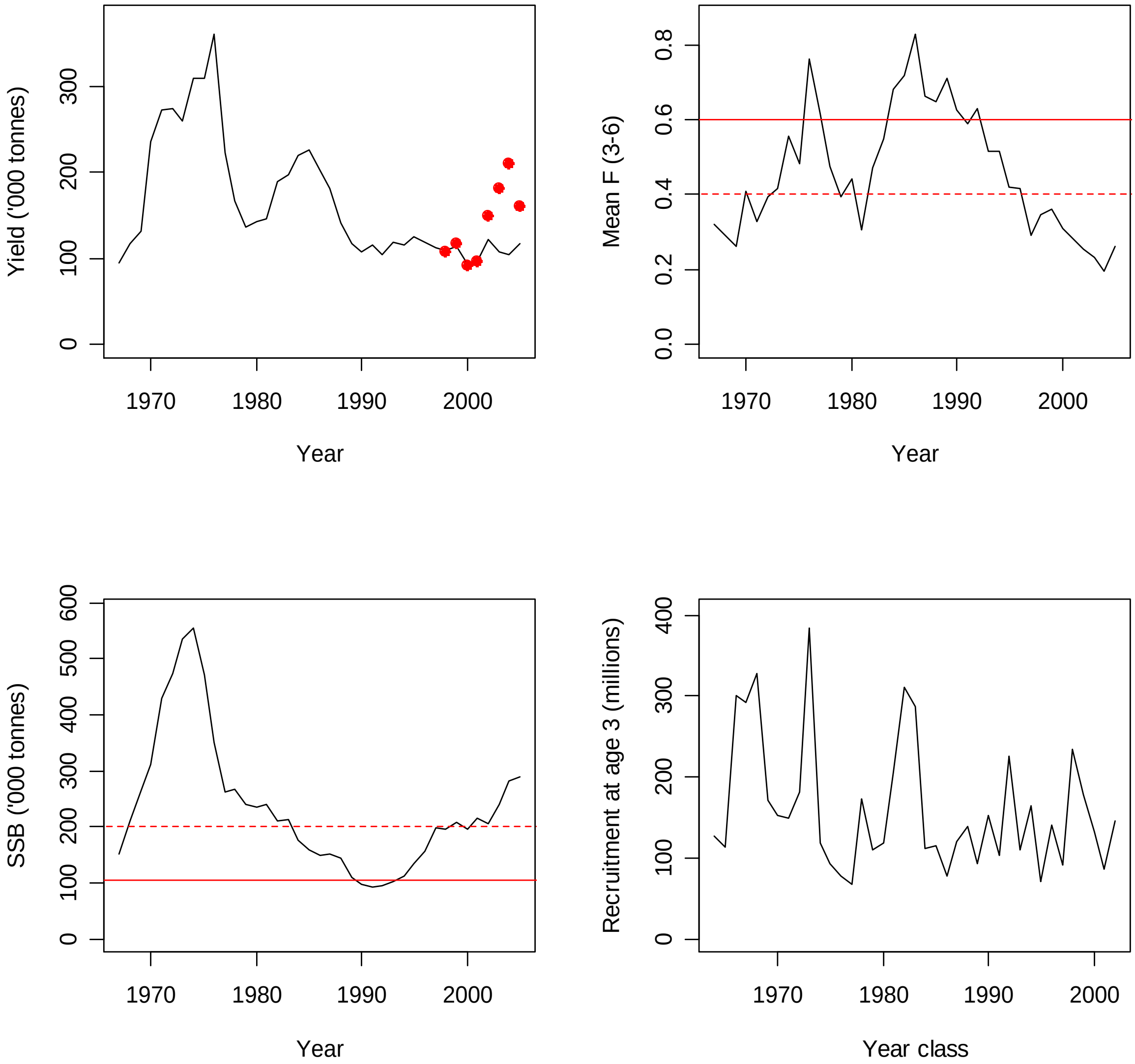


Figure 11.4.1 Saithe in Sub-Areas IV and VI and Division IIIa. Stock summary. Dots are TAC.

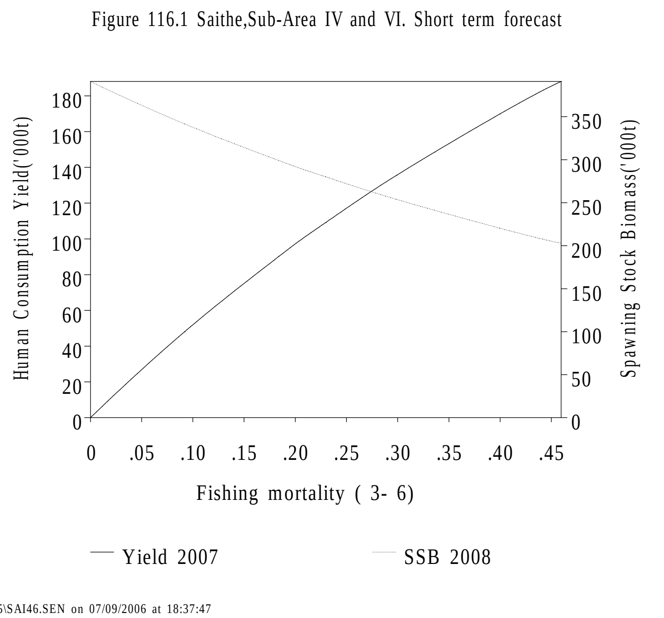


Figure 11.6.1. Saithe in Sub-Areas IV and VI and Division IIIa. Short term forecast.

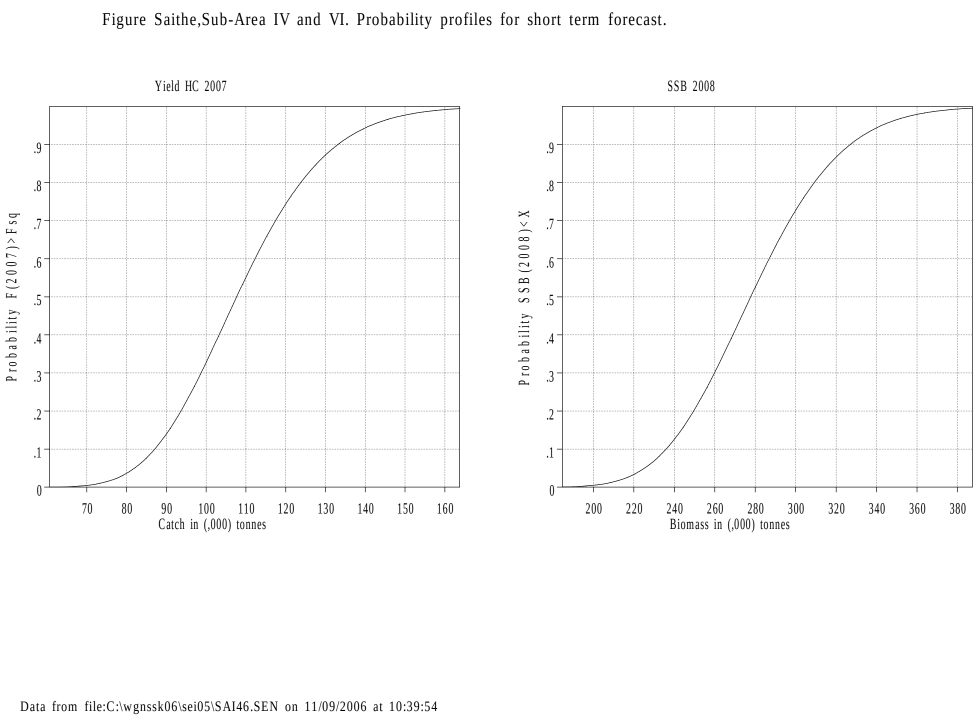


Figure 11.6.2. Saithe in Sub-Areas IV and VI and Division IIIa. Probability profiles for short term forecast.

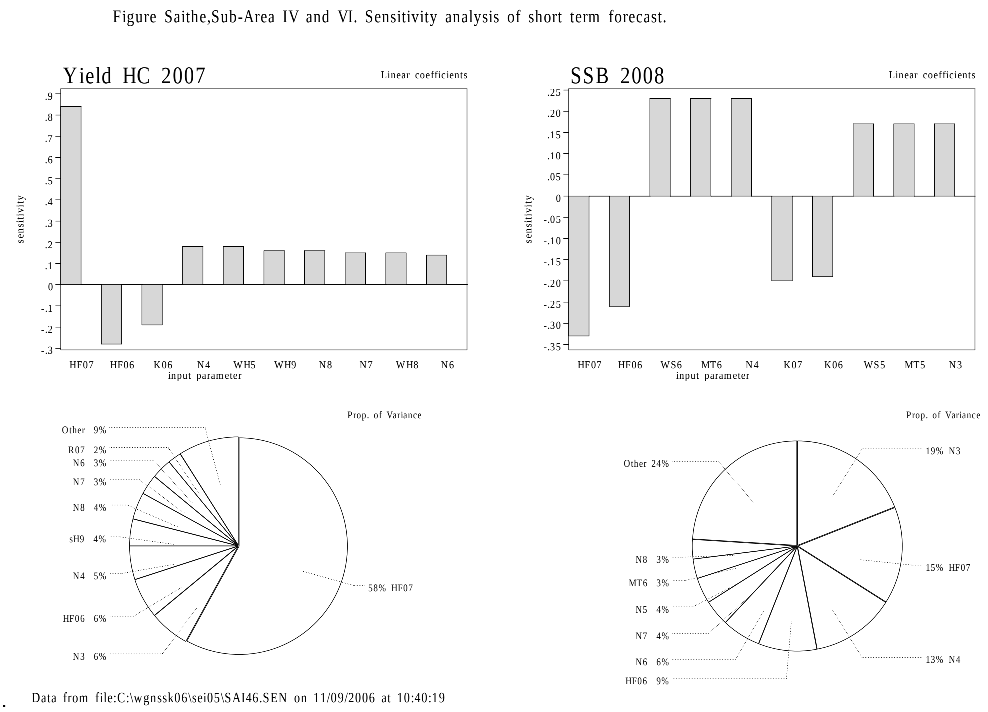


Figure 11.6.3. Saithe in Sub-Areas IV and VI and Division IIIa. Sensitivity analysis of the short term forecast.

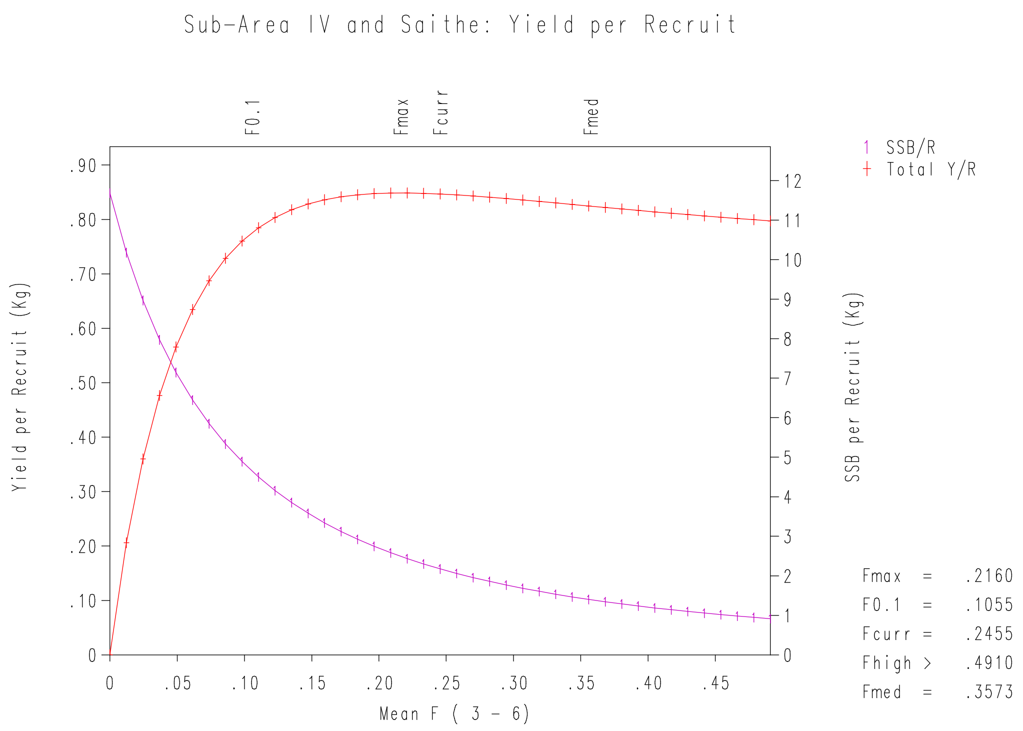


Figure. 11.8.1. Saithe in Sub-Areas IV and VI and Division IIIa. Yield per recruit.

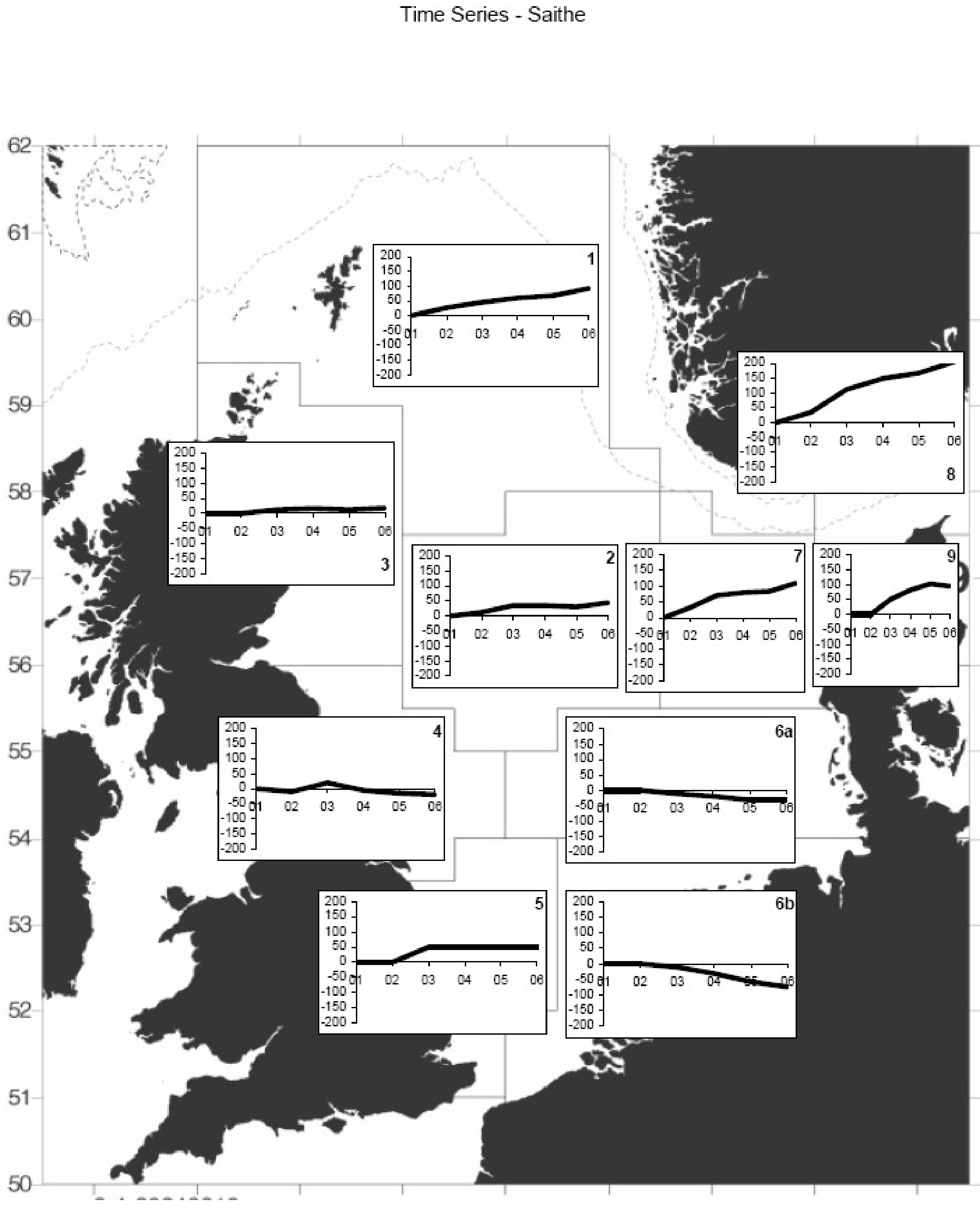


Figure 11.9.1. Saithe in Sub-Areas IV and VI and Division IIIa. Results from fishermen's survey for saithe in different areas of the North Sea from 2001 to 2006.

12 Whiting in Sub-area IV and Divisions VIId and IIIa

Since 1996 this assessment has covered whiting in the North Sea (ICES Sub-area IV) and eastern Channel (ICES Division VIId). Prior to 1996 whiting in these areas were assessed separately. The current assessment was formally to be classified as an update assessment. The assessment from the last WG meeting (2005) was not accepted by ACFM. The main concern was that there is possibly a population substructure, in particular a north/south split, which would make a combined assessment inappropriate.

12.1 General

12.1.1 Ecosystem aspects

Whiting are found throughout the North Sea, predominantly to the south of the Norwegian Deep and its extension around the north of the Shetland Isles. The report of the Study Group on Stock Identity and Management Units of Whiting (ICES-SGSIMUW 2005) documents the background to the basis of the long-held view that whiting in the northern and southern North Sea comprise different stock units, and concludes that sufficient information exists to support the view of stock units that are separated in the region of the Dogger Bank – an area associated in the summer with the separation of mixed and stratified water and roughly approximated by the 50m depth contour. Limited tagging information indicates limited movement of whiting across this boundary.

Results from key runs of the ICES SG on Multispecies Assessment in the North Sea (ICES-SGMSNS 2005) indicate three major sources of mortality for whiting. For ages 0-1, grey gurnard is a very important predator and for ages 1-2 cod becomes and important predator. For ages three and above, the primary source of mortality is the fishery, followed by predation by seals. More notable, there is evidence for cannibalism on the 0- and 1-group. It has been postulated by Bromley et al. (1997) that the spawning habit of whiting, *i.e.*, multiple spawings over a protracted period, may provide continued food resources for earlier spawned 0-group whiting.

Results from SGMSNS (ICES - SGMSNS 2005) shows that that the main diet of whiting is commercial important fish species, and that the predominant prey species of whiting were whiting, sprat, Norway pout, sandeel and haddock.

12.1.2 Fisheries

For whiting, there are three distinct areas of major catch: a northern zone, an area off the eastern English coast; and a southern area extending into the English Channel.

In the northern area, roundfish are caught in otter trawl and seine fisheries, currently with a 120 mm minimum mesh size. These are mixed demersal fisheries with more specific targeting of individual species in some areas and/or seasons. Cod, haddock and whiting form the predominant roundfish catch in the mixed fisheries, although there can be important bycatches of other species, notably saithe and anglerfish in the northern and eastern North Sea and of *Nephrops* in the more offshore *Nephrops* grounds. The southern whiting fishery uses 80 mm nets and is, in part, regulated by catch composition rules – see section 12.1.4.

Whiting also comprise a by-catch in the beam trawl fisheries and the *Nephrops* fisheries, both of which can operate with 80 mm mesh sizes depending on area (beam trawls) or gear configuration (*Nephrops* trawls).

Recent fuel price increases and a lack of quota for deep-water species has resulted in some vessels formerly fishing in deep-water and along the shelf edge to move into the northern

North Sea with the shift in fishing grounds likely to result in a change in the species composition of their catches from monkfish to roundfish species including whiting.

Historically by-catch of whiting by industrial fisheries for reduction purposes was an important part of the catch, but due to the recent reduced fishery for sandeel and norway pout impact of this fishery on the whiting stock is considered much reduced.

Changes in the French fishing fleet are unknown (see Section 1.1.1).

For the Scottish fleets, quota uptake is quite high and was above 50% by July this year. Whiting is becoming a more important species for the Scottish fleet, with many vessels actively targeting whiting a during a fishing trip.

The main English fleets are experiencing high levels of quota uptake this year (85% by early September) in particular off the North East English coastline.

12.1.3 ICES Advice

No analytical assessment of whiting has been accepted in recent years due to discrepancies between survey information and catch data. To address this, the assessment that formed the basis for the advice given in 2005 covered a short time-series of catch data and survey information where the discrepancy did not occur. The assessment was considered indicative of trends but as such could not form the basis for a short-term forecast. Therefore the advice was based on the average of recent landings.

For whiting the single species exploitation boundaries were that:

> *The stock status cannot be assessed with reference to precautionary reference points. However, in the light of the low estimate of stock size in combination with the low recent landings with indication of current low exploitation rates, ICES recommends that the human consumption landings in 2006 should not be allowed to increase above the recent (2002-2004) average of 17 300 t for Subarea IV and Division VIId.*

Given the problem with the interpretation of historical stock trends, ICES considers that the current state of the stock, with respect to biological reference points, is unknown.

For all demersal fisheries in the North Sea, ICES advice was based on mixed-fishery considerations and it advised the following:

Fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2006 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- with minimal bycatch or discards of cod;
- implement TACs or other restrictions that will curtail fishing mortality for those stocks … for which reduction in fishing pressure is advised;
- within the precautionary exploitation limits for all other stocks;
- where stocks extends beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;
- with minimum by-catch of spurdog, porbeagle and thornback ray and skate.

12.1.4 Management

Management of whiting is by TAC and technical measures. The agreed TACs for whiting in Subarea IV and Division IIa (EU waters) was 28 500t in 2005 and 23 800 t in 2006.

EU technical regulations in force in 2004 and 2005 are contained in Council Regulation (EC) 850/98 and its amendments. For the North Sea, the basic minimum mesh size for towed gears for roundfish was 120 mm from the start of 2002, although under a transitional arrangement until 31 December 2002 vessels were allowed to fish with a 110 mm codend provided that the trawl was fitted with a 90 mm square mesh panel and the catch composition of cod retained on board was not greater than 30% by weight of the total catch. From 1 January 2003, the minimum mesh size for towed roundfish gears has been 120 mm. Restrictions on fishing effort were introduced in 2003 and details of its implementation in 2004 can be found in Annex V of Council Regulation (EC) no. 2287/2003, for 2005 in Annex IVa of Council Regulation (EC) no 27/2005 and for 2006 in Annex IIa of Council Regulation (EC) 51/2006. Currently, vessels fishing with towed gears for roundfish in Subareas IV and VIId and Division IIa (EU waters) are restricted to 103 days at sea per year, excluding derogations (see also Section 2.1.2). The minimum landing size for whiting in the North Sea is 27 cm.

Whiting are a by-catch in some *Nephrops* fisheries that use a smaller mesh size, although landings are restricted through by-catch regulations. They are also caught in flatfish fisheries that use a smaller mesh size. Industrial fishing with small-meshed gear is permitted, subject to by-catch limits of protected species including whiting. Regulations also apply to the area of the Norway pout box, preventing industrial fishing with small meshes in an area where the by-catch limits are likely to be exceeded.

There is no separate TAC for Division VIId, landings from this Division are counted against the TAC for Divisions VIIb-k combined (21 600 t in 2005 and 19 940 t in 2006). The minimum mesh size for whiting in Division VIId is 80 mm, with a 27 cm minimum landing size.

12.2 Data available

12.2.1 Catch

Total nominal landings are given in Table 12.2.1 for the North Sea (Sub-area IV) and Eastern Channel (Division VIId).

In 2002, the WG decided to truncate the catch data to start from 1980. This was due to the very large change in estimated recruitment levels around 1980 that was present in the assessment. The WG could not determine whether this was due to a shift in the recruitment regimen or because discard data for years prior to 1978 were not measured but estimated according to a discard ogive that may not have been representative of discarding during the earlier period (biological reference points for this stock had originally been established on the basis of the truncated series, so this represented no change with respect to them).

WG estimates of weights and numbers of the catch components for the North Sea and Eastern Channel are given in Tables 12.2.2 and 12.2.3, both tables cover the period 1980 to 2005.

For the North Sea the total international catches were 22 000 t in 2005, of which 10 500 t were human consumption landings, 10 600 t discards and 900 t industrial by-catch. The total catch is the lowest ever recorded as are discards. Human consumption landings have increased from last year, but nonetheless are the second lowest in the series. The whiting industrial by-catch was also the lowest on record due to the very limited fishery for Norway pout and a reduced sandeel fishery in 2005. For the Eastern Channel, the total catch in 2005 (4 800 t) is not dissimilar to those of the previous 15 years. As a proportion of total catch, the VIId catch has been increasing since the early nineties.

No short-term catch predictions have been accepted for this stock for the last two years, so it is not appropriate to compare the actual 2004 catches with earlier predictions.

Discard data apply to the North Sea catches only and are based largely on samples from the Scottish fleet. In earlier years when Eastern Channel landings were a much smaller proportion of the landings from the combined areas, the omission of discard data for Eastern Channel whiting would be of less concern than now, where Eastern Channel landings comprise around one third of the combined area landings. There is no industrial fishery in the Eastern Channel.

Figure 12.2.1 plots the trends in the catch weights for each component, note that estimates of discards from VIId are not included. Each component shows a general decline. Industrial by-catch can be seen to be removing proportionately less through time. It can be seen that human consumption landings have fluctuated around approximately 45% of the total catch during the period 1980-2004.

12.2.2 Age compositions

Total international catch numbers at age (IV and VIId combined) are presented in Table 12.2.4. Total catch consists of human consumption landings, discards and industrial by-catch for reduction purposes.

Total international human consumption landings (North Sea and Eastern Channel combined) are given in Table 12.2.5. Landings of whiting during 1980-2004 have generally consisted of around 80% in number of 1 to 4 year olds. Since 2002 the proportion has declined to approximately 60% in 2005 after the introduction of the 120mm mesh. The 2002 year-class continues to have a low representation in the catch in 2005.

Discard numbers at age for the North Sea are presented in Table 12.2.6. The proportion by number of age 1 whiting has been decreasing since the mid eighties, with an increase for older fish (ages 4 to 6) in the discards in 2004 and 2005.

Discards are estimated by applying the Scottish discard ogive to international landings for the North Sea fleets. This reflects historical practice but may be inappropriate due to different spatial distributions in fleet effort and discarding practices. Discard information is available from other nations but the form of this data (for example, only partial rather than complete age-compositions have been provided), the current collation system and the time available make their inclusion impracticable.

Industrial by-catch numbers at age for the North Sea are presented in Table 12.2.7.

Proportion in number at age in the catch, human consumption landings, discards and industrial by-catch are plotted in Figure 12.2.2.

The contribution by number to each catch component is plotted in Figure 12.2.3. This figure shows a dramatic reduction in age 0 catches due to a reduction in catch in the industrial by-catch fishery.

12.2.3 Weight at age

Mean weights at age (Sub-Area IV and Division VIId combined) in the catch are presented in Table 12.2.8. These are also used as stock weights. Mean weights at age (both areas combined) in human consumption landings are presented in Table 12.2.9, and for the discards and industrial by-catch in the North Sea in Tables 12.2.10 and 12.2.11. These are shown graphically in Figure 12.2.4, which indicates a decline in mean weight in the landings and catch for ages 6 to 8, and a reasonably constant mean weights for all other ages in all the catch components. From 1990 to 2005 ages 4 and above in the catch and landings have shown a periodic increase and decrease in mean weight.

12.2.4 Maturity and natural mortality

Values for natural mortality and maturity remain unchanged from those used in recent assessments and are:

Age	1	2	3	4	5	6	7	8+
Natural Mortality	0.95	0.45	0.35	0.3	0.25	0.25	0.2	0.2
Maturity Ogive	0.11	0.92	1	1	1	1	1	1

Their derivation is given in the Stock Annex (Q12).

12.2.5 Catch, effort and research vessel data

The full commercial CPUE and survey tuning indices available to the WG are presented in Table 12.2.12. The report of the 2001 meeting of this WG (ICES-WGNSSK 2001), and the ICES advice for 2002 (ICES-ACFM 2001) provides arguments for the exclusion of commercial CPUE tuning series from calibration of the catch-at-age analysis see section 14.2.4. Such arguments remain valid and only survey data have been considered for calibration purposes. Nevertheless, a summary of all available tuning series is presented in Table 12.2.13. These data sets are presented in full in response to previous requests from the NSCFP.

Data from the VIId French groundfish survey for 2005 and 2006 are available but in a form that was different from previous data and havenot been presented here. The English groundfish survey and Scottish groundfish survey series form part of the third-quarter IBTS index (IBTS_Q3). The practice of this WG for this stock has been to use the English groundfish survey and Scottish groundfish survey series individually rather than to use a combined IBTS_Q3 index as they pre-date it. A thorough evaluation of the IBTS_Q3 index and the separate English groundfish survey and Scottish groundfish survey series will be required for this stock if the former is to be considered a replacement for the latter two.

In 1998 FRS (Aberdeen) introduced a new survey vessel; it was considered at the time that no evidence existed to say the new vessel had different catch abilities to the old vessel (Zuur et al. 2001). This is now generally considered not to be the case. In line with other roundfish stock assessments we present the Scottish groundfish survey as two separate series.

In 1991 the English groundfish survey changed fishing gear from the Granton trawl to the GOV trawl. For this reason the English groundfish survey is treated as two independent series.

Several revisions have been made to the IBTS Q1 survey, for more information see section 1.2.6.

Distribution maps for the English groundfish survey are given in Figure 12.2.5. These plots show a relatively large year-classes in 1998, 1999, 2000 and 2001. The distributions of young whiting appears to be changing; the 1998 year-class was found along the entire east coast of the UK, where as subsequent year-classes are found in higher densities more southerly, on the north west coast of England, however there are still concentrations to the north east of Scotland and in the central North Sea.

Density maps for the Scottish groundfish survey in Figure 12.2.6, data for this survey is incomplete and only years 2000 to 2006 are shown. These plots show concentrations on the north east cost of England of older whiting (ages 4- 6).

Density maps for the IBTS survey are shown in Figure 12.2.7. These plots show a general decline in the numbers of young whiting in recent years. It can also be seen that young whiting are distributed widely in the North Sea with concentrations on the west coast of the UK, in the Skagerrak and Kategat and also in the Eastern Channel, but that older whiting tend to be found to the north east of England and in the Northern North Sea.

Trends in survey CPUE are shown in Figure 12.2.8, these figures sow a general increase in CPUE for ages 5 and 6, with a decline in recent years for ages 0 to 4. CPUE for age 0 is typically highly variable.

Trends in commercial CPUE for the Scottish seine and light trawl fleet are shown in Figure 12.2.9 and shows similar catch rate between the two fleets. These fleets show an increase in CPUE since 1990 for ages 5 to 8 and steady but variable CPUE for ages 1 to 4. Ages 3 and 4 show a recent decline since 2002/2003, while ages 5 and 6 show a sharp rise since 2002.

Trends in commercial CPUE for the French otter trawl and beam trawl (IV and VIID separately) (Figure 12.2.10) are highly variable. The two beam trawl fleets show similar trends.

Nominal effort for all available commercial fleets is shown in Figure 12.2.11, and shows declining effort in the recent period for all fleets.

Commercial CPUE series are not used for tuning in this assessment due to the fact that reporting of commercial effort is not mandatory, and as such commercial CPUE cannot be taken as accurate and unbiased measures of catch rates.

12.3 Data analyses

The methods used in this section include various summaries of the raw data and some modeling approaches. Two models were used: XSA and SURBA. XSA was used to assess stock trends for the North Sea and the Eastern Channel using commercial catch data in conjunction with suitable survey information. SURBA was used to assess stock trends in the North Sea and the Eastern Channel using only survey information. Furthermore SURBA was used to assess stock trends in discrete sub-areas of the North Sea using disaggregated survey information. It was not possible to use XSA in this capacity as commercial data (landings, discards and industrial by-catch) are not at present available in a disaggregated form.

12.3.1 Reviews of last year’s assessment

Several recommendations were made by the RGNSSK regarding last years assessment. These are summarised below.

1. SGSIMUW to collate spatially disaggregated landings and discard data. In the absence of these, the fallback position should be a survey-based assessment.

2. The French VIId GFS should be analysed, with a view to inclusion *if* it gives information on the VIId component of the stock.

3. the use of age-0 data from commercial and survey sources should be reconsidered

4. The use of ages 2–6 in the mean *F* range should be reconsidered, as this range includes partially recruited ages.

5. Splitting of surveys on the basis of gear etc. should be homogenised with the other roundfish assessments.

The RGNSSK also commented on the fact that mean weight declined down some cohorts. The NCFP review group raised similar concerns, and added that whiting catches are heavily dependent on time of day, inferring that survey indices may be noisier than for other roundfish species. The WG responses to these points can be summarised as follows.

1. SGSIMUW did not meet this year and so no spatially disaggregated data are available.
2. The inclusion of the French groundfish survey is dealt with in section 12.3.3.
3. The use of age zero data is dealt with in sections 12.3.2 and 12.3.3.
4. This point was not addressed.
5. The issue with splitting the English and Scottish surveys due to gear and vessel changes to remain consistent with other roundfish stocks has been addressed and all analysis presented here is done treating the separate periods of the surveys series as independent.

With regards to mean weight at age in the catch declining down cohorts at older ages, the WG noted the following:

- ages 6 to 8+ make a vary small proportion of the catch and as such will be poorly sampled given current sampling protocols. This means that mean weights will be estimated with low precision at these ages.
- A set where the mean weights from 1990 to 2005 were replaced by their mean over the same period and a set where the mean weights from 1990 to 2005 were replaced with the mean over the whole time series (1960 – 2005) – both scenarios invlove increased mean weights at older ages and consistently increasing mean weight down cohorts. The resulting SSB estimates show that the trend in SSB is not driven by trends in mean weight and that the numbers of older fish in the catch means that an increase in the estimated mean weight of these ages generally makes little difference. These plots are not shown here but are available in the stock folder.

12.3.2 Exploratory catch-at-age-based analyses

Catch curve analysis provides a useful method of inspecting the data and looking for changes exploitation of the stock. Catch curves for the catch data are plotted in Figure 12.3.1 and shows numbers-at-age on the log scale linked by cohort. This shows partial recruitment to the fishery up to age 2. The plot also shows in the most recent years a decline in young fish in the catch, indicating a reduction in availability of these ages to the fishing gear. Also notable is the very low catch of age 0 whiting in 2000. Plotting the negative of the gradient of these lines gives an indication of mortality inferred from the catch data, the time series of these are shown in figure 12.3.2 and indicates a general decline.

Within cohort correlations between ages are presented as a scatter plot matrix in Figure 12.3.3. A normal linear regression is fitted for each scatter plot and if significant ($Pr(F)<0.05$) the regression line is drawn in bold. We can see from this plot that in general catch numbers correlate well between cohorts with the relationship breaking down as you look at more distant cohorts. One of the RGNSSK recommendations was that the use of age 0 catch data and survey information should be considered. Age 0 whiting enter the catch primarily through the industrial fishery (Figure 12.2.2 and 12.2.3). There are two anomalies in the industrial fishery data set – a large number of age 0 whiting were estimated to have been caught in 1995 and are not seen at a comparable magnitude at age 1 in the catch (Figure 12.3.1), the English groundfish survey (Figure 12.2.5) or the IBTS survey (Figure 12.2.7). There is also a complete absence of age 0 whiting in 2000 in the total catch. Both of these anomalies affect the catch data. Furthermore age 0 catch data do not correlate well with any other age class. It was decided, for these reasons, to exclude age 0 catch data from further analysis.

To assess the sensitivity of XSA to changes in tuning fleets, single fleet runs were conducted. These used were the same as in last years' final assessment but with F-shrinkage reduce to 2.0

Summary plots of these runs are presented in Figure 12.3.4. The most striking feature is that recent SSB as estimated by the English groundfish survey is substantially higher than that estimated by the Scottish and IBTS surveys. Recruitment is estimated to be higher for 1998-2003 by the English groundfish survey than for the other surveys.

The inconsistencies in this assessment have in recent years been attributed to possible population substructure. Due to a lack of complete, spatially disaggregated, international commercial data (landings, discards and industrial bycatch) the WG could not run separate XSAs for sub areas within the North Sea and Eastern Channel. However, there were available LPUE from the Scottish whitefish and Nephrops fleets fishing in the North Sea and a study on regional differences in the whiting stock in the North Sea and Eastern Channel (WD20). LPUE of several fleets from UK(Eng. and Wales) fishing the north east English coast are shown in Figure 12.3.5 and shows an increase in catch rate in 2004 and 2005. LPUE from Scottish fleets are shown in Figure 12.3.6 by IBTS roundfish area. LPUE was calculated using Scottish landings from the main Scottish trawl fleets using days at sea as reported by Scottish Fisheries Protection Agency; this measure of effort is not without its problems but is much less likely to be biased than hours of fishing. We see from this figure that the north and western areas of the North Sea are where catch rates are higher for the recent time period. There has been a decline in most areas, with area 2 (central North Sea) being the exception. Area 2 and 4 (north east coast of England) show an increase in catch rates in 2005, which reflect that seen in Figure 12.3.5.

12.3.3 Exploratory survey-based analyses

Log-abundance indices, linked by cohort, are shown in Figure 12.3.7. We can see a general increase in catches of older whiting through time for each survey, most notable in the Scottish groundfish survey. The plot for SCOGFS shows the extremely low catchability of the 2000 year-class at age 0 identified from the commercial catch curves (Figure 12.3.1). This feature is not seen in the English groundfish survey.

Plots of negative gradient are shown in Figure 12.2.8, these plots show evidence of declining mortality from all three surveys.

The consistency within surveys is assessed using correlation plots as scatter plot matrices. The first period of the Scottish groundfish survey (Figure 12.3.9) shows good agreement across ages 1 to 6, the second period of this survey (Figure 12.3.10) appears to be noisier, although this is a short time series. The extremely low age 0 index in 2000 can be seen on the far right of the age 0 plots – without this outlier the relationship between age 0 and the other ages would be more significant. The first period of the English groundfish survey (Figure 12.3.11) shows correlations between some ages but a lack of correlation at most ages, however, the second period of this survey (Figure 12.3.12) shows correlations for ages 0-5. The IBTS survey (Figure 12.3.13) shows correlations between all ages. The French groundfish survey is shown in Figure 12.3.14 and shows no correlations between any ages. Given these analyses and that only age 1-8+ commercial catch data is being used, the WG considered the following survey data to be considered further: the two periods of the Scottish groundfish survey (ages 1-6), the second period of the English groundfish survey (ages 1-6) and the IBTS survey (ages 1-6+).

Single fleet analyses were carried using SURBA. Mean standardised SSB for these runs, a multi-fleet SURBA, and a multi-fleet XSA (using the same surveys) is presented in Figure 12.3.15. These show broadly similar trends from each survey with a consistent period during 1999 to 2005. The discrepancy between survey and catch data is demonstrated by the divergent trends in the period 1980-1990 for the multi-fleet SURBA and multi-fleet XSA.

To explore the survey data with a view to addressing possible population substructure survey indices were collated for IBTS roundfish areas 1 to 7 based on indices extracted from DATRAS prior to the inclusion of the 2006 data. The indices were calculated as the mean over the indices for each statistical square that comprises each roundfish area. SURBA analyses were carried out on each data set (Figure 12.3.16) as well as calculating survey CPUE (Figure 12.3.17). These figures show declining indices of SSB for all areas with perhaps an indication of a slight increase in 2005 in area 5, from the raw CPUE.

12.3.4 Conclusions drawn from exploratory analyses

Catch curve analysis and correlation plots show that both surveys and catch data track cohorts well and are not only internally consistent but are also correlated with each other (see analysis in stock folder). All sources of information indicate a generally declining mortality and declining catches. However, using the English groundfish survey to tune XSA, results in a much larger terminal SSB than when using either of the other surveys.

The catch data shows a reduction in young fish catches not commensurate with that seen from survey sources indicating a recent change in selection pattern within the fishery.

There is a discrepancy between the catch data and survey information in the period 1980-1995. This is apparent from comparisons of standardized SSB trends, where catch shows a strong decline in SSB where surveys show a relatively constant trend. There is good corroboration between catch data and survey information for the period 1995-2005, where all sources show an increase followed by a decline over the period 2000 to 2005 – this can also be seen from distribution plots of raw survey indices.

There is apparent spatial variation in stock trends seen both in the IBTS survey data and in commercial LPUE series estimated for the IBTS roundfish areas. It can be seen that the largest LPUE has been in the north North Sea and although declining to its lowest levels remains high with respect to other areas. In contrast to this the declining trend in the north it can be seen that areas 3, 4 and 5 have shown constant but variable LPUE, with evidence of an increase in the most recent year.

12.3.5 Final assessment

The final XSA assessment was fitted to the combined landings, discard and industrial by-catch data for the period and used the English groundfish, Scottish groundfish and IBTS surveys as tuning series. The settings are contained in the table below. Those from previous years are also presented; note no assessment was presented in 2004. Last years assessment treated the IBTS survey as if it occurred in quarter 4 of the previous year in order to include the most recent data point in the analysis.

The other difference this year is the use of light shrinkage (SE = 2.0). This was chosen to avoid the problem (which occurs when using strong shrinkage) of potentially biasing upwards *F* estimates when *F* is declining.

	2004	2005	This year(2006)
Catch at age data	-	1980-2004	1980-2005
	-	Ages 1 to 8+	Ages 1 to 8+
Calibration period	-	1990-2004	1990-2005
ENGGFS Q3 (continous series)	-	Ages 1 to 6	-
ENGGFS Q3 (GRT)	-	-	Ages 1 to 6
ENGGFS Q3 (GOV)	-	-	Ages 1 to 6
SCOGFS Q3 (continuous series)	-	Ages 1 to 6	-
SCOGFS Q3 (Scotia II)	-	-	Ages 1 to 6
SCOGFS Q3 (Scotia III)	-	-	Ages 1 to 6
IBTS Q1	-	Ages 0 to 4 (backshifted)	Ages 1 to 5
Catchability independent of stock size	-	Age 1	Age 1
Catchability plateau	-	Age 4	Age 4
Weighting	-	Tricubic over 15 years	Tricubic over 16 years
Shrinkage	-	Last 3 years and 4 ages	Last 3 years and 4 ages
Shrinkage SE	-	0.5	2.0
Minimum SE for fleet survivors estimates	-	0.3	0.3

Full diagnostics for the final XSA run are given in Table 12.3.1. Residual plots are presented in Figure 12.3.18 and show increasing trends in the first period of the Scottish groundfish survey and in the English groundfish survey. Final year survivor contributions are shown in Figure 12.3.19. Fishing mortality estimates are presented in Table 12.3.2, the stock numbers in Table 12.3.3 and the assessment summary in Table 12.3.4 and Figure 12.3.20. A retrospective analysis (possible only over the last four years due to the short span of the second Scottish groundfish survey series), shown in Figure 12.3.21, indicates systematic downwards revisions of F(2-6), upwards revisions of SSB and variable downwards revisions of recruitment.

12.4 Historic Stock Trends

The historic stock trends in SSB are presented in Figure 12.4.1, and those for F(2-6) and recruitment in Figures 12.4.2 and 12.4.3

12.5 Recruitment estimates

The IBTS survey has been seen to be internally consistent across all ages (Figure 12.3.13) and a regression of the IBTS age 1 index against recruitment estimated from the final XSA run for years 1991 to 2005 shows a highly significant relationship. The regression was carried out over the period 1991 to 2005 as this is the period when the IBTS survey is most consistent with trends in the XSA final assessment. A similar regression using the age 1 indices from the Scottish groundfish survey showed no significant relationship. Similar results were found in a run of RCT3.

The input files for the RCT3 run are presented in Table 12.5.1 and the results in Table 12.5.2. This analysis predicts recruitment in 2006 of approximately 545 million. This estimate is a weighted average of 1088 million from the geometric mean and 519 million from the IBTS survey, with the IBTS getting the large majority of the weight.

The RCT3 recruitment estimate is shown on a bar chart of pervious recruitment, with a line showing the IBTS age 1 indices scales using parameters from a simple linear regression in Figure 12.5.1.

The RCT3 estimate was used as the estimate of recruitment for 2007 and 2008.

The following table summarises recruitment assumptions for the short term forecast.

YEAR CLASS	AGE IN 2006	XSA (MILLIONS)	RCT3 (MILLIONS)
2004	2	432	-
2005	1	347	-
2006	0	-	545
2007	Age 0 in 2007	-	545
2008	Age 0 in 2008	-	545

12.6 Short-term forecasts

A short-term forecast was carried out based on the final XSA assessment. XSA survivors in 2006 were used as input population numbers for ages 2 and older. The RCT3 estimate of 545 million was used for one-year-old abundance in 2006, 2007 and 2008.

Ordinarily, the input fishing mortality rates would be the status quo fishing mortality estimated as a recent average, with or without being scaled to the mean of the most recent year. However, inspection of the fishing mortalities-at-age (Figure 12.6.1) indicates values of F at ages 1 and 2 in 2003 that appear anomalous given the overall trend in fishing mortality. This is further unexpected given the mesh-size increase in 2002 in the roundfish fisheries that would be expected to reduce fishing mortality on the younger ages relative to the older fish and the reduction in industrial by-catch as a result of the decreasing activity in the Norway pout and sandeel fisheries. Given that F(2-6) and the pattern of F-at age are similar in 2004 to 2005, the F-at-age in 2005 was taken forward into the forecast.

Figure 12.6.2 shows ages where a significant trend in mean weight was found over the period 1995 to 2005. These are mostly declines in mean weights at older ages in the catch and landings, but there is an increase in mean weight at age 1 in the landings. Given that there exists trends in the mean weights at age, the final year estimates of mean weights were taken forward into the forecasts.

The input to prediction is shown in Table 12.6.1. Results are presented in Tables 12.6.2 and 12.6.3.

Assuming $F_{2006}=F_{2005}$ results in human consumption landings in 2006 of 9.1 kt from a total catch of 19.9 kt. For the same fishing mortality in 2007, human consumption landings are predicted to be 8.1 kt resulting in a SSB in 2007 of 92.5 kt. Under the assumptions of the prediction, SSB in 2007 will be below B_{lim} even in the absence of fishing in 2006 (but see discussion under sections 12.9 and 12.10).

12.7 Medium-term forecasts

No medium-term forecasts were carried out on this stock.

12.8 Biological reference points

The precautionary fishing mortality and biomass reference points agreed by the EU and Norway, (unchanged since 1999), are as follows:

Blim = 225,000 t; Bpa = 315,000 t; Flim = 0.90; Fpa = 0.65.

12.9 Quality of the assessment

Previous meetings of this WG have concluded that the survey data and commercial catch data contain varying signals concerning the stock. Analyses by WG members and by the SGSIMUW indicate that data since the early- to mid- 1990s are sufficiently consistent to undertake a catch-at-age analysis calibrated against survey data from the most recent period.

This has been taken forward into prediction for catch option purposes. However, due to the lack of concordance in the data pre-dating the early 1990s, the WG considers that it is not possible categorically to classify the current state of the stock with reference to precautionary reference points as the biomass reference points are derived from a consideration of the stock dynamics at a time when the commercial catch-at-age data and the survey data conflict.

Due to the likely population structuring in the North Sea and Eastern Channel, it is probable that the overall stock estimates may not reflect trends in more localised areas.

Despite the minimum mesh-size increase in 2002 in the towed demersal roundfish gears and the decline in industrial by-catch as activity in the Norway pout and sandeel fisheries have reduced in extent, there are seemingly anomalous estimates of fishing mortality at ages 1 and 2 in 2003, and the estimates of fishing mortality at ages 1 and 2 have increased since 2002. The WG has no explanation for this. It is possible that the age interpretation of whiting samples may cause problems with the catch-at-age data, but a less age-structured assessment carried out last year showed similar recent trends in stock biomass to the age-based assessment.

An appropriate time series of discard data suitable for use in catch-at-age analysis was available only for Scottish catches. For assessment purposes, historical discards for other human consumption fleets are estimated by extrapolation from Scottish data. Discard data from other countries should be made available for the WG in the appropriate format.

The forecast landings yield for the full assessment area in 2006 is around 9000 tonnes, against a TAC of 23 800 tonnes for Sub-Area IV and Division IIa (EU waters), and a further TAC of 19 940 tonnes in Divisions VIIb-k (there is no separate VIId quota). However, quota uptake data for the two fisheries for which the WG has information (Scotland and England) suggest that the quota will be fully taken up by the end of 2006. A similar discrepancy was observed in last year’s assessment. The forecast does not therefore seem to reflect real landings, which must cast some doubt on the utility of the assessment and forecast.

Concerns remain over difficulties with the assessment of whiting, which may be due to unaccounted sub-stock structure. The WG **recommends** that the ICES Study Group on Stock Identity and Management Units in Whiting (SGSIMUW) be reconvened to address this problem, as a matter of urgency.

The historic performance of the assessment is summarised in Figure 12.9.1.

12.10 Status of the Stock

The WG considers the status of the stock unknown with respect to biological reference points, for the reasons given in section 12.9. Nevertheless all indications are that the stock, at the level of the entire North Sea and Eastern Channel, is at or approaching a low level relative to the period since 1991. Fishing mortality is also estimated to be low relative to low relative to that period.

Whiting mature at a relatively young age and trends in SSB respond rapidly to changes in recruitment. Spatial effects, possibly due to population structuring in the North Sea and eastern Channel, are likely to result in different localised perceptions of the abundance of whiting. This is reflected by the area-based IBTS_Q1 survey analyses presented in section 5.3.3 (NB does not include 2006). This indicates for most areas that SSB has declined in the most recent years to the one of the lowest in the series. Exceptions to this pattern were the IBTS standard roundfish areas 2 (central) and 4 (southwest Scottish coast and northeast English coast) which indicated a recent decrease to a level above that observed in the early mid-eighties. Indications from commercial LPUE estimated on the same spatial scale show recent increases in catch rates for these areas and for area 3 (east of Scotland).

Indications from the fishers' survey also vary by area. Figure 12.10.1 shows the fishers' perception trends in abundance in the North Sea between 2001 and 2005. In general, this indicates that whiting in the southern area are considered to be relatively more abundant whereas those in the central and northern area have remained stable or declined. Comparison is hindered by the lack of area-based information from the 2006 IBTS_Q1 survey. Nevertheless, the indication of a more northerly decline in abundance is reflected in both the IBTS_Q1 and commercial LPUE spatial analysis and the fishers' survey.

12.11 Management Considerations

Whiting are caught in mixed demersal roundfish fisheries, fisheries targeting flatfish, the *Nephrops* fisheries and the Norway pout fishery.

The current minimum mesh-size in the mixed demersal roundfish fishery in the North Sea should result in reduced discards from that sector compared with the longer-term discard rates. Discarding is likely to remain a problem in the other demersal consumption fisheries either due to their capture below the minimum landing size or because whiting is not a commercial species for those fleets.

Catches of whiting in the North Sea are also likely to be affected by the effort reduction seen in the targeted demersal roundfish fisheries, although this will in part be offset by increases in the number of vessels switching from roundfish to *Nephrops.*

The by-catch of whiting in the Norway pout and sandeel fisheries is dependent on activity in that fishery, and this has recently declined.

TACs for this stock are split between two areas: (i) Subarea IVand Division IIa (EU waters) and, (ii) Divisions VIIb-k. Since 1996 when the North Sea and eastern Channel whiting assessments were first combined into one, 11.5% of any combined area catch option has been attributed to the VIId component for TAC management purposes. This value is based on the average contribution of Division VIId human consumption landings to the combined area human consumption landings over the period 1992-1996.

12.12 Whiting in Division IIIa

Total landings are shown in Table 5.12.1.

No assessment of this stock was possible

Table 12.2.1 Whiting in Sub-area IV and Division VIId. Nominal landings (in tonnes) as officially reported to ICES.

Sub-area IV

Country	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	944	1042	880	843	391	268	529	536	454	270	248	144	105
Denmark	1418	549	368	189	103	46	58	105	105	96	89	62	57
Faroe Islands	7	2	21	0	6	1	1	0	0	17	5	0	0
France	5502	4735	5963	4704	3526	1908	0	2527	3455	3314	2675	1721	1059
Germany	441	239	124	187	196	103	176	424	402	354	334	296	149
Netherlands	4799	3864	3640	3388	2539	1941	1795	1884	2478	2425	1442	977	802
Norway	130	79	115	66	75	65	68	33	44	47	38	23	16
Poland	0	0	0	0	0	1	0	0	0	0	0	0	0
Sweden	18	10	1	1	1	0	9	4	6	7	10	2	1
UK (E.&W)[3]	2774	2722	2477	2329	2638	2909	2268	1782	1301	1322	680	1209	2653
UK (Scotland)	31268	28974	27811	23409	22098	16696	17206	17158	10589	7756	5734	5057	5361
Total	**47301**	**42216**	**41400**	**35116**	**31573**	**23938**	**22110**	**24453**	**18834**	**15608**	**11256**	**9491**	**10202**
Unallocated landings	695	423	-549	812	-273	-50	3884	29	552	308	-597	-258	315
WG estimate of H.Cons. landings	47996	42639	40851	35928	31300	23888	25994	24482	19386	15916	10659	9233.4	10517
WG estimate of discards	42953	33050	30315	28156	17194	12721	23525	23214	16488	17509	24093	12561	10448
WG estimate of Ind. By-catch	20140	10360	26544	4691	5974	3161	5160	8885	7357	7327	2743	1218	882
WG estimate of total catch	**116284**	**92683**	**103095**	**73731**	**59087**	**44370**	**59108**	**60857**	**49011**	**46271**	**43208**	**27362**	**21847**

Division VIId

Country	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	74	61	68	84	98	53	48	65	75	58	66	45	45
France	5032	6734	5202	4771	4532	4495	-	5875	6338	5172	6478	-	3819
Netherlands	-	-	-	1	1	32	6	14	67	19	175	132	125
UK (E.&W)	321	293	280	199	147	185	135	118	134	112	109	80	86
UK (Scotland)	2	-	1	1	1	+	-	-	-	-	-	-	-
United Kingdom													-
Total	**5429**	**7088**	**5551**	**5056**	**4779**	**4765**	**189**	**6072**	**6614**	**5361**	**6828**	**274**	**4074**
Unallocated	-214	-463	-161	-104	-156	-167	4,242	-1775	-810	439	-1117	4076	713
W.G. estimate	5194	6633	5385	4956	4619	4599	4428	4275	5780	5519	5712	4350	4787

Sub-area IV and Division VIId

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
W.G. estimate	116284	92683	103095	73731	59087	44370	59108	60857	49011	46271	43208	27362	26633

Annual TAC for Subarea IV and Division IIa

	2000	2001	2002	2003	2004	2005	2006
TAC	29700	32358	16000	16000	16000	28500	23800

Table 12.2.2 Whiting in IV and VIId. WG estimates of catch components by weight ('000s tonnes).

	Sub Area IV (North Sea)				VIId (Eastern Channel)	Total	VIId HC as a proportion of total HC
	H. cons.	Disc.	Ind. BC	Total catch	H. Cons.		
1980	91.64	76.95	45.76	214.35	9.17	223.52	9.1%
1981	80.59	35.92	66.61	183.12	8.93	192.05	10.0%
1982	72.64	26.60	33.04	132.28	7.91	140.20	9.8%
1983	81.04	49.56	23.68	154.28	6.94	161.21	7.9%
1984	78.91	40.56	18.90	138.37	7.37	145.74	8.5%
1985	54.74	28.91	15.32	98.97	7.39	106.36	11.9%
1986	58.62	79.66	17.97	156.25	5.50	161.74	8.6%
1987	63.63	54.00	16.48	134.10	4.67	138.77	6.8%
1988	51.68	28.15	49.22	129.04	4.43	133.47	7.9%
1989	41.03	35.85	42.71	119.60	4.16	123.75	9.2%
1990	43.41	55.84	50.72	149.97	3.48	153.45	7.4%
1991	47.31	33.64	38.31	119.26	5.72	124.98	10.8%
1992	46.44	30.61	26.90	103.96	5.74	109.70	11.0%
1993	47.98	42.87	20.10	110.95	5.21	116.17	9.8%
1994	42.62	33.01	10.35	85.98	6.62	92.61	13.5%
1995	41.05	30.26	26.56	97.88	5.39	103.27	11.6%
1996	36.12	28.18	4.70	69.00	4.95	73.96	12.1%
1997	31.30	17.22	5.97	54.48	4.62	59.10	12.9%
1998	23.87	12.71	3.14	39.71	4.60	44.31	16.2%
1999	25.98	23.58	5.18	54.75	4.43	59.18	14.6%
2000	24.51	23.21	8.89	56.61	4.30	60.91	14.9%
2001	19.41	16.49	7.36	43.26	5.80	49.06	23.0%
2002	15.92	17.51	7.33	40.75	5.80	46.55	26.7%
2003	10.66	24.09	2.74	37.50	5.71	43.21	34.9%
2004	9.23	14.26	1.22	24.71	4.35	29.06	32.0%
2005	10.52	10.61	0.88	22.01	4.79	26.79	31.3%
min.	9.23	10.61	0.88	22.01	3.48	26.79	6.8%
mean	44.26	33.47	21.16	98.89	5.69	104.58	14.3%
max.	91.64	79.66	66.61	214.35	9.17	223.52	34.9%

Table 12.2.3 Whiting in IV and VIId. WG estimates of catch components by number (millions).

	Sub Area IV (North Sea)				VIId (Eastern Channel)	Total	VIId HC as a proportion of total HC
	H. cons.	Disc.	Ind. BC	Total catch	H. Cons.		
1980	304.8	471.2	644.5	1420.5	35.5	1456.0	10.4%
1981	261.4	213.9	929.3	1404.6	34.3	1438.9	11.6%
1982	238.3	173.2	333.3	744.8	33.0	777.8	12.1%
1983	260.6	370.2	697.2	1328.1	29.5	1357.5	10.2%
1984	252.1	326.8	296.6	875.4	33.4	908.8	11.7%
1985	156.8	231.2	280.1	668.2	19.6	687.7	11.1%
1986	204.2	582.6	398.6	1185.4	21.1	1206.5	9.4%
1987	226.8	415.9	285.2	927.8	18.2	946.0	7.4%
1988	193.6	231.4	951.7	1376.7	17.9	1394.6	8.5%
1989	155.3	280.3	430.8	866.5	16.9	883.3	9.8%
1990	163.6	539.0	577.9	1280.4	13.6	1294.1	7.7%
1991	181.6	241.8	1170.1	1593.5	17.9	1611.4	9.0%
1992	163.1	215.6	464.8	843.5	19.4	862.9	10.6%
1993	155.8	342.7	714.5	1213.0	17.8	1230.8	10.3%
1994	138.1	235.3	304.4	677.9	24.0	701.9	14.8%
1995	128.9	213.6	1659.5	2001.9	18.5	2020.4	12.5%
1996	120.5	177.1	128.3	425.9	22.4	448.3	15.6%
1997	108.5	100.6	61.3	270.4	22.6	292.9	17.2%
1998	86.5	83.2	97.2	266.9	23.0	290.0	21.0%
1999	98.4	178.5	160.1	437.0	18.9	455.8	16.1%
2000	91.6	142.3	55.0	288.8	22.1	310.9	19.4%
2001	73.7	114.3	281.7	469.7	28.6	498.2	27.9%
2002	56.8	96.3	205.0	358.1	19.7	377.8	25.7%
2003	34.4	209.6	84.2	328.2	22.8	351.0	39.9%
2004	30.7	56.9	42.4	129.9	16.4	146.3	34.8%
2005	36.9	59.4	24.2	120.4	19.6	140.0	34.7%
min.	30.7	56.9	24.2	120.4	13.6	140.0	7.4%
mean	150.9	242.4	433.8	827.1	22.6	849.6	16.1%
max.	304.8	582.6	1659.5	2001.9	35.5	2020.4	39.9%

Table 12.2.4 Whiting in IV and VIId. Total catch numbers at age (thousands). Data used in the assessment are highlighted in bold.

HC+Disc+IB	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1960	60827.5	482895.9	259439.7	215393.1	21459.7	23278.5	3633.5	891.8	2134.6	238.1	7.4	0.0	0.0	2380.2
1961	215700.2	1079197.3	619964.7	219882.1	32744.6	1355.3	4098.8	384.8	120.5	229.5	18.9	0.0	0.0	368.9
1962	76256.8	1022790.3	220148.0	156642.2	31722.2	5997.6	275.9	406.7	111.9	13.3	0.0	0.0	0.0	125.1
1963	105981.8	549436.3	751817.3	96114.5	45331.8	9333.9	1738.6	8.9	126.3	14.0	1.3	0.0	0.0	141.6
1964	234479.0	137589.5	369667.8	164882.4	22843.4	10907.7	2769.8	435.1	1.6	40.8	11.4	1.6	0.0	55.5
1965	63911.6	342622.0	148165.9	330155.8	72199.8	8001.9	3554.9	765.4	123.7	1.7	8.7	0.0	0.0	134.2
1966	84279.0	517081.4	343402.1	93850.5	255875.0	37708.4	8535.1	1520.4	339.4	130.8	0.0	0.0	0.0	470.2
1967	177435.6	973201.8	216063.5	122955.0	23957.5	69081.5	7885.8	848.9	127.5	33.1	3.1	0.0	0.0	163.7
1968	104751.3	830540.5	523774.0	111754.8	49514.0	7493.6	31182.7	1940.4	97.7	24.4	4.9	0.0	0.0	127.0
1969	1206087.3	374343.2	1025995.7	158808.3	28972.4	13239.7	1734.0	5988.6	659.5	36.2	1.4	0.0	0.0	697.1
1970	1187095.2	606831.1	83063.6	571695.6	52107.6	11462.9	3722.8	1210.7	1359.7	137.2	16.9	0.0	0.0	1513.8
1971	1232837.0	621941.3	107932.6	18786.3	128541.4	13639.5	2305.9	730.0	170.9	429.4	27.7	0.0	0.0	627.9
1972	553710.6	939140.7	319094.2	46392.2	7832.6	59312.9	8391.9	3486.0	258.1	71.1	680.0	0.0	0.0	1009.2
1973	175647.0	1155303.9	666563.4	135507.0	19027.5	5738.9	18186.0	2503.7	367.2	125.3	53.2	0.0	0.0	545.7
1974	571476.0	756260.2	986440.6	234062.9	33306.8	4976.8	1243.2	5856.4	353.4	51.7	21.7	0.0	0.0	426.8
1975	238839.1	955909.7	407207.4	303536.6	56548.7	9273.0	8013.7	116.4	1382.6	140.6	1.7	0.0	0.0	1524.8
1976	425080.9	479609.9	1129374.7	169610.5	88015.0	15988.4	3163.1	494.7	18.0	627.2	29.4	0.0	0.0	674.6
1977	666974.8	1006082.1	480938.5	279225.8	30130.3	21334.1	5561.0	531.6	237.3	20.2	158.4	3.2	0.0	419.1
1978	687238.3	418909.9	313391.2	242369.7	90046.7	7563.3	7564.6	1850.9	252.6	11.3	9.2	4.1	0.0	277.2
1979	476383.1	615523.8	467537.2	218282.6	100975.5	29266.8	3110.6	1657.0	264.3	35.0	1.0	4.1	0.0	304.4
1980	332209.0	265359.3	416008.4	286076.9	90717.9	52969.1	10751.1	1152.1	688.9	58.3	13.5	5.2	1.0	766.9
1981	516868.6	162898.6	346343.4	266517.2	102295.0	27775.9	12297.2	3539.9	243.5	44.8	36.7	1.0	0.0	326.0
1982	101057.8	192640.2	114443.6	245246.5	88136.8	26795.6	6909.1	2082.2	400.0	52.7	25.8	4.1	1.0	483.7
1983	668603.7	205646.4	184745.6	118411.6	131508.2	37231.1	8687.8	1780.2	793.9	101.2	35.2	0.0	0.0	930.3
1984	157818.9	323408.2	175964.7	124886.1	49504.5	59816.5	13859.8	2964.2	410.2	181.8	21.4	0.0	0.0	613.4
1985	186722.9	203321.1	141715.5	82036.6	37847.4	14419.7	17444.8	3327.9	805.2	89.1	8.8	0.5	0.0	903.6
1986	225201.3	576731.2	167077.2	169577.4	46516.6	13366.9	3487.3	3975.3	496.9	70.7	0.1	1.1	0.0	568.8
1987	84862.7	267051.1	368229.2	122747.9	85239.8	11391.6	4555.5	928.0	929.4	98.3	7.3	0.0	0.0	1035.0
1988	416924.4	430344.0	307428.5	179502.3	39634.5	17901.4	2174.9	543.9	59.3	71.7	36.9	0.0	0.0	167.8
1989	87325	331672	173676	191942	78463.9	14367.4	5050.0	516.3	291.2	36.2	5.7	0.8	0.0	333.8
1990	284755	253745	505010	129126	86323.6	32270.0	2002.5	735.3	96.1	16.1	0.0	0.0	0.0	112.2
1991	1035089	128507	191193	187195	36830.2	26209.3	5518.8	542.5	254.8	17.4	1.1	0.0	0.0	273.4
1992	252963	239791	165354	89563	93636.1	11967.0	6877.9	2609.1	108.8	7.6	0.7	0.0	0.0	117.1
1993	622530	217539	167577	124287	46543.0	46135.7	3945.6	1519.1	697.6	57.6	15.6	0.0	0.0	770.8
1994	216868	163609	147177	90611	47533.0	17383.9	17264.1	998.4	385.8	74.2	0.3	0.0	0.0	460.3
1995	1571419	137481	139010	111489	35728.0	15161.4	5158.5	4514.6	317.4	101.3	54.8	0.0	0.0	473.6
1996	93296	72645	113956	98476	48575.4	14235.2	4694.6	1294.4	910.5	167.8	32.4	0.0	2.2	1112.9
1997	16893	53408	74200	82944	42153.7	18491.9	3358.4	1019.7	306.6	136.9	16.5	0.0	0.0	460.0
1998	68619	71430	44697	42771	36459.1	17755.8	6392.3	1425.8	306.4	66.2	33.7	0.4	0.0	406.7
1999	77814	178079	91355	45627	34174.9	18528.3	7546.9	2048.6	568.5	95.0	12.3	0.0	0.0	675.9
2000	1753	66789	124365	63526	23888.0	16231.9	8790.7	4321.7	970.5	244.4	47.5	3.0	0.0	1265.4
2001	230987	84121	86178	58908	20558.6	9176.6	4814.0	2231.9	896.9	246.1	123.8	1.6	0.0	1268.4
2002	137485	49857	61239	82940	34005.6	8006.7	2042.9	1456.9	620.2	101.6	13.1	9.4	9.8	754.0
2003	61111	72709	104040	53560	42048	14305	2372	474	329	50	16	1	0	397.0
2004	26426	25440	16412	24354	25738	19126	7285	1193	191	91	12	1	4	298.5
2005	13072	25796	27907	11177	17135	13919	8295	2641	426	24	29	1	0	479.7

Table 12.2.5 Whiting in IV and VIId. Human consumption landings numbers at age (thousands).

HC	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1960	1.2	15664.1	54915.3	85350.2	13313.5	22070.3	3526.2	890.5	2134.6	238.1	7.4	0.0	0.0	2380.2
1961	0.0	39893.6	133425.0	88161.2	28668.2	1208.3	4015.4	384.8	120.5	229.5	18.9	0.0	0.0	368.9
1962	33.8	43936.7	73215.7	84657.6	20691.6	5503.2	258.2	397.0	109.8	13.3	0.0	0.0	0.0	123.1
1963	0.0	7866.1	126516.8	51092.8	30797.0	7735.9	1702.8	8.9	126.3	14.0	1.3	0.0	0.0	141.6
1964	4.9	5251.3	95718.1	101128.1	18806.1	9475.6	2369.8	411.4	1.6	40.8	11.4	1.6	0.0	55.5
1965	0.0	11833.7	30063.3	208879.6	56780.9	7199.6	3182.4	761.6	123.7	1.7	8.7	0.0	0.0	134.2
1966	12.1	9947.3	49714.7	50028.2	220625.8	33765.7	8194.5	1509.6	285.8	130.8	0.0	0.0	0.0	416.7
1967	0.0	40672.0	60976.3	64889.6	17125.2	65983.0	7557.0	823.6	122.8	33.1	3.1	0.0	0.0	159.0
1968	0.0	34084.0	139709.5	64838.7	35934.7	6548.8	30946.8	1924.1	97.7	24.4	4.9	0.0	0.0	127.0
1969	0.0	3790.9	107205.9	68777.9	19913.9	9055.6	1207.4	5660.7	659.5	36.2	1.4	0.0	0.0	697.1
1970	0.0	4683.5	16526.3	201636.8	44706.5	10316.8	3405.1	1144.6	1359.7	137.2	16.9	0.0	0.0	1513.8
1971	10.8	24445.4	34384.1	12622.5	106465.4	12172.2	2253.3	726.5	170.9	429.4	27.7	0.0	0.0	627.9
1972	0.0	17314.5	71822.6	27550.5	6672.6	52517.6	7901.7	3486.0	258.1	71.1	680.0	0.0	0.0	1009.2
1973	0.0	37536.8	101245.8	68216.3	16238.1	5505.4	15771.0	2112.5	367.2	125.3	53.2	0.0	0.0	545.7
1974	751.8	12844.7	128537.9	97192.9	22049.2	3895.4	985.1	4435.5	345.0	51.7	21.7	0.0	0.0	418.4
1975	0.0	18427.8	58114.4	127341.7	42718.9	7741.8	7884.9	116.4	1281.7	131.3	1.7	0.0	0.0	1414.7
1976	0.0	6786.1	126260.4	58556.1	65488.6	14251.7	3042.4	477.4	18.0	626.0	22.4	0.0	0.0	666.5
1977	8.6	19563.5	79948.0	138190.7	19290.5	17959.5	4772.3	516.9	237.3	20.2	158.4	3.2	0.0	419.1
1978	0.0	14793.5	99836.1	155424.3	76828.9	6692.7	7202.3	1836.5	252.6	11.3	9.2	4.1	0.0	277.2
1979	8.2	8487.8	108547.8	144342.5	89093.0	26584.2	3011.0	1617.3	250.0	35.0	1.0	4.1	0.0	290.1
1980	0.0	3655.7	62405.2	152570.1	68421.6	41429.8	9910.7	1134.6	688.9	58.3	13.5	5.2	1.0	766.9
1981	6.1	4239.8	69211.0	104347.6	78253.1	23697.9	12036.3	3529.6	243.5	44.8	36.7	1.0	0.0	326.0
1982	0.0	10889.7	46703.4	124655.8	59393.4	21375.6	5663.7	2057.9	400.0	52.7	25.8	4.1	1.0	483.7
1983	1.0	10567.6	68639.5	67311.8	101342.4	31265.9	8329.9	1730.1	784.2	101.2	35.2	0.0	0.0	920.6
1984	0.0	14387.8	62693.2	99203.9	41277.3	51744.6	12735.3	2812.7	410.2	181.7	21.4	0.0	0.0	613.3
1985	1.1	2287.9	51194.4	57048.7	32340.1	12973.6	16360.7	3237.6	805.2	89.1	8.8	0.5	0.0	903.6
1986	28.5	12878.9	44499.6	111526.8	37287.3	11284.7	3379.0	3911.9	485.0	70.7	0.1	1.1	0.0	556.9
1987	22.2	11073.9	72371.6	70503.5	73741.9	10808.0	4505.9	928.0	898.8	98.3	7.3	0.0	0.0	1004.4
1988	0.3	7461.9	61360.3	94162.9	29147.1	16556.0	2158.3	543.9	55.9	71.7	36.9	0.0	0.0	164.4
1989	52.5	8635.7	28405.9	77008.9	44306.8	9249.3	3887.8	420.0	208.0	34.6	5.7	0.8	0.0	249.0
1990	22.9	6948.9	54361.1	45423.1	50602.9	17747.1	1407.3	621.8	94.2	16.1	0.0	0.0	0.0	110.3
1991	409.9	11610.2	43109.5	91128.7	26169.5	21697.2	4686.7	404.8	254.8	17.4	1.1	0.0	0.0	273.4
1992	297.3	9602.8	45153.9	48838.1	60806.0	9955.6	6222.9	1495.9	101.3	7.6	0.7	0.0	0.0	109.6
1993	719.4	5979.8	29304.7	64352.6	33514.5	34651.1	2989.5	1360.8	697.4	57.6	15.6	0.0	0.0	770.6
1994	76.5	17125.6	31659.7	46216.6	36813.6	14169.2	14705.6	927.5	371.5	74.2	0.3	0.0	0.0	446.0
1995	277.0	8831.9	28131.7	58538.2	28013.5	13766.8	4953.5	4401.5	311.1	101.3	54.8	0.0	0.0	467.2
1996	1014.8	12516.5	26768.3	47593.5	36288.4	12022.5	4452.9	1115.9	910.5	167.8	32.4	0.0	2.2	1112.9
1997	608.1	6522.2	23542.9	48237.5	31903.7	15823.5	2957.2	1017.3	291.0	136.7	15.4	0.0	0.0	443.1
1998	1202.2	17081.3	19894.2	25015.9	24712.9	14716.9	5445.6	1212.9	219.9	64.4	16.0	0.4	0.0	300.7
1999	68.4	16689.0	26966.5	25862.8	23791.7	14708.4	6660.2	1882.2	517.3	61.4	12.3	0.0	0.0	591.1
2000	0.2	15406.0	31988.9	28499.7	14327.4	11841.4	6657.3	3773.7	863.9	244.4	47.5	3.0	0.0	1158.8
2001	149.5	12257.0	28498.7	27331.8	17517.6	8640.1	4505.6	2092.4	878.0	246.1	123.8	1.6	0.0	1249.5
2002	0.0	2606.2	10342.9	30858.3	22328.2	6703.2	1710.3	1328.5	510.5	98.5	9.8	9.4	9.8	638.0
2003	20.1	403.0	11610.3	13990.9	18981.1	9514.5	1861.5	443.5	328.9	50.2	16.4	0.0	0.0	395.6
2004	0.0	3972.2	2812.9	9633.0	13311.5	11859.6	4411.4	747.0	173.7	84.5	11.7	0.6	3.8	274.3
2005	11.5	2241.8	4657.5	4345.2	9502.5	8941.7	5003.2	1900.5	203.5	18.3	29.5	0.5	0.2	252.0

Table 12.2.6 Whiting in IV and VIId. Discard numbers at age (thousands), representing North Sea discards only. Data used in the assessment area highlighted in bold.

Disc	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1960	43541.4	382492.3	199836.5	128345.4	8023.9	938.9	53.7	1.3	0.0	0.0	0.0	0.0	0.0	0.0
1961	65012.7	975752.0	469799.4	130985.0	4026.7	147.0	72.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1962	16385.3	947166.4	141396.2	69548.4	10365.9	391.8	12.6	2.5	0.0	0.0	0.0	0.0	0.0	0.0
1963	33167.8	242446.5	522615.0	40206.8	13649.8	1470.0	35.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1964	15752.1	72053.0	193073.7	55433.9	3351.8	1313.2	313.1	10.4	0.0	0.0	0.0	0.0	0.0	0.0
1965	25055.4	258289.0	114409.1	80801.7	10770.3	468.1	275.9	3.8	0.0	0.0	0.0	0.0	0.0	0.0
1966	57368.7	247504.8	188053.5	26346.1	24093.8	2793.3	45.0	10.7	0.0	0.0	0.0	0.0	0.0	0.0
1967	38123.2	861553.8	142197.9	52393.7	5284.5	2859.8	316.6	8.6	0.0	0.0	0.0	0.0	0.0	0.0
1968	14936.3	427489.7	257403.2	40977.5	12487.9	787.0	235.9	16.3	0.0	0.0	0.0	0.0	0.0	0.0
1969	36566.3	48203.3	486340.4	45540.0	5393.0	3548.4	62.3	257.3	0.0	0.0	0.0	0.0	0.0	0.0
1970	31609.2	92729.3	50019.3	198504.8	6582.2	1146.1	317.7	66.1	0.0	0.0	0.0	0.0	0.0	0.0
1971	12605.2	355900.0	68071.5	5013.7	15441.1	1380.2	52.6	3.5	0.0	0.0	0.0	0.0	0.0	0.0
1972	19087.4	199995.1	163387.6	11710.9	877.3	2861.9	369.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1973	13148.6	358453.1	236725.1	47591.4	2025.8	209.1	654.3	40.5	0.0	0.0	0.0	0.0	0.0	0.0
1974	21539.5	169070.7	230446.3	50100.9	5512.3	501.3	16.0	32.0	0.0	0.0	0.0	0.0	0.0	0.0
1975	30897.6	330551.8	205334.1	122404.3	8805.3	949.2	43.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1976	31834.0	143726.5	416465.7	36071.4	11904.6	474.5	52.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1977	28446.0	256701.5	188865.6	69078.9	2788.5	1144.7	57.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1978	28587.4	52684.0	114965.1	37682.1	7153.7	254.6	110.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1979	4577.2	473829.5	126723.6	31600.9	7321.7	1262.5	27.0	6.8	0.0	0.0	0.0	0.0	0.0	0.0
1980	3144.4	103203.4	250734.6	88398.7	14134.6	10795.3	785.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1981	866.7	50407.0	96509.0	57403.1	7312.8	1284.7	148.7	10.3	0.0	0.0	0.0	0.0	0.0	0.0
1982	18639.4	53753.0	26922.0	52348.8	18229.7	2971.7	343.0	22.0	0.0	0.0	0.0	0.0	0.0	0.0
1983	71015.5	152487.6	85317.5	33325.4	23442.4	4309.1	295.2	24.9	9.3	0.0	0.0	0.0	0.0	9.3
1984	16724.3	200589.3	82562.7	16814.5	4436.9	4494.8	1033.8	151.0	0.0	0.0	0.0	0.0	0.0	0.0
1985	8497.4	154232.4	48790.5	15117.1	2985.1	761.3	800.6	64.6	0.0	0.0	0.0	0.0	0.0	0.0
1986	7966.0	404603.7	120491.6	43479.1	5242.0	626.5	107.9	63.3	11.9	0.0	0.0	0.0	0.0	11.9
1987	9977.8	158531.2	202153.8	34824.1	9775.9	582.1	49.2	0.0	30.5	0.0	0.0	0.0	0.0	30.5
1988	21320.8	65020.8	87196.8	51134.9	5876.8	845.7	16.5	0.0	3.3	0.0	0.0	0.0	0.0	3.3
1989	6897.6	150597.5	36711.9	61441.9	21267.0	3276.2	102.5	7.7	12.4	0.0	0.0	0.0	0.0	12.4
1990	145308.4	79487.8	245128.5	33194.3	23488.1	12011.6	253.1	87.2	0.0	0.0	0.0	0.0	0.0	0.0
1991	6565.8	76938.4	77382.7	74004.7	4899.7	1827.9	88.7	59.5	0.0	0.0	0.0	0.0	0.0	0.0
1992	6880.2	98967.4	57628.7	26526.7	22975.7	1199.4	350.1	1064.2	1.9	0.0	0.0	0.0	0.0	1.9
1993	47768.6	124426.1	101119.1	49064.2	8991.7	10708.7	518.7	131.1	0.3	0.0	0.0	0.0	0.0	0.3
1994	8207.2	77782.6	97847.3	36761.9	9527.5	2856.1	2337.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0
1995	32846.0	46209.4	77320.2	48600.5	6942.7	1318.2	205.1	113.1	6.4	0.0	0.0	0.0	0.0	6.4
1996	2388.3	30480.2	82019.6	48239.9	11319.3	2191.8	239.5	178.6	0.0	0.0	0.0	0.0	0.0	0.0
1997	9800.1	19346.8	28836.5	30615.6	9174.9	2392.3	398.8	2.4	15.6	0.3	1.0	0.0	0.0	16.9
1998	2849.9	29978.7	18755.3	16360.6	10991.8	2976.3	934.5	212.8	86.5	1.8	17.7	0.0	0.0	106.0
1999	14697.1	84613.4	51739.7	14422.1	8843.8	3076.9	856.9	166.4	51.2	33.6	0.0	0.0	0.0	84.8
2000	1685.3	33848.0	75868.8	23590.2	2897.8	2256.8	1547.5	474.4	106.6	0.0	0.0	0.0	0.0	106.6
2001	16864.7	27570.2	44645.2	21930.3	2527.7	385.0	268.1	139.5	18.9	0.0	0.0	0.0	0.0	18.9
2002	1158.4	8670.4	31958.9	43444.1	9491.4	1098.5	211.2	128.4	109.6	3.1	3.2	0.0	0.0	116.0
2003	3695.6	54780.7	87376.3	36988.6	21853.2	4400.5	461.2	30.8	0.3	0.0	0.0	1.1	0.0	1.5
2004	2617.5	8603.1	9086.0	13668.8	12279.1	7266.7	2862.1	445.7	17.4	6.7	0.0	0.0	0.0	24.1
2005	1134.1	12622.3	22530.0	6342.1	7603.7	4944.1	3235.5	729.9	213.9	5.5	0.0	0.0	0.0	219.4

Table 12.2.7 Whiting in IV and VIId. Industrial bycatch numbers at age (thousands). Representing the industrial fishery in the North Sea (there is no industrial fishery in the Eastern Channel).

IB	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1960	17284.8	84739.5	4687.9	1697.5	122.3	269.3	53.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1961	150687.5	63551.7	16740.3	735.9	49.7	0.0	11.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1962	59837.7	31687.2	5536.1	2436.2	664.7	102.5	5.2	7.2	2.1	0.0	0.0	0.0	0.0	2.1
1963	72814.0	299123.7	102685.5	4814.8	885.0	128.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1964	218722.0	60285.1	80876.0	8320.4	685.5	118.8	86.9	13.2	0.0	0.0	0.0	0.0	0.0	0.0
1965	38856.2	72499.3	3693.5	40474.5	4648.6	334.3	96.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1966	26898.2	259629.3	105633.9	17476.2	11155.4	1149.4	295.6	0.0	53.6	0.0	0.0	0.0	0.0	53.6
1967	139312.4	70976.0	12889.3	5671.7	1547.8	238.7	12.1	16.8	4.7	0.0	0.0	0.0	0.0	4.7
1968	89815.0	368966.8	126661.3	5938.6	1091.4	157.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1969	1169521.0	322348.9	432449.4	44490.4	3665.5	635.7	464.3	70.5	0.0	0.0	0.0	0.0	0.0	0.0
1970	1155486.0	509418.3	16518.0	171554.0	819.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1971	1220221.0	241595.9	5477.0	1150.0	6634.9	87.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1972	534623.2	721831.1	83884.0	7130.8	282.8	3933.4	121.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1973	162498.4	759314.0	328592.5	19699.4	763.7	24.4	1760.7	350.7	0.0	0.0	0.0	0.0	0.0	0.0
1974	549184.8	574344.8	627456.4	86769.1	5745.2	580.0	242.1	1389.0	8.4	0.0	0.0	0.0	0.0	8.4
1975	207941.5	606930.1	143758.9	53790.7	5024.5	582.0	85.8	0.0	100.9	9.3	0.0	0.0	0.0	110.1
1976	393246.9	329097.3	586648.6	74982.9	10621.8	1262.1	68.0	17.3	0.0	1.2	6.9	0.0	0.0	8.1
1977	638520.2	729817.1	212124.9	71956.3	8051.4	2229.8	731.8	14.7	0.0	0.0	0.0	0.0	0.0	0.0
1978	658650.9	351432.4	98589.9	49263.4	6064.1	615.9	252.3	14.3	0.0	0.0	0.0	0.0	0.0	0.0
1979	471797.6	133206.5	232265.8	42339.2	4560.8	1420.0	72.6	33.0	14.3	0.0	0.0	0.0	0.0	14.3
1980	329064.6	158500.2	102868.6	45108.2	8161.7	744.0	54.8	17.6	0.0	0.0	0.0	0.0	0.0	0.0
1981	515995.8	108251.8	180623.4	104766.5	16729.2	2793.3	112.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1982	82418.5	127997.5	40818.2	68241.9	10513.7	2448.3	902.4	2.3	0.0	0.0	0.0	0.0	0.0	0.0
1983	597587.1	42591.1	30788.6	17774.5	6723.3	1656.1	62.7	25.2	0.3	0.0	0.0	0.0	0.0	0.3
1984	141094.6	108431.1	30708.8	8867.8	3790.4	3577.0	90.7	0.4	0.0	0.0	0.0	0.0	0.0	0.1
1985	178224.5	46800.8	41730.6	9870.8	2522.2	684.9	283.5	25.8	0.0	0.0	0.0	0.0	0.0	0.0
1986	217206.7	159248.6	2086.0	14571.5	3987.3	1455.7	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0
1987	74862.8	97446.0	93703.8	17420.2	1722.1	1.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	395603.3	357861.3	158871.5	34204.6	4610.7	499.8	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.2
1989	80375.4	172438.3	108558.4	53491.1	12890.1	1841.9	1059.7	88.6	70.8	1.6	0.0	0.0	0.0	72.4
1990	139424.1	167308.1	205520.5	50508.4	12232.7	2511.3	342.1	26.3	1.9	0.0	0.0	0.0	0.0	1.9
1991	1028113.0	39958.8	70700.7	22061.9	5761.0	2684.2	743.4	78.1	0.0	0.0	0.0	0.0	0.0	0.0
1992	245785.8	131221.3	62571.2	14198.2	9854.5	812.0	304.9	49.0	5.6	0.0	0.0	0.0	0.0	5.6
1993	574041.6	87133.2	37152.8	10869.8	4036.8	775.9	437.4	27.2	0.0	0.0	0.0	0.0	0.0	0.0
1994	208584.6	68700.7	17670.0	7632.3	1191.9	358.6	221.5	64.3	14.3	0.0	0.0	0.0	0.0	14.3
1995	1538296.0	82439.3	33558.2	4350.6	771.8	76.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	89893.3	29648.0	5167.9	2643.1	967.7	20.9	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997	6485.3	27538.6	21820.4	4091.2	1075.0	276.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1998	64567.1	24370.3	6047.1	1394.6	754.4	62.7	12.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1999	63048.0	76776.5	12648.5	5342.1	1539.4	742.9	29.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2000	67.1	17534.8	16507.6	11436.2	6662.8	2133.7	585.9	73.6	0.0	0.0	0.0	0.0	0.0	0.0
2001	213973.1	44293.8	13033.8	9646.4	513.3	151.5	40.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2002	136326.4	38580.3	18936.8	8638.1	2185.9	205.0	121.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2003	57394.9	17525.3	5053.8	2580.2	1213.7	390.5	48.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2004	23808.2	12865.2	4513.5	1052.4	147.5	0.0	11.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2005	11926.2	10931.8	719.2	489.6	29.3	33.5	56.5	10.5	8.4	0.0	0.0	0.0	0.0	8.4

Table 12.2.8 Whiting in IV and VIId. Total catch mean weights at age (kg).

HC+Disc+IB	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1960	0.058	0.117	0.190	0.256	0.314	0.344	0.384	0.501	0.457	0.383	0.398	0.000	0.000	0.449
1961	0.042	0.119	0.193	0.259	0.303	0.412	0.420	0.493	0.386	0.468	0.475	0.000	0.000	0.442
1962	0.055	0.119	0.187	0.267	0.333	0.400	0.520	0.519	0.539	0.585	0.000	0.000	0.000	0.544
1963	0.049	0.112	0.195	0.272	0.353	0.412	0.472	0.820	0.626	0.499	0.610	0.000	0.000	0.613
1964	0.042	0.124	0.174	0.268	0.355	0.444	0.489	0.535	0.601	0.764	0.698	0.649	0.000	0.742
1965	0.058	0.124	0.209	0.242	0.332	0.421	0.499	0.542	0.635	1.256	0.614	0.000	0.000	0.642
1966	0.072	0.109	0.187	0.249	0.288	0.368	0.434	0.473	0.698	0.694	0.000	0.000	0.000	0.697
1967	0.062	0.118	0.199	0.269	0.332	0.340	0.425	0.495	0.626	0.621	0.486	0.000	0.000	0.622
1968	0.038	0.112	0.188	0.295	0.359	0.484	0.447	0.620	0.730	0.779	0.842	0.000	0.000	0.744
1969	0.043	0.097	0.173	0.262	0.363	0.415	0.419	0.535	0.670	0.787	1.236	0.000	0.000	0.677
1970	0.020	0.110	0.204	0.241	0.349	0.455	0.452	0.512	0.628	0.785	0.802	0.000	0.000	0.644
1971	0.036	0.116	0.219	0.286	0.319	0.433	0.531	0.637	0.560	0.728	0.729	0.000	0.000	0.682
1972	0.022	0.071	0.201	0.284	0.389	0.419	0.521	0.575	0.748	0.801	0.822	0.000	0.000	0.802
1973	0.027	0.084	0.166	0.278	0.372	0.439	0.463	0.552	0.738	0.860	0.846	0.000	0.000	0.777
1974	0.026	0.071	0.150	0.259	0.383	0.471	0.521	0.544	0.787	1.032	0.966	0.000	0.000	0.826
1975	0.030	0.100	0.215	0.278	0.376	0.470	0.356	0.817	0.595	0.713	1.022	0.000	0.000	0.607
1976	0.019	0.107	0.194	0.294	0.348	0.439	0.501	0.514	0.554	0.698	0.882	0.000	0.000	0.702
1977	0.022	0.117	0.210	0.319	0.399	0.444	0.462	0.547	0.440	0.694	0.491	0.941	0.000	0.475
1978	0.010	0.074	0.182	0.234	0.322	0.427	0.428	0.466	0.615	0.702	1.539	0.589	0.000	0.649
1979	0.009	0.098	0.166	0.259	0.301	0.411	0.455	0.492	0.578	0.617	0.737	0.515	0.000	0.582
1980	0.013	0.075	0.176	0.252	0.328	0.337	0.458	0.458	0.568	0.539	0.790	0.688	1.711	0.572
1981	0.011	0.083	0.168	0.242	0.321	0.379	0.411	0.444	0.651	0.833	1.041	0.695	0.000	0.720
1982	0.029	0.061	0.184	0.253	0.314	0.376	0.478	0.504	0.702	0.772	1.141	0.853	1.081	0.736
1983	0.015	0.107	0.191	0.273	0.325	0.384	0.426	0.452	0.520	0.677	0.516	0.000	0.000	0.537
1984	0.020	0.089	0.188	0.271	0.337	0.382	0.391	0.463	0.575	0.514	0.871	0.000	0.000	0.567
1985	0.014	0.094	0.192	0.284	0.332	0.402	0.435	0.494	0.426	0.507	0.852	0.976	0.000	0.438
1986	0.015	0.105	0.183	0.255	0.318	0.378	0.475	0.468	0.540	1.226	0.990	0.535	0.000	0.626
1987	0.013	0.077	0.148	0.247	0.297	0.375	0.379	0.542	0.555	0.857	0.603	1.193	0.000	0.584
1988	0.013	0.054	0.146	0.223	0.301	0.346	0.423	0.506	0.854	0.585	0.648	0.000	0.000	0.694
1989	0.023	0.070	0.157	0.225	0.267	0.318	0.391	0.431	0.369	0.517	0.857	0.609	0.000	0.394
1990	0.015	0.083	0.137	0.209	0.250	0.279	0.408	0.490	0.646	0.317	0.920	0.000	0.000	0.599
1991	0.017	0.103	0.169	0.218	0.290	0.307	0.338	0.365	0.385	0.589	0.993	2.756	0.000	0.401
1992	0.013	0.082	0.185	0.257	0.277	0.332	0.346	0.314	0.477	0.764	1.727	0.000	0.000	0.503
1993	0.012	0.073	0.175	0.252	0.319	0.329	0.349	0.403	0.378	0.418	0.359	0.000	0.000	0.380
1994	0.013	0.080	0.170	0.254	0.323	0.371	0.367	0.414	0.420	0.395	0.487	0.000	0.000	0.416
1995	0.010	0.087	0.181	0.258	0.341	0.385	0.430	0.434	0.446	0.347	0.406	0.000	0.000	0.420
1996	0.017	0.093	0.167	0.236	0.302	0.387	0.406	0.428	0.438	0.402	0.367	0.000	0.276	0.430
1997	0.026	0.091	0.178	0.243	0.295	0.333	0.381	0.381	0.390	0.476	0.451	0.000	0.000	0.418
1998	0.017	0.091	0.180	0.236	0.281	0.314	0.339	0.330	0.332	0.491	0.435	0.571	0.000	0.367
1999	0.022	0.076	0.174	0.233	0.256	0.289	0.303	0.309	0.282	0.310	0.323	0.000	0.000	0.287
2000	0.031	0.113	0.182	0.238	0.288	0.287	0.277	0.277	0.273	0.268	0.295	0.306	0.000	0.273
2001	0.010	0.072	0.191	0.227	0.283	0.270	0.300	0.287	0.288	0.303	0.315	0.495	0.000	0.294
2002	0.010	0.067	0.156	0.222	0.281	0.314	0.360	0.357	0.338	0.413	0.281	0.223	0.308	0.346
2003	0.012	0.053	0.114	0.195	0.260	0.298	0.352	0.383	0.340	0.454	0.618	0.000	0.000	0.365
2004	0.013	0.109	0.190	0.240	0.265	0.304	0.298	0.304	0.358	0.353	0.353	1.456	0.337	0.358
2005	0.017	0.090	0.186	0.233	0.245	0.280	0.298	0.300	0.285	0.449	0.314	0.337	0.670	0.295

Table 12.2.9 Whiting in IV and VIId. Human consumption landings mean weights at age (kg).

HC	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1960	0.127	0.179	0.200	0.248	0.298	0.346	0.384	0.501	0.457	0.383	0.398	0.000	0.000	0.449
1961	0.000	0.183	0.212	0.252	0.308	0.418	0.420	0.493	0.386	0.468	0.475	0.000	0.000	0.442
1962	0.159	0.187	0.222	0.277	0.338	0.406	0.526	0.520	0.542	0.585	0.000	0.000	0.000	0.547
1963	0.000	0.189	0.231	0.297	0.367	0.419	0.472	0.820	0.626	0.499	0.610	0.000	0.000	0.613
1964	0.127	0.199	0.215	0.287	0.368	0.455	0.499	0.539	0.601	0.764	0.698	0.649	0.000	0.742
1965	0.000	0.193	0.235	0.258	0.338	0.423	0.503	0.541	0.635	1.256	0.614	0.000	0.000	0.642
1966	0.141	0.196	0.226	0.250	0.294	0.369	0.440	0.471	0.747	0.694	0.000	0.000	0.000	0.730
1967	0.000	0.190	0.230	0.277	0.335	0.342	0.423	0.493	0.631	0.621	0.486	0.000	0.000	0.626
1968	0.000	0.200	0.238	0.322	0.376	0.496	0.448	0.620	0.730	0.779	0.842	0.000	0.000	0.744
1969	0.000	0.137	0.222	0.296	0.394	0.443	0.503	0.535	0.670	0.787	1.236	0.000	0.000	0.677
1970	0.000	0.217	0.236	0.268	0.359	0.464	0.455	0.511	0.628	0.785	0.802	0.000	0.000	0.644
1971	0.127	0.221	0.261	0.309	0.333	0.440	0.533	0.637	0.560	0.728	0.729	0.000	0.000	0.682
1972	0.000	0.204	0.258	0.321	0.403	0.438	0.528	0.575	0.748	0.801	0.822	0.000	0.000	0.802
1973	0.000	0.199	0.239	0.312	0.381	0.440	0.479	0.597	0.738	0.860	0.846	0.000	0.000	0.777
1974	0.193	0.217	0.249	0.323	0.424	0.505	0.548	0.589	0.798	1.032	0.966	0.000	0.000	0.836
1975	0.000	0.244	0.270	0.313	0.386	0.473	0.352	0.817	0.597	0.729	1.022	0.000	0.000	0.610
1976	0.000	0.214	0.251	0.310	0.349	0.450	0.496	0.510	0.554	0.697	0.895	0.000	0.000	0.700
1977	0.180	0.208	0.214	0.286	0.380	0.418	0.463	0.548	0.440	0.694	0.491	0.941	0.000	0.475
1978	0.000	0.185	0.233	0.250	0.334	0.426	0.434	0.466	0.615	0.702	1.539	0.589	0.000	0.649
1979	0.113	0.206	0.231	0.277	0.304	0.416	0.456	0.491	0.583	0.617	0.737	0.515	0.000	0.587
1980	0.000	0.204	0.239	0.273	0.335	0.358	0.473	0.457	0.568	0.539	0.790	0.688	1.711	0.572
1981	0.144	0.194	0.242	0.292	0.331	0.378	0.411	0.445	0.651	0.833	1.041	0.695	0.000	0.720
1982	0.000	0.186	0.230	0.282	0.340	0.396	0.461	0.507	0.702	0.772	1.141	0.853	1.081	0.736
1983	0.132	0.199	0.240	0.282	0.332	0.383	0.429	0.452	0.522	0.677	0.516	0.000	0.000	0.538
1984	0.000	0.194	0.231	0.279	0.346	0.391	0.403	0.472	0.575	0.514	0.871	0.000	0.000	0.567
1985	0.137	0.187	0.248	0.307	0.337	0.408	0.443	0.498	0.426	0.507	0.852	0.976	0.000	0.438
1986	0.131	0.189	0.230	0.279	0.327	0.376	0.484	0.472	0.546	1.226	0.990	0.535	0.000	0.632
1987	0.135	0.188	0.226	0.286	0.310	0.381	0.381	0.542	0.564	0.857	0.603	1.193	0.000	0.593
1988	0.117	0.194	0.226	0.256	0.328	0.351	0.425	0.506	0.887	0.585	0.648	0.000	0.000	0.702
1989	0.171	0.178	0.226	0.253	0.288	0.345	0.370	0.440	0.373	0.522	0.857	0.609	0.000	0.405
1990	0.167	0.201	0.220	0.260	0.292	0.335	0.449	0.522	0.650	0.317	0.920	0.000	0.000	0.601
1991	0.139	0.204	0.250	0.252	0.309	0.318	0.349	0.388	0.385	0.589	0.993	2.756	0.000	0.401
1992	0.146	0.195	0.248	0.290	0.307	0.342	0.358	0.383	0.474	0.764	1.727	0.000	0.000	0.503
1993	0.153	0.195	0.251	0.287	0.348	0.359	0.388	0.422	0.378	0.418	0.359	0.000	0.000	0.380
1994	0.132	0.184	0.250	0.297	0.345	0.393	0.382	0.413	0.415	0.395	0.487	0.000	0.000	0.412
1995	0.140	0.172	0.255	0.298	0.367	0.398	0.437	0.437	0.449	0.347	0.406	0.000	0.000	0.422
1996	0.143	0.170	0.222	0.274	0.328	0.407	0.413	0.448	0.438	0.402	0.367	0.000	0.276	0.430
1997	0.150	0.171	0.207	0.261	0.314	0.348	0.398	0.381	0.394	0.476	0.429	0.000	0.000	0.421
1998	0.139	0.164	0.209	0.259	0.304	0.330	0.360	0.344	0.388	0.500	0.603	0.571	0.000	0.424
1999	0.135	0.184	0.237	0.270	0.280	0.302	0.314	0.317	0.287	0.359	0.323	0.000	0.000	0.295
2000	0.049	0.166	0.226	0.271	0.300	0.292	0.315	0.278	0.274	0.268	0.295	0.306	0.000	0.274
2001	0.138	0.160	0.217	0.268	0.286	0.269	0.303	0.291	0.289	0.303	0.315	0.495	0.000	0.294
2002	0.000	0.199	0.223	0.269	0.304	0.325	0.376	0.365	0.339	0.390	0.301	0.223	0.308	0.344
2003	0.128	0.209	0.239	0.263	0.309	0.310	0.373	0.389	0.340	0.454	0.618	0.000	0.000	0.366
2004	0.000	0.210	0.221	0.250	0.295	0.333	0.335	0.339	0.373	0.353	0.353	1.456	0.337	0.368
2005	0.166	0.208	0.247	0.275	0.267	0.311	0.338	0.320	0.339	0.496	0.314	0.337	0.670	0.348

Table 12.2.10 Whiting in IV and VIId. Discard mean weights at age (kg), representing North Sea discards only.

Disc	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1960	0.06	0.117	0.188	0.262	0.342	0.317	0.45	0.74	0	0	0	0	0	0.000
1961	0.058	0.116	0.189	0.264	0.271	0.367	0.411	0	0	0	0	0	0	0.000
1962	0.084	0.116	0.169	0.255	0.33	0.35	0.474	0.74	0	0	0	0	0	0.000
1963	0.098	0.139	0.196	0.25	0.329	0.383	0.452	0	0	0	0	0	0	0.000
1964	0.069	0.143	0.168	0.241	0.302	0.377	0.493	0.74	0	0	0	0	0	0.000
1965	0.074	0.121	0.203	0.212	0.305	0.358	0.495	0.74	0	0	0	0	0	0.000
1966	0.09	0.118	0.188	0.259	0.249	0.374	0.463	0.74	0	0	0	0	0	0.000
1967	0.082	0.113	0.182	0.257	0.332	0.295	0.479	0.74	0	0	0	0	0	0.000
1968	0.097	0.123	0.177	0.264	0.318	0.422	0.342	0.649	0	0	0	0	0	0.000
1969	0.097	0.104	0.187	0.256	0.328	0.369	0.427	0.617	0	0	0	0	0	0.000
1970	0.064	0.142	0.192	0.237	0.301	0.377	0.419	0.525	0	0	0	0	0	0.000
1971	0.076	0.118	0.2	0.248	0.262	0.382	0.455	0.622	0	0	0	0	0	0.000
1972	0.076	0.137	0.205	0.26	0.331	0.321	0.464	0	0	0	0	0	0	0.000
1973	0.067	0.139	0.195	0.257	0.306	0.43	0.478	0.685	0	0	0	0	0	0.000
1974	0.12	0.133	0.196	0.248	0.331	0.404	0.653	0.568	0	0	0	0	0	0.000
1975	0.1	0.161	0.216	0.252	0.303	0.417	0.607	0	0	0	0	0	0	0.000
1976	0.099	0.158	0.228	0.297	0.324	0.431	0.542	0	0	0	0	0	0	0.000
1977	0.162	0.293	0.278	0.406	0.544	0.575	1.11	0	0	0	0	0	0	0.000
1978	0.036	0.145	0.158	0.185	0.209	0.222	0.239	0	0	0	0	0	0	0.000
1979	0.08	0.104	0.158	0.191	0.189	0.234	0.265	0.295	0	0	0	0	0	0.000
1980	0.03	0.107	0.166	0.202	0.244	0.253	0.264	0	0	0	0	0	0	0.000
1981	0.071	0.131	0.164	0.197	0.23	0.289	0.252	0.268	0	0	0	0	0	0.000
1982	0.047	0.091	0.182	0.211	0.225	0.241	0.244	0.261	0	0	0	0	0	0.000
1983	0.036	0.114	0.167	0.235	0.264	0.29	0.317	0.277	0.365	0	0	0	0	0.365
1984	0.038	0.101	0.162	0.216	0.246	0.265	0.248	0.278	0	0	0	0	0	0.000
1985	0.022	0.105	0.169	0.213	0.238	0.242	0.253	0.255	0	0	0	0	0	0.000
1986	0.028	0.123	0.166	0.19	0.208	0.227	0.194	0.217	0.311	0	0	0	0	0.311
1987	0.016	0.09	0.149	0.206	0.205	0.263	0.257	0	0.292	0	0	0	0	0.292
1988	0.03	0.063	0.146	0.181	0.21	0.219	0.235	0	0.284	0	0	0	0	0.284
1989	0.033	0.083	0.164	0.191	0.213	0.227	0.241	0.351	0.221	0	0	0	0	0.221
1990	0.024	0.095	0.13	0.183	0.186	0.196	0.249	0.302	0	0	0	0	0	0.000
1991	0.041	0.089	0.154	0.177	0.213	0.23	0.253	0.268	0	0	0	0	0	0.000
1992	0.037	0.093	0.173	0.21	0.215	0.241	0.245	0.22	1.183	0	0	0	0	1.183
1993	0.023	0.087	0.16	0.205	0.237	0.235	0.225	0.213	0	0	0	0	0	0.000
1994	0.04	0.09	0.151	0.203	0.23	0.244	0.254	0.332	0	0	0	0	0	0.000
1995	0.032	0.102	0.163	0.204	0.233	0.247	0.247	0.332	0.29	0	0	0	0	0.290
1996	0.031	0.094	0.151	0.198	0.225	0.281	0.265	0.304	0	0	0	0	0	0.000
1997	0.031	0.125	0.181	0.213	0.225	0.233	0.256	0.617	0.32	0.601	0.773	0	0	0.352
1998	0.026	0.086	0.173	0.204	0.228	0.234	0.224	0.247	0.191	0.18	0.284	0	0	0.206
1999	0.062	0.1	0.166	0.197	0.201	0.225	0.231	0.212	0.231	0.22	0	0	0	0.227
2000	0.033	0.127	0.167	0.195	0.226	0.209	0.219	0.222	0.264	0.000	0.000	0	0	0.264
2001	0.023	0.084	0.183	0.217	0.259	0.248	0.240	0.225	0.243	0.000	0.000	0	0	0.243
2002	0.039	0.130	0.167	0.196	0.224	0.224	0.225	0.272	0.334	1.120	0.218	0	0	0.352
2003	0.048	0.057	0.098	0.169	0.215	0.262	0.257	0.293	0.237	0.000	0.000	0	0	0.055
2004	0.044	0.178	0.233	0.240	0.232	0.257	0.241	0.246	0.204	0.351	0.000	0.000	0.000	0.245
2005	0.049	0.110	0.175	0.208	0.217	0.223	0.235	0.246	0.223	0.293	0.000	0.000	0.000	0.225

Table 12.2.11 Whiting in IV and VIId. Industrial bycatch mean weights at age (kg).

IB	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1960	0.054	0.107	0.179	0.203	0.233	0.251	0.292	0	0	0	0	0	0	0.000
1961	0.035	0.121	0.157	0.202	0.276	0	0.315	0	0	0	0	0	0	0.000
1962	0.047	0.111	0.193	0.23	0.242	0.285	0.354	0.389	0.402	0	0	0	0	0.402
1963	0.027	0.089	0.149	0.199	0.246	0.289	0	0	0	0	0	0	0	0.000
1964	0.04	0.094	0.141	0.21	0.243	0.267	0.196	0.24	0	0	0	0	0	0.000
1965	0.048	0.124	0.188	0.217	0.314	0.464	0.392	0	0	0	0	0	0	0.000
1966	0.034	0.097	0.167	0.233	0.245	0.313	0.262	0	0.435	0	0	0	0	0.435
1967	0.056	0.135	0.234	0.279	0.293	0.345	0.429	0.472	0.488	0	0	0	0	0.488
1968	0.028	0.092	0.154	0.205	0.253	0.297	0	0	0	0	0	0	0	0.000
1969	0.041	0.096	0.145	0.215	0.249	0.274	0.201	0.246	0	0	0	0	0	0.000
1970	0.019	0.103	0.206	0.213	0.166	0	0	0	0	0	0	0	0	0.000
1971	0.036	0.103	0.199	0.199	0.232	0.328	0	0	0	0	0	0	0	0.000
1972	0.02	0.05	0.144	0.178	0.234	0.238	0.257	0	0	0	0	0	0	0.000
1973	0.024	0.053	0.123	0.21	0.355	0.297	0.309	0.269	0	0	0	0	0	0.000
1974	0.022	0.049	0.113	0.193	0.276	0.304	0.402	0.401	0.333	0	0	0	0	0.333
1975	0.02	0.063	0.192	0.255	0.422	0.52	0.555	0	0.573	0.493	0	0	0	0.566
1976	0.013	0.082	0.157	0.28	0.369	0.325	0.67	0.601	0	1.076	0.842	0	0	0.875
1977	0.016	0.052	0.149	0.299	0.394	0.585	0.41	0.52	0	0	0	0	0	0.000
1978	0.009	0.059	0.158	0.22	0.295	0.529	0.351	0.449	0	0	0	0	0	0.000
1979	0.008	0.069	0.141	0.249	0.428	0.477	0.467	0.605	0.482	0	0	0	0	0.482
1980	0.013	0.051	0.164	0.281	0.412	0.38	0.389	0.561	0	1	0	0	0	1.000
1981	0.011	0.056	0.141	0.218	0.318	0.433	0.596	0.6	0.8	0	0	0	0	0.800
1982	0.025	0.038	0.133	0.232	0.32	0.366	0.674	0.284	0.8	1	1.2	0	0	0.840
1983	0.012	0.058	0.148	0.311	0.431	0.651	0.565	0.602	0.8	1	0	0	0	0.802
1984	0.018	0.053	0.173	0.289	0.343	0.39	0.228	0.6	0.8	1	0	0	0	0.896
1985	0.014	0.054	0.15	0.263	0.382	0.454	0.504	0.584	0.8	1	0	0	0	0.809
1986	0.014	0.054	0.15	0.262	0.381	0.455	0.5	0.6	0.8	0	0	0	0	0.800
1987	0.012	0.043	0.085	0.173	0.262	0.4	0.5	0.6	0.8	1	0	0	0	0.822
1988	0.012	0.05	0.115	0.197	0.245	0.38	0.5	0.6	0.8	0	0	0	0	0.800
1989	0.022	0.053	0.137	0.224	0.285	0.344	0.482	0.396	0.385	0.401	0	0	0	0.385
1990	0.006	0.073	0.123	0.181	0.199	0.28	0.355	0.335	0.473	0	0	0	0	0.473
1991	0.017	0.101	0.136	0.213	0.269	0.265	0.279	0.322	0	0	0	0	0	0.000
1992	0.012	0.066	0.15	0.228	0.242	0.335	0.219	0.255	0.282	0	0	0	0	0.282
1993	0.011	0.044	0.155	0.259	0.264	0.308	0.235	0.392	0	0	0	0	0	0.000
1994	0.012	0.042	0.132	0.242	0.374	0.521	0.555	0.44	0.555	0	0	0	0	0.555
1995	0.009	0.069	0.159	0.31	0.373	0.511	0	0	0	0	0	0	0	0.000
1996	0.015	0.059	0.143	0.235	0.233	0.347	0.25	0	0	0	0	0	0	0.000
1997	0.007	0.048	0.144	0.25	0.321	0.348	0.588	0	0	0	0	0	0	0.000
1998	0.014	0.045	0.105	0.2	0.304	0.286	0	0	0	0	0	0	0	0.000
1999	0.013	0.027	0.077	0.146	0.196	0.286	0	0	0	0	0	0	0	0.000
2000	0	0.041	0.164	0.242	0.289	0.339	0	0.588	0	0	0	0	0	0.000
2001	0.009	0.040	0.164	0.132	0.320	0.351	0.386	0	0	0	0	0	0	0.000
2002	0.010	0.044	0.101	0.184	0.293	0.415	0.38	0	0	0	0	0	0	0.000
2003	0.010	0.035	0.101	0.189	0.302	0.418	0.4618195	0	0	0	0	0	0	0.000
2004	0.010	0.032	0.083	0.143	0.264	0.000	0.380	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2005	0.014	0.043	0.133	0.196	0.205	0.366	0.438	0.541	0.530	0.000	0.000	0.000	0.000	0.530

Table 12.2.12 Whiting in IV and VIId. Complete available tuning series. Data used in assessment is highlighted in bold.

SCOSEI IV	effort	0	1	2	3	4	5	6	7	8	9	10
1978	325246	5346	14994	29308	43711	15390	1058	1409	201	36	0	7
1979	316419	302	90750	41092	28124	14745	6084	677	156	3	0	0
1980	297227	669	27032	73704	37658	11915	9368	2556	260	229	27	7
1981	289672	93	8727	22244	25048	10552	2402	2084	374	41	4	1
1982	297730	43	3721	7032	26194	13117	2713	539	277	81	5	0
1983	333168	572	11565	14957	21690	34199	9831	2155	407	158	16	0
1984	388035	297	4923	24016	20670	14986	21269	4715	960	87	50	7
1985	381647	773	20068	20263	19696	8956	4796	8013	1363	334	18	6
1986	425017	138	139498	48705	34509	11341	2624	1098	1771	216	7	0
1987	418536	1359	13793	52715	38939	18440	3638	1097	298	348	16	4
1988	377132	26	2502	28446	44869	12631	4072	679	64	21	17	2
1989	355735	10	6879	15704	41407	23710	4769	1323	112	43	11	1
1990	252732	185	14230	124636	27694	29921	14768	721	207	23	0	0
1991	336675	887	11952	44964	63414	10436	8730	1743	195	94	0	0
1992	300217	426	16614	19452	21217	27962	2805	1958	565	32	3	0
1993	268413	600	9564	31623	26013	12458	14446	899	332	153	8	8
1994	264738	83	9236	21452	22571	11778	5531	5612	204	116	15	0
1995	204545	26	8288	22153	30007	9019	3875	1373	1270	86	15	18
1996	177092	224	5732	26021	21430	10506	3483	1031	296	289	28	1
1997	166817	176	6628	8974	16231	9922	4445	575	110	62	37	2
1998	150361	14	3711	4695	6806	6840	3670	1417	244	13	2	12
1999	93796	663	13384	13750	7009	6068	3462	1684	409	77	3	0
2000	69505	3	5176	11208	6458	2112	1972	836	298	90	7	0
2001	36135	930	607	6352	5592	1715	486	353	146	66	11	0
2002	21830	2	1017	3349	7716	2182	363	140	79	23	6	0
2003	15371	5	388	1089	2514	2980	1046	256	30	17	5	1
2004	15663	0	282	689	1912	2003	1711	456	108	16	4	0
2005	16149	63	1131	1889	994	1638	1852	1035	362	41	1	0

SCOLTR IV	effort	0	1	2	3	4	5	6	7	8	9	10
1978	236944	7158	8785	19910	30722	14473	956	1612	635	72	6	0
1979	287494	368	171147	42910	23155	17996	4058	377	286	57	5	0
1980	333197	869	20806	58382	38436	9525	9430	1864	144	145	3	0
1981	251504	171	6576	19069	21550	9706	1777	1455	310	9	1	0
1982	250870	6390	5214	8197	26681	12945	3334	647	339	74	16	3
1983	244349	20191	37496	17926	12535	19234	6124	1217	183	141	26	1
1984	240775	2553	38267	16048	10784	6307	9019	2371	479	13	30	5
1985	267393	1222	28761	9368	7617	3086	1333	2901	443	173	14	0
1986	279727	797	8138	8572	9578	4109	767	425	609	52	2	0
1987	351131	600	18761	25933	16161	5954	1183	388	116	129	4	0
1988	391988	60	2398	15779	22526	5128	1641	207	31	15	6	6
1989	405883	492	20319	10052	21390	10837	2394	448	33	54	2	1
1990	371493	371	3677	35322	7665	8960	3423	160	40	5	0	0
1991	408056	688	8727	11908	22146	3192	2906	629	50	41	0	0
1992	473955	1379	17581	14551	11823	15418	1500	1160	304	13	0	1
1993	447064	614	16439	20513	14386	6591	10105	574	204	97	24	5
1994	480400	1259	4133	15771	13005	6454	2710	2997	172	84	14	0
1995	442010	208	9248	15887	19322	6262	2983	1092	1132	89	3	14
1996	445995	188	6662	12461	13523	9223	3012	861	282	243	9	1
1997	479449	100	2557	6768	15603	9464	4535	628	181	52	31	0
1998	427868	39	5096	5350	8058	9507	4312	1729	276	58	12	3
1999	329750	1274	26519	20672	9295	6706	4080	2051	487	41	7	0
2000	280938	1	8385	16220	9287	3788	2621	1470	602	79	7	0
2001	245489	2222	1303	11409	10419	3287	745	431	247	66	27	0
2002	184099	6	980	4653	11067	3686	818	221	180	60	13	0
2003	98721	13	871	1639	3986	5136	2080	286	73	59	7	5
2004	63953	0	224	1088	2225	2463	2168	669	123	18	15	1
2005	54905	80	954	2414	1236	1448	1901	831	251	26	2	0

Table 12.2.12 (cont'd) Whiting in IV and VIId. Complete available tuning series.

FRATRB IV	effort	1	2	3	4	5	6	7	8	9
1978	69739	1153	10312	14789	8544	807	1091	227	34	4
1979	89974	698	12272	14379	10884	3789	394	315	45	14
1980	63577	90	5388	11298	4605	4051	1004	78	71	10
1981	76517	144	6591	13139	8196	2090	1644	314	16	10
1982	78523	173	1643	16561	11241	3948	1035	539	119	14
1983	69720	500	4407	8188	16698	5541	1061	228	126	19
1984	76149	317	4281	7465	4576	5999	1596	308	32	26
1985	25915	315	3653	2942	1225	566	599	117	12	4
1986	28611	891	3830	3991	1202	369	94	160	22	1
1987	28692	431	4823	3667	2152	497	166	48	46	3
1988	25208	150	2718	4815	1125	530	100	31	3	4
1989	25184	448	2064	4351	1877	314	106	10	4	1
1990	21758	164	3794	2124	2010	620	55	13	1	0
1991	19840	292	2224	3829	819	657	138	15	3	0
1992	15656	365	1598	1686	2204	248	195	44	3	0
1993	19076	173	1225	2633	1141	1233	97	37	14	4
1994	17315	108	1806	1721	1466	413	430	29	8	1
1995	17794	114	1023	3304	1537	1163	240	212	14	7
1996	18883	21	655	1594	1438	482	199	38	30	10
1997	15574	40	357	1407	1139	606	86	16	10	2
1998	14949	31.876	125.79	316.615	326.182	191.966	62.826	7.943	2.306	1.191
1999	-9	95.725	489.82	489.298	683.822	451.527	239.347	58.668	13.88	1.208
2000	11747	47.2489	1148.44	2968.16	1204.67	319.601	298.195	124.422	53.5917	5.26778
2001	6771	297.733	648.675	528.066	149.798	36.4882	35.6206	13.5305	6.27816	2.107

FRATRO 7D	effort	0	1	2	3	4	5	6	7	8
1986	56099	19.48	1541.94	1891.94	7145.98	3782.82	599.91	157.52	39.03	2.14
1987	71765	12.20	2507.72	4984.96	1271.29	5713.14	412.56	257.90	91.79	69.82
1988	84052	0.31	2536.92	8981.89	3222.83	704.34	1320.59	122.85	55.31	0.54
1989	88397	26.94	2958.16	3739.55	5628.95	1654.27	208.58	280.47	47.27	10.86
1990	71750	37.70	3209.61	6169.85	3780.85	2456.12	365.14	28.65	43.61	1.65
1991	67836	323.02	4464.91	6083.87	2864.37	1412.45	776.93	84.61	5.78	2.53
1992	51340	355.02	3426.92	6498.04	1939.69	635.38	358.08	96.22	4.78	0.12
1993	62553	937.84	3950.46	4586.36	4306.75	877.04	289.87	68.31	39.73	6.21
1994	51241	86.53	7005.88	3298.43	1190.63	612.13	108.28	11.05	8.38	0.98
1995	57823	262.76	6331.03	6125.08	2673.85	543.82	98.58	19.19	0.03	1.79
1996	50163	577.46	5522.73	4742.85	3214.22	890.19	155.83	7.73	12.12	0.03
1997	48904	266.77	1961.14	4676.60	3929.12	1020.11	220.78	18.01	3.07	0.02
1998	38103	566.68	4893.44	1959.25	532.61	161.28	68.00	35.86	0.39	1.55
1999	-	51.18	7651.96	2885.69	1452.71	960.37	500.08	133.31	45.54	30.71
2000	30082	129.16	7366.57	8191.31	2452.95	1056.07	737.31	454.67	345.11	94.79
2001	50846	3357.15	10766.56	15475.91	6922.60	3226.67	1700.58	637.70	344.65	127.90
2002	2002 French data not broken down by gear - given as "all gears"									
2003	52609	625.48	9276.84	16879.91	7857.03	5528.14	1701.23	188.34	18.53	23.06
2004	21074	0.00	937.63	366.50	918.84	946.50	743.29	255.68	35.66	4.22
2005	23683	0.00	1037.25	1664.79	385.90	177.88	149.11	103.27	51.52	14.15

Table 12.2.12 (cont'd) Whiting in IV and VIId. Complete available tuning series.

SCOGFS I	effort	0	1	2	3	4	5	6	7	8
1982	100	102	**653**	**971**	**972**	**224**	**60**	**16**	3	+
1983	100	210	**563**	**578**	**407**	**511**	**116**	**17**	3	5
1984	100	442	**1048**	**371**	**170**	**77**	**92**	**18**	5	+
1985	100	169	**1577**	**973**	**247**	**63**	**36**	**18**	10	+
1986	100	406	**1111**	**452**	**224**	**27**	**5**	**5**	1	0
1987	100	120	**1405**	**1150**	**208**	**77**	**16**	**3**	+	+
1988	100	642	**967**	**1606**	**452**	**70**	**19**	**2**	0	2
1989	100	427	**4043**	**741**	**733**	**157**	**13**	**6**	1	0
1990	100	1943	**2239**	**2053**	**248**	**255**	**47**	**5**	1	1
1991	100	1379	**1769**	**950**	**759**	**51**	**40**	**9**	+	0
1992	100	2417	**2925**	**1267**	**553**	**585**	**47**	**26**	5	0
1993	100	247	**3169**	**1168**	**423**	**156**	**182**	**6**	11	+
1994	100	648	**2635**	**950**	**254**	**57**	**34**	**23**	+	1
1995	100	1243	**4176**	**2010**	**903**	**196**	**58**	**22**	15	3
1996	100	440	**2888**	**3047**	**1215**	**460**	**43**	**15**	22	9
1997	100	317	**1824**	**1434**	**1191**	**319**	**122**	**17**	8	+

SCOGFS II	effort	0	1	2	3	4	5	6	7	8
1998	100	12302	**4141**	**1285**	**649**	**321**	**131**	**62**	5	3
1999	100	15276	**5410**	**2090**	**615**	**329**	**129**	**58**	12	0
2000	100	17076	**6646**	**3329**	**676**	**202**	**130**	**81**	16	5
2001	100	117	**3499**	**2451**	**844**	**207**	**51**	**48**	18	9
2002	100	1606	**4980**	**2422**	**1608**	**724**	**94**	**44**	12	14
2003	100	5393	**1891**	**1433**	**1211**	**823**	**276**	**36**	9	6
2004	100	2553	**2580**	**440**	**583**	**566**	**408**	**96**	19	6
2005	100	1818	**1139**	**830**	**249**	**336**	**236**	**203**	37	4

Table 12.2.12 (cont'd) **Whiting in IV and VIId. Complete available tuning series.**

ENGFS I	effort	0	1	2	3	4	5	6
1977	100	**28.43**	**21.95**	**7.44**	**1.11**	**0.22**	**0.09**	**0.08**
1978	100	**18.44**	**24.71**	**5.15**	**1.06**	**0.34**	**0.05**	**0.02**
1979	100	**35.48**	**20.06**	**7.12**	**1.90**	**0.84**	**0.06**	**0.03**
1980	100	**19.90**	**35.33**	**12.51**	**4.81**	**1.20**	**0.31**	**0.06**
1981	100	**34.94**	**18.31**	**28.80**	**16.05**	**0.62**	**0.62**	**0.08**
1982	100	**6.93**	**27.72**	**7.93**	**8.59**	**2.22**	**0.34**	**0.05**
1983	100	**71.67**	**11.85**	**10.80**	**1.91**	**1.70**	**0.24**	**0.07**
1984	100	**17.25**	**50.61**	**10.82**	**3.01**	**0.89**	**0.77**	**0.38**
1985	100	**19.99**	**15.88**	**17.04**	**1.67**	**0.98**	**0.18**	**0.15**
1986	100	**16.33**	**15.16**	**6.59**	**3.85**	**0.41**	**0.10**	**0.01**
1987	100	**13.73**	**22.76**	**13.04**	**2.69**	**2.01**	**0.35**	**0.12**
1988	100	**38.17**	**18.81**	**13.16**	**4.55**	**0.64**	**0.17**	**0.02**
1989	100	**116.95**	**29.47**	**11.76**	**7.69**	**1.67**	**0.34**	**0.02**
1990	100	**87.53**	**19.01**	**12.84**	**3.85**	**2.32**	**0.33**	**0.05**
1991	100	**16.73**	**33.30**	**7.67**	**3.82**	**1.09**	**0.37**	**0.04**

ENGFS II	effort	0	1	2	3	4	5	6
1992	100	**45.50**	**26.55**	**13.07**	**3.05**	**2.61**	**0.49**	**0.59**
1993	100	**25.24**	**25.10**	**9.63**	**3.75**	**1.16**	**0.74**	**0.19**
1994	100	**21.14**	**30.55**	**10.59**	**2.44**	**1.12**	**0.33**	**0.11**
1995	100	**36.28**	**35.51**	**23.74**	**7.36**	**1.87**	**0.25**	**0.14**
1996	100	**9.92**	**18.84**	**10.93**	**6.03**	**1.36**	**0.27**	**0.12**
1997	100	**48.97**	**15.47**	**8.71**	**7.51**	**2.27**	**0.86**	**0.48**
1998	100	**158.81**	**17.71**	**11.53**	**2.92**	**2.36**	**0.89**	**0.16**
1999	100	**105.79**	**44.57**	**10.01**	**3.76**	**1.43**	**0.78**	**0.16**
2000	100	**70.27**	**60.17**	**18.59**	**3.55**	**0.95**	**0.51**	**0.20**
2001	100	**99.90**	**54.45**	**14.71**	**5.08**	**1.26**	**0.33**	**0.38**
2002	100	**5.32**	**62.57**	**17.97**	**8.01**	**2.45**	**0.27**	**0.06**
2003	100	**0.00**	**15.00**	**6.80**	**13.04**	**9.32**	**2.02**	**0.38**
2004	100	**0**	**63.96**	**5.8**	**4**	**6.08**	**2.77**	**1.37**
2005	100	**7.15**	**12.57**	**3.83**	**2.55**	**5**	**5.57**	**2.16**

Table 12.2.12 (cont'd) Whiting in IV and VIId. Complete available tuning series.

IBTS Q1	effort	0	1	2	3	4	5
1983	100	**126.62**	**125.03**	**110.00**	**76.43**	**32.20**	**6.08**
1984	100	**434.49**	**177.97**	**88.98**	**30.26**	**25.36**	**10.46**
1985	100	**339.18**	**362.26**	**65.85**	**18.64**	**7.14**	**7.38**
1986	100	**468.74**	**268.27**	**194.65**	**32.12**	**6.60**	**3.85**
1987	100	**684.90**	**561.08**	**90.44**	**45.50**	**4.90**	**1.91**
1988	100	**447.99**	**865.72**	**314.31**	**32.98**	**12.61**	**1.32**
1989	100	**1446.08**	**538.56**	**414.76**	**109.90**	**12.05**	**5.09**
1990	100	**518.94**	**862.35**	**198.16**	**91.61**	**16.94**	**3.67**
1991	100	**1007.62**	**686.45**	**479.62**	**70.95**	**37.64**	**7.59**
1992	100	**907.30**	**665.71**	**240.16**	**150.83**	**12.67**	**13.93**
1993	100	**1075.62**	**522.81**	**244.59**	**65.49**	**59.02**	**11.44**
1994	100	**721.71**	**627.41**	**181.02**	**68.08**	**11.86**	**9.11**
1995	100	**678.59**	**448.48**	**239.45**	**58.07**	**11.87**	**5.58**
1996	100	**502.36**	**485.97**	**244.70**	**69.74**	**23.09**	**9.85**
1997	100	**287.73**	**342.21**	**162.52**	**60.43**	**18.01**	**9.18**
1998	100	**543.12**	**160.70**	**125.38**	**54.05**	**15.50**	**9.26**
1999	100	**676.27**	**305.45**	**94.68**	**57.45**	**25.83**	**11.08**
2000	100	**756.87**	**537.86**	**182.22**	**53.07**	**20.02**	**14.74**
2001	100	**648.65**	**598.39**	**299.18**	**98.32**	**25.72**	**26.16**
2002	100	**670.59**	**416.82**	**275.25**	**66.63**	**22.11**	**10.41**
2003	100	**131.60**	**298.87**	**237.01**	**133.36**	**48.37**	**12.63**
2004	100	**184.58**	**90.95**	**170.60**	**98.99**	**50.25**	**23.14**
2005	100	**167.63**	**55.97**	**31.48**	**56.39**	**37.85**	**29.36**
2006	100	**223.01**	**92.38**	**32.56**	**16.54**	**28.25**	**27.14**

Table 12.2.12 (cont'd) Whiting in IV and VIId. Complete available tuning series.

FRATRO_7D	effort	0	1	2	3	4	5	6
1986	257794	2586.59	2249.77	7740.58	4462.98	804.35	198.40	19.35
1987	188236	1954.81	5050.15	907.04	4606.14	331.43	218.34	53.97
1988	215422	2233.10	7957.35	2551.70	536.69	1192.83	127.34	61.15
1989	320383	2577.84	3916.35	6005.56	1489.83	216.08	342.97	50.48
1990	257120	2491.70	5240.14	3362.65	2168.19	251.50	29.80	51.08
1991	294594	4009.06	8176.54	3984.56	2625.40	1474.03	155.42	10.50
1992	285718	5732.56	10924.16	3241.05	881.71	587.01	171.40	3.38
1993	283999	3158.34	6542.83	8606.51	1676.81	442.49	123.89	79.06
1994	286019	13931.57	7979.57	3268.93	1776.04	443.66	40.33	20.73
1995	268151	6301.32	8449.94	5260.61	1217.42	263.53	62.53	8.18
1996	274495	6140.12	6465.75	5465.37	1622.56	324.48	47.21	14.16
1997	282216	3320.15	8143.54	6607.75	1974.21	450.88	58.75	8.43
1998	291360	9921.00	6863.22	2384.88	781.09	264.61	104.76	15.31
1999	-	5536.90	5976.23	2822.66	1672.18	702.49	343.31	69.31
2000	215553	7096.32	7026.28	1733.97	1724.37	1374.95	876.77	674.78
2001	163848	89.05	6101.35	10124.09	3975.55	2563.21	2302.84	1039.71
2002	192589	985.42	1922.07	6247.38	6475.65	2269.58	461.30	463.12
2003	296717	154.90	6896.37	5488.74	5551.26	2397.47	311.73	64.69
2004	89127	1830.97	705.87	2311.74	2945.43	2611.11	901.64	109.43
2005	108369	5813.26	3730.23	792.61	812.53	719.75	509.52	261.95

FRAGFS_7D	effort	0	1	2	3
1988	27	24.77	-	-	-
1989	27	25.56	-	-	-
1990	27	17.92	-	-	-
1991	27	171.89	26.25	2.94	0.48
1992	27	162.73	42.70	7.66	0.85
1993	27	67.53	17.09	7.22	1.14
1994	27	24.25	68.93	8.09	1.42
1995	27	61.68	17.80	2.82	0.26
1996	27	30.12	27.31	5.53	1.02
1997	27	17.76	50.11	16.34	2.52
1998	27	27.52	12.34	8.19	4.53
1999	27	8.24	70.87	5.82	0.99
2000	27	10.82	64.25	27.45	2.58
2001	27	19.37	15.10	14.57	1.41
2002	-	-	-	-	-
2003	27	19.56	6.84	30.65	4.12

Table 12.2.12 (cont'd) Whiting in IV and VIId. Complete available tuning series.

IBTS Q4	effort	0	1	2	3	4	5	6	7
1991	100	46.826	55.276	19.642	15.092	3.255	1.851	1.329	0.030
1992	100	94.233	45.090	26.462	5.379	5.030	0.645	0.534	0.122
1993	100	78.871	54.210	19.474	7.161	2.335	0.827	0.237	0.008
1994	100	69.848	61.335	26.413	4.140	0.842	0.621	0.106	0.079
1995	100	71.328	107.996	41.715	11.186	2.560	0.523	0.204	0.071
1996	100	29.983	36.556	30.330	8.653	4.815	1.626	0.515	0.326

IBTS Q2	effort	0	1	2	3	4	5
1991	100	94.900	38.560	22.860	3.740	1.230	0.510
1992	100	129.760	47.500	11.420	4.280	1.140	0.450
1993	100	104.670	41.490	20.860	5.170	4.850	0.360
1994	100	65.400	35.710	8.550	2.380	0.900	0.750
1995	100	191.610	77.300	26.190	4.420	2.210	0.410
1996	100	44.020	49.620	22.300	8.330	1.250	0.590
1997	100	14.07	22.60	18.02	6.43	1.40	0.13

Table 12.2.13 Whiting in IV and VIId. Summary of available tuning series.

Country	Fleet	Name / Code	Time of year	Year range	Age Range
Scotland	Groundfish survey	SCOGFS Scotia II	Q3	1982–1997	0-6
		SCOGFS Scotia III	Q3	1998-2006	0-6
	Seiners	SCOSEI IV	-	1978–2005	0–10
	Light trawlers	SCOLTR IV	-	1978–2005	0–10
England	Groundfish survey	ENGGFS GRT	Q3	1977–1991	0-6
		ENGGFS GOV	Q3	1992-2005	
France	Groundfish survey	FRAGFS 7d	Q3	1978–2001	1–9
	Trawlers	FRATRB IV	-	1986–2005[1]	0-8
		FRATRO IV	-	1986-2005	1-7
		FRATRO 7d	-	1988–2003[1]	0-3
International	Groundfish survey[2]	IBTS_QI	Q1	1983–2006	1-6[3]
	Q II survey[4]	IBTS_Q2_SCO	Q2	1991–1997	1-6
	Q IV survey[5]	IBTS_Q4_ENG	Q4	1991–1996	0-7

[1] Excluding 2002.
[2] Formerly IYFS
[3] Age 6 is a plus group
[4] Scottish sub-set of IBTS data – discontinued in 1997.
[5] English sub-set of IBTS data – discontinued in 1996.

Table 12.3.1 Whiting in IV and VIId. XSA tunning diagnostics.

```
Lowestoft VPA Version 3.1

   14/09/2006   9:15

 Extended Survivors Analysis

 North Sea/Eastern Channel Whiting, ages 0-8+

 CPUE data from file whiivviidEF.dat

 Catch data for  26 years. 1980 to 2005. Ages  1 to   8.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 ENGGFS(GOV)         ,   1992, 2005,   1,     6,   .500,   .750
 SCOGFS(old)         ,   1982, 2005,   1,     6,   .500,   .750
 SCOGFS(new)         ,   1998, 2005,   1,     6,   .500,   .750
 IBTS                ,   1983, 2005,   1,     5,   .000,   .250


 Time series weights :

      Tapered time weighting applied
      Power =    3 over  16 years


 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    4


 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   3 years or the   4 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =   2.000

      Minimum standard error for population
      estimates derived from each fleet =    .300

      Prior weighting not applied


 Tuning had not converged after   40 iterations


 Total absolute residual between iterations
 39 and  40 =     .00017

 Final year F values
 Age         ,      1,      2,      3,      4,      5,      6,      7
 Iteration 39,  .1275,  .2629,  .2669,  .2611,  .2482,  .2233,  .1851
 Iteration 40,  .1275,  .2629,  .2669,  .2611,  .2482,  .2232,  .1850


1


 Regression weights
       ,  .555,  .670,  .769,  .850,  .911,  .954,  .980,  .994,  .999, 1.000



 Fishing mortalities
    Age,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005

      1,  .119,  .120,  .118,  .193,  .065,  .108,  .081,  .345,  .100,  .127
      2,  .323,  .300,  .241,  .388,  .356,  .192,  .183,  .436,  .207,  .263
      3,  .585,  .536,  .359,  .538,  .677,  .360,  .362,  .304,  .212,  .267
      4,  .744,  .638,  .564,  .648,  .726,  .569,  .425,  .366,  .269,  .261
      5,  .952,  .805,  .682,  .707,  .845,  .774,  .499,  .347,  .307,  .248
      6, 1.171,  .658,  .796,  .764,  .983,  .705,  .407,  .283,  .316,  .223
      7, 1.077,  .930,  .684,  .671, 1.728,  .759,  .491,  .158,  .230,  .185
```

Table 12.3.1 Cont.

1

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7
1996	1.04E+06	5.16E+05	2.65E+05	1.08E+05	2.63E+04	7.71E+03	2.17E+03
1997	7.61E+05	3.58E+05	2.38E+05	1.04E+05	3.79E+04	7.89E+03	1.86E+03
1998	1.03E+06	2.61E+05	1.69E+05	9.83E+04	4.07E+04	1.32E+04	3.18E+03
1999	1.63E+06	3.56E+05	1.31E+05	8.32E+04	4.14E+04	1.60E+04	4.63E+03
2000	1.71E+06	5.20E+05	1.54E+05	5.38E+04	3.22E+04	1.59E+04	5.81E+03
2001	1.32E+06	6.18E+05	2.32E+05	5.50E+04	1.93E+04	1.08E+04	4.64E+03
2002	1.03E+06	4.59E+05	3.25E+05	1.14E+05	2.31E+04	6.93E+03	4.15E+03
2003	4.01E+05	3.69E+05	2.44E+05	1.60E+05	5.53E+04	1.09E+04	3.59E+03
2004	4.32E+05	1.10E+05	1.52E+05	1.27E+05	8.20E+04	3.04E+04	6.41E+03
2005	3.47E+05	1.51E+05	5.68E+04	8.66E+04	7.18E+04	4.70E+04	1.73E+04

Estimated population abundance at 1st Jan 2006

	0.00E+00	1.18E+05	7.41E+04	3.07E+04	4.94E+04	4.36E+04	2.93E+04

Taper weighted geometric mean of the VPA populations:

	8.88E+05	3.44E+05	1.83E+05	9.38E+04	3.93E+04	1.42E+04	4.58E+03

Standard error of the weighted Log(VPA populations) :

	.6271	.5899	.5117	.3543	.4956	.6330	.6281

1

Log catchability residuals.

Fleet : ENGGFS(GOV)

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	99.99	99.99	99.99	99.99	99.99	99.99	-.82	-.99	-.71	-.43
2	99.99	99.99	99.99	99.99	99.99	99.99	-.32	-.41	-.53	.35
3	99.99	99.99	99.99	99.99	99.99	99.99	-.67	-.49	-.71	.08
4	99.99	99.99	99.99	99.99	99.99	99.99	-.77	-.59	-.53	.07
5	99.99	99.99	99.99	99.99	99.99	99.99	.06	-.97	-.62	-.78
6	99.99	99.99	99.99	99.99	99.99	99.99	1.00	.39	-1.54	-.12

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	-.68	-.56	-.74	-.22	-.05	.13	.50	.19	1.41	.02
2	-.31	-.19	.37	.01	.23	-.28	.21	-.38	.53	-.17
3	-.07	.22	-.49	.13	.00	-.25	-.13	.61	-.16	.41
4	-.60	-.12	-.08	-.36	-.28	-.12	-.27	.69	.43	.61
5	-.73	-.02	-.13	-.26	-.34	-.32	-.86	1.05	.08	.87
6	-.17	.88	-.62	-.87	-.48	.37	-1.30	1.76	.37	.33

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6
Mean Log q	-14.1785	-14.5723	-14.6429	-14.6303	-14.6303	-14.6303
S.E(Log q)	.6524	.3364	.3588	.4464	.6525	.9380

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	2.06	-1.574	14.69	.22	14	1.24	-14.18
2	1.32	-1.291	15.15	.68	14	.43	-14.57
3	1.26	-.861	15.31	.58	14	.46	-14.64
4	.69	1.086	13.63	.61	14	.30	-14.63
5	.54	2.402	12.82	.78	14	.28	-14.72
6	.93	.136	14.28	.34	14	.93	-14.63

1

Table 12.3.1 Cont.

Fleet : SCOGFS(old)

Age	1982	1983	1984	1985
1	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99
6	99.99	99.99	99.99	99.99

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	99.99	99.99	99.99	99.99	-.64	-.87	-.26	-.30	-.40	.20
2	99.99	99.99	99.99	99.99	-.77	-.70	-.51	-.38	-.81	.01
3	99.99	99.99	99.99	99.99	-1.00	-.88	-.34	-.64	-.94	.01
4	99.99	99.99	99.99	99.99	-.26	-1.13	.01	-.32	-1.24	.08
5	99.99	99.99	99.99	99.99	-.74	-.78	-.02	-.10	-.63	.02
6	99.99	99.99	99.99	99.99	-.45	-1.27	.16	-.78	-.87	.27

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	.21	.06	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	.54	.14	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	.36	.42	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	.58	.19	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	-.28	.31	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
6	.03	-.19	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6
Mean Log q	-10.0351	-9.8003	-9.7674	-9.9934	-9.9934	-9.9934
S.E(Log q)	.3340	.5920	.6707	.7611	.4433	.6003

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.63	-.370	7.52	.53	8	.94	-10.04
2	11.40	-.290	-24.73	.00	8	12.43	-9.80
3	.94	.010	9.94	.07	8	1.31	-9.77
4	.62	.132	10.57	.29	8	.96	-9.99
5	.85	.106	10.13	.62	8	.75	-10.07
6	2.07	-.376	11.28	.29	8	1.93	-10.19

1

Fleet : SCOGFS(new)

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	99.99	99.99	-.03	-.18	-.09	-.45	.13	.27	.35	-.05
2	99.99	99.99	-.04	.23	.29	-.29	-.01	-.16	-.27	.28
3	99.99	99.99	-.16	.16	.18	-.21	.10	.07	-.25	.12
4	99.99	99.99	-.24	.01	.00	-.09	.34	.10	-.11	-.05
5	99.99	99.99	-.21	-.23	.12	-.35	-.09	.02	-.01	-.26
6	99.99	99.99	.24	-.04	.43	.13	.30	-.46	-.46	.00

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6
Mean Log q	-9.4266	-9.4461	-9.5685	-9.5533	-9.5533	-9.5533
S.E(Log q)	.2637	.2419	.1761	.1709	.2085	.3390

Table 12.3.1 Cont.

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1,	1.34,	-1.939,	8.01,	.86,	8,	.30,	-9.43,
2,	.99,	.060,	9.48,	.87,	8,	.26,	-9.45,
3,	1.07,	-.493,	9.39,	.90,	8,	.20,	-9.57,
4,	.89,	.712,	9.77,	.88,	8,	.16,	-9.55,
5,	.93,	.610,	9.74,	.93,	8,	.16,	-9.68,
6,	1.21,	-.803,	9.52,	.73,	8,	.42,	-9.55,

1

Fleet : IBTS

Age	1982	1983	1984	1985
1	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99
6	No data for this fleet at this age			

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	99.99	99.99	99.99	99.99	-.56	.17	.11	.18	-.12	-.04
2	99.99	99.99	99.99	99.99	-.29	.35	.27	.19	.22	-.04
3	99.99	99.99	99.99	99.99	-.08	.00	.14	.04	-.02	-.03
4	99.99	99.99	99.99	99.99	-.24	.28	-.14	-.08	.01	.01
5	99.99	99.99	99.99	99.99	-.80	.16	-.25	-.11	-.64	-.51
6	No data for this fleet at this age									

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	.05	-.19	.14	-.09	-.03	.07	.35	-.30	-.07	.06
2	.17	.18	-.27	.08	.26	.18	.11	.03	.02	-.77
3	.07	-.24	-.18	-.18	.33	.37	-.05	.08	.22	-.48
4	-.15	-.27	-.33	-.10	.27	.85	-.29	.06	-.02	-.20
5	.18	-.46	-.69	-.20	-.18	.57	.21	.10	-.26	-.42
6	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5
Mean Log q	-12.1665	-11.6440	-11.5436	-11.6721	-11.6721
S.E(Log q)	.1803	.3099	.2654	.3439	.4069

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1,	.92,	.849,	12.28,	.94,	16,	.17,	-12.17,
2,	.75,	2.279,	11.92,	.91,	16,	.19,	-11.64,
3,	.80,	1.590,	11.66,	.89,	16,	.19,	-11.54,
4,	2.34,	-2.031,	11.97,	.23,	16,	.69,	-11.67,
5,	1.60,	-1.565,	12.55,	.47,	16,	.56,	-11.81,

1

Table 12.3.1 Cont.

Terminal year survivor and F summaries :

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 2004

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
ENGGFS(GOV) ,	120319.,	.685,	.000,	.00,	1,	.086,	.125
SCOGFS(old) ,	1.,	.000,	.000,	.00,	0,	.000,	.000
SCOGFS(new) ,	111965.,	.300,	.000,	.00,	1,	.451,	.134
IBTS ,	125152.,	.300,	.000,	.00,	1,	.451,	.121
F shrinkage mean ,	79643.,	2.00,,,,				.012,	.184

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
118001.,	.20,	.04,	4,	.195,	.127

1

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2003

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
ENGGFS(GOV) ,	84809.,	.314,	.625,	1.99,	2,	.195,	.233
SCOGFS(old) ,	1.,	.000,	.000,	.00,	0,	.000,	.000
SCOGFS(new) ,	101669.,	.212,	.036,	.17,	2,	.416,	.198
IBTS ,	49165.,	.221,	.353,	1.60,	2,	.383,	.374
F shrinkage mean ,	68956.,	2.00,,,,				.006,	.280

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
74121.,	.14,	.20,	7,	1.438,	.263

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2002

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
ENGGFS(GOV) ,	47786.,	.244,	.068,	.28,	3,	.221,	.179
SCOGFS(old) ,	1.,	.000,	.000,	.00,	0,	.000,	.000
SCOGFS(new) ,	31374.,	.177,	.154,	.87,	3,	.397,	.262
IBTS ,	23117.,	.182,	.153,	.84,	3,	.377,	.341
F shrinkage mean ,	27239.,	2.00,,,,				.005,	.296

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
30672.,	.11,	.11,	10,	.991,	.267

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2001

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
ENGGFS(GOV) ,	52137.,	.223,	.240,	1.08,	4,	.209,	.249
SCOGFS(old) ,	1.,	.000,	.000,	.00,	0,	.000,	.000
SCOGFS(new) ,	44799.,	.157,	.074,	.47,	4,	.422,	.285
IBTS ,	54005.,	.167,	.120,	.72,	4,	.364,	.241
F shrinkage mean ,	34388.,	2.00,,,,				.004,	.357

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
49441.,	.10,	.07,	13,	.735,	.261

Table 12.3.1 Cont.

Age 5 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2000

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
ENGGFS(GOV)	,	70012.,	.214,	.116,	.54,	5,	.185,	.162
SCOGFS(old)	,	1.,	.000,	.000,	.00,	0,	.000,	.000
SCOGFS(new)	,	37409.,	.142,	.082,	.57,	5,	.465,	.284
IBTS	,	41868.,	.158,	.099,	.63,	5,	.346,	.257
F shrinkage mean	,	25932.,	2.00,,,,				.004,	.388

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
43611.,	.09,	.08,	16,	.817,	.248

1

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 1999

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
ENGGFS(GOV)	,	32597.,	.221,	.162,	.73,	6,	.172,	.203
SCOGFS(old)	,	1.,	.000,	.000,	.00,	0,	.000,	.000
SCOGFS(new)	,	28979.,	.142,	.049,	.34,	6,	.530,	.225
IBTS	,	28222.,	.163,	.073,	.45,	5,	.292,	.231
F shrinkage mean	,	18202.,	2.00,,,,				.005,	.338

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
29271.,	.10,	.05,	18,	.490,	.223

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 1998

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
ENGGFS(GOV)	,	13402.,	.234,	.215,	.92,	6,	.169,	.164
SCOGFS(old)	,	1.,	.000,	.000,	.00,	0,	.000,	.000
SCOGFS(new)	,	10942.,	.149,	.132,	.89,	6,	.542,	.198
IBTS	,	12603.,	.172,	.123,	.72,	5,	.280,	.174
F shrinkage mean	,	8370.,	2.00,,,,				.008,	.251

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
11757.,	.10,	.08,	18,	.783,	.185

1

1

Table 12.3.2 Whiting in IV and VIId. Final XSA fishing mortality.

Run titl ages 0-8+

At 14/09/2006 9:16

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1980	1981	1982	1983	1984	1985
AGE						
1	0.1014	0.1652	0.1734	0.2103	0.2233	0.1901
2	0.4401	0.3294	0.2933	0.4552	0.5164	0.2494
3	0.8223	0.7515	0.5312	0.7466	0.8708	0.6352
4	0.975	0.9979	0.719	0.7345	1.0277	0.8736
5	1.2296	1.0954	0.8931	0.88	1.0479	1.1654
6	0.944	1.2779	1.0099	0.9178	1.122	1.1822
7	1.004	1.0426	0.7963	0.8282	1.0288	0.9749
+gp	1.004	1.0426	0.7963	0.8282	1.0288	0.9749
0 FBAR 2-	0.8822	0.8904	0.6893	0.7468	0.917	0.8212

Table 8 Fishing mortality (F) at age

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
1	0.2699	0.1406	0.3586	0.1295	0.2269	0.1171	0.2397	0.194	0.1593	0.1532
2	0.4252	0.508	0.4306	0.4316	0.5515	0.4885	0.3883	0.4801	0.3448	0.3502
3	0.7046	0.8695	0.6567	0.6957	0.913	0.5225	0.5801	0.7593	0.6873	0.6259
4	1.1921	1.2437	0.9656	0.8248	0.9825	0.889	0.6445	0.8335	0.9206	0.7751
5	1.0467	1.3456	1.1471	1.4971	1.1836	1.1024	0.9489	0.8844	1.0215	1.0063
6	1.1564	1.6547	1.1918	1.5072	0.9696	0.6884	1.1325	1.1091	1.1488	1.1307
7	1.0368	1.2945	1.0016	1.1448	1.0238	0.8105	0.883	0.8718	1.0322	1.2226
+gp	1.0368	1.2945	1.0016	1.1448	1.0238	0.8105	0.883	0.8718	1.0322	1.2226
0 FBAR 2-	0.905	1.1243	0.8784	0.9913	0.92	0.7382	0.7389	0.8133	0.8246	0.7776
1										

Run titl ages 0-8+

At 14/09/2006 9:16

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	FBAR **-**
AGE											
1	0.1188	0.1198	0.1177	0.1931	0.0651	0.108	0.0808	0.3452	0.0995	0.1275	0.1907
2	0.3235	0.3004	0.2415	0.3882	0.3561	0.192	0.1829	0.4361	0.2075	0.2629	0.3022
3	0.5854	0.5356	0.3586	0.5377	0.6774	0.3599	0.3622	0.3036	0.2119	0.2669	0.2608
4	0.7435	0.6376	0.5639	0.6483	0.7255	0.569	0.4248	0.3656	0.269	0.2611	0.2986
5	0.9524	0.8052	0.6825	0.7068	0.845	0.7744	0.4993	0.3469	0.307	0.2482	0.3007
6	1.1713	0.6582	0.7965	0.7639	0.9834	0.7046	0.4068	0.2827	0.3163	0.2232	0.2741
7	1.0766	0.9302	0.6835	0.6708	1.728	0.7595	0.4906	0.1578	0.2304	0.185	0.1911
+gp	1.0766	0.9302	0.6835	0.6708	1.728	0.7595	0.4906	0.1578	0.2304	0.185	
0 FBAR 2-	0.7552	0.5874	0.5286	0.609	0.7175	0.52	0.3752	0.347	0.2623	0.2525	

Table 12.3.3 Whiting in IV and VIId. Final XSA stock numbers.

Run titl ages 0-8+

At 14/09/2006 9:16

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1980	1981	1982	1983	1984	1985
AGE						
1	4423046	1719958	1945650	1743356	2598919	1888842
2	1463366	1545550	563874	632663	546339	803986
3	607921	600894	708926	268157	255881	207850
4	169230	188246	199713	293697	89566	75480
5	84825	47287	51410	72091	104386	23743
6	19941	19317	12315	16391	23288	28508
7	2010	6042	4192	3494	5098	5906
+gp	1314	546	959	1798	1036	1576
0 TOTA	6771652	4127840	3487038	3031646	3624513	3035890

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
1	3920893	3274683	2296284	4390746	2010082	1870627	1808831	1984081	1786739	1556333
2	604050	1157710	1100379	620443	1491820	619581	643531	550426	632041	589259
3	399482	251746	444151	456146	256928	547968	242392	278296	217155	285484
4	77603	139157	74361	162304	160314	72659	229004	95626	91779	76963
5	23341	17453	29724	20974	52703	44464	22127	89057	30782	27079
6	5766	6382	3539	7351	3655	12567	11499	6672	28643	8632
7	6807	1413	950	837	1268	1080	4917	2886	1714	7072
+gp	956	1541	288	530	190	536	217	1441	776	726
0 TOTA	5038899	4850084	3949676	5659331	3976961	3169481	2962518	3008486	2789628	2551548
1										

Run titl ages 0-8+

At 14/09/2006 9:16

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	GMST 80-**	AMST 80-**
AGE													
1	1042654	760592	1034330	1630524	1705173	1321825	1033294	400547	431825	346583	0	1758804	2006167
2	516401	358060	260939	355596	519846	617925	458890	368612	109691	151184	118002	636067	709220
3	264726	238276	169060	130691	153790	232161	325192	243702	151959	56837	74121	294056	324457
4	107587	103883	98282	83230	53794	55047	114150	159534	126772	86640	30672	111827	123800
5	26264	37893	40676	41429	32244	19291	23085	55295	81995	71762	49441	37157	42401
6	7709	7892	13192	16009	15913	10787	6926	10912	30439	46979	43611	10856	12659
7	2170	1861	3182	4633	5808	4636	4152	3591	6406	17278	29271	2975	3572
+gp	1830	826	896	1509	1652	2597	2128	2993	1594	3124	13882		
TOTAL	1969342	1509283	1620557	2263621	2488221	2264269	1967817	1245186	940683	780386	358999		

Table 12.3.4 Whiting in IV and VIId. Final XSA summary table.

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 2- 6,
1980,	4423046,	837816,	522370,	223517,	.4279,	.8822,
1981,	1719958,	636483,	489007,	192049,	.3927,	.8904,
1982,	1945650,	492859,	378623,	140195,	.3703,	.6893,
1983,	1743356,	512747,	337432,	161212,	.4778,	.7468,
1984,	2598919,	485835,	271618,	145741,	.5366,	.9170,
1985,	1888842,	441802,	271139,	106363,	.3923,	.8212,
1986,	3920893,	665447,	288766,	161744,	.5601,	.9050,
1987,	3274683,	537109,	299204,	138775,	.4638,	1.1243,
1988,	2296284,	419715,	295557,	133470,	.4516,	.8784,
1989,	4390746,	560503,	279608,	123753,	.4426,	.9913,
1990,	2010082,	482543,	317003,	153453,	.4841,	.9200,
1991,	1870627,	456375,	276318,	124975,	.4523,	.7382,
1992,	1808831,	406518,	264473,	109704,	.4148,	.7389,
1993,	1984081,	374555,	238393,	116165,	.4873,	.8133,
1994,	1786739,	357568,	222335,	92606,	.4165,	.8246,
1995,	1556333,	358722,	230120,	103268,	.4488,	.7776,
1996,	1042654,	293130,	200094,	73957,	.3696,	.7552,
1997,	760592,	238120,	171433,	59102,	.3448,	.5874,
1998,	1034330,	226921,	139660,	44312,	.3173,	.5286,
1999,	1630524,	256994,	141161,	59179,	.4192,	.6090,
2000,	1705173,	355795,	175997,	60907,	.3461,	.7175,
2001,	1321825,	292309,	198007,	49062,	.2478,	.5200,
2002,	1033294,	256791,	189603,	46552,	.2455,	.3752,
2003,	400547,	174798,	152577,	43208,	.2832,	.3470,
2004,	431825,	174521,	130895,	29057,	.2220,	.2623,
2005,	346583,	134062,	103970,	26795,	.2577,	.2525,
Arith. Mean ,	1881785,	401155,	253283,	104582,	.3951,	.7159,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

Table 12.5.1 Whiting in IV and VIId. RCT3 input table

```
Whi4&7d (age 1)
       8      16       2
    1991 1870627     -11      27    1379    2925     -11     -11    1008     666
    1992 1808831      46      25    2417    3169     -11     -11     907     523
    1993 1984081      25      31     247    2635     -11     -11    1076     627
    1994 1786738      21      36     648    4176     -11     -11     722     448
    1995 1556333      36      19    1243    2888     -11     -11     679     486
    1996 1042654      10      15     440    1824     -11     -11     502     342
    1997  760591      49      18     317     -11     -11    4141     288     161
    1998 1034329     159      45     -11     -11   12302    5410     543     305
    1999 1630523     106      60     -11     -11   15276    6646     676     538
    2000 1705172      70      54     -11     -11   17076    3499     757     598
    2001 1321823     100      63     -11     -11     117    4980     649     417
    2002 1033293       5      15     -11     -11    1606    1891     671     299
    2003  400547       0      64     -11     -11    5393    2580     132      91
    2004  431825       0      13     -11     -11    2553    1355     185      56
    2005  346584       7     -11     -11     -11    1765    1580     168      92
    2006     -11     -11     -11     -11     -11     397     -11     223     -11
enggfs0
enggfs1
scogfso0
scogfso1
scogfsn0
scogfsn1
ibts1
ibtsq2
```

Table 12.5.2 Whiting in IV and VIId. RCT3 output table.

Analysis by RCT3 ver3.1 of data from file :

whirec1s.txt

Whi4&7d (age 1)

Data for 8 surveys over 16 years : 1991 - 2006

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .00
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2006

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
enggfs									
enggfs									
scogfs									
scogfs									
scogfs	2.60	-7.47	4.59	.023	8	5.99	8.11	6.182	.001
scogfs									
ibts1	.91	8.21	.15	.946	15	5.41	13.16	.172	.923
ibtsq2									
					VPA Mean =		13.90	.597	.077

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2006	545476	13.21	.17	.17	1.06		

Table 12.6.1 Whiting in IV and VIId. Short term forecast input

MFDP version 1a
Run: whi.me
Time and date: 10:17 14/09/2006
Fbar age range (Total) : 2-6
Fbar age range Fleet 1 : 2-6
Fbar age range Fleet 2 : 2-6

2006

Age	N	M	Mat	PF	PM	SWt
1	545476	0.95	0.11	0	0	0.09
2	118002	0.45	0.92	0	0	0.186
3	74121	0.35	1	0	0	0.233
4	30672	0.3	1	0	0	0.245
5	49441	0.25	1	0	0	0.28
6	43611	0.25	1	0	0	0.298
7	29271	0.2	1	0	0	0.3
8	13882	0.2	1	0	0	0.295

Catch

Age	Sel	CWt	DSel	DCWt
1	0.011	0.208	0.062	0.11
2	0.044	0.247	0.212	0.175
3	0.104	0.275	0.151	0.208
4	0.145	0.267	0.116	0.217
5	0.159	0.311	0.088	0.223
6	0.135	0.338	0.087	0.235
7	0.133	0.32	0.051	0.246
8	0.097	0.348	0.085	0.225

IndBycatch

Age	Sel	CWt
1	0.054	0.043
2	0.007	0.133
3	0.012	0.196
4	0	0.205
5	0.001	0.366
6	0.002	0.438
7	0.001	0.541
8	0.003	0.53

2007

Age	N	M	Mat	PF	PM	SWt
1	545476	0.95	0.11	0	0	0.09
2	.	0.45	0.92	0	0	0.186
3	.	0.35	1	0	0	0.233
4	.	0.3	1	0	0	0.245
5	.	0.25	1	0	0	0.28
6	.	0.25	1	0	0	0.298
7	.	0.2	1	0	0	0.3
8	.	0.2	1	0	0	0.295

Catch

Age	Sel	CWt	DSel	DCWt
1	0.011	0.208	0.062	0.11
2	0.044	0.247	0.212	0.175
3	0.104	0.275	0.151	0.208
4	0.145	0.267	0.116	0.217
5	0.159	0.311	0.088	0.223
6	0.135	0.338	0.087	0.235
7	0.133	0.32	0.051	0.246
8	0.097	0.348	0.085	0.225

IndBycatch

Age	Sel	CWt
1	0.054	0.043
2	0.007	0.133
3	0.012	0.196
4	0	0.205
5	0.001	0.366
6	0.002	0.438
7	0.001	0.541
8	0.003	0.53

2008

Age	N	M	Mat	PF	PM	SWt
1	545476	0.95	0.11	0	0	0.09
2	.	0.45	0.92	0	0	0.186
3	.	0.35	1	0	0	0.233
4	.	0.3	1	0	0	0.245
5	.	0.25	1	0	0	0.28
6	.	0.25	1	0	0	0.298
7	.	0.2	1	0	0	0.3
8	.	0.2	1	0	0	0.295

Catch

Age	Sel	CWt	DSel	DCWt
1	0.011	0.208	0.062	0.11
2	0.044	0.247	0.212	0.175
3	0.104	0.275	0.151	0.208
4	0.145	0.267	0.116	0.217
5	0.159	0.311	0.088	0.223
6	0.135	0.338	0.087	0.235
7	0.133	0.32	0.051	0.246
8	0.097	0.348	0.085	0.225

IndBycatch

Age	Sel	CWt
1	0.054	0.043
2	0.007	0.133
3	0.012	0.196
4	0	0.205
5	0.001	0.366
6	0.002	0.438
7	0.001	0.541
8	0.003	0.53

Input units are thousands and kg - output in tonnes

Table 12.6.2 Whiting in IV and VIId. Short term forecast output.

MFDP version 1a
Run: whi.me
Time and date: 10:17 14/09/2006
Fbar age range (Total) : 2-6
Fbar age range Fleet 1 : 2-6
Fbar age range Fleet 2 : 2-6

2006

		Catch	Landings		Discards		IndBycatch	Landings	
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	FMult	FBar	Yield
135542	90094	1	0.1174	9105	0.1308	9736	1	0.0044	1060

2007										2008	
		Catch	Landings		Discards		IndBycatch	Landings			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	FMult	FBar	Yield	Biomass	SSB
137588	91131	0	0	0	0	0	1	0.0044	1137	156528	109861
.	91131	0.1	0.0117	896	0.0131	1182	1	0.0044	1131	154602	107957
.	91131	0.2	0.0235	1774	0.0262	2341	1	0.0044	1124	152719	106095
.	91131	0.3	0.0352	2634	0.0392	3477	1	0.0044	1118	150876	104273
.	91131	0.4	0.047	3476	0.0523	4592	1	0.0044	1112	149072	102491
.	91131	0.5	0.0587	4301	0.0654	5684	1	0.0044	1106	147307	100747
.	91131	0.6	0.0704	5110	0.0785	6756	1	0.0044	1101	145580	99041
.	91131	0.7	0.0822	5902	0.0916	7807	1	0.0044	1095	143890	97372
.	91131	0.8	0.0939	6678	0.1046	8838	1	0.0044	1089	142236	95738
.	91131	0.9	0.1057	7438	0.1177	9849	1	0.0044	1083	140617	94139
.	91131	1	0.1174	8183	0.1308	10841	1	0.0044	1078	139032	92575
.	91131	1.1	0.1291	8913	0.1439	11814	1	0.0044	1072	137481	91044
.	91131	1.2	0.1409	9628	0.157	12769	1	0.0044	1067	135963	89546
.	91131	1.3	0.1526	10329	0.17	13706	1	0.0044	1061	134477	88080
.	91131	1.4	0.1644	11016	0.1831	14625	1	0.0044	1056	133022	86644
.	91131	1.5	0.1761	11689	0.1962	15527	1	0.0044	1050	131598	85239
.	91131	1.6	0.1878	12349	0.2093	16413	1	0.0044	1045	130203	83864
.	91131	1.7	0.1996	12996	0.2224	17282	1	0.0044	1040	128838	82518
.	91131	1.8	0.2113	13629	0.2354	18134	1	0.0044	1035	127501	81201
.	91131	1.9	0.2231	14251	0.2485	18972	1	0.0044	1030	126192	79911
.	91131	2	0.2348	14860	0.2616	19793	1	0.0044	1025	124910	78648

Input units are thousands and kg - output in tonnes

Table 12.6.3 Whiting in IV and VIId. Short term forecast detailed output

MFDP version 1a
Run: whi.me
Time and date: 10:17 14/09/2006
Fbar age range (Total) : 2-6
Fbar age range Fleet 1 : 2-6
Fbar age range Fleet 2 : 2-6

Year: 2006 F multiplier: 1 Fleet1 HCFbar: 0.1174 Fleet1 DFb 0.1308

	Catch						IndBycatch								
Age	F	CatchNos	Yield	DF	DCatchNos	DYield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.011	3674	764	0.062	20706	2278	0.054	18034	775	545476	49093	60002	5400	60002	5400
2	0.044	3713	917	0.212	17888	3130	0.007	591	79	118002	21948	108562	20193	108562	20193
3	0.104	5753	1582	0.151	8352	1737	0.012	664	130	74121	17270	74121	17270	74121	17270
4	0.145	3404	909	0.116	2723	591	0	0	0	30672	7515	30672	7515	30672	7515
5	0.159	6192	1926	0.088	3427	764	0.001	39	14	49441	13843	49441	13843	49441	13843
6	0.135	4689	1585	0.087	3022	710	0.002	69	30	43611	12996	43611	12996	43611	12996
7	0.133	3231	1034	0.051	1239	305	0.001	24	13	29271	8781	29271	8781	29271	8781
8	0.097	1118	389	0.085	979	220	0.003	35	18	13882	4095	13882	4095	13882	4095
Total		31772	9105		58336	9736		19456	1060	904476	135542	409562	90094	409562	90094

Year: 2007 F multiplier: 1 Fleet1 HCFbar: 0.1174 Fleet1 DFb 0.1308

	Catch						IndBycatch								
Age	F	CatchNos	Yield	DF	DCatchNos	DYield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.011	3674	764	0.062	20706	2278	0.054	18034	775	545476	49093	60002	5400	60002	5400
2	0.044	5846	1444	0.212	28165	4929	0.007	930	124	185798	34558	170934	31794	170934	31794
3	0.104	4489	1234	0.151	6518	1356	0.012	518	102	57841	13477	57841	13477	57841	13477
4	0.145	4438	1185	0.116	3551	770	0	0	0	39993	9798	39993	9798	39993	9798
5	0.159	2192	682	0.088	1213	271	0.001	14	5	17503	4901	17503	4901	17503	4901
6	0.135	3231	1092	0.087	2082	489	0.002	48	21	30048	8954	30048	8954	30048	8954
7	0.133	2997	959	0.051	1149	283	0.001	23	12	27148	8144	27148	8144	27148	8144
8	0.097	2364	823	0.085	2072	466	0.003	73	39	29363	8662	29363	8662	29363	8662
Total		29230	8183		65455	10841		19639	1078	933170	137588	432832	91131	432832	91131

Year: 2008 F multiplier: 1 Fleet1 HCFbar: 0.1174 Fleet1 DFb 0.1308

	Catch						IndBycatch								
Age	F	CatchNos	Yield	DF	DCatchNos	DYield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.011	3674	764	0.062	20706	2278	0.054	18034	775	545476	49093	60002	5400	60002	5400
2	0.044	5846	1444	0.212	28165	4929	0.007	930	124	185798	34558	170934	31794	170934	31794
3	0.104	7068	1944	0.151	10262	2135	0.012	816	160	91073	21220	91073	21220	91073	21220
4	0.145	3463	925	0.116	2771	601	0	0	0	31209	7646	31209	7646	31209	7646
5	0.159	2858	889	0.088	1582	353	0.001	18	7	22821	6390	22821	6390	22821	6390
6	0.135	1144	387	0.087	737	173	0.002	17	7	10637	3170	10637	3170	10637	3170
7	0.133	2065	661	0.051	792	195	0.001	16	8	18705	5611	18705	5611	18705	5611
8	0.097	3096	1077	0.085	2713	610	0.003	96	51	38453	11344	38453	11344	38453	11344
Total		29213	8090		67728	11273		19926	1132	944172	139032	443835	92575	443835	92575

Input units are thousands and kg - output in tonnes

Table 12.12.1 Nominal landings (t) of Whiting from Division IIIa as supplied by the Study Group on Division IIIa Demersal Stocks (ICES 1992b) and updated by the Working Group.

Year	Denmark			Norway	Sweden	Others	Total
1975	19,018			57	611	4	19,690
1976	17,870			48	1,002	48	18,968
1977	18,116			46	975	41	19,178
1978	48,102			58	899	32	49,091
1979	16,971			63	1,033	16	18,083
1980	21,070			65	1,516	3	22,654
	Total consumption	Total industrial	Total				
1981	1,027	23,915	24,942	70	1,054	7	26,073
1982	1,183	39,758	40,941	40	670	13	41,664
1983	1,311	23,505	24,816	48	1,061	8	25,933
1984	1,036	12,102	13,138	51	1,168	60	14,417
1985	557	11,967	12,524	45	654	2	13,225
1986	484	11,979	12,463	64	477	1	13,005
1987	443	15,880	16,323	29	262	43	16,657
1988	391	10,872	11,263	42	435	24	11,764
1989	917	11,662	12,579	29	675	-	13,283
1990	1,016	17,829	18,845	49	456	73	19,423
1991	871	12,463	13,334	56	527	97	14,041
1992	555	10,675	11,230	66	959	1	12,256
1993	261	3,581	3,842	42	756	1	4,641
1994	174	5,391	5,565	21	440	1	6,027
1995	85	9,029	9,114	24	431	1	9,570
1996	55	2,668	2,723	21	182	-	2,926
1997	38	568	606	18	94	-	718
1998	35	847	882	16	81	-	979
1999	37	1,199	1,236	15	111	-	1,362
2000	59	386	445	17	138	1	622
2001	61	n/a	n/a	27	126	+	214
2002	101	n/a	n/a	23	127	1	252
2003	93	n/a	n/a	20	71	2	186
2004	93	n/a	n/a	17	74	1	185
2005	49	n/a	n/a	13	73	0	135

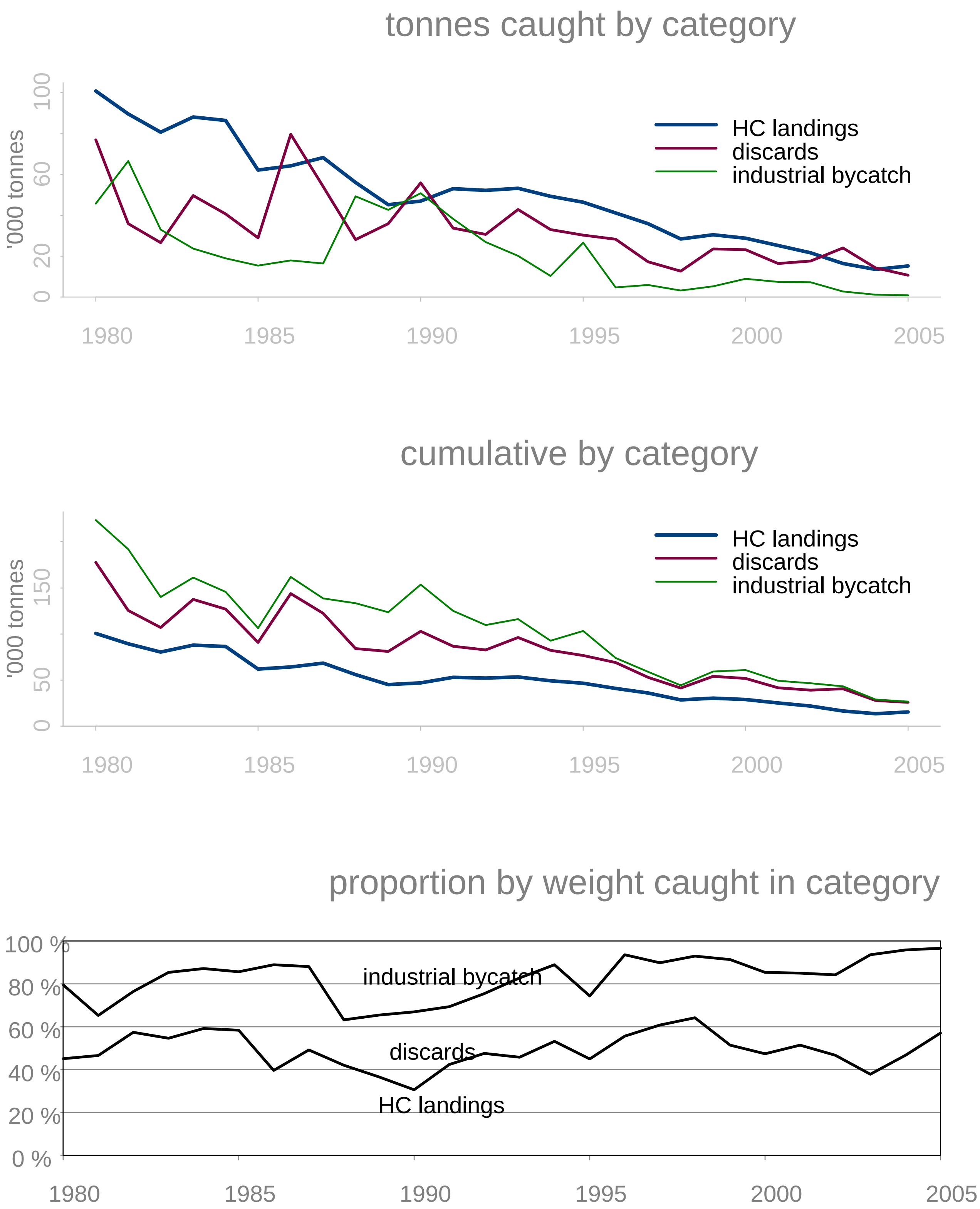


Figure 12.2.1 **Whiting in IV and VIId. The contribution of different catch components to the total catch.**

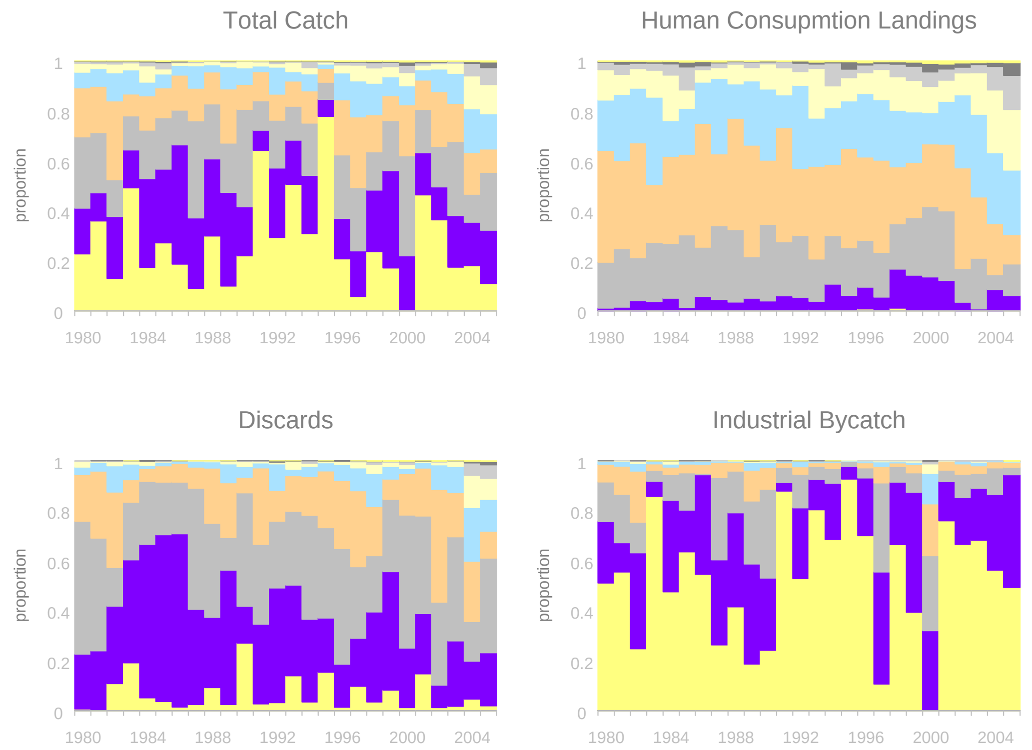


Figure 12.2.2 **Whiting in IV and VIId. Proportion at age by number for each catch component.**

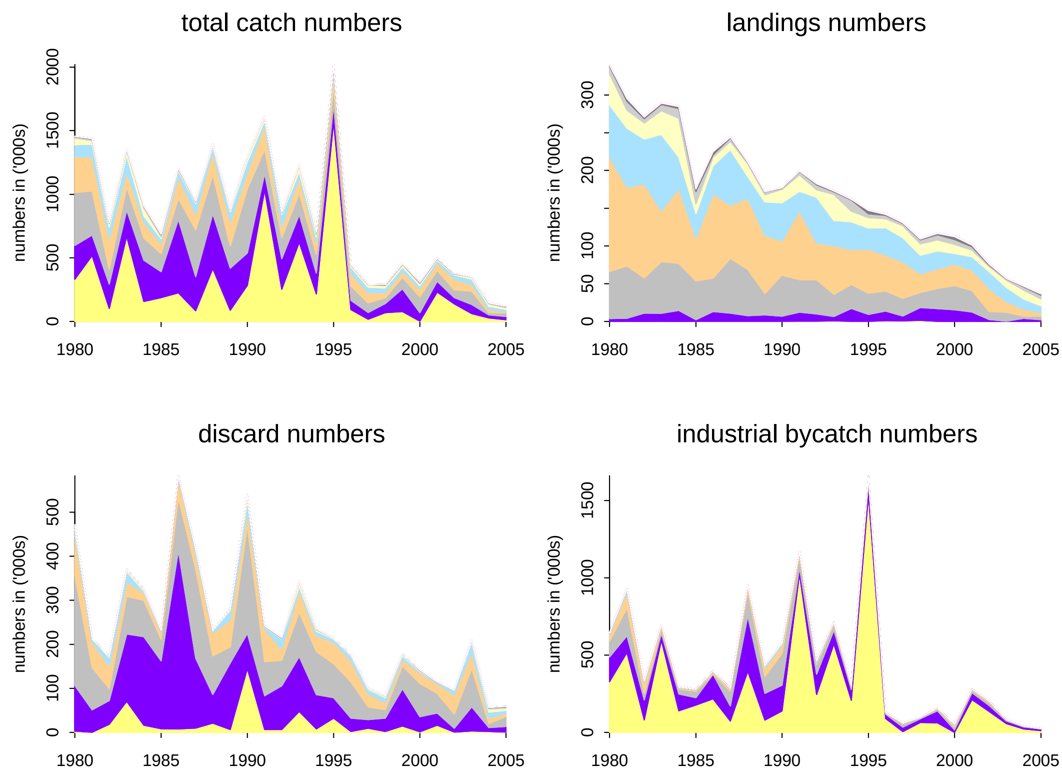


Figure 12.2.3 **Whiting in IV and VIId. Numbers in catch by age for each catch component**

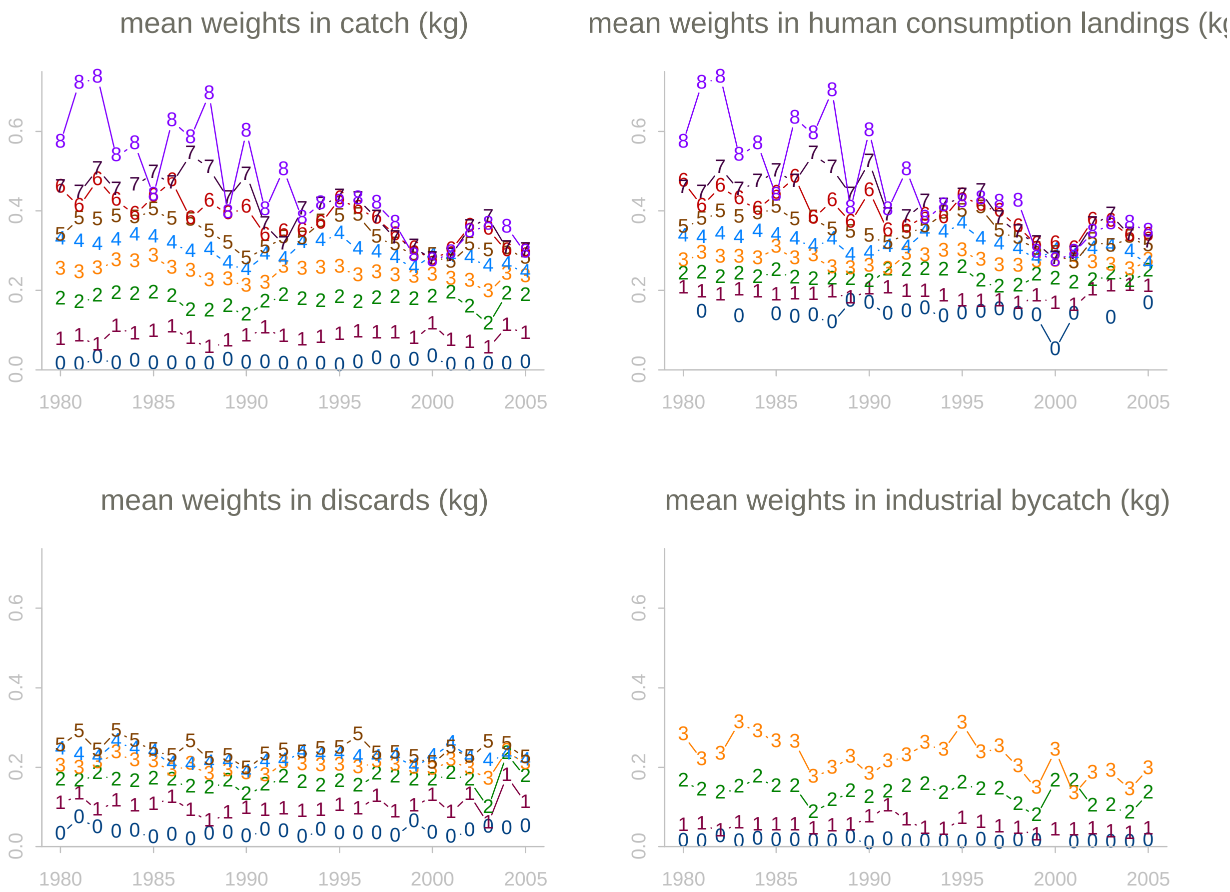


Figure 12.2.4 Whiting in IV and VIId. Mean weights at age (kg) by catch component. Catch mean weights are also used as stock mean weights.

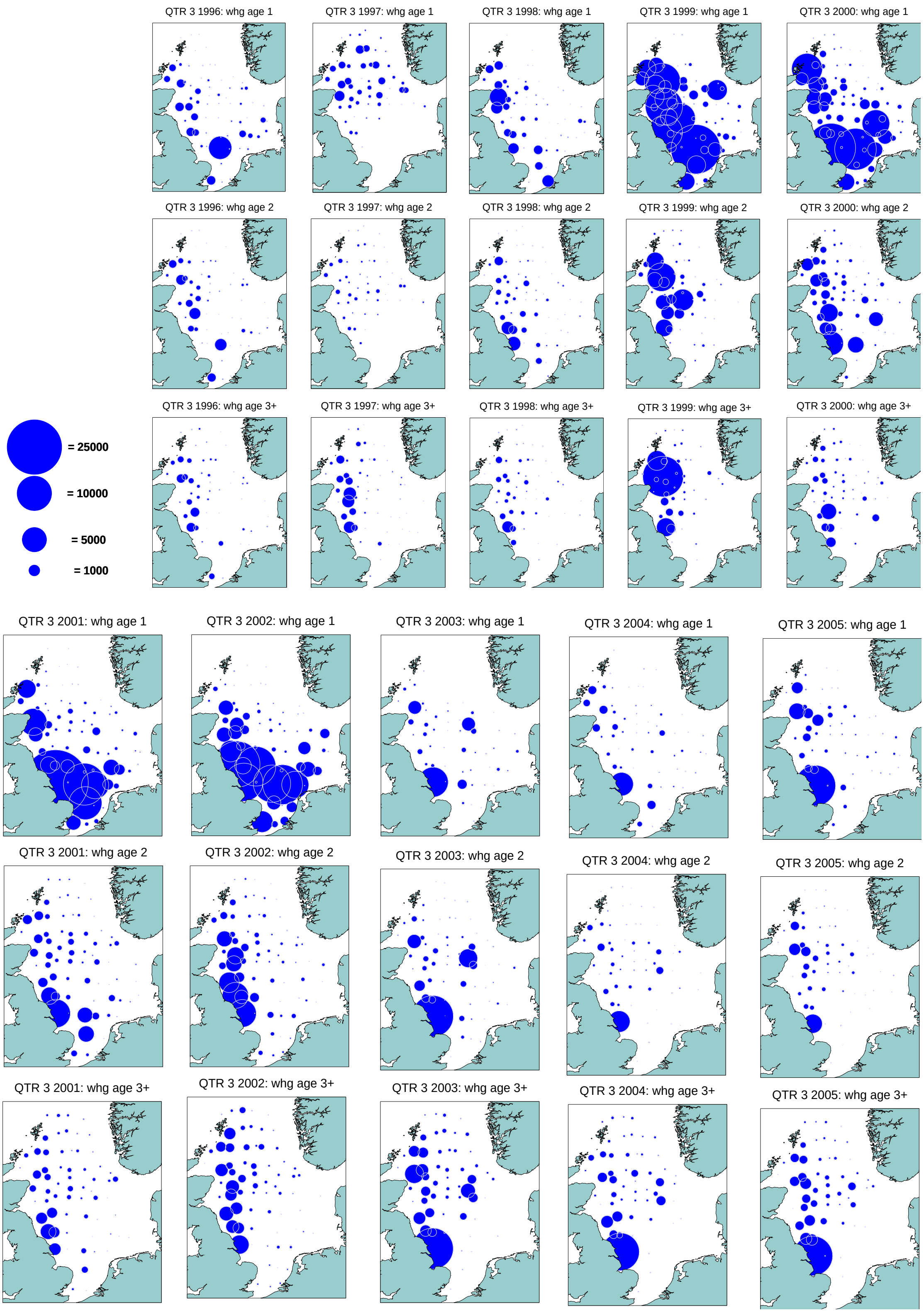


Figure 12.2.5 Whiting in IV and VIId. Distribution plot of the English Groundfish Survey.

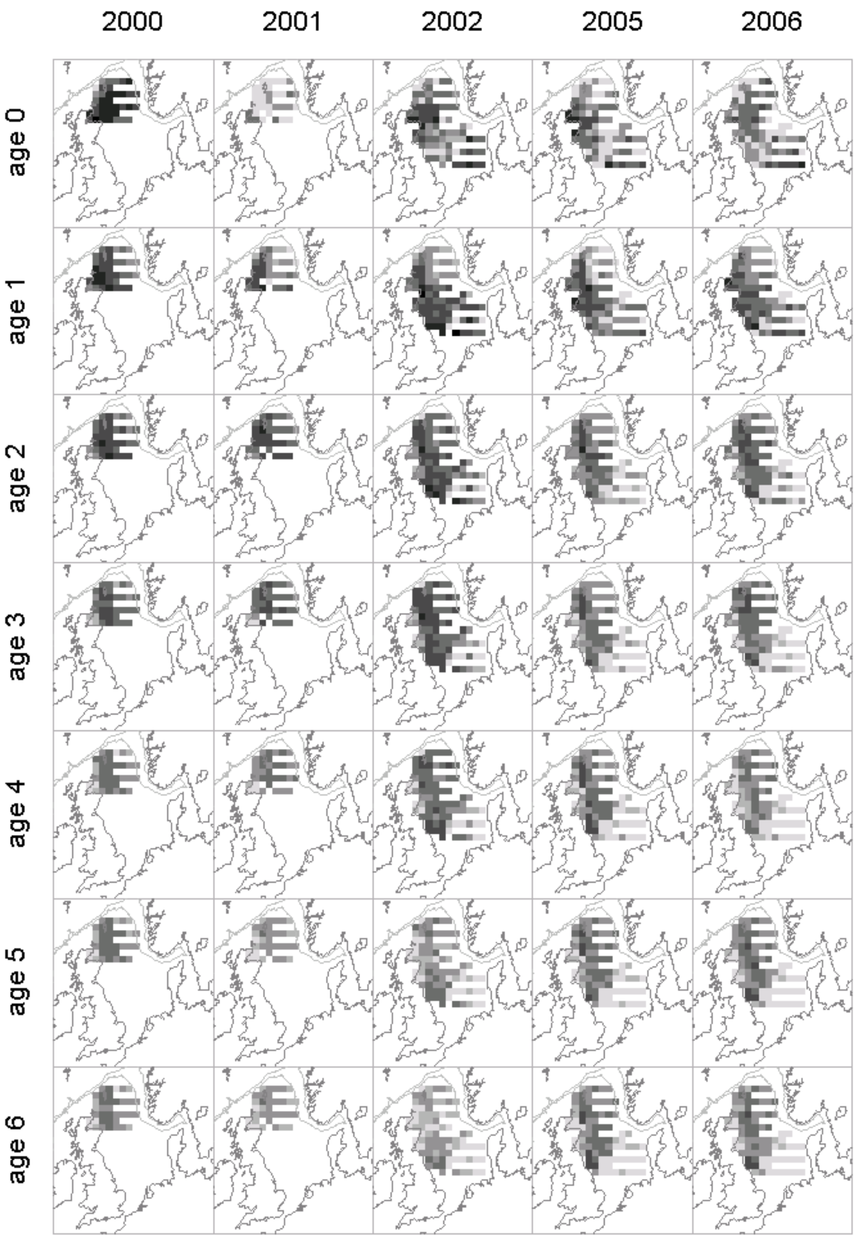


Figure 12.2.6 Whiting in IV and VIId. Distribution plot of the Scottish Groundfish Survey.

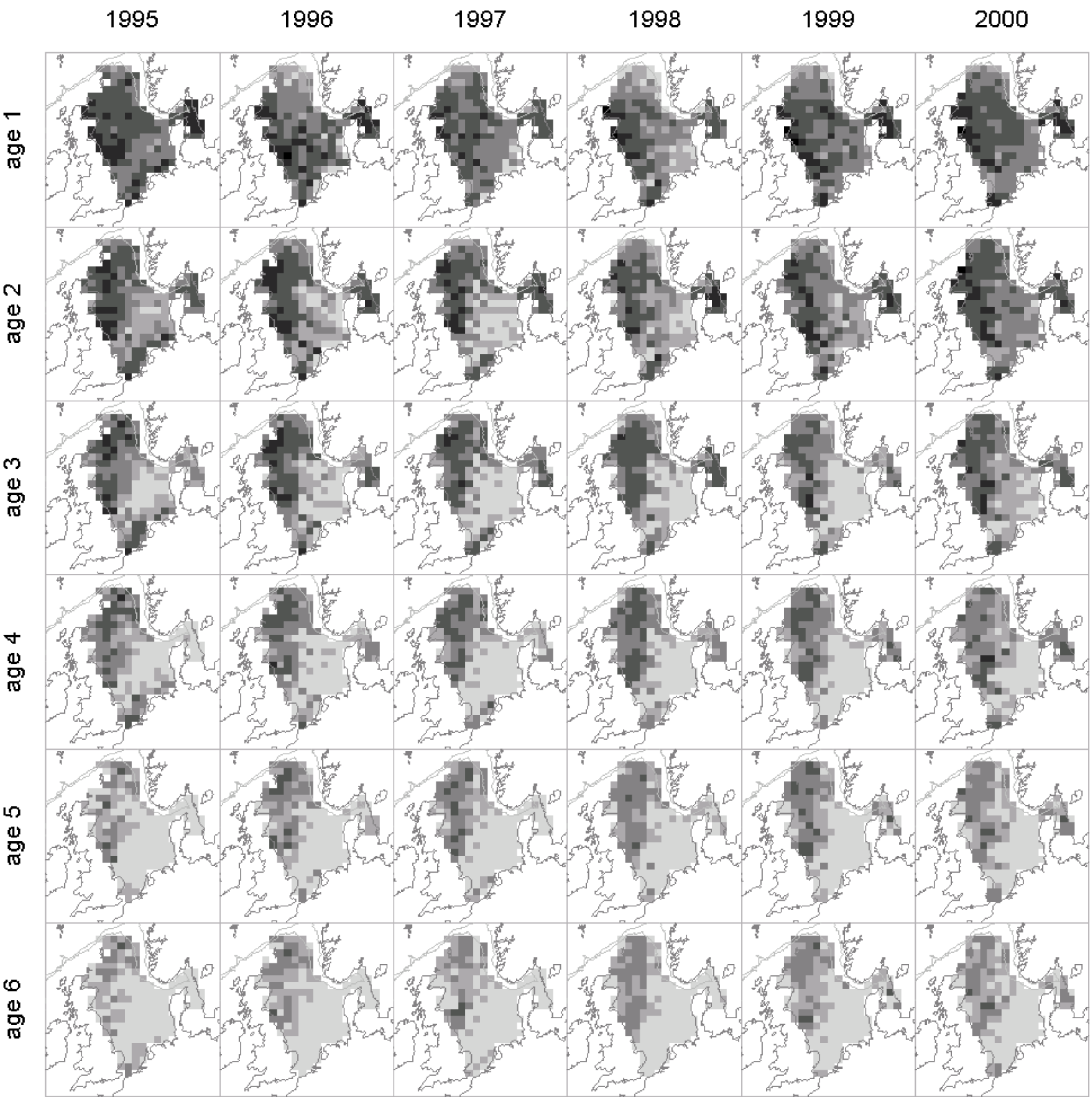


Figure 12.2.7 Whiting in IV and VIId. Distribution plot of the IBTS Survey.

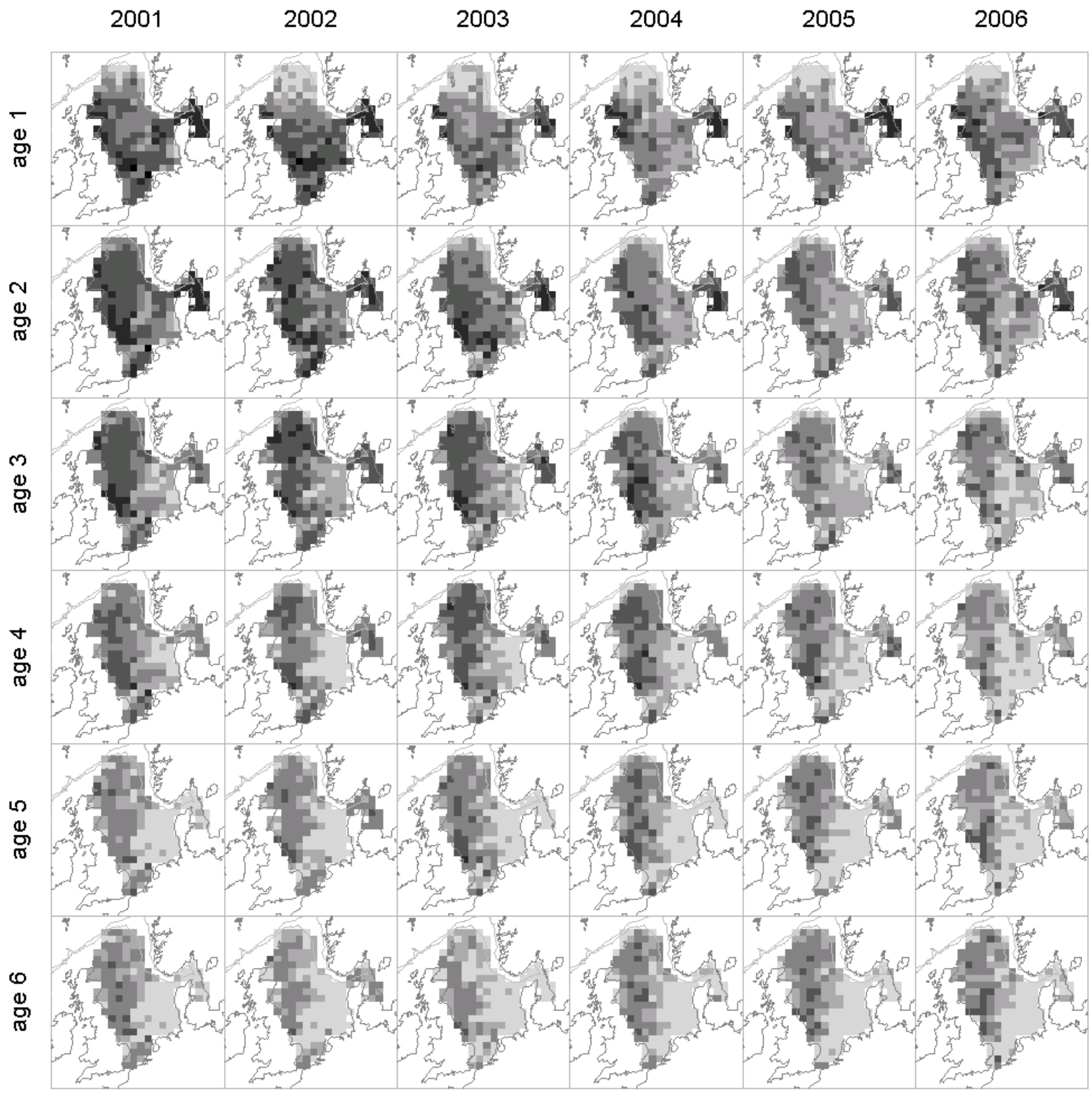


Figure 12.2.7 (cont.) **Whiting in IV and VIId. Distribution plot of the IBTS Survey.**

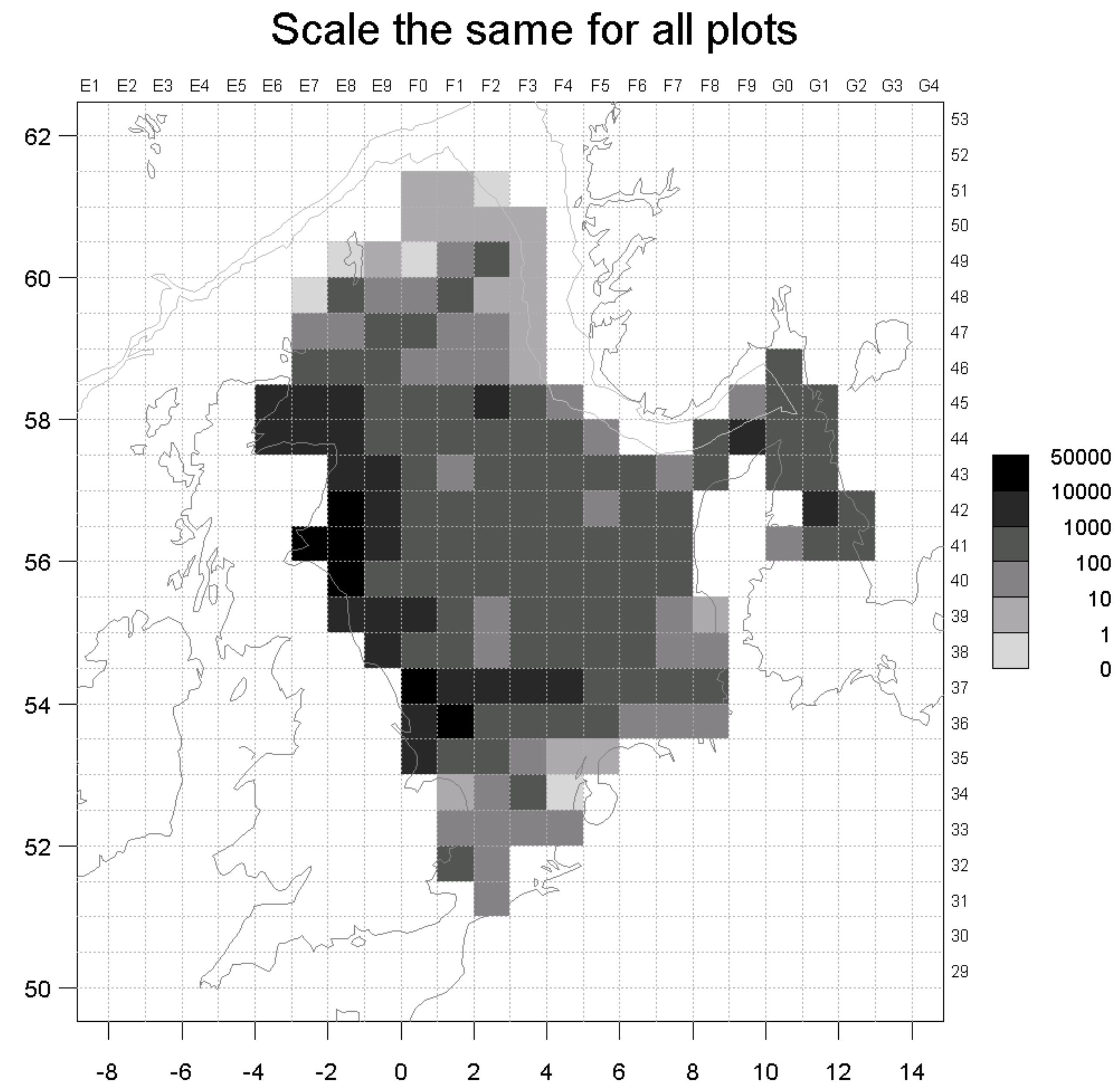


Figure 12.2.7 (cont.) **Whiting in IV and VIId. Distribution plot of the IBTS Survey – scale used.**

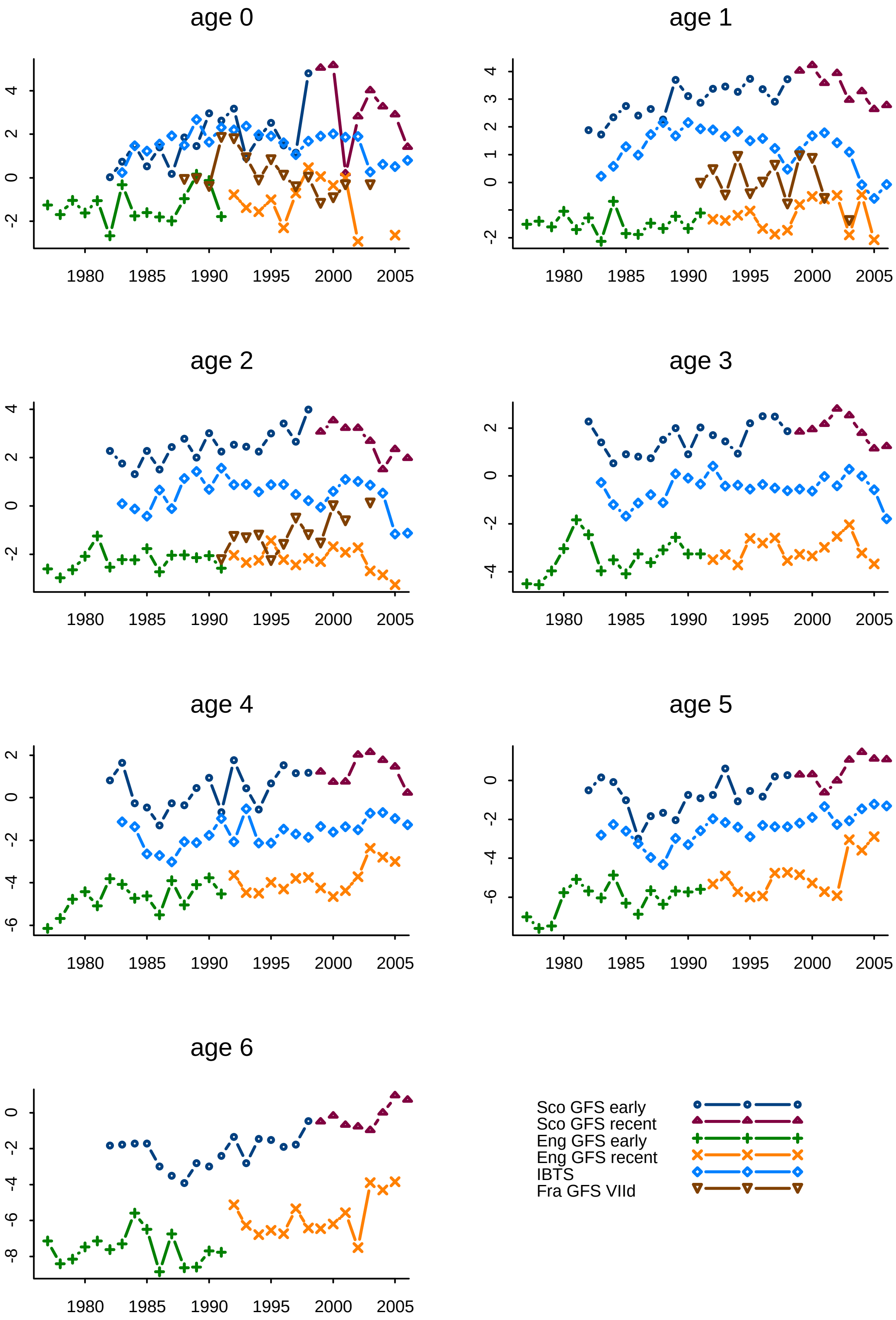


Figure 12.2.8 **Whiting in IV and VIId. Log CPUE (log numbers-per-hour) series for all available surveys.**

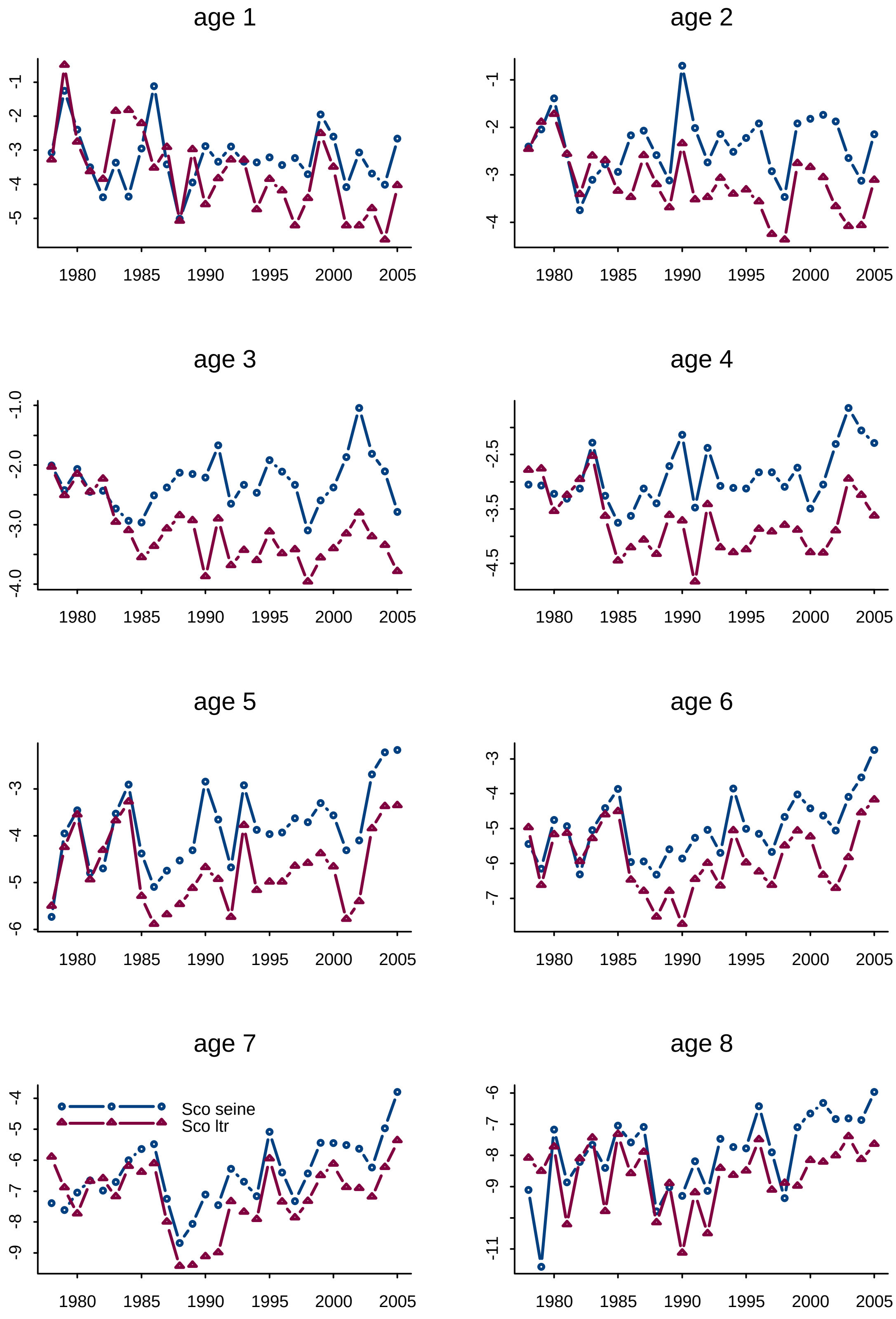


Figure 12.2.9 Whiting in IV and VIId. Log CPUE (log numbers-per-hour) series for two Scottish commercial fleets.

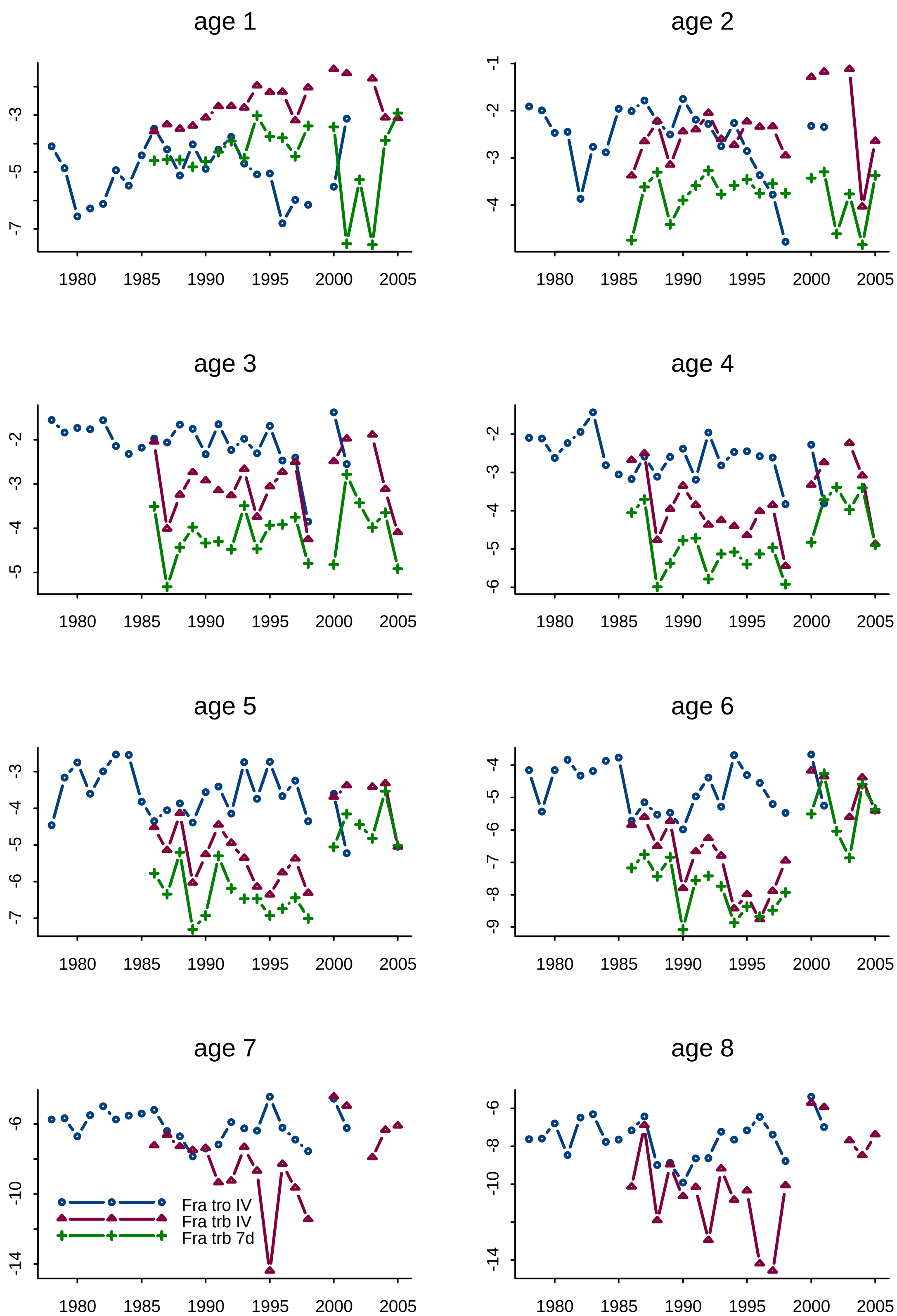


Figure 12.2.10 Whiting in IV and VIId. Log CPUE (log numbers-per-hour) series for three French commercial fleets.

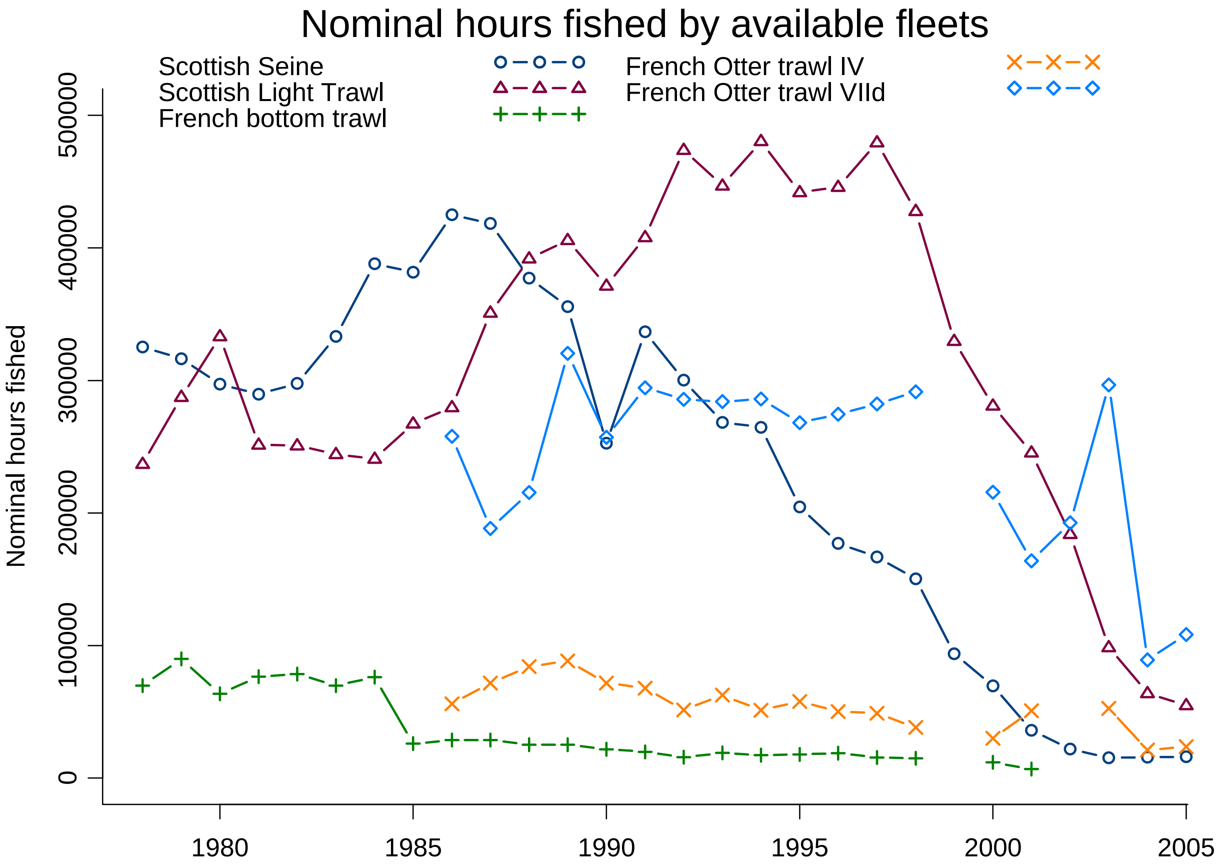


Figure 12.2.11 Whiting in IV and VIId. Nominal hours fished for all available commercial fleets.

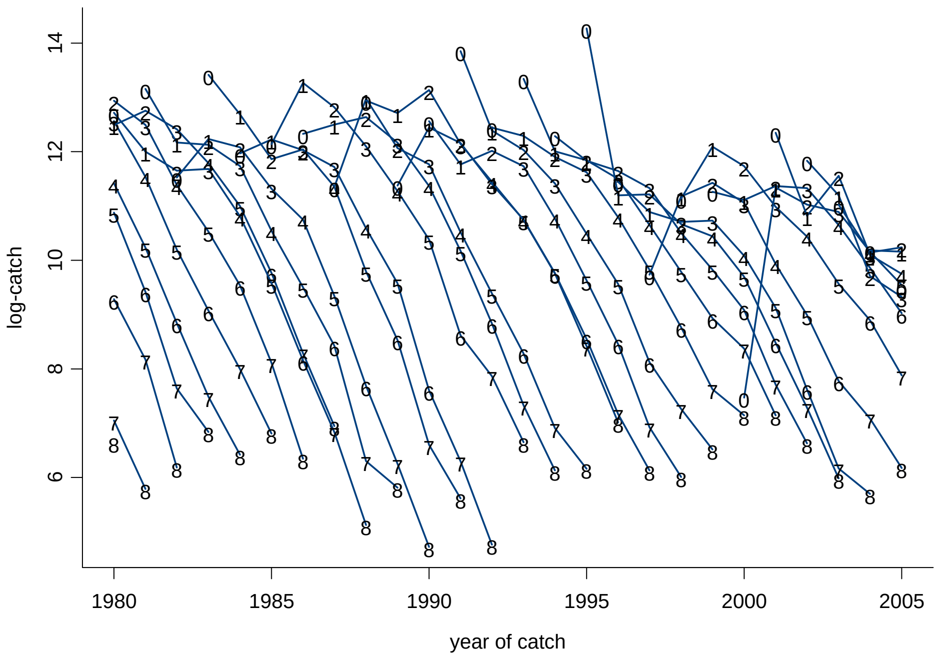


Figure 12.3.1 **Whiting in IV and VIId. Log catch-numbers linked by cohort for commercial catch data**

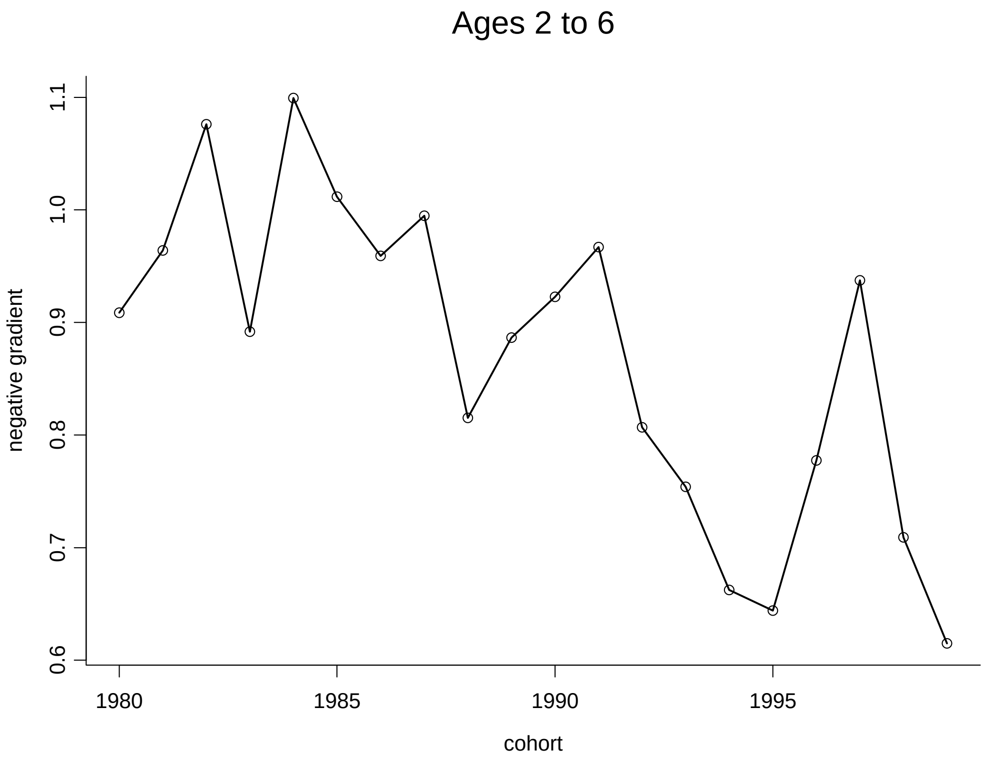


Figure 12.3.2 **Whiting in IV and VIId. Gradients of log-catches per cohort for the age range specified (2-6).**

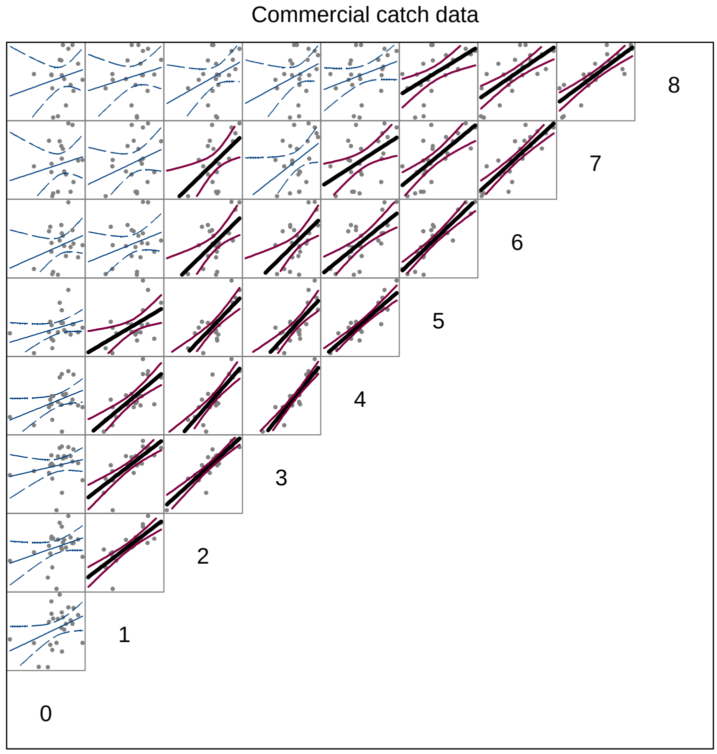


Figure 12.3.3 Whiting in IV and VIId. Correlations in the catch at age matrix (log numbers). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant (p<0.05) regression. Curved lines indicate approximate 95% confidence limits for the fitted lines.

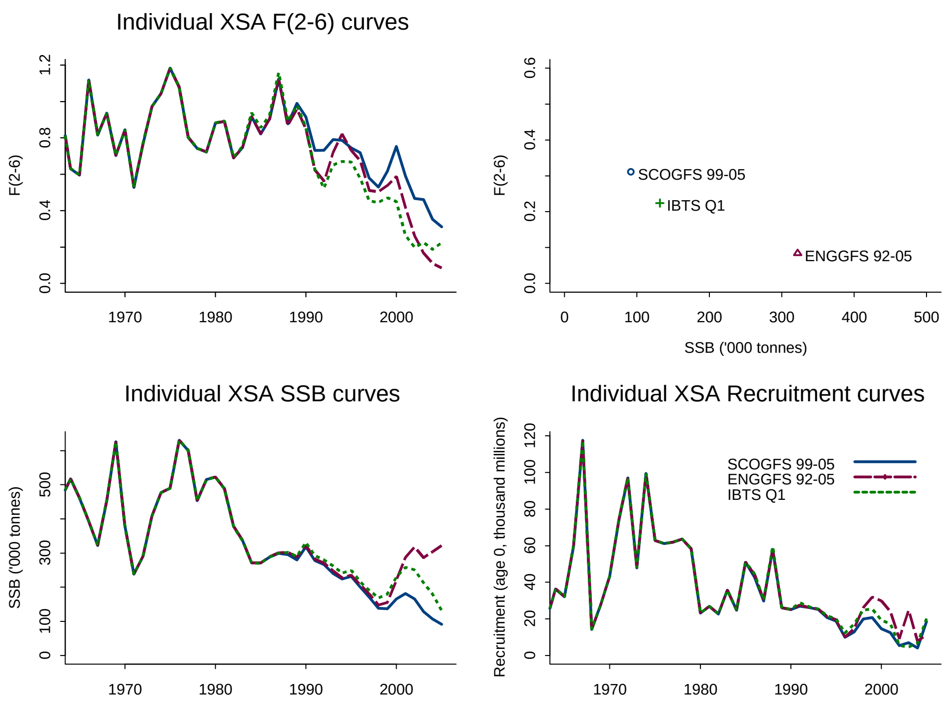


Figure 12.3.4 Whiting in IV and VIId. Comparison of F(2-6), SSB and recruitment time series for individual fleet XSA runs (with the same settings as this years final assessment).

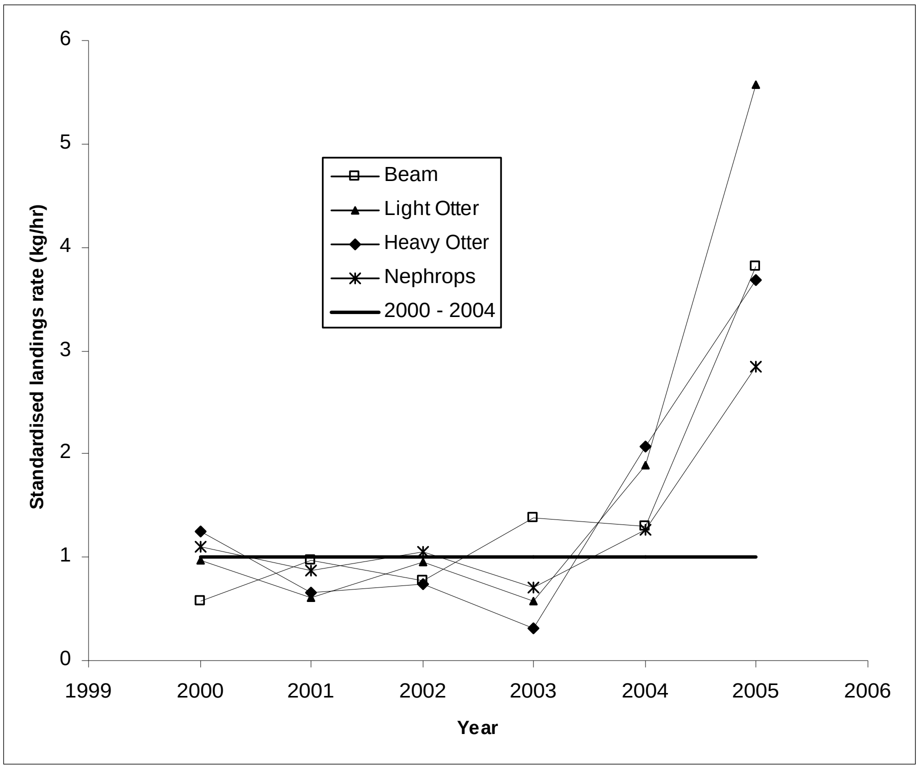


Figure 12.3.5 Whiting in IV and VIId. Time series of UK (Eng. & Wales) vessels, fishing on the northeast coast, standardised (to the average of 2000 – 2004) average annual landings per unit effort (kg/hr uncorrected for kw) during the years 2000 – 2005, illustrating the marked increase in catch rates from 2004 – 2005. From WD20.

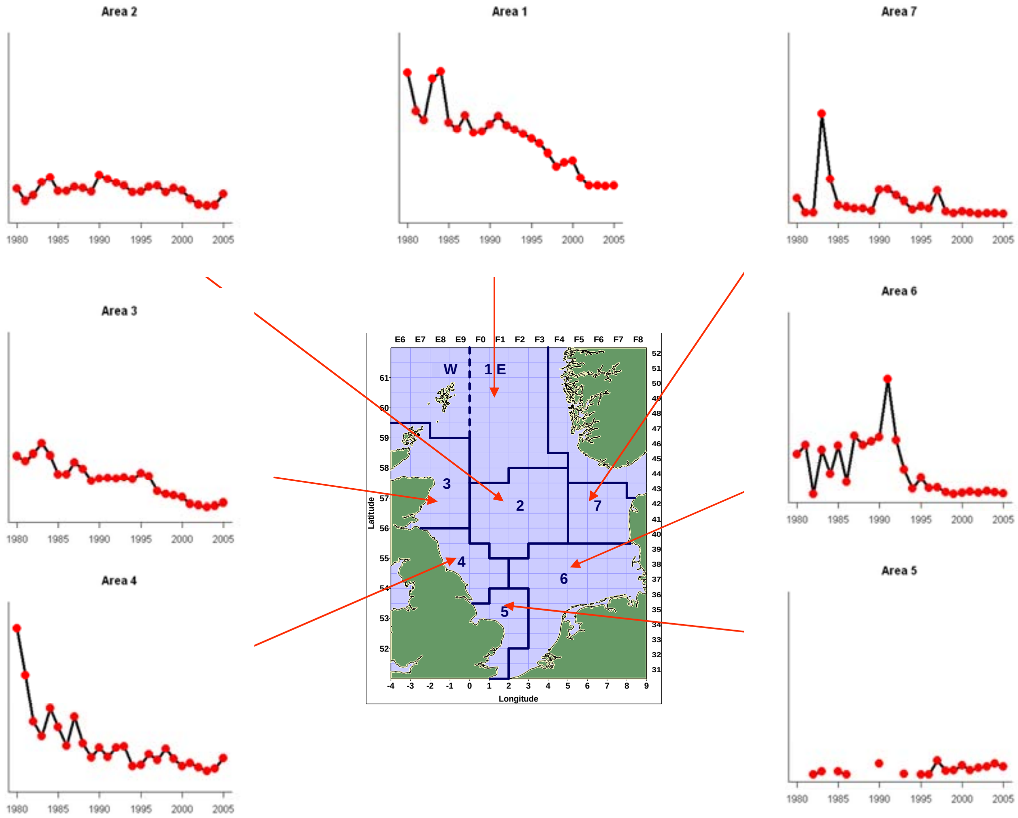


Figure 12.3.6 Whiting in IV and VIId. Spatial Scottish LPUE (tones per day at sea); all figures are on the same scale

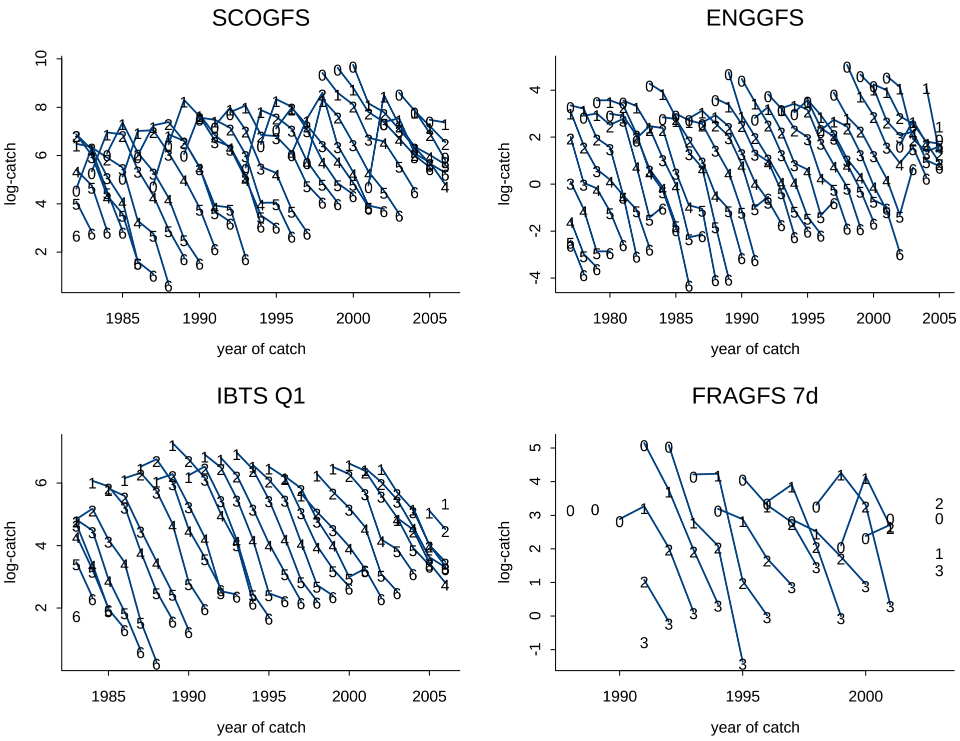


Figure 12.3.7 Whiting in IV and VIId. Log-abundance indices by cohort for each of the available survey series. (note for the IBTS Q1 age 6 is a plus group.)

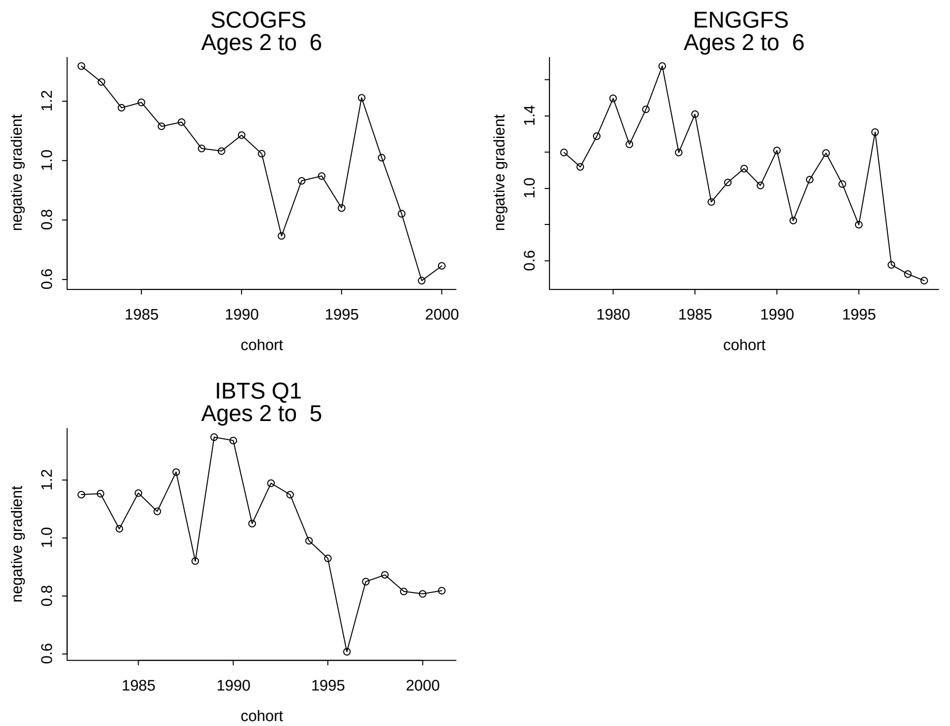


Figure 12.3.8 Whiting in IV and VIId. Gradients of log-abundance per cohort for each of the available survey series with the exception of the French GFS as this survey contains information few ages.

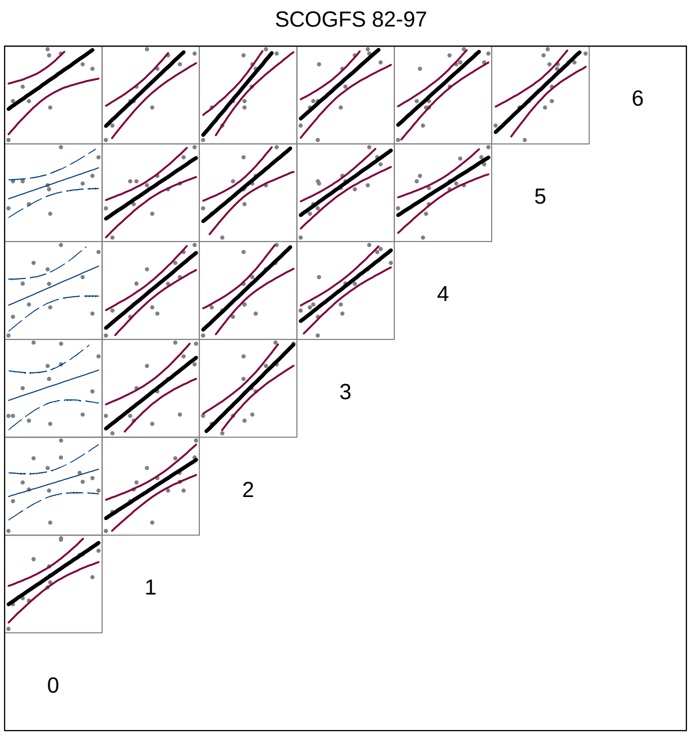


Figure 12.3.9 Whiting in IV and VIId. Within survey correlations for the Scottish groundfish survey (82-97). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant (p<0.05) regression and the curved lines are approximate 95% confidence intervals.

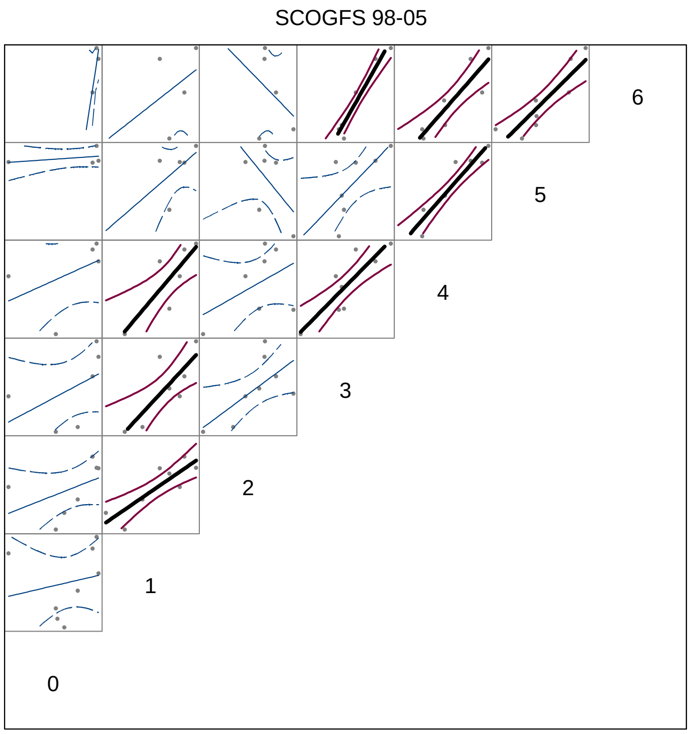


Figure 12.3.10 Whiting in IV and VIId. Within survey correlations for the Scottish groundfish survey (98-05). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant (p<0.05) regression and the curved lines are approximate 95% confidence intervals.

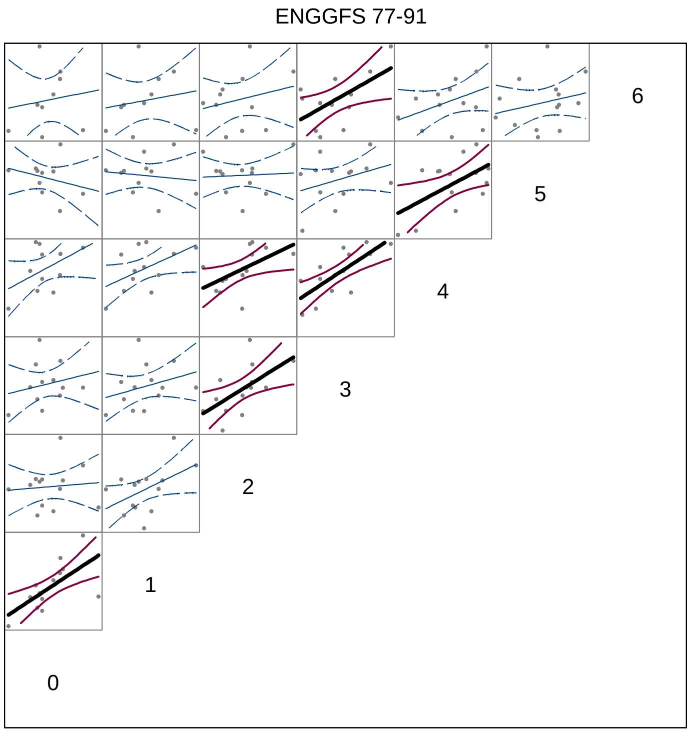


Figure 12.3.11 Whiting in IV and VIId. Within survey correlations for the English groundfish survey (77-91). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant ($p<0.05$) regression and the curved lines are approximate 95% confidence intervals.

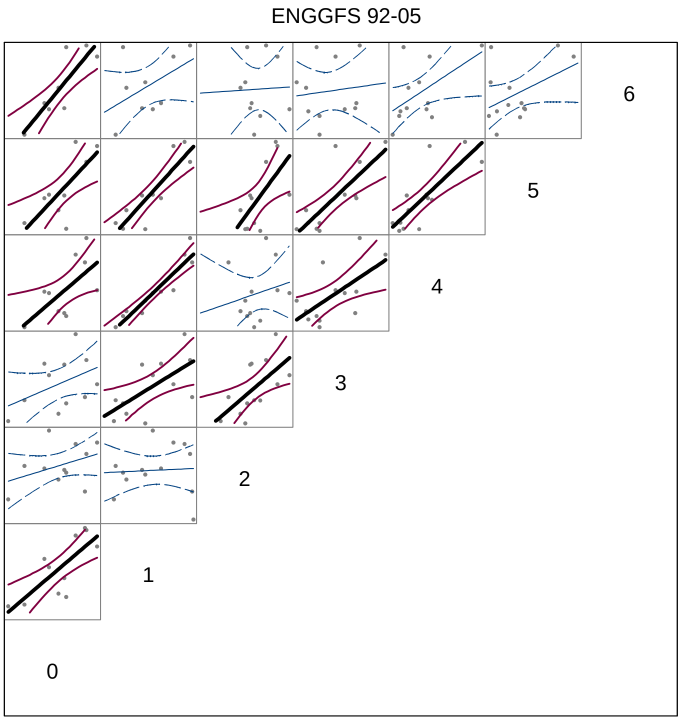


Figure 12.3.12 Whiting in IV and VIId. Within survey correlations for the English groundfish survey (92-05). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant ($p<0.05$) regression and the curved lines are approximate 95% confidence intervals.

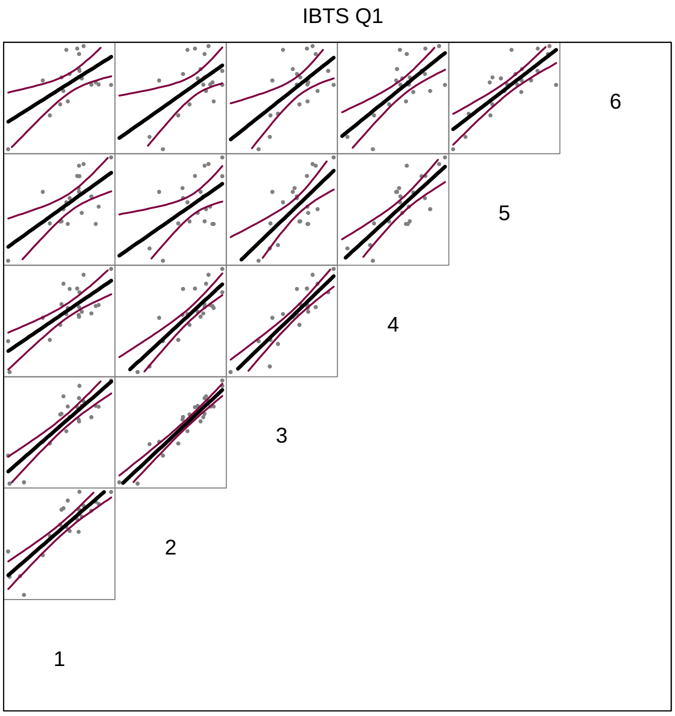


Figure 12.3.13 Whiting in IV and VIId. Within survey correlations for the IBTS survey. Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant (p<0.05) regression and the curved lines are approximate 95% confidence intervals.

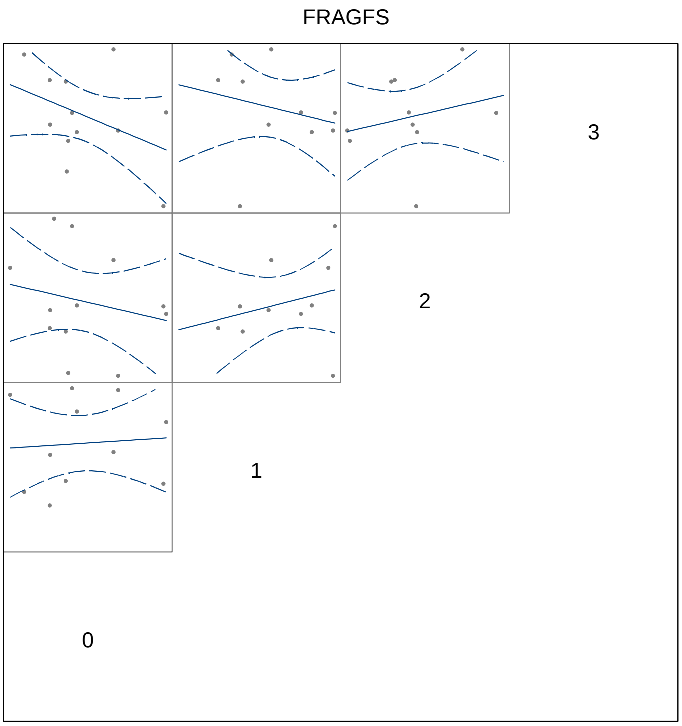


Figure 12.3.14 Whiting in IV and VIId. Within survey correlations for the French groundfish survey. Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant (p<0.05) regression and the curved lines are approximate 95% confidence intervals.

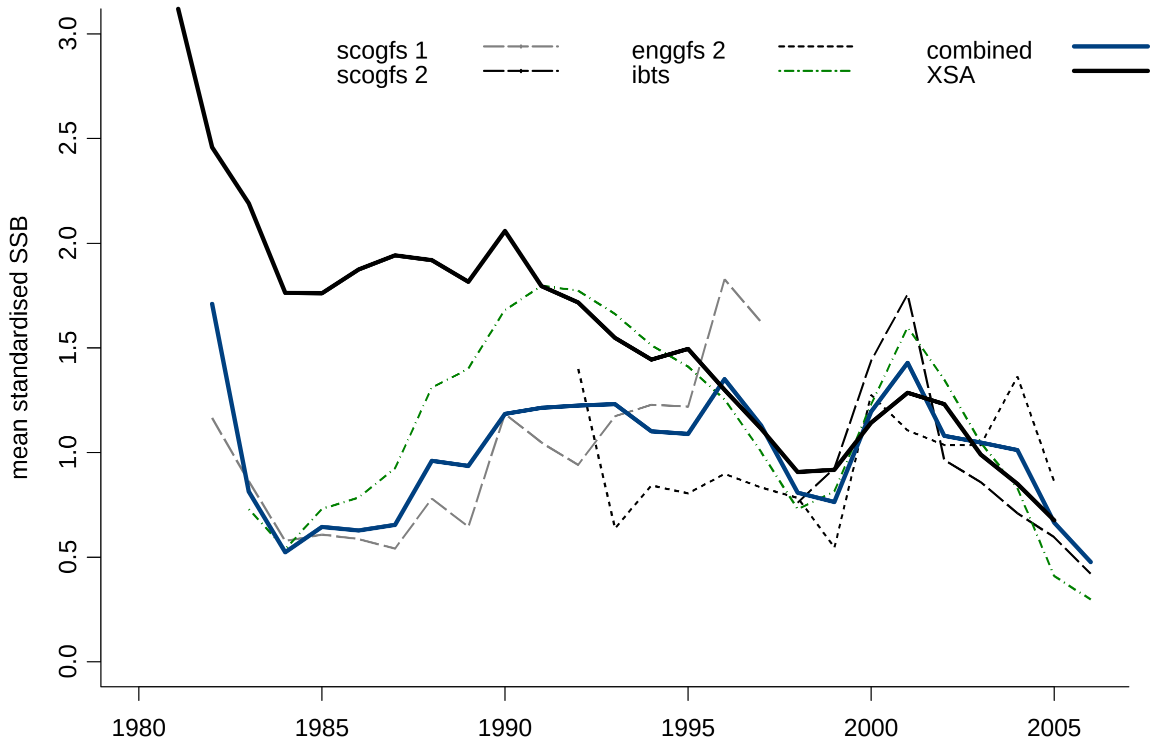


Figure 12.3.15 Whiting in IV and VIId. Comparison of SSB trends from SURBA runs and a mutli-fleet XSA run using last years setting (with shrinkage reduced to 2.0).

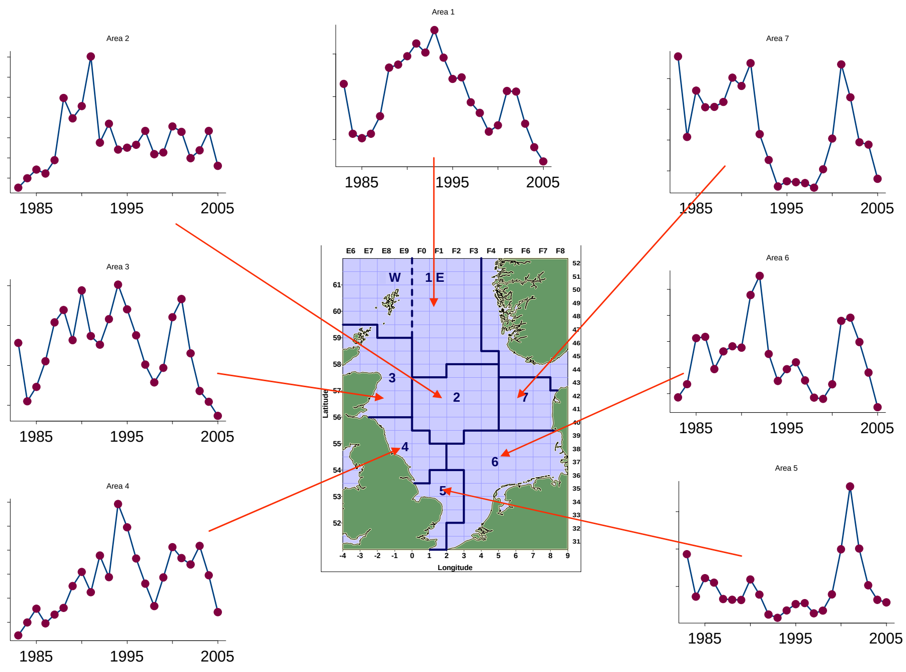


Figure 12.3.16 **Whiting in IV and VIId. Surba estimated SSB by IBTS roundfish area.**

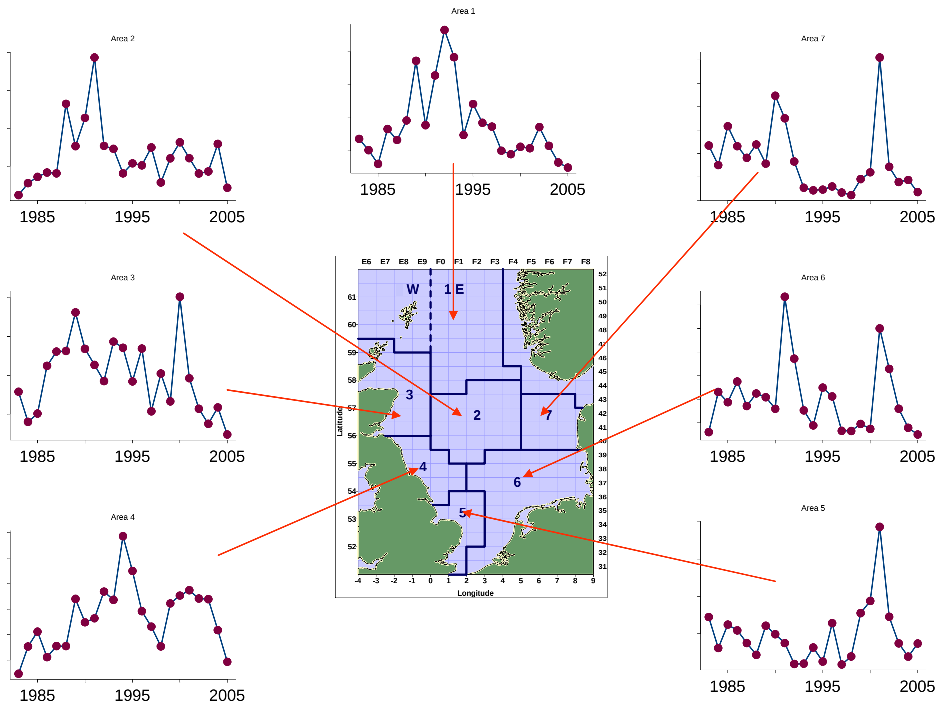


Figure 12.3.17 **Whiting in IV and VIId. IBTS CPUE (kg / hr) by IBTS roundfish area.**

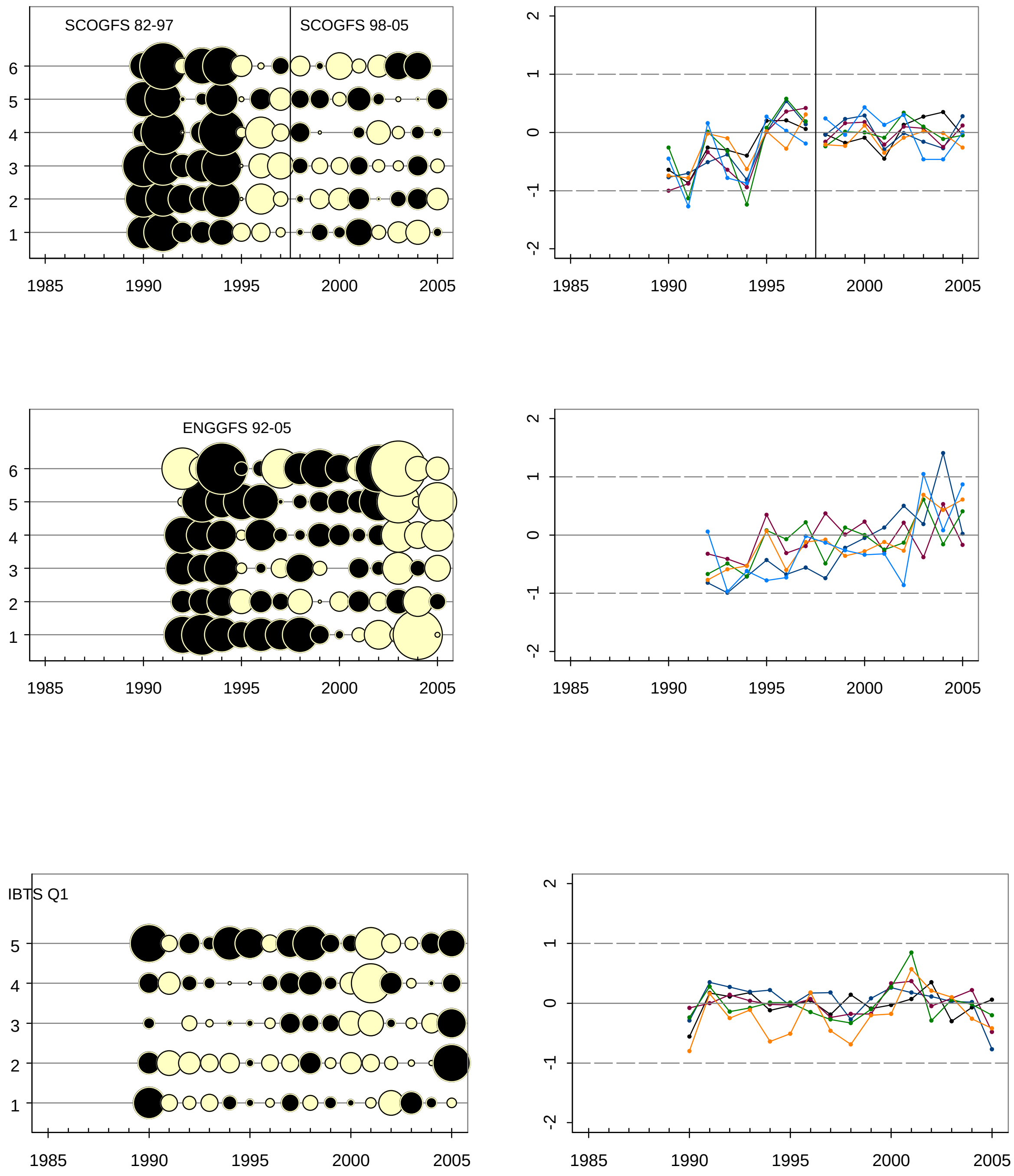
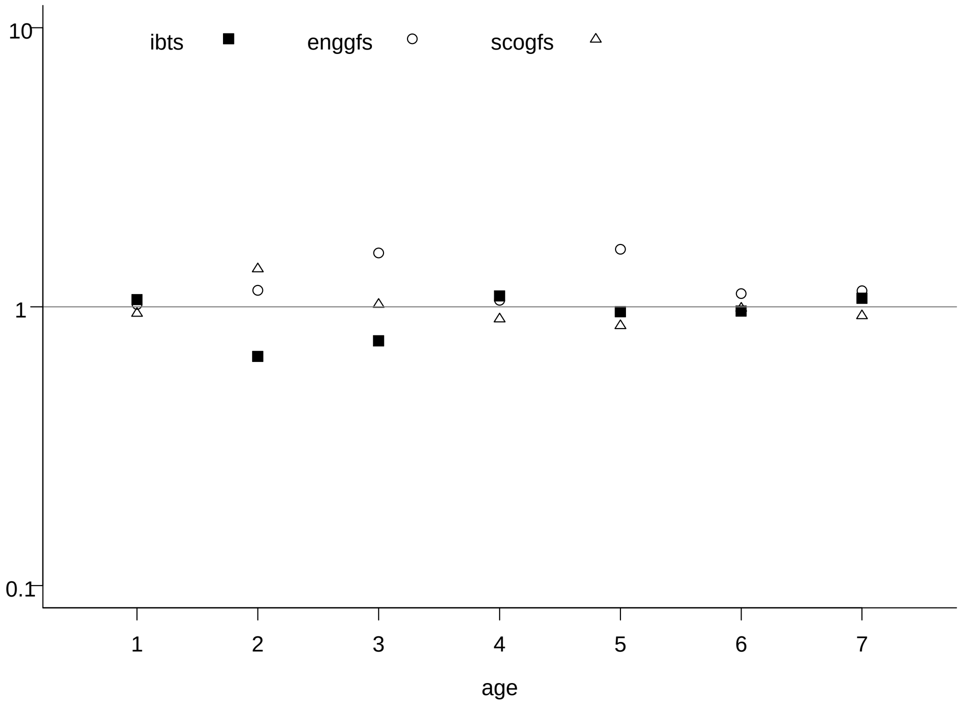


Figure 12.3.18 Whiting in IV and VIId. XSA final run: log catchability residuals. The two halves of the SCOGFS and the ENGGFS are treated separately as independent tuning series.



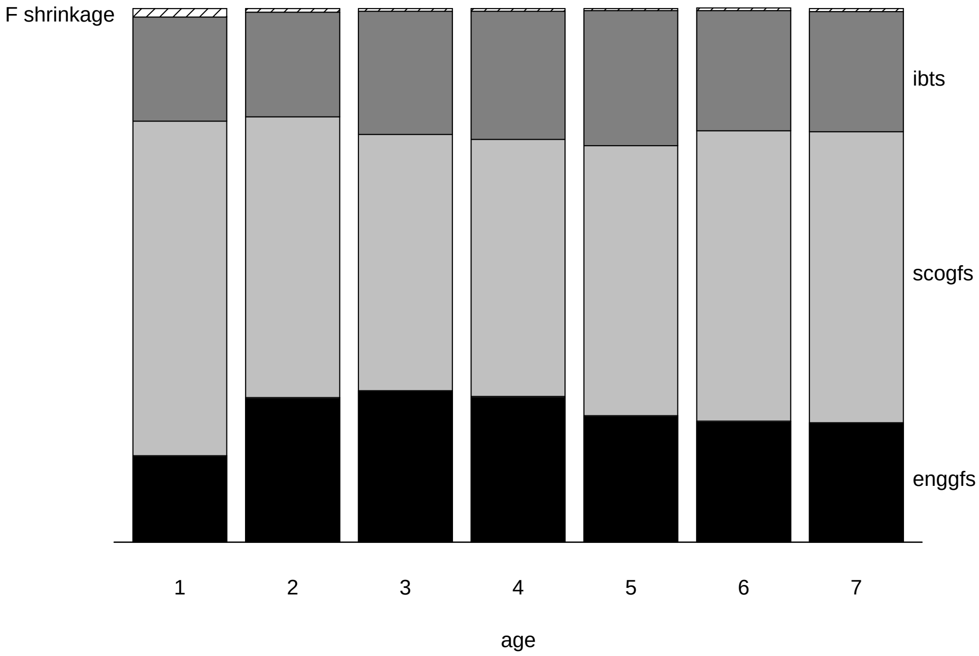


Figure 12.3.19 Whiting in IV and VIId. XSA final run: comparison of (a) fleet survivor ratios and (b) fleet weights. Note: only three fleets, ENGGFS (92-05), SCOGFS (98-05) and IBTS Q1, contribute to the survivor estimates in the final year.

Figure 12.3.20 Whiting in IV and VIId. XSA final run: Summary plots. The dotted horizontal lines indicate Fpa, Flim, Bpa and Blim.

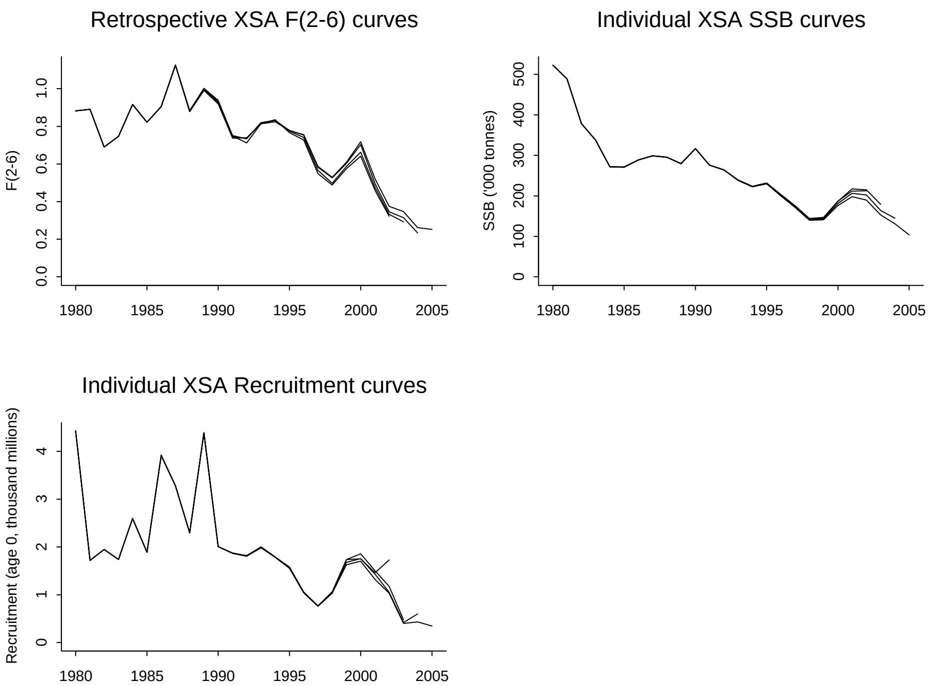


Figure 12.3.21 Whiting in IV and VIId. XSA final run: Retrospective patterns.

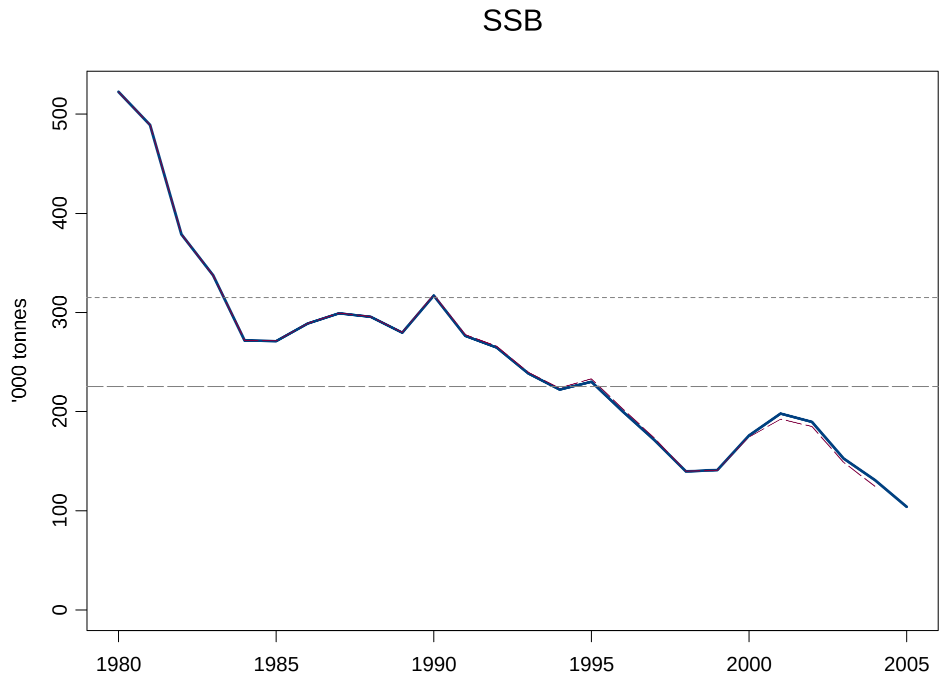


Figure 12.4.1 Whiting in IV and VIId. Historical stock trends in SSB (last years final runs shown as a dotted line).

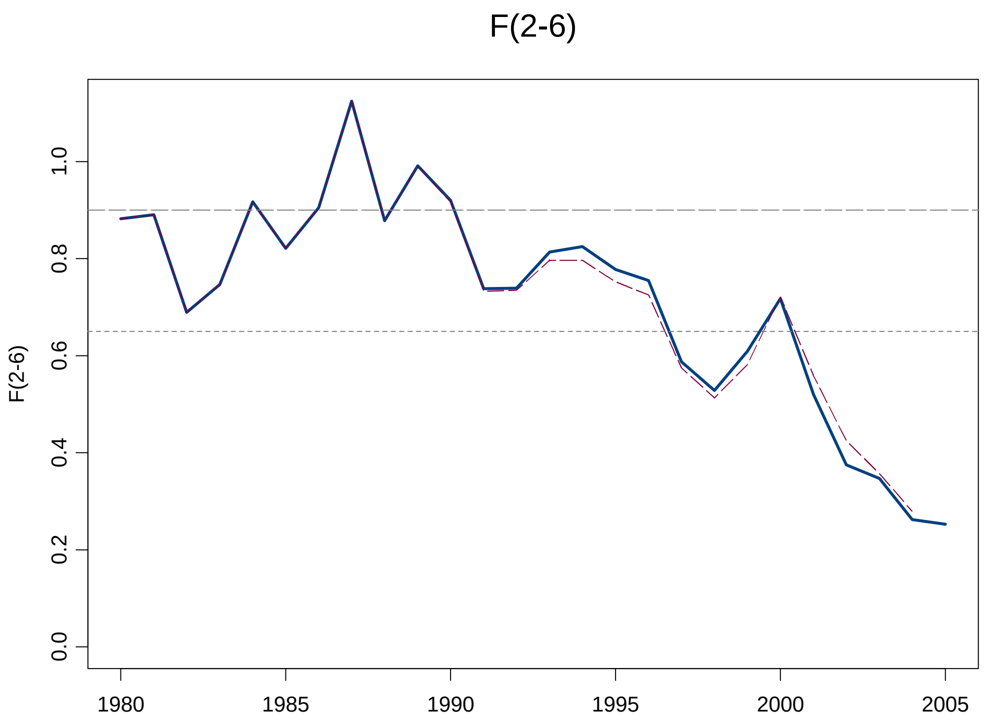


Figure 12.4.2 Whiting in IV and VIId. Historical stock trends in F(2-6) (last years final runs shown as a dotted line).

Figure 12.4.3 Whiting in IV and VIId. Historical stock trends in recruitment (last years final runs shown as a dotted line).

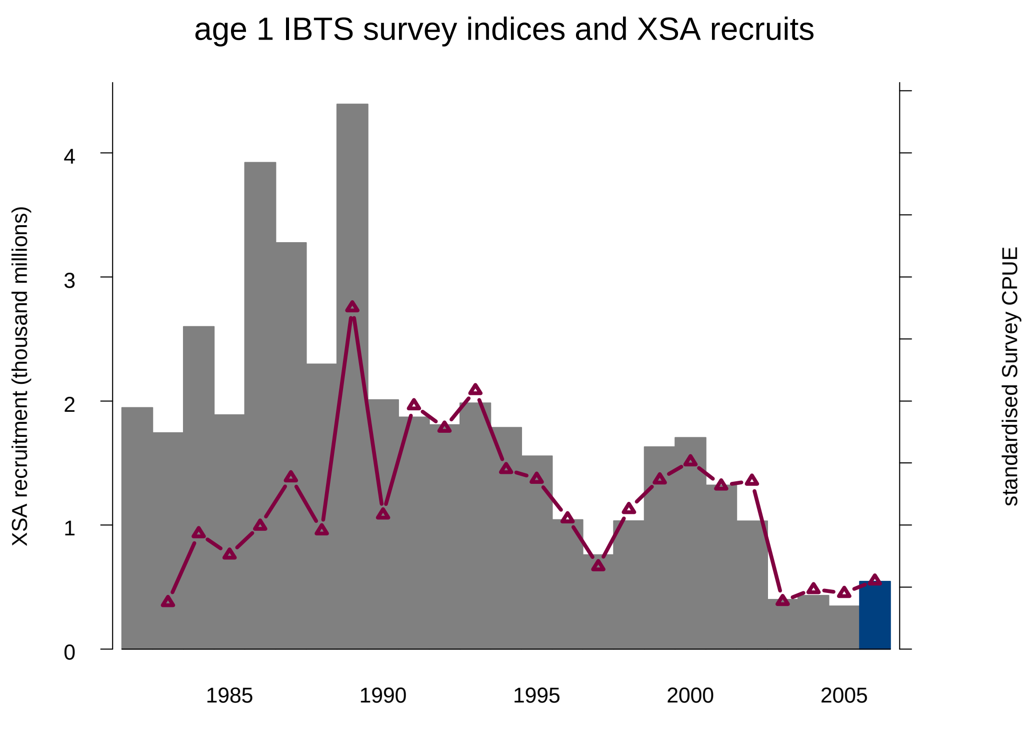


Figure 12.5.1 Whiting in IV and VIId. Recruitment estimates from XSA, the RCT3 estimate of recruitment on 2006 and the IBTS age 1 index (scaled by linear regression).

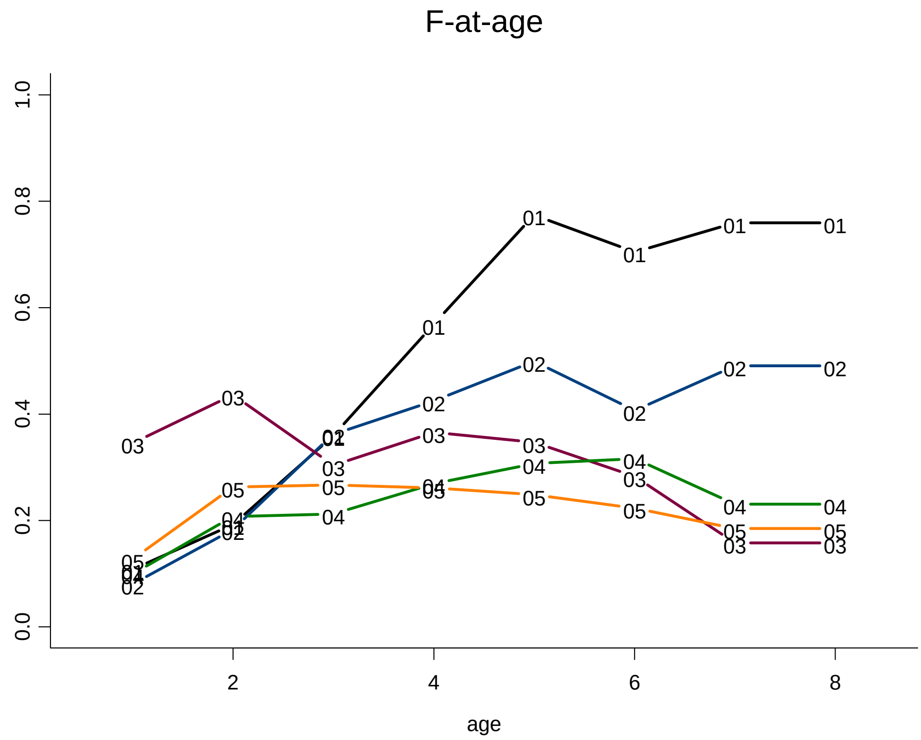


Figure 12.6.1 Whiting in IV and VIId. Estimated fishing mortality at age for the years 2001 to 2005.

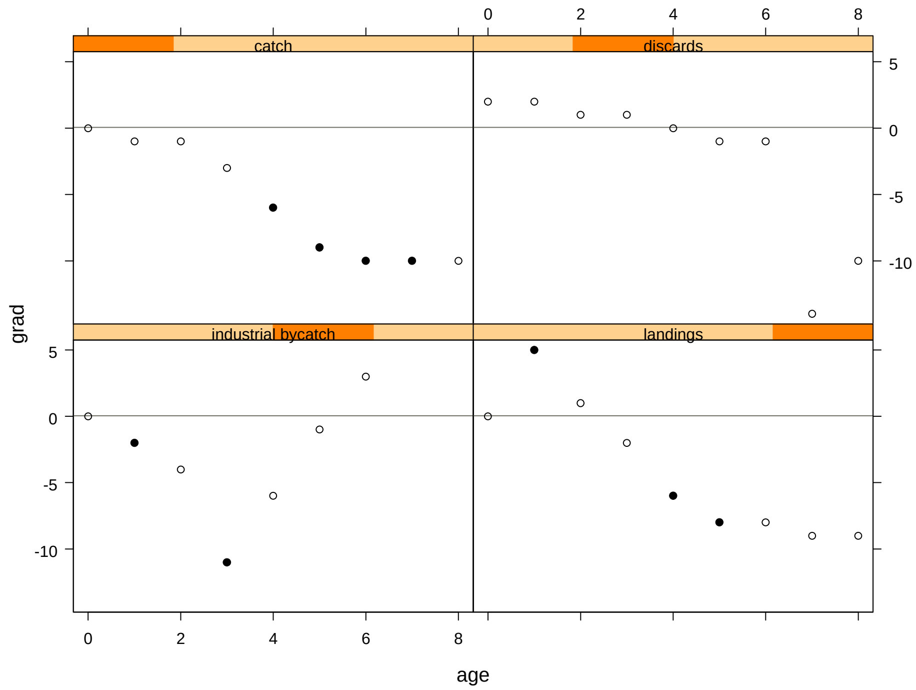


Figure 12.6.2 Whiting in IV and VIId. Gradients (grams per year) of mean weights at age estimated y linear model for each catch component over the period 1995-2005. Full circles mean the regression gradient coefficient was significant.

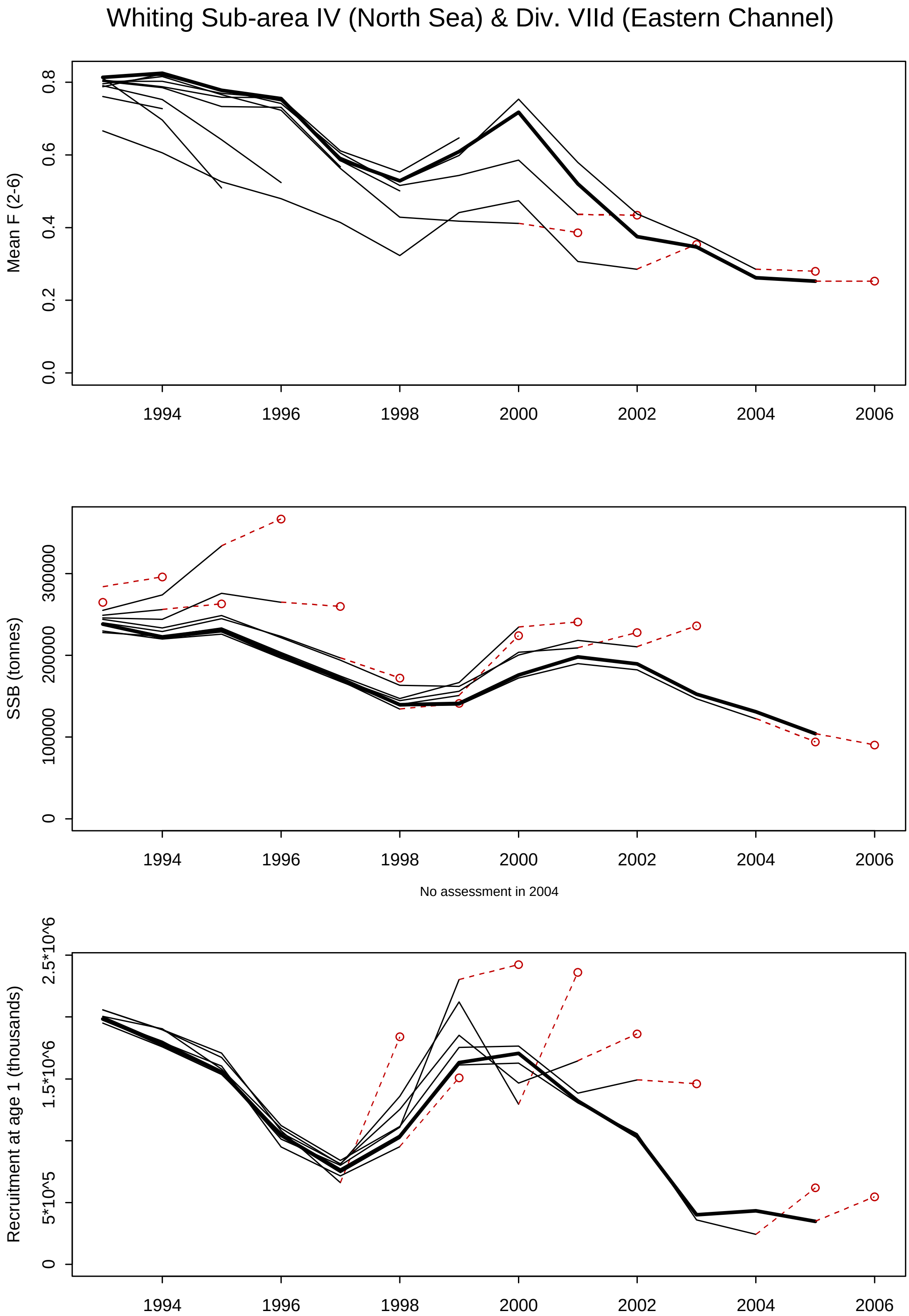


Figure 12.9.1 Whiting in IV and VIId. Historical performance of the assessment. Circles indicate forecasts.

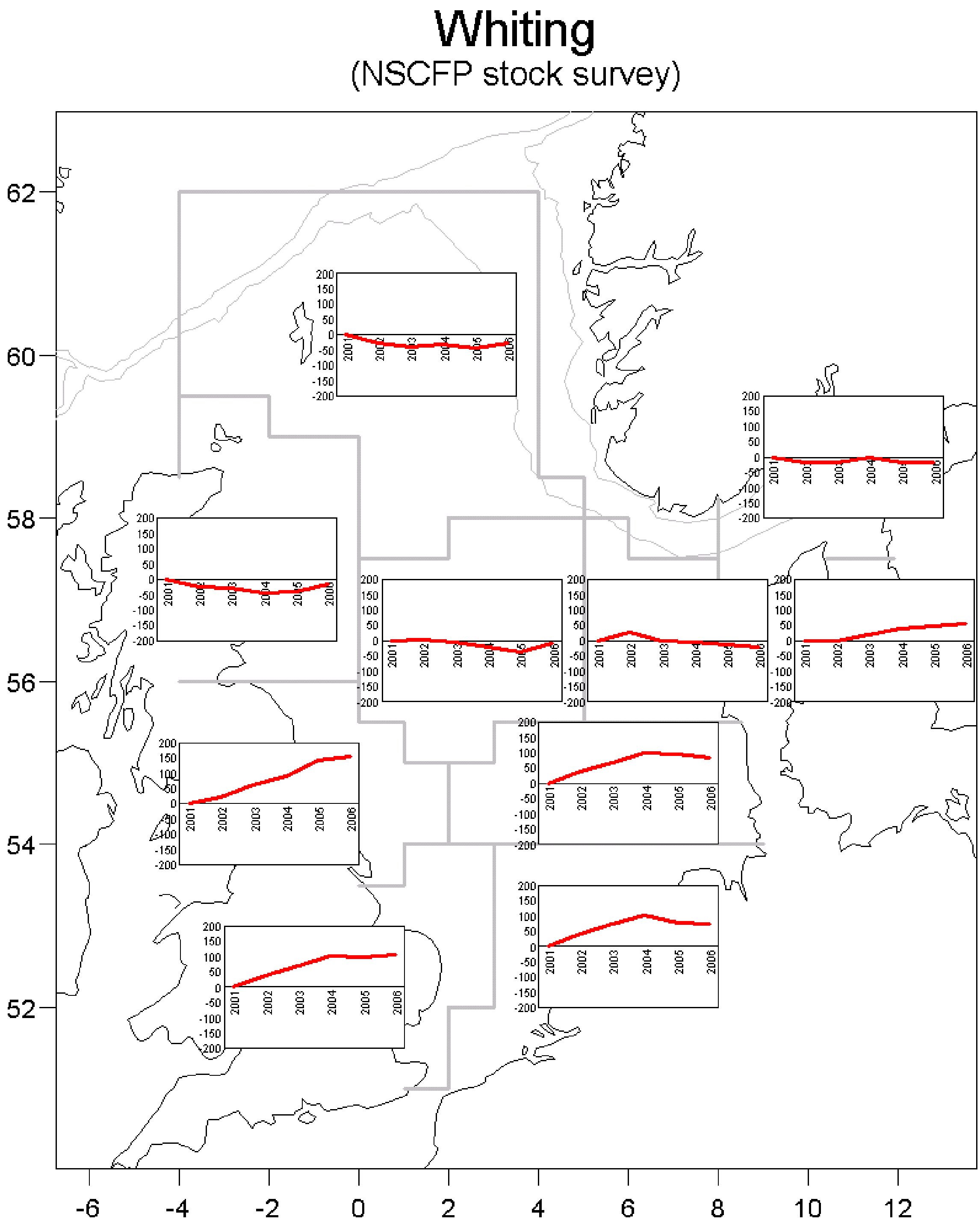


Figure 12.10.1 **Whiting in IV and VIId. North Sea Commision Fisheries Partnership Stock Survey.**

13 Haddock

The assessment of haddock in sub-area IV and division IIIa is presented as an update assessment.

13.1 General

13.1.1 Ecosystem aspects

Haddock in sub-area IV and division IIIa occupy the northern and central North Sea and Skagerrak and are possibly linked to the division VIa stock on the West of Scotland. Haddock tend not to live below 300m, but prefer depths between 50m and 200m. They are found as juvenile fish in coastal areas in particular in the Moray Firth, around Orkney and Shetland, along the continental shelf at around 200m and continuing round to the Skagerrak. Adult fish are found around Shetland and more centrally in the northern North Sea near the continental shelf edge. They are characterised by sporadically high recruitment leading to dominant year classes in the fishery. These large year-classes tend to lead to slow growth possibly due to density dependent effects. They primarily prey on benthic and epibenthic invertebrates, sandeels and demersal egg deposits of herring. They are an important prey species for mainly saithe and other gadoids.

13.1.2 Fisheries

A general description of the fishery is presented in the stock annex. Most of the information presented in this section pertains to the Scottish fleet, which takes a large proportion of the haddock stock. A more general description of changes in the Scottish fleet can be found in Section 2.1.4.

The number of Scottish based vessels (over 10m) in the demersal sector was reduced by approximately one third during 2002 and 2003, the bulk of this being due to vessels accepting decommissioning. Although the decommissioning scheme encompassed all vessel types and sizes, a significant number of the vessels which eventually accepted terms were of the older class of vessel. The remaining vessels continue with the same fishing methods, although it would appear that there has been a reduction in the segment operating seine net or pair seine. Although the observed shift towards pair trawling from single boat seine and trawls in the early 2000’s may have implied an increase in catchability, the decommissioning rounds in 2002 and 2003 included a slightly higher proportion of pair trawlers, resulting in no real overall change in fleet composition.

More recently (2005-6) increased fuel prices have resulted in a shift from twin trawl to single trawl and pair seine/trawl by many boats in the Scottish demersal mixed fishery sector (ICES-WGFTFB 2006). Furthermore, there has been an expansion in 2005 in the squid fishery in the Moray Firth area resulting from an increase in effort from smaller (<10m) vessels, and from a number of larger vessels that have switched from demersal fisheries for haddock and cod to squid fisheries to avoid days-at-sea restrictions (ICES-WGFTFB 2006). The mesh regulation for squid fishing is 40mm codend, which could lead to bycatch/discard of young haddock and cod. The shift into the squid fishery does not seem to have re-occurred in 2006.

With the reduced cod quota, many vessels have tended to concentrate more on the haddock fishery, with others taking the opportunity to move between the *Nephrops* and demersal fisheries. With the change in emphasis towards the haddock fishery, an increase in the inshore sector had been anticipated. However, this did not materialise in 2006. The traditional grounds have been poor. The fleet is having to travel considerable distances (70 miles and further east) to find haddock, although those fish that are caught are reported to be of good sizes. The medium-sized fish which predominated in catches in 2005 are now less prevalent than larger fish. The industry perceived this to be evidence of improved growth of the 1999 year-class in 2006. Substantial numbers of juvenile haddock (probably the 2005 year-class) have started appearing in catches. This supports survey-based indications that this year-class is strong (relative to the previous four).

There is some evidence of Scottish whitefish boats moving between Areas IVa and VIa to retain haddock and monkfish quotas and create track records in both areas, and of misreporting of haddock and other species caught in VIa and b, these being landed as IVa (implying inaccurate landings data for Scotland; ICES-WGFTFB 2006). It is not possible to quantify the extent of this problem.

Haddock are still the mainstay of the Scottish whitefish fleet. Quota uptake so far in 2006 is on the low side and the quota may not be fully taken. This is thought to be due to periodic poor markets earlier in the year, during which skippers decided to reserve their quota for a time when prices improved.

There has been an increase in haddock landings values by the Danish Seine fleet in the North Sea, although no increase in effort levels for this fleet (ICES-WGFTFB 2006).

13.1.3 ICES Advice

In 2005, based on the most recent estimate of SSB and fishing mortality, ICES classified the stock as having full reproductive capacity and being harvested sustainably. SSB for 2004 was estimated at 289 000 t, with an estimated decrease to around 266 000 t for 2005. SSB was considered to be well above the Bpa of 140 000 t. However, ICES noted that the 2001–2004 year classes were all estimated to be well below average. Indications from surveys and industry were that the 2005 year-class would be above the long-term geometric mean.

Fishing mortality for 2004 was estimated at 0.31, well below Fpa = 0.7. Following the agreed management plan (F=0.3) would imply human consumption landings of 39 400 t in 2006 which is expected to lead to an SSB of 225 800 t in 2007.

For all demersal fisheries in the North Sea, ICES advice was based on mixed-fishery considerations and it advised the following:

Fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2006 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- with minimal bycatch or discards of cod;
- implement TACs or other restrictions that will curtail fishing mortality for those stocks … for which reduction in fishing pressure is advised;
- within the precautionary exploitation limits for all other stocks;
- where stocks extends beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;
- with minimum by-catch of spurdog, porbeagle and thornback ray and skate.

13.1.4 Management

In 1999 the EU and Norway have *"agreed to implement a long-term management plan for the haddock stock, which is consistent with the precautionary approach and is intended to constrain harvesting within safe biological limits and designed to provide for sustainable fisheries and greater potential yield." The agreement was updated in November 2004:*

"The plan shall consist of the following elements:

1. *Every effort shall be made to maintain a minimum level of Spawning Stock Biomass (SSB) greater than 100,000 tonnes (Blim).*
2. *For 2005 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.30 for appropriate age groups.*
3. *Should the SSB fall below a reference point of 140,000 tonnes (Bpa), the fishing mortality rate referred to under paragraph 2, shall be adapted in the light of scientific estimates of the conditions then prevailing. Such adaptation shall ensure a safe and rapid recovery of SSB to a level in excess of 140,000 tonnes.*
4. *In order to reduce discarding and to enhance the spawning biomass of haddock, the Parties agreed that the exploitation pattern shall, while recalling that other demersal species are harvested in these fisheries, be improved in the light of new scientific advice from inter alia ICES.*
5. *A review of this arrangement shall take place no later than 31 December 2006.*
6. *This arrangement enters into force on 1 January 2005."*

ICES considers that the agreed Precautionary Approach reference points in the management plan are consistent with the precautionary approach, provided they are used as lower boundaries on SSB, and not as targets.

Annual management of the fishery operates through TACs. The 2005 and 2006 TACs for haddock in Sub-Area IV and Division IIa (EC waters) were 66 000 and 51 850 t respectively, while these TACs for Divisions IIIa-d were 4 018 t and 3 189 t respectively.

EU technical regulations in force are contained in Council Regulation (EC) 850/98 and its amendments. The regulation prescribes the minimum target species composition for different mesh size ranges. In 2001, haddock in the whole of NEAFC region 2 were a legitimate target species for towed gears with a minimum codend mesh size of 100 mm. As part of the cod recovery measures, the EU and Norway introduced additional technical measures from 1 January 2002 (EC 2056/2001). The basic minimum mesh size for towed gears for cod from 2002 was 120 mm, although in a transitional arrangement running until 31 December 2002 vessels were allowed to exploit cod with 110-mm codends provided that the trawl was fitted with a 90-mm square mesh panel and the catch composition of cod retained on board was not greater than 30% by weight of the total catch. From 1 January 2003, the basic minimum mesh size for towed gears for cod was 120 mm. The minimum mesh size for vessels targeting haddock in Norwegian waters is also 120 mm.

The change in mesh size might be expected to shift exploitation patterns to older ages and increase the weight-at-age for retained fish from younger age classes. Improvements in the exploitation pattern have not been observed. It was not possible to examine if this is due to confounding effects from other fleet segments.

Effort restrictions in the EC were introduced in 2003 (EC 2341/2002, Annex XVII, amended in EC 671/2003). Effort restriction measures were revised for 2005 (EC 27/2005, Annex IV). Preliminary analysis of fishing effort trends in the major fleets exploiting North Sea cod indicates that fishing effort in those fleets has been decreasing since the mid-1990s due to a combination of decommissioning and days-at-sea regulations (STECF-SGRST-05-01 & 04, 2005). The decrease in effort is most pronounced in the years 2002 and beyond.

Information presented to ICES noted that the UK large mesh, demersal trawl fleet category (>100 mm, 4A) has been reduced by decommissioning and days-at-sea regulations to 40% of the levels recorded in the EU reference year of 2001. There was a movement into the 70-90 mm sector to increase days at sea in 2002 and 2003, but the level of effort stabilised in 2004. The effort of the combined trawl gears has shown a continued decrease of 36% overall, from the EU reference year of 2001 (STECF-SGRST-05-01 & 04, 2005).

13.2 Data available

13.2.1 Catch

Official landings data for each country participating in the fishery are presented in Table 13.2.1.1, together with the corresponding WG estimates and Total Allowable Catch (TAC). The full time series of landings, discards and industrial by-catch (in thousand tonnes) is presented in Table 13.2.1.2. See the stock annex for a description of how the catch data are collated.

13.2.2 Age compositions

Total catch-at-age data are given in Table 13.2.2.1, while catch-at-age data for each catch component are given in Tables 13.2.2-4. Discard data for the Skagerrak are not included because, although data are available for 2005, no data is provided for the period prior to 2003 and only partial data is available for 2003-4.

13.2.3 Weight at age

Weight-at-age for the total catch in the North Sea is given in Table 13.2.3.1. Weight-at-age in the total catch is a weighted average of weight-at-age in the human consumption landings, discards and industrial by-catch. Weight-at-age in the stock is taken as the weight-at-age in the total catch. The mean weights-at-age for the separate catch components are given in Tables 13.2.3.2-4.

A summary of the catch data is given in Figure 13.2.3.1. The top plot shows a bar graph of total catch, separated by weight, into age class. Each age class retains the same colour to allow one see the contribution of an age-class to the total catch. This plot shows the strong reliance of the recent fishery on the 1999 year class. The middle plot presents the mean weight at age in the catch through time. This plot shows evidence for reduced growth rates for large year classes. The bottom plot presents a bubble plot of the number in each age class contributing to the total catch.

13.2.4 Maturity and natural mortality

Maturity and natural mortality are assumed fixed over time and are given below. The basis for these estimates are described in the stock annex.

age	0	1	2	3	4	5	6	7+
Natural Mortality	2.05	1.65	0.40	0.25	0.25	0.20	0.20	0.20
Proportion Mature	0	0.01	0.32	0.71	0.87	0.95	1	1

Maxwell and Mitchell (WD9) provide estimates of haddock maturity from the 3rd quarter ENGGFS, based on data processing originally used for the EU data collection regulations. The results show that the WG ogive is in the lower quartile of ENGGFS Q3 estimates for ages 1 and 2, and closely matches them for ages 3 upwards. The WG supports this work, but raised a few concerns. For example, it was unclear to the WG to what extent the differences between the ENGGFS Q3 and the WG maturity estimates (the latter based on the IBTS Q1 survey) were due to seasonal effects. Furthermore, it was unclear, given that haddock spawn in Q1, how useful estimates are based on data from Q3, outside the spawning period. Any further analysis should address these concerns.

13.2.5 Catch, effort and research vessel data

Survey distribution and annual density at age for recent years is given in Figure 13.2.5.1 for the IBTS Q1 survey, Figure 13.2.5.2 for the quarter 3 Scottish groundfish survey, and Figure 13.2.5.3 for the quarter 3 English groundfish survey. All plots show a northern distribution of haddock (statistical rectangles with zero catches are shaded light grey in the first two Figures). Strong year classes can also be seen and tracked.

In 1998 the research vessel *Scotia*, that conducts the Q3 Scottish groundfish survey, was replaced with a new vessel of the same name. It was considered at the time that the change in vessel did not affect the catchability of the survey and the series was assumed to be consistent through time. In 1999, the coverage of the survey was extended slightly, and to keep indices in accordance with those from previous years, the survey indices from 1999 are corrected for this change. Given that the new vessel has been in operation for 8 years, it is now feasible to split the survey into two parts: 1982-1997, and 1998-2006. This will remove any possibility of an effect caused by the change in vessel. The same has been done with the quarter 3 English groundfish survey (split into two parts: 1977-1991 and 1992-2005) to remove any possible effects due to a change in gear in 1992.

Because XSA uses survey data up to the last year of catch data, the IBTS quarter 1 survey is backshifted three months so that, for example, the index for age 4 in 2006 becomes the index for age 3 in 2005, thus allowing the inclusion of the entire series. The IBTS Q1 time series presented are revised estimates (compared to those used last year – see Section 1.2.6).

Data available for calibration of the assessment are presented in Tables 13.2.5.1-2. Trends in survey CPUE are shown in Figure 13.2.5.4 and trends in commercial CPUE in Figure 13.2.5.5. During preparations for the 2000 round of assessment WG meetings it became apparent that the 1999 effort data for the Scottish commercial fleets were not in accordance with the historical series (Figure 13.2.5.6) and specific concerns were outlined in the 2000 report of WGNSSK (ICES-WGNSSK 2001). Effort recording is still not mandatory for these fleets, and concerns remain about the validity of the historical and current estimates of commercial CPUE.

Data available are summarised in the Table below, the series used are in bold. [Note the 2006 data for the quarter 3 Scottish groundfish survey are used only for the short-term forecast. Furthermore, English groundfish survey data for 2006 were not available in time for the WG meeting this year due to vessel scheduling problems, which caused slight delays to the vessel survey programme.]

Country	Fleet	Quarter	Code	Year range	Age range available	Age range used
Scotland	seine	Q1-4	ScoSEI	1978-2005	0 - 13	-
	light trawl	Q1-4	ScoLTR	1978-2005	0 - 13	-
	groundfish survey (Scotia II)	**Q3**	**ScoGFS (early)**	**1982-1997**	0 - 8	**0 - 5**
	groundfish survey (Scotia III)	**Q3**	**ScoGFS (recent)**	**1998-2006**	0 - 8	**0 - 5**
England	groundfish survey (Granton trawl)	**Q3**	**EngGFS (early)**	**1977-1991**	0 - 10+	**0 - 5**
	groundfish survey (GOV trawl)	**Q3**	**EngGFS (recent)**	**1992-2005**	0 - 10+	**0 - 5**
International	groundfish survey	**Q1**	IBTS	1983-2006	1 - 6+	1 - 5
			IBTS (backshifted) *	**1982-2005**	0 - 5+	**0 - 4**

* This survey is used as if it occurred at the end of the previous year

13.3 Data analyses

This year's assessment is treated as an update, so data analysis is not as extensive as last year. Nevertheless, the information content of catch and survey data, and the consistency of information from the various data sources, are illustrated through catch curve analysis and correlation plots. Given problems with the recording of effort (Section 13.2.5), the available commercial CPUE series are not considered for further analysis. XSA is used as the principal method of assessment.

13.3.1 Reviews of last year's assessment

Several concerns were raised by the RGNSSK regarding last year's haddock assessment. These are summarized as follows:

- The review group supported the split of the ENGGFS and SCOGFS time series, but was concerned that this split be justified on *a priori* grounds. They were also concerned that the earlier part of each time series be kept. *A priori* justification is provided in Section 13.2.5, and the earlier part of each survey time series has been kept (as was the case last year).
- The review group requested information on escapement mortality. Although a workshop on unaccounted mortality did occur in 2005, the outcome of this workshop was inconclusive, and no further meeting was held in 2006. There is therefore currently no further information.
- The review group requested that a yield per recruit analysis be included in the report. This can be found in Section 13.6.
- The review group disagreed with use of only 4 years of data in RCT3. This situation arose because the three most recent XSA estimates of age 0 (regarded as too uncertain) were ignored in the analysis, but all XSA estimates of age 0 have now been included (see Section 13.5).
- The review group could not understand how the exploitation rate on the 1999 year class could be so low. An attempt is made in Section 13.3.2 to provide a possible explanation, based on the very slow growth of this year class.

Similar concerns were expressed by the NSCFP Review Group.

13.3.2 Exploratory catch-at-age-based analyses

Catch-curve analysis for both commercial and survey catch-at-age data, plotted on a log scale, allow a simple assessment of the consistency of catches, assuming such catches decline consistently with age as influenced by natural and fishing mortality as well as appropriate catchability/selectivity-at-age (ICES-SGAMHBW 2004). Figure 13.3.2.1 plots the catch-at-age data in the form of log-catch curves linked by cohort, and indicates partial recruitment to the fishery up to age 2. Gradients between consecutive values within a cohort are fairly constant from ages 2 to 7-8, after which they become more variable. Figure 13.3.2.2 plots the negative gradient fitted to each cohort over the age range 2-5, which can be viewed as a rough proxy for average total mortality for ages 2-5 in the cohort. Values fluctuate around a mean of 1.1-1.2.

A noticeable feature of Figures 13.3.2.1 is the shallower gradient for the 1999 and 2000 year classes (also seen in Figure 13.3.2.2 as a smaller negative gradients), which may be linked to the slower growth of these year classes, leading to delayed recruitment to the fishery. There is some indication (but more years of data are needed to confirm this) that the gradients of subsequent, faster growing year classes (e.g. the 2001 year class) are not as shallow (Figure 13.3.2.1). Figure 13.3.2.3 investigates the hypothesis that the total mortality on a cohort is linked to the average growth of the cohort by regressing the negative catch-curve gradient (proxy for Z) against the mean weight at age 5, and shows weak evidence in support of such a hypothesis, with temporal patterns in residuals. Such a hypothesis would help explain the lower relative exploitation (F at age relative to Fbar 2-4) of the 1999 and 2000 year classes when compared to other year classes at corresponding ages. Figure 13.3.2.4 illustrates the wide range of lengths of the 1999 year class (age 6) still occurring in the landings in the first quarter of 2005, with a mode around 40cm, indicating that the slow growth may have implications for the selectivity of this year class in the fishery.

Within-cohort correlations in the catch-at-age matrix (plotted as log-numbers) are shown in Figure 13.3.2.5. These correlations show good consistency within cohorts up to age 8-9, verifying the ability of the catch-at-age data to track relative cohort strengths. Standard and robust linear regression lines are fitted to the data, and these are consistent indicating no undue influence on the standard regression from outliers for most ages. There are limits to the interpretation of within-cohort correlation coefficients for a particular data source. Stocks with high recruitment variability tend to produce higher correlations than stocks with low recruitment variability and there may also be a confounding effect of catchability varying with year-class strength, although this may not apply for surveys. Despite these concerns, such correlations do provide useful indicators (ICES-SGAMHBW 2004). In particular, they can be used to highlight difficulties in the data, which may include phenomena that require further biological interpretation.

In order to investigate the sensitivity of XSA to individual-fleet tuning, single-fleet XSAs with the same setting as last year's final assessment were produced. Results are shown in Figure 13.3.2.6 for the later half of the ENGGFS and SCOGFS series, as well as for the IBTS Q1 series, with corresponding log-catchability residual plots shown in Figure 13.3.2.7 (the Figure also shows the residuals for single-fleet XSAs fitted to the earlier ENGGFS and SCOGFS series). Overall trends are similar for the three tuning fleets, but absolute levels differ towards the end of the time series, the IBTS Q1 producing higher estimates of SSB and recruitment.

13.3.3 Exploratory survey-based analyses

Log-abundance indices, linked by cohort, are shown in Figure 13.3.3.1 for all the available survey series (the ENGGFS and SCOGFS series are treated as continuous series for the purpose of this analysis). These indicate partial recruitment to the survey gear up to age 1-2 for all three surveys, and little distortion in the cohort curves from year to year, although cohort gradients appear to become shallower towards the end of all three surveys. This is highlighted in Figure 13.3.3.2, which plots the negative gradient over ages 2-5 for ENGGFS and SCOGFS, and ages 2-4 for IBTS Q1. These negative gradients can be considered proxies for total mortality if vulnerability to survey gear is similar for ages within the age range considered. Values from the surveys have means of around 1.3.

Mean-standardised log-abundance indices by cohort for the three survey series are shown in Figure 13.3.3.3. This Figure demonstrates that the surveys are generally able to detect the relative strength of individual cohorts. This is further highlighted in Figures 13.3.3.4-6, which show good within-survey correlations up to ages 5-6 (again, treating the ENGGFS and SCOGFS series as continuous). The consistency between the standard and robust linear regression lines indicate no undue influence on the standard regression from outliers in most cases.

The consistency between surveys for each age is shown in Figures 13.3.3.7-9. Correlations are high up to age 5-6, indicating generally good agreement between surveys. Figure 13.3.3.10 shows a comparison of relative trends in SSB based on single fleet runs of SURBA, also indicating good agreement between the surveys.

13.3.4 Conclusions drawn from exploratory analyses

Catch-curve analyses show very consistent descending right-hand limbs, indicating commercial and survey catch-at-age data for haddock track cohorts very well. The shallower catch-curve gradients for the 1999 and 2000 year classes, implying lower total mortality relative to other year classes, may be due to the slower growth of these year classes.

High within-cohort correlations for both commercial and survey catch-at-age data highlight once again that data for haddock track cohorts very well. Furthermore, the high correlations between indices from independently conducted surveys for haddock for ages 0-5 indicate the suitability of the combined use of these indices for the assessment of haddock.

There are *a priori* reasons for splitting both the ENGGFS and SCOGFS in two, related to vessel and gear changes. Each half of the split series is treated as an independent tuning series, continuing the practice adopted last year.

13.3.5 Final assessment

An update assessment, based on the same settings as last year, was selected as the XSA final assessment. The XSA final assessment takes catchability to be dependent on stock size for age 0, constant catchability for ages 3 and above, and incorporates split ENGGFS and SCOGFS tuning series, together with the full IBTS Q1 series. The following Table summarises the changes in XSA settings for the last three years (the remaining settings can be found in Table 13.3.5.1):

		2004	2005	2006
q plateau		2	3	3
Tuning fleet year ranges	ENGGFS	92-03 (single fleet only)	fleet 1: 77-91 fleet 2: 92-04	fleet 1: 77-91 fleet 2: 92-05
	SCOGFS	82-03 (single fleet only)	fleet 1: 82-97 fleet 2: 98-04	fleet 1: 82-97 fleet 2: 98-05
	IBTS Q1*	82-03	82-04	82-05
Tuning fleet age ranges	ENGGFS	0-5	0-5 (both)	0-5 (both)
	SCOGFS	0-5	0-5 (both)	0-5 (both)
	IBTS Q1*	0-4	0-4	0-4

*backshifted

The XSA final assessment tuning diagnostics are presented in Table 13.3.5.1, with log-catchability residuals given in Figure 13.3.5.1, and a comparison of fleet-based survivor estimates in Figure 13.3.5.2. Fishing mortality estimates for the XSA final assessment are presented in Table 13.3.5.2, the stock numbers in Table 13.3.5.3, and the assessment summary in Table 13.3.5.4 and Figure 13.3.5.3. A retrospective analysis (possible for only the last four years because of the short second half of the SCOGFS series), shown in Figure 13.3.5.4, indicates little retrospective bias.

13.4 Historic Stock Trends

The historic stock and fishery trends are presented in Figure 13.3.5.3.

The stock experienced a very high peak in recruitment in 1967, with several other much smaller but yet still high peaks throughout the time series, the most recent occurring in 1999. The 1999 peak was subsequently followed by four very low recruitments in 2001-2004. The most recent recruitment (2005) appears to be of moderate size, much larger than those in 2001-2004, but still only a third of the size of the 1999 year class.

Mean F(2-4) has fluctuated above Fpa for most of the time series, with extended periods above Flim as well. However, mean F over recent years has declined and is estimated to have been well below Fpa for the last four years, around the management plan target of F(2-4)=0.3.

The stock experienced very high SSB levels in the late 1960 s, but has also had periods below Blim, in the early 1990s and most recently around Blim in 2000. Recent levels have been the highest over the past two decades, but SSB is now declining as the 1999 year-class disappears, with a number of weak year classes following it.

13.5 Recruitment estimates

Results from Q3 SCGGFS indicate that the abundance of the 0-group recruitment in 2006 is low, and of a similar size to recruitments in 2002-2004. This is illustrated in Figure 13.5.1, which plots the survey abundance index for age 0 together with estimates of recruitment from the XSA final assessment. Within-cohort correlations between age 0 and 1 estimated from SCOGFS are relatively high (correlation coefficient = 0.82; Figure 13.3.3.5), indicating that SCOGFS provides reasonable estimates of recruitment. It would therefore be appropriate to take this information into account in the short-term forecasts. The RCT3 program was used for this purpose, and Tables 13.5.1 and 13.5.2 present the RCT3 inputs and outputs.

The RCT3 estimate of recruitment of 11 028 million (which relies on the estimate of the 2006 year-class from SCOGFS) is shown in Figure 13.5.1.

Recruitment following a high year class has generally tended to be low (Figure 13.3.5.3). In order to take this feature into account, the average of the 5 lowest recruitment values over the period 1993-2002, 8 116 million, has been assumed for recruitment in 2007 and 2008. This value is 74% of the value assumed for 2006 recruitment. The period considered for this value excludes 2003-2005 because recruitment estimates from the XSA final assessment are considered less reliable for the most recent years.

The following table summarises the recruitment, age 1 and age 2 assumptions for the shortterm forecast.

Year Class	Age in 2005	XSA (millions)	RCT3 (using Q3 SCOGFS, 2006) (millions)	Average Low Recruitment (5 lowest values for 1993-2002) (millions)
2004	2	80		
2005	1	4598		
2006	0		11028	
2007	Age 0 in 2007			8116
2008	Age 0 in 2008			8116

13.6 Short-term forecasts and yield-per-recruit

The slow growth of the 1999 and 2000 year classes continues to pose a problem for the short-term forecast. This is illustrated in Figure 13.6.1, which presents mean stock weights-at-age from the total catch for the 1954-2005 year classes, with the 1999 and 2000 year-classes highlighted (note: stock weights=total catch weights for haddock). The 1999 and 2000 year-class weights are the smallest of all available weights at ages 5-6, so that regression techniques to predict mean weights at subsequent ages for these year classes cannot be used (because they would extrapolate beyond the range of available data for the regression). One possibility for future mean weights for the 1999 and 2000 year classes is to use proportional increments (i.e. to model growth from age *a* to *a*+1 by using the mean proportional increment from age *a* to *a*+1 for all other year classes for which this information is available), and this is illustrated in Figure 13.6.1 as broken lines. Another possibility is to use the observed median weights from the Q1 and Q3 Scottish groundfish surveys for 2006 – weight frequency distributions for these surveys are shown in Figures 13.6.2-3. However, the survey data can only be used for 2006 mean weights, and mean weights for subsequent years in the forecast would still rely on methods such as proportion increments from stock weights (based on total catch weights), given the paucity of data at age 7 and 8 (Figures 13.6.2-3). These two options (proportional increments only, and survey data for 2006 coupled with proportional increments for subsequent years) are shown in Figure 13.6.4, together with median weights-at-age from the observed weights in the Q1 and Q3 Scottish groundfish surveys.

Proportional increments only (solid lines in Figure 13.6.4) was adopted as a basis for calculating mean stock weights for the 1999 and 2000 year classes in the forecast. This method provides a more consistent basis to proceed than the alternative, which mixes stock weights from the total catch with observed survey data. There is also the possibility of a downwards bias in the survey-derived weights because of the short duration of tows, which may allow larger haddock to escape capture. Mean stock weights for other ages in the forecast where taken as a 5-year average (2001-2005), omitting the 1999 and 2000 year classes from the calculation where appropriate. An equivalent plot to Figure 13.6.1 applied to human consumption mean weights at age, so that the basis for deriving mean weights-at-age for this fleet component in the forecast was the same as for the stock weights-at-age. However, mean weights at age for the 1999 and 2000 year classes did not show unusual growth in the discard and industrial bycatch components, so future mean weights-at-age were set to the average for the years 2001-2005 for these components.

The 1999 and 2000 year-classes enter the plus-group in 2006 and 2007 respectively, which requires a re-calculation of the plus-group stock and human consumption mean weights for 2006 onwards. This was achieved by using the XSA final assessment estimates of stock numbers, appropriately adjusted for mortality, to provide a weighted average of mean weights for ages 7-10+, where the low weight of the 1999 and 2000 year-classes were included at the appropriate age.

Three averaging options were considered as possible exploitation patterns for the forecast, and these are shown in Figure 13.6.5. The first two (average over 2003-5 and 2004-5) still include the effect of the lower exploitation on the 1999 and 2000 year class (F-at-age in Table 13.3.5.2 relative to F (2-4); Section 13.3.2), but relative F-at-age for these year classes in 2005 appear to be more comparable to other year classes at the corresponding ages. The 2005 exploitation pattern was therefore taken to represent the exploitation pattern for the forecast. Partial fishing mortality values were obtained for each catch component (human consumption, discards and bycatch) by using the relative contribution of each component to the total catch, and these are also shown in Figure 13.6.5.

The inputs to the short-term forecast are presented in Table 13.6.1. Results for the short-term forecasts are presented in Table 13.6.2, with detailed outputs given in Table 13.6.3. Status-quo F is assumed to be the mean F (2-4) for 2005 only, given the upward trend in F (2-4) for 2003-5 (Figure 13.3.5.3).

The RCT3 estimate is used for recruitment (age 0) in 2006, with values for the remaining ages in 2006 provided by the XSA final assessment. Recruitment in 2007 and 2008 is taken to be the average of the 5 lowest recruitment values over the period 1993-2002, as estimated by the XSA final assessment.

At status-quo F in 2006 and 2007, SSB is expected to be 262 000 tonnes in 2007 and 287 000 tonnes in 2008. The human consumption yield at status-quo F will be around 47 000 tonnes in 2006, and around 59 000 tonnes in 2007. Discards at status-quo F will be around 21 000 tonnes in 2006, and around 34 000 tonnes in 2007.

Table 13.6.4 shows the contribution of the assumed future recruitment values to the forecast estimates of human consumption landings in 2007 and SSB in 2008. The RCT3 estimate of recruitment in 2006 makes a small contribution (7%) to the estimate of SSB in 2008.

A yield per recruit analysis was performed, assuming the same exploitation pattern as for the short-term forecast, but mean stock and human consumption weights for all ages in the forecast where taken as a 5-year average (2001-2005) omitting the 1999 and 2000 year classes from the calculation. The justification for this is that the yield per recruit analysis is essentially an equilibrium calculation, and the slow growth of the 1999 and 2000 year classes are not assumed to represent the “average” mean weight scenario. Mean weights for the discard and industrial bycatch components were, as for the forecast, set to the average for the years 2001-2005. The inputs to the yield per recruit analysis are presented in Table 13.6.5, while results are presented in Table 13.6.6.

Figure 13.6.6 provides a visual summary of the short-term forecast and yield per recruit analysis.

13.7 Medium-term forecasts

No medium-term forecasts have been carried out for this stock using the usual software because of the difficulty of accounting for haddock recruitment dynamics. However, management simulations over the medium-term period have been performed for haddock, and these are discussed in Section 16.1.

13.8 Biological reference points

Biological reference points for this stock are presented below, together with their technical basis.

	ICES considers that:	**ICES proposed that:**
Limit reference points	**B**lim is 100 000 t	**B**pa be set at 140 000 t
	Flim is 1.0	**F**pa be set at 0.7
Target reference points		**F**y not defined

Technical basis

$\mathbf{B}_{lim}$: Smoothed $\mathbf{B}_{loss}$.	$\mathbf{B}_{pa}$: 1.4*$\mathbf{B}_{lim}$.
$\mathbf{F}_{lim}$: 1.4* $\mathbf{F}_{pa}$	$\mathbf{F}_{pa}$: implies a long-term biomass > $\mathbf{B}_{pa}$ and a less than 10% probability that SSB_{MT} < $\mathbf{B}_{pa}$.

13.9 Quality of the assessment

Survey data are consistent both within and between surveys, and the catch data are internally consistent. Trends in mortality from catch data and survey indices are similar, as are trends in estimated relative SSB. There is very little retrospective bias in the assessment.

The main issue raising concern is how to deal with the slow growth of the 1999 and 2000 year classes in forecasts. The mean weight at age in these cohorts appears to have increased only marginally from 2003 to 2004 and 2005. The pragmatic solution of applying proportional increments as a basis for predicting the weight at age for the 1999 and 2000 year classes incorporates the history of growth in the stock, while recognising the slow growth rate of these cohorts.

13.10 Status of the Stock

The general perception of the haddock stock remains unchanged from last year's assessment (Figure 13.10.1). All sources of information indicate that mortality has declined from a previously high historic mean to well below Fpa, and appears to have remained stable since 2002. Spawning stock biomass is predicted to have decline from it's recent peak in 2002-3, but remains well above Bpa.

Although the fishery in 2005 remains dependent on the 1999 year class (Figure 13.2.3.1), with the 2001 to 2004 recruitments being unsubstantial, several sources have confirmed that the 2005 year class is of moderate size (about the same size as the 2000 year class), and is predicted to be about 10 times larger than the average for 2001-4. The 2005 year class should enter the fishery as discards in 2007-8 and as landings from 2008 onwards. It is possible that the 2005 year class may be heavily discarded, as was seen with the 1999 and 2000 year classes. The Q3 Scottish groundfish survey indicates poor recruitment for 2006.

13.11 Management Considerations

Recent effort restrictions appear to have reduced fishing mortality effectively in the years 2002-5. Spawning Stock Biomass (SSB) has declined from its recent peak due to the large 1999 year class passing through the fishery and subsequently being followed by several low recruitments (2001-4). However, the decline in SSB is not expected to continue in the short-term, given current reduced fishing mortality levels and a moderately-sized 2005 year class starting to contribute to the SSB.

Figure 13.11.1 shows the North Sea Commission Fisheries Partnership's stock survey results for haddock. The overall picture from this study echoes that of the stock assessment; that the haddock has been increasing since 2001, with evidence of a stable or reducing biomass in the most recent years, likely due to the ageing 1999 year class. Continued reduced fishing mortality would be preferable to ensure the success of the 2005 recruits, and to maintain the 1999 year class as a proportion of the catch for future years. With the moderate 2005 year class entering the fishery (10 times larger than average recruitment for 2001-4), and given current fishing patterns, discards are expected to be substantial in the near future. Improved gear selectivity measures, that allow for the release of small fish, would be highly beneficial not only for the haddock stock, but also for the survival of juveniles of other species that occur in mixed fisheries along with haddock.

Haddock is a specific target for some fleets, but is also caught as part of a mixed fishery catching cod, whiting and *Nephrops*. It is important to consider the species-specific assessments of these species for effective management. However, from fishing patterns in Scotland, and the fact that haddock is experiencing reduced fishing mortality while the exploitation of cod appears to have remained high, there is a possibility that an amount of decoupling has occurred between these fisheries.

Quota uptake for the Scottish fleet so far in 2006 is on the low side and the quota may not be fully taken. This is thought to be due to periodic poor markets earlier in the year, during which skippers decided to reserve their quota for a time when prices improved.

EU-Norway have agreed on a Management Plan for this stock, which states that every effort be made to maintain a minimum level of SSB greater than 100,000 tonnes (Blim). Furthermore, for 2005 and subsequent years, fishing will be restricted on the basis of a TAC consistent with a fishing mortality rate of no more than 0.30 for appropriate age groups. The Management Plan is currently under review, and an evaluation is presented in Section 16.1.

Table 13.2.1.1 Haddock in Sub-Area IV and Division IIIa. Nominal catch ('000 t) 1999–2005, as officially reported to ICES and estimated by ACFM.

Division IIIa

Country	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Denmark	1012	1033	1590	3791	1741	1116	615	
Germany	3	1	128	239	113	69	69	
Netherlands	0	0	0	0	6	1	0	
Norway	168	126	149	149	211	154	93	
Sweden	206	367	283	393	165	158	175	
UK – Scotland	0	0	7	0	0	0	0	
Total reported	1389	1527	2157	4572	2236	1498	952	
Unallocated	-29	-42	-254	-435	-428	-55	-188	
WG estimate of H.cons. landings	1360	1485	1903	4137	1808	1443	764	
WG estimate of industrial by-catch	334	617	218	0	0	0	0	
WG estimate of total catch	**1694**	**2102**	**2121**	**4137**	**1808**	**1443**	**764**	
TAC	*5400*	*4450*	*4000*	*6300*	*3150*	*4940*	*4018*	*3189* *

* Includes areas III bcd (EC waters)

Sub-area IV

Country	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	
Belgium	462	399	606	559	374	373	190	
Denmark	2104	1670	2407	5123	3035	2075	1274	
Faeroe Islands	55	0	1	25	12	22	11	
France	0	724	485	914	1108	552	419	
Germany	565	342	681	852	1562	1241	733	
Greenland	0	0	0	0	149	10	0	
Ireland	0	0	0	0	1	0	0	
Netherlands	110	119	274	359	187	104	64	
Norway	3830	3150	1902	2404	2196	2258	2069	
Poland	17	13	12	17	16	0	0	
Sweden	686	596	804	572	477	188	132	
UK - Eng+Wales+N.Irl.	2398	1876	3334	3647	1561	1159	843	
UK – Scotland	53628	37772	29263	39624	31527	39339	41584	
Total reported	63855	46661	39769	54096	42205	47321	47319	
Unallocated	354	-577	-811	75	74	-68	297	
WG estimate of H.cons. landings	64209	46084	38958	54171	42279	47253	47616	
WG estimate of discards	42562	48841	118320	45892	23499	17226	9508	
WG estimate of industrial by-catch	3834	8134	7879	3717	1149	554	168	
WG estimate of total catch	**110605**	**103059**	**165157**	**103780**	**66927**	**65033**	**57292**	
TAC	*88550*	*73000*	*61000*	*104000*	*51735*	*77000*	*66000*	*51850* *

* Includes area II a (EC waters)

Division IIIa and Sub-area IV

	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	
WG estimate of total catch	112299	105161	167278	107917	68735	66476	58056	
TAC	*93950*	*77450*	*65000*	*110300*	*54885*	*81940*	*70018*	*55039* *

* Includes areas II a and III bcd (EC waters)

Table 13.2.1.2 Haddock in Sub-Area IV and Division IIIa. WG estimates of catch components by weight ('000 tonnes) and the proportion of IIIa HC landings to the total HC landings.

	Sub-Area IV (North Sea)				Division IIIa			Total	IIIa HC as proportion of tot HC
Year	H.cons	Disc	Ind. BC	Total	H. cons.	Ind. BC	Total		
1963	68.4	189.0	13.7	271.0	0.4	0.1	0.5	271.5	0.6%
1964	130.5	160.3	88.6	379.4	0.4	0.3	0.7	380.2	0.3%
1965	161.6	62.2	74.6	298.4	0.7	0.3	1.0	299.5	0.4%
1966	225.8	73.6	46.7	346.0	0.6	0.1	0.7	346.7	0.3%
1967	147.4	78.1	20.7	246.1	0.4	0.1	0.4	246.6	0.3%
1968	105.4	161.9	34.2	301.5	0.4	0.1	0.5	302.0	0.4%
1969	330.9	260.2	338.4	929.5	0.5	0.5	1.1	930.5	0.2%
1970	524.6	101.4	179.7	805.7	0.7	0.2	0.9	806.7	0.1%
1971	235.4	177.5	31.5	444.4	2.0	0.3	2.2	446.6	0.8%
1972	192.9	128.1	29.6	350.6	2.6	0.4	3.0	353.6	1.3%
1973	178.6	114.7	11.3	304.6	2.9	0.2	3.1	307.7	1.6%
1974	149.6	166.8	47.8	364.2	3.5	1.1	4.6	368.8	2.3%
1975	146.6	260.4	41.4	448.4	4.8	1.3	6.1	454.5	3.2%
1976	165.6	154.3	48.2	368.1	7.0	2.0	9.1	377.1	4.1%
1977	137.3	44.3	35.0	216.6	7.8	2.0	9.8	226.4	5.4%
1978	85.8	76.9	10.8	173.5	5.9	0.7	6.6	180.1	6.4%
1979	83.1	41.7	16.4	141.2	4.0	0.8	4.8	146.0	4.6%
1980	98.6	94.7	22.3	215.7	6.4	1.5	7.9	223.6	6.1%
1981	129.6	60.1	17.1	206.8	9.1	1.2	10.4	217.2	6.6%
1982	165.8	40.5	19.4	225.8	10.8	1.3	12.1	237.8	6.1%
1983	159.3	65.9	13.1	238.4	8.0	7.2	15.2	253.6	4.8%
1984	128.1	75.3	10.1	213.5	6.4	2.7	9.1	222.6	4.7%
1985	158.5	85.4	6.0	250.0	7.2	1.0	8.1	258.1	4.3%
1986	165.5	52.2	2.6	220.4	3.6	1.7	5.3	225.7	2.2%
1987	108.0	59.2	4.4	171.6	3.8	1.4	5.3	176.9	3.4%
1988	105.1	62.1	4.0	171.2	2.9	1.5	4.3	175.5	2.6%
1989	76.2	25.7	2.4	104.3	4.1	0.4	4.5	108.8	5.1%
1990	51.5	32.6	2.6	86.7	4.1	2.0	6.1	92.7	7.4%
1991	44.6	40.3	5.4	90.3	4.1	2.6	6.7	97.0	8.4%
1992	70.2	48.0	10.8	129.0	4.4	4.6	9.0	138.0	5.9%
1993	79.6	79.6	10.7	169.9	2.0	2.4	4.4	174.3	2.4%
1994	80.9	65.4	3.6	149.9	1.8	2.2	4.0	153.9	2.2%
1995	75.3	57.4	7.7	140.4	2.2	2.2	4.4	144.8	2.8%
1996	76.0	72.5	5.0	153.6	3.1	2.9	6.1	159.7	4.0%
1997	79.1	52.1	6.7	137.9	3.4	0.6	4.0	141.9	4.1%
1998	77.3	45.2	5.1	127.6	3.8	0.3	4.0	131.6	4.6%
1999	64.2	42.6	3.8	110.6	1.4	0.3	1.7	112.3	2.1%
2000	46.1	48.8	8.1	103.1	1.5	0.6	2.1	105.2	3.1%
2001	39.0	118.3	7.9	165.2	1.9	0.2	2.1	167.3	4.7%
2002	54.2	45.9	3.7	103.8	4.1	0.0	4.1	107.9	7.1%
2003	42.3	23.5	1.1	66.9	1.8	0.0	1.8	68.7	4.1%
2004	47.3	17.2	0.6	65.0	1.4	0.0	1.4	66.5	3.0%
2005	47.6	9.5	0.2	57.3	0.8	0.0	0.8	58.1	1.6%
Min	39.0	9.5	0.2	57.3	0.4	0.0	0.4	58.1	0.1%
Mean	124.2	85.4	29.1	238.7	3.5	1.2	4.7	243.4	3.4%
Max	524.6	260.4	338.4	929.5	10.8	7.2	15.2	930.5	8.4%

Table 13.2.2.1 Haddock in Sub-Area IV and Division IIIa. Catch-at-age data (thousands). Data used in the assessment are highlighted in bold.

HC+Disc+IB	**0**	**1**	**2**	**3**	**4**	**5**	**6**	7	8	9	10	11	12	13	14	15	**7+**
1963	**1367**	**1307178**	**335092**	**20963**	**13026**	**5781**	**502**	653	566	59	18	0	0	0	0	0	**1295**
1964	**140235**	**7436**	**1296771**	**135227**	**9069**	**5350**	**2405**	287	236	231	25	0	0	0	0	0	**779**
1965	**652537**	**368593**	**15184**	**649840**	**29496**	**4662**	**1972**	452	107	90	41	0	0	0	0	0	**690**
1966	**1671205**	**1007322**	**25674**	**6425**	**412551**	**9980**	**1045**	601	165	90	23	2	0	0	0	0	**880**
1967	**306037**	**838189**	**89083**	**4863**	**3585**	**177857**	**2443**	215	216	57	34	0	0	0	0	0	**521**
1968	**11146**	**1098748**	**439511**	**19600**	**1947**	**2529**	**45973**	325	40	13	5	0	0	0	0	0	**383**
1969	**72670**	**20493**	**3578611**	**303489**	**7596**	**2411**	**2515**	19129	200	24	7	0	0	0	0	0	**19360**
1970	**925768**	**266379**	**218480**	**1908736**	**57435**	**1178**	**1197**	256	5954	67	11	19	0	0	0	0	**6308**
1971	**333396**	**1815054**	**71035**	**47546**	**400469**	**10374**	**462**	195	147	1592	160	3	5	0	0	0	**2102**
1972	**244075**	**679205**	**587590**	**40604**	**21213**	**158000**	**3563**	190	34	27	408	11	0	0	0	0	**670**
1973	**60545**	**366830**	**570630**	**240604**	**6192**	**4470**	**39459**	1257	108	29	109	49	5	0	0	0	**1556**
1974	**614903**	**1220855**	**176342**	**332967**	**54314**	**1875**	**1351**	10922	242	23	32	4	5	0	0	0	**11228**
1975	**46388**	**2116937**	**641755**	**58991**	**109062**	**15813**	**983**	620	2714	266	63	11	0	8	0	0	**3682**
1976	**174161**	**170529**	**1062943**	**211544**	**9952**	**31311**	**4996**	206	76	759	60	3	0	0	0	0	**1106**
1977	**120798**	**258923**	**107675**	**394175**	**40185**	**4318**	**6275**	1300	135	29	200	3	0	1	0	0	**1668**
1978	**305115**	**463554**	**146957**	**30377**	**113703**	**8708**	**1264**	2076	402	116	15	64	13	2	0	0	**2688**
1979	**881823**	**351451**	**204046**	**41297**	**7406**	**28024**	**2237**	262	483	152	54	12	11	1	0	0	**976**
1980	**399372**	**678499**	**333261**	**73043**	**10476**	**1901**	**8067**	598	121	162	75	31	9	3	1	0	**1002**
1981	**646419**	**134470**	**423059**	**143151**	**15228**	**2034**	**458**	2498	125	64	23	30	4	1	3	0	**2749**
1982	**278705**	**275686**	**86126**	**299895**	**41435**	**3407**	**713**	279	784	30	15	7	2	2	0	0	**1119**
1983	**639814**	**157259**	**252258**	**73920**	**127250**	**16480**	**1708**	297	61	191	53	6	4	4	0	0	**616**
1984	**95502**	**432193**	**168273**	**122984**	**22079**	**32658**	**3789**	596	84	41	112	16	5	1	1	0	**857**
1985	**139579**	**178878**	**534269**	**78726**	**37445**	**5306**	**7355**	965	212	52	21	88	4	0	0	0	**1343**
1986	**56503**	**160398**	**178824**	**323650**	**27685**	**9691**	**1237**	1810	237	117	49	32	36	13	4	1	**2298**
1987	**13384**	**314017**	**250496**	**47432**	**67864**	**4761**	**2877**	545	778	135	36	50	27	29	5	8	**1613**
1988	**16535**	**30044**	**490706**	**89940**	**13431**	**18579**	**1602**	639	166	141	50	18	11	10	15	1	**1051**
1989	**12042**	**47648**	**35358**	**182748**	**18106**	**2636**	**4058**	510	200	83	30	13	6	2	2	1	**848**
1990	**57702**	**86819**	**103021**	**18947**	**57830**	**3905**	**896**	1380	210	78	41	11	11	1	4	2	**1738**
1991	**123910**	**228553**	**78258**	**23197**	**3888**	**12526**	**976**	401	614	148	54	6	5	1	2	1	**1231**
1992	**270758**	**209879**	**253286**	**32494**	**6552**	**1250**	**4861**	454	301	293	124	22	6	2	0	0	**1203**
1993	**141209**	**359995**	**262765**	**108421**	**7107**	**1698**	**450**	1138	146	103	144	59	3	2	0	0	**1595**
1994	**85966**	**99260**	**296776**	**100476**	**29609**	**1920**	**573**	191	509	115	32	27	25	5	0	0	**905**
1995	**273689**	**301733**	**85925**	**167801**	**25875**	**7645**	**511**	127	45	62	19	8	6	2	1	0	**269**
1996	**347568**	**53415**	**357942**	**56894**	**55147**	**7503**	**3052**	756	52	31	25	5	8	3	1	0	**882**
1997	**40082**	**134642**	**86231**	**213293**	**15272**	**15406**	**1892**	679	62	15	12	4	4	4	2	0	**782**
1998	**23902**	**83557**	**167359**	**49648**	**108066**	**5743**	**3562**	472	140	14	6	5	2	2	1	1	**643**
1999	**108254**	**81423**	**121249**	**87242**	**24739**	**39860**	**2338**	1595	342	41	6	2	1	1	0	0	**1988**
2000	**52181**	**350998**	**88624**	**43351**	**26356**	**6026**	**8707**	560	234	32	12	2	1	1	0	0	**842**
2001	**3510**	**86744**	**632880**	**32343**	**8886**	**4122**	**1561**	1305	195	64	17	3	1	0	0	0	**1585**
2002	**50754**	**18400**	**66343**	**242196**	**6547**	**2038**	**1066**	549	458	265	15	8	5	0	0	0	**1301**
2003	**6132**	**18616**	**14122**	**44745**	**109063**	**1970**	**602**	271	110	89	38	5	1	0	0	0	**515**
2004	**918**	**9872**	**18069**	**6574**	**34945**	**91121**	**723**	147	56	35	35	10	1	0	0	0	**284**
2005	**4447**	**9039**	**18135**	**11382**	**3329**	**25076**	**58753**	314	89	34	10	7	4	1	0	0	**459**

Table 13.2.2.2 Haddock in Sub-Area IV and Division IIIa. HC catch-at-age data (thousands). Data used in the assessment are highlighted in bold.

HC	**0**	**1**	**2**	**3**	**4**	**5**	**6**	7	8	9	10	11	12	13	14	15	**7+**
1963	**0**	**27353**	**118185**	**16692**	**12212**	**5644**	**498**	653	566	59	18	0	0	0	0	0	**1295**
1964	**0**	**48**	**250523**	**86368**	**8166**	**4689**	**2283**	286	236	231	25	0	0	0	0	0	**777**
1965	**0**	**2636**	**3445**	**335396**	**23479**	**4063**	**1852**	446	107	90	41	0	0	0	0	0	**684**
1966	**0**	**12976**	**6724**	**4250**	**372535**	**9188**	**1018**	599	165	90	23	2	0	0	0	0	**878**
1967	**0**	**54953**	**33894**	**3845**	**3345**	**174011**	**2421**	215	216	57	34	0	0	0	0	0	**521**
1968	**0**	**18443**	**139035**	**14557**	**1806**	**2495**	**45047**	324	40	13	5	0	0	0	0	0	**382**
1969	**0**	**139**	**713860**	**166997**	**6542**	**2014**	**2381**	18876	200	24	7	0	0	0	0	0	**19107**
1970	**0**	**2259**	**51861**	**1133133**	**50823**	**1012**	**1131**	254	5954	67	11	19	0	0	0	0	**6305**
1971	**0**	**34019**	**25862**	**35168**	**369443**	**10006**	**455**	195	147	1592	160	3	5	0	0	0	**2102**
1972	**0**	**12778**	**207267**	**33215**	**19853**	**156344**	**3550**	190	34	27	408	11	0	0	0	0	**670**
1973	**0**	**6024**	**205717**	**193852**	**5829**	**4238**	**39336**	1257	108	29	109	49	5	0	0	0	**1556**
1974	**0**	**23993**	**52416**	**227998**	**46793**	**1785**	**1232**	10693	242	23	32	4	5	0	0	0	**10999**
1975	**0**	**24144**	**200961**	**38295**	**90302**	**15524**	**978**	620	2709	266	63	11	0	8	0	0	**3677**
1976	**0**	**2301**	**223465**	**142803**	**9721**	**28103**	**4978**	206	76	759	60	3	0	0	0	0	**1106**
1977	**0**	**8484**	**31741**	**249285**	**37092**	**4057**	**6021**	1300	135	29	200	3	0	1	0	0	**1668**
1978	**0**	**12883**	**54630**	**25305**	**100036**	**8568**	**1152**	2070	402	116	15	64	13	2	0	0	**2682**
1979	**0**	**14009**	**110008**	**36486**	**7284**	**27543**	**2219**	262	483	152	54	12	11	1	0	0	**976**
1980	**0**	**8982**	**141895**	**61901**	**9063**	**1843**	**7975**	591	121	161	75	31	9	3	1	0	**994**
1981	**0**	**1759**	**153466**	**112407**	**14679**	**2025**	**455**	2498	125	64	23	30	4	1	3	0	**2748**
1982	**0**	**7373**	**38819**	**236209**	**37728**	**2913**	**713**	279	784	30	15	7	2	2	0	0	**1119**
1983	**0**	**7101**	**109201**	**52566**	**117819**	**15760**	**1603**	297	61	190	53	6	4	4	0	0	**616**
1984	**0**	**19501**	**75963**	**104651**	**21372**	**31874**	**3788**	596	84	41	112	16	5	1	1	0	**857**
1985	**0**	**2120**	**248125**	**70806**	**36734**	**5076**	**7329**	965	212	52	21	88	4	0	0	0	**1343**
1986	**0**	**12132**	**62362**	**261225**	**27548**	**9671**	**1237**	1810	237	117	49	32	36	13	4	1	**2298**
1987	**0**	**6896**	**113196**	**37763**	**66221**	**4760**	**2877**	545	778	135	36	50	27	29	5	8	**1613**
1988	**0**	**1524**	**146403**	**76925**	**12024**	**18310**	**1602**	639	166	141	50	18	11	10	15	1	**1051**
1989	**0**	**4519**	**16387**	**128051**	**16762**	**2574**	**3916**	498	199	83	30	13	6	2	2	1	**835**
1990	**0**	**5493**	**43168**	**14338**	**45015**	**3269**	**775**	1242	202	78	41	11	11	1	4	2	**1592**
1991	**0**	**19482**	**46902**	**21841**	**3812**	**12337**	**976**	401	614	148	54	6	5	1	2	1	**1231**
1992	**0**	**2853**	**117953**	**28828**	**6485**	**1247**	**4779**	454	300	293	124	22	6	2	0	0	**1203**
1993	**0**	**2488**	**77820**	**86806**	**6976**	**1686**	**450**	1119	146	103	144	59	3	2	0	0	**1575**
1994	**0**	**467**	**69457**	**70354**	**27587**	**1860**	**524**	191	509	115	32	27	25	5	0	0	**905**
1995	**0**	**1870**	**29177**	**101663**	**24715**	**7565**	**511**	127	45	62	19	8	6	2	1	0	**269**
1996	**0**	**742**	**74892**	**36685**	**47168**	**7501**	**3052**	756	52	31	25	5	8	3	1	0	**882**
1997	**0**	**1409**	**23943**	**123178**	**14028**	**15208**	**1892**	679	62	15	12	4	4	4	2	0	**782**
1998	**0**	**822**	**38321**	**36736**	**92738**	**5607**	**3543**	472	140	14	6	5	2	2	1	1	**643**
1999	**0**	**994**	**25856**	**53192**	**23301**	**37630**	**2155**	1595	342	41	6	2	1	1	0	0	**1988**
2000	**0**	**4750**	**30316**	**28653**	**23407**	**5873**	**8644**	560	234	32	12	2	1	1	0	0	**842**
2001	**0**	**611**	**67196**	**16117**	**7406**	**3929**	**1561**	1295	191	64	17	3	1	0	0	0	**1571**
2002	**0**	**639**	**13666**	**111346**	**5640**	**2004**	**1066**	419	458	265	15	8	5	0	0	0	**1171**
2003	**0**	**32**	**1091**	**13925**	**73059**	**1920**	**571**	270	109	89	38	5	1	0	0	0	**513**
2004	**0**	**481**	**2897**	**4101**	**22159**	**73191**	**710**	139	56	35	35	10	1	0	0	0	**276**
2005	**0**	**782**	**5490**	**8086**	**2926**	**21703**	**54742**	313	89	34	10	7	4	1	0	0	**458**

Table 13.2.2.3 Haddock in Sub-Area IV and Division IIIa. Discards catch-at-age data (thousands; North Sea only). Data used in the assessment are highlighted in bold.

Disc	**0**	**1**	**2**	**3**	**4**	**5**	**6**	7	8	9	10	11	12	13	14	15	**7+**
1963	**42**	**1047925**	**193718**	**3476**	**708**	**51**	**2**	0	0	0	0	0	0	0	0	0	**0**
1964	**2395**	**4182**	**623111**	**13597**	**262**	**21**	**10**	0	0	0	0	0	0	0	0	0	**0**
1965	**5307**	**110628**	**4020**	**130369**	**3641**	**4**	**1**	0	0	0	0	0	0	0	0	0	**0**
1966	**7880**	**444111**	**12388**	**1166**	**24114**	**35**	**2**	0	0	0	0	0	0	0	0	0	**0**
1967	**6250**	**389691**	**49635**	**863**	**216**	**1576**	**9**	0	0	0	0	0	0	0	0	0	**0**
1968	**39**	**615649**	**219022**	**3006**	**94**	**15**	**186**	0	0	0	0	0	0	0	0	0	**0**
1969	**1732**	**5152**	**1158445**	**37686**	**420**	**16**	**8**	0	0	0	0	0	0	0	0	0	**0**
1970	**51717**	**92978**	**77992**	**289679**	**2640**	**13**	**4**	0	0	0	0	0	0	0	0	0	**0**
1971	**7586**	**1205838**	**35117**	**8960**	**24590**	**66**	**2**	0	0	0	0	0	0	0	0	0	**0**
1972	**4231**	**424657**	**322547**	**6353**	**1212**	**1212**	**13**	0	0	0	0	0	0	0	0	0	**0**
1973	**18540**	**241423**	**352310**	**46740**	**352**	**33**	**123**	0	0	0	0	0	0	0	0	0	**0**
1974	**24758**	**915157**	**90904**	**57011**	**2814**	**6**	**4**	0	0	0	0	0	0	0	0	0	**0**
1975	**630**	**1478590**	**353422**	**15781**	**13388**	**143**	**0**	0	0	0	0	0	0	0	0	0	**0**
1976	**2191**	**98420**	**648662**	**38317**	**183**	**137**	**0**	0	0	0	0	0	0	0	0	0	**0**
1977	**11812**	**95090**	**44918**	**73431**	**605**	**9**	**0**	0	0	0	0	0	0	0	0	0	**0**
1978	**5250**	**316339**	**80219**	**4207**	**12085**	**72**	**106**	0	0	0	0	0	0	0	0	0	**0**
1979	**1824**	**205555**	**75517**	**3232**	**34**	**84**	**0**	0	0	0	0	0	0	0	0	0	**0**
1980	**644**	**369727**	**168124**	**2346**	**39**	**0**	**0**	0	0	0	0	0	0	0	0	0	**0**
1981	**1509**	**33434**	**237524**	**25928**	**86**	**3**	**0**	0	0	0	0	0	0	0	0	0	**0**
1982	**3703**	**93865**	**31915**	**49462**	**1845**	**0**	**0**	0	0	0	0	0	0	0	0	0	**0**
1983	**151108**	**85338**	**128171**	**15966**	**7112**	**717**	**105**	0	0	0	0	0	0	0	0	0	**0**
1984	**2915**	**314421**	**80803**	**13430**	**327**	**240**	**0**	0	0	0	0	0	0	0	0	0	**0**
1985	**17501**	**165086**	**267747**	**6088**	**149**	**4**	**8**	0	0	0	0	0	0	0	0	0	**0**
1986	**23807**	**108204**	**114606**	**61612**	**31**	**12**	**0**	0	0	0	0	0	0	0	0	0	**0**
1987	**1166**	**188582**	**133010**	**9320**	**1506**	**0**	**0**	0	0	0	0	0	0	0	0	0	**0**
1988	**1528**	**24588**	**325259**	**9684**	**788**	**67**	**0**	0	0	0	0	0	0	0	0	0	**0**
1989	**1790**	**40211**	**16959**	**51491**	**814**	**20**	**42**	0	0	0	0	0	0	0	0	0	**1**
1990	**52477**	**68625**	**56359**	**3977**	**10190**	**235**	**77**	0	0	0	0	0	0	0	0	0	**0**
1991	**7001**	**182162**	**27942**	**725**	**27**	**145**	**0**	0	0	0	0	0	0	0	0	0	**0**
1992	**29056**	**110995**	**123961**	**3298**	**38**	**0**	**65**	0	0	0	0	0	0	0	0	0	**0**
1993	**16715**	**235123**	**170794**	**18375**	**48**	**3**	**0**	1	0	0	0	0	0	0	0	0	**1**
1994	**16059**	**82033**	**217538**	**29100**	**1862**	**53**	**48**	0	0	0	0	0	0	0	0	0	**0**
1995	**3228**	**191807**	**54448**	**65250**	**1095**	**79**	**0**	0	0	0	0	0	0	0	0	0	**0**
1996	**3968**	**35340**	**275597**	**16870**	**7872**	**2**	**0**	0	0	0	0	0	0	0	0	0	**0**
1997	**7162**	**85588**	**50976**	**85664**	**1061**	**182**	**0**	0	0	0	0	0	0	0	0	0	**0**
1998	**3132**	**72793**	**112075**	**10165**	**13766**	**71**	**18**	0	0	0	0	0	0	0	0	0	**0**
1999	**14588**	**69196**	**90861**	**31119**	**1094**	**2064**	**180**	0	0	0	0	0	0	0	0	0	**0**
2000	**2474**	**272894**	**36568**	**12614**	**2764**	**148**	**64**	0	0	0	0	0	0	0	0	0	**0**
2001	**545**	**61878**	**529908**	**6100**	**1446**	**186**	**0**	10	4	0	0	0	0	0	0	0	**14**
2002	**946**	**3872**	**48189**	**127212**	**403**	**8**	**0**	130	0	0	0	0	0	0	0	0	**130**
2003	**1987**	**12601**	**10930**	**29535**	**34480**	**37**	**31**	1	0	0	0	0	0	0	0	0	**2**
2004	**918**	**8801**	**14907**	**2388**	**12528**	**17177**	**5**	3	0	0	0	0	0	0	0	0	**3**
2005	**4447**	**8081**	**12548**	**3271**	**394**	**3369**	**3810**	0	0	0	0	0	0	0	0	0	**0**

Table 13.2.2.4 Haddock in Sub-Area IV and Division IIIa. Industrial bycatch catch-at-age data (thousands). Data used in the assessment are highlighted in bold.

Ind. BC	**0**	**1**	**2**	**3**	**4**	**5**	**6**	7	8	9	10	11	12	13	14	15	**7+**
1963	**1325**	**231900**	**23190**	**795**	**106**	**85**	**3**	0	0	0	0	0	0	0	0	0	**0**
1964	**137840**	**3205**	**423136**	**35262**	**641**	**641**	**112**	1	0	0	0	0	0	0	0	0	**1**
1965	**647230**	**255329**	**7719**	**184075**	**2375**	**594**	**119**	6	0	0	0	0	0	0	0	0	**6**
1966	**1663325**	**550235**	**6562**	**1009**	**15901**	**757**	**25**	2	0	0	0	0	0	0	0	0	**2**
1967	**299787**	**393545**	**5554**	**156**	**24**	**2269**	**12**	0	0	0	0	0	0	0	0	0	**0**
1968	**11107**	**464656**	**81454**	**2036**	**46**	**19**	**740**	1	0	0	0	0	0	0	0	0	**1**
1969	**70938**	**15201**	**1706305**	**98806**	**633**	**380**	**126**	253	0	0	0	0	0	0	0	0	**253**
1970	**874052**	**171142**	**88628**	**485924**	**3972**	**153**	**61**	2	0	0	0	0	0	0	0	0	**2**
1971	**325810**	**575197**	**10056**	**3419**	**6435**	**302**	**6**	0	0	0	0	0	0	0	0	0	**0**
1972	**239844**	**241771**	**57776**	**1037**	**148**	**444**	**0**	0	0	0	0	0	0	0	0	0	**0**
1973	**42005**	**119383**	**12604**	**11**	**11**	**199**	**0**	0	0	0	0	0	0	0	0	0	**0**
1974	**590144**	**281705**	**33021**	**47958**	**4707**	**84**	**115**	229	0	0	0	0	0	0	0	0	**229**
1975	**45758**	**614202**	**87373**	**4916**	**5372**	**146**	**5**	0	5	0	0	0	0	0	0	0	**5**
1976	**171970**	**69809**	**190817**	**30424**	**48**	**3071**	**18**	0	0	0	0	0	0	0	0	0	**0**
1977	**108986**	**155349**	**31016**	**71460**	**2488**	**251**	**254**	0	0	0	0	0	0	0	0	0	**0**
1978	**299865**	**134332**	**12109**	**864**	**1582**	**68**	**7**	6	0	0	0	0	0	0	0	0	**6**
1979	**879999**	**131887**	**18520**	**1579**	**88**	**397**	**17**	0	0	0	0	0	0	0	0	0	**0**
1980	**398727**	**299790**	**23243**	**8796**	**1375**	**58**	**92**	7	0	1	0	0	0	0	0	0	**8**
1981	**644910**	**99277**	**32070**	**4817**	**463**	**6**	**3**	0	0	0	0	0	0	0	0	0	**0**
1982	**275003**	**174449**	**15392**	**14225**	**1862**	**494**	**0**	0	0	0	0	0	0	0	0	0	**0**
1983	**488707**	**64821**	**14885**	**5387**	**2320**	**3**	**0**	0	0	0	0	0	0	0	0	0	**0**
1984	**92587**	**98272**	**11507**	**4903**	**380**	**543**	**0**	0	0	0	0	0	0	0	0	0	**0**
1985	**122079**	**11672**	**18397**	**1832**	**563**	**226**	**18**	0	0	0	0	0	0	0	0	0	**0**
1986	**32696**	**40062**	**1857**	**813**	**106**	**8**	**0**	0	0	0	0	0	0	0	0	0	**0**
1987	**12217**	**118539**	**4290**	**348**	**138**	**0**	**0**	0	0	0	0	0	0	0	0	0	**0**
1988	**15007**	**3933**	**19044**	**3332**	**620**	**202**	**0**	0	0	0	0	0	0	0	0	0	**0**
1989	**10251**	**2918**	**2013**	**3206**	**530**	**42**	**99**	12	0	0	0	0	0	0	0	0	**12**
1990	**5225**	**12702**	**3494**	**632**	**2625**	**401**	**44**	138	8	0	0	0	0	0	0	0	**146**
1991	**116909**	**26909**	**3415**	**631**	**49**	**44**	**0**	0	0	0	0	0	0	0	0	0	**0**
1992	**241702**	**96031**	**11373**	**367**	**29**	**3**	**17**	0	0	0	0	0	0	0	0	0	**0**
1993	**124495**	**122384**	**14151**	**3240**	**83**	**9**	**0**	18	0	0	0	0	0	0	0	0	**18**
1994	**69907**	**16759**	**9782**	**1022**	**160**	**7**	**1**	0	0	0	0	0	0	0	0	0	**0**
1995	**270461**	**108056**	**2300**	**888**	**65**	**0**	**0**	0	0	0	0	0	0	0	0	0	**0**
1996	**343600**	**17333**	**7453**	**3338**	**107**	**0**	**0**	0	0	0	0	0	0	0	0	0	**0**
1997	**32920**	**47645**	**11312**	**4451**	**184**	**17**	**0**	0	0	0	0	0	0	0	0	0	**0**
1998	**20771**	**9942**	**16963**	**2748**	**1562**	**65**	**0**	0	0	0	0	0	0	0	0	0	**0**
1999	**93667**	**11232**	**4531**	**2932**	**344**	**166**	**3**	0	0	0	0	0	0	0	0	0	**0**
2000	**49707**	**73355**	**21740**	**2085**	**186**	**5**	**0**	0	0	0	0	0	0	0	0	0	**0**
2001	**2965**	**24255**	**35776**	**10127**	**35**	**8**	**0**	0	0	0	0	0	0	0	0	0	**0**
2002	**49807**	**13889**	**4489**	**3638**	**504**	**27**	**0**	0	0	0	0	0	0	0	0	0	**0**
2003	**4145**	**5983**	**2101**	**1285**	**1524**	**12**	**0**	0	0	0	0	0	0	0	0	0	**0**
2004	**0**	**590**	**265**	**84**	**258**	**753**	**8**	4	0	0	0	0	0	0	0	0	**4**
2005	**0**	**176**	**97**	**26**	**9**	**5**	**201**	1	0	0	0	0	0	0	0	0	**1**

Table 13.2.3.1 Haddock in Sub-Area IV and Division IIIa. Combined weight-at-age data (kg; average of the North Sea weights-at-age data, with each component weighted by the combined North Sea and Skagerrak catches, omitting Skagerrak discards), which are also used as stock weights-at-age. Data used in the assessment are highlighted in bold.

CWt catch	**0**	**1**	**2**	**3**	**4**	**5**	**6**	7	8	9	10	11	12	13	14	15	**7+**
1963	**0.012**	**0.123**	**0.253**	**0.473**	**0.695**	**0.807**	**1.004**	1.131	1.173	1.576	1.825	0.000	0.000	0.000	0.000	0.000	**1.179**
1964	**0.011**	**0.118**	**0.239**	**0.403**	**0.664**	**0.814**	**0.908**	1.382	1.148	1.470	1.781	0.000	0.000	0.000	0.000	0.000	**1.350**
1965	**0.010**	**0.069**	**0.225**	**0.366**	**0.648**	**0.844**	**1.193**	1.173	1.482	1.707	2.239	0.000	0.000	0.000	0.000	0.000	**1.353**
1966	**0.010**	**0.088**	**0.247**	**0.367**	**0.533**	**0.949**	**1.266**	1.525	1.938	1.727	2.963	2.040	0.000	0.000	0.000	0.000	**1.662**
1967	**0.011**	**0.115**	**0.281**	**0.461**	**0.594**	**0.639**	**1.057**	1.501	1.922	2.069	2.348	0.000	0.000	0.000	0.000	0.000	**1.792**
1968	**0.010**	**0.125**	**0.253**	**0.510**	**0.731**	**0.857**	**0.837**	1.606	2.260	2.702	2.073	0.000	0.000	0.000	0.000	0.000	**1.718**
1969	**0.011**	**0.063**	**0.216**	**0.406**	**0.799**	**0.891**	**1.031**	1.094	2.040	3.034	3.264	0.000	0.000	0.000	0.000	0.000	**1.107**
1970	**0.013**	**0.073**	**0.222**	**0.352**	**0.735**	**0.873**	**1.191**	1.362	1.437	2.571	3.950	3.869	0.000	0.000	0.000	0.000	**1.458**
1971	**0.011**	**0.106**	**0.247**	**0.362**	**0.506**	**0.887**	**1.267**	1.534	1.337	1.275	1.969	4.306	3.543	0.000	0.000	0.000	**1.366**
1972	**0.024**	**0.115**	**0.243**	**0.388**	**0.506**	**0.606**	**1.000**	1.366	2.241	2.006	1.651	2.899	0.000	0.000	0.000	0.000	**1.635**
1973	**0.044**	**0.112**	**0.241**	**0.373**	**0.586**	**0.649**	**0.725**	1.044	1.302	2.796	1.726	2.020	2.158	0.000	0.000	0.000	**1.176**
1974	**0.024**	**0.127**	**0.226**	**0.344**	**0.549**	**0.891**	**0.895**	0.952	1.513	2.315	2.508	4.152	2.264	0.000	0.000	0.000	**0.973**
1975	**0.020**	**0.100**	**0.242**	**0.357**	**0.450**	**0.680**	**1.245**	1.124	1.093	1.720	2.217	2.854	0.000	3.426	0.000	0.000	**1.173**
1976	**0.013**	**0.124**	**0.225**	**0.402**	**0.512**	**0.588**	**0.922**	1.933	1.784	1.306	2.425	2.528	0.000	0.000	0.000	0.000	**1.521**
1977	**0.019**	**0.107**	**0.242**	**0.346**	**0.602**	**0.613**	**0.802**	1.181	1.943	2.322	1.780	3.189	0.000	4.119	0.000	0.000	**1.340**
1978	**0.011**	**0.142**	**0.255**	**0.420**	**0.442**	**0.719**	**0.745**	0.955	1.398	2.124	2.867	1.849	2.454	4.782	0.000	0.000	**1.114**
1979	**0.009**	**0.095**	**0.292**	**0.443**	**0.637**	**0.664**	**0.933**	1.187	1.187	1.468	2.679	1.624	1.760	1.643	0.000	0.000	**1.326**
1980	**0.012**	**0.102**	**0.285**	**0.487**	**0.732**	**1.046**	**0.936**	1.394	1.599	1.593	1.726	3.328	1.119	3.071	3.111	0.000	**1.542**
1981	**0.009**	**0.074**	**0.264**	**0.477**	**0.745**	**1.147**	**1.479**	1.180	1.634	1.764	1.554	1.492	3.389	4.273	1.981	0.000	**1.226**
1982	**0.011**	**0.100**	**0.293**	**0.462**	**0.785**	**1.166**	**1.441**	1.672	1.456	2.634	2.164	1.924	1.886	3.179	0.000	0.000	**1.558**
1983	**0.022**	**0.135**	**0.298**	**0.449**	**0.651**	**0.916**	**1.215**	1.162	1.920	1.376	1.395	1.907	2.853	4.689	0.000	0.000	**1.366**
1984	**0.010**	**0.141**	**0.302**	**0.489**	**0.671**	**0.805**	**1.097**	1.100	1.868	2.425	1.972	2.247	2.422	2.822	4.995	0.000	**1.389**
1985	**0.013**	**0.149**	**0.280**	**0.481**	**0.668**	**0.857**	**1.049**	1.459	1.833	2.124	2.145	2.003	2.387	2.471	2.721	3.970	**1.594**
1986	**0.025**	**0.124**	**0.242**	**0.397**	**0.613**	**0.863**	**1.257**	1.195	1.715	1.525	2.484	2.653	2.538	3.075	2.778	2.894	**1.348**
1987	**0.007**	**0.116**	**0.267**	**0.407**	**0.615**	**1.029**	**1.276**	1.433	1.529	1.877	2.054	1.940	2.471	2.411	2.996	2.638	**1.592**
1988	**0.022**	**0.164**	**0.217**	**0.416**	**0.590**	**0.748**	**1.284**	1.424	1.551	1.627	1.680	3.068	2.468	2.885	3.337	2.863	**1.565**
1989	**0.025**	**0.197**	**0.304**	**0.372**	**0.606**	**0.811**	**0.983**	1.364	1.655	1.684	2.248	2.166	2.364	2.389	2.307	1.146	**1.520**
1990	**0.042**	**0.190**	**0.292**	**0.435**	**0.476**	**0.775**	**0.968**	1.152	1.521	2.037	2.653	2.530	2.392	3.444	1.852	4.731	**1.296**
1991	**0.029**	**0.177**	**0.322**	**0.472**	**0.640**	**0.651**	**1.042**	1.232	1.481	1.776	1.996	2.253	2.404	1.070	3.509	2.936	**1.468**
1992	**0.018**	**0.104**	**0.307**	**0.486**	**0.748**	**1.016**	**0.896**	1.395	1.537	1.912	1.997	2.067	2.441	1.781	0.000	0.000	**1.637**
1993	**0.010**	**0.113**	**0.282**	**0.447**	**0.680**	**0.894**	**1.173**	1.102	1.592	1.737	1.920	1.718	2.274	2.516	0.000	0.000	**1.288**
1994	**0.017**	**0.115**	**0.251**	**0.420**	**0.597**	**0.943**	**1.209**	1.570	1.469	1.620	2.418	2.108	2.849	2.403	2.580	0.000	**1.606**
1995	**0.013**	**0.101**	**0.299**	**0.364**	**0.592**	**0.763**	**1.099**	1.423	1.685	1.873	1.881	2.508	1.674	1.699	2.243	0.000	**1.644**
1996	**0.018**	**0.121**	**0.247**	**0.390**	**0.483**	**0.780**	**0.870**	0.846	1.833	2.025	1.623	2.393	2.369	2.598	3.439	0.000	**0.999**
1997	**0.017**	**0.133**	**0.280**	**0.359**	**0.579**	**0.615**	**0.909**	0.966	1.647	2.247	2.146	2.634	2.757	2.262	2.867	2.782	**1.092**
1998	**0.023**	**0.153**	**0.254**	**0.394**	**0.440**	**0.651**	**0.760**	1.103	1.153	1.825	2.357	2.150	2.824	2.423	2.085	2.509	**1.163**
1999	**0.022**	**0.168**	**0.243**	**0.361**	**0.473**	**0.498**	**0.680**	0.782	0.749	1.247	1.559	1.913	2.232	2.392	2.912	2.225	**0.791**
2000	**0.057**	**0.119**	**0.254**	**0.367**	**0.498**	**0.615**	**0.650**	1.100	1.091	1.760	1.959	2.331	2.385	2.315	3.810	1.843	**1.142**
2001	**0.019**	**0.109**	**0.216**	**0.311**	**0.467**	**0.697**	**0.754**	0.971	1.892	1.198	2.114	2.706	3.237	2.534	1.239	3.425	**1.111**
2002	**0.016**	**0.096**	**0.264**	**0.326**	**0.530**	**0.736**	**0.924**	0.846	1.423	1.941	2.368	1.840	2.349	2.762	0.000	0.000	**1.302**
2003	**0.030**	**0.097**	**0.213**	**0.321**	**0.404**	**0.674**	**0.770**	1.155	1.380	1.646	2.181	2.209	2.506	2.606	1.981	3.092	**1.379**
2004	**0.054**	**0.178**	**0.254**	**0.392**	**0.394**	**0.443**	**0.726**	1.040	1.372	1.741	1.765	2.355	2.172	0.000	0.000	0.000	**1.331**
2005	**0.057**	**0.214**	**0.292**	**0.380**	**0.506**	**0.480**	**0.521**	0.863	1.100	1.360	1.929	2.682	2.553	2.319	3.431	0.000	**1.013**

Table 13.2.3.2 Haddock in Sub-Area IV and Division IIIa. Weight-at-age data (kg) from the HC catch in the North Sea. Data used in the assessment are highlighted in bold.

CWt HC	**0**	**1**	**2**	**3**	**4**	**5**	**6**	7	8	9	10	11	12	13	14	15	**7+**
1963	**0.000**	**0.233**	**0.326**	**0.512**	**0.715**	**0.817**	**1.009**	1.131	1.173	1.576	1.825	0.000	0.000	0.000	0.000	0.000	**1.179**
1964	**0.000**	**0.221**	**0.313**	**0.459**	**0.695**	**0.870**	**0.934**	1.386	1.148	1.470	1.781	0.000	0.000	0.000	0.000	0.000	**1.351**
1965	**0.000**	**0.310**	**0.357**	**0.410**	**0.679**	**0.907**	**1.242**	1.182	1.482	1.707	2.239	0.000	0.000	0.000	0.000	0.000	**1.361**
1966	**0.000**	**0.301**	**0.384**	**0.416**	**0.553**	**0.995**	**1.288**	1.529	1.938	1.727	2.963	2.040	0.000	0.000	0.000	0.000	**1.665**
1967	**0.000**	**0.260**	**0.404**	**0.510**	**0.614**	**0.645**	**1.063**	1.501	1.922	2.069	2.348	0.000	0.000	0.000	0.000	0.000	**1.792**
1968	**0.000**	**0.256**	**0.361**	**0.591**	**0.761**	**0.863**	**0.846**	1.610	2.260	2.702	2.073	0.000	0.000	0.000	0.000	0.000	**1.722**
1969	**0.000**	**0.178**	**0.302**	**0.506**	**0.870**	**0.984**	**1.065**	1.102	2.040	3.034	3.264	0.000	0.000	0.000	0.000	0.000	**1.115**
1970	**0.000**	**0.242**	**0.310**	**0.403**	**0.786**	**0.949**	**1.235**	1.370	1.437	2.571	3.950	3.869	0.000	0.000	0.000	0.000	**1.458**
1971	**0.000**	**0.256**	**0.335**	**0.399**	**0.524**	**0.905**	**1.281**	1.534	1.337	1.275	1.969	4.306	3.543	0.000	0.000	0.000	**1.366**
1972	**0.000**	**0.244**	**0.329**	**0.421**	**0.523**	**0.609**	**1.003**	1.366	2.241	2.006	1.651	2.899	0.000	0.000	0.000	0.000	**1.635**
1973	**0.000**	**0.225**	**0.315**	**0.406**	**0.606**	**0.663**	**0.726**	1.044	1.302	2.796	1.726	2.020	2.158	0.000	0.000	0.000	**1.176**
1974	**0.000**	**0.275**	**0.320**	**0.389**	**0.585**	**0.908**	**0.954**	0.963	1.513	2.315	2.508	4.152	2.264	0.000	0.000	0.000	**0.984**
1975	**0.000**	**0.258**	**0.345**	**0.408**	**0.487**	**0.686**	**1.248**	1.124	1.094	1.720	2.217	2.854	0.000	3.426	0.000	0.000	**1.174**
1976	**0.000**	**0.250**	**0.344**	**0.467**	**0.516**	**0.614**	**0.923**	1.933	1.784	1.306	2.425	2.528	0.000	0.000	0.000	0.000	**1.521**
1977	**0.000**	**0.286**	**0.362**	**0.396**	**0.614**	**0.630**	**0.817**	1.181	1.943	2.322	1.780	3.189	0.000	4.119	0.000	0.000	**1.340**
1978	**0.000**	**0.275**	**0.356**	**0.457**	**0.470**	**0.725**	**0.789**	0.956	1.398	2.124	2.868	1.849	2.454	4.782	0.000	0.000	**1.115**
1979	**0.000**	**0.274**	**0.361**	**0.468**	**0.642**	**0.668**	**0.935**	1.187	1.187	1.468	2.679	1.624	1.760	1.643	0.000	0.000	**1.326**
1980	**0.000**	**0.299**	**0.367**	**0.526**	**0.750**	**1.056**	**0.934**	1.392	1.599	1.592	1.726	3.328	1.119	3.071	3.111	0.000	**1.541**
1981	**0.000**	**0.339**	**0.385**	**0.525**	**0.754**	**1.149**	**1.481**	1.180	1.634	1.764	1.554	1.492	3.389	4.273	1.981	0.000	**1.226**
1982	**0.000**	**0.300**	**0.364**	**0.507**	**0.818**	**1.237**	**1.441**	1.672	1.456	2.634	2.164	1.924	1.886	3.179	0.000	0.000	**1.558**
1983	**0.000**	**0.312**	**0.387**	**0.482**	**0.663**	**0.925**	**1.243**	1.162	1.920	1.376	1.395	1.907	2.853	4.689	0.000	0.000	**1.366**
1984	**0.000**	**0.281**	**0.376**	**0.515**	**0.677**	**0.810**	**1.097**	1.100	1.868	2.425	1.972	2.247	2.422	2.822	4.995	0.000	**1.389**
1985	**0.000**	**0.277**	**0.359**	**0.502**	**0.671**	**0.871**	**1.051**	1.459	1.833	2.124	2.145	2.003	2.387	2.471	2.721	3.970	**1.594**
1986	**0.000**	**0.276**	**0.351**	**0.433**	**0.613**	**0.863**	**1.257**	1.195	1.715	1.525	2.484	2.653	2.538	3.075	2.778	2.894	**1.348**
1987	**0.000**	**0.274**	**0.345**	**0.451**	**0.622**	**1.029**	**1.276**	1.433	1.529	1.877	2.054	1.940	2.471	2.411	2.996	2.638	**1.592**
1988	**0.000**	**0.258**	**0.324**	**0.445**	**0.619**	**0.752**	**1.284**	1.424	1.551	1.627	1.680	3.068	2.468	2.885	3.337	2.863	**1.565**
1989	**0.000**	**0.310**	**0.388**	**0.415**	**0.617**	**0.810**	**0.982**	1.361	1.653	1.684	2.236	2.166	2.364	2.389	2.307	1.146	**1.519**
1990	**0.000**	**0.308**	**0.379**	**0.484**	**0.516**	**0.802**	**1.039**	1.191	1.543	2.037	2.653	2.530	2.392	3.444	1.852	4.731	**1.341**
1991	**0.000**	**0.319**	**0.377**	**0.480**	**0.643**	**0.653**	**1.042**	1.232	1.481	1.776	1.996	2.253	2.404	1.070	3.509	2.936	**1.468**
1992	**0.000**	**0.336**	**0.379**	**0.510**	**0.751**	**1.017**	**0.904**	1.395	1.538	1.912	1.997	2.067	2.441	1.781	0.000	0.000	**1.637**
1993	**0.000**	**0.326**	**0.393**	**0.483**	**0.684**	**0.896**	**1.173**	1.111	1.592	1.737	1.920	1.718	2.274	2.516	0.000	0.000	**1.297**
1994	**0.000**	**0.288**	**0.390**	**0.482**	**0.617**	**0.962**	**1.296**	1.570	1.469	1.620	2.418	2.108	2.849	2.403	2.580	0.000	**1.606**
1995	**0.000**	**0.312**	**0.396**	**0.421**	**0.603**	**0.767**	**1.099**	1.423	1.685	1.873	1.881	2.508	1.674	1.699	2.243	0.000	**1.644**
1996	**0.000**	**0.342**	**0.359**	**0.462**	**0.515**	**0.780**	**0.870**	0.846	1.833	2.025	1.623	2.393	2.369	2.598	3.439	0.000	**0.999**
1997	**0.000**	**0.333**	**0.396**	**0.412**	**0.601**	**0.618**	**0.909**	0.966	1.647	2.247	2.146	2.634	2.757	2.262	2.867	2.782	**1.092**
1998	**0.000**	**0.263**	**0.361**	**0.429**	**0.460**	**0.657**	**0.762**	1.103	1.153	1.825	2.357	2.150	2.824	2.423	2.085	2.509	**1.163**
1999	**0.000**	**0.286**	**0.347**	**0.416**	**0.482**	**0.510**	**0.717**	0.782	0.749	1.247	1.559	1.913	2.232	2.392	2.912	2.225	**0.791**
2000	**0.000**	**0.298**	**0.366**	**0.419**	**0.520**	**0.622**	**0.653**	1.100	1.091	1.760	1.959	2.331	2.385	2.315	3.810	1.843	**1.142**
2001	**0.000**	**0.378**	**0.348**	**0.439**	**0.498**	**0.714**	**0.754**	0.976	1.922	1.198	2.114	2.706	3.237	2.534	1.239	3.425	**1.117**
2002	**0.000**	**0.356**	**0.427**	**0.393**	**0.556**	**0.742**	**0.924**	0.997	1.423	1.941	2.368	1.840	2.349	2.762	0.000	0.000	**1.407**
2003	**0.000**	**0.311**	**0.424**	**0.450**	**0.439**	**0.679**	**0.777**	1.156	1.382	1.647	2.181	2.209	2.506	2.606	1.981	3.092	**1.381**
2004	**0.000**	**0.348**	**0.372**	**0.461**	**0.444**	**0.467**	**0.729**	1.054	1.372	1.741	1.765	2.355	2.172	0.000	0.000	0.000	**1.346**
2005	**0.000**	**0.369**	**0.387**	**0.419**	**0.532**	**0.507**	**0.533**	0.864	1.100	1.360	1.929	2.682	2.553	2.319	3.431	0.000	**1.014**

Table 13.2.3.3 Haddock in Sub-Area IV and Division IIIa. Weight-at-age data (kg) from the Discards catch in the North Sea. Data used in the assessment are highlighted in bold.

CWt disc	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	7+
1963	0.064	0.139	0.218	0.327	0.397	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1964	0.065	0.177	0.249	0.306	0.337	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1965	0.064	0.131	0.200	0.341	0.613	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1966	0.063	0.141	0.208	0.244	0.310	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1967	0.064	0.171	0.209	0.274	0.306	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1968	0.063	0.186	0.212	0.256	0.318	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1969	0.064	0.129	0.216	0.237	0.301	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1970	0.063	0.129	0.210	0.238	0.263	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1971	0.063	0.134	0.201	0.242	0.263	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1972	0.063	0.139	0.206	0.237	0.261	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1973	0.063	0.131	0.201	0.235	0.263	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1974	0.062	0.145	0.200	0.233	0.259	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1975	0.050	0.123	0.200	0.257	0.275	0.348	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1976	0.079	0.176	0.197	0.237	0.292	0.337	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1977	0.071	0.196	0.197	0.216	0.309	0.347	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1978	0.037	0.180	0.199	0.222	0.224	0.265	0.284	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1979	0.053	0.118	0.219	0.242	0.259	0.340	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1980	0.051	0.149	0.231	0.274	0.324	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1981	0.073	0.160	0.198	0.290	0.650	0.727	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1982	0.072	0.197	0.248	0.271	0.264	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1983	0.067	0.187	0.237	0.347	0.476	0.711	0.792	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1984	0.046	0.162	0.245	0.317	0.300	0.314	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1985	0.040	0.155	0.214	0.264	0.336	0.423	0.421	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1986	0.045	0.138	0.184	0.245	0.408	0.329	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1987	0.023	0.159	0.200	0.225	0.287	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1988	0.063	0.172	0.170	0.238	0.254	0.360	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1989	0.085	0.187	0.229	0.268	0.335	0.708	0.844	0.000	2.572	0.000	3.048	0.000	0.000	0.000	0.000	0.000	2.810
1990	0.046	0.196	0.229	0.249	0.266	0.290	0.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.065	0.179	0.243	0.344	0.464	0.493	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.043	0.137	0.246	0.286	0.347	0.000	0.415	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1993	0.027	0.142	0.237	0.287	0.344	0.369	0.000	0.369	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.369
1994	0.044	0.126	0.211	0.269	0.306	0.304	0.270	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1995	0.064	0.131	0.251	0.275	0.363	0.384	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1996	0.046	0.138	0.219	0.279	0.297	0.358	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1997	0.063	0.161	0.254	0.286	0.321	0.385	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1998	0.041	0.162	0.231	0.293	0.315	0.391	0.428	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1999	0.049	0.183	0.217	0.273	0.307	0.304	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2000	0.030	0.129	0.246	0.281	0.319	0.355	0.287	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2001	0.045	0.116	0.205	0.307	0.308	0.364	0.000	0.411	0.416	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.413
2002	0.042	0.166	0.226	0.268	0.352	0.378	0.000	0.357	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.357
2003	0.067	0.128	0.223	0.265	0.332	0.536	0.654	0.951	0.946	1.154	0.000	0.000	0.000	0.000	0.000	0.000	0.979
2004	0.054	0.173	0.232	0.280	0.308	0.342	0.639	0.716	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.716
2005	0.057	0.201	0.251	0.283	0.313	0.305	0.345	0.621	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.621

Table 13.2.3.4 Haddock in Sub-Area IV and Division IIIa. Weight-at-age data (kg) from the industrial bycatch in the North Sea. Data used in the assessment are highlighted in bold.

CWt Ind BC	**0**	**1**	**2**	**3**	**4**	**5**	**6**	7	8	9	10	11	12	13	14	15	**7+**
1963	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1964	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.500**
1965	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.500**
1966	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.500**
1967	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1968	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.500**
1969	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.500**
1970	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.500**
1971	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1972	**0.023**	**0.067**	**0.136**	**0.255**	**0.288**	**0.231**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1973	**0.035**	**0.068**	**0.141**	**0.246**	**0.327**	**0.396**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1974	**0.022**	**0.058**	**0.150**	**0.260**	**0.359**	**0.579**	**0.277**	0.447	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.447**
1975	**0.020**	**0.039**	**0.173**	**0.275**	**0.267**	**0.413**	**0.585**	0.000	0.585	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.585**
1976	**0.012**	**0.046**	**0.181**	**0.304**	**0.473**	**0.360**	**0.725**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1977	**0.013**	**0.042**	**0.184**	**0.307**	**0.490**	**0.352**	**0.442**	1.234	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.272**
1978	**0.011**	**0.040**	**0.174**	**0.286**	**0.372**	**0.473**	**0.411**	0.456	1.315	0.000	1.400	0.000	0.000	0.000	0.000	0.000	**0.458**
1979	**0.009**	**0.039**	**0.177**	**0.285**	**0.384**	**0.461**	**0.735**	1.234	1.315	0.000	1.400	0.000	0.000	0.000	0.000	0.000	**1.319**
1980	**0.012**	**0.039**	**0.176**	**0.268**	**0.623**	**0.722**	**1.102**	1.591	0.000	1.796	0.000	0.000	0.000	0.000	0.000	0.000	**1.620**
1981	**0.009**	**0.040**	**0.176**	**0.371**	**0.467**	**0.858**	**1.200**	1.234	1.315	1.319	1.400	0.000	0.000	0.000	0.000	0.000	**1.262**
1982	**0.010**	**0.040**	**0.206**	**0.379**	**0.636**	**0.751**	**1.225**	1.233	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.287**
1983	**0.008**	**0.047**	**0.173**	**0.428**	**0.584**	**1.006**	**1.225**	1.234	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.284**
1984	**0.009**	**0.045**	**0.211**	**0.414**	**0.626**	**0.751**	**1.225**	1.234	1.315	1.319	1.400	1.400	0.000	0.000	0.000	0.000	**1.289**
1985	**0.009**	**0.043**	**0.186**	**0.371**	**0.550**	**0.563**	**0.565**	1.234	1.315	1.319	1.400	0.000	0.000	0.000	0.000	0.000	**1.265**
1986	**0.010**	**0.040**	**0.186**	**0.375**	**0.626**	**1.259**	**1.225**	1.234	1.315	1.319	1.400	0.000	0.000	0.000	0.000	0.000	**1.256**
1987	**0.006**	**0.038**	**0.258**	**0.442**	**0.908**	**1.171**	**1.225**	1.234	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.292**
1988	**0.018**	**0.077**	**0.196**	**0.274**	**0.455**	**0.549**	**1.225**	1.234	1.315	1.319	1.400	0.000	0.000	0.000	0.000	0.000	**1.259**
1989	**0.015**	**0.165**	**0.251**	**0.347**	**0.670**	**0.923**	**1.065**	1.492	1.315	0.000	1.400	0.000	0.000	0.000	0.000	0.000	**1.491**
1990	**0.005**	**0.104**	**0.229**	**0.506**	**0.609**	**0.842**	**0.829**	0.796	0.956	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**0.805**
1991	**0.027**	**0.058**	**0.206**	**0.357**	**0.472**	**0.477**	**1.225**	1.234	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.284**
1992	**0.015**	**0.059**	**0.217**	**0.422**	**0.552**	**0.615**	**0.548**	1.234	0.621	0.820	0.000	0.000	0.000	0.000	0.000	0.000	**0.662**
1993	**0.008**	**0.053**	**0.206**	**0.399**	**0.521**	**0.578**	**1.225**	0.582	1.315	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.582**
1994	**0.011**	**0.055**	**0.155**	**0.435**	**0.595**	**0.698**	**0.490**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1995	**0.012**	**0.045**	**0.193**	**0.285**	**0.387**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1996	**0.018**	**0.077**	**0.136**	**0.162**	**0.264**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1997	**0.007**	**0.076**	**0.149**	**0.309**	**0.419**	**0.601**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1998	**0.020**	**0.075**	**0.166**	**0.291**	**0.351**	**0.453**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1999	**0.018**	**0.064**	**0.177**	**0.304**	**0.416**	**0.309**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2000	**0.058**	**0.070**	**0.113**	**0.176**	**0.370**	**0.203**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2001	**0.014**	**0.086**	**0.133**	**0.110**	**0.353**	**0.431**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2002	**0.016**	**0.064**	**0.178**	**0.283**	**0.374**	**0.431**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2003	**0.012**	**0.031**	**0.056**	**0.231**	**0.326**	**0.339**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2004	**0.000**	**0.116**	**0.183**	**0.255**	**0.276**	**0.446**	**0.539**	0.840	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.840**
2005	**0.000**	**0.107**	**0.187**	**0.239**	**0.268**	**0.287**	**0.598**	0.619	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.619**

Table 13.2.5.1 Haddock in Sub-Area IV and Division IIIa. Data available for calibration of the assessment. Data used in the assessment are highlighted in bold.

English Groundfish Survey, age 0 – 10+. Survey period: 0.5-0.75. Span: 1977-1991

EngGFS (early)	effort	0	1	2	3	4	5	6	7	8	9	10+
1977	100	**53.48**	**6.68**	**3.21**	**6.16**	**0.93**	**0.07**	0.09	0.01	0.00	0.01	0.00
1978	100	**35.83**	**13.69**	**2.62**	**0.24**	**2.22**	**0.21**	0.00	0.07	0.01	0.00	0.01
1979	100	**87.55**	**29.55**	**5.46**	**0.87**	**0.11**	**0.44**	0.04	0.00	0.02	0.00	0.00
1980	100	**37.40**	**62.33**	**16.73**	**2.57**	**0.27**	**0.04**	0.14	0.02	0.00	0.00	0.00
1981	100	**153.75**	**17.32**	**43.91**	**7.56**	**0.74**	**0.06**	0.00	0.06	0.01	0.00	0.01
1982	100	**28.13**	**31.55**	**7.98**	**11.80**	**1.02**	**0.24**	0.10	0.01	0.01	0.00	0.00
1983	100	**83.19**	**21.82**	**10.95**	**2.14**	**2.17**	**0.27**	0.04	0.01	0.00	0.00	0.00
1984	100	**22.85**	**59.93**	**6.16**	**3.08**	**0.42**	**0.48**	0.10	0.01	0.00	0.01	0.02
1985	100	**24.59**	**18.66**	**23.82**	**2.11**	**0.70**	**0.20**	0.13	0.04	0.01	0.00	0.00
1986	100	**26.60**	**14.97**	**4.47**	**3.38**	**0.28**	**0.17**	0.04	0.04	0.01	0.00	0.00
1987	100	**2.24**	**28.19**	**4.31**	**0.53**	**0.69**	**0.05**	0.03	0.00	0.00	0.00	0.00
1988	100	**6.07**	**2.86**	**18.35**	**1.55**	**0.16**	**0.28**	0.04	0.01	0.00	0.00	0.00
1989	100	**9.43**	**8.17**	**1.45**	**3.97**	**0.25**	**0.03**	0.06	0.01	0.02	0.00	0.00
1990	100	**28.19**	**6.64**	**1.98**	**0.29**	**0.88**	**0.05**	0.03	0.01	0.01	0.00	0.00
1991	100	**26.33**	**11.50**	**0.96**	**0.23**	**0.05**	**0.22**	0.01	0.01	0.00	0.00	0.00

English Groundfish Survey, age 0 – 10+. Survey period: 0.5-0.75. Span: 1992-2005

EngGFS (recent)	effort	0	1	2	3	4	5	6	7	8	9	10+
1992	100	**82.77**	**19.69**	**9.77**	**0.58**	**0.05**	**0.01**	0.08	0.00	0.05	0.00	0.01
1993	100	**13.58**	**24.61**	**5.86**	**1.67**	**0.06**	**0.02**	0.00	0.01	0.00	0.00	0.00
1994	100	**94.30**	**8.07**	**9.02**	**0.84**	**0.28**	**0.02**	0.00	0.00	0.00	0.00	0.00
1995	100	**17.99**	**38.31**	**4.45**	**3.40**	**0.28**	**0.09**	0.01	0.00	0.00	0.00	0.00
1996	100	**20.62**	**8.97**	**14.39**	**1.20**	**0.69**	**0.07**	0.03	0.00	0.00	0.00	0.00
1997	100	**13.03**	**14.86**	**4.33**	**6.61**	**0.23**	**0.22**	0.03	0.01	0.00	0.00	0.00
1998	100	**5.30**	**8.89**	**5.68**	**1.35**	**1.42**	**0.08**	0.05	0.00	0.01	0.00	0.00
1999	100	**210.98**	**5.57**	**2.83**	**1.23**	**0.42**	**0.40**	0.01	0.01	0.00	0.00	0.00
2000	100	**31.02**	**84.11**	**1.52**	**0.55**	**0.25**	**0.11**	0.12	0.00	0.00	0.00	0.00
2001	100	**0.37**	**9.64**	**32.49**	**1.02**	**0.28**	**0.12**	0.05	0.02	0.06	0.00	0.00
2002	100	**0.92**	**1.33**	**7.60**	**20.40**	**0.18**	**0.03**	0.05	0.03	0.01	0.00	0.00
2003	100	**1.08**	**2.02**	**0.42**	**4.71**	**15.18**	**0.24**	0.01	0.07	0.03	0.00	0.00
2004	100	**0.94**	**1.57**	**1.07**	**0.14**	**1.92**	**5.12**	0.06	0.06	0.02	0.03	0.00
2005	100	**41.21**	**3.28**	**2.02**	**0.87**	**0.42**	**2.23**	1.23	0.01	0.00	0.00	0.00

Scottish Groundfish Survey. Ages 0-8. Survey period: 0.5-0.75. Span: 1982-1997.

ScoGFS (early)	effort	0	1	2	3	4	5	6	7	8
1982	100	**1235**	**2488**	**996**	**1336**	**115**	**7**	2	1	2
1983	100	**2203**	**1813**	**1611**	**372**	**455**	**53**	12	1	1
1984	100	**873**	**4367**	**788**	**336**	**55**	**65**	9	5	1
1985	100	**818**	**1976**	**2981**	**232**	**103**	**14**	22	4	2
1986	100	**1747**	**2329**	**574**	**598**	**36**	**27**	4	3	+
1987	100	**277**	**2393**	**704**	**106**	**128**	**8**	5	1	2
1988	100	**406**	**467**	**1982**	**170**	**27**	**23**	2	1	+
1989	100	**432**	**886**	**214**	**574**	**31**	**4**	7	1	+
1990	100	**3163**	**1002**	**240**	**32**	**103**	**7**	1	3	1
1991	100	**3471**	**1705**	**178**	**21**	**5**	**16**	2	+	1
1992	100	**8270**	**3832**	**963**	**48**	**8**	**3**	8	+	+
1993	100	**859**	**5836**	**1380**	**269**	**6**	**4**	1	3	+
1994	100	**13762**	**1265**	**2080**	**210**	**53**	**2**	+	+	+
1995	100	**1566**	**8153**	**734**	**926**	**74**	**28**	2	0	0
1996	100	**1980**	**2231**	**4705**	**231**	**206**	**22**	6	+	0
1997	100	**972**	**2779**	**849**	**1397**	**66**	**56**	6	+	+

Table 13.2.5.1 cont Haddock in Sub-Area IV and Division IIIa. Data available for calibration of the assessment. Data used in the assessment are highlighted in bold. [Note the 2006 data from the Scottish Groundfish survey are used only for short-term forecasts (RCT3)].

Scottish Groundfish Survey. Ages 0-8. Survey period: 0.5-0.75. Span: 1998-2006

ScoGFS (recent)	effort	**0**	**1**	**2**	**3**	**4**	**5**	6	7	8
1998	100	**3280**	**6349**	**1924**	**490**	**511**	**24**	18	2	+
1999	100	**66067**	**1907**	**1141**	**688**	**197**	**164**	6	7	1
2000	100	**11902**	**30611**	**460**	**221**	**130**	**73**	27	4	3
2001	100	**79**	**3790**	**11352**	**179**	**65**	**40**	18	14	1
2002	100	**2149**	**675**	**2632**	**6931**	**70**	**37**	18	3	3
2003	100	**2159**	**1172**	**307**	**2092**	**4344**	**22**	17	8	2
2004	100	**1729**	**1198**	**547**	**101**	**819**	**1420**	9	1	1
2005	100	**19708**	**761**	**657**	**153**	**112**	**347**	483	4	3
2006	100	**2280**	**7275**	272	158	33	14	73	227	2

IBTS Q1 survey (prior to backshifting). Ages 1-6+. Survey period: 0.99-1. Span: 1983-2006

IBTS Q1	effort	**1**	**2**	**3**	**4**	**5**	6+
1983	10	**302.28**	**403.08**	**89.46**	**116.45**	**13.18**	2.05
1984	10	**1072.29**	**221.28**	**127.77**	**20.41**	**20.90**	4.61
1985	10	**230.97**	**833.26**	**107.60**	**32.32**	**3.58**	6.57
1986	10	**573.02**	**266.91**	**303.55**	**17.89**	**6.49**	2.15
1987	10	**912.56**	**328.06**	**45.20**	**58.26**	**4.35**	2.43
1988	10	**101.69**	**677.64**	**97.15**	**12.68**	**13.97**	2.07
1989	10	**219.71**	**98.09**	**274.79**	**16.65**	**2.11**	4.70
1990	10	**217.45**	**139.11**	**33.00**	**50.37**	**3.16**	1.80
1991	10	**680.23**	**134.08**	**25.03**	**4.26**	**8.48**	2.43
1992	10	**1141.40**	**331.04**	**17.04**	**3.03**	**0.66**	2.20
1993	10	**1242.12**	**519.52**	**152.38**	**8.85**	**1.08**	0.95
1994	10	**227.92**	**491.05**	**97.66**	**23.31**	**1.57**	0.79
1995	10	**1355.49**	**201.07**	**176.17**	**24.35**	**5.29**	0.82
1996	10	**267.41**	**813.27**	**65.87**	**46.69**	**7.73**	3.06
1997	10	**849.94**	**353.88**	**466.73**	**24.99**	**15.24**	3.43
1998	10	**357.60**	**420.93**	**103.53**	**112.63**	**8.76**	5.41
1999	10	**211.14**	**222.91**	**127.06**	**48.22**	**36.65**	4.35
2000	10	**3734.19**	**107.06**	**48.64**	**24.55**	**15.59**	10.05
2001	10	**894.65**	**2255.21**	**47.90**	**10.96**	**7.22**	5.76
2002	10	**58.21**	**492.30**	**1387.88**	**10.01**	**7.46**	4.34
2003	10	**89.96**	**38.59**	**251.27**	**524.14**	**4.28**	2.36
2004	10	**71.86**	**81.81**	**38.68**	**173.92**	**324.35**	1.02
2005	10	**69.98**	**60.99**	**32.63**	**11.00**	**61.29**	95.69
2006	10	**1212.16**	**47.78**	**28.58**	**8.98**	**4.40**	53.18

Table 13.2.5.2 Haddock in Sub-Area IV and Division IIIa. Data available for calibration of the assessment. These data are not used in the assessment because recording of hours fished is not mandatory in logbooks in the UK and is not considered to be representative of deployed fishing effort

Scottish Seiners CPUE. Ages 0-13.

ScoLTR	fishing hours	0	1	2	3	4	5	6	7	8	9	10	11	12	13
1978	236929	1692	45733	11471	2914	12279	774	110	167	24	4	0	5	1	0
1979	287494	464	44562	23135	4109	714	3644	203	20	57	20	0	0	1	0
1980	333197	180	92519	46282	8062	755	197	1015	61	18	8	5	0	0	0
1981	251504	436	7979	58146	13653	1518	161	20	320	12	6	7	6	0	0
1982	250870	352	24575	10170	33463	3937	133	67	7	58	0	0	2	0	0
1983	244349	63676	19635	48680	6955	11807	1258	124	27	4	25	7	0	0	2
1984	240725	514	56769	22191	13375	2074	3392	402	98	15	7	14	1	0	0
1985	268136	3548	38850	57422	4913	2787	414	872	128	27	2	0	18	0	0
1986	279767	4371	26322	26549	32339	2797	1014	124	307	43	37	2	2	2	3
1987	351128	97	26220	33648	6464	7197	496	377	72	119	27	2	4	3	4
1988	391988	209	2931	57589	14075	2367	2924	167	84	28	21	6	0	0	0
1989	405883	1077	10415	2919	24895	2754	541	627	109	30	21	7	4	1	1
1990	441084	201	11886	19205	2665	10237	669	168	264	45	14	5	2	1	0
1991	408056	1041	44141	12394	3356	564	2213	226	80	146	38	16	2	1	0
1992	473955	1838	20443	31073	3889	757	144	766	98	52	58	17	3	1	0
1993	447064	231	39863	39176	20213	1527	362	84	274	29	27	26	8	2	1
1994	480400	1482	8267	49047	23557	6304	474	128	42	64	13	7	7	2	2
1995	442010	144	22874	13762	32063	5821	1658	97	15	13	17	3	2	1	1
1996	445995	353	14281	72692	9860	13959	2041	955	304	10	14	7	1	2	1
1997	479449	460	15907	13451	49548	3537	4511	553	163	13	2	2	1	1	1
1998	427868	157	27498	33166	9597	29614	1666	1228	173	46	4	1	1	0	1
1999	329750	2101	24475	36849	24426	5531	11752	841	579	94	9	2	0	0	0
2000	280938	5	64710	15038	11707	7061	1300	2593	174	83	8	2	1	0	0
2001	245489	87	15567	173376	6323	2897	1253	365	444	62	17	9	0	0	0
2002	184096	8	982	11514	53313	1738	664	395	165	218	94	5	4	2	0
2003	98723	71	2804	3186	10931	30249	601	235	123	56	35	15	2	1	0
2004	63953	0	1114	3797	1602	6436	18851	243	68	26	17	11	3	0	0
2005	54905	567	1571	4512	2971	760	5634	11540	42	30	11	2	2	1	0

Scottish light trawlers, ages 0-13.

ScoSEI	fishing hours	0	1	2	3	4	5	6	7	8	9	10	11	12	13
1978	325246	1665	160843	69033	14340	44152	2366	482	673	86	29	3	16	6	0
1979	316419	543	83631	78815	17215	3040	8073	648	70	113	24	4	1	1	0
1980	297227	210	131314	128306	26205	3393	501	2415	123	20	56	23	13	1	1
1981	289672	345	10367	134260	55726	5181	702	102	579	15	22	1	10	2	0
1982	297730	1445	31143	30969	118898	14297	682	145	39	230	1	9	1	0	0
1983	333168	18101	29021	77289	30414	50115	6394	583	119	15	69	26	1	2	0
1984	388085	422	120868	63391	49286	9426	14977	1594	254	18	8	38	3	2	0
1985	382910	2052	29239	164839	33203	15993	2293	2846	308	47	19	9	28	2	0
1986	425017	8265	33999	72604	155836	12895	4169	490	620	58	11	20	15	11	3
1987	418734	138	43646	97731	19731	28883	1989	1174	199	285	31	16	15	12	7
1988	377132	499	11576	201533	37421	4736	7415	718	290	80	70	27	6	6	7
1989	355735	123	19004	19274	91070	8389	1091	1611	223	89	40	13	6	4	1
1990	300076	712	35844	46489	9055	26705	1434	302	408	67	29	5	3	0	0
1991	336675	2226	66144	30755	9531	1485	5028	308	122	183	42	11	1	1	0
1992	300217	1232	30384	64733	8588	1512	290	1180	79	57	53	18	4	0	1
1993	268413	2913	74523	88375	34997	2349	446	100	314	29	15	14	3	0	1
1994	264738	3231	26626	125357	34127	10522	415	138	42	95	9	7	7	2	1
1995	204545	236	67772	32301	70290	8734	2181	117	39	13	9	4	2	3	1
1996	177092	1333	9192	123829	18532	17077	2161	707	84	12	8	11	3	2	1
1997	166817	3109	30046	19165	59309	3918	4083	495	195	10	7	2	0	0	2
1998	150361	38	12692	36813	12003	26564	1659	856	69	22	4	2	2	0	0
1999	93796	3466	23253	35102	21991	6628	11164	690	456	56	12	0	1	0	0
2000	69505	110	46422	13650	8497	5610	1761	2357	110	41	4	1	0	0	0
2001	36135	60	3973	91165	4469	1720	799	273	263	27	18	1	1	0	0
2002	21817	14	708	10089	45219	1177	400	169	61	45	15	1	1	0	0
2003	15374	29	395	1312	8571	23778	346	80	32	11	4	5	2	0	0
2004	15674	0	3711	6459	868	9719	24783	125	19	4	4	3	1	0	0
2005	16149	845	1841	3189	3210	491	5839	14660	26	2	6	1	1	0	0

Table 13.3.5.1 Haddock in Sub-Area IV and Division IIIa. XSA final assessment: Tuning diagnostics.

```
Lowestoft VPA Version 3.1

   6/09/2006  11:17

 Extended Survivors Analysis

 Haddock in the North Sea and Skagerrak, ages 0-7+

 CPUE data from file hadivef.txt

 Catch data for  43 years. 1963 to 2005. Ages  0 to   7.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 ENGFS_early         ,   1977, 2005,   0,     5,   .500,   .750
 ENGGFS              ,   1992, 2005,   0,     5,   .500,   .750
 SCOGFS_early        ,   1982, 2005,   0,     5,   .500,   .750
 SCOGFS              ,   1998, 2005,   0,     5,   .500,   .750
 IBTS_Q1(backshift&5p,   1982, 2005,   0,     4,   .990,  1.000


 Time series weights :

      Tapered time weighting not applied


 Catchability analysis :

      Catchability dependent on stock size for ages <    1

         Regression type = C
         Minimum of   5 points used for regression
         Survivor estimates shrunk to the population mean for ages <  1


      Catchability independent of age for ages >=    3


 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   3 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =   2.000

      Minimum standard error for population
      estimates derived from each fleet =    .300

      Prior weighting not applied


 Tuning had not converged after   30 iterations


 Total absolute residual between iterations
 29 and  30 =     .00062

 Final year F values
 Age          ,      0,      1,      2,      3,      4,      5,      6
 Iteration 29,  .0003,  .0485,  .2831,  .3825,  .2962,  .2727,  .2171
 Iteration 30,  .0003,  .0485,  .2831,  .3824,  .2961,  .2725,  .2169
```

Table 13.3.5.1 cont Haddock in Sub-Area IV and Division IIIa. XSA final assessment: Tuning diagnostics.

Regression weights

, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000

Fishing mortalities

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	.047	.009	.007	.003	.006	.004	.038	.004	.001	.000
1	.077	.127	.132	.168	.056	.071	.133	.094	.047	.049
2	.461	.449	.635	.849	.813	.342	.170	.364	.311	.283
3	.958	.660	.600	1.021	1.085	1.005	.244	.190	.332	.382
4	1.016	.808	.936	.747	1.168	.725	.599	.174	.235	.296
5	1.127	.958	.880	1.257	.413	.569	.365	.369	.221	.273
6	1.740	1.028	.604	1.208	1.111	.177	.277	.173	.223	.217

XSA population numbers (Thousands)

	AGE						
YEAR	0	1	2	3	4	5	6
1996	2.09E+07	1.64E+06	1.18E+06	1.05E+05	9.80E+04	1.23E+04	4.09E+03
1997	1.21E+07	2.57E+06	2.91E+05	5.00E+05	3.12E+04	2.76E+04	3.26E+03
1998	9.38E+06	1.54E+06	4.35E+05	1.25E+05	2.02E+05	1.08E+04	8.68E+03
1999	1.14E+08	1.20E+06	2.59E+05	1.55E+05	5.33E+04	6.16E+04	3.68E+03
2000	2.26E+07	1.47E+07	1.94E+05	7.42E+04	4.34E+04	1.97E+04	1.43E+04
2001	2.62E+06	2.90E+06	2.67E+06	5.78E+04	1.95E+04	1.05E+04	1.07E+04
2002	3.81E+06	3.36E+05	5.18E+05	1.27E+06	1.65E+04	7.36E+03	4.87E+03
2003	3.83E+06	4.73E+05	5.66E+04	2.93E+05	7.75E+05	7.05E+03	4.18E+03
2004	3.39E+06	4.90E+05	8.26E+04	2.63E+04	1.89E+05	5.07E+05	3.99E+03
2005	3.57E+07	4.36E+05	8.98E+04	4.06E+04	1.47E+04	1.16E+05	3.33E+05

Estimated population abundance at 1st Jan 2006

, 0.00E+00, 4.60E+06, 7.97E+04, 4.54E+04, 2.16E+04, 8.53E+03, 7.25E+04,

Taper weighted geometric mean of the VPA populations:

, 2.16E+07, 2.83E+06, 4.54E+05, 1.53E+05, 4.70E+04, 1.44E+04, 4.30E+03,

Standard error of the weighted Log(VPA populations) :

, 1.1228, 1.1709, 1.1733, 1.2040, 1.2204, 1.2748, 1.2878,

Table 13.3.5.1 cont Haddock in Sub-Area IV and Division IIIa. XSA final assessment: Tuning diagnostics.

Log catchability residuals.

Fleet : ENGFS_early

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985
0	.45	-.31	-.14	.67	1.16	.15	-.11	.14	-.13
1	-.51	-.23	.00	.17	.43	.30	.36	.16	.39
2	.22	-.30	-.08	.32	.56	.38	.10	-.04	.05
3	-.25	-.83	.13	.65	.83	.38	.29	.16	.21
4	.27	.10	-.23	.34	.60	-.02	-.03	-.06	.01
5	-.13	.02	-.14	.08	-.06	.28	-.06	-.09	.33

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	-.80	-.44	-.30	.06	-.18	-.21	99.99	99.99	99.99	99.99
1	-.21	-.33	-.12	.20	.03	-.63	99.99	99.99	99.99	99.99
2	.07	-.46	.17	.05	-.09	-.94	99.99	99.99	99.99	99.99
3	-.42	-.53	.15	.02	-.10	-.71	99.99	99.99	99.99	99.99
4	-.30	-.56	-.23	-.11	-.09	-.54	99.99	99.99	99.99	99.99
5	-.06	-.53	.07	-.47	-.20	-.14	99.99	99.99	99.99	99.99

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5
Mean Log q	-15.5064	-15.0167	-15.1650	-15.1650	-15.1650
S.E(Log q)	.3304	.3644	.4756	.3133	.2421

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.86	.843	16.96	.73	15	.50	-16.96

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.02	-.187	15.52	.84	15	.35	-15.51
2	.84	1.652	14.69	.89	15	.29	-15.02
3	.86	1.296	14.71	.87	15	.40	-15.17
4	.96	.530	15.02	.92	15	.30	-15.22
5	.96	.550	15.01	.94	15	.23	-15.24

Table 13.3.5.1 cont Haddock in Sub-Area IV and Division IIIa. XSA final assessment: Tuning diagnostics.

Fleet : ENGGFS

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	99.99	99.99	99.99	99.99	99.99	99.99	.13	.24	-.06	.36
1	99.99	99.99	99.99	99.99	99.99	99.99	.16	.00	.06	.12
2	99.99	99.99	99.99	99.99	99.99	99.99	.41	-.03	-.12	.30
3	99.99	99.99	99.99	99.99	99.99	99.99	.33	-.01	-.59	.10
4	99.99	99.99	99.99	99.99	99.99	99.99	-.63	-.52	-.47	-.37
5	99.99	99.99	99.99	99.99	99.99	99.99	-.63	-.20	-.17	-.36

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	-.01	.26	-.02	-.35	.14	-.32	-.14	-.06	-.02	-.15
1	.08	.17	.17	-.02	.12	-.42	-.21	-.15	-.47	.39
2	-.07	.12	.11	.06	-.29	-.14	-.06	-.62	-.10	.43
3	.19	.14	-.09	-.14	-.17	.65	.08	.05	-.97	.45
4	-.27	-.35	-.32	-.32	-.37	.26	-.09	.23	-.38	.69
5	-.44	-.21	-.34	-.23	-.90	-.09	-1.25	.88	-.43	.24

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5
Mean Log q	-15.7329	-15.3163	-15.4150	-15.4150	-15.4150
S.E(Log q)	.2376	.2789	.4066	.4219	.5813

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.59	7.816	17.01	.97	14	.22	-17.41

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	.95	.997	15.66	.96	14	.22	-15.73
2	.97	.408	15.24	.94	14	.28	-15.32
3	.96	.355	15.28	.88	14	.41	-15.42
4	.99	.178	15.55	.92	14	.37	-15.62
5	.98	.237	15.58	.91	14	.50	-15.71

Table 13.3.5.1 cont Haddock in Sub-Area IV and Division IIIa. XSA final assessment: Tuning diagnostics.

Fleet : SCOGFS_early

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985
0	99.99	99.99	99.99	99.99	99.99	-.18	-.86	-.31	-.71
1	99.99	99.99	99.99	99.99	99.99	-.23	-.12	-.45	.16
2	99.99	99.99	99.99	99.99	99.99	.27	.16	-.12	-.05
3	99.99	99.99	99.99	99.99	99.99	.23	.58	-.02	.04
4	99.99	99.99	99.99	99.99	99.99	-.17	.44	-.06	.13
5	99.99	99.99	99.99	99.99	99.99	-1.22	.34	-.06	-.30

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	-.78	.09	-.28	-.24	.31	.42	.79	-.02	.96	.46
1	-.06	-.78	.08	-.01	.15	-.53	.31	.35	-.01	.36
2	-.01	-.30	-.08	.11	-.23	-.65	-.23	.20	.09	.17
3	-.12	-.10	-.03	.12	-.27	-1.07	-.38	-.05	-.19	.58
4	-.31	-.21	.02	-.16	-.21	-.81	-.68	-1.04	-.35	.08
5	.13	-.34	-.39	-.45	-.13	-.73	-.05	-.03	-.69	.25

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	.22	.13	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	.48	.28	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	.49	.17	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	.32	.37	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	.31	.18	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	.19	.20	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5
Mean Log q	-10.6123	-10.0838	-10.2897	-10.2897	-10.2897
S.E(Log q)	.3534	.2705	.4001	.4403	.4734

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.88	.666	13.32	.67	16	.55	-12.83

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.18	-1.307	9.85	.78	16	.41	-10.61
2	.92	.973	10.32	.91	16	.25	-10.08
3	.79	2.769	10.64	.93	16	.26	-10.29
4	.76	4.068	10.50	.95	16	.21	-10.47
5	.91	.798	10.39	.86	16	.39	-10.49

Table 13.3.5.1 cont Haddock in Sub-Area IV and Division IIIa. XSA final assessment: Tuning diagnostics.

Fleet : SCOGFS

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	99.99	99.99	.00	-.22	.10	-1.57	.59	.57	.52	.02
1	99.99	99.99	.70	-.23	-.03	-.49	-.02	.17	.12	-.21
2	99.99	99.99	.03	.16	-.49	-.19	-.12	.07	.23	.31
3	99.99	99.99	-.06	.32	-.04	-.05	.04	.28	-.25	-.24
4	99.99	99.99	-.29	-.03	.02	-.15	.01	.03	-.19	.41
5	99.99	99.99	-.49	-.08	-.27	-.14	.01	-.47	-.67	-.57

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5
Mean Log q	-9.6883	-9.4111	-9.5521	-9.5521	-9.5521
S.E(Log q)	.3524	.2591	.2118	.2120	.4370

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.76	1.126	12.41	.79	8	.76	-11.26

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.03	-.278	9.55	.93	8	.39	-9.69
2	1.11	-1.310	9.09	.96	8	.27	-9.41
3	.90	1.933	9.75	.99	8	.16	-9.55
4	1.07	-1.181	9.47	.98	8	.22	-9.58
5	1.09	-1.536	9.85	.98	8	.25	-9.89

Table 13.3.5.1 cont Haddock in Sub-Area IV and Division IIIa. XSA final assessment: Tuning diagnostics.

Fleet : IBTS_Q1(backshift&5p

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985
0	99.99	99.99	99.99	99.99	99.99	-.45	-.45	-.55	-.03
1	99.99	99.99	99.99	99.99	99.99	-.16	-.34	-.23	.06
2	99.99	99.99	99.99	99.99	99.99	-.08	-.23	.04	-.20
3	99.99	99.99	99.99	99.99	99.99	-.02	-.08	-.11	-.28
4	99.99	99.99	99.99	99.99	99.99	-.13	-.32	-.52	-.34
5	No data for this fleet at this age								

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	-.33	.08	.10	.07	-.04	.48	.17	-.25	-.03	-.14
1	-.15	-.17	.40	.01	.04	-.28	.19	-.23	.04	-.08
2	-.26	-.04	.14	.39	-.16	-.80	.11	-.25	-.27	-.15
3	-.10	.07	.03	-.05	.05	-.73	.27	-.22	-.06	-.18
4	-.01	-.11	-.15	-.08	-.36	-.59	-.38	-.07	-.38	.10
5	No data for this fleet at this age									

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	.50	.20	-.04	.16	.44	.01	.08	-.16	-.07	.26
1	.49	.27	.15	-.30	.13	.25	-.08	.29	-.09	-.21
2	.25	.13	.12	-.11	.13	.41	.16	.70	.10	-.14
3	.34	-.02	.46	-.01	-.02	.06	.17	.48	.27	-.31
4	-.04	.35	.04	.33	.18	.57	.06	.11	-.08	-.10
5	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	1	2	3	4
Mean Log q	-7.2151	-7.2295	-7.4721	-7.4721
S.E(Log q)	.2313	.2960	.2608	.2907

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.94	.985	9.04	.93	24	.29	-8.58

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.05	-.968	6.86	.95	24	.24	-7.22
2	1.02	-.322	7.11	.91	24	.31	-7.23
3	.98	.387	7.56	.94	24	.26	-7.47
4	.98	.480	7.63	.94	24	.28	-7.55

Table 13.3.5.1 cont Haddock in Sub-Area IV and Division IIIa. XSA final assessment: Tuning diagnostics.

```
Terminal year survivor and F summaries :

 Age  0   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
 ENGFS_early         ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 ENGGFS              ,   3956655.,   .300,       .000,    .00,   1,  .451,     .000
 SCOGFS_early        ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 SCOGFS              ,   4698178.,   .843,       .000,    .00,   1,  .057,     .000
 IBTS_Q1(backshift&5p,   5964163.,   .300,       .000,    .00,   1,  .451,     .000

   P shrinkage mean  ,   2831147.,   1.17,,,,                        .030,     .001

   F shrinkage mean  ,    125673.,   2.00,,,,                        .010,     .013

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
   4597572.,       .20,      .21,    5,   1.059,   .000

 Age  1   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
 ENGFS_early         ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 ENGGFS              ,     95554.,   .212,       .204,    .96,   2,  .420,     .041
 SCOGFS_early        ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 SCOGFS              ,     73207.,   .340,       .278,    .82,   2,  .164,     .053
 IBTS_Q1(backshift&5p,     69055.,   .215,       .071,    .33,   2,  .411,     .056

   F shrinkage mean  ,     41972.,   2.00,,,,                        .005,     .090

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     79718.,       .14,      .10,    7,    .713,   .049

Age  2   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
 ENGFS_early         ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 ENGGFS              ,     44243.,   .173,       .263,   1.52,   3,  .386,     .289
 SCOGFS_early        ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 SCOGFS              ,     59157.,   .225,       .088,    .39,   3,  .232,     .224
 IBTS_Q1(backshift&5p,     39770.,   .175,       .023,    .13,   3,  .379,     .317

   F shrinkage mean  ,     29591.,   2.00,,,,                        .004,     .407

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     45379.,       .11,      .09,   10,    .881,   .283

 Age  3   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
 ENGFS_early         ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 ENGGFS              ,     21267.,   .162,       .135,    .83,   4,  .325,     .387
 SCOGFS_early        ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 SCOGFS              ,     22075.,   .183,       .143,    .78,   4,  .287,     .375
 IBTS_Q1(backshift&5p,     21577.,   .153,       .135,    .88,   4,  .385,     .382

   F shrinkage mean  ,     12851.,   2.00,,,,                        .004,     .578

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     21570.,       .10,      .07,   13,    .729,   .382
```

Table 13.3.5.1 cont Haddock in Sub-Area IV and Division IIIa. XSA final assessment: Tuning diagnostics.

Age 4 Catchability constant w.r.t. time and age (fixed at the value for age) 3

Year class = 2001

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
ENGFS_early ,	1.,	.000,	.000,	.00,	0,	.000,	.000
ENGGFS ,	6586.,	.159,	.277,	1.74,	5,	.282,	.369
SCOGFS_early ,	1.,	.000,	.000,	.00,	0,	.000,	.000
SCOGFS ,	9183.,	.163,	.173,	1.06,	5,	.324,	.278
IBTS_Q1(backshift&5p,	9744.,	.143,	.144,	1.00,	5,	.390,	.264
F shrinkage mean ,	3682.,	2.00,,,,				.004,	.587

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
8527.,	.09,	.11,	16,	1.252,	.296

Age 5 Catchability constant w.r.t. time and age (fixed at the value for age) 3

Year class = 2000

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
ENGFS_early ,	1.,	.000,	.000,	.00,	0,	.000,	.000
ENGGFS ,	65738.,	.150,	.108,	.72,	6,	.302,	.297
SCOGFS_early ,	1.,	.000,	.000,	.00,	0,	.000,	.000
SCOGFS ,	62163.,	.150,	.130,	.87,	6,	.336,	.311
IBTS_Q1(backshift&5p,	91122.,	.136,	.108,	.79,	5,	.359,	.222
F shrinkage mean ,	47548.,	2.00,,,,				.004,	.390

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
72463.,	.08,	.07,	18,	.883,	.273

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 3

Year class = 1999

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
ENGFS_early ,	1.,	.000,	.000,	.00,	0,	.000,	.000
ENGGFS ,	205073.,	.153,	.105,	.69,	6,	.296,	.231
SCOGFS_early ,	1.,	.000,	.000,	.00,	0,	.000,	.000
SCOGFS ,	193855.,	.153,	.111,	.72,	6,	.345,	.242
IBTS_Q1(backshift&5p,	264020.,	.141,	.051,	.36,	5,	.355,	.183
F shrinkage mean ,	141526.,	2.00,,,,				.004,	.319

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
219646.,	.09,	.06,	18,	.695,	.217

Table 13.3.5.2 Haddock in Sub-Area IV and Division IIIa. XSA final assessment: F at age. Estimates refer to the full year (January – December) except for age 0 for which the mortality rate given refers to the second half-year only (July – December)

Run title : Haddock in the North Sea and Skagerrak, ages 0-7+

At 6/09/2006 11:20

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1963	1964	1965
AGE			
0	.0016	.0434	.0716
1	.1219	.0564	1.3531
2	.7914	.4438	.4010
3	.6391	1.1202	.4901
4	.7267	.6872	.8640
5	.7653	.7973	1.0111
6	.7172	.8775	.7964
+gp	.7172	.8775	.7964
FBAR 2- 4	.7190	.7504	.5850

Table 8 Fishing mortality (F) at age

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
0	.0701	.0022	.0018	.0168	.0299	.0120	.0322	.0023	.0130	.0113
1	1.3051	.2633	.0515	.0215	.5027	.4747	.1694	.3744	.3520	.3360
2	.8142	1.0863	.5803	.6543	1.0391	.6645	.7944	.5661	.9376	.9629
3	.3409	.3999	.9110	1.3932	1.1454	.7989	1.3723	1.1631	.9541	1.2709
4	.7247	.3440	.2914	1.3465	1.3308	.8615	1.2063	.8593	1.0151	1.1130
5	.8713	.8545	.4505	.7436	.8037	.9935	1.1248	.9619	.7263	1.0261
6	.6515	.5371	.5555	1.1752	1.1063	.8942	1.2498	1.0061	.9082	1.1503
+gp	.6515	.5371	.5555	1.1752	1.1063	.8942	1.2498	1.0061	.9082	1.1503
FBAR 2- 4	.6266	.6101	.5942	1.1313	1.1717	.7750	1.1243	.8628	.9690	1.1156

Table 8 Fishing mortality (F) at age

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
0	.0298	.0130	.0217	.0347	.0731	.0572	.0387	.0271	.0157	.0164
1	.3086	.3374	.3858	.1754	.1897	.1772	.1738	.1528	.1257	.2084
2	.8186	1.0111	1.0071	.8618	.7064	.4510	.4249	.6621	.6777	.6190
3	1.3422	1.0510	1.1480	1.1265	1.1317	.9426	.8189	.9912	1.0036	.9880
4	.8106	1.1700	1.1683	1.1198	1.1365	.8265	.8729	1.1738	1.0495	1.1258
5	1.3267	1.1356	.9237	1.1524	1.0893	.7225	.4465	1.1848	1.2661	.8179
6	1.1739	1.1323	1.4087	.6472	1.4333	.8683	.6045	.4226	1.0148	1.2060
+gp	1.1739	1.1323	1.4087	.6472	1.4333	.8683	.6045	.4226	1.0148	1.2060
FBAR 2- 4	.9904	1.0773	1.1078	1.0360	.9915	.7400	.7055	.9424	.9103	.9109

Table 8 Fishing mortality (F) at age

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
0	.0032	.0090	.0055	.0039	.0057	.0127	.0186	.0315	.0045	.0582
1	.1287	.1193	.1383	.1064	.1986	.1568	.1479	.1733	.1542	.1059
2	1.0376	.9104	.8025	.6666	1.1277	.8029	.7431	.8121	.5705	.5145
3	1.2681	1.1058	1.3399	1.0066	1.2135	1.0524	1.2310	1.0588	1.0876	.9209
4	1.4322	1.1636	1.3284	1.3042	1.2226	.9760	1.1276	1.1425	1.0795	1.0512
5	1.1239	1.1601	1.4054	1.1457	1.2916	1.0497	1.0964	1.1323	1.2807	.9899
6	.4469	1.3985	2.3038	1.7201	2.2111	1.6370	2.1207	2.0910	2.0155	1.8638
+gp	.4469	1.3985	2.3038	1.7201	2.2111	1.6370	2.1207	2.0910	2.0155	1.8638
FBAR 2- 4	1.2460	1.0600	1.1569	.9925	1.1879	.9438	1.0339	1.0045	.9125	.8289

Table 8 Fishing mortality (F) at age

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	FBAR 03-05
AGE											
0	.0473	.0093	.0071	.0026	.0064	.0037	.0378	.0045	.0008	.0003	.0019
1	.0773	.1272	.1323	.1685	.0561	.0708	.1333	.0942	.0470	.0485	.0632
2	.4610	.4487	.6349	.8493	.8133	.3422	.1700	.3638	.3108	.2831	.3192
3	.9584	.6596	.6000	1.0210	1.0851	1.0054	.2435	.1900	.3323	.3824	.3016
4	1.0157	.8076	.9356	.7465	1.1676	.7253	.5986	.1737	.2354	.2961	.2351
5	1.1266	.9577	.8797	1.2566	.4132	.5686	.3652	.3694	.2212	.2725	.2877
6	1.7399	1.0279	.6041	1.2081	1.1106	.1766	.2770	.1732	.2235	.2169	.2045
+gp	1.7399	1.0279	.6041	1.2081	1.1106	.1766	.2770	.1732	.2235	.2169	
FBAR 2- 4	.8117	.6386	.7235	.8723	1.0220	.6910	.3374	.2425	.2928	.3205	

Table 13.3.5.3 Haddock in Sub-Area IV and Division IIIa. XSA final assessment: Stock numbers at age. Estimates are at Jan 1st of each year, except for age 0 for which estimates are at July 1st.

Run title : Haddock in the North Sea and Skagerrak, ages 0-7+
At 6/09/2006 11:20
Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1963,	1964,	1965,
AGE			
0,	24064,	92014,	263163,
1,	259948,	3093,	11342,
2,	7485,	44195,	561,
3,	503,	2274,	19007,
4,	286,	207,	578,
5,	119,	108,	81,
6,	11,	45,	40,
+gp,	28,	15,	14,
TOTAL,	292445,	141950,	294786,

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
AGE										
0,	688326,	3885138,	170966,	121527,	877106,	781864,	215008,	730933,	1331872,	115136,
1,	31537,	82615,	499055,	21969,	15384,	109593,	99457,	26803,	93879,	169252,
2,	563,	1642,	12193,	91028,	4129,	1787,	13093,	16124,	3540,	12679,
3,	252,	167,	371,	4575,	31719,	979,	616,	3966,	6136,	929,
4,	9068,	140,	87,	116,	885,	7858,	343,	122,	965,	1841,
5,	190,	3422,	77,	51,	24,	182,	2586,	80,	40,	272,
6,	24,	65,	1192,	40,	20,	9,	55,	687,	25,	16,
+gp,	20,	14,	10,	303,	102,	39,	10,	27,	205,	58,
TOTAL,	729980,	3973203,	683951,	239610,	929368,	902311,	331169,	778742,	1436663,	300184,

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
0,	165131,	260051,	395796,	720620,	157884,	324254,	204533,	666322,	171185,	239385,
1,	14656,	20633,	33044,	49858,	89605,	18892,	39424,	25331,	83483,	21695,
2,	23228,	2067,	2828,	4315,	8035,	14235,	3039,	6363,	4176,	14139,
3,	3245,	6867,	504,	692,	1222,	2658,	6078,	1332,	2200,	1421,
4,	203,	660,	1870,	125,	175,	307,	806,	2087,	385,	628,
5,	471,	70,	160,	453,	32,	44,	105,	262,	503,	105,
6,	80,	102,	18,	52,	117,	9,	17,	55,	66,	116,
+gp,	17,	27,	38,	22,	14,	52,	27,	20,	15,	21,
TOTAL,	207030,	290478,	434259,	776137,	257083,	360450,	254029,	701772,	262011,	277510,

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
0,	496571,	41598,	84169,	85766,	280754,	274090,	408609,	127080,	534686,	134935,
1,	30316,	63723,	5307,	10776,	10998,	35936,	34840,	51631,	15853,	68524,
2,	3383,	5119,	10862,	888,	1861,	1732,	5900,	5771,	8338,	2610,
3,	5103,	803,	1381,	3263,	305,	404,	520,	1881,	1717,	3159,
4,	412,	1118,	207,	282,	929,	71,	110,	118,	508,	451,
5,	159,	77,	272,	43,	60,	213,	21,	28,	29,	134,
6,	38,	42,	20,	55,	11,	13,	61,	6,	7,	7,
+gp,	70,	23,	12,	11,	21,	16,	15,	19,	11,	3,
TOTAL,	536052,	112505,	102230,	101084,	294938,	312475,	450075,	186534,	561150,	209824,

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,
AGE											
0,	209472,	120594,	93757,	1144024,	226449,	26234,	38130,	38258,	33868,	357221,	0,
1,	16389,	25719,	15381,	11984,	146887,	28965,	3365,	4727,	4903,	4357,	45976,
2,	11838,	2913,	4349,	2588,	1945,	26672,	5183,	566,	826,	898,	797,
3,	1046,	5005,	1247,	1545,	742,	578,	12697,	2931,	263,	406,	454,
4,	980,	312,	2015,	533,	434,	195,	165,	7751,	1888,	147,	216,
5,	123,	276,	108,	616,	197,	105,	74,	71,	5074,	1162,	85,
6,	41,	33,	87,	37,	143,	107,	49,	42,	40,	3330,	725,
+gp,	11,	13,	15,	31,	14,	108,	59,	36,	16,	26,	2214,
TOTAL,	239899,	154866,	116960,	1161357,	376810,	82963,	59720,	54380,	46878,	367546,	50466,

GMST 63-03	AMST 63-03
222954,	413840,
30929,	58582,
4923,	9609,
1651,	3464,
467,	1130,
126,	294,
39,	89,

Table 13.3.5.4 Haddock in Sub-Area IV and Division IIIa. XSA final assessment: Stock summary table.

	Recruitment Age 0	Total Biomass	SSB	Total Catch	HC	Disc (NS only)	IBC	Yield/SSB	F (2-4)	F HC (2-4)	F Disc (2-4)	F IBC (2-4)
1963	2.406	3473	140	272	69	189	14	1.94	0.72	0.49	0.20	0.03
1964	9.201	1314	430	380	131	160	89	0.88	0.75	0.47	0.12	0.16
1965	26.316	1101	544	299	162	62	75	0.55	0.59	0.34	0.10	0.14
1966	68.833	1497	458	347	226	74	47	0.76	0.63	0.36	0.17	0.10
1967	388.514	5514	254	247	148	78	21	0.97	0.61	0.35	0.23	0.03
1968	17.097	6851	288	302	106	162	34	1.05	0.59	0.38	0.15	0.07
1969	12.153	2476	813	931	331	260	339	1.15	1.13	0.69	0.15	0.29
1970	87.711	2545	899	807	525	101	180	0.90	1.17	0.70	0.20	0.27
1971	78.186	2521	419	447	237	177	32	1.07	0.78	0.54	0.18	0.06
1972	21.501	2183	301	354	195	128	30	1.17	1.12	0.84	0.24	0.04
1973	73.093	4118	296	308	182	115	11	1.04	0.86	0.65	0.21	0.00
1974	133.187	4759	259	369	153	167	49	1.42	0.97	0.60	0.23	0.13
1975	11.514	2373	237	455	151	260	43	1.92	1.12	0.68	0.34	0.10
1976	16.513	1098	307	377	173	154	50	1.23	0.99	0.62	0.25	0.11
1977	26.005	1058	237	226	145	44	37	0.95	1.08	0.68	0.21	0.18
1978	39.580	1098	131	180	92	77	12	1.37	1.11	0.79	0.28	0.04
1979	72.062	1325	110	146	87	42	17	1.33	1.04	0.85	0.14	0.04
1980	15.788	1421	152	224	105	95	24	1.47	0.99	0.75	0.13	0.11
1981	32.425	970	244	217	139	60	18	0.89	0.74	0.57	0.14	0.03
1982	20.453	1071	305	238	177	41	21	0.78	0.71	0.54	0.11	0.05
1983	66.632	2227	257	254	167	66	20	0.99	0.94	0.69	0.21	0.04
1984	17.118	1658	199	223	135	75	13	1.12	0.91	0.73	0.15	0.03
1985	23.939	1165	239	258	166	85	7	1.08	0.91	0.76	0.13	0.02
1986	49.657	1955	223	226	169	52	4	1.01	1.25	0.94	0.30	0.01
1987	4.160	1023	151	177	112	59	6	1.17	1.06	0.81	0.24	0.01
1988	8.417	602	152	176	108	62	5	1.16	1.16	0.86	0.25	0.05
1989	8.577	603	122	109	80	26	3	0.89	0.99	0.74	0.22	0.03
1990	28.075	1508	76	93	56	33	5	1.23	1.19	0.78	0.36	0.04
1991	27.409	1528	59	97	49	40	8	1.65	0.94	0.81	0.11	0.03
1992	40.861	1322	97	138	75	48	15	1.43	1.03	0.85	0.17	0.02
1993	12.708	971	130	174	82	80	13	1.34	1.00	0.74	0.24	0.03
1994	53.469	1408	152	154	83	65	6	1.01	0.91	0.63	0.27	0.01
1995	13.494	1099	148	145	78	57	10	0.98	0.83	0.58	0.24	0.01
1996	20.947	970	179	160	79	73	8	0.89	0.81	0.53	0.26	0.02
1997	12.059	848	193	142	82	52	7	0.73	0.64	0.42	0.20	0.03
1998	9.376	715	165	132	81	45	5	0.80	0.72	0.46	0.22	0.04
1999	114.402	2898	118	112	66	43	4	0.95	0.87	0.50	0.34	0.03
2000	22.645	3160	94	105	48	49	9	1.12	1.02	0.68	0.26	0.09
2001	2.623	996	235	167	41	118	8	0.71	0.69	0.38	0.20	0.11
2002	3.813	670	363	108	58	46	4	0.30	0.34	0.22	0.10	0.02
2003	3.826	593	356	69	44	23	1	0.19	0.24	0.07	0.15	0.02
2004	3.387	606	298	66	49	17	1	0.22	0.29	0.14	0.15	0.00
2005	35.722	2410	256	58	48	10	0	0.23	0.32	0.21	0.11	0.00
mean	40.369	1853	258	243	128	85	30	1.05	0.87	0.6	0.2	0.06
units	1000 million	1000 tonnes	1000 tonnes	1000 tonnes	1000 tonnes	1000 tonnes	1000 tonnes					

Table 13.5.1 Haddock in Sub-Area IV and Division IIIa. Input to RCT3.

had3a&4 (age 0)

10 31 2

1976	165131	-11	6.68	-11	-11	-11	-11	-11	-11	-11	-11
1977	260051	53.48	13.69	-11	-11	-11	-11	-11	-11	-11	-11
1978	395796	35.83	29.55	-11	-11	-11	-11	-11	-11	-11	-11
1979	720620	87.55	62.33	-11	-11	-11	-11	-11	-11	-11	-11
1980	157884	37.40	17.32	-11	-11	-11	-11	-11	-11	-11	-11
1981	324254	153.75	31.55	-11	-11	-11	2488	-11	-11	-11	403.08
1982	204533	28.13	21.82	-11	-11	1235	1813	-11	-11	302.28	221.28
1983	666322	83.19	59.93	-11	-11	2203	4367	-11	-11	1072.29	833.26
1984	171185	22.85	18.66	-11	-11	873	1976	-11	-11	230.97	266.91
1985	239385	24.59	14.97	-11	-11	818	2329	-11	-11	573.02	328.06
1986	496571	26.60	28.19	-11	-11	1747	2393	-11	-11	912.56	677.64
1987	41598	2.24	2.86	-11	-11	277	467	-11	-11	101.69	98.09
1988	84169	6.07	8.17	-11	-11	406	886	-11	-11	219.71	139.11
1989	85766	9.43	6.64	-11	-11	432	1002	-11	-11	217.45	134.08
1990	280754	28.19	11.50	-11	-11	3163	1705	-11	-11	680.23	331.04
1991	274090	26.33	-11	-11	19.69	3471	3832	-11	-11	1141.40	519.52
1992	408609	-11	-11	82.77	24.61	8270	5836	-11	-11	1242.12	491.05
1993	127080	-11	-11	13.58	8.07	859	1265	-11	-11	227.92	201.07
1994	534686	-11	-11	94.30	38.31	13762	8153	-11	-11	1355.49	813.27
1995	134935	-11	-11	17.99	8.97	1566	2231	-11	-11	267.41	353.88
1996	209472	-11	-11	20.62	14.86	1980	2779	-11	-11	849.94	420.93
1997	120594	-11	-11	13.03	8.89	972	-11	-11	6349	357.60	222.91
1998	93757	-11	-11	5.30	5.57	-11	-11	3280	1907	211.14	107.06
1999	1144024	-11	-11	210.98	84.11	-11	-11	66067	30611	3734.19	2255.21
2000	226449	-11	-11	31.02	9.64	-11	-11	11902	3790	894.65	492.30
2001	26234	-11	-11	0.37	1.33	-11	-11	79	675	58.21	38.59
2002	38130	-11	-11	0.92	2.02	-11	-11	2149	1172	89.96	81.81
2003	38258	-11	-11	1.08	1.57	-11	-11	2159	1198	71.86	60.99
2004	33868	-11	-11	0.94	3.28	-11	-11	1729	761	69.98	47.78
2005	357221	-11	-11	41.21	-11	-11	-11	19708	7275	1212.16	-11
2006	-11	-11	-11	-11	-11	-11	-11	2280	-11	-11	-11

enggfs_77-91_age0
enggfs_77-91_age1
enggfs_92-05_age0
enggfs_92-05_age1
scogfs_82-97_age0
scogfs_82-97_age1
scogfs_98-06_age0
scogfs_98-06_age1
ibtsq1_82-05_age0
ibtsq1_82-05_age1

Table 13.5.2 Haddock in Sub-Area IV and Division IIIa. RCT3 output.

```
Analysis by RCT3 ver3.1 of data from file :

 hadrec0.txt

 had3a&4 (age 0)

 Data for   10 surveys over   31 years :  1976 - 2006

 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied

 Final estimates shrunk towards mean
 Minimum S.E. for any survey taken as    .00
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Yearclass =   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

 enggfs
 enggfs
 enggfs     .71   9.96    .15   .984     12    .66   10.43     .183     .358
 enggfs    1.04   9.44    .16   .981     13   1.45   10.96     .186     .345
 scogfs
 scogfs
 scogfs     .72   5.66    .83   .787      6   7.46   11.07    1.110     .010
 scogfs    1.05   3.21    .41   .924      7   6.64   10.17     .558     .038
 ibtsq1     .96   6.27    .30   .920     22   4.26   10.36     .341     .102
 ibtsq1    1.08   6.00    .26   .937     23   3.89   10.19     .299     .133

                                         VPA Mean =   12.13     .946     .013


 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

 enggfs
 enggfs
 enggfs     .71   9.96    .14   .986     13   3.74   12.61     .165     .700
 enggfs
 scogfs
 scogfs
 scogfs     .76   5.26    .83   .765      7   9.89   12.82    1.116     .015
 scogfs    1.03   3.42    .38   .929      8   8.89   12.54     .487     .080
 ibtsq1     .96   6.30    .29   .928     23   7.10   13.09     .321     .184
 ibtsq1

                                         VPA Mean =   12.07     .981     .020


 Yearclass =   2006

          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 enggfs
 enggfs
 enggfs
 enggfs
 scogfs
 scogfs
 scogfs     .76   5.27    .76   .792      8   7.73   11.17     .929     .523
 scogfs
 ibtsq1
 ibtsq1

                                         VPA Mean =   12.10     .973     .477



 Year     Weighted      Log     Int     Ext     Var     VPA      Log
 Class     Average      WAP     Std     Std    Ratio             VPA
          Prediction           Error   Error

 2004       39816     10.59     .11     .14     1.72  33869    10.43
 2005      321600     12.68     .14     .10      .57 357222    12.79
 2006      110278     11.61     .67     .47      .48
```

Table 13.6.1 Haddock in Sub-Area IV and Division IIIa. Short term forecast input.

MFDP version 1a
Run: had4_A_
Time and date: 08:31 13/09/2006
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2006

Age	N	M	Mat	PF	PM	SWt
0	110278	2.05	0	0	0	0.035
1	45976	1.65	0.01	0	0	0.146
2	797	0.4	0.32	0	0	0.253
3	454	0.25	0.71	0	0	0.361
4	216	0.25	0.87	0	0	0.501
5	85	0.2	0.95	0	0	0.702
6	725	0.2	1	0	0	0.609
7	2214	0.2	1	0	0	0.663

Catch

Age	Sel	CWt	DSel	DCWt
0	0	0	0.0003	0.059
1	0.0042	0.346	0.0434	0.167
2	0.0857	0.394	0.1959	0.235
3	0.2717	0.44	0.1099	0.276
4	0.2602	0.529	0.0351	0.318
5	0.2358	0.711	0.0366	0.394
6	0.2021	0.639	0.0141	0.546
7	0.2163	0.672	0.0001	0.772

Industrialbycatch

Age	Sel	CWt
0	0	0.012
1	0.0009	0.085
2	0.0015	0.142
3	0.0009	0.242
4	0.0008	0.29
5	0.0001	0.357
6	0.0007	0.569
7	0.0005	0.73

2007

Age	N	M	Mat	PF	PM	SWt
0	81159	2.05	0	0	0	0.035
1	.	1.65	0.01	0	0	0.146
2	.	0.4	0.32	0	0	0.253
3	.	0.25	0.71	0	0	0.361
4	.	0.25	0.87	0	0	0.501
5	.	0.2	0.95	0	0	0.702
6	.	0.2	1	0	0	0.794
7	.	0.2	1	0	0	0.82

Catch

Age	Sel	CWt	DSel	DCWt
0	0	0	0.0003	0.059
1	0.0042	0.346	0.0434	0.167
2	0.0857	0.394	0.1959	0.235
3	0.2717	0.44	0.1099	0.276
4	0.2602	0.529	0.0351	0.318
5	0.2358	0.711	0.0366	0.394
6	0.2021	0.796	0.0141	0.546
7	0.2163	0.833	0.0001	0.772

Industrialbycatch

Age	Sel	CWt
0	0	0.012
1	0.0009	0.085
2	0.0015	0.142
3	0.0009	0.242
4	0.0008	0.29
5	0.0001	0.357
6	0.0007	0.569
7	0.0005	0.73

2008

Age	N	M	Mat	PF	PM	SWt
0	81159	2.05	0	0	0	0.035
1	.	1.65	0.01	0	0	0.146
2	.	0.4	0.32	0	0	0.253
3	.	0.25	0.71	0	0	0.361
4	.	0.25	0.87	0	0	0.501
5	.	0.2	0.95	0	0	0.702
6	.	0.2	1	0	0	0.794
7	.	0.2	1	0	0	0.994

Catch

Age	Sel	CWt	DSel	DCWt
0	0	0	0.0003	0.059
1	0.0042	0.346	0.0434	0.167
2	0.0857	0.394	0.1959	0.235
3	0.2717	0.44	0.1099	0.276
4	0.2602	0.529	0.0351	0.318
5	0.2358	0.711	0.0366	0.394
6	0.2021	0.796	0.0141	0.546
7	0.2163	1.008	0.0001	0.772

Industrialbycatch

Age	Sel	CWt
0	0	0.012
1	0.0009	0.085
2	0.0015	0.142
3	0.0009	0.242
4	0.0008	0.29
5	0.0001	0.357
6	0.0007	0.569
7	0.0005	0.73

Input units are *10-5 and kg - output in hundred tonnes

Table 13.6.2 Haddock in Sub-Area IV and Division IIIa. Short term forecast output.

MFDP version 1a
Run: had4_A_
Time and date: 08:31 13/09/2006
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2006

Biomass	SSB	Catch FMult	Landings FBar	Yield	Discards FBar	Yield	Industrialbycatch FMult	Landings FBar	Yield	Total Yield
13015	2308	1.0000	0.2059	466	0.1136	205	1.0000	0.0011	3	674

2007											2008	
Biomass	SSB	Catch FMult	Landings FBar	Landings Yield	Discards FBar	Discards Yield	Industrialbycatch FMult	Landings FBar	Industrial Yield	Total Yield	Biomass	SSB
9025	2624	0.0000	0.0000	0	0.0000	0	1.0000	0.0011	3	3	9076	3640
.	2624	0.1000	0.0206	65	0.0114	38	1.0000	0.0011	3	106	8970	3554
.	2624	0.2000	0.0412	129	0.0227	75	1.0000	0.0011	3	207	8866	3469
.	2624	0.3000	0.0618	191	0.0341	112	1.0000	0.0011	3	306	8765	3387
.	2624	0.4000	0.0823	251	0.0455	147	1.0000	0.0011	3	401	8667	3307
.	2624	0.5000	0.1029	310	0.0568	182	1.0000	0.0011	3	495	8571	3229
.	2624	0.6000	0.1235	368	0.0682	216	1.0000	0.0011	3	587	8478	3152
.	2624	0.7000	0.1441	425	0.0795	249	1.0000	0.0011	3	677	8387	3078
.	2624	0.8000	0.1647	480	0.0909	281	1.0000	0.0011	3	764	8298	3006
.	2624	0.9000	0.1853	534	0.1023	313	1.0000	0.0011	3	850	8211	2935
.	2624	1.0000	0.2059	586	0.1136	344	1.0000	0.0011	3	933	8127	2866
.	2624	1.1000	0.2265	637	0.1250	374	1.0000	0.0011	3	1014	8045	2799
.	2624	1.2000	0.2470	687	0.1364	403	1.0000	0.0011	2	1092	7965	2734
.	2624	1.3000	0.2676	736	0.1477	432	1.0000	0.0011	2	1170	7887	2670
.	2624	1.4000	0.2882	784	0.1591	461	1.0000	0.0011	2	1247	7810	2608
.	2624	1.5000	0.3088	831	0.1705	488	1.0000	0.0011	2	1321	7736	2548
.	2624	1.6000	0.3294	876	0.1818	515	1.0000	0.0011	2	1393	7664	2489
.	2624	1.7000	0.3500	921	0.1932	542	1.0000	0.0011	2	1465	7593	2431
.	2624	1.8000	0.3706	965	0.2045	568	1.0000	0.0011	2	1535	7525	2375
.	2624	1.9000	0.3911	1007	0.2159	593	1.0000	0.0011	2	1602	7457	2321
.	2624	2.0000	0.4117	1049	0.2273	618	1.0000	0.0011	2	1669	7392	2268

Input units are *10-5 and kg - output in hundred tonnes

Table 13.6.3 Haddock in Sub-Area IV and Division IIIa. Short term forecast detailed output.

MFDP version 1a
Run: had4_A_
Time and date: 08:31 13/09/2006
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

Year:		2006	F multiplier	1	Fleet1 HCF	0.2059	Fleet1 DFb	0.1136								
		Catch						Industrialbycatch								
Age		F	CatchNos	Yield	DF	DCatchNos	DYield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	0	0	0	0	0.0003	14	1	0	0	0	110278	3860	0	0	0	0
	1	0.0042	93	32	0.0434	960	160	0.0009	20	2	45976	6712	460	67	460	67
	2	0.0857	49	19	0.1959	113	27	0.0015	1	0	797	202	255	65	255	65
	3	0.2717	91	40	0.1099	37	10	0.0009	0	0	454	164	322	116	322	116
	4	0.2602	43	23	0.0351	6	2	0.0008	0	0	216	108	188	94	188	94
	5	0.2358	16	11	0.0366	2	1	0.0001	0	0	85	60	81	57	81	57
	6	0.2021	120	77	0.0141	8	5	0.0007	0	0	725	442	725	442	725	442
	7	0.2163	392	263	0.0001	0	0	0.0005	1	1	2214	1468	2214	1468	2214	1468
Total			804	466		1141	205		23	3	160745	13015	4245	2308	4245	2308

Year:		2007	F multiplier	1	Fleet1 HCF	0.2059	Fleet1 DFb	0.1136								
		Catch						Industrialbycatch								
Age		F	CatchNos	Yield	DF	DCatchNos	DYield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	0	0	0	0	0.0003	10	1	0	0	0	81159	2841	0	0	0	0
	1	0.0042	29	10	0.0434	296	49	0.0009	6	1	14192	2072	142	21	142	21
	2	0.0857	522	206	0.1959	1194	281	0.0015	9	1	8412	2128	2692	681	2692	681
	3	0.2717	81	36	0.1099	33	9	0.0009	0	0	403	145	286	103	286	103
	4	0.2602	48	26	0.0351	7	2	0.0008	0	0	241	121	210	105	210	105
	5	0.2358	24	17	0.0366	4	1	0.0001	0	0	125	88	119	83	119	83
	6	0.2021	9	7	0.0141	1	0	0.0007	0	0	53	42	53	42	53	42
	7	0.2163	343	285	0.0001	0	0	0.0005	1	1	1937	1588	1937	1588	1937	1588
Total			1055	586		1544	344		17	3	106522	9025	5438	2624	5438	2624

Year:		2008	F multiplier	1	Fleet1 HCF	0.2059	Fleet1 DFb	0.1136								
		Catch						Industrialbycatch								
Age		F	CatchNos	Yield	DF	DCatchNos	DYield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	0	0	0	0	0.0003	10	1	0	0	0	81159	2841	0	0	0	0
	1	0.0042	21	7	0.0434	218	36	0.0009	5	0	10445	1525	104	15	104	15
	2	0.0857	161	64	0.1959	369	87	0.0015	3	0	2597	657	831	210	831	210
	3	0.2717	855	376	0.1099	346	95	0.0009	3	1	4248	1534	3016	1089	3016	1089
	4	0.2602	43	23	0.0351	6	2	0.0008	0	0	214	107	186	93	186	93
	5	0.2358	26	19	0.0366	4	2	0.0001	0	0	140	98	133	93	133	93
	6	0.2021	13	10	0.0141	1	0	0.0007	0	0	78	62	78	62	78	62
	7	0.2163	232	234	0.0001	0	0	0.0005	1	0	1312	1304	1312	1304	1312	1304
Total			1352	733		954	223		11	2	100192	8127	5660	2866	5660	2866

Input units are *10-5 and kg - output in hundred tonnes

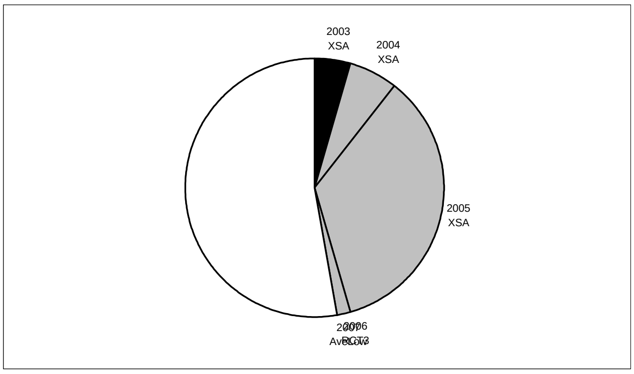
Table 13.6.4 Haddock in Sub-Area IV and Division IIIa. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

Year-class	2003	2004	2005	2006	2007
Stock No. (*10-5) of 0 year-olds	38258	33868	357221	110278	81159
Source	XSA	XSA	XSA	RCT3	AveLow
Status Quo F:					
% in 2006 landings	8.6	4.1	6.9	0.0	-
% in 2007	4.4	6.1	35.1	1.7	0.0
% in 2006 SSB	5.0	2.8	2.9	0.0	-
% in 2007 SSB	4.0	3.9	26.0	0.8	0.0
% in 2008 SSB	3.2	3.2	38.0	7.3	0.5

GM : geometric mean recruitment

Haddock in Sub-area IV and Divisions IIIa: : Year-class % contribution to

a) 2007 landings



b) 2008 SSB

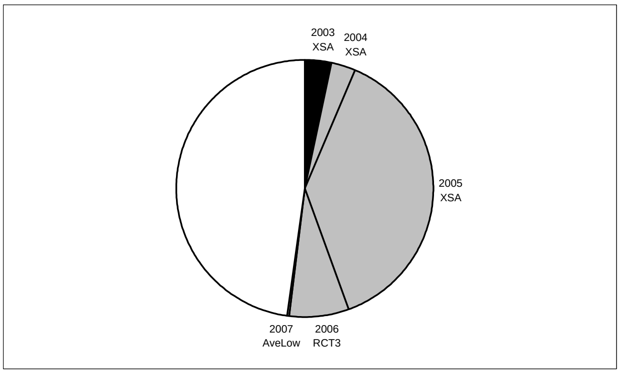


Table 13.6.5 Haddock in Sub-Area IV and Division IIIa. Yield per recruit analysis input.

MFYPR version 2a
Run: had4_
hadMFYPR Index file 13/09/2006
Time and date: 00:50 14/09/2006
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

Age	M	Mat	PF	PM	SWt
0	2.05	0	0	0	0.035
1	1.65	0.01	0	0	0.146
2	0.4	0.32	0	0	0.253
3	0.25	0.71	0	0	0.361
4	0.25	0.87	0	0	0.501
5	0.2	0.95	0	0	0.702
6	0.2	1	0	0	0.794
7	0.2	1	0	0	1.227

Catch

Age	Sel	CWt	DSel	DCWt
0	0	0	0.0003	0.059
1	0.0042	0.346	0.0434	0.167
2	0.0857	0.394	0.1959	0.235
3	0.2717	0.44	0.1099	0.276
4	0.2602	0.529	0.0351	0.318
5	0.2358	0.711	0.0366	0.394
6	0.2021	0.796	0.0141	0.546
7	0.2163	1.253	0.0001	0.772

Industrialbycatch

Age	Sel	CWt
0	0	0.012
1	0.0009	0.085
2	0.0015	0.142
3	0.0009	0.242
4	0.0008	0.29
5	0.0001	0.357
6	0.0007	0.569
7	0.0005	0.73

Weights in kilograms

Table 13.6.6 Haddock in Sub-Area IV and Division IIIa. Yield per recruit analysis output.

MFYPR version 2a
Run: had4_
Time and date: 00:50 14/09/2006
Yield per results

Catch FMult	Landings Fbar	CatchNos	Landings Yield	Discards Fbar	CatchNos	Discards Yield	Industrial bycatch FMult	Landings Fbar	CatchNos	Industrial Yield	Total Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0011	0.0001	0.0000	0.0000	1.2379	0.1313	0.0867	0.0705	0.0867	0.0705
0.1000	0.0206	0.0017	0.0013	0.0114	0.0009	0.0002	1.0000	0.0011	0.0001	0.0000	0.0015	1.2265	0.1194	0.0757	0.0588	0.0757	0.0588
0.2000	0.0412	0.0031	0.0023	0.0227	0.0018	0.0004	1.0000	0.0011	0.0001	0.0000	0.0027	1.2173	0.1101	0.0669	0.0497	0.0669	0.0497
0.3000	0.0618	0.0041	0.0029	0.0341	0.0026	0.0006	1.0000	0.0011	0.0001	0.0000	0.0035	1.2098	0.1027	0.0597	0.0424	0.0597	0.0424
0.4000	0.0823	0.0049	0.0034	0.0455	0.0034	0.0008	1.0000	0.0011	0.0001	0.0000	0.0042	1.2035	0.0967	0.0538	0.0366	0.0538	0.0366
0.5000	0.1029	0.0055	0.0037	0.0568	0.0041	0.0009	1.0000	0.0011	0.0001	0.0000	0.0046	1.1982	0.0918	0.0488	0.0318	0.0488	0.0318
0.6000	0.1235	0.0060	0.0039	0.0682	0.0048	0.0011	1.0000	0.0011	0.0001	0.0000	0.0050	1.1937	0.0878	0.0446	0.0279	0.0446	0.0279
0.7000	0.1441	0.0064	0.0040	0.0795	0.0055	0.0012	1.0000	0.0011	0.0001	0.0000	0.0052	1.1898	0.0844	0.0410	0.0246	0.0410	0.0246
0.8000	0.1647	0.0068	0.0041	0.0909	0.0062	0.0014	1.0000	0.0011	0.0001	0.0000	0.0055	1.1864	0.0815	0.0380	0.0218	0.0380	0.0218
0.9000	0.1853	0.0070	0.0041	0.1023	0.0068	0.0015	1.0000	0.0011	0.0001	0.0000	0.0056	1.1834	0.0791	0.0353	0.0195	0.0353	0.0195
1.0000	0.2059	0.0072	0.0042	0.1136	0.0074	0.0016	1.0000	0.0011	0.0001	0.0000	0.0058	1.1808	0.0770	0.0329	0.0176	0.0329	0.0176
1.1000	0.2265	0.0074	0.0041	0.1250	0.0080	0.0017	1.0000	0.0011	0.0001	0.0000	0.0058	1.1785	0.0752	0.0309	0.0159	0.0309	0.0159
1.2000	0.2470	0.0075	0.0041	0.1364	0.0086	0.0019	1.0000	0.0011	0.0001	0.0000	0.0060	1.1764	0.0737	0.0291	0.0144	0.0291	0.0144
1.3000	0.2676	0.0076	0.0041	0.1477	0.0091	0.0020	1.0000	0.0011	0.0001	0.0000	0.0061	1.1745	0.0723	0.0274	0.0132	0.0274	0.0132
1.4000	0.2882	0.0077	0.0041	0.1591	0.0097	0.0021	1.0000	0.0011	0.0001	0.0000	0.0062	1.1729	0.0711	0.0260	0.0121	0.0260	0.0121
1.5000	0.3088	0.0078	0.0040	0.1705	0.0102	0.0022	1.0000	0.0011	0.0001	0.0000	0.0062	1.1713	0.0701	0.0247	0.0111	0.0247	0.0111
1.6000	0.3294	0.0078	0.0040	0.1818	0.0107	0.0023	1.0000	0.0011	0.0001	0.0000	0.0063	1.1699	0.0692	0.0235	0.0103	0.0235	0.0103
1.7000	0.3500	0.0078	0.0039	0.1932	0.0112	0.0024	1.0000	0.0011	0.0001	0.0000	0.0063	1.1687	0.0684	0.0225	0.0096	0.0225	0.0096
1.8000	0.3706	0.0078	0.0039	0.2045	0.0117	0.0025	1.0000	0.0011	0.0001	0.0000	0.0064	1.1675	0.0677	0.0215	0.0089	0.0215	0.0089
1.9000	0.3911	0.0079	0.0038	0.2159	0.0121	0.0025	1.0000	0.0011	0.0001	0.0000	0.0063	1.1664	0.0670	0.0207	0.0083	0.0207	0.0083
2.0000	0.4117	0.0079	0.0038	0.2273	0.0126	0.0026	1.0000	0.0011	0.0001	0.0000	0.0064	1.1654	0.0664	0.0199	0.0078	0.0199	0.0078

Reference point	F multiplier	Absolute F
Fleet1 Landings Fbar(2-4)	1.0000	0.2059
FMax	1.0126	0.2085
F0.1	0.6138	0.1264
F35%SPR	0.6972	0.1435

Weights in kilograms

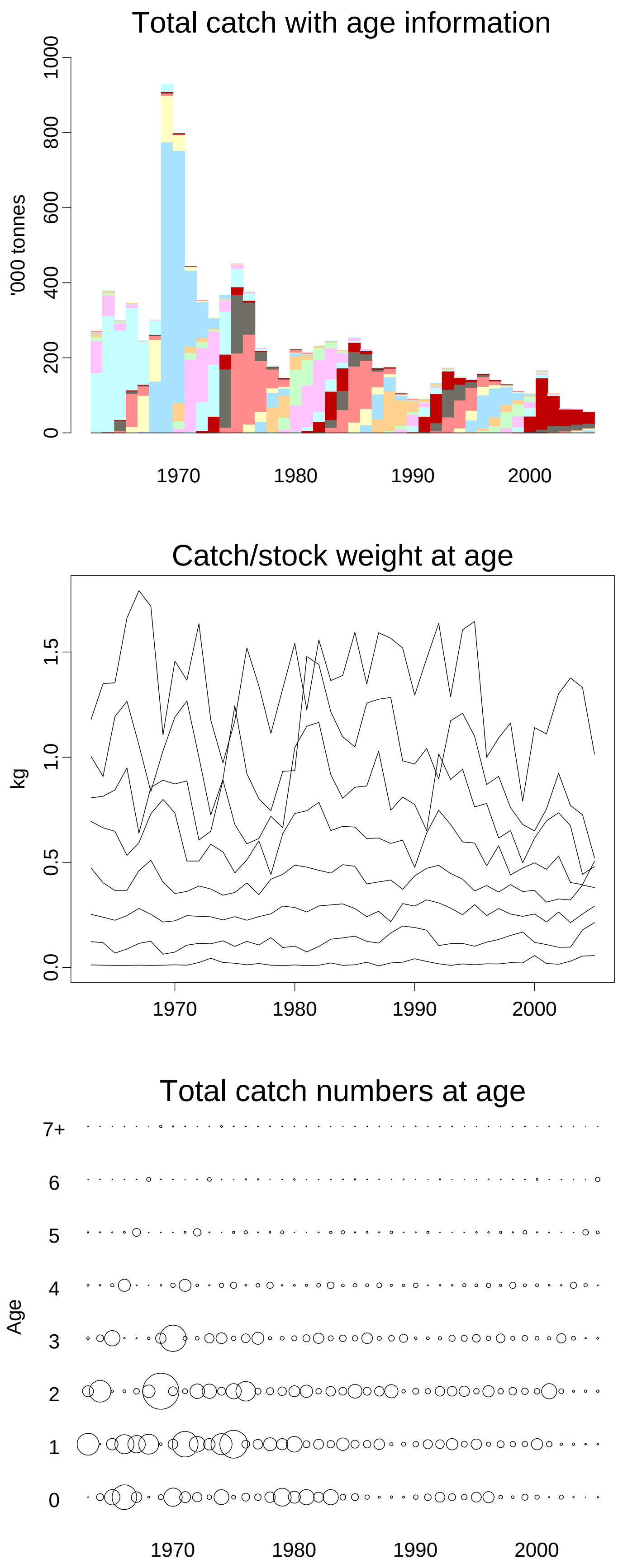


Figure 13.2.3.1 Haddock in Sub-Area IV and Division IIIa. Summary of catch data showing age contribution to total catch, mean weight at age in the catch and numbers landed at age (colours in the top plot show a cohort's history in the catch data).

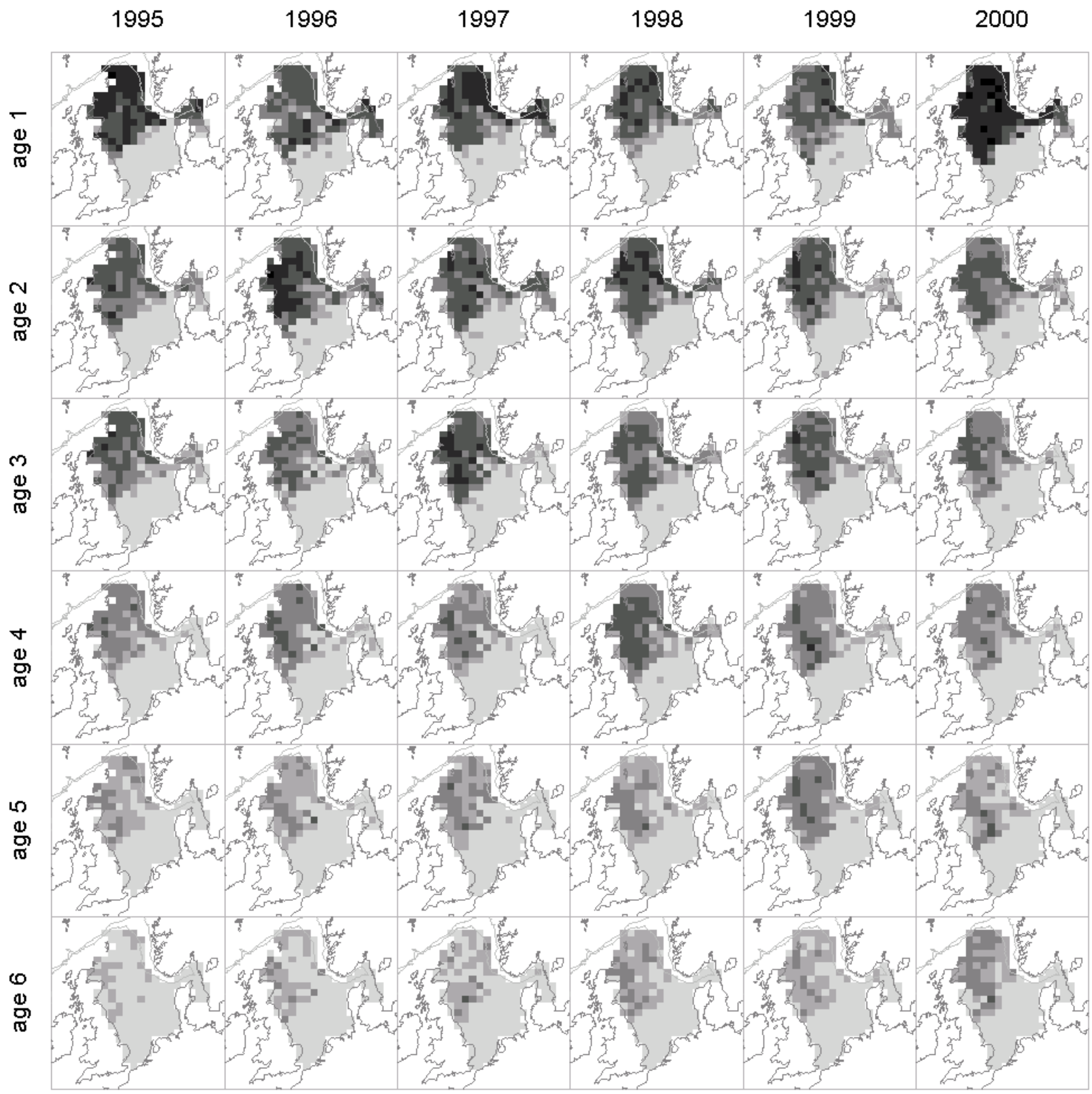


Figure 13.2.5.1 Haddock in Sub-Area IV and Division IIIa. Spatial distribution of haddock from IBTS Q1.

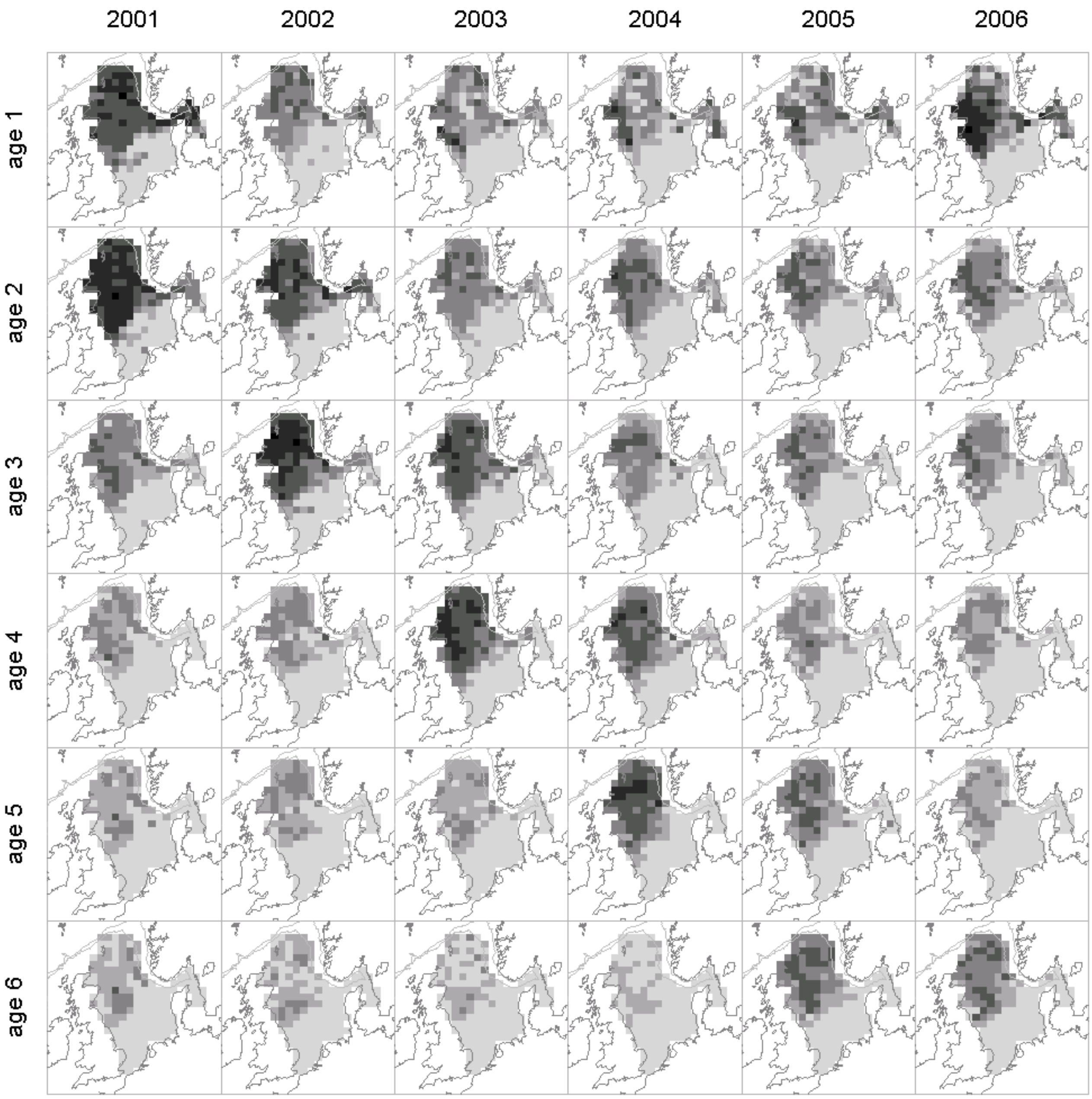


Figure 13.2.5.1 cont **Haddock in Sub-Area IV and Division IIIa. Spatial distribution of haddock from IBTS Q1.**

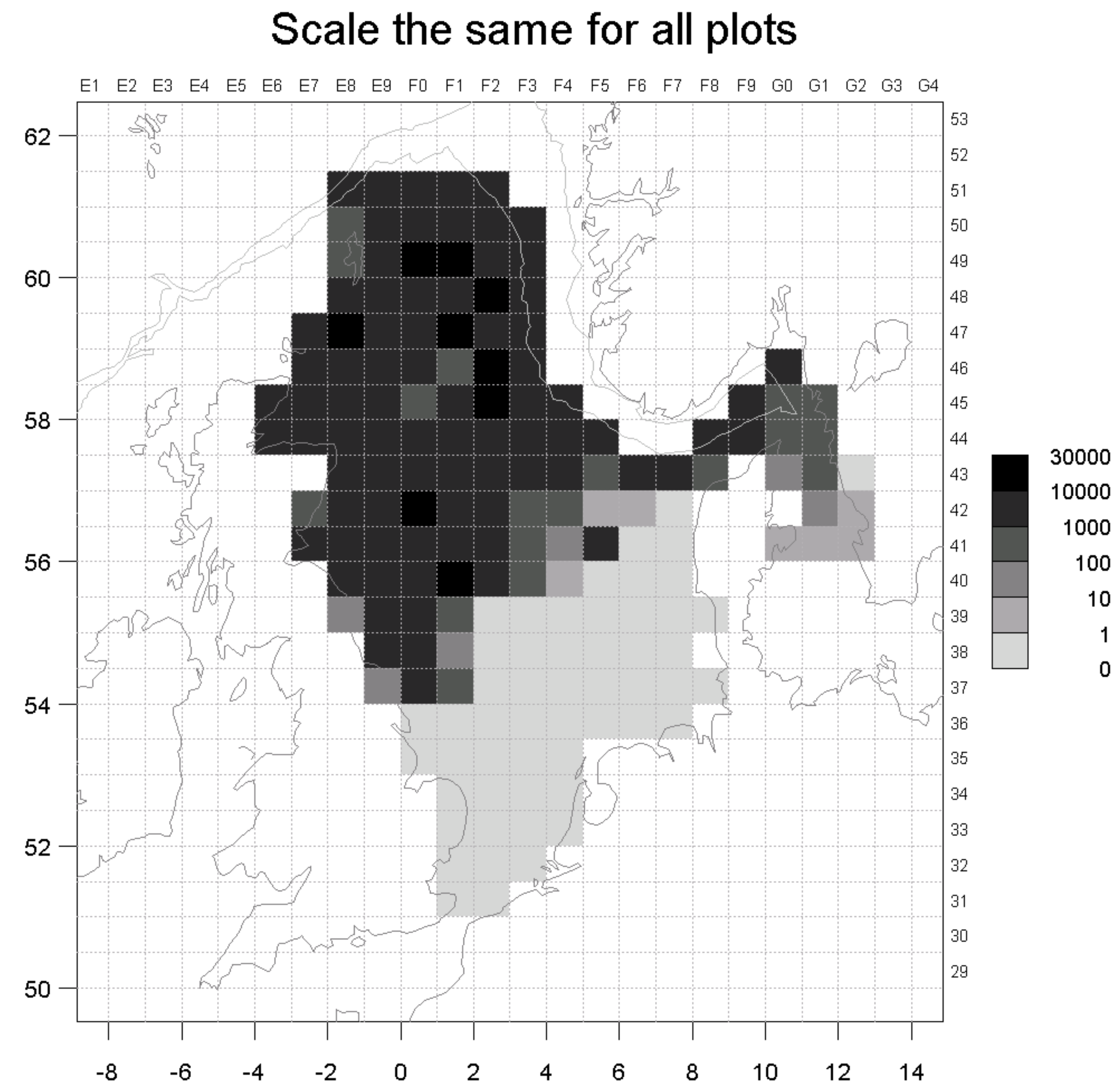


Figure 13.2.5.1 cont Haddock in Sub-Area IV and Division IIIa. Spatial distribution of haddock from IBTS Q1. An example of the scale used for all plots (age 1 in 2000).

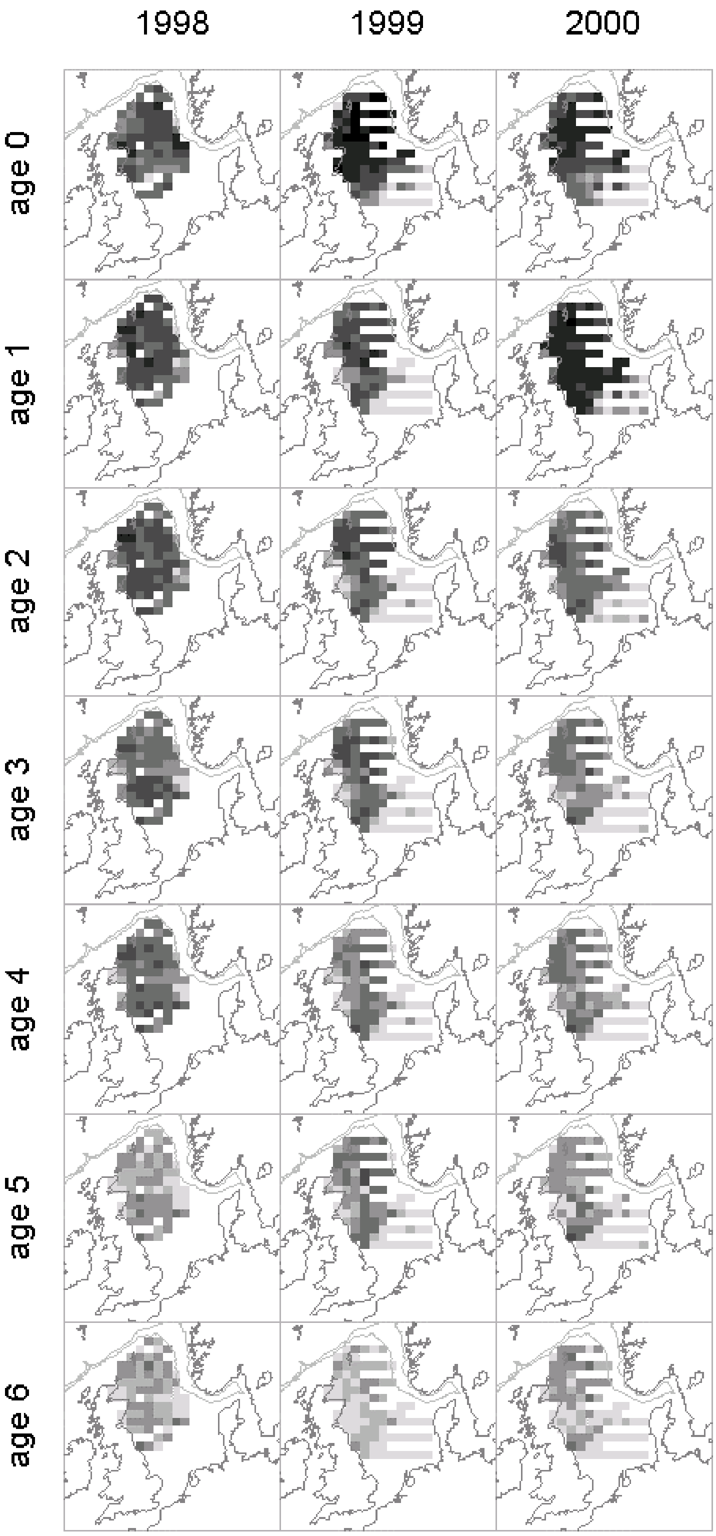


Figure 13.2.5.2 Haddock in Sub-Area IV and Division IIIa. Spatial distribution of haddock from the Q3 Scottish groundfish survey.

Figure 13.2.5.2 cont **Haddock in Sub-Area IV and Division IIIa. Spatial distribution of haddock from the Q3 Scottish groundfish survey.**

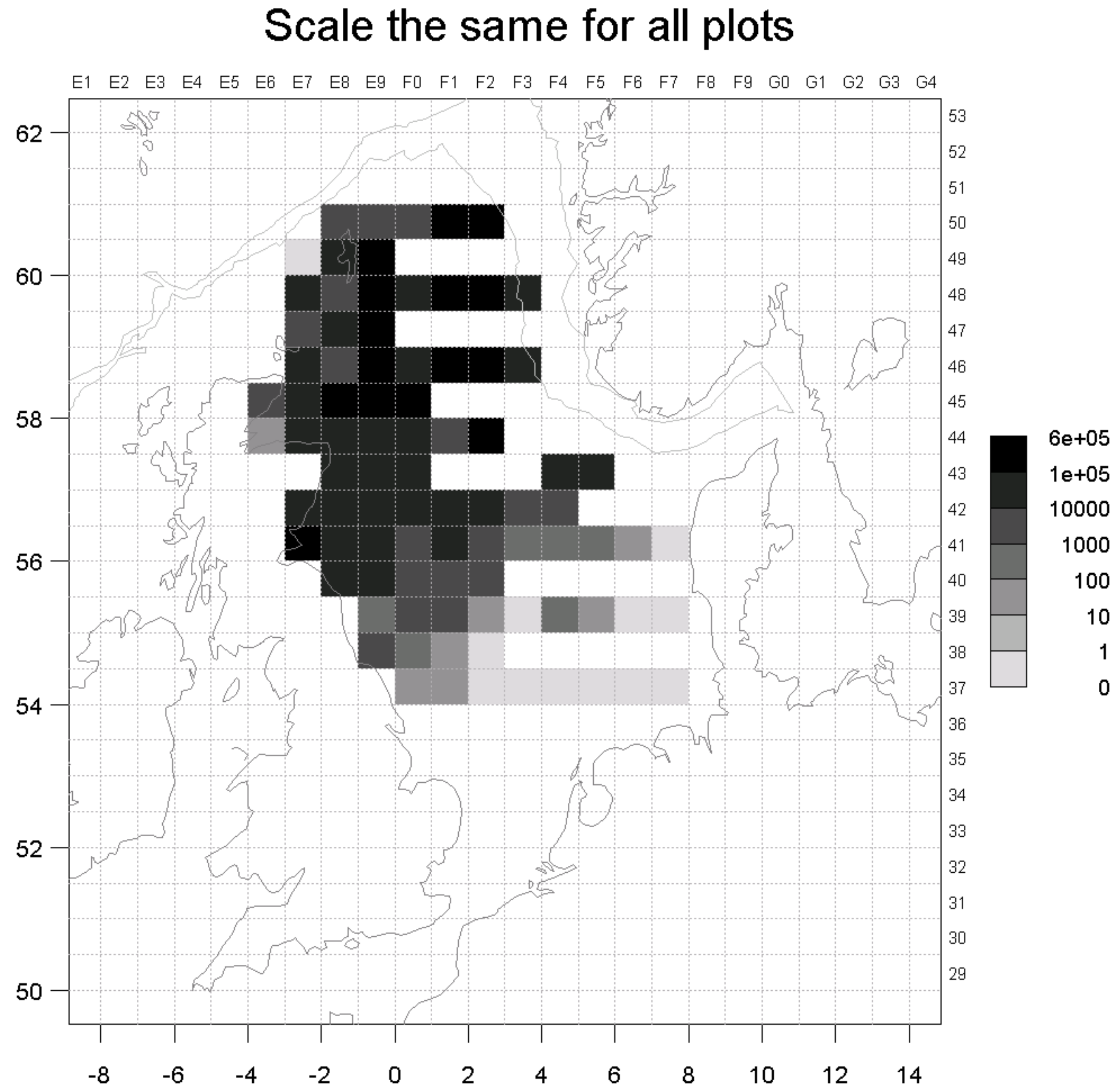


Figure 13.2.5.2 cont **Haddock in Sub-Area IV and Division IIIa. Spatial distribution of haddock from the Q3 Scottish groundfish survey. An example of the scale used for all plots (age 0 in 1999).**

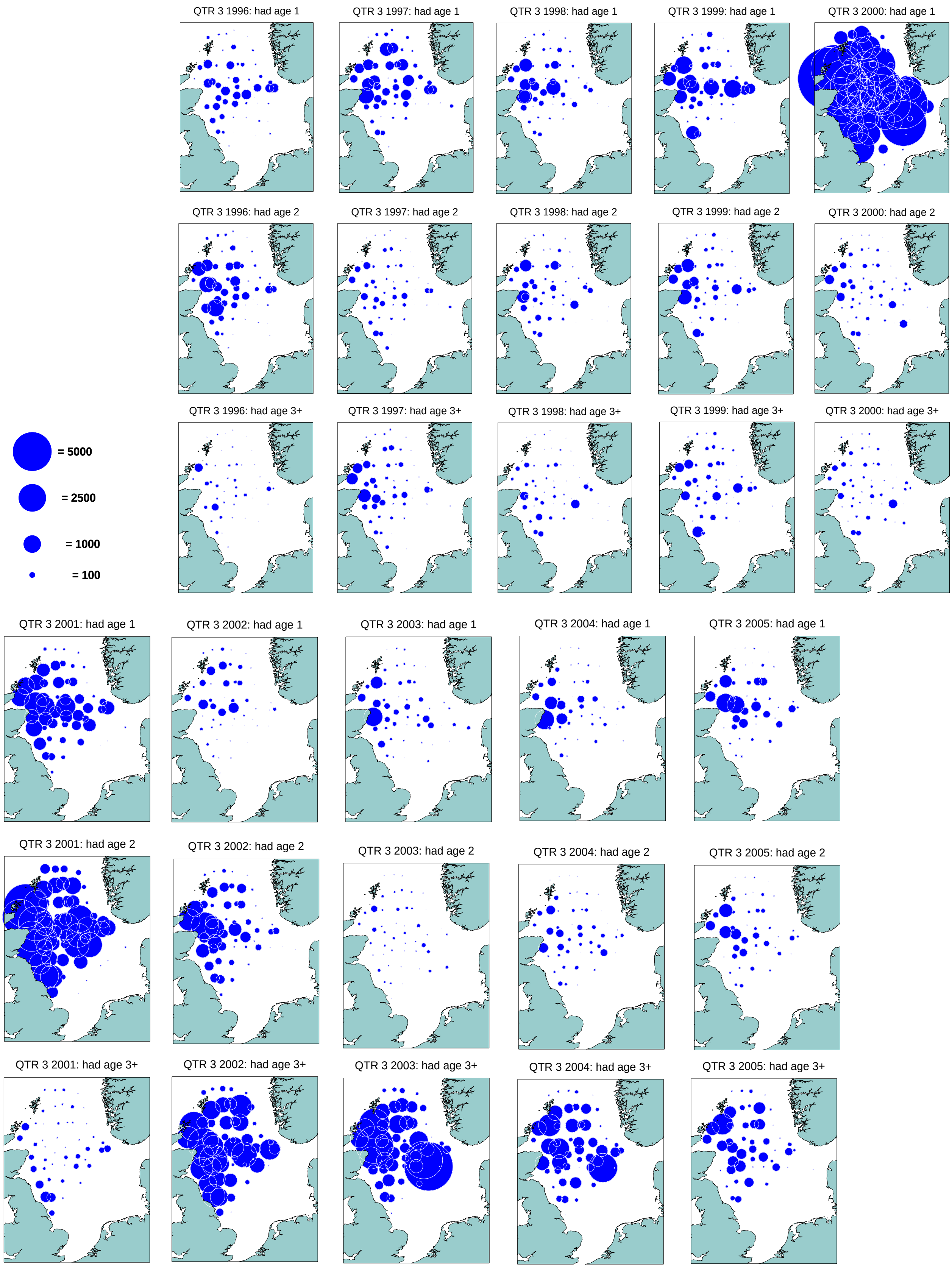


Figure 13.2.5.3 Haddock in Sub-Area IV and Division IIIa. Spatial distribution of haddock from the Q3 English groundfish survey.

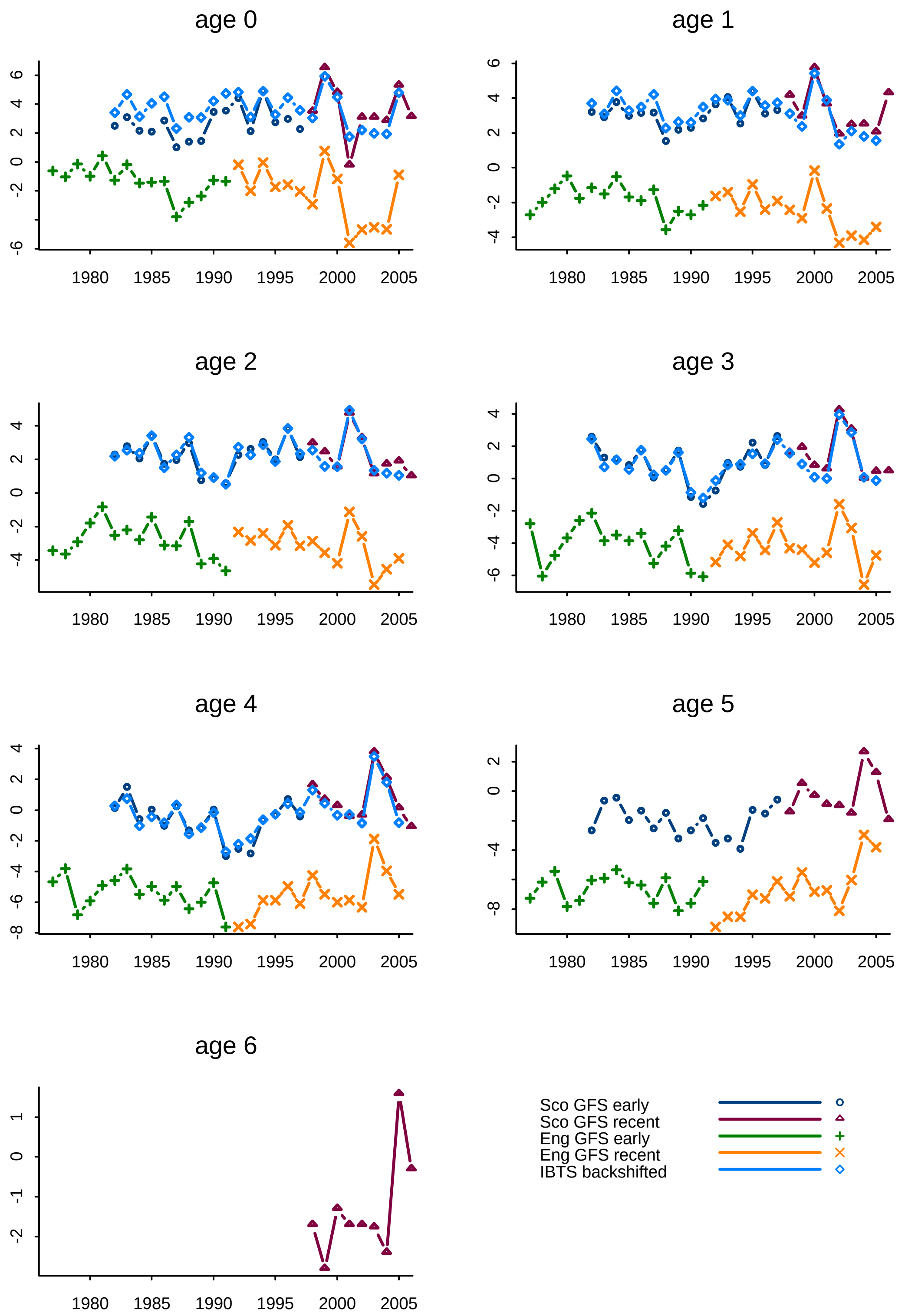


Figure 13.2.5.4 Haddock in Sub-Area IV and Division IIIa. Survey log-CPUE data at age.

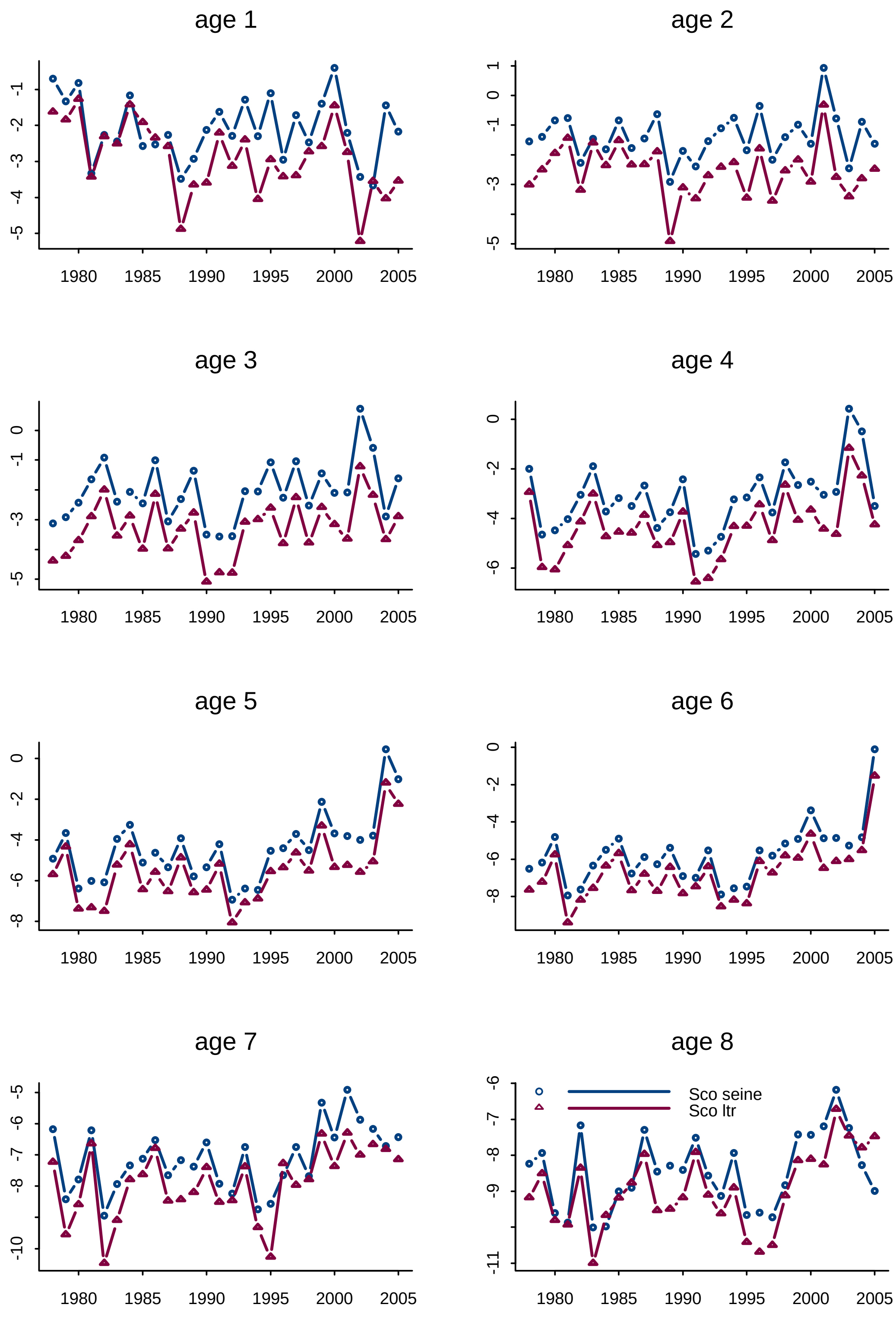


Figure 13.2.5.5 Haddock in Sub-Area IV and Division IIIa. Commercial log-CPUE data at age.

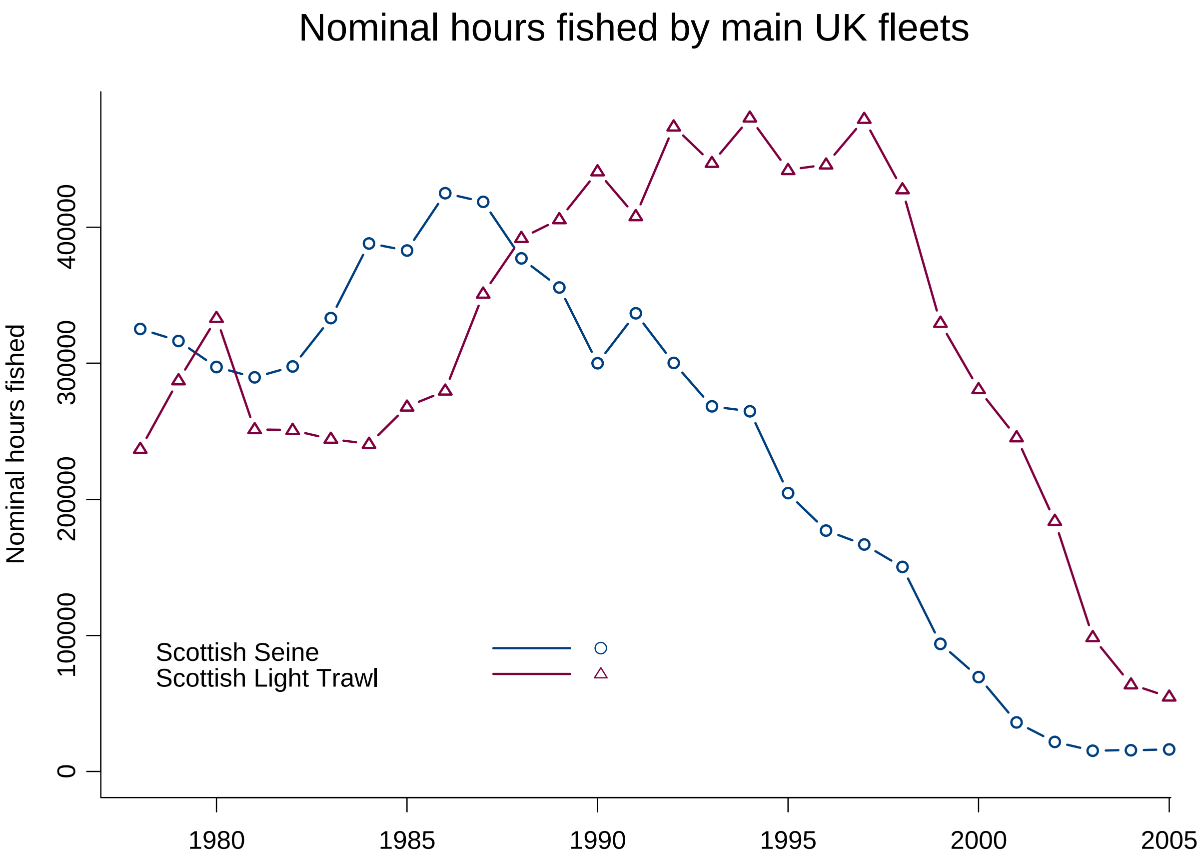


Figure 13.2.5.6 Haddock in Sub-Area IV and Division IIIa. Nominal hours fished by UK fleets. The values plotted are those from Table 13.2.5.2, indicating the catch at age fleet information available to the WG. Recording of hours fished is not mandatory in logbooks in the UK and is not considered to be representative of deployed fishing effort.

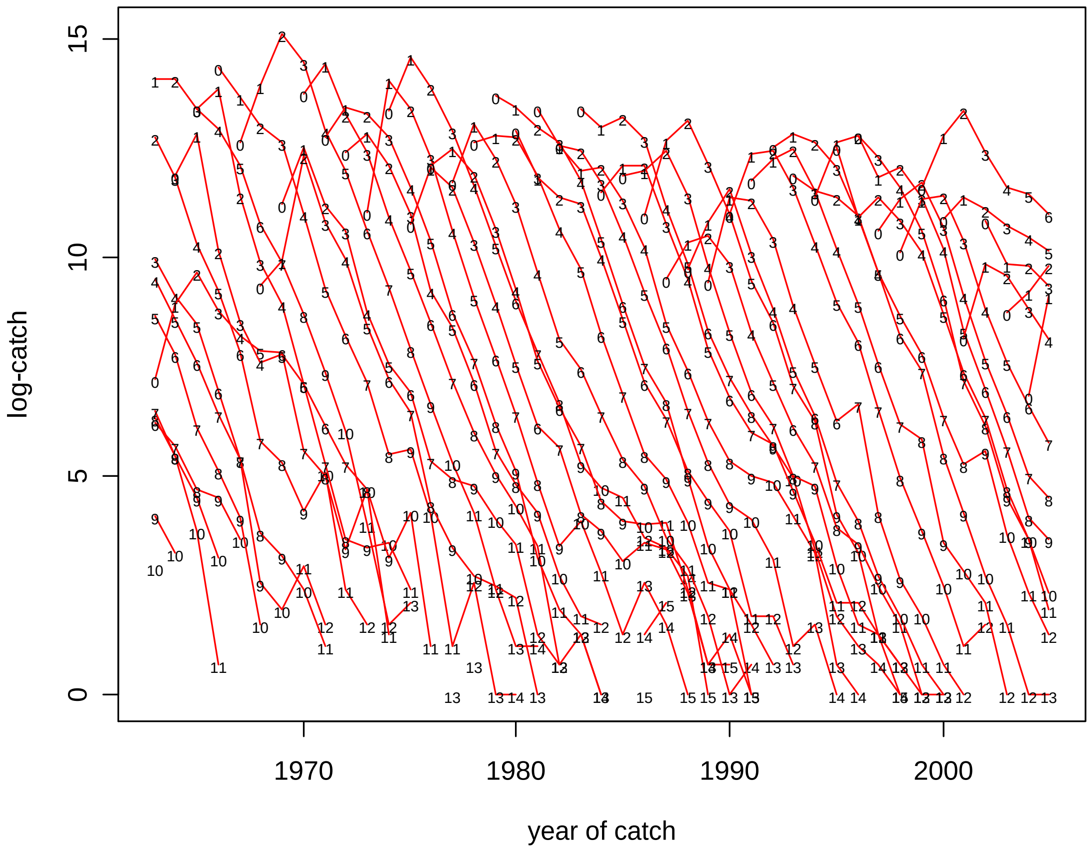


Figure 13.3.2.1 Haddock in Sub-Area IV and Division IIIa. Log-catch by cohort for total catches.

Figure 13.3.2.2 Haddock in Sub-Area IV and Division IIIa. Negative gradients of log-catches per cohort for the age-range 2-5.

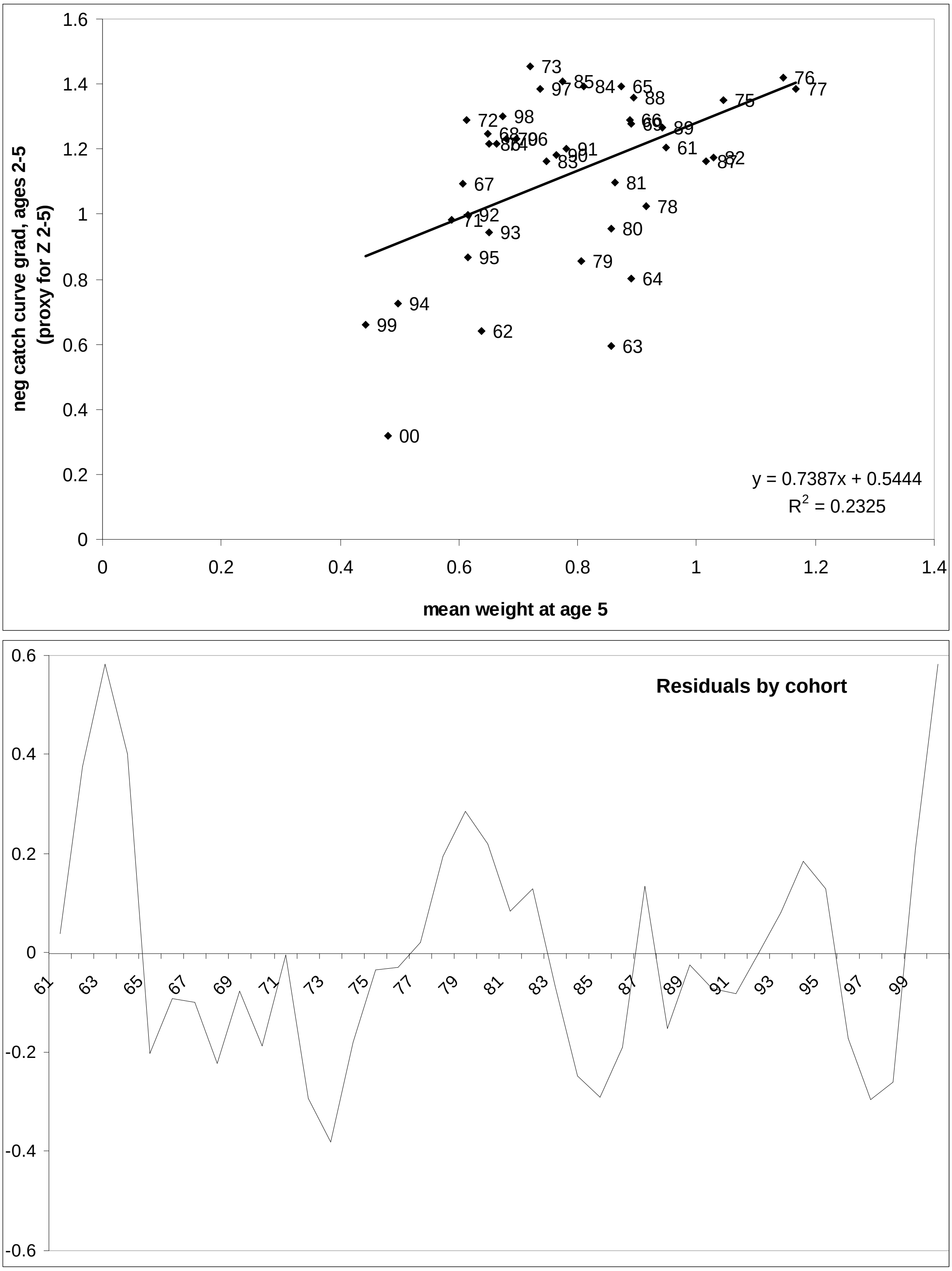


Figure 13.3.2.3 Haddock in Sub-Area IV and Division IIIa. The top panel regresses the negative catch-curve gradient of a given cohort (given in Figure 13.3.2.2) against the mean weight for that cohort at age 5 (the linear regression fit and cohort labels are given in the plot), with the bottom panel showing the associated residuals by cohort.

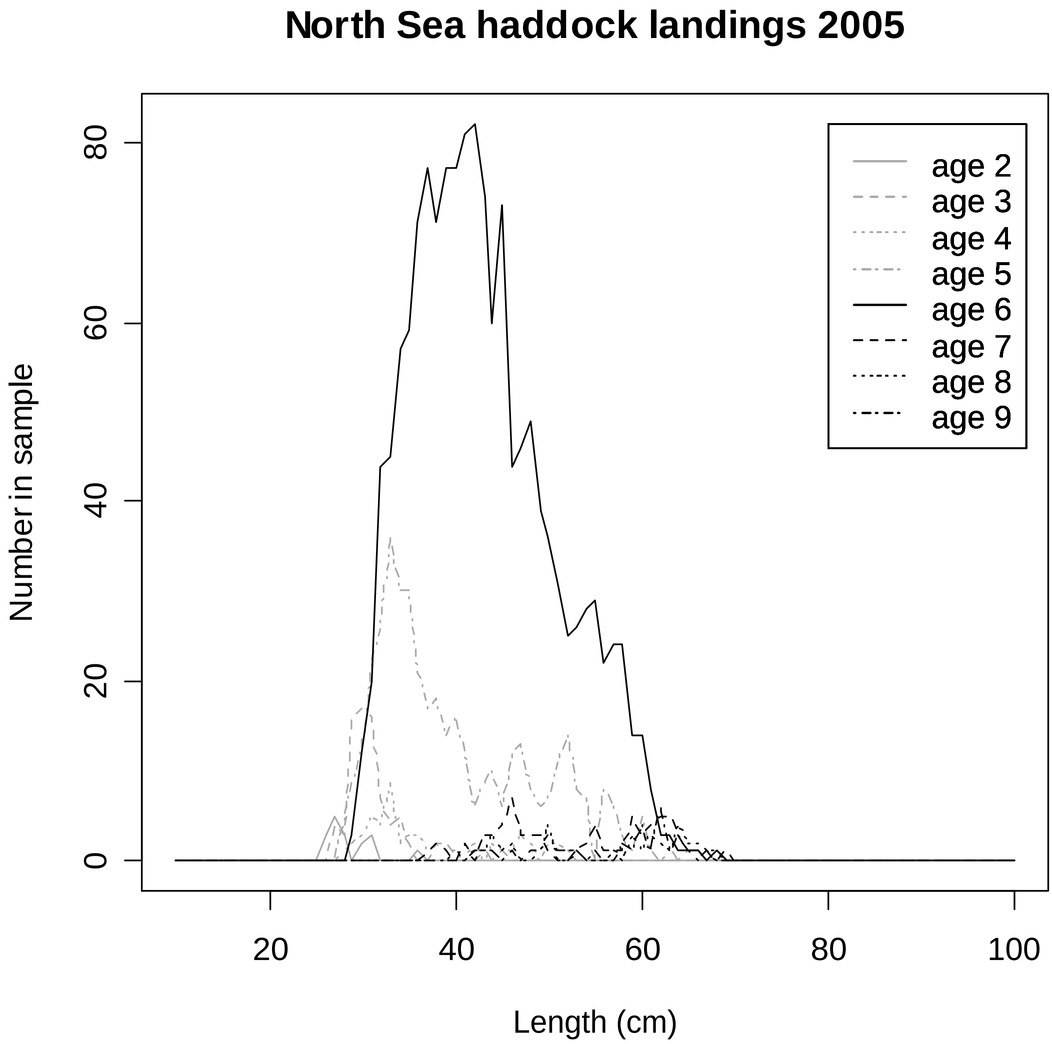


Figure 13.3.2.4 Haddock in Sub-Area IV and Division IIIa. Length distributions by age group for landings in the first quarter of 2005.

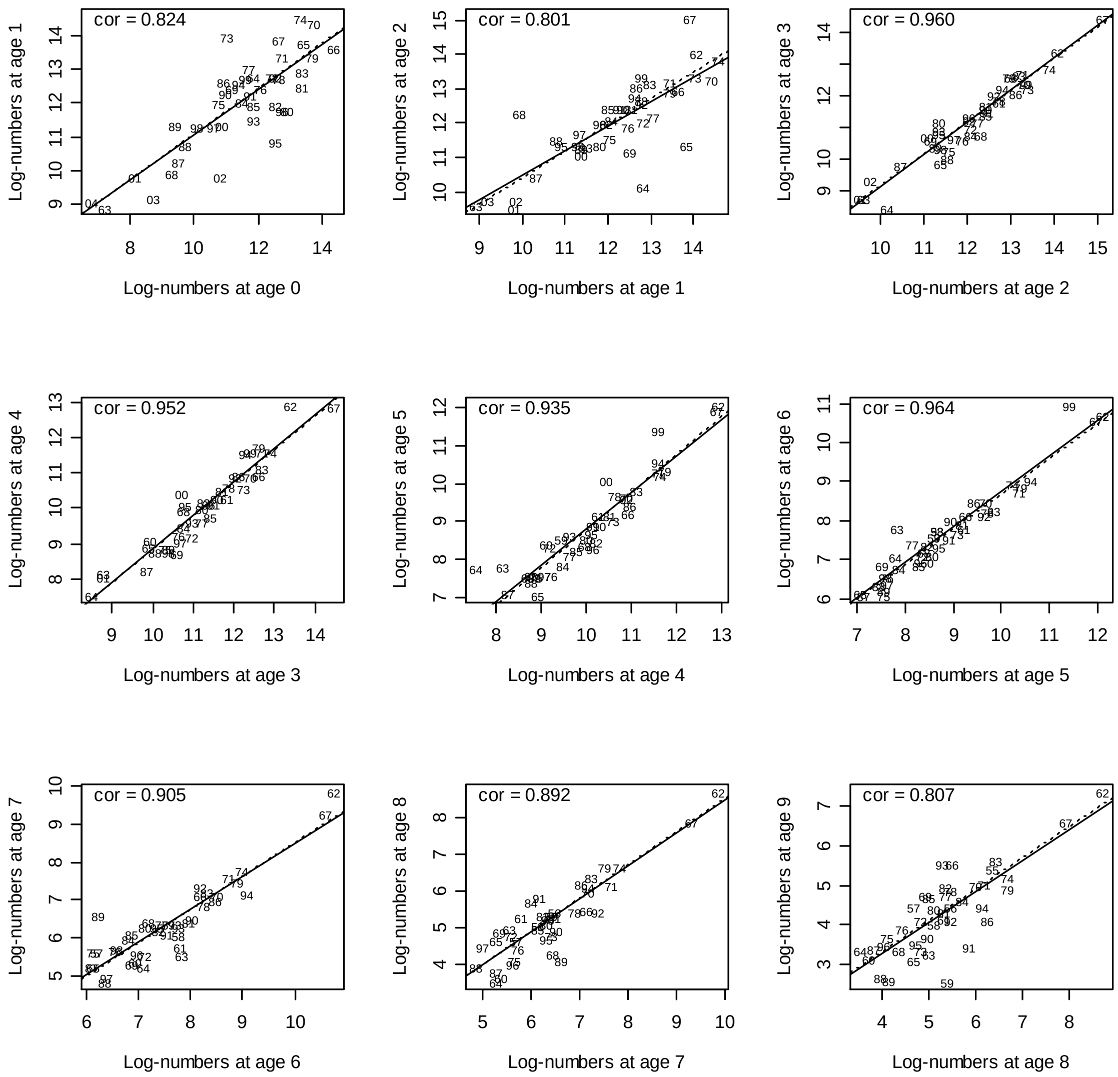


Figure 13.3.2.5 Haddock in Sub-Area IV and Division IIIa. Correlations in the catch-at-age matrix (log-numbers). Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line a robust linear regression line, and "cor" denotes the correlation coefficient.

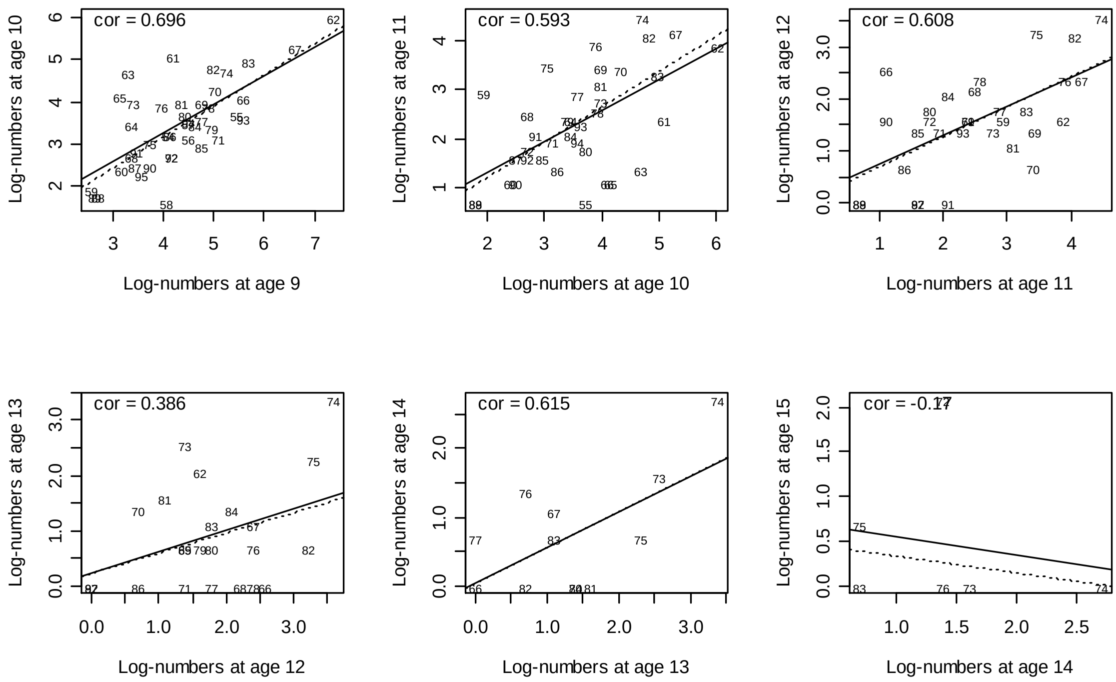


Figure 13.3.2.5 cont Haddock in Sub-Area IV and Division IIIa. Correlations in the catch-at-age matrix (log-numbers).

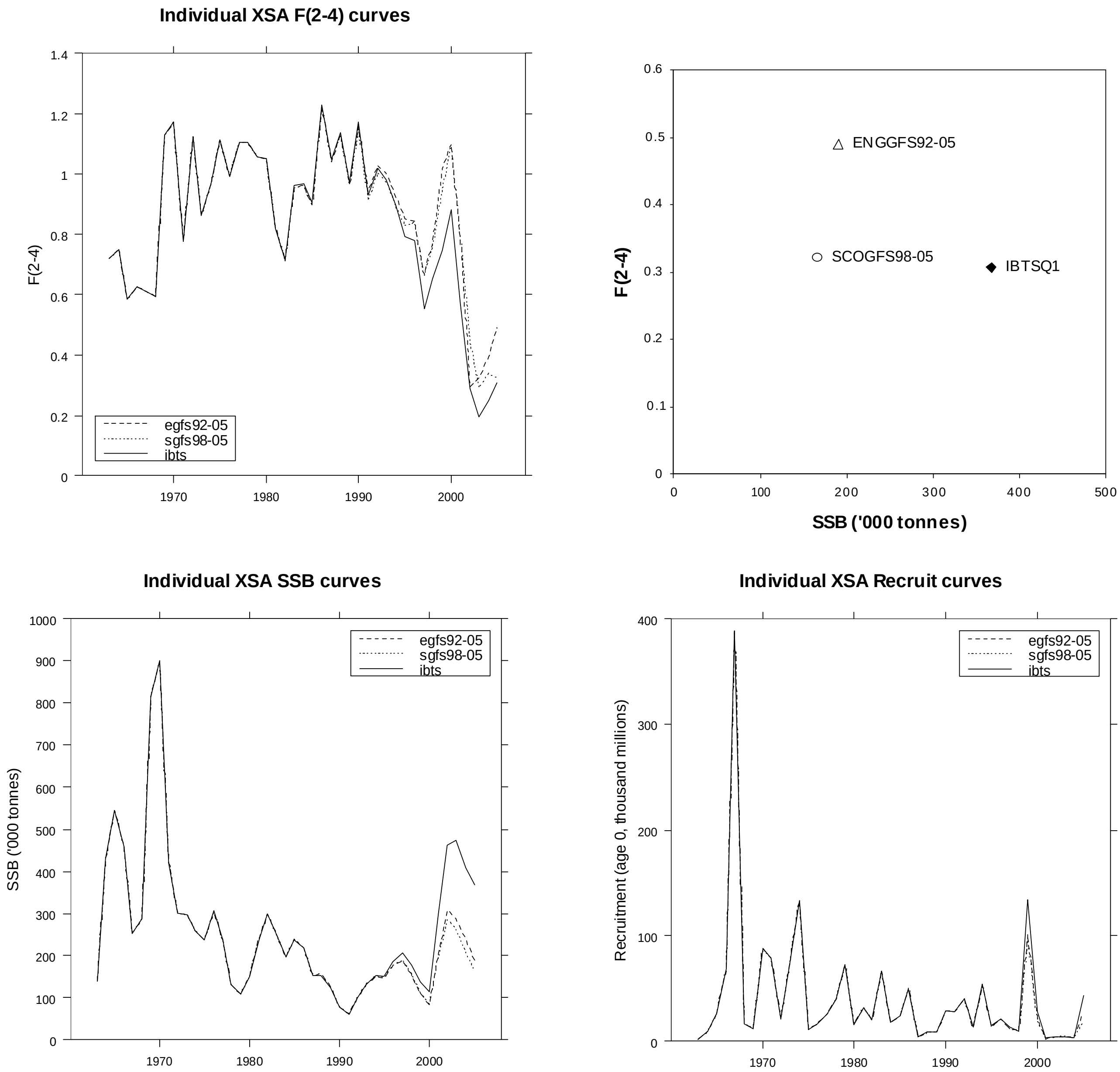


Figure 13.3.2.6 Haddock in Sub-Area IV and Division IIIa. Comparison of F (2-4), SSB and Recruitment time series for individual-fleet XSA runs (with the same setting as the last year's final assessment), together with final-year estimates for F (2-4) and SSB shown on a single plot (top-right).

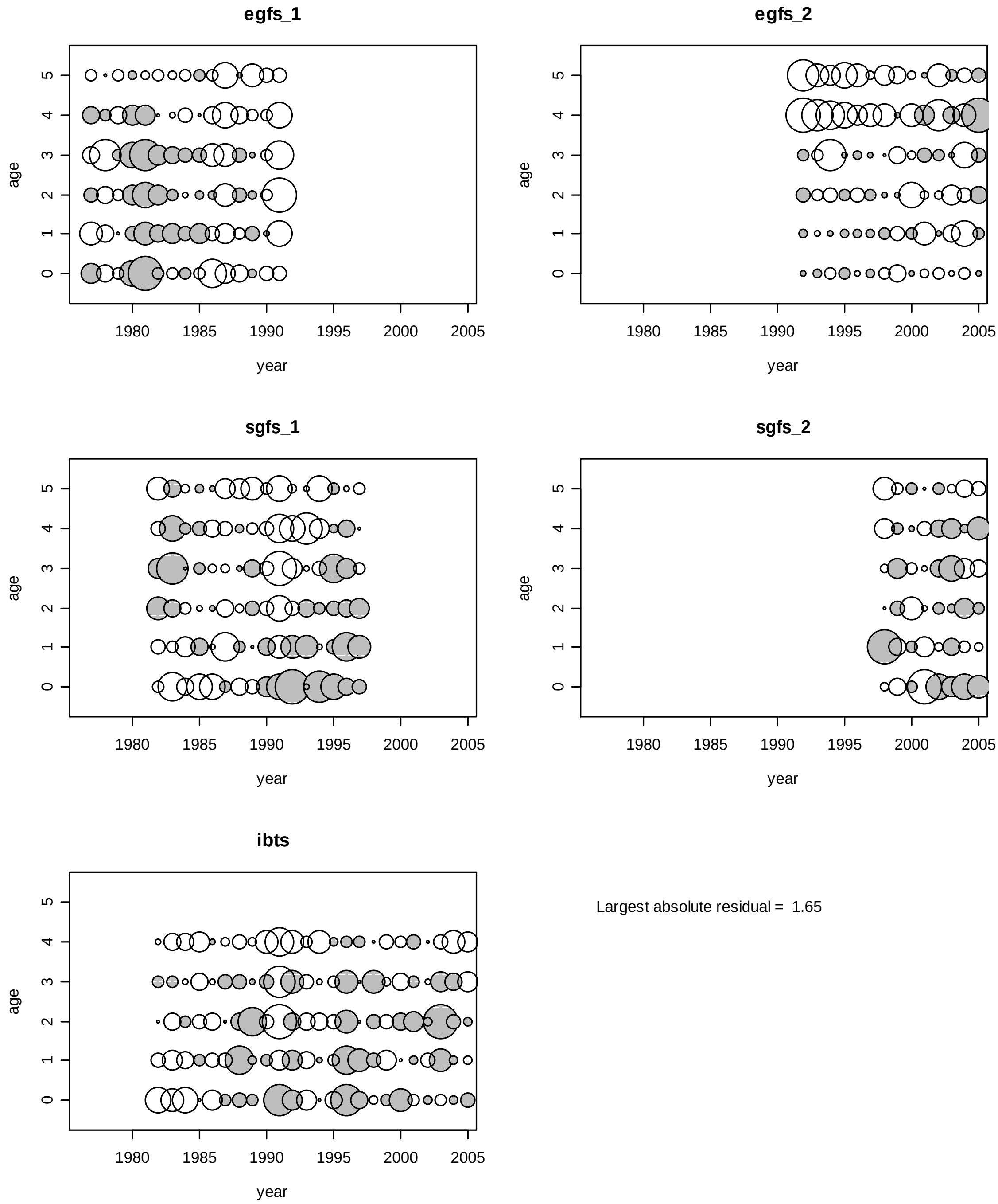


Figure 13.3.2.7 Haddock in Sub-Area IV and Division IIIa. Log-catchability residuals corresponding to the individual-fleet XSA runs (with the same setting as the last year's final assessment), shown in Figure 13.3.2.6 (but also including the early ENGGFS and SCOGFS series, indicated with "_1").

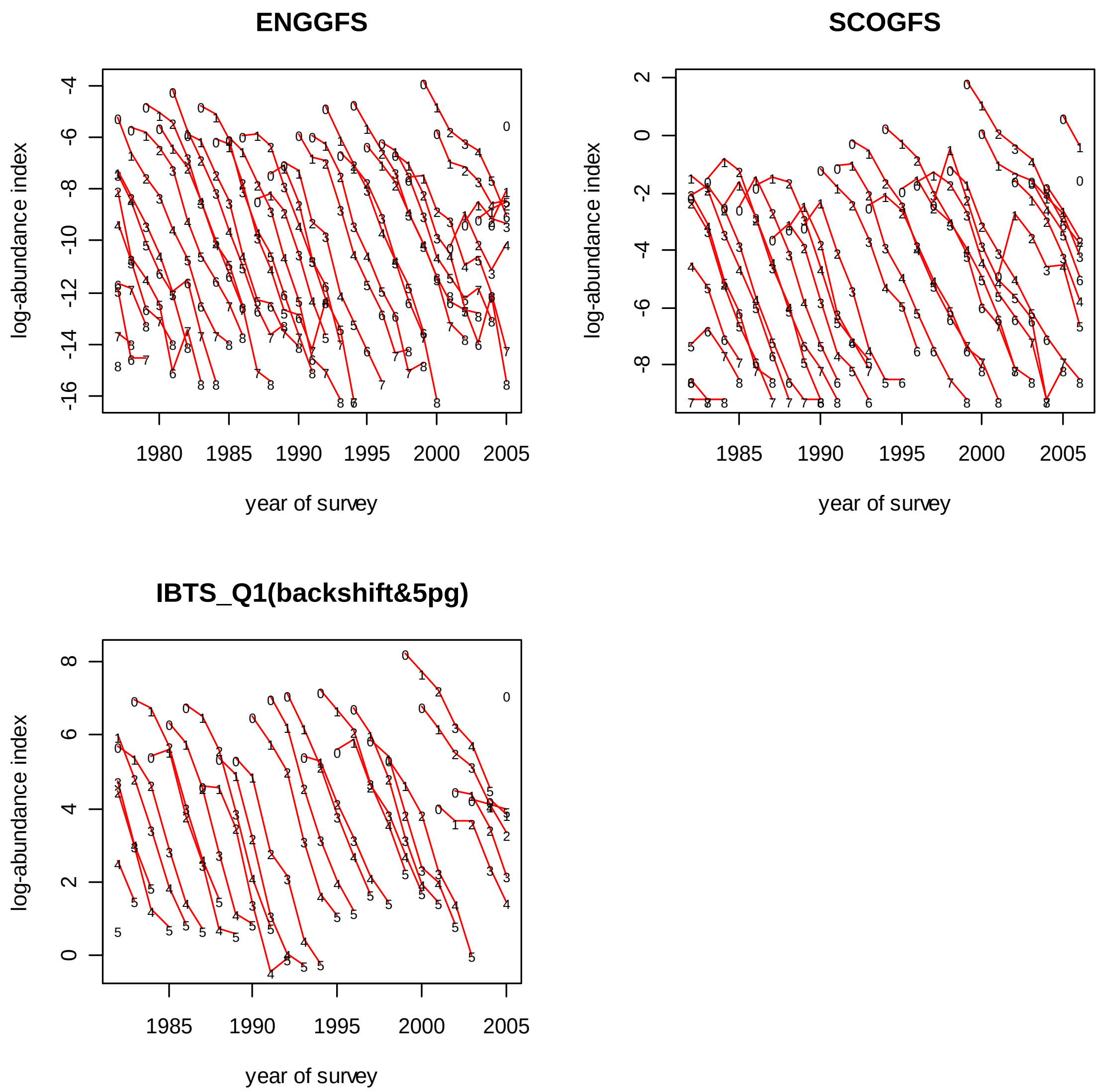


Figure 13.3.3.1 Haddock in Sub-Area IV and Division IIIa. Log-abundance indices by cohort for each of the three surveys (Note: age 5 for the IBTS Q1 survey is a plusgroup).

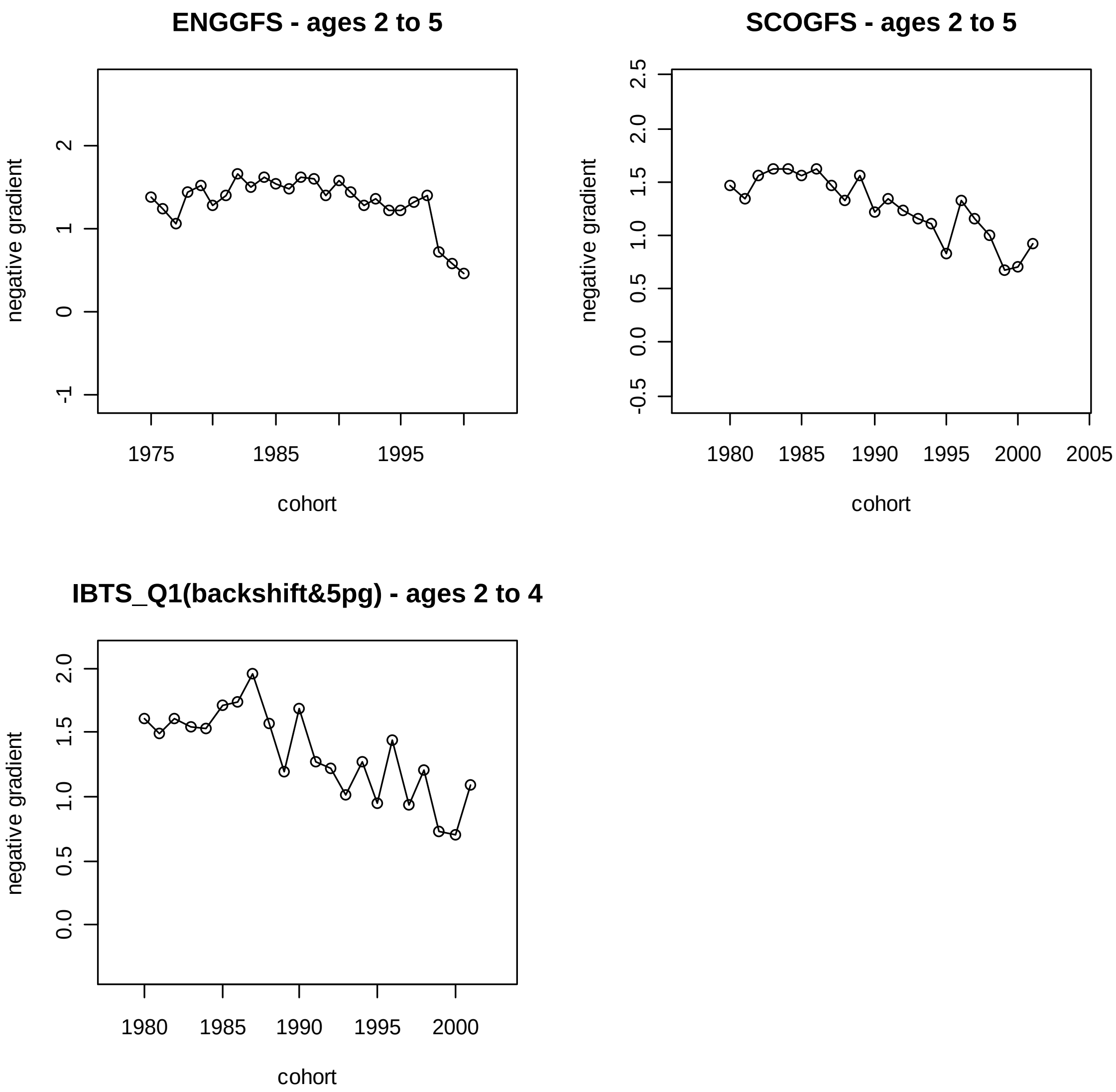


Figure 13.3.3.2 Haddock in Sub-Area IV and Division IIIa. Negative gradients of log-abundance per cohort for each of the three surveys for the age-ranges specified separately for each survey.

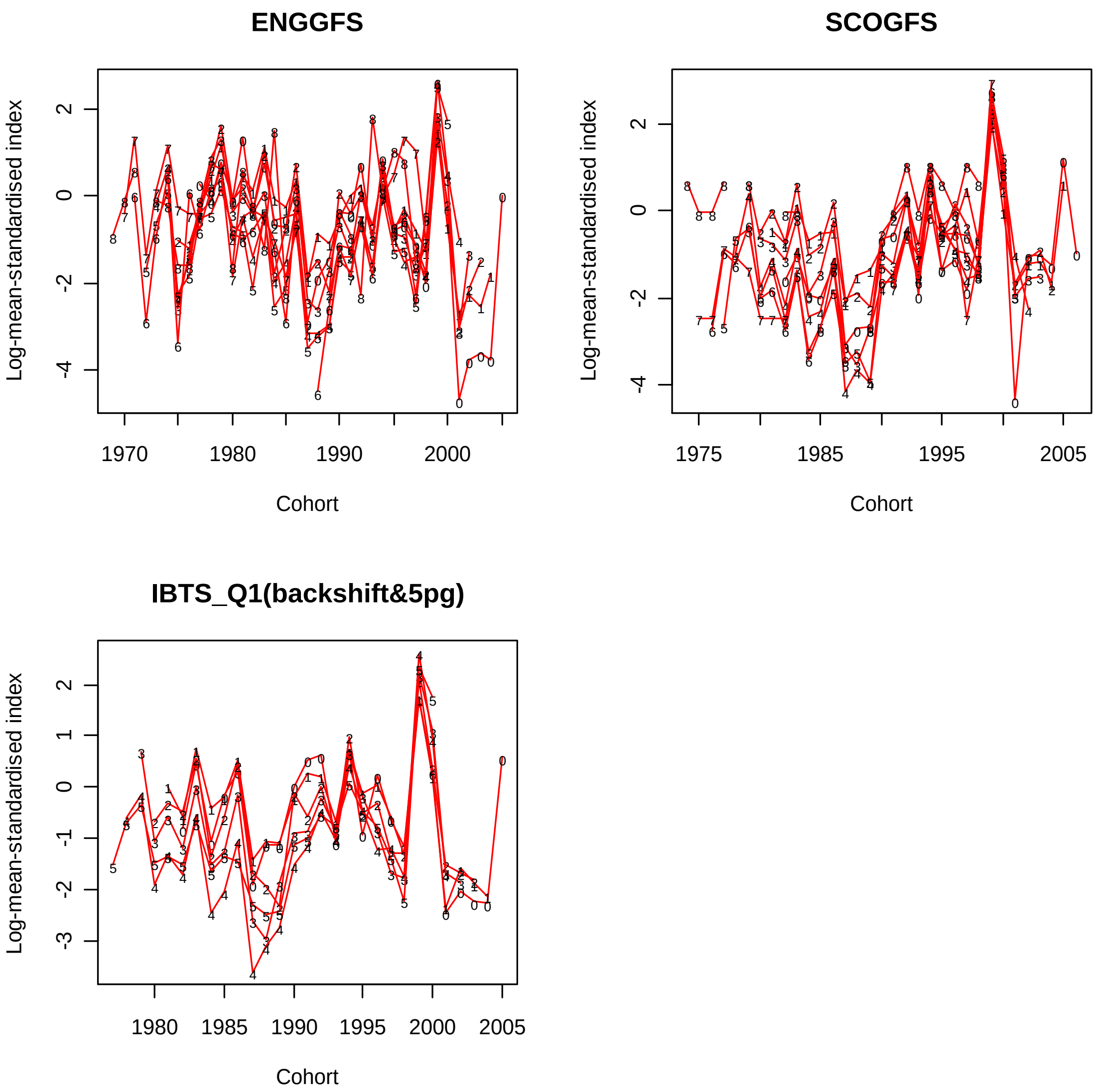


Figure 13.3.3.3 Haddock in Sub-Area IV and Division IIIa. Log-mean-standardised abundance indices by cohort for each of the three surveys (Note: age 5 for the IBTS Q1 survey is a plusgroup).

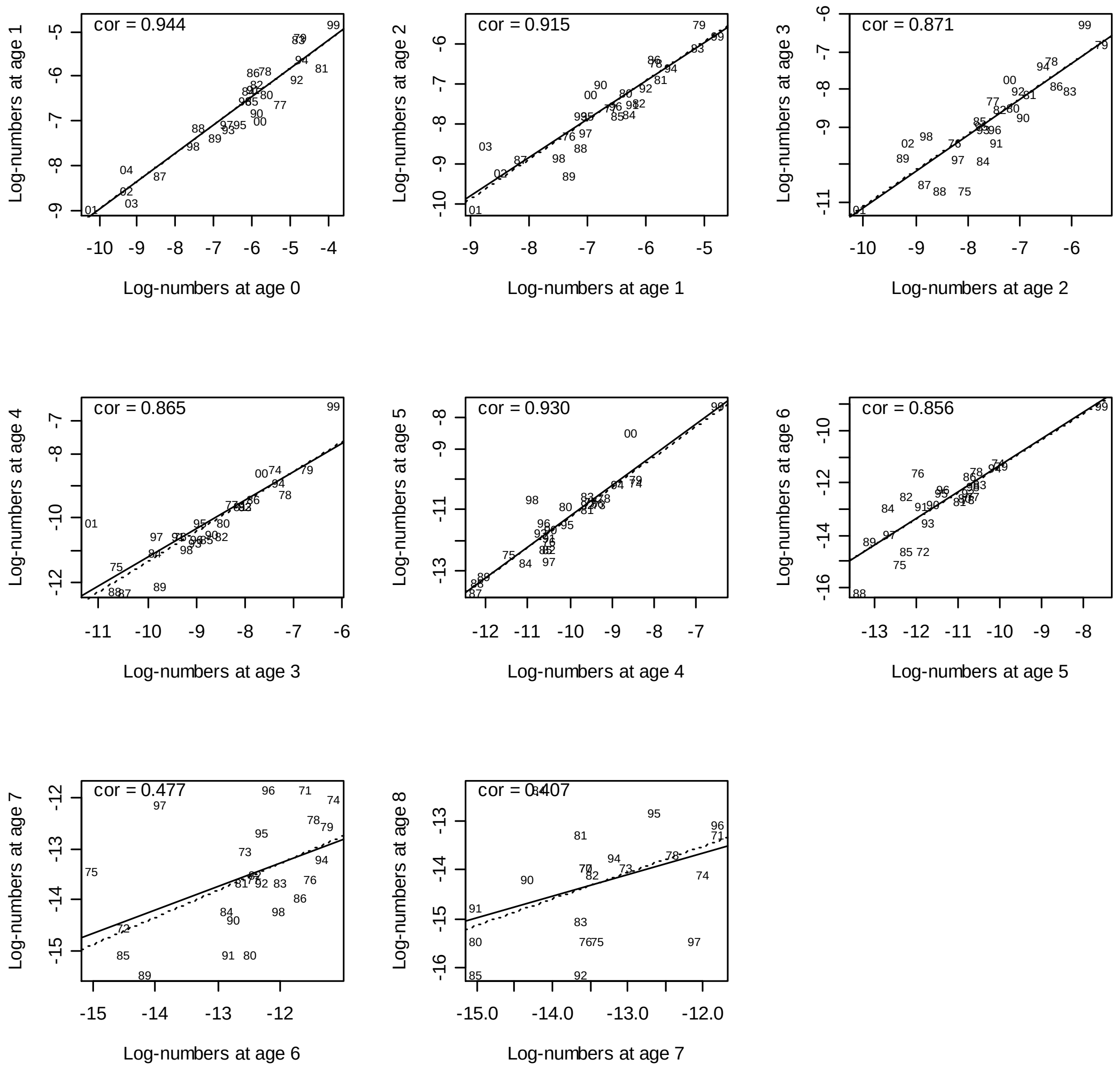


Figure 13.3.3.4 Haddock in Sub-Area IV and Division IIIa. Within-survey correlations for ENGGFS for the period 1977-2005. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line a robust linear regression line, and “cor” denotes the correlation coefficient.

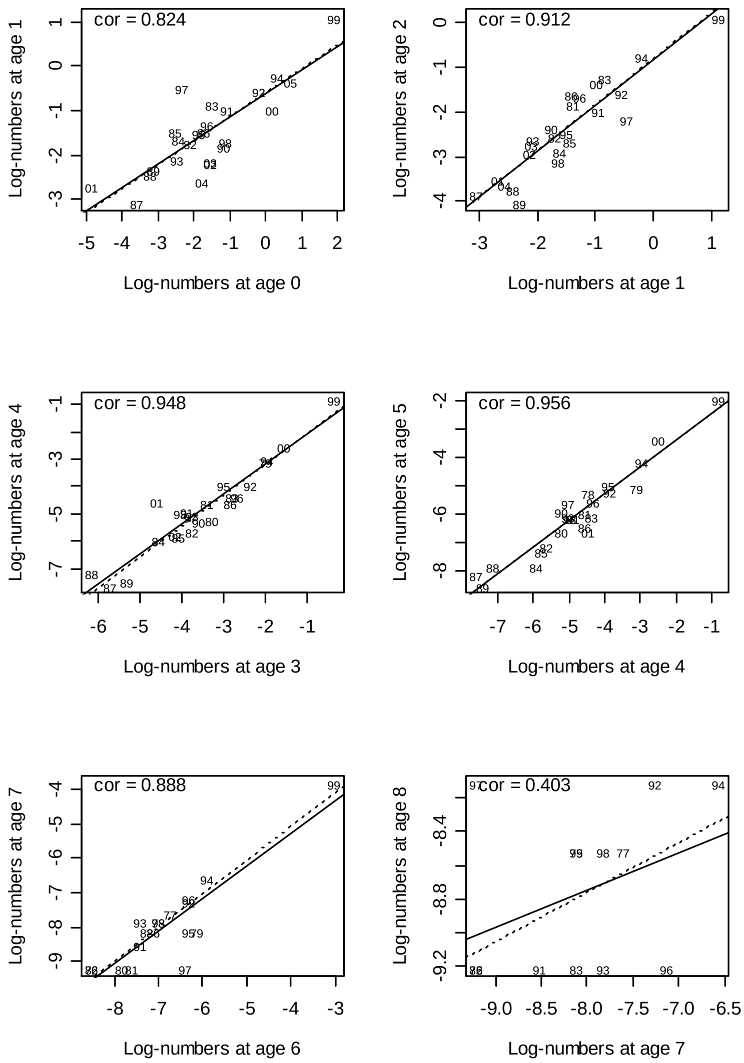


Figure 13.3.3.5 Haddock in Sub-Area IV and Division IIIa. Within-survey correlations for SCOGFS for the period 1982-2006. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line a robust linear regression line, and "cor" denotes the correlation coefficient.

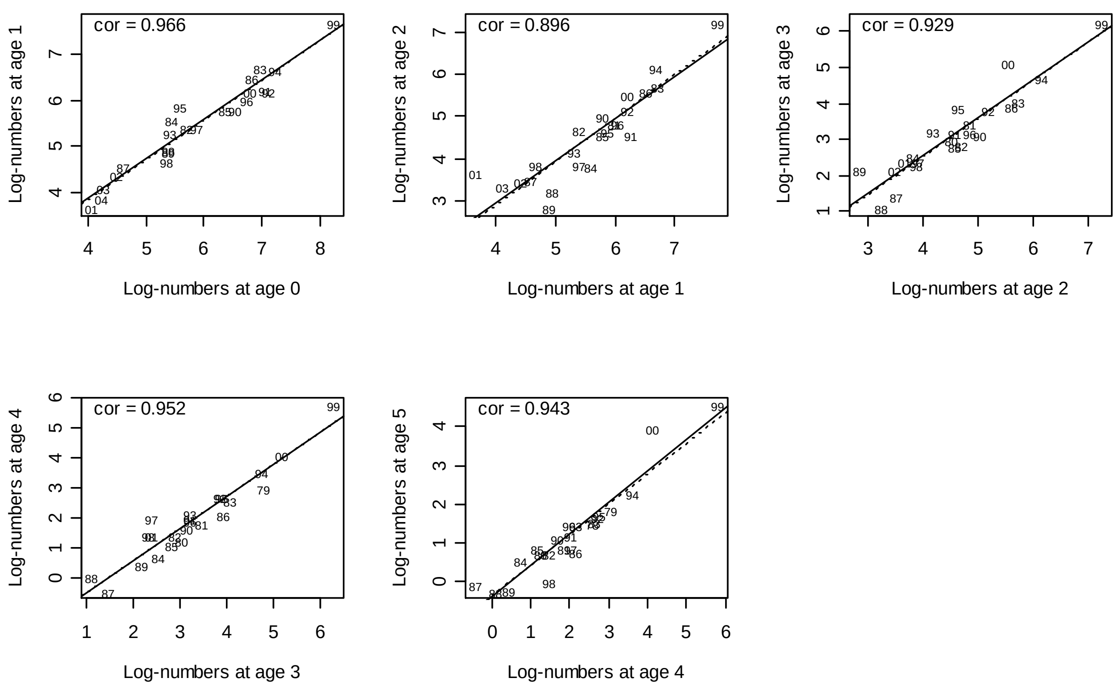


Figure 13.3.3.6 Haddock in Sub-Area IV and Division IIIa. Within-survey correlations for IBTS Q1 (backshifted; note: age 5 is a plusgroup) for the period 1982-2005. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line a robust linear regression line, and "cor" denotes the correlation coefficient.

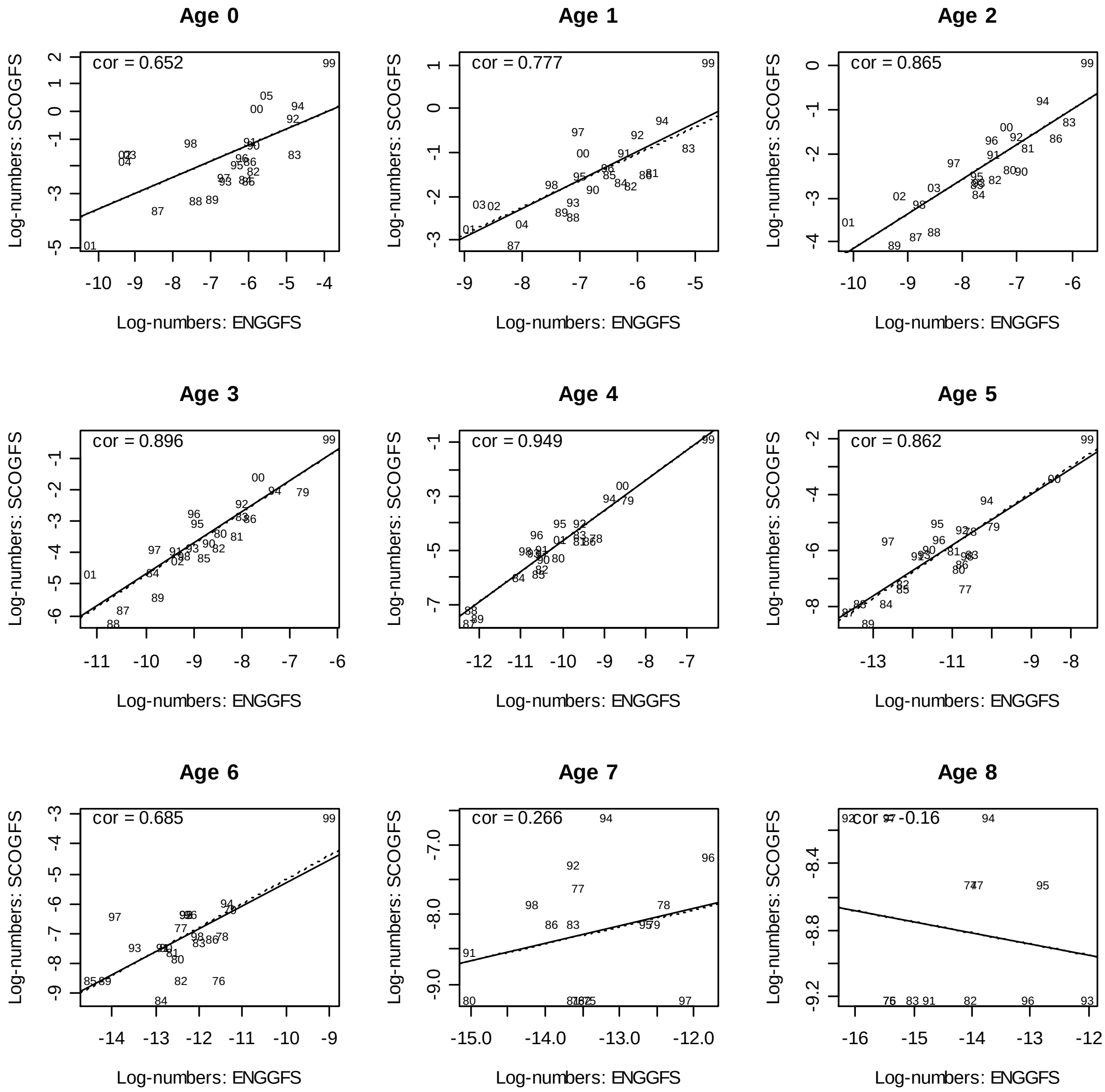


Figure 13.3.3.7 Haddock in Sub-Area IV and Division IIIa. Between-survey correlations for ENGGFS and SCOGFS, by age. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line a robust linear regression line, and "cor" denotes the correlation coefficient.

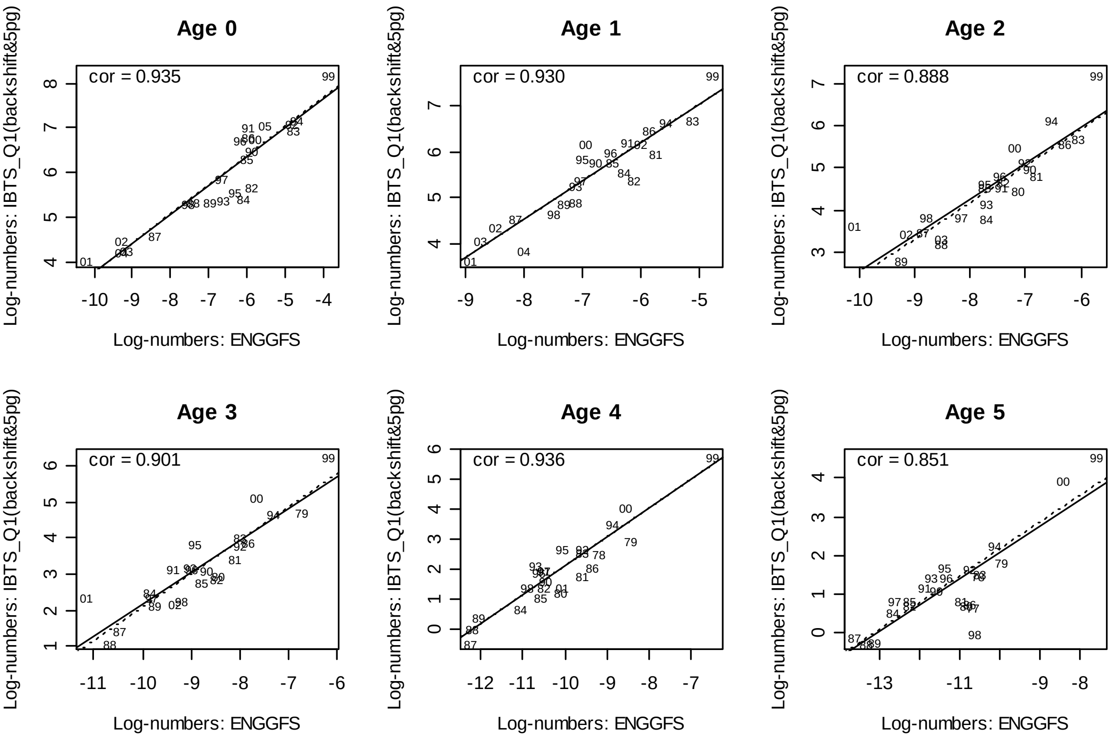


Figure 13.3.3.8 Haddock in Sub-Area IV and Division IIIa. Between-survey correlations for ENGGFS and IBTS Q1 (backshifted; note: age 5 for the IBTS Q1 survey is a plusgroup), by age. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line a robust linear regression line, and "cor" denotes the correlation coefficient.

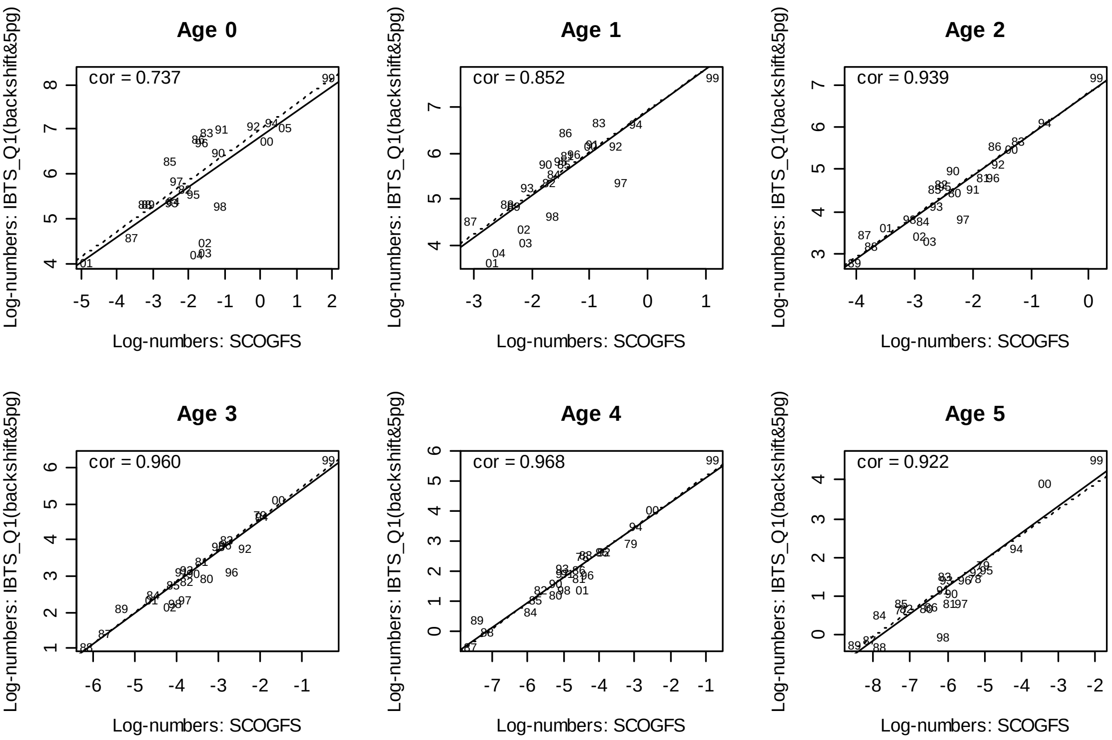


Figure 13.3.3.9 Haddock in Sub-Area IV and Division IIIa. Between-survey correlations for SCOGFS and IBTS Q1 (backshifted; note: age 5 for the IBTS Q1 survey is a plusgroup), by age. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line a robust linear regression line, and "cor" denotes the correlation coefficient.

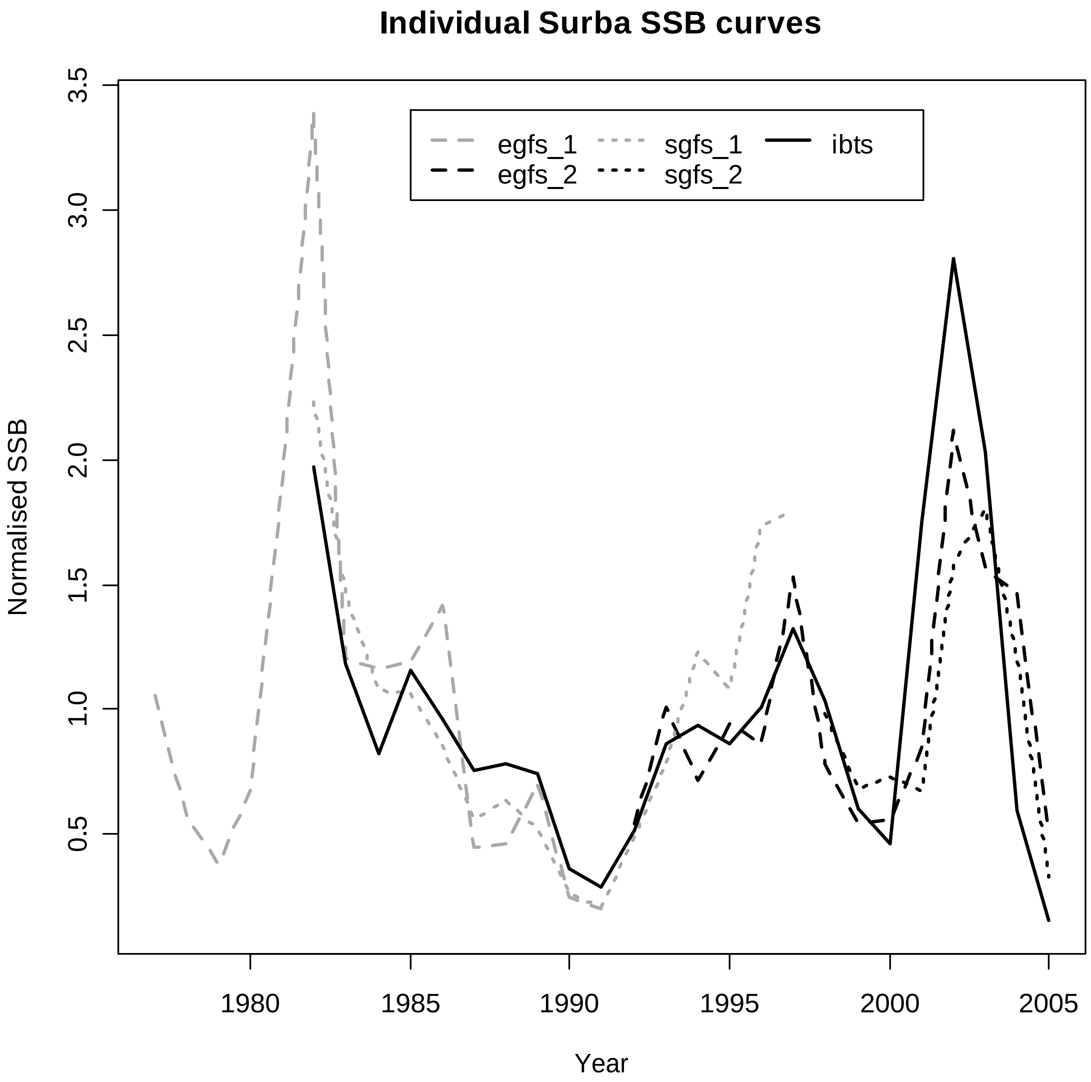


Figure 13.3.3.10 Haddock in Sub-Area IV and Division IIIa. Comparison of SSB trends for single fleet SURBA runs (with settings: reference age = 3, lambda = 2, Fbar range = 2-4).

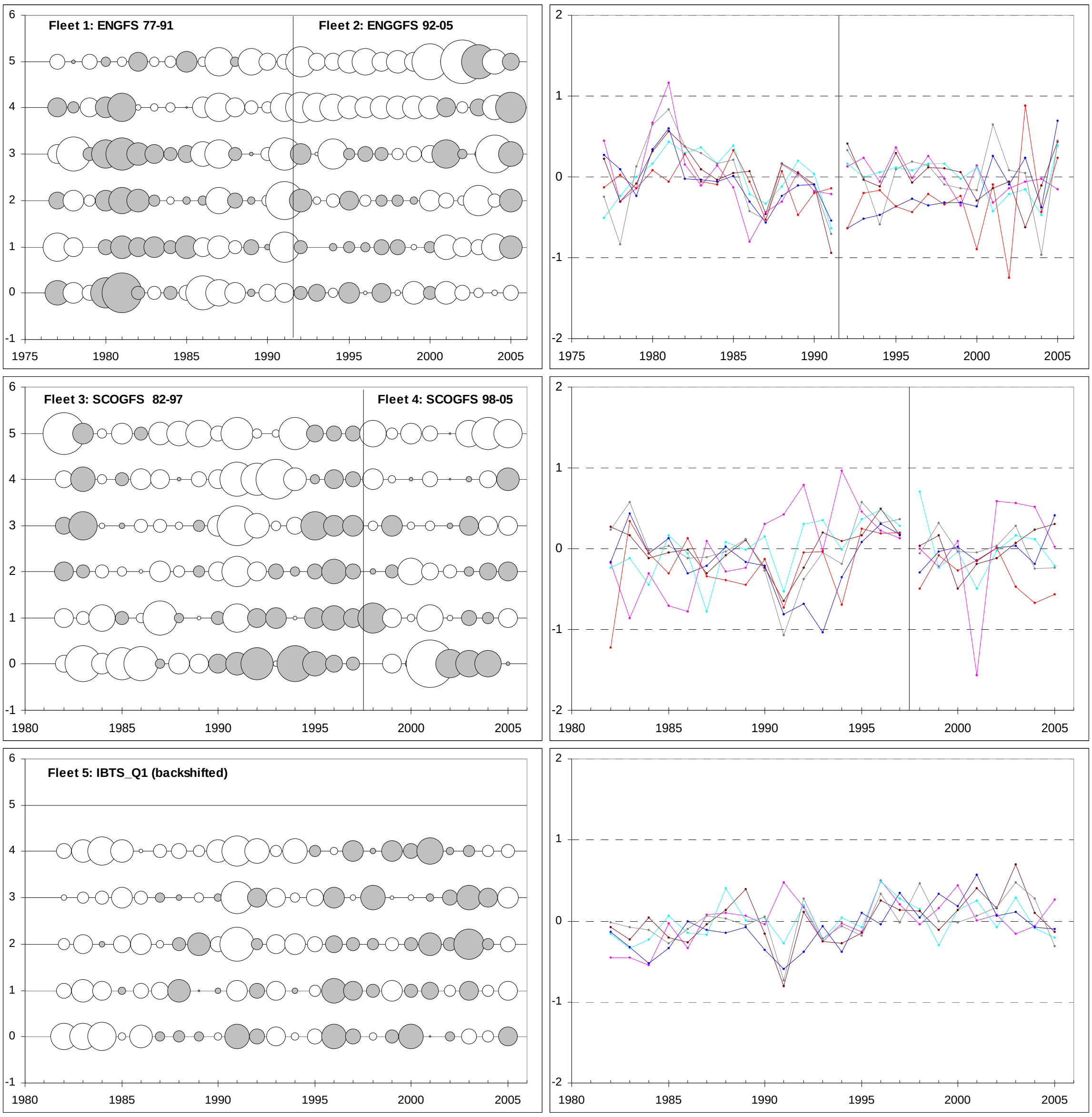


Figure 13.3.5.1 Haddock in Sub-Area IV and Division IIIa. XSA final assessment: log catchability residuals. The two halves of each of ENGGFS and SCOGFS are treated as independent tuning series, hence the residuals are separated by a solid vertical line indicating the appropriate split in the time series.

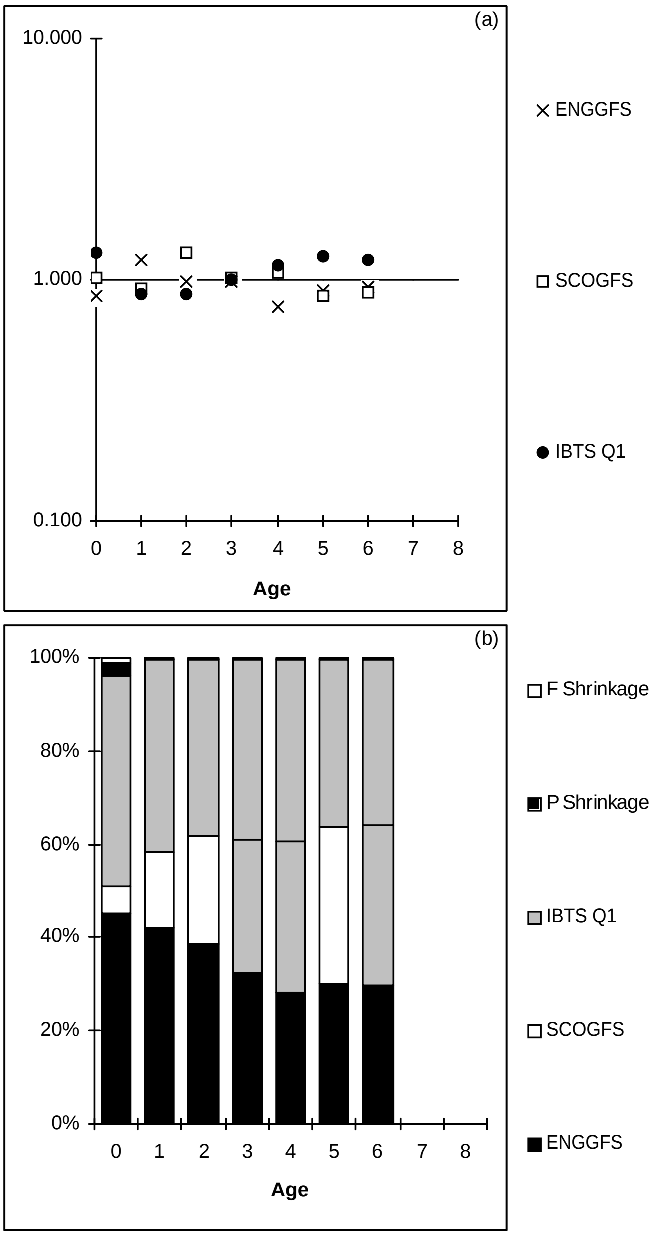


Figure 13.3.5.2 Haddock in Sub-Area IV and Division IIIa. XSA final assessment: comparison of (a) fleet survivor ratios and (b) fleet weights. Note: only 3 fleets, ENGGFS (92-05), SCOGFS (98-05) and IBTS Q1 contribute to survivor estimates in the final year.

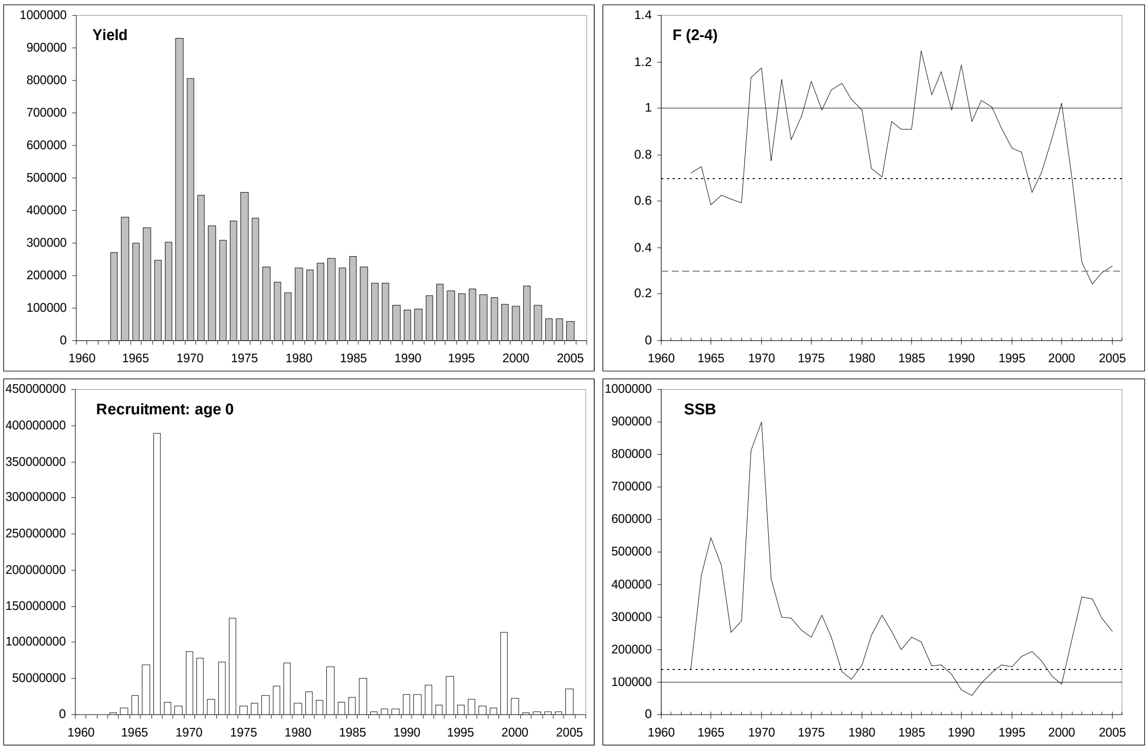


Figure 13.3.5.3 Haddock in Sub-Area IV and Division IIIa. XSA final assessment: Summary plots. The dotted horizontal lines indicate Fpa (top right plot) and Bpa (bottom right plot), while the solid ones indicate Flim (top right plot) and Blim (bottom right plot). The dashed line in the top right plot indicates F(2-4)=0.3, the current management plan target.

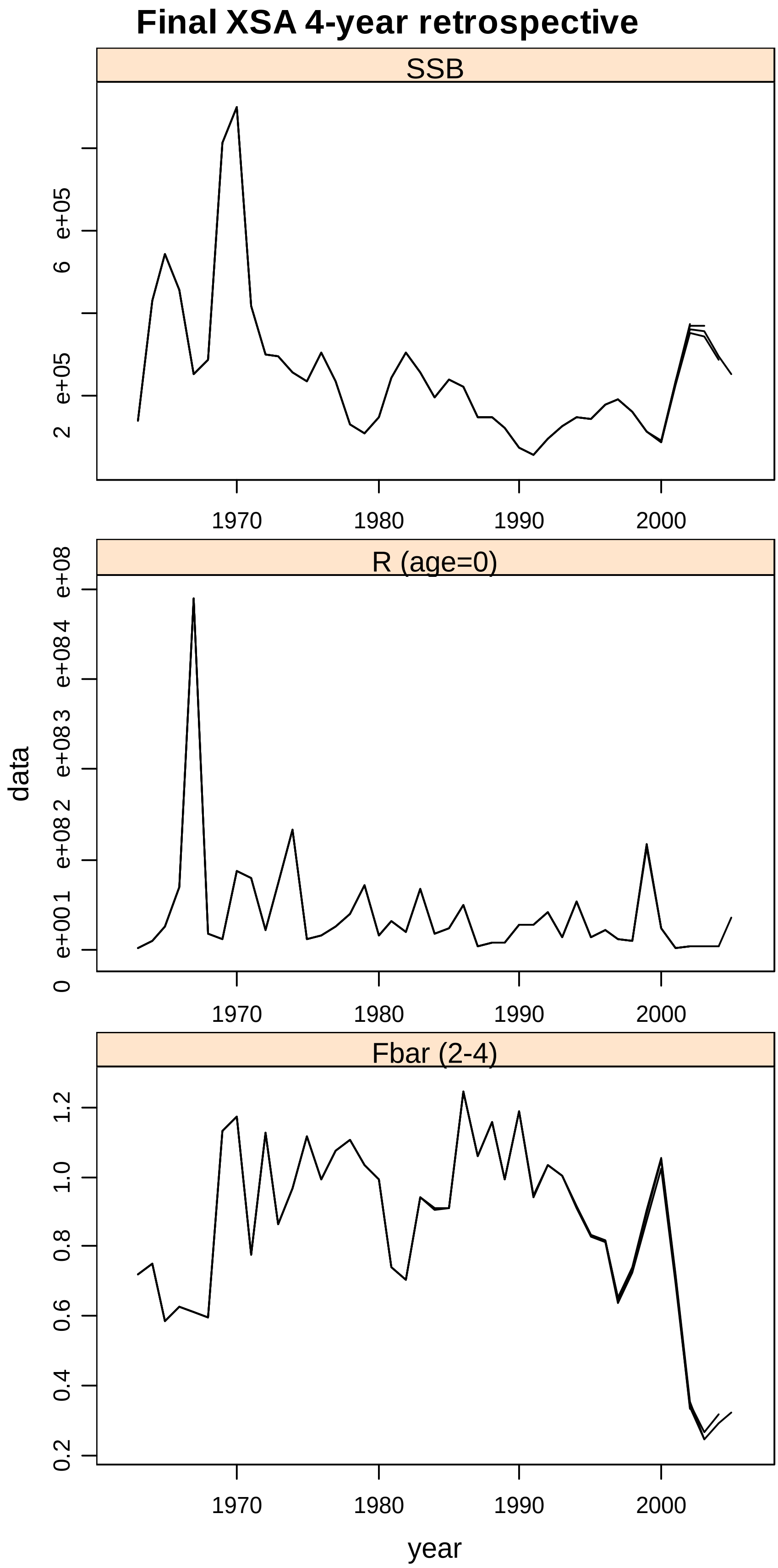


Figure 13.3.5.4 Haddock in Sub-Area IV and Division IIIa. XSA final assessment: retrospective patterns (last 4 years).

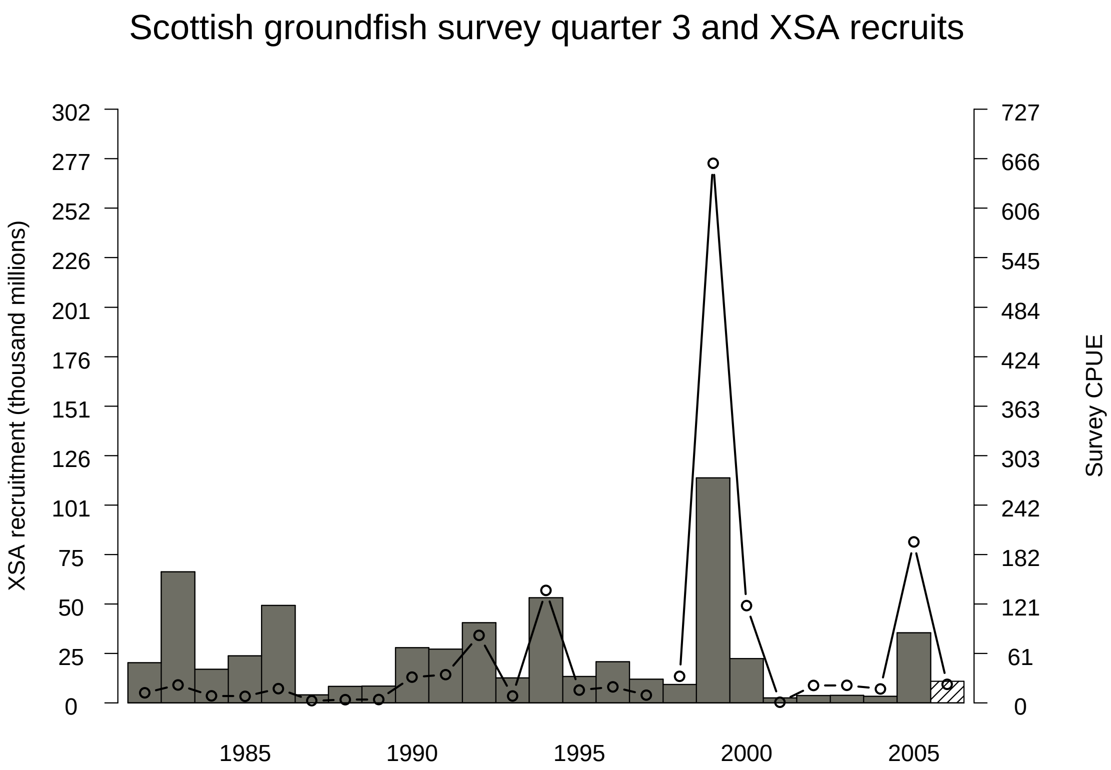


Figure 13.5.1 Haddock in Sub-Area IV and Division IIIa. Scottish groundfish survey CPUE for age 0 in quarter 3 (line, split for 1982-1997 and 1998-2006) compared to estimates of recruits at age 0 from the final XSA run (bars shaded grey), with the recruitment for 2006 (estimated using RCT3) taken forward in the short term forecast, shaded with a hashed pattern.

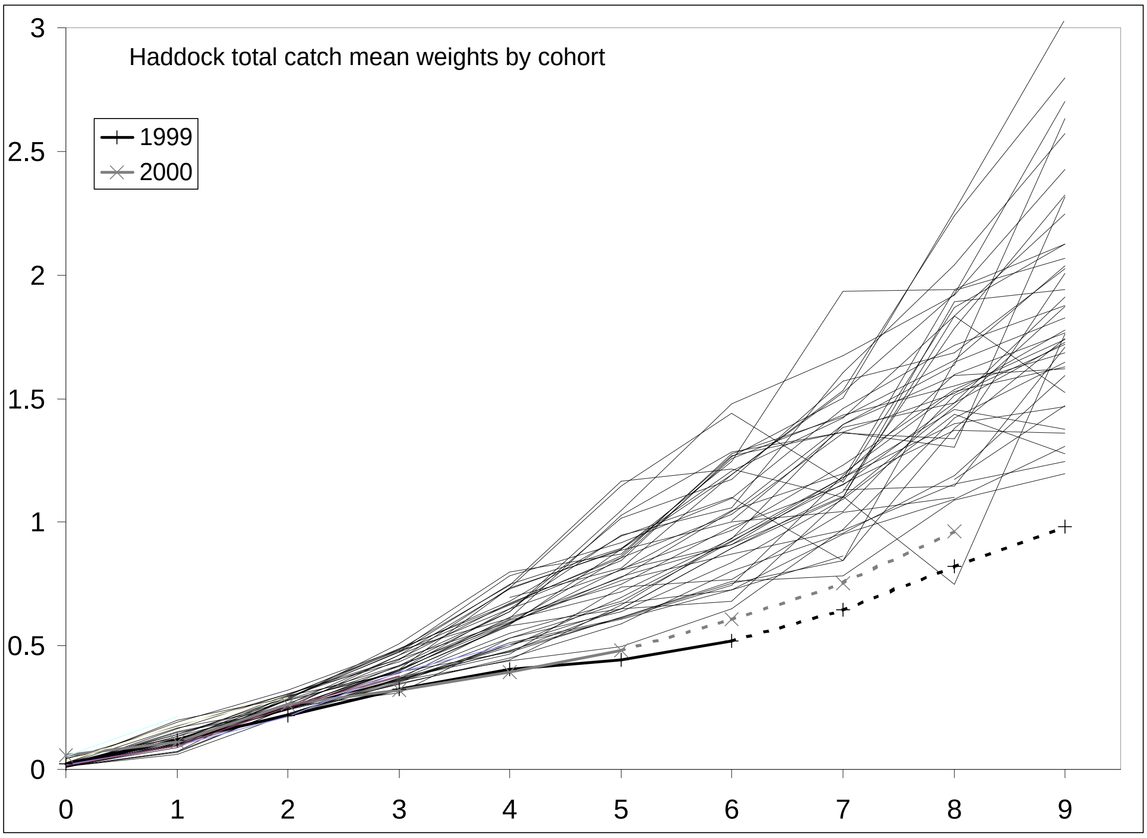


Figure 13.6.1 Haddock in Sub-Area IV and Division IIIa. Mean stock weights-at-age from the total catch by year class, with the 1999 and 2000 year classes indicated with + and × symbols respectively. The broken line indicates the predicted growth of these year classes using mean proportional increments (e.g. to predict the weight of the 1999 year class at age 7, ratios of w7/w6 are calculated for all cohorts for which this information is available, and the mean of these ratios is applied to the weight of the 1999 year class at age 6).

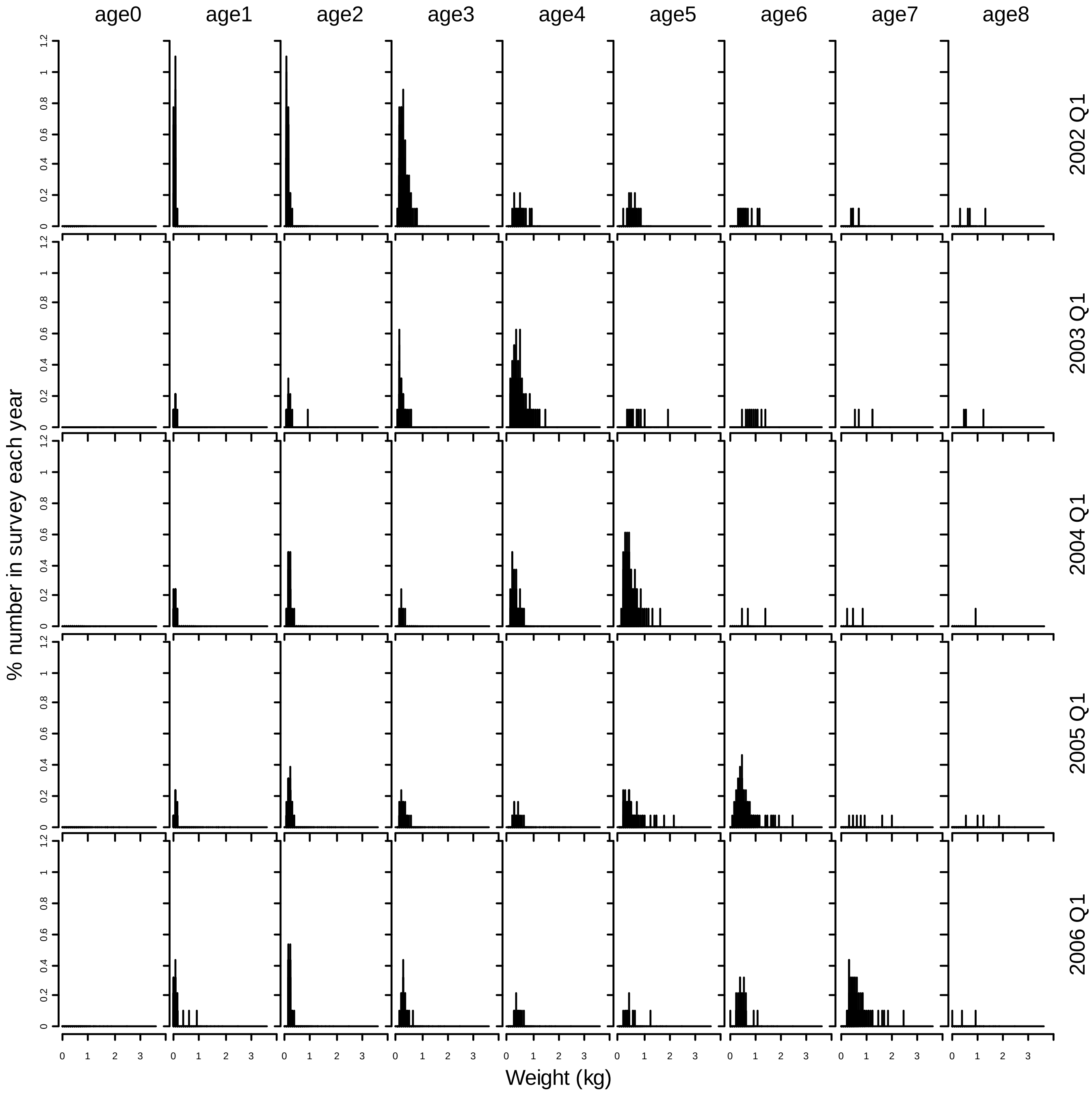


Figure 13.6.2 Haddock in Sub-Area IV and Division IIIa. Frequency distributions for the observed weight-at-age from the Q1 Scottish groundfish survey.

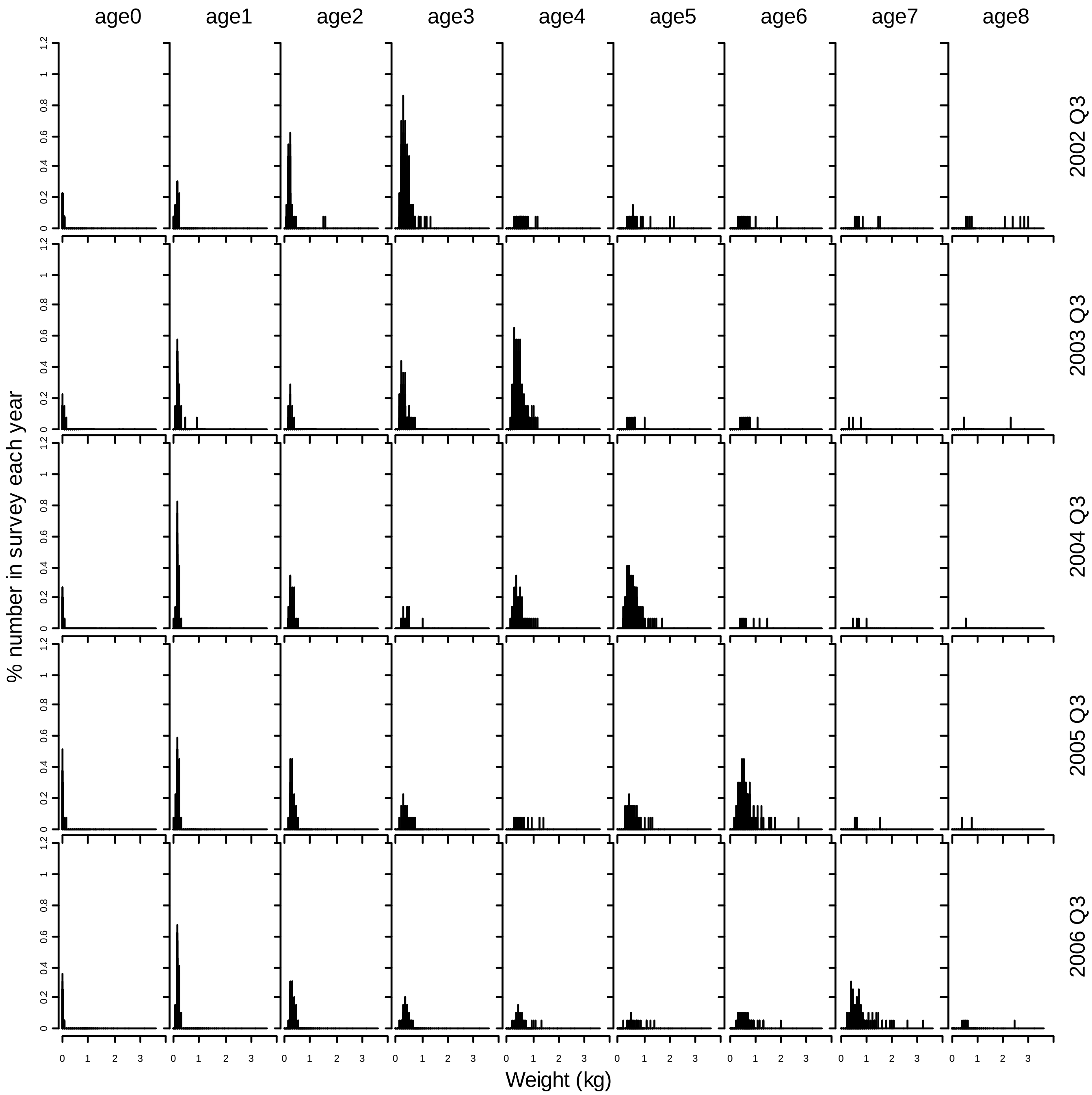


Figure 13.6.3 Haddock in Sub-Area IV and Division IIIa. Frequency distributions for the observed weight-at-age from the Q3 Scottish groundfish survey.

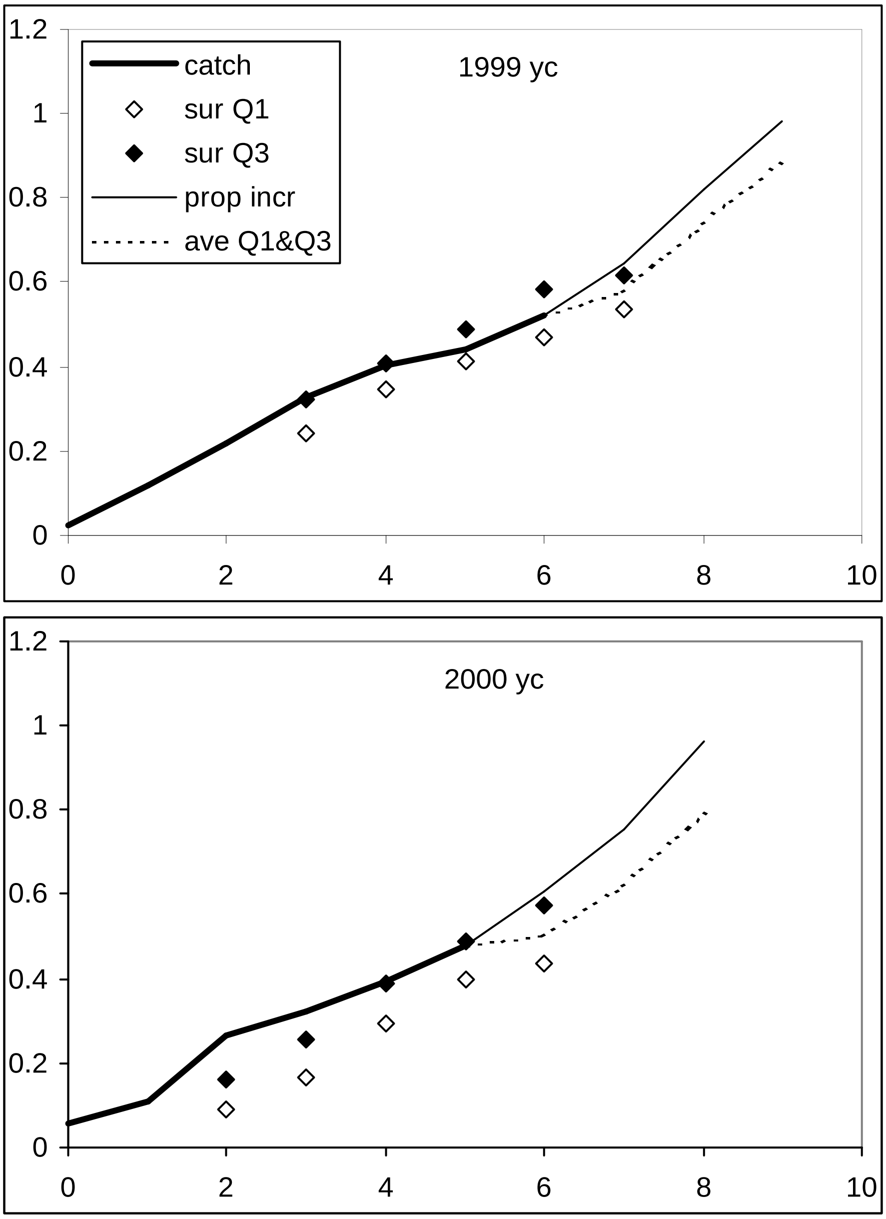


Figure 13.6.4 Haddock in Sub-Area IV and Division IIIa. Stock weight prediction options for the 1999 and 2000 year classes. The thick solid lines are observed stock weights-at-age from the total catch, while the open and solid diamonds are observed weights-at-age from the Q1 and Q3 Scottish groundfish surveys respectively, which are the medians from the corresponding plots in Figures 13.6.2-3. The thin solid line predicts future weights-at-age on the basis of proportional increments, as in Figure 13.6.1, while the broken line uses an average of the observed survey values in 2006 (indicated by the right-most diamonds) for the first year of the prediction, then applies proportional increments, as before, for subsequent years. Weights are given as kg.

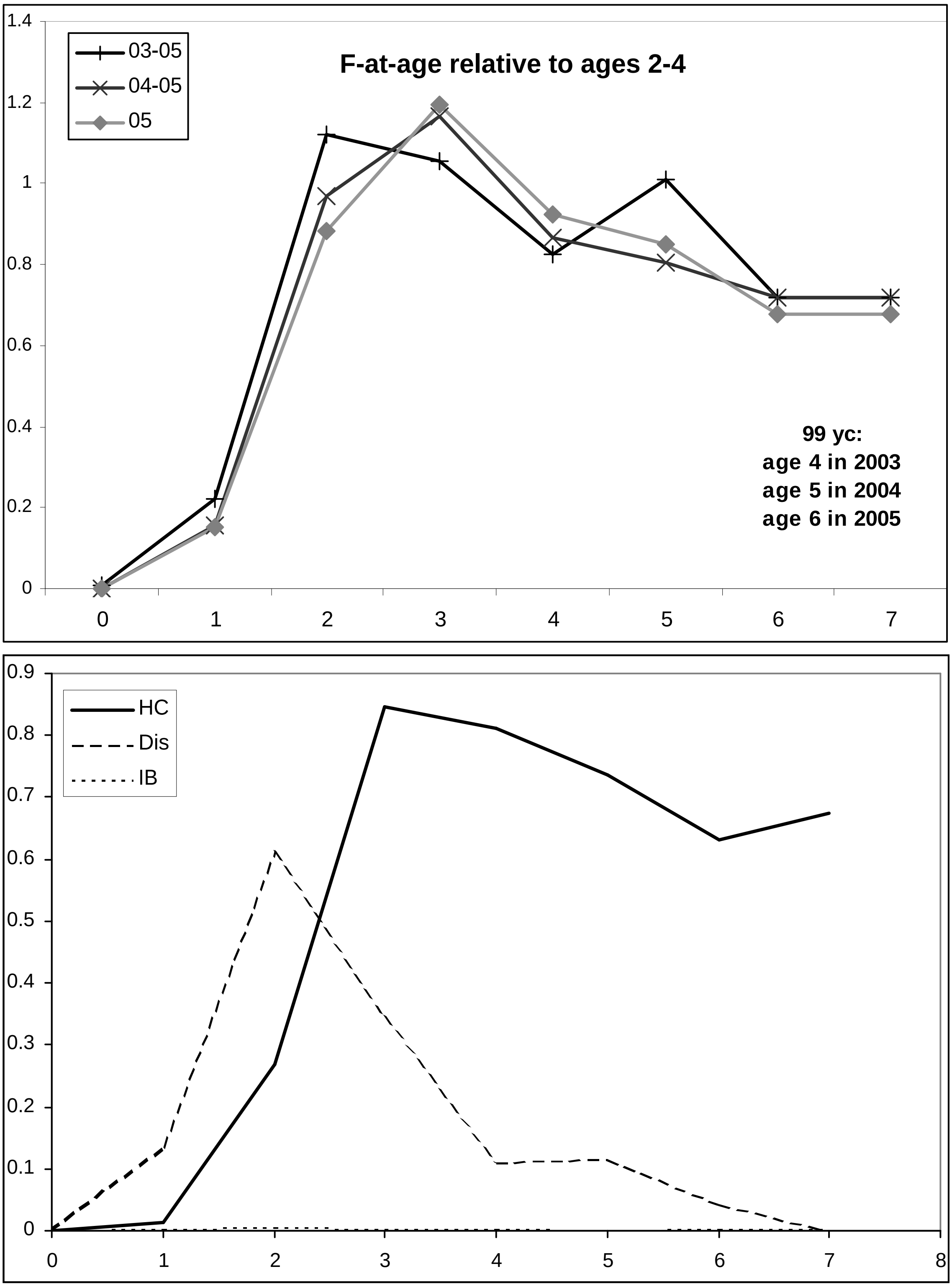
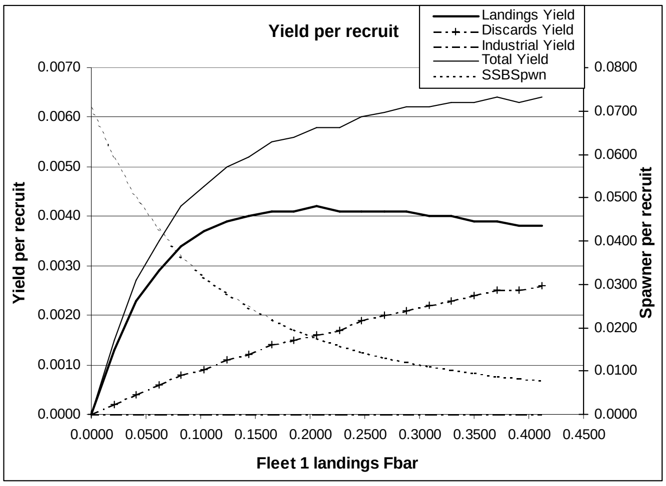
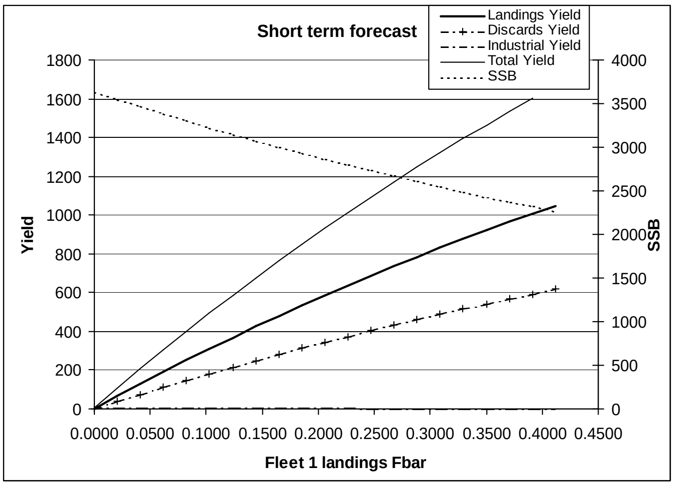


Figure 13.6.5 Haddock in Sub-Area IV and Division IIIa. Exploitation patterns for three averaging options (top panel), and with the 2005 exploitation pattern split into the various fleet components (bottom; HC=human consumption, Dis=discard, IB=industrial bycatch).





MFYPR version 2a
Run: had4_
Time and date: 00:50 14/09/2006

Reference point	F multiplier	Absolute F
Fleet1 Landings Fbar(2-4)	1.0000	0.2059
FMax	1.0126	0.2085
F0.1	0.6138	0.1264
F35%SPR	0.6972	0.1435

Weights in kilograms

MFDP version 1a
Run: had4_A_
Time and date: 08:31 13/09/2006
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

Input units are *10-5 and kg - output in hundred tonnes

Figure 13.6.6 Haddock in Sub-Area IV and Division IIIa. Results from the yield per recruit analysis and short term forecast.

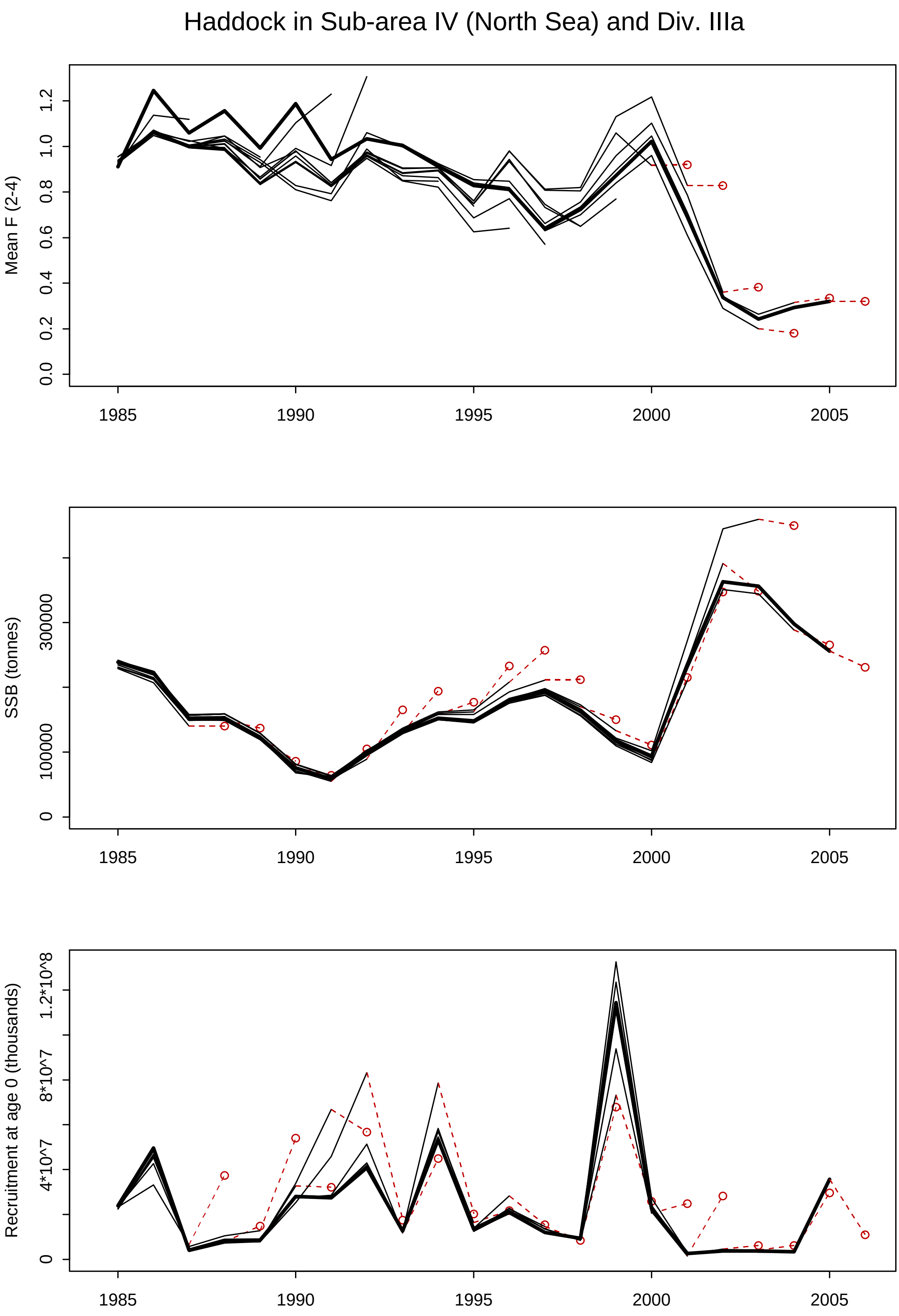


Figure 13.10.1 Haddock in Sub-Area IV and Division IIIa. Historical performance of the assessment.

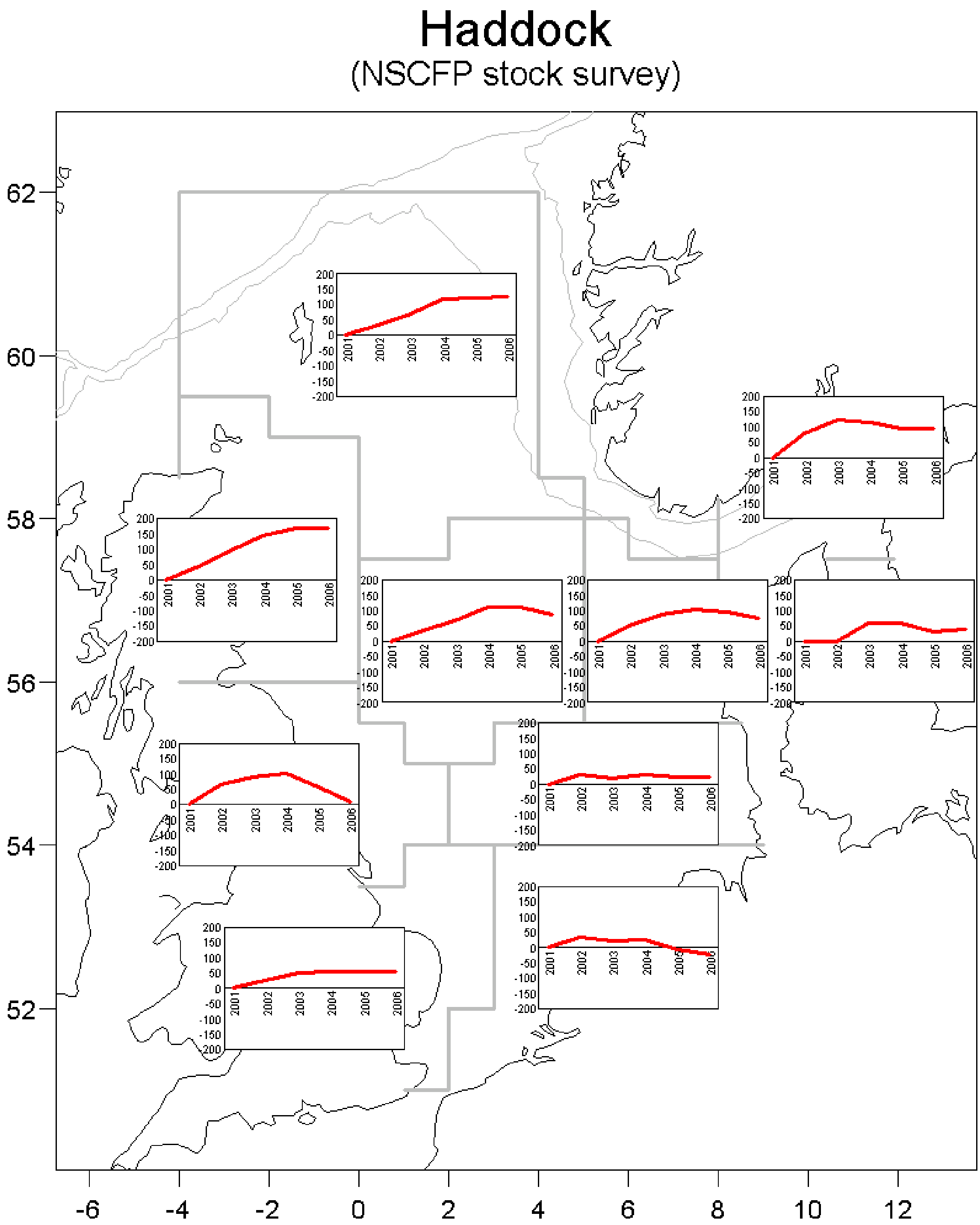


Figure 13.11.1 Haddock in Sub-Area IV and Division IIIa. Results of the North Sea fishermen survey.

14 Cod

Since 1996, this assessment has related to the cod stock in the North Sea (Sub-area IV), the Skagerrak (Division IIIa) and the eastern Channel (Division VIIa). Prior to 1996 cod in these areas were assessed separately.

Due to its very poor state, this stock is classified as an “observation” stock by ICES with the consequence that an update assessment is not considered appropriate. Previously, the assessment of this stock has also been reviewed by the North Sea Commission Fisheries Partnership (NSCFP). Its successor, the North Sea Regional Advisory Council (NSRAC), is not carrying out such a review this year.

14.1 General

14.1.1 Ecosystem aspects

Cod are widely distributed throughout the North Sea. Scientific survey data indicate that young fish (ages 1 and 2) have historically been found in large numbers in the southern part of the North Sea. Adult fish are located in concentrations of distribution in the Southern Bight, the north east coast of England, in the German Bight, the east coast of Scotland and in the north-eastern North Sea. As stock abundance fluctuates, these groupings appear to be relatively discreet but the area occupied has contracted. During the last three years, the highest densities of 3+ cod have been observed in the deeper waters of the northern North Sea and in the central North Sea.

A genetic survey of cod in European continental shelf waters using micro-satellite DNA detected significant fine scale differentiation suggesting the existence of at least 3-4 genetically divergent cod populations, resident in the northern North Sea off Bergen Bank, within the Moray Firth, off Flamborough Head and within the Southern Bight (Hutchinson et al., 2001). As is typical of marine fishes, the level of detectable genetic differentiation among these populations was low, which is to be expected from the large population sizes and high dispersal potentials. The biological significance of such low differentiation is often questioned in part because the temporal stability of the observed patterns is generally unknown and where different studies exist these have sometimes provided conflicting results. This new genetic evidence is largely consistent with the limited movements suggested by tagging studies (ICES-NSRWG 1971).

Available information indicates that spawning takes place from December through to April, offshore in waters of salinity 34-35 ‰. Around the British Isles there is a tendency towards later timing with increasing latitude. Cod spawn throughout much of the North Sea but spawning adult and egg survey data and fishermen’s observations indicate a number of spawning aggregations. It is not yet possible to quantify long-term changes in the use of spawning grounds. Limited data available do suggest a contraction in significant spawning areas, beginning with the loss of sites at Great Fisher Bank and Aberdeen Bank by the 1980s, and more recently from other coastal spawning sites around Scotland and in the Forties area. The information required will soon be available as in 2004 an international consortium comprising England, Scotland, Netherlands, Germany, Denmark and Norway conducted an ichthyoplankton survey covering the North Sea in order to comprehensively survey the distribution of cod and plaice spawning (Fox et. al. 2005). Preliminary results indicate that the recent distribution of stage I cod eggs were located around the southern and eastern edge of the Dogger Bank, in the German Bight, off the Moray Firth and to the east of the Shetland Isles; a distribution consistent with historic information. Further results from the study will be published as the analysis is completed.

In recent years much has been discussed about the possibility of large scale shift of cod distributions northwards within the North Sea caused by climate change. The arguments state that cod, preferring cooler temperatures, have moved north away from a warming North Sea. A working paper presented to WGNSSK at its 2003 meeting (Turrell & Bannister, 2003) analysed the oceanographic evidence for this hypothesis and found that it was contrary to the available information. Briefly, it concluded that owing to the effect of the Atlantic water flowing past the northern boundary of the North Sea, the North Sea has rather a unique internal ocean climate. In the winter, water temperatures increases further north, they are not cooler. Hence if fish move according to some temperature preference, seeking cooler water, they will move south in the winter in the North Sea.

More recently Perry et al (2005) analysed the shift in centres of population for 36 North Sea fish species, and for 20 of these, they also examined the movement of southerly or northerly range limits. The study examined fish distributions from long-term trawl survey data in relation to North Sea temperatures, general climatic patterns, the influence of the Gulf Stream, and the relative abundances of northerly and southerly species of zooplankton. The authors found a correlation between the rise of temperature of the North Sea and a northwards shift of the centre of populations of fish such as cod and a southwards movement of other species. The North Sea cod’s centre of population has shifted 117 km towards the Arctic while the haddock’s southern boundary has also moved 105 km north.

In the case of cod the Bannister and Turrell (2003) and the Perry et al (2005) studies appear to contradict each other. However, Perry et al (2005) did not examine the effects of spatial differences in effort distribution and the fishing mortality to which the commercially exploited fish stocks had been subjected and therefore unbalanced depletions of the local concentrations described by Hutchinson et al (2001) cannot be excluded as a cause of the distribution shifts.

Cod are predated upon by a variety of species through its life history. SGMSNS (ICES-SGMSNS 2005) estimated predation mortalities using MSVPA (Multispecies Virtual Population Analysis) with diet information largely derived from the Years of the Stomach databases. Long-term trends have been observed in several partial predation mortalities with significant increases for grey gurnard and grey seals.

MSVPA identified grey gurnard as a significant predator of 0-group cod. The abundance of grey gurnard (as monitored by IBTS) is estimated to have increased in recent years resulting in a rise in estimated predation mortality from 0.77 to 2.12 between 1991 and 2003. A degree of caution is required with these estimates as they assume that the spatial overlap and stomach contents of the species has remained unchanged since 1991. Given the change in abundance of both species this assumption is unlikely to hold and new diet information is required before these predation mortalities can be relied upon.

Several other predators contribute to predation mortality upon 0-group cod, whiting and seabirds being the next largest components.

Grey seals are the major source of predation mortality on older (3+) cod with values currently estimated to be around 0.13 having risen from 0.74 in 1991. The main reason for the rise in partial predation mortality is due to an increase in grey seal numbers, assumed to be 6% per year. There is currently a great deal of uncertainty as to total grey-seal population numbers in the North Sea. The 6% per year increase in grey-seal numbers no longer seems to be the case as recent indications are that population growth may now be levelling off. New population estimates were obtained and introduced to MSVPA for the years 2001, 2002, 2003. As with the gurnards the dietary information for seals is quite old and new dietary information is due shortly which may result in a re-evaluation of the relatively high M2 values for seals on cod.

14.1.2 Fisheries

Cod are caught by virtually all the demersal gears in Sub-area IV and Divisions IIIa (Skagerrak) and VIId, including beam trawls, otter trawls, seine nets, gill nets and lines. Most of these gears take a mixture of species, but in some of them cod are considered to be a by-catch, for example in beam trawls targeting flatfish and in others the fisheries are directed mainly towards cod, for example some of the fixed gear fisheries. The fisheries catching cod are described in more detail in Section 2.1.1.

Technical Conservation Measures

ICES-WGFTFB (2006) reported on changes in fishing practices and new technical conservation measures introduced into the North Sea fisheries in 2005. The information provided in the reports relevant to the cod fisheries in the North Sea is repeated below. The report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. It did not cover fully all fleets engaged in North Sea fisheries; information was obtained from Denmark, Scotland, England, Belgium, Netherlands, Sweden and Norway.

Fuel prices - Increasing fuel prices are having an effect in reducing effort. 2005/2006 has seen a shift from twin to single trawl by many boats in the Scottish demersal mixed fishery sector – North Sea, IVa, Fladen grounds Nephrops and whitefish fisheries; some boats are changing to pair seine/trawl in the same sector to reduce fuel costs and to minimize gear damage. Norwegian offshore demersal fish trawling fleet operators are either remaining in port or switching to the shrimp fishery. In addition to targeting high aggregations, vessels are also adjusting practice to maximise revenue obtained from by-products, typically targeting fish with a high roe or liver (oil) content.

There are visible changes in effort in the Danish industry with effort is being shifted between areas (North Sea and Skagerrak/Kattegat) by the trawl and seine sectors of the Danish fleet without this being visible/changing the overall picture of the total effort allocation on methods and areas. The changes in fleet dynamics are being driven by a variety of underlying mechanism of biological, economical and management related nature with the two major ones being I) the negative stock developments of cod and sand eel with attached regulatory initiatives and II) the ongoing general revision of the Danish management measures towards a system with individual quotas, where building up historical rights (in terms of a catch history) in as many geographical management units as possible is becoming increasingly important for the individual vessels.

There has been a large expansion in the squid fishery in the Moray Firth area. There has been an increase in effort from smaller <10m vessels, but also a number of larger vessels have switched from demersal fisheries for haddock and cod to squid fishery to avoid days at sea restrictions. These vessels are using small mesh size (40mm codends), which may result in bycatch/discard of young haddock and cod.

In order to reduce discards of cod in the mixed fishery primarily in the North Sea, a 140 mm window was introduced in the EU effort regulations from 2006. Using the window is granted with 1 day at sea / month. There has been some uptake of this measure in Denmark.

Fisher's perception of the cod stock

The fishers survey results were presented to the WG and comparison between the results and the assessment estimates is made in Section 14.4. Information was also provided to the group on the fishers perception the stock changes in Scotland and England.

In Scotland cod is mostly viewed as a high-value by-catch. The industry notes there is no directed Scottish cod fishery, although it may be the case that a 10-day trip spends 2 or 3 days focussing on cod (which is not a directed fishery in skippers' eyes). There is a strong view that cod are moving north – not from southern to northern North Sea, but on a much finer scale of 20 or 30 miles. The industry is reporting clear evidence of an improvement in cod abundance. Good landings of cod of all sizes were obtained during the first half of 2006 in the Shetland and Viking areas. A high level of 1-year old cod are appearing in discard samples from Shetland, as well as in the Fladen *Nephrops* fishery. In 2006 0-group cod have also been reported in substantial numbers in saithe and turbot stomachs. At the time of writing (September) the SFO (the largest Scottish producer organisation) had run out of cod quota for 2006. The quota availability for haddock and *Nephrops* is still good, so the fleet will continue to fish. Black landing and misreporting of over-quota cod is thought to be more difficult now following increased enforcement and the UK Buyers & Sellers regulation, so cod taken in the mixed fishery are likely to be discarded between now and the New Year.

In England there has been a reduction in effort in 2006 with several boats taking alternative work guarding rigs. Reports from potters and a Fisheries Science Partnership survey trip conducted by the industry indicated good cod recruitment from the 2005 year class in the north eastern North Sea. The industry is reporting an increasing abundance of cod of all sizes in area IV and VIId. Good numbers of sizeable cod (25kg fish) have been caught by trips gillnetting hard ground and wrecks towards the Dutch coast and they are reporting consistently high quality fish. All fisheries organisations are running low on quota for the remainder of the year and several have already closed for cod. There a perception that this holds for all countries as many are trying to buy quota. The industry fishing in areas IV and (independently) VIId have reported large parties of anglers fishing wrecks and landing substantial quantities of cod.

STECF WG

An STECF study group that met in ISPRA in May 2006 is currently collating the data and should report in October 2006. The data sets were provided to the North Sea WG for information and are discussed in Section 15.

14.1.3 ICES Advice

ICES ACFM advice for 2005:

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

According to the agreed management plan the TAC should not be more than 15% above the 2004 level, corresponding to 35 880 t (for Division IIIa and Subarea IV). This implies a 55% reduction in fishing mortality relative to 2003.

Indications are that this would allow a 30% increase in SSB from 2005 to 2006 and rebuilding to above Blim.

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

Targets reference points have not been agreed for this stock, but long-term yield would be maximized by fishing at approximately 20% of the recent levels of fishing effort.

Exploitation boundaries in relation to precautionary limits

Given the low stock size, recent poor recruitment, continued substantial catch [78 000 t in 2003], the uncertainty in the assessment, and the inability to reliably forecast catch, ICES recommends zero catch until the estimate of SSB is above

Blim or other strong evidence of rebuilding is observed.

Within the North Sea demersal fisheries ICES identified the stocks where spawning stock biomass is at reduced reproductive capacity (Cod in the North Sea, Eastern Channel and Skagerrak, Cod in Kattegat, Sandeel in the North Sea) and/or where fishing mortality indicates unsustainable harvesting of the stock (Cod in the North Sea, Eastern Channel and Skagerrak, Cod in Kattegat). Norway pout was being considered as a critical stock because the spawning stock is around Blim and recent recruitments of this short-living species have been very low. The North Sea mackerel component is still considered to be severely depleted and should be protected. These stocks were considered to be the overriding concerns in the management of all demersal fisheries. Therefore ICES advised that:

Mixed fishery advice:

for cod in Division IIIa, North Sea and Eastern Channel and cod in Kattegat, ICES recommends a zero catch;

for Norway pout in the North Sea ICES recommends that no fishing takes place;

for sandeel in the North Sea ICES recommends a in-year monitoring system or in the absence of that a reduction in fishing effort to 40% of the 2004 level.

Fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2005 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries with minimal bycatch or discards of cod;

Implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised; within the precautionary exploitation limits for all other stocks.

Where stocks extent beyond this area, e.g. into Division VI (saithe and anglerfish) or is widely migratory (Northern hake) taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;

The ICES ACFM advice for 2006

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

Due to the lack of a short-term forecast the exploitation boundaries in relation to existing management plans cannot be calculated.

Exploitation boundaries in relation to precautionary limits

Given the low stock size and recent poor recruitment, it is not possible to identify any non-zero catch which will be compatible with the Precautionary Approach. Rebuilding can only be achieved if fishing mortality is significantly reduced on a longer term.

Advice for mixed fisheries management

Demersal fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2006 be managed according to the following rules, which should be applied simultaneously:

- with minimal bycatch or discards of cod;
- Implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised;

- within the precautionary exploitation limits for all other stocks;
- Where stocks extend beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits.
- With minimum by-catch of spurdog, porbeagle and thornback ray and skate.

Mixed fisheries management options should be based on the expected catch in specific combinations of effort in the various fisheries taking into consideration the advice given above. The distributions of effort across fisheries should be responsive to objectives set by managers, which is also the basis for the scientific advice presented above.

Short-term implications

Outlook for 2006

With zero catch in 2006 in all fisheries, SSB in 2007 could be around $\boldsymbol{B_{lim}}$.

The single species fishing mortality and biomass reference points agreed by the EU and Norway are as follows:

B_{lim} = 70,000t; B_{pa} = 150,000t, F_{lim} = 0.86; F_{pa} = 0.65

14.1.4 Management

Management of cod is by TAC and technical measures. The agreed TACs for Cod in Division IIIa (Skagerrak) and Sub-area IV were as follows:

TAC(000t)	2003	2004	2005	2006
IIIa (Skagerrak)	3.9	3.9	3.9	3.3
IIa + IV	27.3	27.3	27.3	23.2

There is no TAC for cod set for Division VIId alone. Landings from Division VIId count against the overall TAC agreed for ICES Divisions VII b-k.

In 2005 the EU and Norway renewed their initial agreement from 1999 and *"agreed to implement a long-term management plan for the cod stock, which is consistent with the precautionary approach and is intended to provide for sustainable fisheries and high yield.*

Once the stock of cod has been measured for the current year and for the previous year as no longer being at risk of reduced reproductive capacity, the plan will come into operation on 1 January of the subsequent year.

The plan shall consist of the following elements:

1. *Every effort shall be made to maintain a minimum level of Spawning Stock Biomass (SSB) greater than 70,000 tonnes (B_{lim}).*

2. *Where the SSB is estimated to be above 150,000 tonnes the parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate that maximises long term yield. The parties agreed to use F=0.4 on appropriate age groups.*

3. *Where the rule in paragraph 2 would lead to a TAC which deviates by more than 15% from the TAC for the preceding year, the Parties shall fix a TAC that is neither more than 15% greater nor 15% less than the TAC of the preceding year.*

4. *Should the SSB of cod fall below 150 000t (B_{pa}) the Parties shall decide on a TAC that is lower than that corresponding to the application of the rules in paragraphs 2 and 3.*

5. *The Parties may where considered appropriate reduce the TAC by more than 15% compared to the TAC of the preceding year.*

6. *This plan shall be subject to triennial review, the first of which will take place before 1 January 2009, including appropriate adaptations to the target mortality rate specified in paragraph 2.*

The main changes between this and the plan of 1999 is the reduction of a target F to 0.4, and a limitation of the change of the TAC between years of 15%. ICES have not yet fully evaluated the consistency of the new management plan with the precautionary approach: interim work is presented in Section 16 of this report.

ICES considers that the reference points in the management plan are consistent with the precautionary approach, provided they are used as upper bounds on F and lower bounds on SSB, and not as targets.

The recovery plan adopted by the EU Council in 2004, is still to be fully implemented. Details of it are given in Council Regulation (EC) 423/2004:

Article 3. Purpose of the recovery plan: The recovery plan (...) shall aim to increase the quantities of mature fish to values equal to or greater than 150 000 t (Cod in the North Sea, Skagerrak and eastern Channel)

Article 4: Reaching of target levels. Where the Commission finds, on the basis of advice (...), that for two consecutive years the target level for any cod stock concerned has been reached, the Council shall decide by (...) to remove that stock from the scope of this Regulation (...)

Article 5: Setting of TACs. A TAC shall be set in accordance with Article 6 where the quantities of mature cod have been estimated by the STECF, in the light of the most recent report of ICES, to be equal to or above the minimum level of 70 000 t (Cod in the North Sea, Skagerrak and eastern Channel).

Article 6: Procedure for setting TACs. (1.) Each year, the Council shall decide (...) on a TAC for the following year for each of the depleted cod stocks. (2.) The TACs shall not exceed a level of catches which a scientific evaluation (...) has indicated will result in an increase of 30 % in the quantities of mature fish in the sea at the end of the year of their application, compared to the quantities estimated to have been in the sea at the start of that year. (3.) The Council shall not adopt a TAC whose capture is predicted (...) to generate in its year of application a fishing mortality rate greater than 0.65 (Cod in the North Sea, Skagerrak and eastern Channel). (4.) (...) (5.) Except for the first year of application of this Article: (a) where the rules provided for in paragraphs 2 or 4 would lead to a TAC which exceeds the TAC of the preceding year by more than 15 %, the Council shall adopt a TAC which shall not be more than 15 % greater than the TAC of that year; or (b) where the rules provided for in paragraphs 2 or 4 would lead to a TAC which is more than 15 % less than the TAC of the preceding year, the Council shall adopt a TAC which is not more than 15 % less than the TAC of that year.

Article 7: Setting TACs in exceptional circumstances. Where the quantities of mature fish of any of the cod stocksconcerned have been estimated by the STECF, in the light of the most recent report of the ICES, to be less than the quantities set out in Article 5, the following rules shall apply: (a) Article 6 shall apply where its application is expected to result in an increase in the quantities of mature fish at the end of the year of application of the TAC to a quantity

equal to or greater than the quantity indicated in Article 5; (b) where the application of Article 6 is not expected to result in an increase in the quantities of mature fish at the end of the year of application of the TAC to a quantity equal to or greater than the quantity indicated *in Article 5, the Council shall decide (...) on a TAC for the following year that is lower than the TAC resulting from the application of the method described in Article 6.*

Article 8. Fishing effort limitations and associated conditions. (1.) The TACs referred to in Chapter III shall be complemented by a system of fishing effort limitation based on the geographical areas and groupings of fishing gear, and the associated conditions for the use of these fishing opportunities specified in Annex V to Council Regulation (EC) No 2287/2003 of 19 December 2003 fixing for 2004 the fishing opportunities and associated conditions for certain fish stocks and groups of fish stocks, applicable in Community waters and, for Community vessels, in waters where catch limitations are required. (2.) Each year, the Council shall decide by a qualified majority, on the basis of a proposal from the Commission, on adjustments to the number of fishing days for vessels deploying gear of mesh size equal to or greater than 100 mm in direct proportion to the annual adjustments in fishing mortality that are estimated by ICES and STECF as being consistent with the application of the TACs established according to the method described in Article 6.

ICES has not evaluated the current cod recovery plan but a start to the process has been made in this report (see Section 16.2).

For 2006 Council Regulation (EC) No 51/2006 allocates different days at sea depending on gear, mesh size and catch composition (see Section 2.1.2 for a complete list).

14.2 Data available

14.2.1 Catch

Landings data from human consumption fisheries for recent years as officially reported to ICES together with those estimated by the WG are given for each area separately and combined in Table 14.1. The WG estimate for landings from the three areas combined in 2005 is 28.7 thousand tonnes, split as follows for the separate areas.

	2005 Landings (‘000 t)	TAC
IIIa(Skagerrak)	3.8	3.9
IV	23.9	27.3
VIId	1.0	Combined Subarea VII
Total	28.7	

WG estimates of landings indicate that the TACs for Subarea IV was not fully taken in 2005. This is in keeping with previous years.

Discard numbers-at-age were estimated for areas IV and VIId by applying the Scottish discard ogives to the international landings-at-age. Discard numbers-at-age for IIIa were based on observer sampling estimates. Although in some cases other nations’ discard proportions are available for a range of years, these have not been transmitted to the relevant WG data coordinator in an appropriate form for inclusion in the international dataset.

For cod in IIIa, IV and VIId, ICES first raised concerns about the mis-reporting and non-reporting of landings in the early 1990s, particularly when TACs became intentionally restrictive for management purposes. Some WG members have since provided estimates of under-reporting of landings to the WG, but by their very nature these are difficult to quantify. In terms of events since the mid-1990s, the WG suspects that under-reporting of landings may have been significant in 1998 because of the abundance in the population of the relatively strong 1996 year-class as 2-year-olds. The landed weight and input numbers at age data for

1998 were adjusted to include an estimated 3000 t of under-reported catch. The 1998 catch estimates remain unchanged in the present assessment.

For 1999 and 2000, the WG has no a priori reason to suspect that there was significant under-reporting of landings. However, the substantial reduction in fishing effort implied by the 2001, 2002 and 2003 TACs is likely to have resulted in an increase in unreported catch in those years. Anecdotal information from the fisheries in some countries indicated that this may indeed have been the case, but the extent of the alleged under-reporting of catch varies considerably. Since the WG has no basis to judge the overall extent of under-reported catch, it has no alternative than to use its best estimates of landings, which in general are in line with the officially reported landings. An attempt is made to incorporate a statistical correction to the reported landings data in the assessment of this stock, but the figures shown in Table 14.1 nevertheless comprise the input values to the assessment.

The by-catch of cod from the Danish and Norwegian industrial fisheries that was sent for reduction to fishmeal and oil in 2005 was 18 tonnes (Table 2.1.3).

Age compositions

Age compositions were provided by Denmark, Germany, England, France, the Netherlands, Norway, Sweden and Scotland (see Section 1.2.4).

Landings in numbers at age for age groups 1-11+ and 1963-2005 are given in Table 14.2. SOP corrections have been applied. These data form the basis for the catch at age analysis but do not include industrial fishery by-catches landed for reduction purposes, or discards. By-catch estimates are available for the total Danish and Norwegian small-meshed fishery in Sub-area IV (Tables 2.1.3 to 2.1.5) and separately for the Skagerrak (Table 14.1), but as in previous years, these data were not included in the assessment. During the last five years an average of 85% (83% in 2005) of the international landings in number were accounted for by juvenile cod aged 1-3.

Discard numbers-at-age are shown in Table 14.3. In IV and VIId values are derived from the application of Scottish and discard ogives to the international landings-at-age. Discard numbers-at-age for IIIa were based on observer sampling estimates. The proportions of the estimated total numbers discarded are plotted in Figure 14.1 and the proportion of the estimated discards for ages 1- 3, in Figure 14.2. Estimated total numbers discarded have been constant at around 50% since 1995. Historically, the proportion of numbers discarded at age 1 have fluctuated around 80% with no decline apparent after the introduction of the 120mm mesh in 2002 during the last three years it is estimated to be at 90%. At ages 2 and 3 discard proportions have been increasing steadily and at age 2 are currently estimated to be around 40% in 2005. Note that these observations refer to **numbers** discarded, not weight.

14.2.2 Weight at age

Mean weight at age data for landings, discards and catch, are given in Tables 14.4-6. Total catch mean values were also used as stock mean weights the values. Long-term trends in mean catch weight at age for ages 1-11 are plotted in Figure 14.3, which indicates that there have been short-term trends in mean weight at age and that the decline over the recent decade on ages 3-5 now seems to have stabilised. The data also indicate a slight downward trend in mean weight for ages 3-6 during the 1980'and 90's. Ages 1 and 2 show little absolute variation over the long-term.

14.2.3 Maturity and natural mortality

Values for natural mortality and maturity are given in Table 14.7; they are applied to all years and are unchanged from those used in recent assessments. The natural mortality values are model estimates from a multi-species VPA fitted by the Multi-species WG in 1986. The maturity values were estimated using the International Bottom trawl Survey series 1981-1985. These values were derived for the North Sea and are equally applied to the three stock components.

14.2.4 Catch, effort and research vessel data

Reliable, individual, disaggregated trip data were not available for the analysis of CPUE. Since the mid-to-late 1990s, changes to the method of recording data means that individual trip data are now more accessible than before; however, the recording of fishing effort as hours fished has become less reliable as it is not a mandatory field in the logbook data. Consequently, the effort data, as hours fished, are not considered to be representative of the actual deployed fishing effort.

The WG has previously argued that although they are in general agreement with the survey information commercial CPUE tuning series should not be used for the calibration of assessment models due to potential problems with effort recording and hyper-stability (ICES-WGNSSK 2001) and also changes in gear design and usage, as discussed by ICES-WGFTFB (2006). Therefore, although the commercial fleet series are updated and presented, only survey and commercial landings and discard information are analysed within the following assessment.

Four survey series are available for this assessment:

- English third-quarter groundfish survey (EngGFS), ages 0-7, which covers the whole of the North Sea in August-September each year to about 200m depth using a fixed station design of 75 standard tows. The survey was conducted using the Granton trawl from 1977-1991 and with the GOV trawl from 1992-2003. Only ages 1–6 are used for calibration, as catch rates for older ages are very low. The age-composition data for 2006 from this survey were not available at the WG meeting. At its 2003 meeting, the WG split this survey into 2 periods based on the timing of the change from the Granton to the GOV trawl (ICES-WGNSSK 2003). This was due to a step change in total mortality (Z) that was implied by the survey. This was coincident with the change in gear despite the inclusion of a GOV-to-Granton conversion factor being applied, and interpreted as a change in catchability at age 1 with the change in gear. Consequently, the WG split the survey series into two for calibrating catch data, and this has been maintained this year. This survey covers the whole of the North Sea in August-September each year to about 200m depth, using a fixed station design of 75 standard tows and the GOV trawl.
- Scottish third-quarter groundfish survey (ScoGFS): ages 1–8. This survey covers the period 1982–2006. Only ages 1–6 are used for calibration, as catch rates for older ages are very low. This survey is undertaken during August each year using a fixed station design and the GOV trawl. Coverage was restricted to the northern part of the North Sea until 1998, corresponding to only the northernmost distribution of cod in the North Sea. Since 1999? it has been extended into the central North Sea. For the purpose of this assessment, the indices used correspond to the area of the pre-1998 change, ie. the indices since 1997 are calculated by excluding the “new” central North sea stations in the survey. The ScoGFS has also used a new gear and vessel since 1999. The catch rates as presented are corrected for the change in vessel and gear, on the basis of comparative trawl haul data (Zuur et al 2001).
- Quarter 1 international bottom-trawl survey (IBTSQ1): ages 1–6+, covering the period 1976–2006. This multi-vessel survey covers the whole of the North Sea using fixed stations of at least two tows per rectangle with the GOV trawl.
- Quarter 3 international bottom-trawl survey (IBTSQ3): ages 1–6+, covering the period 1976–2005. This multi-vessel survey covers the whole of the North Sea using fixed stations of at least two tows per rectangle with the GOV trawl. The Scottish and English third quarter surveys contribute to this index.

Maps showing the IBTS distribution of cod are shown in Figure 14.4 (ages 1-3+). The recent dominant effect of the size and distribution of the 1996 and, to a lesser extent, the 1999 year-classes are clearly apparent from these charts. As expected from the 0 group indices from the previous years Scottish and English quarter 3 surveys, reported last year, in 2006 there has been a stronger recruitment of 1 group fish from the 2005 year class. However, fish of older ages have continued to decline due to the very weak 2000, 2002 and 2005 year classes. The abundance of 3+ fish is currently at its lowest level.

The complete data available for calibrating the catch-at-age analysis are shown in Table 14.8a-g. These tables include the addition of discard estimates to the fleet landings-at-age.

14.2.4.1 Survey consistency

At the 2004 meeting of this WG (ICES-WGNSSK 2004) a benchmark review examined each of the sources of information available for assessment of the status of the North Sea cod stock. The recorded landings data and survey series were screened for sampling errors; the time series of surveys were examined for correlation between and within series and used independently of the catch data as indices of the stock dynamics; finally a catch at age model was fitted to the catch and survey series in order to derive a time series of stock and exploitation estimates.

The analysis showed surveys and commercial series are mostly concordant at ages 2 and 3; thereafter the relationships between survey and commercial series become noisier, but there is still a reasonable degree of concordance between the Scottish survey and the two English commercial series up to age 6. Between the commercial series alone, the agreement within English fleets and within Scottish fleets is generally more consistent than between the English and Scottish fleets.

At last years meeting assessment (ICES-WGNSSK 2005)models fitted to the IBTS Q1, English and Scottish groundfish survey data estimated differing trends in recent fishing mortality. The English and IBTS surveys estimated a decline in mortality, the Scottish survey a sharp increase. It was hypothesised that the contraction of the cod stock distribution in the North Sea could be resulting in regional differences in the catch rates from some surveys. Surveys covering a wider area would therefore present a more representative picture of the stock dynamics. The WG decided that without further analysis to resolve the differences in signal, the surveys could not be used to provide management advice on mortality rates only biomass and spawning biomass trends.

Parker-Humphries and Darby (WD 24) presented the findings from an analysis of the third quarter survey data from the England and Scotland. A bootstrap procedure was used to examine the variability of the English survey indices. At ages 1 – 4 coefficients of variation from the bootstrap were in the region of 20% increasing with age such that at age 5, the inherent noise in the sampling of recent estimates was substantial and at the current low sampling levels, ages 5 and above should be used with caution in fitting assessment models. Spawning stock biomass indices were derived from each bootstrap index and the variance in the time series illustrated that the stock index is significantly below the levels recorded during the early 1990’s at a time when the stock was estimated to be at Blim. The method will be applied to data from other countries in order to examine the variance and utility of the survey data from other surveys and the overall combined indices.

Parker-Humphries and Darby (WD 25) also examined data from the Scottish third quarter survey in order to establish whether there were any spatial effects in the survey that could have resulted in the estimate of a substantially increased mortality rate at the older assessment ages noted by the previous years WG. In 2004 a station with extremely high survey catch rates at ages 2,3,4 was recorded from the east coast of Shetland. All other stations in the survey recorded substantially low catch rates. Parker-Humphries and Darby calculated Scottish survey indices for the years 1991 - 2004 using a roundfish area weighted average. The calculated indices showed good correlation with the data submitted to the WG but there is an unresolved scaling difference. Relatively high index values were calculated for ages 3, 4 and 5 in 2004. If the high catch station was removed from the raising procedure the index values for those ages were consistent with the strength of the year classes in the preceding and subsequent years. Survey Z values calculated with the high catch station included showed a strong reduction in mortality in 2004 followed by high mortality rate in 2005. Removing the station from the estimate resulted in Z values that were consistent with previous years.

The WG discussed the approach used by Parker-Humphries and Darby and agreed that it would be *ad hoc* and statistically inappropriate to remove the station from the calculation of the Scottish index. After reviewing the information available on survey catch rates and spatial distribution the WG decided that because of the low current low catch rates recorded by the English and Scottish surveys and the potential for noise at the oldest ages due to low sampling levels, the utility of the IBTS quarter 3 survey in the assessment model fits should be investigated with the aim of using the IBTS quarter 1 and 3 surveys in the final assessment. The Scottish and English surveys form part of the data contributed to the IBTS quarter 3 survey and therefore cannot be used in conjunction with that time series.

Figures 14.5 – 14.6 present the between adjacent age group pair-wise scatter plots and time series of standardised log indices for the IBTSQ1 and Q3 roundfish surveys. In general IBTS quarter 1 shows good consistency in the estimates between all ages, with a gradual increase in the regression noise at older ages, but maintenance of the signal. Similarly, IBTS quarter 3 has good correlation at all age combinations apart from 4/5. After reviewing the correlations the WG agreed to use the IBTSq1 data in full and the IBTSq3 survey ages 1 – 4 in the fitting of the assessment models.

14.3 Data analyses

14.3.1 Reviews of last year’s assessment

In 2005 the ACFM review group raised similar concerns to those of the WG in that:

- There was extreme sensitivity of the assessment estimates of fishing mortality to the final year of English and Scottish groundfish survey data. When considered separately, these are relatively sparse surveys and seem to have very low sampling rates now for cod. Rates are better in the collated surveys (IBTS Q1 and Q3). Low sampling rates mean that conclusions about recent mortality are driven by the absence or presence of very small numbers of mature fish.
- The review group noted that reported landings are still considered unreliable, so a survey-based method (such as B-ADAPT) must be used. However, the review considered that such an analysis could only be used to provide advice on abundance, not mortality, given the problems outlined above. For this reason no forecast was agreed.

The study presented to the review group by Parker-Humphries and Darby (WD 24) identified the data sampling noise that resulted in the noted differences between the Scottish groundfish and other surveys and were been addressed by fitting the assessment model to the IBTS quarter 3 survey series.

The development of B-ADAPT has continued and a bootstrapped assessment and forecast procedure developed. ACFM have previously based their advice for the Irish Sea cod on the assessment and forecast approach and the Methods WG have reviewed and recommended use of the method for situations in which catch at age data are uncertain, at their most recent meeting (ICES-WGMG 2006).

14.3.2 Exploratory catch-at-age-based analyses

Separable VPA

As in previous years, a Separable VPA model was used to examine the structure of the catch numbers at age data before its use in a catch at age analysis. The results of the model fit are within ICES files. The residuals in the most recent years indicate no strong patterns or large values for ages less than age 10. The fitted model indicates that the age structure of the recorded landings has been relatively consistent in recent years and that the catch data are not subject to large random or process errors that would lead to concerns as to the way in which the recorded catch has been processed.

Catch curve cohort trends

Figure 14.7 presents the log catch curve plot for the catch at age data. Through time there is an increase in the slope of the cohort plots indicating faster removal rates or high total mortality. In the most recent years there has been a gradual decrease in the slope at the youngest ages – a sign of decreased mortality rates. Figure 14.8 plots the slope of a regression fitted to the ages 2 – 4; the ages range used as the reference for mortality trends. The decrease in the negative slope (upwards trend) indicates that total mortality rates at the ages comprising the dominant ages within the fishery are declining.

B-ADAPT

Single fleet runs of the B-ADAPT model were fitted to the IBTSQ1 and IBTSQ3 groundfish surveys in order to examine the time series of estimates derived from independent survey data sets. Two technical problems have to be addressed when fitting the model to the IBTSq3 data series.

- The model was designed to be fitted to a time series during which the catch data was at first considered to be reliable and then have uncertainty in the level of catches but not the catch age structure. This is the case for the IBTSq1 survey and was the case for the Scottish survey. The IBTSQ3 survey has not been collated for the full time series of years over which the uncertainty in the estimated North Sea cod catch data has occurred. Therefore in order to use the survey data to estimate the most recent mortality trends the estimates of unrecorded mortality from model fits using IBTSQ1 and Q3 surveys were applied to the catch at age data for the years 1993 – 1999 and the model used to estimate unallocated mortality in 2000 – 2005.
- The age range of the IBTSq3 series was truncated to ages 1 – 4 therefore a 6+ plus group model fit is required.

Figures 14.9 – 14.13 plot the time series of expected values and bootstrap percentiles of losses from the stock, fishing mortality, SSB and recruitment for the fits to the IBTS quarter 1 and quarter 3 data. The estimates from a model fitted in which the catch data are treated as exact are also presented.

The estimated removals are higher than the recorded catches in the fits to both the IBTS and survey series. The pattern of discrepancies between estimated removals and recorded catch estimated from the IBTS quarter 1 series shows consistent trends between surveys and with the previous years model fit. The differences increase from 1995 – 1996, followed by a drop in 1997/8, when the 1996 year class arrived in the fishery and then increasing again in 2001 and 2003.

The SSB estimates from the B-ADPAT model estimating removals from the stock are higher than those assuming exact catches. The time series is consistent between surveys and with the previous years estimates.

The estimates of recent fishing mortality from the fits to the two survey series are consistently higher than the values estimated with no bias parameter but have the same downwards trend. In both series fishing mortality is more uncertain in the final year. It was noted by Darby (2004) that when the model was fitted to series including survey data collected after the final catch year, the uncertainty associated with the final year estimates is reduced. This is the case for the IBTSQ3 survey at the time of this WG when compared to the IBTSQ1 as the latter incorporates survey data recorded in 2006.

For both surveys there are years in which the expected value of average fishing mortality lies outside the 75th or 25th bootstrap percentiles. This arises as a result of noise in the fitted survey residuals especially at ages 1 and 5. The bootstrapping procedure was incorporated to reduce the influence of such sampling noise on the year to year variation in the estimated time series. and therefore the WG adopted the time series of percentiles, which incorporate the uncertainty in the model estimates, as the appropriate time series for presentation of management parameter trends. The median of the bootstrapped estimates from the IBTSq3 survey indicate a decline in fishing mortality to around 0.78, the IBTSq1 survey indicates a similar decline in recent years to around 0.6 but has a larger difference between the expected value and the median in the final year.

The recruitment patterns are consistent between model fits, the fits estimating additional removals indicate higher levels in recent years, but the average is still estimated to be well below historic values.

14.3.3 Exploratory survey-based analyses

Log catch per unit effort curves for each of the four survey series are plotted in Figure 14.14 they indicate the rapid decline in the age classes with time. The noise at the oldest ages in the IBTSq3 and Scottish surveys are apparent.

The SURBA survey analysis model was fitted to the survey data for the IBTSq1, IBTSq3, English and Scottish surveys; the summary plots are presented in Figures 14.15a - d.

Biomass - All time series indicate that total biomass and spawning stock biomass are continuing to decline as a result of a series of poor recruitments and high fishing mortality and discard rates at the youngest ages.

Total mortality – In all model fits, there is a high level of uncertainty in the model estimates, trends in mean Z cannot be determined with any confidence.

Recruitment – All surveys indicate that the recruiting years classes since 1996 have been relatively weak. The IBTSQ1 and Scottish surveys recorded in 2006 indicate that the 2005 year class is one of the highest of the recent low values. All surveys indicate that the variation recorded in year class strength at age 1 is substantially higher than that recorded subsequently at ages 2 and 3, indicating that the high rates of discarding (90%) and high mortality rates at this age are resulting in reduced contributions from one year old fish to the stock and catches.

14.3.4 Conclusions drawn from exploratory analyses

All of the time series used to examine the dynamics of the North Sea cod stock indicate that the spawning stock biomass of the stock is at its lowest level within the recorded time series. This conclusion is robust to the source of information used for the analysis and is unchanged from the previous years perception of the stock's status.

The assessment model estimates that total stock biomass has shown some decline since 2001 – only the fishers survey trends (submitted to the WG in the North Sea Survey responses Laurenson 2006, WD 17) in the western North Sea reflect this; in other areas the trend is stable or increasing in the most recent years. Survey estimates indicate that as a result of the recent poor recruitments the stock biomass decline has continued into 2006.

The time series of abundance of the recruiting year classes are also consistent between analyses. All indicate the recruitment of 1 year old cod has varied considerably since the 1960s but since 1997 average recruitment has been lower than at any other time. The survey estimates of 0-group recorded in 2005 and 1 group in 2006 indicate that the 2005 year class is of higher abundance than the recent low levels, especially in the central and northern north sea. However, high rates of discarding in 2006 could reduce the contribution that the year class makes to the catches and the stock in future years.

Mortality trends cannot be determined from the fit of the survey only models. The catch at age model fits both indicate that the mortality rate remained high since through the 70's to the late 90's with a strong reduction since 2000. The magnitude of the decline differs between series and there is uncertainty associated with the final year estimates from the separate model fits.

14.3.5 Final assessment

The final ADAPT model structure was fitted to landings data for the years 1963 – 2005 and ages 1-7+, adjusted for discarding by applying estimates from the Scottish discard sampling program to areas IV and VIId and observer estimates in IIIa. Survey data from the the International Bottom Trawl Survey quarter 1 (1983 – 2006, ages 1 – 5) and quarter 3 (1991 – 2005, ages 1 – 4). Surviving population numbers at ages 1 - 5 were estimated in 2006 with fishing mortality at age 6 in all years calculated as the average of ages 3 – 5. Bias parameters were estimated in the years 1993 – 2005. A smoothing weight of 0.5 was applied residuals between year of the log of total landings in tonnes. No time series weighting was applied and survey residuals were given equal eight in the analysis. Catchability was assumed to be constant in time and independent of age for ages 1 – 4 for the IBTSQ1 survey 1 – 3 for the IBTSQ3 survey.

The WG considered the smoothed ADAPT to be the most appropriate of the models available at the meeting for estimating the dynamics of the fishery and stock.

The diagnostics and stock estimates of the fitted model expected values are presented in Tables 14.9 – 14.12. Median values from the bootstrapped approach for fishing mortality mortality are presented in Table 14.10, stock numbers in Table 14.11, and the median of the assessment summary time series in Table 14.12. Figure 14.16 presents the time series of log catchability residuals from the fitted smoothed ADAPT model. Figures 14.17-14.22 presents the time series of ADAPT derived assessment estimates of the stock, exploitation trends and the stock and recruitment plot.

Retrospective estimates of median fishing mortality from the B-ADAPT bootstrap model are presented in Figure 14.23. The time series shows a slight under-estimation of fishing mortality with the end points of each of the historic time series lying within the 5^{th} and 9^{th} percentiles of the most recent run. The perception of a decrease in mortality rates for the stock is robust to the period over which the model is fitted. Retrospective time series of SSB are not plotted as there is very little variation between runs the perception of a low stock size is unchanged.

14.4 Historic Stock Trends

The historic stock and fishery trends are presented in Figures 14.17-14.22 and Table 14.12.

Recruitment has fluctuated at a relatively low level since 1997. The 1996 year class was the last large year class that contributed to the fishery subsequent year classes have been the lowest in the time series although survey results from three surveys carried out in 2006 indicate that the 2005 year class is stronger. Addition of discards to the assessment has raised the overall level of recruitment abundance but not the trend in recent year class strengths.

Fishing mortality increased until the early 1980's remained high until 2000 after which it has decreased. Median fishing mortality (human consumption and discard mortality) at ages 2 – 4 in 2005 is estimated to be 0.86.

SSB declined steadily during the 1970's and 80's. There was a small increase in SSB following the recruitment of the 1995 and 1996 year classes but with low recruitment abundance since 1997 and continued high mortality rates. SSB is estimated to have decreased n recent year to 35,000t the level estimated for 2001, however given the uncertainties in the assessment data and reported landings, the SSB could be considered to be stable. Surveys indicate that SSB has declined in 2006 as a result of the recent poor year classes.

Comparisons with the North Sea Stock Survey 2006

The North Sea Stock Survey (Laurenson 2006, WD 17) was submitted to the WG in order for the fishers' perception of the state of the stock to be considered as part of the assessment process. The spatial distribution of the change in the abundance since 2001 is recorded by survey area in Figure 14.25.

The North Sea Survey responses indicate that apart from areas 1, 7 and 8 the abundance of cod has remained relatively stable since 2001. In area 1 there has been a steady year on year increase, in areas 7 and 8 there has been an increase since 2003.

Comparison between the fishers survey and the IBTS survey data has been shown in previous years the time series are broadly in agreement in recording a stable overall stock abundance in the central North Sea, declining abundance in the western North Sea and increasing abundance in the north east. The IBTS survey (Figure 14.27) has more variability due to the inherent variation, but shows declines in areas 1 and 7 whereas the fisher's survy records strong increases, this requires analysis to resolve where the differences are occurring and whether they occur as a result if the scale of the analysis.

14.5 Recruitment estimates

Figures 14.15a presents the SURBA estimates of age 1 recruitment from the IBTS groundfish survey. The 2006 surveys are concurrent in indicating that the 2005 yearclass above the recent low values recorded in recent years. It has equivalent magnitude and uncertainty to the estimate of the 1999 year class in 2000. For the medium term forecasts used to evaluate future stock dynamics the estimate of the 1999 year class strength in each bootstrap iteration was used as the estimate for 2006 at age 1.

14.6 Short-term forecasts

Due to the uncertainty in the final year estimates of fishing mortality the WG agreed that a standard (deterministic) short-term forecast was not appropriate for this stock.

14.7 Medium-term forecasts

Stochastic projections were run forward using each of the non-parametric bootstrap iterations. Starting populations were taken from each bootstrap iteration, fishing mortalities were taken as a three year average scaled to the final year. Weights and mortalities were taken from the average of the final three years of assessment data. The 2006 recruitment at age 1 was assumed to be equivalent to the model estimate for 2000 in each model iteration (section 14.5) Recruitment after 2007 was re-sampled from the 1997 – 2004 year-classes, seven years with low recruitment and one with the slightly higher levels estimated for 1999. This is a pessimistic sampling representing concern that the low levels estimated in the last few years may continue.

The scenarios explored were:

- constant;
- a reduction in fishing mortality by 15% in 2006 followed by constant fishing at the 2006 level; or
- further reductions in fishing mortality of 10, 15, 20, 25% and 100% in 2007-2010.

Tables 14.13 – 14.18 present the results of the stochastic projections, for each scenario the associated figures present fishing mortality, catch, SSB and recruitment 5th, 25th, median 75th and 95th percentiles from the bootstrap distributions are plotted. Percentiles of fishing mortality, SSB and catch in 2005, 2006 and 2007 are tabulated with the probability that SSB in a year exceeds the SSB estimated for 2005 and the ratio of median SSB at the start of the year to the end of the year in order to quantify stock rebuilding.

In each of the stock projections SSB continues to decline in 2006 to its historic low with a median value of 31,000t. It is only in 2007 that SSB begins to rebuild with the increase dependent on the scale of the reduction in fishing mortality.

For 2007 the only catch option that returns median SSB levels to the Blim of 70,000 t in 2008 is the zero catch option (Table 14.18).

14.8 Biological reference points

The Precautionary Approach reference points for cod in IIIa (Skagerrak), IV and VIId have been unchanged since 1999. They are:

Reference point:

Blim	70 000 t.	**B**pa	150 000 t.
Flim:	0.86	**F**pa	0.65

Technical basis:

Blim	Rounded **B**loss. The lowest observed spawning stock biomass.
Bpa	The previously agreed MBAL and affords a high probability of maintaining SSB above **B**lim, taking into account the uncertainty of assessments. Below this value the probability of below average recruitment increases. Previous MBAL and signs of impaired recruitment below: 150 000 t.
Flim	**F**loss
Fpa	Approx. 5th percentile of **F**loss

No estimates of other reference points ($\mathbf{F}_{0.1}$, $\mathbf{F}_{max}$ etc) were made by the WG this year.

14.9 Quality of the assessment

The quality of the commercial landings and catch-at-age data for this stock deteriorated in the 1990s following reductions in the TAC without associated control of fishing effort. The WG considers the international landings figures from 1993 onwards to have inaccuracies that lead to retrospective underestimation of fishing mortality and over estimation of spawning stock biomass and other problems with an analytical assessment.

Estimates of discards for areas IV and VIId are taken from the Scottish discard sampling program and the average proportions across gears applied to raise the landings data from other areas. If the gear and fishery characteristics differ this could introduce bias. This bias is likely to introduce sensitivity to the estimates of the youngest age classes (1 and 2) and will not affect estimates of SSB.

The North Sea has good survey coverage with consistency within and between survey indices. The indication that SSB in 2006 has declined to a historically low is supported by SURBA analyses and single survey assessment model fits. The low level of recent recruitments is consistent between model fits and within and between survey indices. The estimate of a “relatively” higher year class entering the fishery and range of maximum discards is confirmed by the IBTSQ, English and Scottish third quarter surveys.

The B-ADAPT model was developed to correct for retrospective bias by estimating the quantity of additional “unallocated removals” that would be required to be added or removed from the catch-at-age data in order to remove any persistent trends in survey catchability. The unallocated removals figures given by B-ADAPT could potentially include components due to increased natural mortality and discarding as well as misreported landings.

The estimates of bias can also be influenced by any remaining non-randomness of survey catchability or outlying values, particularly where the calibration period surveys are noisy at the oldest and youngest ages. For this reason, the bootstrap percentiles are used to provide stock and exploitation trends and the estimated values should not be over-interpreted.

Values for natural mortality and maturity are applied to all years. They are model estimates from a multi-species VPA fitted by the Multi-species WG in 1986. The maturity values were estimated using the International Bottom trawl Survey series 1981-1985. These values were derived for the North Sea and are equally applied to the three stock components.

In its 2003 meeting (ICES-WGNSSK 2003), this WG examined the sensitivity of XSA estimates to recent revision of the Multi-species WG estimates of natural mortality concluding that the estimates of recruitment were rescaled but otherwise stock parameters were unaffected. The sensitivity of the B-ADAPT estimates to the revision of the time series of multi-species natural mortality should be examined.

Similarly the estimated constant maturity ogive should be examined in order to examine its relevance in the current low stock situation.

The historical performance of the assessment is summarised in Figure 14.26.

14.10 Status of the Stock

The general perception of the cod stock remains unchanged.

Survey indices and results from models fitted to the commercial catch at age data indicate that the spawning stock biomass is at about 20-25% of the level it was in the 1980’s and that it is likely to decline further in 2006.

The assessment models indicate that the mortality rate has begun to decline towards the lower levels required to allow the stock to rebuild since 2000, but the most recent values are uncertain.

The proportion of mature individuals in the stock and the catches remains very low. Only about 5% of individuals at age 1 survive to age 5.

Recruitment of 1 year old cod has varied considerably since the 1960s but since 1997 average recruitment has been lower than any other time. There are indications of a moderate year-class entering the fishery this year and indications of relatively larger numbers of 0-group cod in the south eastern North Sea and Skagerrak in 2006. The last substantial year class to enter the fishery was in 1996. The year class was a prominent feature in all surveys and was heavily exploited and discarded by the fishery at ages 1-5. There are indications from the change in relative year class strength in indices from recent surveys that discarding is having a strong damping effect Figure 14.24 on the contribution of age 1 to the stock. The incoming 2003 year class is estimated to be close to the average of the recent low values.

14.11 Management Considerations

There is a need to reduce fishing mortality on North Sea cod in order to allow more fish to reach sexual maturity and increase the probability of good recruitment. In addition, there is also a need to reduce the mortality rate on younger age groups (1-3) further. The exploitation pattern has remained the same since the early 1960s despite various changes to technical regulations (gear modifications and mesh size changes) aimed at improving it. Recent management measures to increase mesh sizes in the cod directed fisheries may have been negated by the allowance of more days at sea for fisheries directed at other species that have small mesh sizes but have a by-catch of cod.

The recruitment of the relatively more abundant 2005 cohort to the fishery may have no beneficial effect on the stock if it is heavily discarded.

Cod is still a specific target for some boats but the majority of cod in the North Sea are caught (landings and discards) as by-catch in mixed demersal fisheries. This means it is important to take into account the impact of the management of cod on other stocks, especially haddock and whiting, although fishing opportunities for other commercially important stocks will also be affected; the reverse is also true. This issue is addressed elsewhere in this report in Section 15 (mixed fisheries). Comparisons between the extent of the reduction in fishing mortality on haddock in recent years compared to that on cod indicate that some degree of de-coupling may have occurred.

The discard data available to the WG do not indicate a substantial decline in discards at the youngest ages in recent years. Measures to protect North Sea cod, such as the proposals to voluntarily increase mesh size by the nephrops fleet, exclusion grids etc, will most likely have a greater beneficial effect to stocks other than cod but will help to allow survivorship of the 2005 year class in the north eastern North Sea and the possible 2006 year classes in the southern North Sea and Skagerrak. Any benefits for cod by such measures are likely to be through reduced discarding of fish below the minimum landing size.

It is considered that conclusions drawn from the trends in the historic stock dynamics are robust to the uncertainty in the level of recent recorded catches. A sensitivity analysis has shown that the recent stock trends are largely unaffected by the measured rate of discarding but are highly sensitive, especially estimates of fishing mortality, to bias in the reported landings.

Table 14.1. Nominal landings (in tonens) of COD in IIIa (Skagerrak), IV and VIId, 1986—2005 as officially reported to ICES, and as used by the Working Group.

Sub-area IV										
Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Belgium	6,604	6,693	5,508	3,398	2,934	2,331	3,356	3,374	2,648	4,827
Denmark	32,892	36,948	34,905	25,782	21,601	18,998	18,479	19,547	19,243	24,067
Faroe Islands	45	57	46	35	96	23	109	46	80	219
France	8,402	8,199	8,323	2,578	1,641	975	2,146	1,868	1,868	3,040
Greenland										9,457
Germany	7,667	8,230	7,707	11,430	11,725	7,278	8,446	6,800	5,974	
Netherlands	25,082	21,347	16,968	12,028	8,445	6,831	11,133	10,220	6,512	11,199
Norway	4,864	5,000	3,585	4,813	5,168	6,022	10,476	8,742	7,707	7,111
Poland	10	13	19	24	53	15	-	-	-	-
Sweden	839	688	367	501	620	784	823	646	630	709
UK (E/W/NI)	25,361	29,960	23,496	18,375	15,622	14,249	14,462	14,940	13,941	14,991
UK (Scotland)	45,748	49,671	41,382	31,480	31,120	29,060	28,677	28,197	28,854	35,848
United Kindom										
Total Nominal Catch	157,514	166,806	142,306	110,444	99,025	86,566	98,107	94,380	87,457	111,468
Unallocated landings	11,292	15,288	14,253	5,256	5,726	1,967	-758	10,200	7,066	8,555
WG estimate of total landings	**168,806**	**182,094**	**156,559**	**115,700**	**104,751**	**88,533**	**97,349**	**104,580**	**94,523**	**120,023**
Agreed TAC	**170,000**	**175,000**	**160,000**	**124,000**	**105,000**	**100,000**	**100,000**	**101,000**	**102,000**	**120,000**
	0.99	1.04	0.98	0.93	1.00	0.89	0.97	1.04	0.93	
Division VIId										
Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Belgium	650	815	486	173	237	182	187	157	228	377
Denmark	4	-	+	+	-	-	1	1	9	-
France	9,938	7,541	8,795	n/a	n/a	n/a	2,079	1,771	2,338	3,261
Netherlands	-	-	1	1	-	-	2	-	-	-
UK (E/W/NI)	830	1,044	867	562	420	341	443	530	312	336
UK (Scotland)	-	-	-	-	7	2	22	2	+	+
United Kingdom										
Total Nominal Catch	11,422	9,400	10,149	n/a	n/a	n/a	2,734	2,461	2,887	3,974
Unallocated landings	3,722	4,819	580	-	-	-	-65	-29	-37	-10
WG estimate of total landings	**15,144**	**14,219**	**10,729**	**5,538**	**2,763**	**1,886**	**2,669**	**2,432**	**2,850**	**3,964**
Division IIIa (Skagerrak)										
Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Denmark	18,424	17,824	14,806	16,634	15,788	10,396	11,194	11,997	11,953	8,948
Sweden	1,505	1,924	1,648	1,902	1,694	1,579	2,436	2,574	1,821	2,658
Norway	174	152	392	256	143	72	270	75	60	169
Germany	-	-	-	12	110	12	-	-	301	200
Others	-	-	106	34	65	12	102	91	25	134
Norwegian coast *	917	838	769	888	846	854	923	909	760	846
Danish industrial by-catch *	997	491	1,103	428	687	953	1,360	511	666	749
Total Nominal Catch	20,103	19,900	16,952	18,838	17,800	12,071	14,002	14,737	14160	12109
Unallocated landings	0	0	0	-141	0	-12	0	0	-899	0
WG estimate of total landings	**20,103**	**19,900**	**16,952**	**18,697**	**17,800**	**12,059**	**14,002**	**14,737**	**13,261**	**12,109**
Agreed TAC	**29,000**	**22,500**	**21,500**	**20,500**	**21,000**	**15,000**	**15,000**	**15,000**	**15,500**	**20,000**
Sub-area IV, Divisions VIId and IIIa (Skagerrak) combined										
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total Nominal Catch	189,039	196,106	169,407	n/a	n/a	n/a	114,843	111,578	104,504	127,551
Unallocated landings	15,014	20,106	14,833	-	-	-	-823	10,171	6,130	8,545
WG estimate of total landings	**204,053**	**216,212**	**184,240**	**139,936**	**125,314**	**102,478**	**114,020**	**121,749**	**110,634**	**136,096**

* The Danish industrial by-catch and the Norwegian coast catches are not included in the (WG estimate of) total landings of Division IIIa

n/a not available ** provisional

Division IIIa (Skagerrak) landings not included in the assessment										
Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Norwegian coast *						854.00	923.00	909.00	760.00	846.00
Danish industrial by-catch						953.00	1,360.00	511.00	666.00	749.00
Total						**1,807.00**	**2,283.00**	**1,420.00**	**1,426.00**	**1,595.00**

Table 14.1. cont., Nominal landings (in tonens) of COD in IIIa (Skagerrak), IV and VIId, 1986—2005 as officially reported to ICES, and as used by the Working Group.

Sub-area IV

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	3,458	4,642	5,799	3,882	3,304	2,470	2,616	1,482	1,615	1,715
Denmark	23,573	21,870	23,002	19,697	14,000	8,358	9,022	4,676	5,889	6,291
Faroe Islands	44	40	102	96		9	34	36		15
France	1,934	3,451	2,934	1,750	1,222	717	1,777	617		515
Germany	8,344	5,179	8,045	3,386	1,740	1,810	2,018	2,048	2,212	2,648
Greenland								1,352		
Netherlands	9,271	11,807	14,676	9,068	5,995	3,574	4,707	2,305	1,728	1,659
Norway	5,869	5,814	5,823	7,432	6,410	4,383	4,994	4,518	3,205	2,886
Poland	18	31	25	19	18	18	39	35		
Sweden	617	832	540	625	640	661	463	252	226	306
UK (E/W/NI)	15,930	13,413	17,745	10,344	6,543	4,087	3,112	2,213	1,889	1,364
UK (Scotland)	35,349	32,344	35,633	23,017	21,009	15,640	15,416	7,852	6,644	6,667
United Kindom										
Total Nominal Catch	104,407	99,423	114,324	79,316	60,881	41,727	44,198	27,386	23,408	24,065
Unallocated landings	2,161	2,746	7,779	-924	-1,114	-754	102	-1,539	141	-194
WG estimate of total landings	**106,568**	**102,169**	**122,103**	**78,392**	**59,767**	**40,973**	**44,300**	**25,847**	**23,549**	**23,870**
Agreed TAC	**130,000**	**115,000**	**140,000**	**132,400**	**81,000**	**48,600**	**49,300**	**27,300**	**27,300**	**27,300**

Division VIId

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	321	310	239	172	110	93	51	54	47	50
Denmark	-	-	-	-	-	-	-			
France	2,808	6,387	7,788		3,084	1,677	1,361	1,127		467
Netherlands	+	-	19	3	4	17	6	36	14	9
UK (E/W/NI)	414	478	618	454	385	249	145	121	100	179
UK (Scotland)	4	3	1	-	-	-	-			
United Kingdom										
Total Nominal Catch	3,547	7,178	8,665	629	3,583	2,036	1,563	1,338	161	705
Unallocated landings	-44	-135	-85	6,229	-1,258	-463	1,534	-104	646	328
WG estimate of total landings	**3,503**	**7,043**	**8,580**	**6,858**	**2,325**	**1,573**	**3,097**	**1,234**	**807**	**1033**

Division IIIa (Skagerrak)

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	13,573	12,164	12,340	8,734	7,683	5,901	5,526	3,071	3,039	3,613
Sweden	2,208	2,303	1608	1,909	1,350	1,035	1,716	509	495	824
Norway	265	348	303	345	301	134	146	193	133	????????
Germany	203	81	16	54	9	32	83	-		
Others	-	-	-	-	-	-	-	-		
Norwegian coast *	748	911	976	788	624	846	n/a	n/a	720	759
Danish industrial by-catch *	676	205	97	62	99	687	n/a	n/a	10	????????
Total Nominal Catch	16249	14896	14267	11042	9343	7102	7471	3773	3667	4437
Unallocated landings	0	50	1,064	-68	-66	-16	-3	18	120	-632
WG estimate of total landings	**16,249**	**14,946**	**15,331**	**10,974**	**9,277**	**7,086**	**7,468**	**3,791**	**3,787**	**3,805**
Agreed TAC	**23,000**	**16,100**	**20,000**	**19,000**	**11,600**	**7,000**	**7,100**	**3,900**	**3,900**	**3,900**

Sub-area IV, Divisions VIId and IIIa (Skagerrak) combined

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total Nominal Catch	124,203	121,497	137,256	90,987	73,807	50,865	53,232	32,497	27,236	29,207
Unallocated landings	2,117	2,661	8,758	5,238	-2,438	-1,233	1,633	-1,625	907	-498
WG estimate of total landings	**126,320**	**124,158**	**146,014**	**96,225**	**71,369**	**49,632**	**54,865**	**30,872**	**28,143**	**28,708**

* The Danish industrial by-catch and the Norwegian coast catches are not included in the (WG estimate of) total landings of Division IIIa

n/a not available

Division IIIa (Skagerrak) landings not included in the assessment

Country	1996	1997	1998	1999	2000	2001	2002	2003	2003	2005
Norwegian coast *	748.00	911.00	976.00	788.00	624.00	846.00	n/a	n/a	720	759
Danish industrial by-catch	676.00	205.00	97.00	62.00	99.00	687.00	n/a	n/a	10	????????
Total	**1,424.00**	**1,116.00**	**1,073.00**	**850.00**	**723.00**	**1,533.00**	**0.00**	**0.00**	**730.00**	**759.00**

Table 14.2 Cod 347d: Landings numbers at age (Thousands)

Landings numbers at age Numbers*10**-3

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	3214	5029	15813	18224	10803	5829	2947	54493	44824	3832	25966
2	42591	22486	51888	62516	70895	83836	22674	33917	155345	187686	31755
3	7030	20104	17645	29845	32693	42586	31578	18488	17219	48126	54931
4	3536	4306	9182	6184	11261	12392	13710	13339	6754	5682	14072
5	2788	1917	2387	3379	3271	6076	4565	6297	7101	2726	2206
6	1213	1818	950	1278	1974	1414	2895	1763	2700	3201	1109
7	81	599	658	477	888	870	588	961	893	1680	1060
8	492	118	298	370	355	309	422	209	458	612	489
9	14	94	51	126	138	151	147	186	228	390	80
10	6	12	75	56	40	111	46	98	77	113	58
+gp	0	4	8	83	17	24	78	40	94	18	162
TOTALNUM	60965	56486	98957	122538	132335	153600	79651	129791	235691	254064	131888
TONSLAND	116457	126041	181036	221336	252977	288368	200760	226124	328098	353976	239051
SOPCOF %	100	100	100	100	100	100	100	100	100	100	100

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	15562	33378	5724	75413	29731	34837	62605	20279	66777	25733	64751
2	58920	47143	100283	51118	175727	91697	104708	189007	65299	129632	66428
3	11404	18944	18574	25621	17258	44653	35056	34821	60411	21662	31276
4	15824	4663	6741	4615	9440	4035	12316	9019	9567	11900	4264
5	4624	7563	1741	2294	3003	3395	1965	4118	3476	2830	3436
6	961	2067	3071	836	1108	712	1273	785	2065	1258	1019
7	438	449	924	1144	410	398	495	604	428	595	437
8	395	196	131	371	405	140	197	134	236	181	244
9	332	229	67	263	153	158	74	65	78	90	60
10	81	95	63	26	36	42	55	37	27	28	45
+gp	189	63	43	96	44	17	25	21	16	23	20
TOTALNUM	108729	114791	137361	161797	237314	180085	218770	258889	208380	193932	171978
TONSLAND	214279	205245	234169	209154	297022	269973	293644	335497	303251	259287	228286
SOPCOF %	100	100	100	100	100	101	100	100	99	100	100

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	8845	100239	24915	21480	22239	11738	13466	27668	4783	15557	15717
2	118047	32437	128282	55330	36358	54290	23456	32059	55272	25279	63586
3	18995	34109	9800	43955	18193	11906	16776	8682	11360	21144	12943
4	7823	5814	8723	3134	9866	4339	3310	5007	3190	3083	5301
5	1377	2993	1534	2557	1002	2468	1390	1060	1577	870	802
6	1265	604	1075	655	1036	310	1053	491	435	519	286
7	373	556	235	295	251	310	225	329	204	142	151
8	173	171	215	66	140	54	139	52	108	58	42
9	79	69	55	63	27	60	28	40	18	32	15
10	16	44	48	23	31	12	4	17	10	7	13
+gp	31	23	12	18	10	9	10	9	13	16	5
TOTALNUM	157022	177058	174895	127577	89153	85496	59857	75415	76970	66706	98861
TONSLAND	214629	204053	216212	184240	139936	125314	102478	114020	121749	110634	136096
SOPCOF %	100	101	100	100	100	99	100	99	99	99	98

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	4938	23769	1255	5941	8294	2220	7192	400	1589	1502
2	36805	29194	81737	9731	23033	20832	7870	9615	4083	8210
3	23364	18646	16958	32224	6472	6200	13252	3511	4949	2865
4	3169	6499	5967	4034	6697	1142	2519	2660	1965	1628
5	1860	1238	2402	1445	1021	1080	366	449	988	474
6	399	700	509	626	385	144	349	66	150	392
7	162	153	236	223	139	84	51	49	43	44
8	88	47	41	91	40	27	31	13	23	11
9	43	14	16	14	18	14	13	7	8	8
10	4	15	4	10	5	6	5	3	3	2
+gp	8	10	12	2	1	1	0	1	0	0
TOTALNUM	70837	80285	109137	54342	46105	31750	31649	16774	13800	15135
TONSLAND	126320	124158	146014	96225	71371	49694	54865	30872	28188	28708
SOPCOF %	100	100	100	100	100	100	100	102	100	100

Table 14.3 Cod 347d: Discard numbers at age (Thousands)

DISCARD numbers at age Numbers*10**-3

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	16231	8089	98414	108921	50467	31272	2515	53225	260226	38442	86349
2	20003	6199	6632	22236	24861	23073	10331	8700	37412	59641	17475
3	33	116	90	71	160	198	113	153	47	178	247
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0
TOTALNUM	36267	14404	105136	131229	75489	54542	12959	62078	297686	98261	104071
TONSLAND	12247	4731	29251	38109	23438	17575	4816	17928	84392	33848	30190
SOPCOF %	100	101	100	100	100	100	101	101	100	100	100

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	124777	137341	227925	474377	29043	584603	1189692	156878	183476	55478	540795
2	15958	16296	83630	48189	78477	5302	17751	34559	8448	11237	12594
3	71	0	193	466	0	0	0	80	99	25	5
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0
TOTALNUM	140807	153637	311747	523032	107520	589904	1207444	191516	192022	66740	553394
TONSLAND	39807	37060	72840	139820	32583	163279	295449	57897	54501	22101	151923
SOPCOF %	100	100	100	100	100	100	100	101	100	102	100

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	63659	565753	24732	15461	178265	34194	48110	104321	34112	324703	45425
2	36780	5784	62194	17179	8751	48699	8495	10065	29119	17012	44083
3	115	305	0	218	492	79	454	2	12	162	30
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0
TOTALNUM	100555	571842	86927	32858	187508	82972	57059	114388	63242	341877	89539
TONSLAND	31503	139081	27839	10714	62119	27022	18552	36920	21860	99578	32188
SOPCOF %	100	100	100	101	100	100	101	100	100	100	100

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	14451	87308	15608	31550	37981	5600	13373	8511	11865	11290
2	23376	13892	91140	5737	5650	33946	2622	9976	4661	5673
3	774	41	1514	8437	0	773	1972	1118	1158	108
4	0	0	0	0	0	0	0	69	0	19
5	0	0	0	0	0	0	0	11	0	4
6	0	0	0	0	0	0	0	2	0	3
7	0	0	0	0	0	0	0	1	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0
TOTALNUM	38601	101241	108262	45725	43631	40319	17967	19688	17684	17097
TONSLAND	14255	33616	40480	14180	13713	13871	5706	6372	5849	6272
SOPCOF %	100	100	100	102	100	100	100	101	102	103

Table 14.4 Cod 347d: Landings weights at age (kg)

Landings weights at age (kg)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.538	0.496	0.581	0.579	0.59	0.64	0.544	0.626	0.579	0.616	0.559
2	1.004	0.863	0.965	0.994	1.035	0.973	0.921	0.961	0.941	0.836	0.869
3	2.657	2.377	2.304	2.442	2.404	2.223	2.133	2.041	2.193	2.086	1.919
4	4.491	4.528	4.512	4.169	3.153	4.094	3.852	4.001	4.258	3.968	3.776
5	6.794	6.447	7.274	7.027	6.803	5.341	5.715	6.131	6.528	6.011	5.488
6	9.409	8.52	9.498	9.599	9.61	8.02	6.722	7.945	8.646	8.246	7.453
7	11.562	10.606	11.898	11.766	12.033	8.581	9.262	9.953	10.356	9.766	9.019
8	11.942	10.758	12.041	11.968	12.481	10.162	9.749	10.131	11.219	10.228	9.81
9	13.383	12.34	13.053	14.06	13.589	10.72	10.384	11.919	12.881	11.875	11.077
10	13.756	12.54	14.441	14.746	14.271	12.497	12.743	12.554	13.147	12.53	12.359
+gp	0	18	15.667	15.6719	19.0163	11.5951	11.1753	14.3667	15.5441	14.3504	12.886
SOPCOFAC	0.9998	1.0001	1	1.0001	1.0001	0.9999	1	1	0.9999	1.0001	0.9999

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.594	0.619	0.568	0.541	0.573	0.55	0.55	0.723	0.589	0.632	0.594
2	1.039	0.899	1.029	0.948	0.937	0.936	1.003	0.837	0.962	0.919	1.007
3	2.217	2.348	2.47	2.16	2.001	2.411	1.948	2.19	1.858	1.835	2.156
4	4.156	4.226	4.577	4.606	4.146	4.423	4.401	4.615	4.13	3.88	3.972
5	6.174	6.404	6.494	6.714	6.53	6.579	6.109	7.045	6.785	6.491	6.19
6	8.333	8.691	8.62	8.828	8.667	8.474	9.12	8.884	8.903	8.423	8.362
7	9.889	10.107	10.132	10.071	9.685	10.637	9.55	9.933	10.398	9.848	10.317
8	10.791	10.91	11.34	11.052	11.099	11.55	11.867	11.519	12.5	11.837	11.352
9	12.175	12.339	12.888	11.824	12.427	13.057	12.782	13.338	13.469	12.797	13.505
10	12.425	12.976	14.139	13.134	12.778	14.148	14.081	14.897	12.89	12.562	13.408
+gp	13.7308	14.4309	14.7599	14.3616	13.9808	15.478	15.3919	18.7844	14.6081	14.4262	13.4716
SOPCOFAC	0.9999	0.9998	0.9999	1.0002	1.0034	1.0087	0.9963	0.9983	0.9946	0.9968	0.9993

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.59	0.583	0.635	0.585	0.673	0.737	0.67	0.699	0.699	0.677	0.721
2	0.932	0.856	0.976	0.881	1.052	0.976	1.078	1.146	1.065	1.075	1.021
3	2.141	1.834	1.955	1.982	1.846	2.176	2.038	2.546	2.479	2.201	2.21
4	4.164	3.504	3.65	3.187	3.585	3.791	3.971	4.223	4.551	4.471	4.293
5	6.324	6.23	6.052	5.992	5.273	5.931	6.082	6.247	6.54	7.167	7.22
6	8.43	8.14	8.307	7.914	7.921	7.89	8.033	8.483	8.094	8.436	8.98
7	10.362	9.896	10.243	9.764	9.724	10.235	9.545	10.101	9.641	9.537	10.282
8	12.074	11.94	11.461	12.127	11.212	10.923	10.948	10.482	10.734	10.323	11.743
9	13.072	12.951	12.447	14.242	12.586	12.803	13.481	11.849	12.329	12.223	13.107
10	14.443	13.859	18.691	17.787	15.557	15.525	13.171	13.904	13.443	14.247	12.052
+gp	16.5876	14.7074	16.6043	16.4767	14.6946	23.2343	14.9888	15.7944	13.9614	12.5231	13.9541
SOPCOFAC	0.9957	1.0098	0.9968	1.0001	0.995	0.9945	0.9968	0.9928	0.9948	0.9942	0.9831

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.699	0.656	0.542	0.64	0.611	0.725	0.758	0.608	0.7	0.828
2	1.117	0.96	0.922	0.935	1.021	1.004	1.082	1.174	0.997	1.19
3	2.147	2.12	1.724	1.663	1.747	2.303	1.916	1.849	2.014	1.978
4	4.034	3.821	3.495	3.305	3.216	3.663	3.857	3.256	3.096	3.69
5	6.637	6.228	5.387	5.726	4.903	5.871	5.372	5.186	5.172	5.06
6	8.494	8.394	7.563	7.403	7.488	7.333	7.991	7.395	7.426	7.551
7	9.729	9.979	9.628	8.582	9.636	9.264	9.627	8.703	8.675	9.607
8	11.08	11.424	10.643	10.365	10.671	10.081	10.403	12.178	9.797	11.229
9	12.264	12.3	11.499	11.6	10.894	12.062	10.963	12.846	11.684	11.501
10	12.756	12.761	13.085	12.33	11.414	12.009	12.816	10.771	13.058	13.333
+gp	11.3036	13.4162	14.921	11.9257	15.0776	10.1956	11.8422	17.494	14.1399	15.3398
SOPCOFAC	0.999	1.0002	0.9998	1.0034	1.0003	1.0001	1.0001	1.0215	1.0001	0.9999

Table 14.5 Cod 347d: Discard weights at age (kg)

Discard weights at age (kg)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.27	0.27	0.269	0.269	0.269	0.269	0.268	0.268	0.268	0.268	0.268
2	0.393	0.393	0.392	0.392	0.392	0.392	0.392	0.392	0.392	0.392	0.392
3	0.505	0.508	0.506	0.509	0.506	0.505	0.504	0.505	0.508	0.507	0.507
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.268	0.227	0.189	0.255	0.287	0.276	0.242	0.279	0.274	0.297	0.27
2	0.392	0.359	0.354	0.382	0.309	0.361	0.411	0.396	0.489	0.458	0.469
3	0.508	0	0.412	0.376	0	0	0	0.517	0.593	0.534	0.509
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.276	0.242	0.237	0.3	0.326	0.26	0.315	0.314	0.274	0.287	0.316
2	0.376	0.365	0.353	0.339	0.431	0.371	0.366	0.408	0.429	0.362	0.404
3	0.652	0.437	0	0.463	0.484	0.526	0.395	2.309	0.705	0.483	0.553
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.342	0.313	0.358	0.257	0.298	0.232	0.294	0.259	0.293	0.284
2	0.38	0.453	0.375	0.389	0.422	0.361	0.42	0.344	0.384	0.468
3	0.515	0.616	0.481	0.422	0	0.406	0.34	0.54	0.427	1.084
4	0	0	0	0	0	0	0	0.675	0	4.099
5	0	0	0	0	0	0	0	2.272	0	4.501
6	0	0	0	0	0	0	0	2.849	0	8.197
7	0	0	0	0	0	0	0	3.585	0	0
8	0	0	0	0	0	0	0	5.033	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	5.771	0	0

Table 14.6 Cod 347d: Catch and stock weights at age (kg)

Stock and total catch weights at age (kg)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.314	0.357	0.313	0.314	0.326	0.328	0.416	0.449	0.313	0.3	0.335
2	0.808	0.762	0.9	0.836	0.868	0.847	0.755	0.845	0.834	0.729	0.7
3	2.647	2.367	2.295	2.437	2.395	2.215	2.127	2.028	2.188	2.08	1.912
4	4.491	4.528	4.512	4.169	3.153	4.094	3.852	4.001	4.258	3.968	3.776
5	6.794	6.447	7.274	7.027	6.803	5.341	5.715	6.131	6.528	6.011	5.488
6	9.409	8.52	9.498	9.599	9.61	8.02	6.722	7.945	8.646	8.246	7.453
7	11.562	10.606	11.898	11.766	12.033	8.581	9.262	9.953	10.356	9.766	9.019
8	11.942	10.758	12.041	11.968	12.481	10.162	9.749	10.131	11.219	10.228	9.81
9	13.383	12.34	13.053	14.06	13.589	10.72	10.384	11.919	12.881	11.875	11.077
10	13.756	12.54	14.441	14.746	14.271	12.497	12.743	12.554	13.147	12.53	12.359
+gp	0	18	15.667	15.6719	19.0163	11.5951	11.1753	14.3667	15.5441	14.3504	12.886

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.304	0.304	0.199	0.295	0.432	0.291	0.258	0.329	0.358	0.403	0.304
2	0.901	0.76	0.722	0.673	0.743	0.905	0.917	0.769	0.908	0.882	0.921
3	2.206	2.348	2.449	2.128	2.001	2.411	1.948	2.186	1.856	1.833	2.156
4	4.156	4.226	4.577	4.606	4.146	4.423	4.401	4.615	4.13	3.88	3.972
5	6.174	6.404	6.494	6.714	6.53	6.579	6.109	7.045	6.785	6.491	6.19
6	8.333	8.691	8.62	8.828	8.667	8.474	9.12	8.884	8.903	8.423	8.362
7	9.889	10.107	10.132	10.071	9.685	10.637	9.55	9.933	10.398	9.848	10.317
8	10.791	10.91	11.34	11.052	11.099	11.55	11.867	11.519	12.5	11.837	11.352
9	12.175	12.339	12.888	11.824	12.427	13.057	12.782	13.338	13.469	12.797	13.505
10	12.425	12.976	14.139	13.134	12.778	14.148	14.081	14.897	12.89	12.562	13.408
+gp	13.7308	14.4309	14.7599	14.3616	13.9808	15.478	15.3919	18.7844	14.6081	14.4262	13.4716

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.314	0.293	0.437	0.466	0.364	0.382	0.392	0.395	0.327	0.305	0.42
2	0.8	0.782	0.773	0.753	0.931	0.69	0.889	0.97	0.845	0.788	0.768
3	2.132	1.822	1.955	1.974	1.81	2.165	1.994	2.545	2.478	2.188	2.207
4	4.164	3.504	3.65	3.187	3.585	3.791	3.971	4.223	4.551	4.471	4.293
5	6.324	6.23	6.052	5.992	5.273	5.931	6.082	6.247	6.54	7.167	7.22
6	8.43	8.14	8.307	7.914	7.921	7.89	8.033	8.483	8.094	8.436	8.98
7	10.362	9.896	10.243	9.764	9.724	10.235	9.545	10.101	9.641	9.537	10.282
8	12.074	11.94	11.461	12.127	11.212	10.923	10.948	10.482	10.734	10.323	11.743
9	13.072	12.951	12.447	14.242	12.586	12.803	13.481	11.849	12.329	12.223	13.107
10	14.443	13.859	18.691	17.787	15.557	15.525	13.171	13.904	13.443	14.247	12.052
+gp	16.5876	14.7074	16.6043	16.4767	14.6946	23.2343	14.9888	15.7944	13.9614	12.5231	13.9541

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.433	0.386	0.372	0.317	0.354	0.372	0.456	0.275	0.341	0.348
2	0.831	0.797	0.633	0.732	0.903	0.605	0.916	0.752	0.671	0.895
3	2.095	2.117	1.622	1.405	1.747	2.093	1.712	1.533	1.713	1.945
4	4.034	3.821	3.495	3.305	3.216	3.663	3.857	3.191	3.096	3.695
5	6.637	6.228	5.387	5.726	4.903	5.871	5.372	5.113	5.172	5.055
6	8.494	8.394	7.563	7.403	7.488	7.333	7.991	7.27	7.426	7.555
7	9.729	9.979	9.628	8.582	9.636	9.264	9.627	8.63	8.675	9.607
8	11.08	11.424	10.643	10.365	10.671	10.081	10.403	12.056	9.797	11.229
9	12.264	12.3	11.499	11.6	10.894	12.062	10.963	12.846	11.684	11.501
10	12.756	12.761	13.085	12.33	11.414	12.009	12.816	10.771	13.058	13.333
+gp	11.3036	13.4162	14.921	11.9257	15.0776	10.1956	11.8422	17.3511	14.1399	15.3398

Table 14.7. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Natural mortality and proportion mature by age-group.

Age group	Natural mortality	Proportion mature
1	0.8	0.01
2	0.35	0.05
3	0.25	0.23
4	0.2	0.62
5	0.2	0.86
6	0.2	1.0
7+	0.2	1.0

Table 14.8a Cod 347d: Survey tuning CPUE. Data used in the assessment are highlighted in bold text.

North Sea/Skagerrak/Eastern Channel Cod, Survey Tuning data.

102

IBTS_Q1 6 is a plus group

1983	2006							
1	1	0	0.25					
1	5							
1	**4.734**	**16.699**	**2.749**	**1.932**	**0.798**	1.357		1983
1	**15.856**	**8.958**	**4.059**	**0.905**	**0.976**	0.875		1984
1	**0.928**	**18.782**	**3.217**	**1.744**	**0.476**	0.93		1985
1	**16.785**	**3.627**	**7.079**	**2.242**	**1.28**	0.967		1986
1	**9.425**	**28.833**	**1.515**	**1.789**	**0.636**	0.819		1987
1	**5.638**	**6.334**	**6.204**	**0.658**	**0.86**	1.127		1988
1	**15.117**	**6.328**	**5.044**	**2.345**	**0.394**	0.992		1989
1	**3.953**	**15.665**	**1.885**	**1.034**	**0.967**	0.619		1990
1	**2.481**	**4.714**	**4.254**	**0.861**	**0.42**	0.771		1991
1	**13.129**	**4.346**	**1.183**	**0.996**	**0.288**	0.483		1992
1	**13.088**	**19.521**	**2.025**	**0.688**	**0.565**	0.377		1993
1	**14.66**	**4.387**	**2.876**	**0.815**	**0.483**	0.521		1994
1	**9.832**	**22.062**	**2.731**	**1.105**	**0.276**	0.335		1995
1	**3.441**	**7.97**	**5.922**	**0.679**	**0.639**	0.384		1996
1	**39.951**	**6.897**	**2.247**	**1.069**	**0.458**	0.417		1997
1	**2.672**	**26.368**	**2.003**	**0.884**	**0.505**	0.392		1998
1	**2.112**	**1.583**	**8.078**	**0.764**	**0.439**	0.495		1999
1	**6.563**	**3.767**	**0.738**	**2.05**	**0.387**	0.504		2000
1	**2.786**	**8.647**	**1.659**	**0.231**	**0.394**	0.262		2001
1	**7.755**	**3.38**	**4.278**	**0.496**	**0.119**	0.218		2002
1	**0.584**	**2.86**	**1.144**	**1.361**	**0.514**	0.192		2003
1	**6.722**	**2.051**	**1.293**	**0.302**	**0.497**	0.15		2004
1	**2.272**	**2.197**	**0.629**	**0.551**	**0.227**	0.424		2005
1	**7.14**	**1.253**	**0.912**	**0.29**	**0.146**	0.253		2006

IBTS_Q3 6 is plus group

1991	2005							
1	1	0.5	0.75					
0	4							
1	29.207	**8.17**	**2.438**	**1.164**	**0.164**	0.066	0.069	1991
1	19.591	**43.487**	**3.596**	**0.737**	**0.457**	0.153	0.136	1992
1	16.288	**10.473**	**7.903**	**0.861**	**0.183**	0.136	0.061	1993
1	16.112	**42.737**	**6.155**	**2.389**	**0.213**	0.082	0.073	1994
1	10.864	**22.282**	**17.419**	**1.468**	**0.762**	0.068	0.07	1995
1	68.916	**10.283**	**5.327**	**1.833**	**0.39**	0.183	0.036	1996
1	0.13	**60.518**	**5.471**	**1.659**	**0.636**	0.13	0.125	1997
1	91.708	**2.397**	**20.057**	**1.294**	**0.386**	0.235	0.117	1998
1	9.543	**11.952**	**0.961**	**3.863**	**0.291**	0.089	0.037	1999
1	1.845	**10.689**	**2.294**	**0.205**	**0.523**	0.075	0.09	2000
1	4.669	**4.723**	**5.533**	**0.792**	**0.15**	0.153	0.145	2001
1	0.767	**11.334**	**2.117**	**1.557**	**0.439**	0.1	0.046	2002
1	12.854	**1.735**	**2.475**	**0.516**	**0.483**	0.401	0.504	2003
1	2.287	**12.178**	**1.703**	**1.088**	**0.202**	0.143	0.046	2004
1	13.755	**4.745**	**2.062**	**0.622**	**0.218**	0.049	0.124	2005

Table 14.8b Cod 347d: Survey tuning cpue data not used in the assessment

ENGGFS_IV_GOV											
1992	2005										
1	1	0.5	0.75								
0	5										
1	2605.264	3727.114	241.162	70.695	54.588	12.080	2.361	0.000	2.957	0.000	1992
1	576.607	1129.616	990.522	125.138	24.173	24.852	3.056	9.686	2.264	0.000	1993
1	3226.821	4081.570	471.312	233.428	28.295	7.553	9.348	0.000	2.361	2.830	1994
1	40.040	1721.070	2019.148	183.599	84.485	2.474	2.474	2.474	0.000	2.474	1995
1	6281.622	1020.414	1100.099	260.179	29.121	30.366	0.000	0.000	0.000	0.000	1996
1	7.455	6483.819	449.466	86.531	40.150	2.361	9.446	0.000	0.000	2.264	1997
1	596.166	179.040	2122.869	125.029	12.646	10.285	7.455	2.264	2.361	0.000	1998
1	144.660	551.768	84.032	359.557	19.730	9.446	0.000	0.000	0.000	0.000	1999
1	60.500	1448.220	299.624	22.935	48.352	0.000	4.523	0.000	0.000	0.000	2000
1	39.754	265.961	804.084	49.128	2.830	6.987	2.361	0.000	0.000	0.000	2001
1	28.292	1207.859	222.010	193.290	25.423	0.000	0.000	0.000	0.000	0.000	2002
1	36.616	202.659	272.022	65.351	49.084	5.310	5.481	3.056	0.000	0.000	2003
1	37.310	527.205	186.276	49.733	11.865	14.695	2.830	0.000	0.000	0.000	2004
1	354.274	297.897	277.403	50.246	10.043	2.361	8.021	3.542	0.000	0.000	2005
SCOGFS_IV											
1982	2006										
1	1	0.5	0.75								
1	5										
100	61.4	35.1	57.2	18.3	9.2	5.9	1.4	0.5			1982
100	32.5	78	18.1	19.7	7.5	2.3	1.5	0			1983
100	81.9	39.1	25.3	5	5.7	1.6	0.5	0.2			1984
100	6.6	114.3	19.7	11.2	3	2.4	0.6	1			1985
100	80.1	10.4	39.6	5.7	3.9	1.9	0.6	0			1986
100	21.9	69.5	3.4	9.2	2.9	0.7	0.2	0			1987
100	16.2	28.8	16.5	2.5	3.3	1.2	0.4	0			1988
100	56.1	13.5	16.8	9.5	2	0.8	0.5	0			1989
100	11.4	49	5.9	7.4	2.6	0.9	0.8	0			1990
100	30.3	15.4	13.3	1.3	0.6	0.4	0.2	0			1991
100	64.2	19.3	7.2	6.7	2.9	1.8	1.2	0.2			1992
100	34.7	74.9	10.1	2.5	1.2	0.3	0	0.1			1993
100	115.8	33.4	28.8	3.1	1.2	0.7	0.2	0			1994
100	47.5	144.3	13	8.5	1.1	0.7	0.4	0			1995
100	31.8	35.6	54.2	7.4	3.4	0.4	0	0			1996
100	99.9	27.8	22.4	10.2	2.2	1	0.2	0			1997
100	10.4	213.4	11.6	5.7	3.7	0.8	0.2	0			1998
100	44	10.3	61.6	2.7	1	0.6	0.3	0			1999
100	70	23.7	2.8	4.4	0	0.8	0.3	0			2000
100	6.9	40.9	6.8	0.3	1.8	0	0	0			2001
100	27.4	12	21.5	1.1	0.6	0.5	0	0			2002
100	11.9	29.4	3.5	5.1	0.5	0	0	0			2003
100	21.5	21.2	27.8	3.4	2.1	0	0	0			2004
100	12	11.5	2.8	0.3	0.8	0.3	0.3	0			2005
100	43.2	8.1	1.9	0.9	0	0	0	0			2006
FRAgfs											
1991	2003										
1	1	0.75	0.85								
1	3										
1	0	0.117	0.057								
1	1.598	0.082	0.137								
1	0.1	0	0.308								
1	2.592	0	0.219								
1	2.652	0.31	0.093								
1	0.154	0.969	0.259								
1	32.85	0.158	0.149								
1	0.214	6.311	0.385								
1	6.253	0.18	0.63								
1	2.194	0.687	0.125								
1	0.402	0.495	0.33								
1	6.088	0.17	0.025								
1	0.059	1.019	0.033								

Table 14.8c Cod 347d: Commercial tuning cpue data not used in the assessment

SCOTRL_IV

1978	2005									
1	1	0	1							
1	10									
135220	409.35	1474.50	285.88	181.93	63.97	15.99	12.00	7.00	3.00	1.00
87467	279.84	925.26	447.24	73.88	46.92	22.96	11.98	3.99	2.99	1.00
55475	247.88	921.57	379.33	127.39	19.96	19.96	7.61	6.65	0.95	1.90
51553	109.31	992.90	387.68	113.70	51.26	13.98	5.59	1.86	0.93	0.93
47889	708.23	310.45	392.91	73.24	17.39	6.41	2.75	0.92	0.92	0.00
48339	358.35	1471.04	208.38	112.43	23.26	9.69	1.94	0.00	0.00	0.97
34574	459.21	787.66	346.03	32.73	16.83	7.48	0.94	0.94	0.00	0.00
33103	177.58	1003.98	196.00	79.31	9.12	4.56	2.73	0.91	0.91	0.00
27839	619.73	194.48	256.04	19.91	10.43	0.95	0.95	0.00	0.00	0.00
27208	294.47	891.52	38.46	39.40	8.44	1.88	0.00	0.94	0.00	0.00
21559	32.13	374.38	159.51	8.08	8.08	4.04	1.01	1.01	0.00	0.00
16657	398.09	62.99	136.74	40.93	2.97	2.23	1.19	0.19	0.73	0.08
14325	70.02	427.76	18.80	22.49	5.12	1.21	1.00	0.23	0.00	0.00
13495	135.02	109.50	103.95	7.73	7.00	1.72	0.48	0.00	0.03	0.00
10887	797.19	103.85	30.24	33.29	1.15	1.21	0.12	0.03	0.05	0.00
11657	66.56	197.39	31.23	4.27	6.33	0.63	0.06	0.00	0.00	0.00
15671	157.27	41.90	124.96	9.46	1.71	1.66	0.52	0.37	0.00	0.00
17728	71.63	482.13	93.74	49.03	1.50	0.47	0.54	0.03	0.02	0.20
13471	6.35	142.44	108.38	23.91	15.04	1.58	0.20	0.36	0.00	0.02
12651	305.51	88.37	91.36	26.79	4.99	2.98	0.73	0.10	0.01	0.00
25744	242.26	1475.28	161.57	91.33	20.55	6.61	3.32	0.71	0.01	0.17
23859	106.70	127.22	819.22	45.34	23.23	5.97	4.04	2.01	0.42	0.36
21320	649.46	581.59	76.82	164.58	25.92	14.45	7.80	1.01	0.29	0.11
11897	183.86	977.54	107.30	12.17	20.42	3.53	1.52	0.87	0.33	0.09
10480	238.47	231.26	412.18	32.26	2.91	10.84	3.30	2.04	1.03	0.00
7186	88.59	202.61	121.08	87.32	7.42	0.61	1.37	0.43	0.35	0.00
7491	75.42	224.25	140.60	32.51	36.29	3.95	0.54	0.57	0.42	0.00
7035	51.11	329.45	101.27	41.77	14.78	16.02	2.26	0.62	0.06	0.28

Table 14.8d Cod 347d: Commercial tuning cpue data not used in the assessment

SCOSEI_IV

1978	2005											
1	1	0	1									
1	12											
325246	3651.88	24305.32	1385.95	850.97	201.99	48.00	23.00	21.00	8.00	3.00	2.00	1.00
316419	11805.66	8634.84	3257.04	382.89	344.90	66.98	43.99	18.99	12.00	4.00	0.00	2.00
297227	44564.51	8048.98	2341.24	828.83	144.37	89.58	33.05	14.78	8.70	4.35	0.87	0.00
289672	4649.45	17426.21	2365.83	698.69	204.82	18.17	10.74	12.39	3.30	0.00	0.00	0.00
297730	17237.39	5730.45	6034.89	822.29	291.11	151.41	25.10	20.91	11.71	0.84	1.67	0.84
333168	5816.79	15348.75	1817.75	1289.70	227.49	98.35	39.34	18.82	15.39	2.57	4.28	0.00
388085	32443.86	11777.36	3784.82	453.75	381.26	108.29	46.54	25.95	6.26	7.16	3.58	1.79
382910	5076.41	22569.68	2515.93	835.29	127.19	107.34	26.16	24.36	9.92	3.61	3.61	0.00
425017	63834.96	3301.31	6910.34	824.86	285.82	42.83	38.17	13.96	7.45	2.79	2.79	0.00
418536	4526.89	25093.95	680.24	1423.57	283.43	186.52	24.69	35.66	15.54	4.57	1.83	0.91
377132	3832.94	9997.08	4672.05	201.99	471.98	132.00	56.00	16.00	10.00	3.00	3.00	4.00
355735	13456.02	4646.70	3251.37	1092.30	91.16	185.07	44.65	18.70	2.39	7.74	2.61	0.59
270869	5255.09	21460.95	1112.95	671.53	291.60	38.81	50.41	11.53	3.70	1.79	0.10	0.28
336675	8860.26	6493.98	3088.67	241.37	173.92	113.16	32.98	25.23	7.59	0.57	0.39	0.14
300217	10044.17	5956.93	942.46	618.21	97.90	59.25	31.81	8.85	8.42	3.23	1.00	1.48
268413	2947.92	9677.09	779.00	208.93	142.39	26.40	19.57	9.16	2.35	0.81	0.54	0.08
264738	10803.36	5124.05	2416.56	301.22	60.54	37.72	13.28	5.08	2.27	0.87	0.54	1.07
204545	7584.97	13810.35	916.64	496.57	84.52	21.56	16.62	0.91	0.97	0.90	1.27	0.22
177092	733.47	5540.03	2728.72	239.20	165.11	19.70	8.66	5.69	1.85	1.19	0.49	0.15
166817	6484.63	4257.16	1586.05	687.77	118.73	71.21	17.33	6.01	2.11	0.85	0.73	0.00
150361	454.31	15319.53	1250.24	423.30	287.30	46.10	29.68	4.19	0.99	0.80	0.25	0.00
93796	2589.31	748.77	3354.51	140.14	88.42	37.97	10.23	7.25	2.03	0.07	0.06	0.05
69505	2057.80	2319.91	115.11	401.66	55.63	24.22	9.99	5.28	1.82	0.16	0.12	0.00
36135	173.94	5090.06	307.77	24.82	64.28	10.45	5.35	2.02	1.59	0.86	0.12	0.02
21831	307.72	443.25	1315.38	93.79	14.34	23.18	2.67	1.92	0.62	0.28	0.18	0.00
15373	282.63	924.43	154.14	180.35	18.17	2.08	3.26	0.44	0.66	0.04	0.02	0.01
15670	455.83	556.96	293.38	46.26	60.58	8.62	1.38	0.94	0.19	0.40	0.00	0.00
16149	470.86	538.63	112.51	31.67	11.31	17.64	1.81	0.94	0.18	0.11	0.00	0.04

Table 14.8e Cod 347d: Commercial tuning cpue data not used in the assessment

SCOLTR_IV

1978	2005										
1	1	0	1								
1	11										
236929	3563.50	6140.81	670.88	269.95	50.99	28.00	7.00	8.00	5.00	0.00	1.00
207494	59063.64	5976.79	1808.12	178.01	61.00	15.00	3.00	4.00	2.00	0.00	0.00
333197	116771.27	5763.40	2100.71	549.20	71.40	15.87	4.41	3.53	0.88	0.00	0.00
251504	8520.90	5931.57	1475.44	293.61	81.84	10.97	5.91	0.00	0.00	0.00	0.84
250870	10234.89	3302.19	2303.32	377.38	110.00	39.35	8.05	6.26	3.58	5.37	0.00
244349	4298.24	6519.32	1020.72	459.82	111.15	31.37	14.34	5.38	2.69	0.90	0.90
240725	24925.01	3487.90	1544.07	180.37	85.68	36.07	9.92	7.21	2.71	0.00	0.00
268136	973.99	6897.39	865.99	293.65	39.34	21.04	3.66	2.74	0.91	0.91	0.00
279767	6008.82	1198.85	1849.55	250.97	95.65	12.31	8.52	4.74	1.89	0.95	0.00
351131	3343.45	7206.32	530.28	468.27	45.35	31.46	10.18	5.55	0.93	0.93	0.00
391988	718.78	3936.69	1919.60	133.37	148.42	33.09	14.04	2.01	1.00	0.00	1.00
405883	8549.30	1550.91	1616.05	565.71	48.61	45.24	13.34	3.38	0.89	0.26	1.05
398153	1367.28	9253.56	525.46	456.83	179.52	25.75	11.32	3.71	1.00	0.13	0.02
408056	5550.41	2470.33	2152.87	138.04	94.19	48.10	8.20	8.48	1.21	0.03	0.00
473955	14015.88	3034.78	748.36	646.73	44.08	36.37	11.91	2.05	2.02	0.22	0.12
447064	3493.38	6959.53	1262.56	163.98	80.12	9.89	5.16	3.79	0.42	0.21	0.21
480400	4978.66	2325.24	2367.07	370.59	47.31	42.37	5.79	2.35	0.30	0.22	0.14
442010	2420.85	9246.37	1579.93	797.17	73.99	8.58	6.86	0.64	0.88	0.55	0.11
445995	1436.90	5317.35	3114.51	424.15	296.50	31.73	9.56	5.48	1.11	0.80	0.11
479449	8339.78	3709.38	2809.41	808.33	112.98	114.51	10.29	0.95	1.94	3.07	1.07
427868	2486.34	17511.68	1694.54	675.57	193.14	36.47	31.48	2.84	0.23	0.23	0.10
329750	3712.02	1757.86	3913.76	299.83	160.48	45.77	13.62	7.65	1.84	0.63	0.04
280938	5732.99	3236.79	378.54	906.00	70.23	36.84	8.21	6.20	3.17	0.09	0.05
245489	318.08	6565.43	535.78	83.25	131.84	11.16	9.61	1.38	1.36	0.18	0.25
184103	1545.65	701.14	2072.43	171.27	38.54	34.31	9.56	8.87	3.94	0.86	0.01
98722	425.62	1290.52	317.54	433.84	25.28	5.62	6.89	0.70	0.75	0.03	0.08
63953	926.67	700.41	382.10	93.28	142.17	14.44	3.55	3.00	1.87	0.01	0.01
54905	561.57	1084.88	262.26	128.89	38.73	48.00	4.84	0.96	1.12	0.04	0.01

Table 14.8f Cod 347d: Commercial tuning cpue data not used in the assessment

ENGTRL_IV

1978	2005											
1	1	0	1									
1	12											
559930	4286.28	17150.92	1093.00	987.00	338.00	117.00	57.00	60.00	22.00	4.00	1.00	5.00
553020	53526.49	8150.57	3341.00	393.00	403.00	99.00	54.00	15.00	30.00	7.00	0.00	0.00
442036	77510.33	4851.41	2106.00	865.00	122.00	114.00	38.00	16.00	6.00	8.00	3.00	0.00
423658	12210.64	15133.98	1890.78	535.00	250.00	38.00	48.00	8.00	6.00	4.00	2.00	0.00
424272	17618.05	3652.63	3808.61	587.00	298.00	179.00	35.00	24.00	11.00	2.00	0.00	0.00
392364	5143.31	15130.79	1186.74	907.00	127.00	87.00	49.00	16.00	4.00	2.00	1.00	0.00
358387	36713.86	4141.78	2656.27	267.00	217.00	42.00	32.00	16.00	3.00	3.00	0.00	0.00
342844	3952.11	10221.10	1052.53	533.00	72.00	54.00	16.00	10.00	4.00	1.00	1.00	0.00
288867	38689.89	2339.11	2403.34	209.00	161.00	15.00	12.00	4.00	2.00	2.00	0.00	0.00
275899	1705.45	13419.24	682.00	596.00	36.00	26.00	3.00	4.00	2.00	1.00	1.00	0.00
296092	1806.40	2818.93	2436.24	90.00	126.00	17.00	10.00	0.00	2.00	0.00	0.00	0.00
310444	9209.52	2293.57	736.95	501.00	25.00	34.00	5.00	4.00	0.00	0.00	0.00	0.00
255314	2153.73	5290.26	515.77	134.00	101.00	11.00	13.00	4.00	1.00	0.00	0.00	0.00
258037	3416.51	1963.24	1113.92	88.00	25.00	17.00	2.00	2.00	0.00	0.00	0.00	0.00
223702	6218.85	2613.98	481.08	234.00	19.00	5.00	5.00	0.00	0.00	0.00	0.00	0.00
209869	2179.17	5417.09	442.50	96.00	55.00	5.00	3.00	2.00	0.00	1.00	0.00	0.00
184764	15928.13	3255.31	1154.46	78.19	14.28	7.04	1.76	0.67	0.85	0.02	0.06	0.00
173463	2737.63	5740.29	873.07	158.03	11.03	2.99	1.90	0.66	0.13	0.25	0.05	0.00
159155	1502.49	4428.23	1688.05	189.24	43.97	6.81	1.65	1.46	0.55	0.16	0.00	0.01
152030	3897.97	3372.26	892.04	334.56	41.12	14.84	2.06	0.78	0.29	0.08	0.17	0.00
161478	1842.66	22614.77	1858.42	243.07	77.42	12.37	4.03	0.81	0.33	0.09	0.00	0.00
137699	1781.07	878.03	2302.69	97.06	11.52	3.96	0.45	0.32	0.04	0.02	0.00	0.00
129140	2078.16	1845.98	154.42	143.88	10.04	1.25	0.26	0.17	0.07	0.03	0.00	0.03
111826	331.85	2258.87	270.95	7.98	5.02	0.54	0.21	0.06	0.00	0.00	0.00	0.00
69953	752.05	540.07	264.56	32.05	1.36	1.08	0.12	0.01	0.01	0.00	0.00	0.00
53661	217.27	582.10	69.02	25.01	2.91	0.19	0.20	0.02	0.02	0.01	0.00	0.00
42362	146.52	185.43	109.95	4.91	2.12	0.44	0.04	0.02	0.00	0.00	0.00	0.00
37563	81.43	168.37	53.57	11.16	1.75	0.38	0.01	0.01	0.00	0.00	0.00	0.00

Table 14.8g Cod 347d: Commercial tuning cpue data not used in the assessment

ENGSEI_IV

1978	2001											
1	1	0	1									
1	12											
203382	2605.23	17803.75	746.00	547.00	131.00	78.00	21.00	37.00	9.00	1.00	1.00	2.00
187180	39918.48	7335.21	2438.00	162.00	280.00	76.00	35.00	14.00	18.00	4.00	1.00	0.00
201169	80642.77	8866.30	1370.00	611.00	146.00	210.00	54.00	29.00	9.00	12.00	4.00	0.00
185423	9402.24	14588.24	1056.73	398.00	359.00	61.00	74.00	12.00	8.00	6.00	3.00	0.00
183209	10494.28	3583.17	2477.40	330.00	294.00	189.00	38.00	31.00	9.00	3.00	2.00	0.00
177004	3155.49	5273.11	574.02	557.00	207.00	150.00	104.00	18.00	17.00	8.00	3.00	2.00
167699	21674.56	1932.85	1215.17	147.00	290.00	72.00	50.00	32.00	6.00	5.00	1.00	0.00
157815	1915.81	4339.90	329.02	241.00	72.00	117.00	40.00	27.00	13.00	4.00	2.00	0.00
136358	11817.84	397.71	577.66	65.00	139.00	34.00	52.00	13.00	7.00	7.00	2.00	1.00
123281	753.42	3560.34	82.00	184.00	44.00	77.00	10.00	22.00	8.00	2.00	1.00	0.00
91178	519.81	1131.19	596.90	19.00	80.00	19.00	12.00	3.00	3.00	1.00	0.00	0.00
88782	3614.58	881.49	223.54	138.00	9.00	46.00	7.00	8.00	1.00	2.00	0.00	1.00
80537	731.68	1778.59	116.97	45.00	58.00	4.00	15.00	3.00	1.00	1.00	0.00	0.00
84346	971.71	396.30	214.28	33.00	26.00	38.00	6.00	16.00	1.00	1.00	1.00	0.00
67810	1586.26	572.75	57.02	42.00	10.00	8.00	8.00	2.00	3.00	0.00	0.00	0.00
54574	288.52	705.42	41.08	19.00	22.00	4.00	3.00	2.00	0.00	1.00	0.00	0.00
39667	2478.60	391.56	139.77	11.37	17.04	14.11	3.08	0.89	0.52	0.07	0.28	0.07
28406	356.65	713.63	83.35	21.00	5.22	3.74	5.62	3.04	0.61	0.16	0.76	0.09
14991	95.14	310.38	170.73	19.59	16.88	4.43	1.54	1.14	0.15	0.24	0.00	0.00
11823	207.10	113.41	35.41	27.91	6.12	5.28	1.70	0.33	0.36	0.26	0.02	0.00
10664	50.76	578.15	38.14	9.67	11.58	3.73	2.00	0.38	0.13	0.11	0.00	0.00
9720	113.26	41.63	107.02	2.90	1.30	0.93	0.33	0.07	0.01	0.01	0.00	0.00
10230	88.75	69.34	2.28	7.20	0.77	0.85	0.44	0.12	0.17	0.00	0.00	0.01
8885	4.44	38.42	3.40	0.25	1.05	0.06	0.12	0.02	0.01	0.00	0.00	0.00

Table 14.9a Cod 347d: B-ADAPT tuning model specification

Lowestoft VPA Program
12/09/2006 8:33
Adapt Analysis
North Sea/Skagerrak/Eastern Channel Cod Tuning data. INCLUDES DISCARDS

CPUE data from file cod347_2006.tun

Catch data for 43 years : 1963 to 2005. Ages 1 to 7+

Fleet	First year	Last year	First age	Last age	Alpha	Beta
IBTS_Q1_IV	1983	2006	1	5	0	0.25
IBTS_Q3	1991	2005	1	4	0.5	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Fleet	PowerQ ages<x	QPlateau ages>x
IBTS_Q1_IV	1	4
IBTS_Q3	1	3

Catchability independent of stock size for all ages

Bias estimation : Bias estimated for the final 13 years.
Oldest age F estimates in 1963 to 2006 calculated as 1.000 * the mean F of ages 3- 5
Total catch penalty applied lambda = 0.500

Individual fleet weighting not applied

INITIAL SSQ =	33.6274	SSQ =	27.52783	IFAIL =	0
PARAMETERS =	18	QSSQ =	26.73227	IFAILCV =	0
OBSERVATIONS =	193	CSSQ =	0.79556		

Table 14.9b Cod 347d: B-ADAPT IBTSQ1 tuning diagnostics

Fleet : IBTS_Q1_IV

Log index residuals

Age	1983	1984	1985	1986
1	-0.49	-0.41	-1.59	-0.5
2	0.09	0	0.13	-0.22
3	-0.06	-0.16	0.07	0.34
4	-0.18	0.02	0.01	0.72
5	0.3	0.28	0.42	0.71

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.37	0.27	0.29	0.07	-0.68	0.21	0.95	-0.23	0.15	-0.31
2	0.35	-0.26	0.17	0.43	0.13	-0.23	0.52	-0.36	0.3	-0.2
3	-0.05	0.03	0.63	0	0.43	-0.33	-0.03	-0.26	0.01	0.22
4	0.05	0.07	0.24	0.15	0.2	-0.07	-0.04	0.13	-0.33	-0.27
5	0.62	0.45	0.69	0.52	0.32	0.12	0.41	0.82	0.01	0.24

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.91	0.26	-0.55	0.03	0.33	0.71	-1.02	0.96	0.26	99.99
2	0.07	0.26	-0.48	-0.06	0.06	0.13	-0.5	0.1	-0.44	-0.35
3	-0.3	-0.32	0.34	-0.27	0.13	0.26	-0.29	-0.06	-0.35	-0.24
4	-0.24	-0.24	-0.03	0.57	-0.16	-0.26	0.19	-0.49	-0.03	0.02
5	0.52	0.1	0.41	0.82	0.43	0.22	1.1	0.41	0.35	0.03

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5
Mean Log	-10.7836	-9.4792	-9.1935	-8.9822	-8.9822
S.E(Log q)	0.6354	0.2895	0.2728	0.2771	0.5246

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.05	-0.268	10.7	0.61	23	0.67968	-10.78
2	0.82	2.746	9.85	0.92	23	0.20934	-9.48
3	0.82	2.257	9.39	0.88	23	0.20562	-9.19
4	0.91	0.869	8.99	0.8	23	0.25221	-8.98
5	1.12	-0.996	8.61	0.76	23	0.29082	-8.54

Table 14.9c Cod 347d: –XSA/ADAPT IBTSQ3 tuning diagnostics

Fleet : IBTS_Q3

Log index residuals

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	99.99	99.99	99.99	99.99	-0.31	0.58	-0.15	0.12	0.11	-0.15
2	99.99	99.99	99.99	99.99	-0.18	-0.07	0.07	0.26	0.56	-0.13
3	99.99	99.99	99.99	99.99	-0.2	-0.22	-0.15	0.18	0.14	-0.12
4	99.99	99.99	99.99	99.99	-0.66	-0.05	-0.45	-0.44	0.14	0.07
5	No data for this fleet at this age									

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.41	-0.73	0.37	-0.38	-0.11	0.18	-0.75	0.62	0.21	99.99
2	0.11	0.47	-0.64	-0.15	-0.07	-0.16	-0.12	0.13	-0.09	99.99
3	0.06	0.05	0.6	-0.7	-0.03	-0.04	-0.33	0.37	0.39	99.99
4	0.05	-0.11	0.05	0.28	0.2	0.56	0.08	-0.07	0.02	99.99
5	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4
Mean Log	-9.3618	-9.2091	-9.2692	-9.2692
S.E(Log q)	0.4251	0.2888	0.3191	0.3068

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	0.82	1.564	9.91	0.86	15	0.33267	-9.36
2	0.79	3.127	9.67	0.94	15	0.17832	-9.21
3	0.84	1.268	9.41	0.83	15	0.26315	-9.27
4	0.96	0.194	9.28	0.7	15	0.3059	-9.29

Table 14.9d Cod 347d: B-ADAPT parameter estimates

Parameters

Age	Survivors	s.e log est
1	27561.72	0.278
2	13426.97	0.297
3	2683.30	0.301
4	1338.55	0.310
5	357.28	0.930

Year	Multiplier	s.e log est
1993	1.259	0.214
1994	1.021	0.244
1995	1.443	0.223
1996	1.505	0.212
1997	1.007	0.240
1998	1.114	0.206
1999	1.261	0.210
2000	1.162	0.207
2001	1.088	0.246
2002	1.456	0.226
2003	2.357	0.202
2004	1.237	0.262
2005	2.091	0.239

Variance covariance matrix

0.078	0.003	0.005	0.004	0.006	0.006	0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.006
0.003	0.088	0.006	0.006	0.026	0.006	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.006	0.007
0.005	0.006	0.091	0.005	0.036	0.006	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.005	-0.001
0.004	0.006	0.005	0.096	-0.004	0.006	0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.003	0.002
0.006	0.026	0.036	-0.004	0.865	0.005	0.003	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.001	-0.003	-0.032
0.006	0.006	0.006	0.006	0.005	0.046	-0.003	0.003	0.006	0.007	0.006	0.006	0.006	0.006	0.006	0.006	0.007
0.005	0.004	0.004	0.005	0.003	-0.003	0.060	-0.008	0.001	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
0.004	0.004	0.004	0.004	0.002	0.003	-0.008	0.050	-0.007	0.001	0.005	0.004	0.004	0.004	0.004	0.004	0.004
0.004	0.004	0.004	0.004	0.003	0.006	0.001	-0.007	0.045	-0.005	0.001	0.005	0.005	0.004	0.004	0.004	0.004
0.004	0.004	0.004	0.004	0.003	0.007	0.005	0.001	-0.005	0.058	-0.008	0.002	0.005	0.005	0.004	0.004	0.004
0.004	0.004	0.004	0.004	0.003	0.006	0.005	0.005	0.001	-0.008	0.042	-0.006	0.003	0.005	0.005	0.004	0.005
0.004	0.004	0.004	0.004	0.003	0.006	0.005	0.004	0.005	0.002	-0.006	0.044	-0.006	0.003	0.005	0.004	0.004
0.004	0.004	0.004	0.004	0.003	0.006	0.005	0.004	0.005	0.005	0.003	-0.006	0.043	-0.003	0.000	0.005	0.005
0.004	0.004	0.004	0.004	0.003	0.006	0.005	0.004	0.004	0.005	0.005	0.003	-0.003	0.060	-0.009	0.002	0.005
0.004	0.004	0.005	0.005	0.001	0.006	0.005	0.004	0.004	0.004	0.005	0.005	0.000	-0.009	0.051	-0.007	0.001
0.005	0.006	0.005	0.003	-0.003	0.006	0.005	0.004	0.004	0.004	0.004	0.004	0.005	0.002	-0.007	0.041	-0.004
0.006	0.007	-0.001	0.002	-0.032	0.007	0.005	0.004	0.004	0.004	0.005	0.004	0.005	0.005	0.001	-0.004	0.068
0.000	-0.012	-0.011	-0.007	-0.082	0.007	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.001	-0.007

Table 14.10 Cod 347d: B-ADAPT median fishing mortality at age.

At 12/09/2006 8:34

Table 8 Fishing mortality (F) at age

AGE\YEAR	1963	1964	1965
1	0.1307	0.0487	0.3157
2	0.7065	0.4656	0.5105
3	0.3951	0.6023	0.6849
4	0.5009	0.4628	0.6372
5	0.4232	0.5623	0.5077
6	0.4397	0.5425	0.6099
+gp	0.4397	0.5425	0.6099
FBAR 2- 4	0.5342	0.5102	0.6109

AGE\YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	0.2953	0.1554	0.2259	0.0352	0.1817	0.3671	0.2552	0.4107	0.5415	0.3245
2	0.6941	0.6354	0.7478	0.5262	0.6908	1.0117	1.0478	0.9380	0.9533	0.9049
3	0.6194	0.7507	0.7724	0.5983	0.7531	0.7932	0.9151	0.8348	0.6865	0.8023
4	0.5655	0.5215	0.7559	0.6358	0.5680	0.7178	0.6965	0.7979	0.6386	0.7011
5	0.5131	0.6741	0.5989	0.7104	0.6892	0.6858	0.7289	0.6496	0.6751	0.7361
6	0.5660	0.6488	0.7091	0.6482	0.6701	0.7323	0.7802	0.7608	0.6668	0.7465
+gp	0.5660	0.6488	0.7091	0.6482	0.6701	0.7323	0.7802	0.7608	0.6668	0.7465
FBAR 2- 4	0.6263	0.6359	0.7587	0.5868	0.6706	0.8409	0.8865	0.8569	0.7595	0.8028

AGE\YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.6564	0.6161	0.1740	0.9836	1.0840	0.6057	0.5075	0.3169	0.8906	0.5052
2	1.3386	1.2759	1.2662	0.8271	0.9735	1.0755	1.0105	1.1285	1.0575	1.1502
3	0.9001	0.8020	0.9601	0.9553	0.9979	1.0208	1.2422	1.1985	1.0094	0.9709
4	0.8003	0.6047	0.8200	0.6475	0.8128	0.8122	0.9501	0.9494	0.8589	0.8001
5	0.6233	0.7142	1.0656	0.8167	0.7775	0.7194	0.8892	0.8531	0.8205	0.7708
6	0.7746	0.7070	0.9485	0.8065	0.8627	0.8508	1.0271	1.0004	0.8963	0.8473
+gp	0.7746	0.7070	0.9485	0.8065	0.8627	0.8508	1.0271	1.0004	0.8963	0.8473
FBAR 2- 4	1.0130	0.8942	1.0154	0.8099	0.9281	0.9695	1.0676	1.0922	0.9753	0.9737

AGE\YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.8302	0.2237	0.2529	0.5748	0.3832	0.3890	0.3835	0.2869	0.6277	0.2978
2	0.9997	1.1579	1.0634	0.9956	1.2914	0.8909	0.8928	1.1083	0.7727	1.1358
3	1.0681	0.9204	1.1752	1.0979	0.9644	0.9348	0.7626	1.0687	0.8659	1.0491
4	0.9885	0.9434	0.9354	0.9983	0.8820	0.8333	0.8350	1.0589	0.7732	0.8648
5	0.8493	0.7886	0.8273	0.9278	0.7457	0.8089	0.7128	0.9721	0.7321	0.6936
6	0.9686	0.8842	0.9793	1.0080	0.8640	0.8591	0.7701	1.0334	0.7903	0.8691
+gp	0.9686	0.8842	0.9793	1.0080	0.8640	0.8591	0.7701	1.0334	0.7903	0.8691
FBAR 2- 4	1.0188	1.0073	1.0580	1.0306	1.0459	0.8863	0.8301	1.0787	0.8040	1.0166

AGE\YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.1721	0.2376	0.2417	0.4026	0.2354	0.1378	0.2263	0.3493	0.2517	0.377
2	1.1027	0.8396	1.0771	0.8808	0.9543	0.9169	0.5092	1.0993	0.7885	0.803
3	1.2236	1.0442	1.1177	1.6056	1.2505	0.8312	1.0175	0.9416	0.9783	0.872
4	0.9739	0.9655	1.0554	1.3265	1.3378	0.9012	1.0783	0.9629	0.9619	0.900
5	1.0235	0.9124	1.0409	1.2675	1.4246	0.9006	1.0274	1.1082	0.7435	0.689
6	1.0740	0.9743	1.0707	1.3996	1.3376	0.8776	1.0409	1.0029	0.8966	0.830
+gp	1.0740	0.9743	1.0707	1.3996	1.3376	0.8776	1.0409	1.0029	0.8966	0.830
FBAR 2- 4	1.1001	0.9498	1.0834	1.2710	1.1809	0.8831	0.8683	1.0013	0.9096	0.859

Table 14.11 Cod 347d: B-ADAPT median population numbers at age.

At 12/09/2006 8:34

Table 10 Stock number at age (start of year) Numbers*10**-3

AGE/YEAR	1963	1964	1965
1	228540	399440	600419
2	143487	90105	170946
3	24260	49885	39859
4	9821	12727	21273
5	8853	4873	6560
6	3734	4747	2274
+gp	1823	2157	2608
TOTAL	420520	563935	843939

AGE/YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	708510	612282	262675	228851	930946	1407998	268138	471634	470721	876157
2	196744	236947	235526	94166	99272	348820	438245	93345	140541	123065
3	72302	69256	88447	78577	39207	35061	89377	108306	25746	38174
4	15650	30311	25460	31816	33643	14379	12353	27877	36604	10092
5	9209	7278	14731	9789	13793	15608	5743	5040	10277	15824
6	3232	4514	3037	6626	3939	5669	6436	2269	2155	4283
+gp	2812	3289	3146	2932	3339	3673	5654	3782	3216	2139
TOTAL	1008461	963876	633023	452759	1124139	1831208	825947	712252	689260	1069735

AGE/YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	675946	1668609	528504	1350157	2566638	544676	883775	425492	1409436	256980
2	284582	157542	404910	199542	226882	390097	133547	239055	139260	259927
3	35087	52583	30994	80438	61496	60395	93776	34259	54497	34085
4	13327	11109	18365	9242	24100	17657	16947	21089	8048	15468
5	4098	4901	4968	6622	3960	8753	6417	5366	6681	2791
6	6206	1799	1965	1401	2396	1490	3490	2159	1872	2408
+gp	2481	4090	1858	1484	1595	1634	1327	1573	1478	1278
TOTAL	1021728	1900634	991563	1648887	2887066	1024701	1139279	728992	1621272	572938

AGE/YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	1626311	354536	236239	641863	204408	270551	586692	278045	1040949	461022
2	69669	318570	127358	82416	162283	62551	82301	181519	93078	247068
3	57986	18067	70523	30987	21457	31432	18082	24045	41767	30036
4	10054	15519	5605	16957	8050	6368	9612	6646	6372	13527
5	5690	3063	4946	1801	5116	2727	2265	3456	1869	2375
6	1057	1992	1140	1770	583	1986	994	920	1058	728
+gp	1511	1047	809	784	837	765	907	747	518	573
TOTAL	1772278	712794	446619	776577	402733	376379	700852	495378	1185612	755330

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	260284	838168	111524	203791	363392	107358	198782	89142	133656	92940	0
2	152926	98622	298482	38929	61703	130218	42009	69782	28844	46611	28625
3	55741	35839	29978	70847	11437	16997	36086	17433	16840	9148	14449
4	8188	12773	9813	7530	11224	2589	5660	9899	5403	4856	2937
5	4666	2522	3984	2763	1660	2447	845	1538	3177	1685	1584
6	971	1369	830	1138	645	332	800	241	429	1222	671
+gp	741	469	504	618	341	305	232	261	220	203	502
TOTAL	483517	989761	455115	325616	450403	260246	284416	188297	188568	156664	48767

Table 14.12 Cod 347d: B-ADAPT median stock and management metrics.

Run title : North Sea/Skagerrak/Eastern Channel Cod
Tuning data. INCLUDES DISCARDS
At 12/09/2006 8:34

B_ADAPT Median values

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	CATCH	YIELD/SSB	FBAR 2- 4
1963	228540	413071	157257	128686	0.818	0.534
1964	399443	482315	158695	130740	0.824	0.510
1965	600416	630354	184554	210237	1.139	0.611
1966	708510	759390	213361	259416	1.216	0.626
1967	612282	800508	236547	276387	1.168	0.636
1968	262676	718662	242373	305911	1.262	0.759
1969	228850	585188	240302	205510	0.855	0.587
1970	930946	866955	249236	243867	0.978	0.671
1971	1407998	1062013	252747	412264	1.631	0.841
1972	268139	780669	230917	387737	1.679	0.886
1973	471632	617157	195341	269139	1.378	0.857
1974	470719	596439	224052	253989	1.134	0.760
1975	876154	654859	202909	242349	1.194	0.803
1976	675946	593758	172324	307102	1.782	1.013
1977	1668615	854151	155895	349038	2.239	0.894
1978	528504	737068	144003	328585	2.282	1.015
1979	1350162	880983	149493	430688	2.881	0.810
1980	2566638	1159434	170284	590678	3.469	0.928
1981	544678	785346	181697	393451	2.165	0.970
1982	883780	771573	176435	359372	2.037	1.068
1983	425491	596833	142449	281696	1.978	1.092
1984	1409448	779630	125187	379974	3.035	0.975
1985	256980	478360	118028	247031	2.093	0.974
1986	1626335	732367	109157	341047	3.124	1.019
1987	354537	540585	101934	244809	2.402	1.007
1988	236236	410934	92697	194798	2.101	1.058
1989	641991	459350	87474	202639	2.317	1.031
1990	204418	311336	75969	153021	2.014	1.046
1991	270675	290415	72207	121204	1.679	0.886
1992	587019	430806	72303	151755	2.099	0.830
1993	276666	369565	74833	177953	2.378	1.079
1994	1040573	538389	71244	214793	3.015	0.804
1995	462448	541105	90769	233088	2.568	1.017
1996	260881	438423	97702	206286	2.111	1.100
1997	844543	562604	84833	175940	2.074	0.950
1998	111400	346435	72236	183470	2.540	1.083
1999	204579	249845	68702	139749	2.034	1.271
2000	361059	254951	45933	96271	2.096	1.181
2001	106642	180588	35504	77199	2.174	0.883
2002	196645	225017	43003	81842	1.903	0.868
2003	89481	148645	40023	75704	1.891	1.001
2004	132136	130128	37196	51913	1.396	0.910
2005	92139	128231	35855	54745	1.527	0.859

Table 14.13 Cod 347d: B-ADAPT median term forecast for a 15% reduction in effort in 2006 held constant for 2007 - 2010.

	2005	2006	2007	2008
F multiplier	1.000	0.850	0.850	0.850

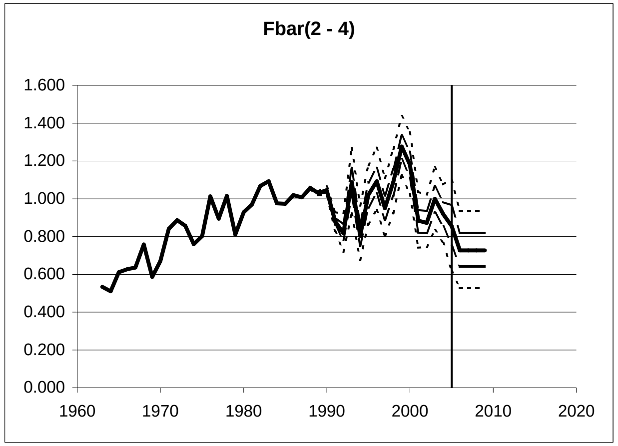
Fbar(2-4)	Year			
Percentile	2005	2006	2007	2008
0.05	0.62	0.53	0.53	0.53
0.25	0.76	0.64	0.64	0.64
0.5	0.86	0.73	0.73	0.73
0.75	0.96	0.82	0.82	0.82
0.95	1.10	0.93	0.93	0.93

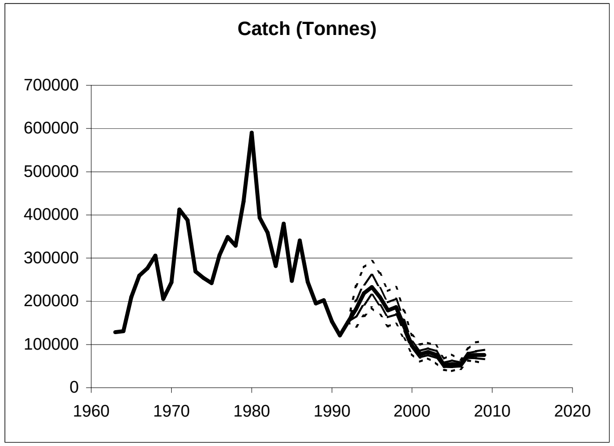
SSB	Year			
Percentile	2005	2006	2007	2008
0.05	30500	25914	26113	30063
0.25	33626	28782	31343	38472
0.5	36144	31542	35655	45883
0.75	38966	34951	41202	54578
0.95	43318	39631	50032	69628

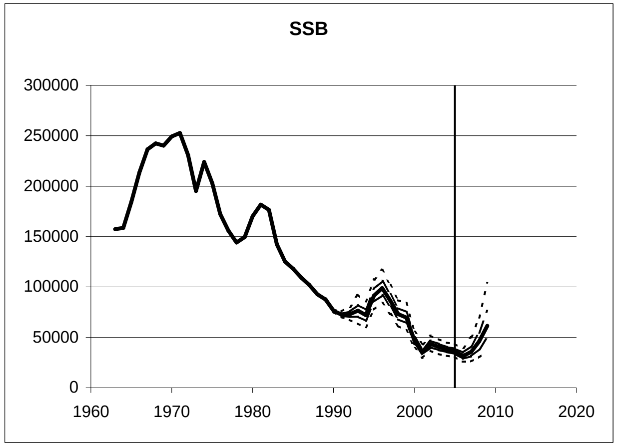
Catch	Year			
Percentile	2005	2006	2007	2008
0.05	38509	43349	62801	60545
0.25	47861	49389	69124	68234
0.5	54720	53748	74499	75526
0.75	63192	58424	79951	84443
0.95	76938	64909	89801	104971

P(SSBYear > SSB 2005)				
2006	2007	2008	2009	2010
0.18	0.49	0.78	0.92	0.90

In year SSB change		
2005	2006	2007
0.87	1.13	1.29







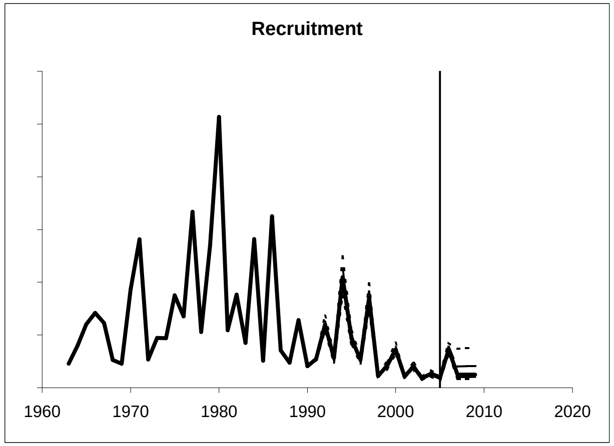


Table 14.14 Cod 347d: B-ADAPT median term forecast for a 15% reduction in effort in 2006 follwed by a further 10% in 2007 held constant for 2008 - 2010

	2005	2006	2007	2008
F multiplier	1.000	0.850	0.765	0.765

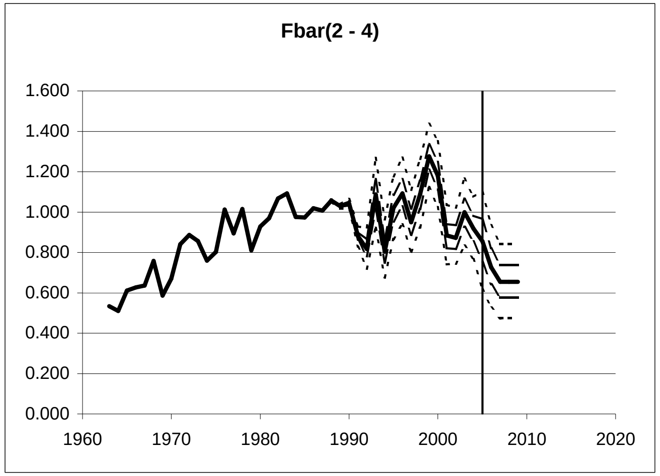
Fbar(2-4)	Year			
Percentile	2005	2006	2007	2008
0.05	0.62	0.53	0.47	0.47
0.25	0.76	0.64	0.58	0.58
0.5	0.86	0.73	0.65	0.65
0.75	0.96	0.82	0.74	0.74
0.95	1.10	0.93	0.84	0.84

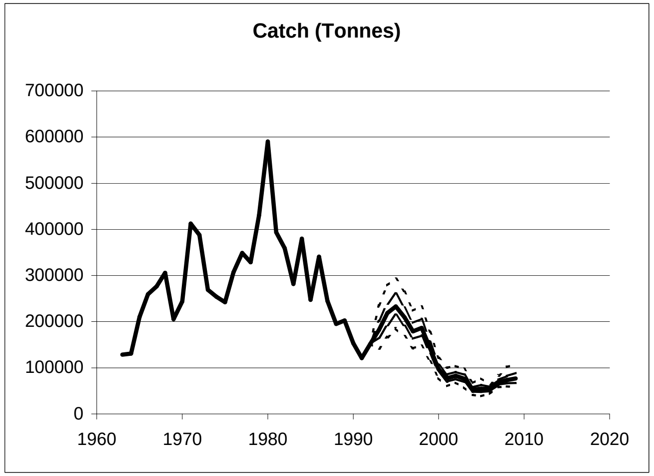
SSB	Year			
Percentile	2005	2006	2007	2008
0.05	30500	25914	26113	32805
0.25	33626	28782	31343	41530
0.5	36144	31542	35655	49111
0.75	38966	34951	41202	57892
0.95	43318	39631	50032	73354

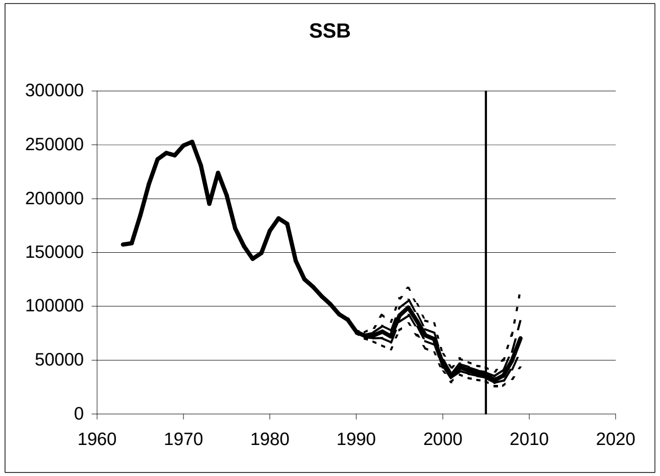
Catch	Year			
Percentile	2005	2006	2007	2008
0.05	38509	43349	57912	59710
0.25	47861	49389	63776	66693
0.5	54720	53748	68948	73663
0.75	63192	58424	74181	82158
0.95	76938	64909	83112	101619

P(SSBYear > SSB 2005)				
2006	2007	2008	2009	2010
0.18	0.49	0.85	0.97	0.96

In year SSB change		
2005	2006	2007
0.87	1.13	1.38







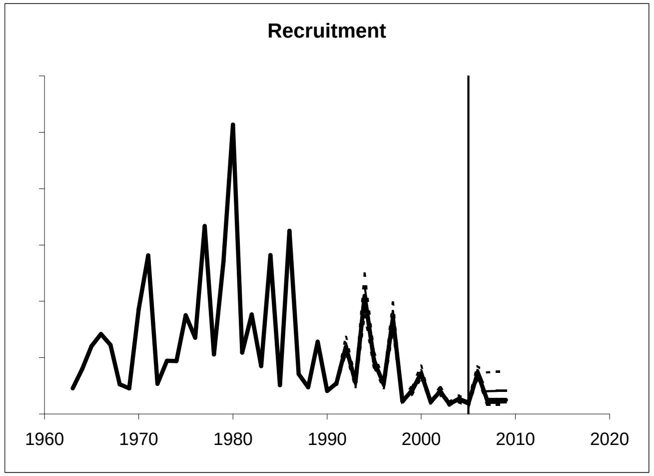


Table 14.15 Cod 347d: B-ADAPT median term forecast for a 15% reduction in effort in 2006 follwed by a further 15% in 2007 held constant for 2008 - 2010

	2005	2006	2007	2008
F multiplier	1.000	0.850	0.723	0.723

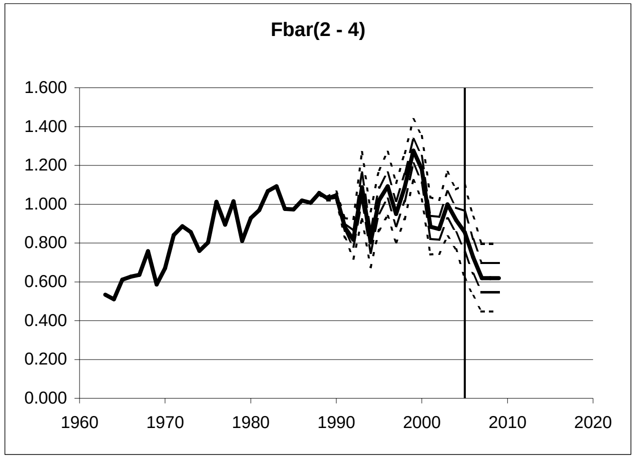
Fbar(2-4)	Year			
Percentile	2005	2006	2007	2008
0.05	0.62	0.53	0.45	0.45
0.25	0.76	0.64	0.55	0.55
0.5	0.86	0.73	0.62	0.62
0.75	0.96	0.82	0.70	0.70
0.95	1.10	0.93	0.80	0.80

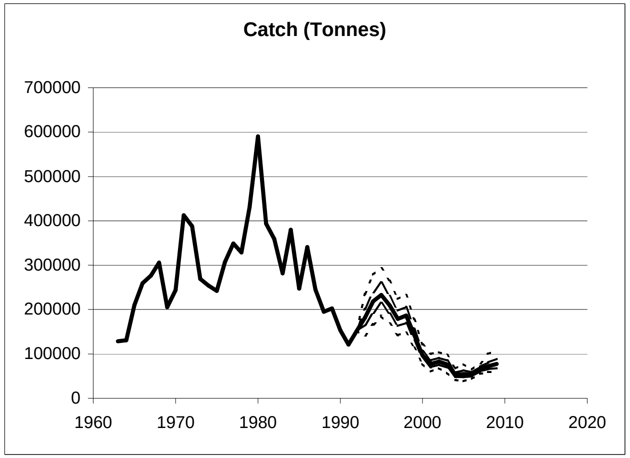
SSB	Year			
Percentile	2005	2006	2007	2008
0.05	30500	25914	26113	34262
0.25	33626	28782	31343	43226
0.5	36144	31542	35655	50788
0.75	38966	34951	41202	59679
0.95	43318	39631	50032	75135

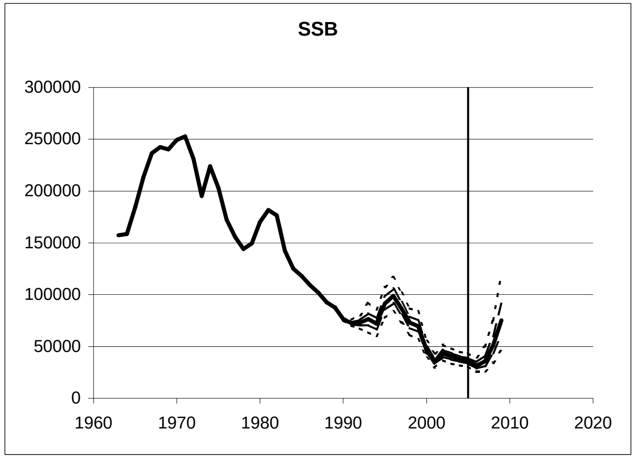
Catch	Year			
Percentile	2005	2006	2007	2008
0.05	38509	43349	55314	58695
0.25	47861	49389	61077	65745
0.5	54720	53748	66110	72504
0.75	63192	58424	71145	80695
0.95	76938	64909	79466	99833

P(SSBYear > SSB 2005)				
2006	2007	2008	2009	2010
0.18	0.49	0.88	0.98	0.98

In year SSB change		
2005	2006	2007
0.87	1.13	1.42







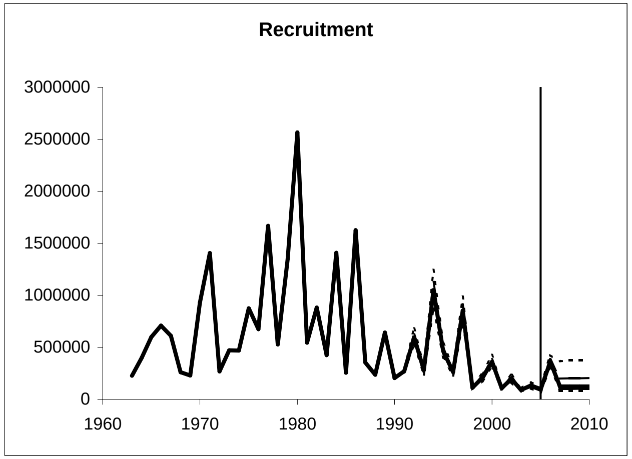


Table 14.16 Cod 347d: B-ADAPT median term forecast for a 15% reduction in effort in 2006 follwed by a further 20% in 2007 held constant for 2008 - 2010

	2005	2006	2007	2008
F multiplier	1.000	0.850	0.680	0.680

Fbar(2-4)	Year			
Percentile	2005	2006	2007	2008
0.05	0.62	0.53	0.42	0.42
0.25	0.75	0.64	0.51	0.51
0.5	0.85	0.73	0.58	0.58
0.75	0.96	0.82	0.66	0.66
0.95	1.10	0.93	0.75	0.75

SSB	Year			
Percentile	2005	2006	2007	2008
0.05	30545	25978	26228	35766
0.25	33622	28762	31343	44997
0.5	36099	31528	35824	52642
0.75	38948	34951	41229	61599
0.95	43326	39598	49868	76698

Catch	Year			
Percentile	2005	2006	2007	2008
0.05	38486	43328	52760	57807
0.25	47861	49389	58187	64389
0.5	55061	53755	63012	70990
0.75	63186	58418	68053	79126
0.95	76822	64855	76108	97952

P(SSBYear > SSB 2005)				
2006	2007	2008	2009	2010
0.16	0.45	0.83	0.91	0.90

In year SSB change		
2005	2006	2007
0.87	1.14	1.47

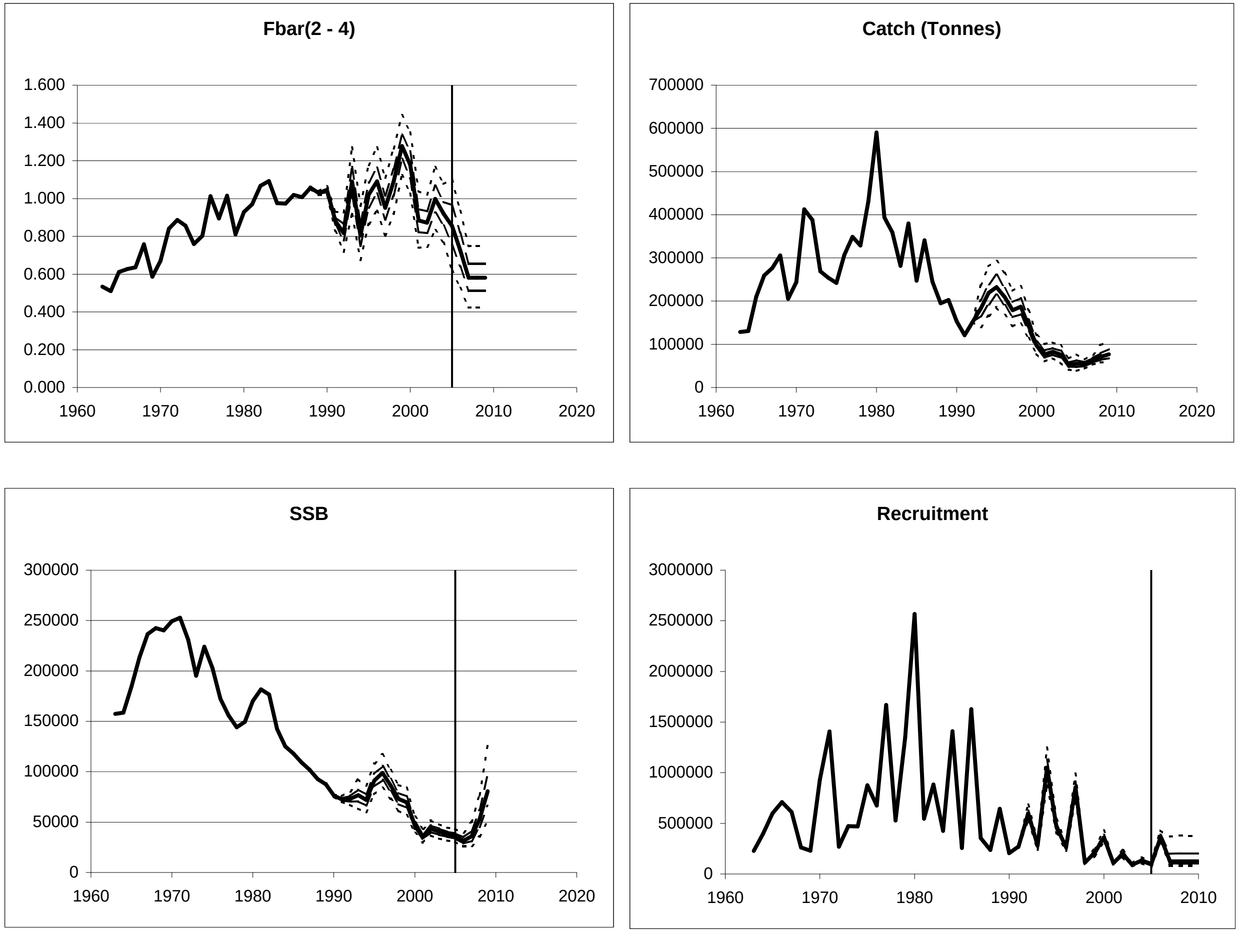


Table 14.17 Cod 347d: B-ADAPT median tern forecast for a 15% reduction in effort in 2006 follwed by a further 25% in 2007 held constant for 2008 - 2010

	2005	2006	2007	2008
F multiplier	1.000	0.850	0.638	0.638

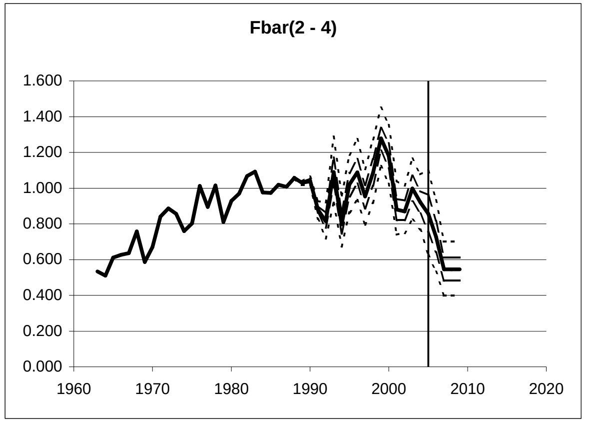
Fbar(2-4)	Year			
Percentile	2005	2006	2007	2008
0.05	0.63	0.53	0.40	0.40
0.25	0.76	0.64	0.48	0.48
0.5	0.86	0.73	0.55	0.55
0.75	0.96	0.82	0.61	0.61
0.95	1.10	0.93	0.70	0.70

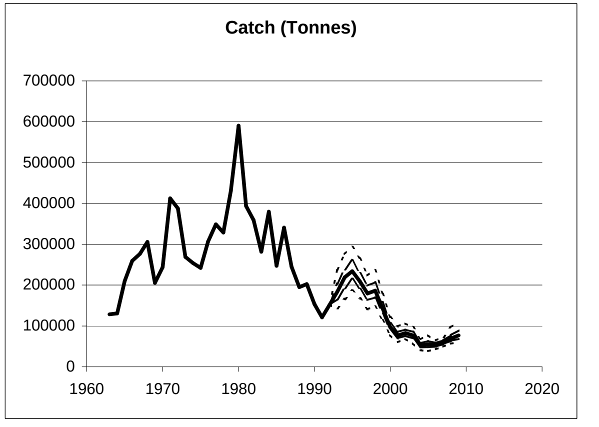
SSB	Year			
Percentile	2005	2006	2007	2008
0.05	30612	26009	26409	37460
0.25	33733	28785	31363	46849
0.5	36249	31689	35898	54453
0.75	39031	34897	41192	63545
0.95	43584	39564	49871	78512

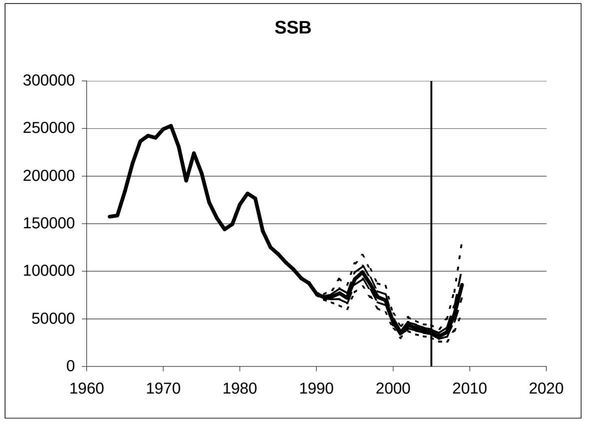
Catch	Year			
Percentile	2005	2006	2007	2008
0.05	38392	43313	49452	56846
0.25	48396	49413	55431	63413
0.5	55122	53850	60247	69685
0.75	63318	58554	64883	77290
0.95	77531	64947	72942	96836

P(SSBYear > SSB 2005)				
2006	2007	2008	2009	2010
0.11	0.32	0.61	0.65	0.65

In year SSB change		
2005	2006	2007
0.87	1.13	1.52







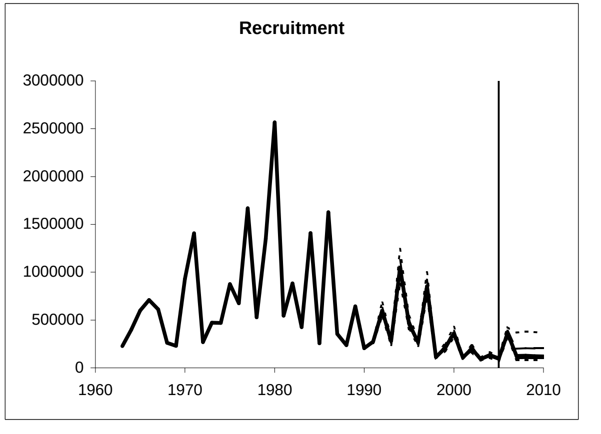


Table 14.18 Cod 347d: B-ADAPT median tern forecast for a 15% reduction in effort in 2006 follwed by a closure in 2007 - 2010

	2005	2006	2007	2008
F multiplier	1.000	0.850	0.000	0.000

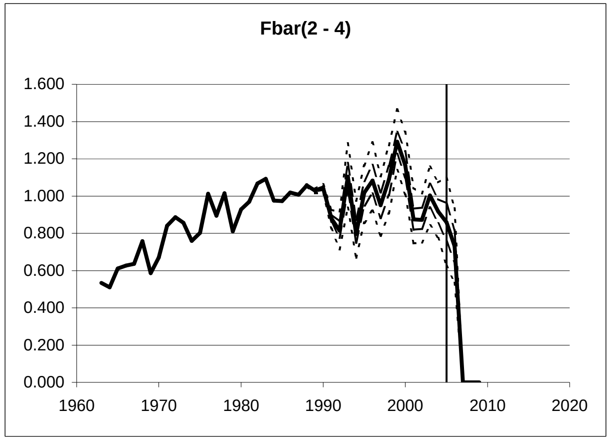
Fbar(2-4)	Year			
Percentile	2005	2006	2007	2008
0.05	0.63	0.53	0.00	0.00
0.25	0.76	0.65	0.00	0.00
0.5	0.86	0.73	0.00	0.00
0.75	0.96	0.82	0.00	0.00
0.95	1.10	0.93	0.00	0.00

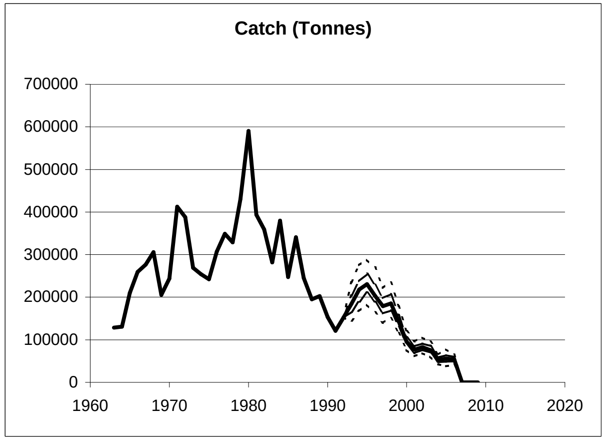
SSB	Year			
Percentile	2005	2006	2007	2008
0.05	30581	25942	26455	72292
0.25	33467	29061	31808	84068
0.5	36032	31963	36058	92305
0.75	39262	34571	40972	101617
0.95	43747	39114	49019	116529

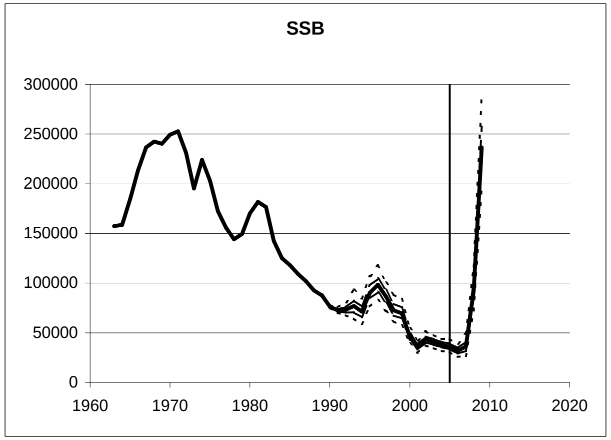
Catch	Year			
Percentile	2005	2006	2007	2008
0.05	37601	41136	0	0
0.25	48533	49406	0	0
0.5	55875	53738	0	0
0.75	63413	59952	0	0
0.95	77706	65238	0	0

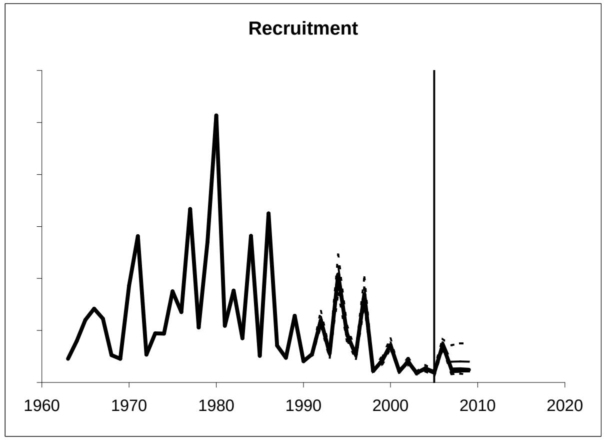
P(SSBYear > SSB 2005)				
2006	2007	2008	2009	2010
0.04	0.11	0.23	0.23	0.23

In year SSB change		
2005	2006	2007
0.89	1.13	2.56









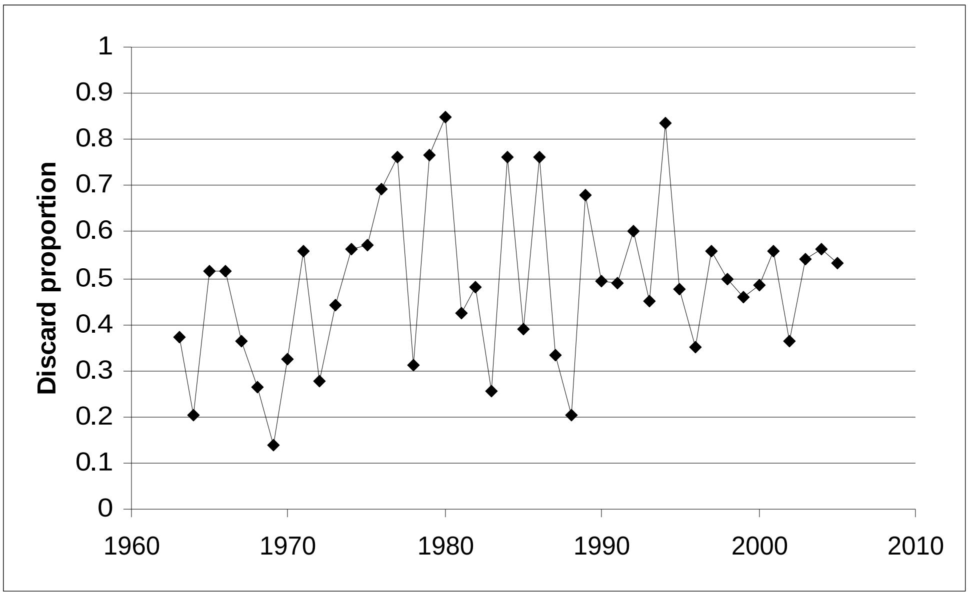


Figure 14.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Proportion of total numbers

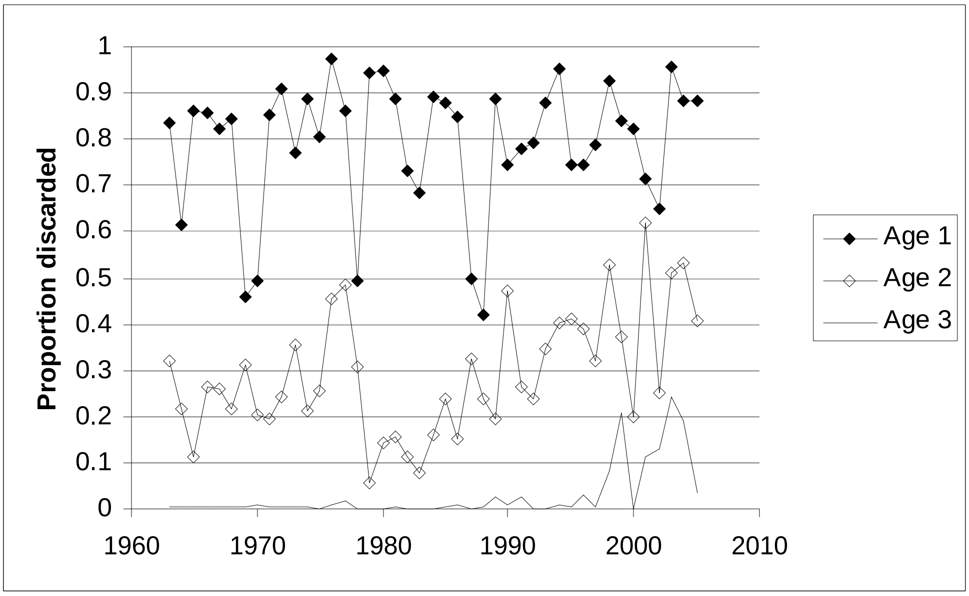


Figure 14.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Proportion of numbers discarded by age.

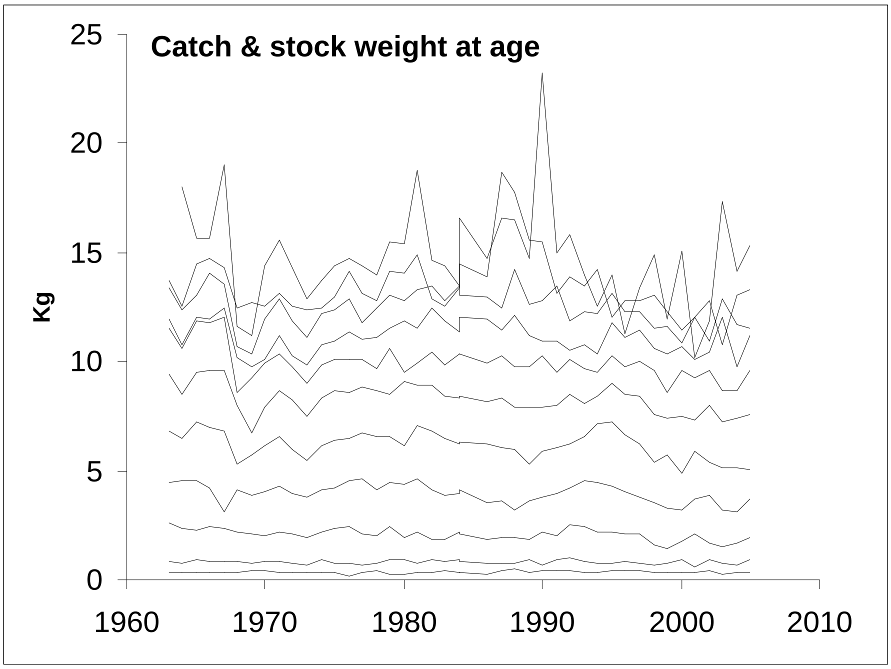


Figure 14.3 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Mean weight at age in the landings.

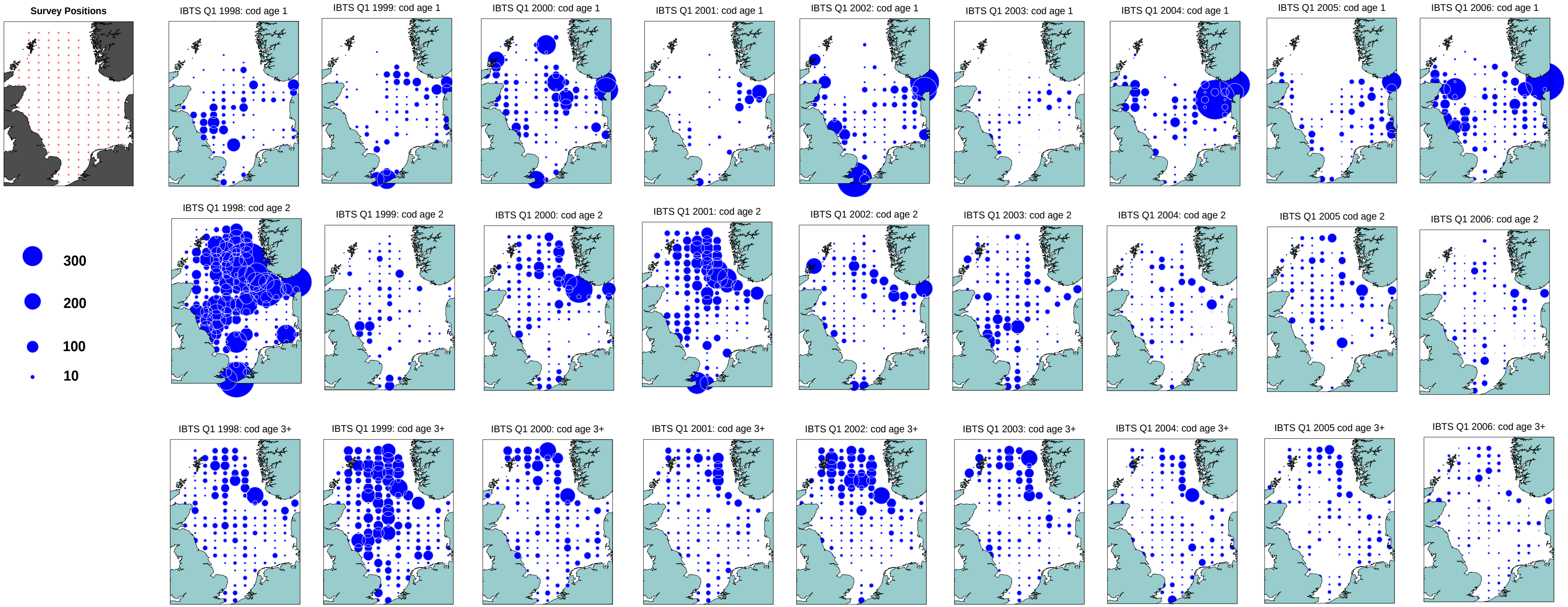


Figure 14.4 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q1 survey 1998-2006 in the North Sea.

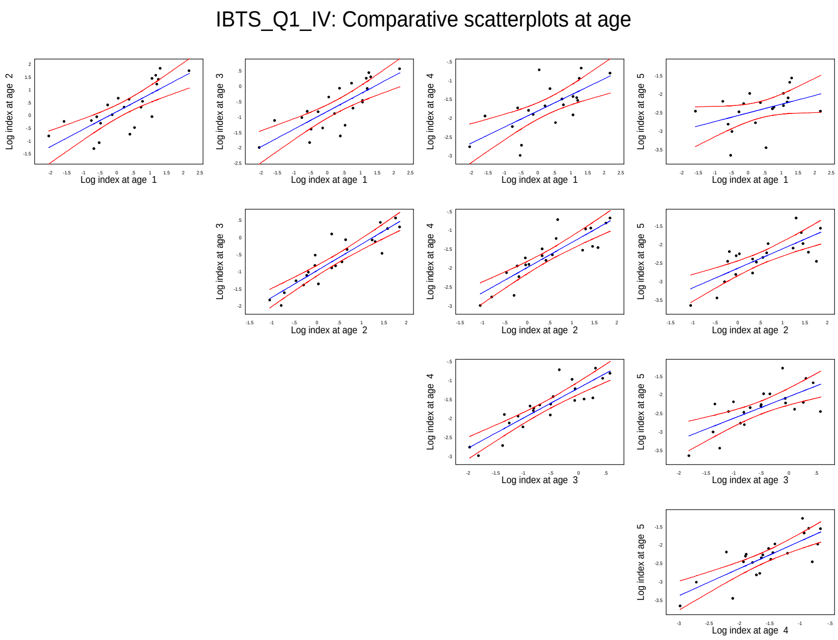


Figure 14.5 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. IBTS quarter 1 between age log index comparative scatter plots

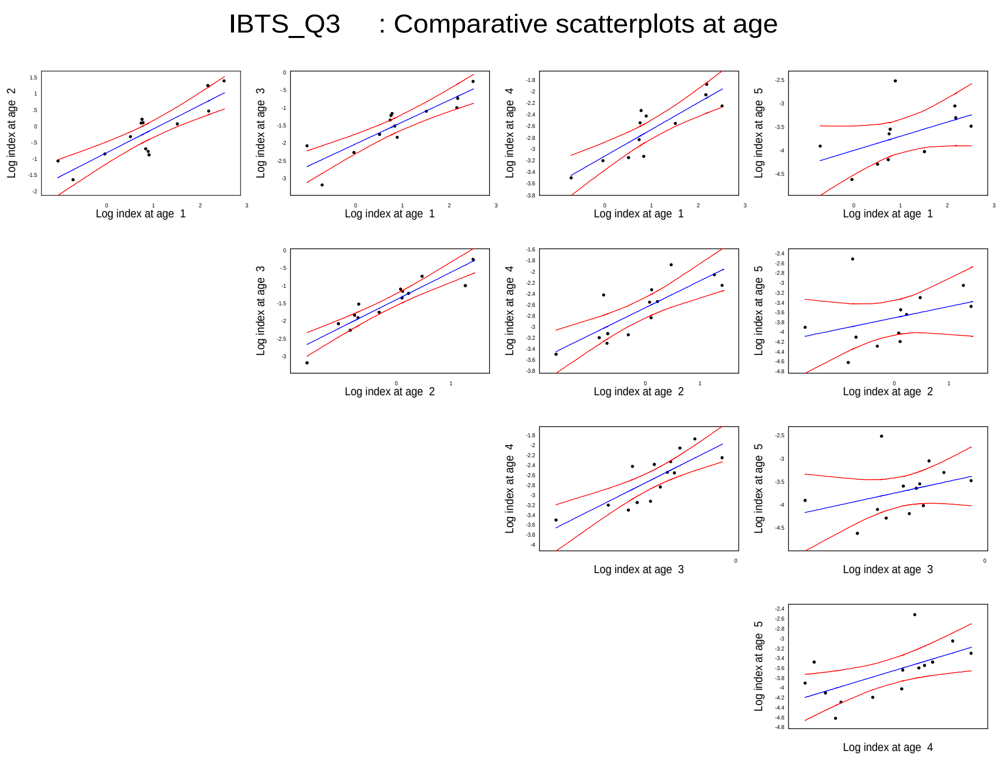


Figure 14.6 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. IBTS quarter 1 between age log index comparative scatter plots

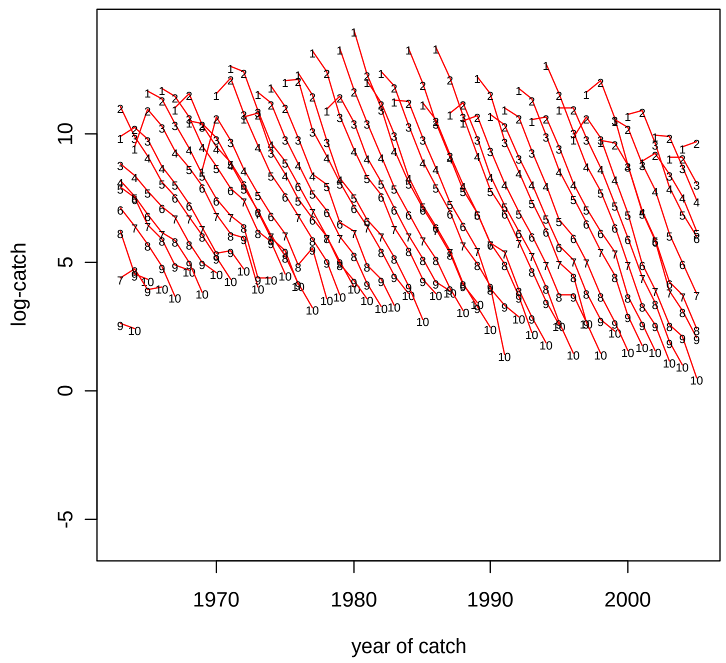


Figure 14.7 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Log catch cohort curves

Figure 14.8 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Slope of the regression of the log catch cohort curves across the reference fishing mortality ages 2 - 4

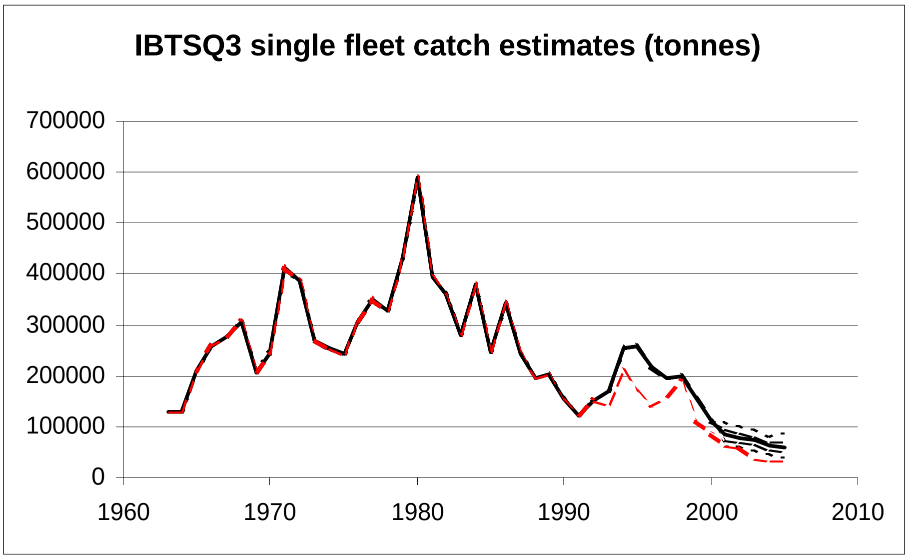


Figure 14.9a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Percentiles (5th, 25th, 50th, 75th, 95th) of estimated losses from the stock for the IBTS quarter 3 single fleet fit of B-ADAPT. The red line indicates reported catch.

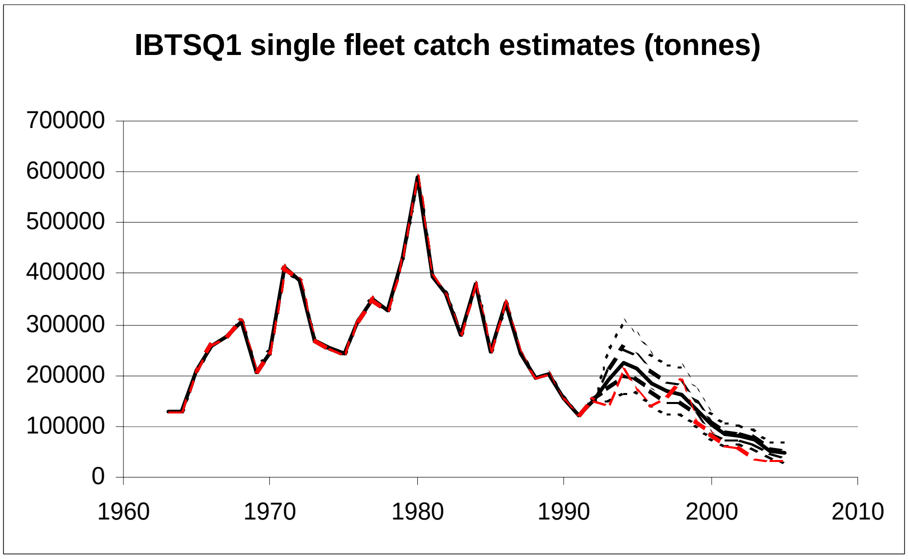


Figure 14.9b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Percentiles (5th, 25th, 50th, 75th, 95th) of estimated losses from the stock for the IBTS quarter 1 single fleet fit of B-ADAPT. The red line indicates reported catch.

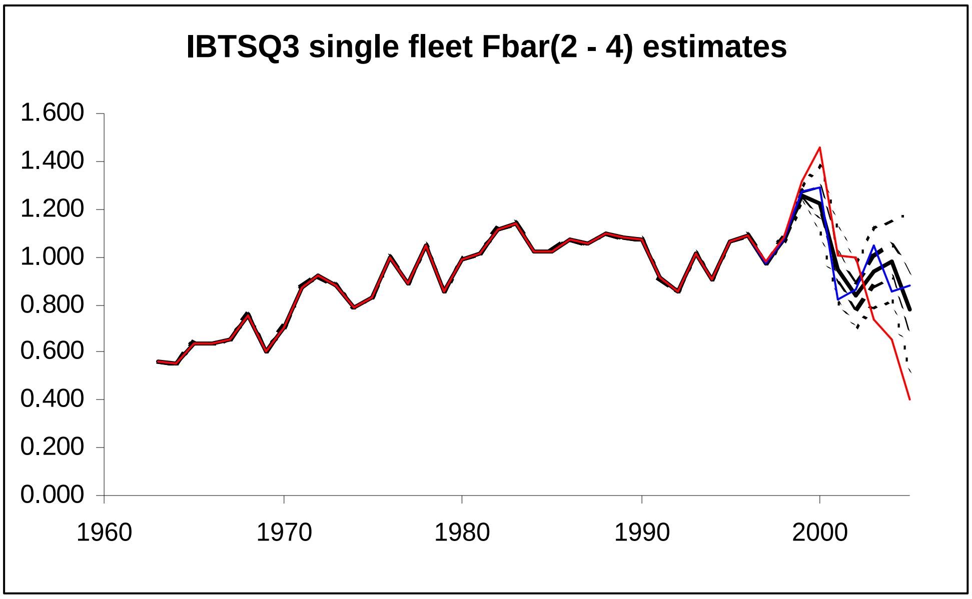


Figure 14.10a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Percentiles (5th, 25th, 50th, 75th, 95th) of estimated fishing mortality from the IBTS quarter 3 single fleet fit of B-ADAPT. The red line shows the estimate values when unallocated removals are not modelled.

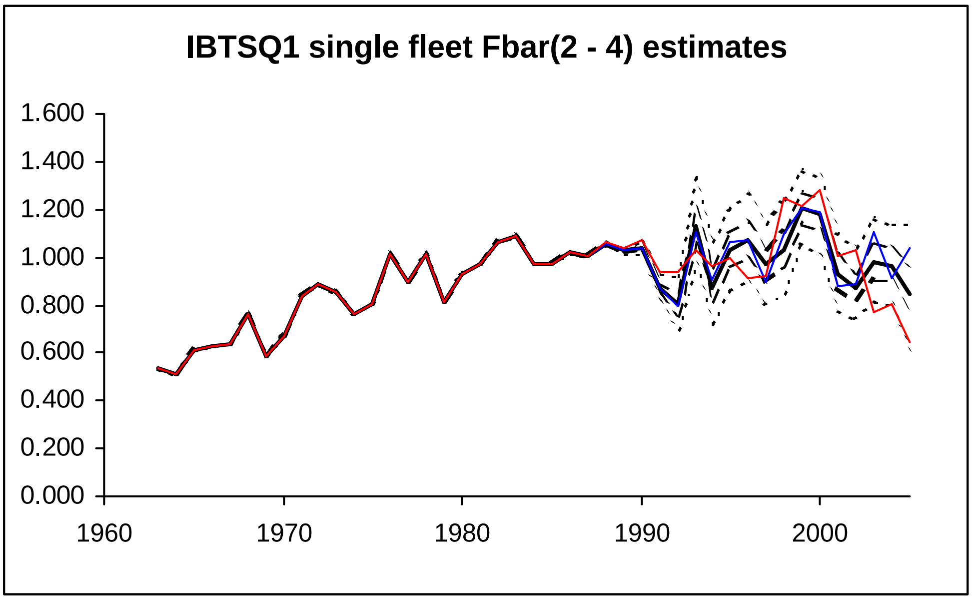


Figure 14.10b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Percentiles (5th, 25th, 50th, 75th, 95th) of estimated fishing mortality from the IBTS quarter 1 single fleet fit of B-ADAPT. The red line shows the estimate values when unallocated removals are not modelled.

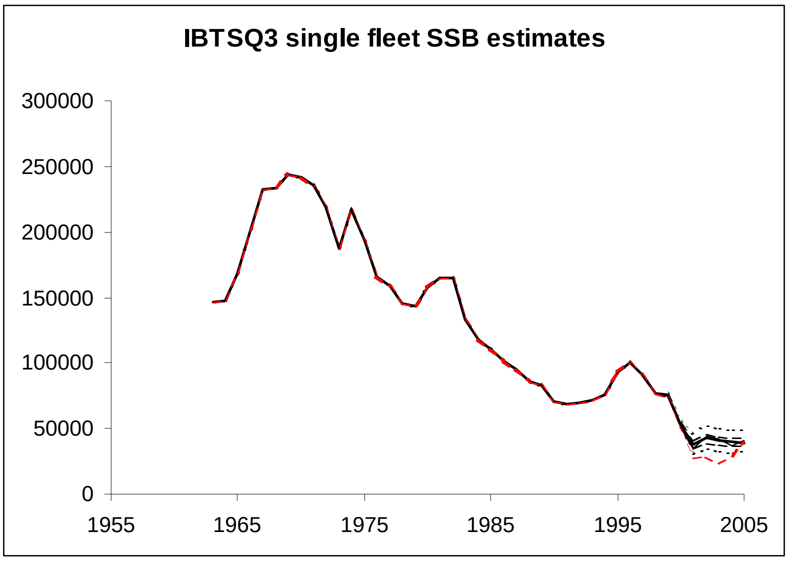


Figure 14.11a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Percentiles (5th, 25th, 50th, 75th, 95th) of estimated spawning stock biomass from the IBTS quarter 3 single fleet fit of B-ADAPT. The red line shows the estimate values when unallocated removals are not modelled.

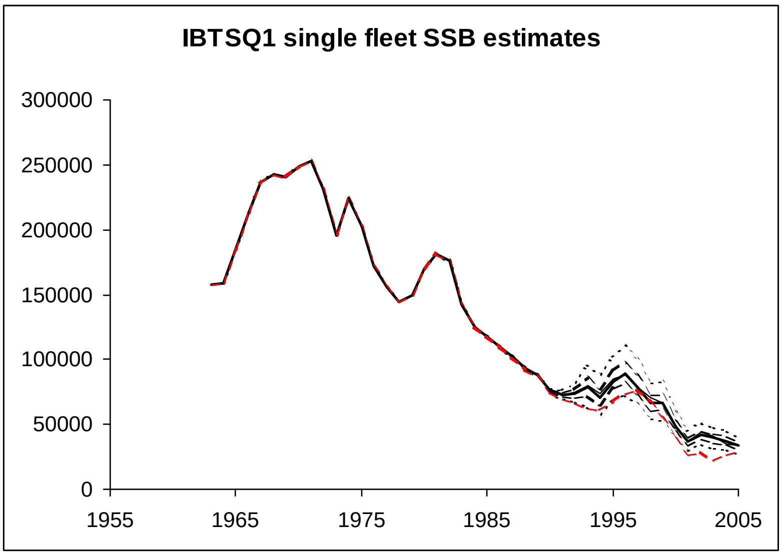


Figure 14.11b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Percentiles (5th, 25th, 50th, 75th, 95th) of estimated spawning stock biomass from the IBTS quarter 1 single fleet fit of B-ADAPT. The red line shows the estimate values when unallocated removals are not modelled.

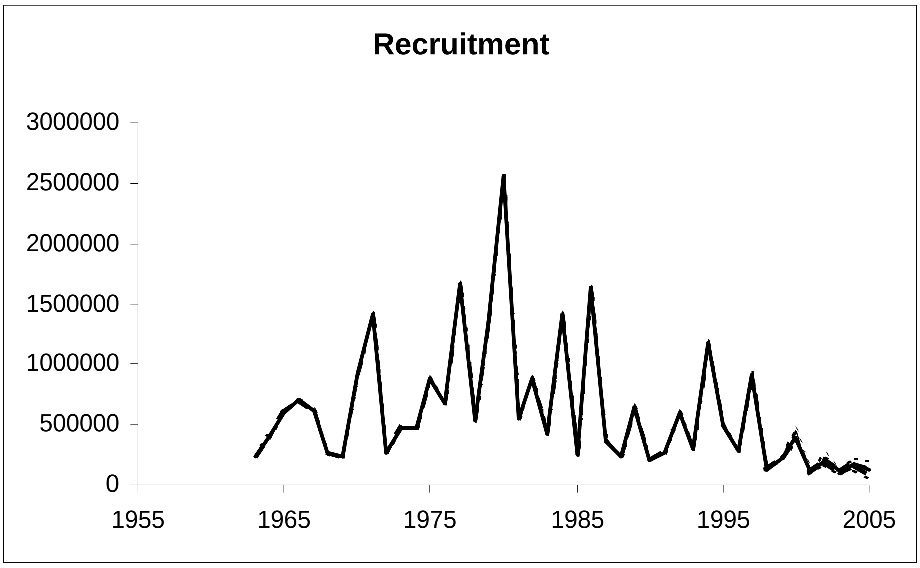


Figure 14.12 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Percentiles (5th, 25th, 50th, 75th, 95th) of estimated recruitment from the IBTS quarter 3 single fleet fit of B-ADAPT, similar results were estimated using the IBTS quarter 1 survey.

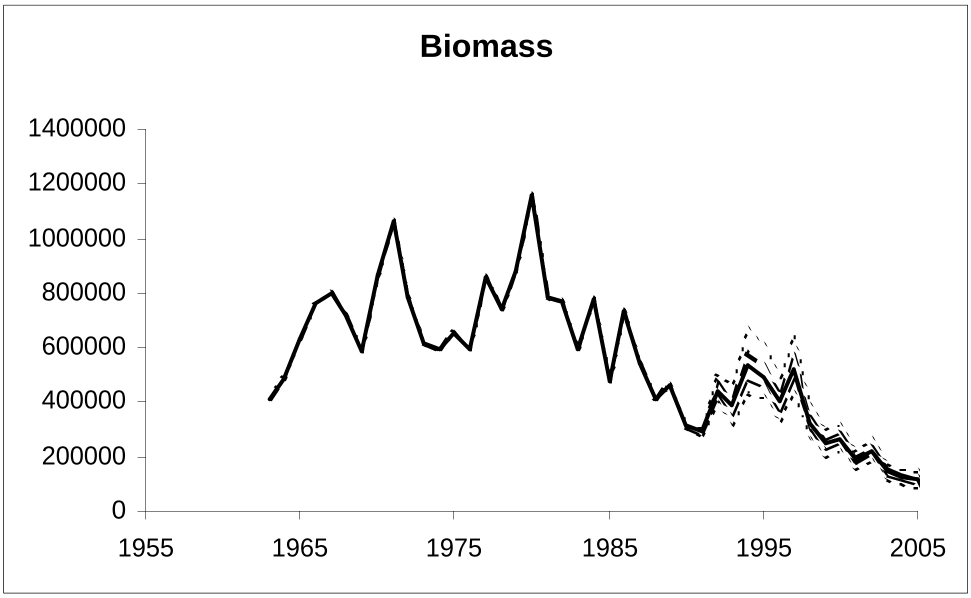


Figure 14.13 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Percentiles (5th, 25th, 50th, 75th, 95th) of estimated total stock biomass from the IBTS quarter 3 single fleet fit of B-ADAPT, similar results were estimated using the IBTS quarter 1 survey.

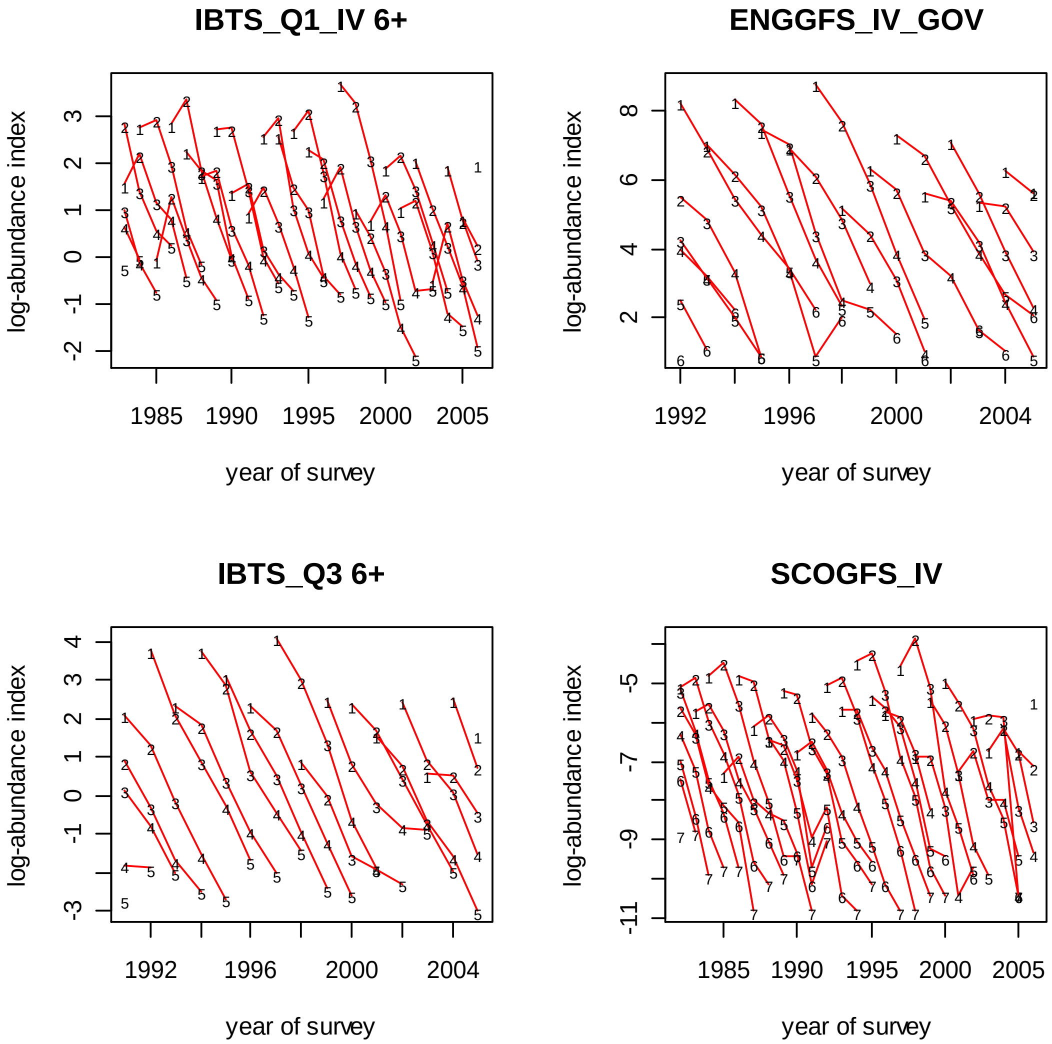


Figure 14.14 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Log CPUE cohort curves for the IBTS quarter 1, quarter 3, English and Scottish groundfish surveys.

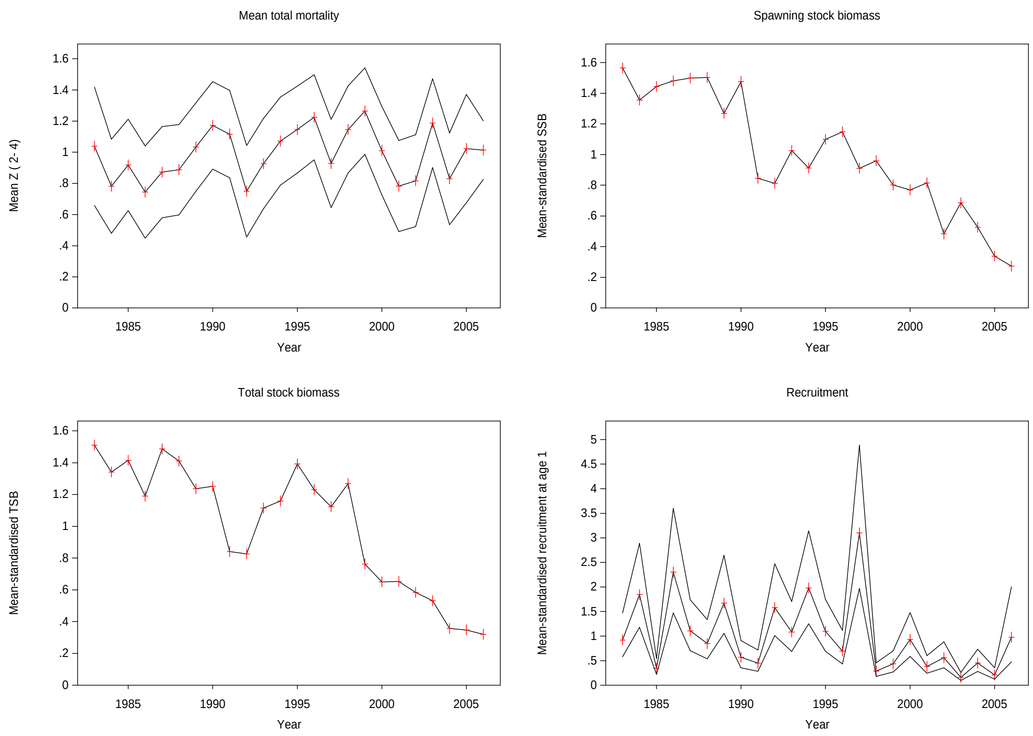


Figure 14.15a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Surba summary plots gor estimates of total mortality, spawning stock biomass, total biomass and recruitment for the IBTS quarter 1 survey

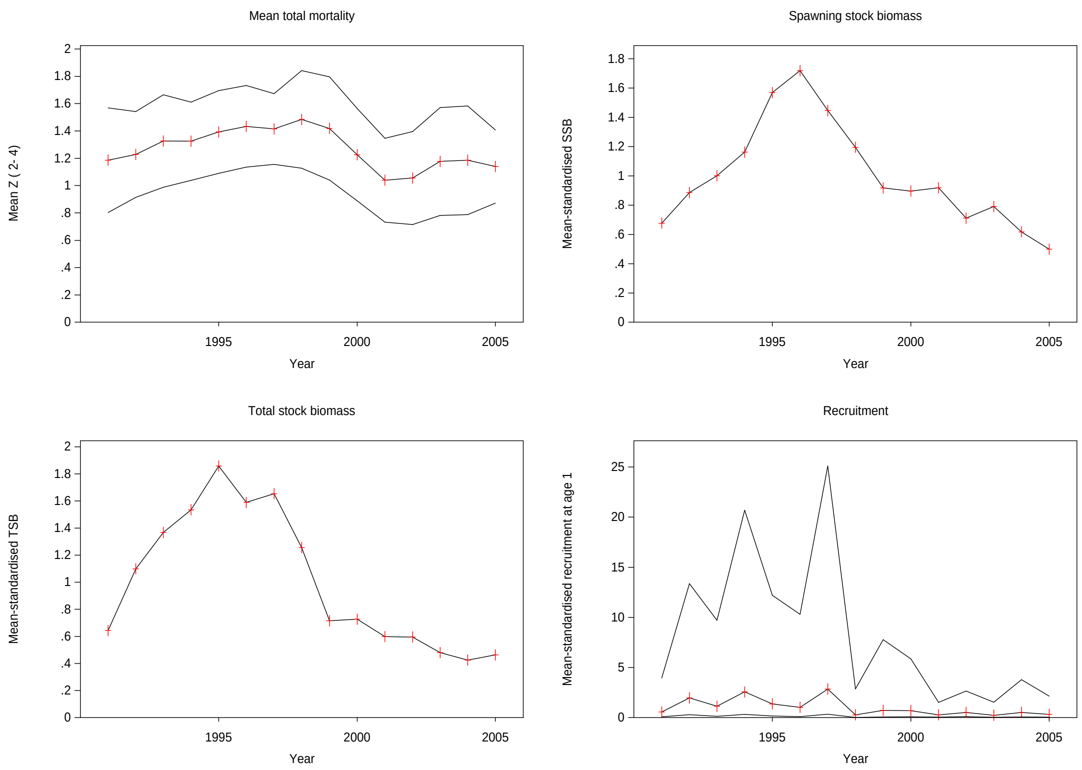


Figure 14.15b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Surba summary plots gor estimates of total mortality, spawning stock biomass, total biomass and recruitment for the IBTS quarter 3 survey

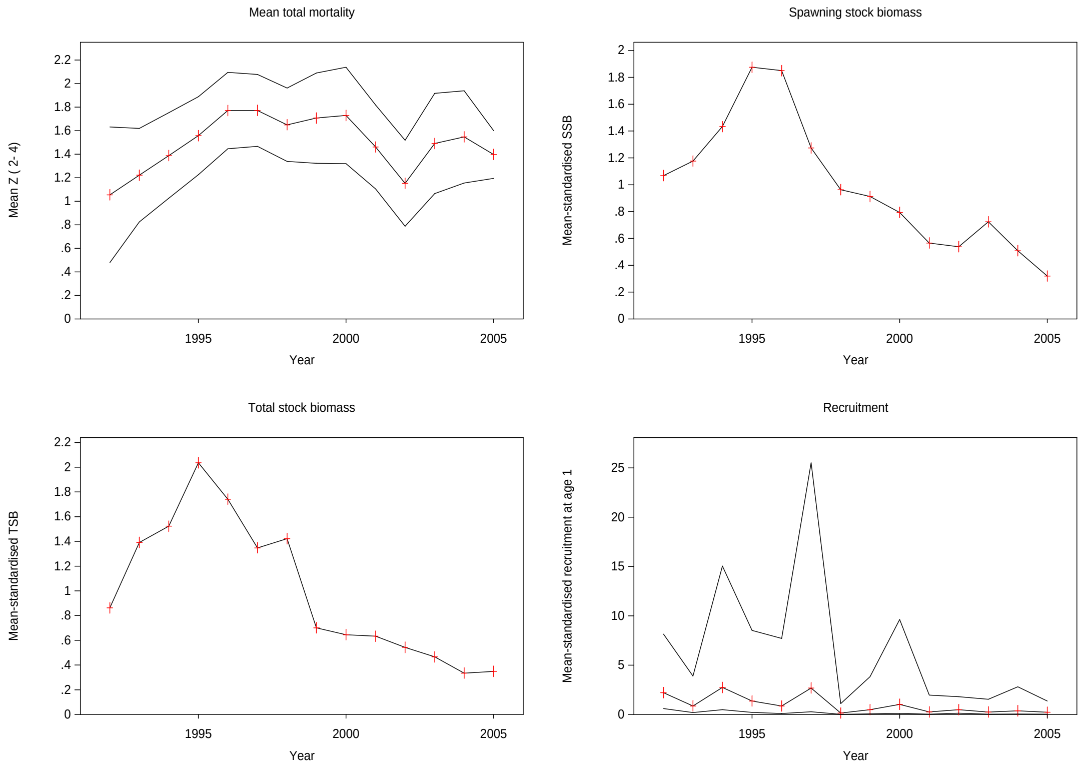


Figure 14.15c Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Surba summary plots gor estimates of total mortality, spawning stock biomass, total biomass and recruitment for the English groundfish survey

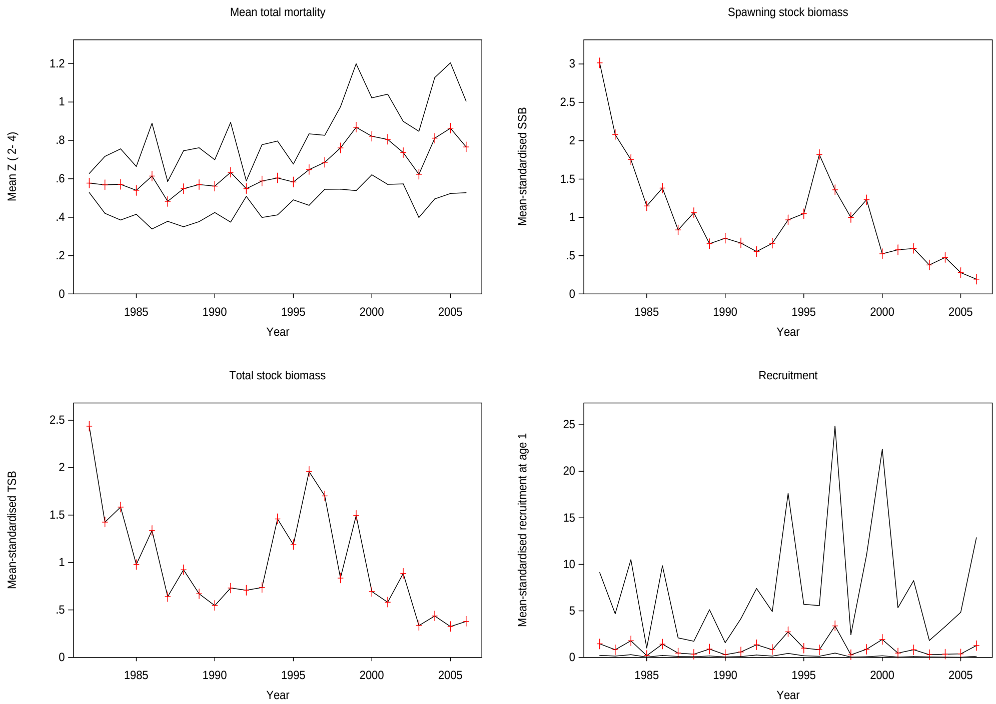


Figure 14.15d Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Surba summary plots gor estimates of total mortality, spawning stock biomass, total biomass and recruitment for the Scottish groundfish survey

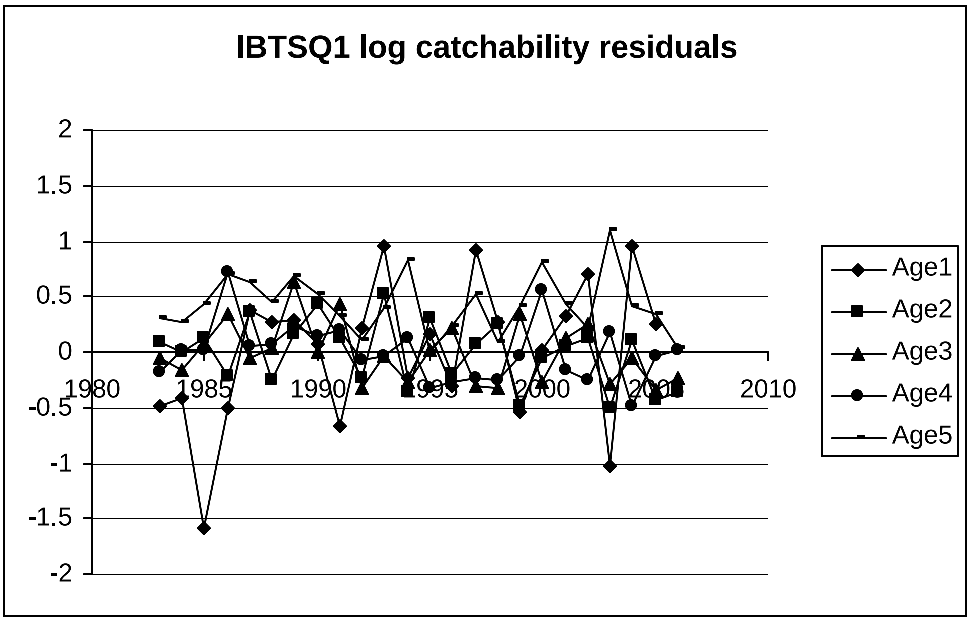


Figure 14.16a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT, applied with smoothing, log catchability residuals for the fit to the IBTS quarter 1 survey

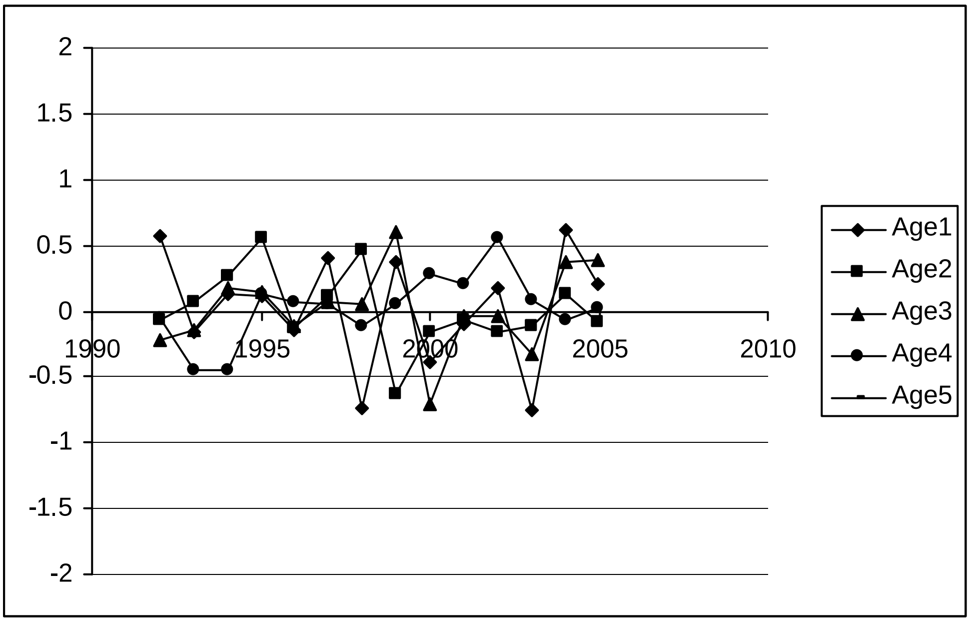


Figure 14.16b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT, applied with smoothing, log catchability residuals for the fit to the IBTS quarter 3 survey

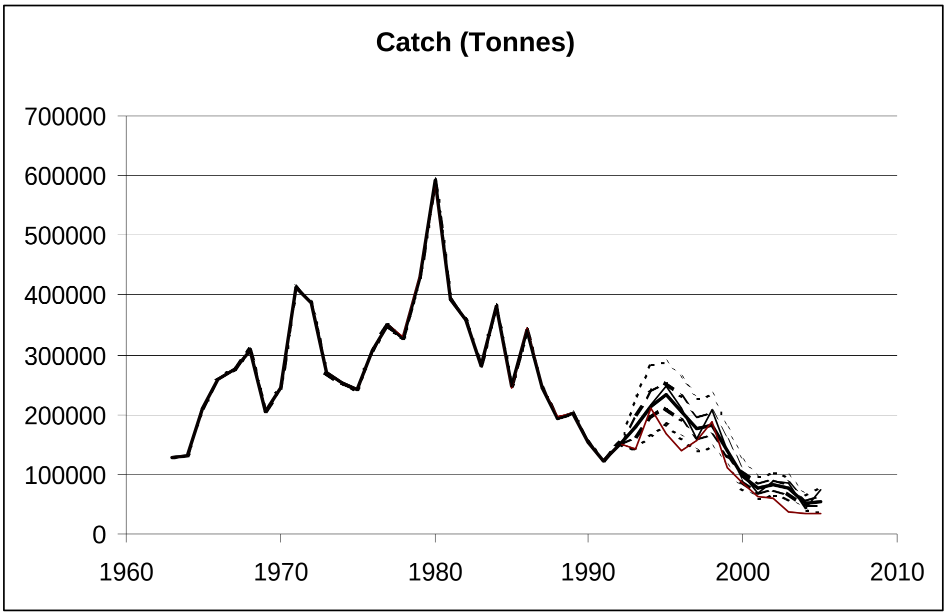


Figure 14.17 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Percentiles (5,25,50,75,95) of the estimated catch from the ADAPT model applied with smoothing. The solid line represents the recorded total catch.

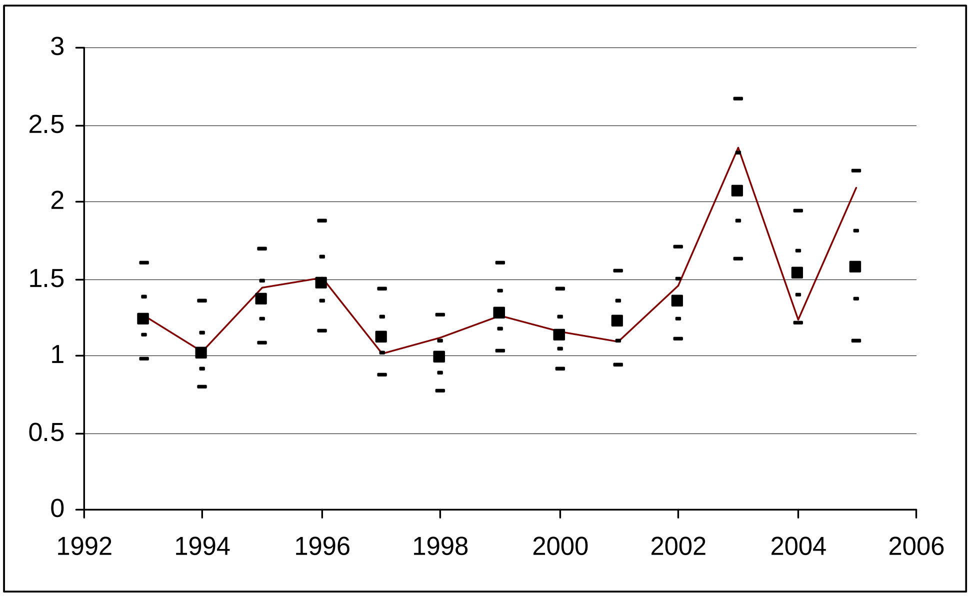


Figure 14.18 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Percentiles (5,25,50,75,95) of the catch raising factor estimates from the ADAPT model applied with smoothing. The solid line represents the expected value.

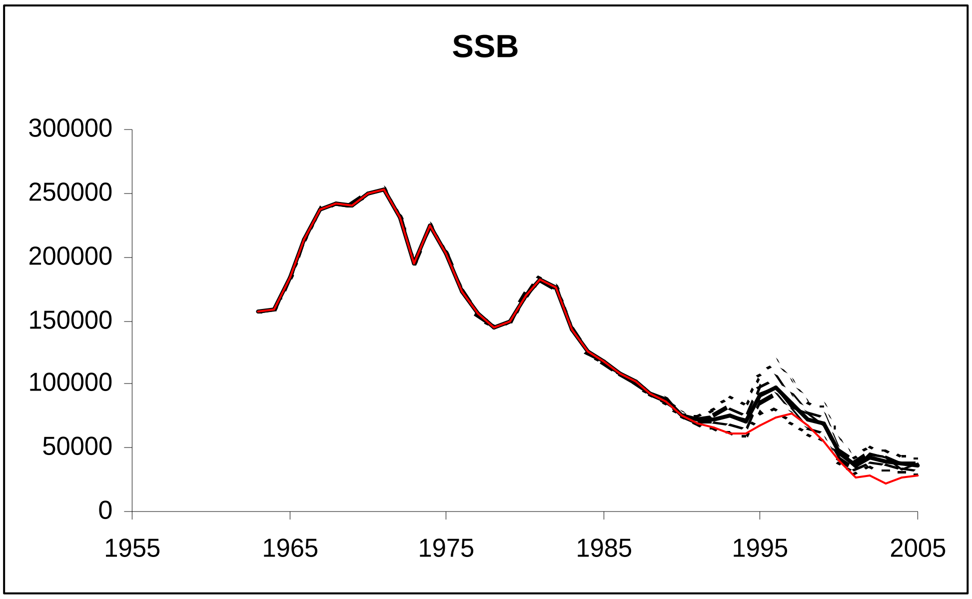


Figure 14.19 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Percentiles (5,25,50,75,95) of estimated SSB from the ADAPT model applied with smoothing. The lower line represents the SSB estimates under an assumption of exact catch at age.

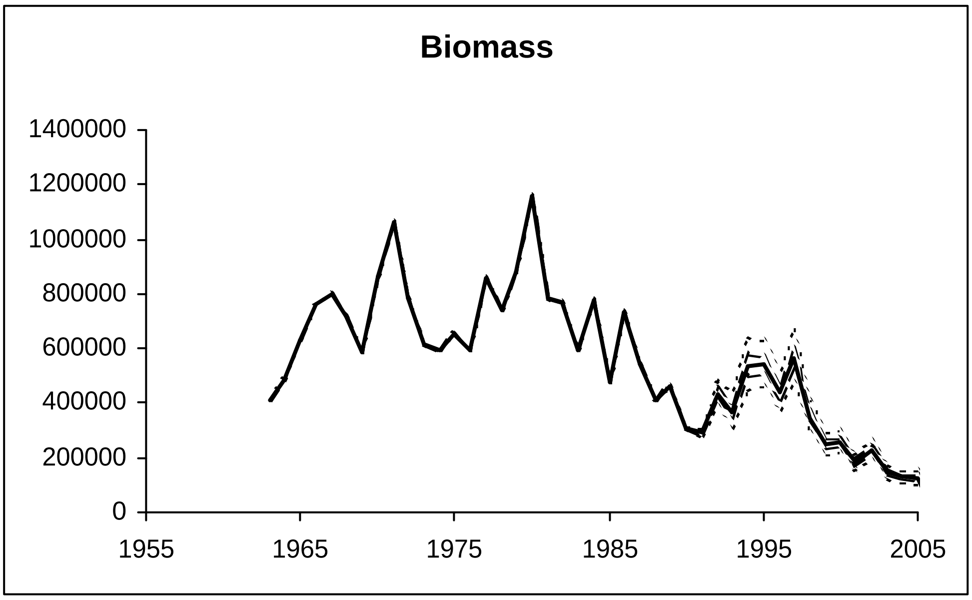


Figure 14.20 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Percentiles (5,25,50,75,95) of estimated total stock biomss from the ADAPT model applied with smoothing.

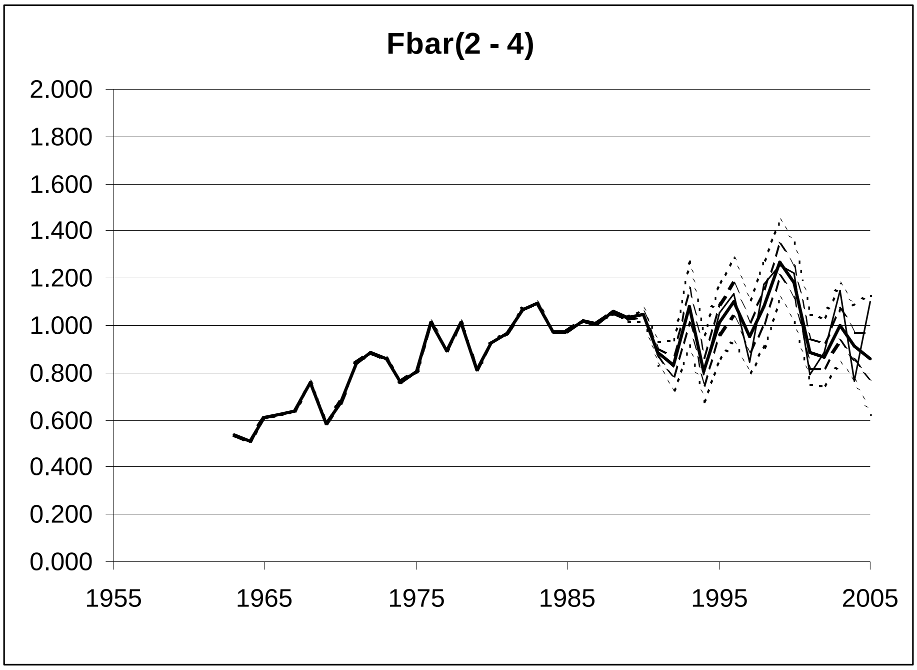


Figure 14.21 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The percentiles (5,25,50,75,95) of estimated fishing mortality (average across ages 2-4) from the B-ADAPT model applied with smoothing. The variable solid line represents the expected value of average fishing mortality.

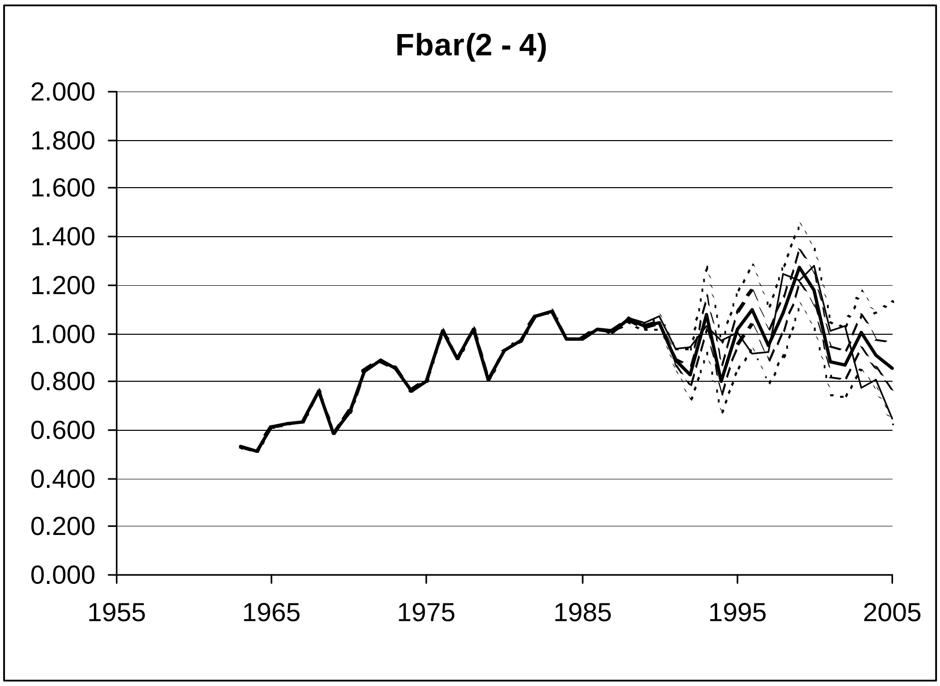


Figure 14.22 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The percentiles (5,25,50,75,95) of estimated fishing mortality (average across ages 2-4) from the B-ADAPT model applied with smoothing. The lower solid line in the most recent years represents the estimates under an assumption of exact catch at age.

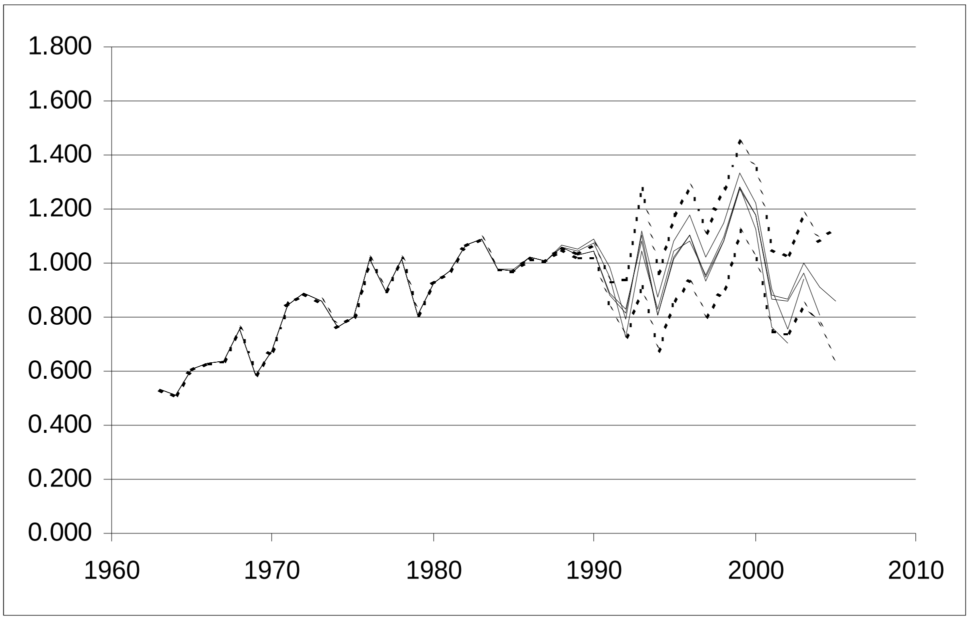


Figure 14.23 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The retrospective bootstrap median and the most recent 5th and 95th percentiles of estimated fishing mortality (average across ages 2-4) from the B-ADAPT model applied with smoothing.

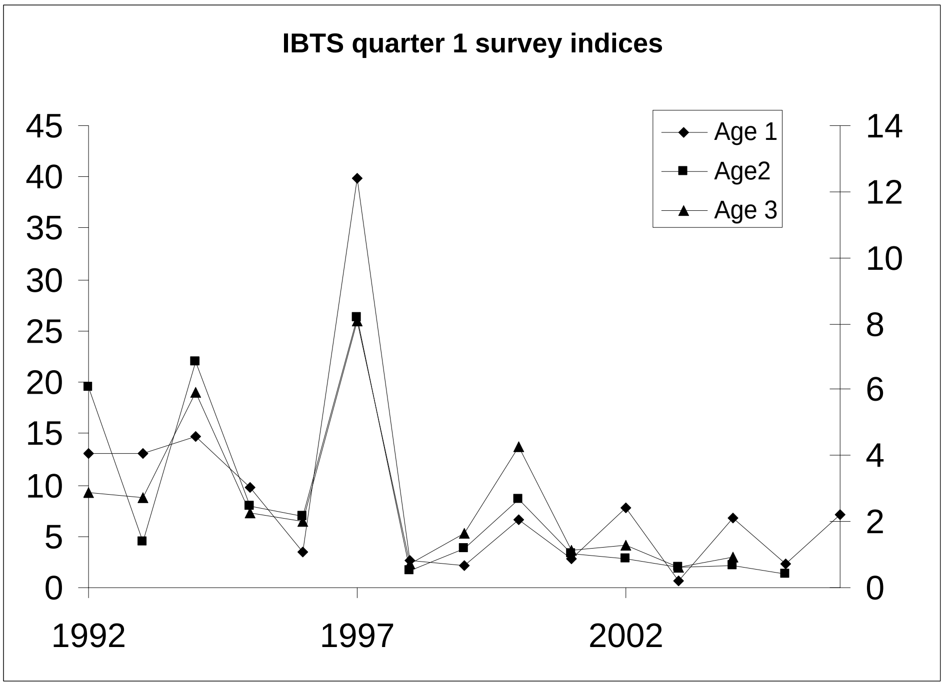


Figure 14.24 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: IBTS quarter 1indices illustrating the change in the relative abundance of age 1 compared to age 2 and 3 cod. More abundant year classes are making less of a contribution to the stock in recent years as a result of increased mortality rates.

Figure 14.25 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Results from the 2006 fishers North Sea Stock survey.

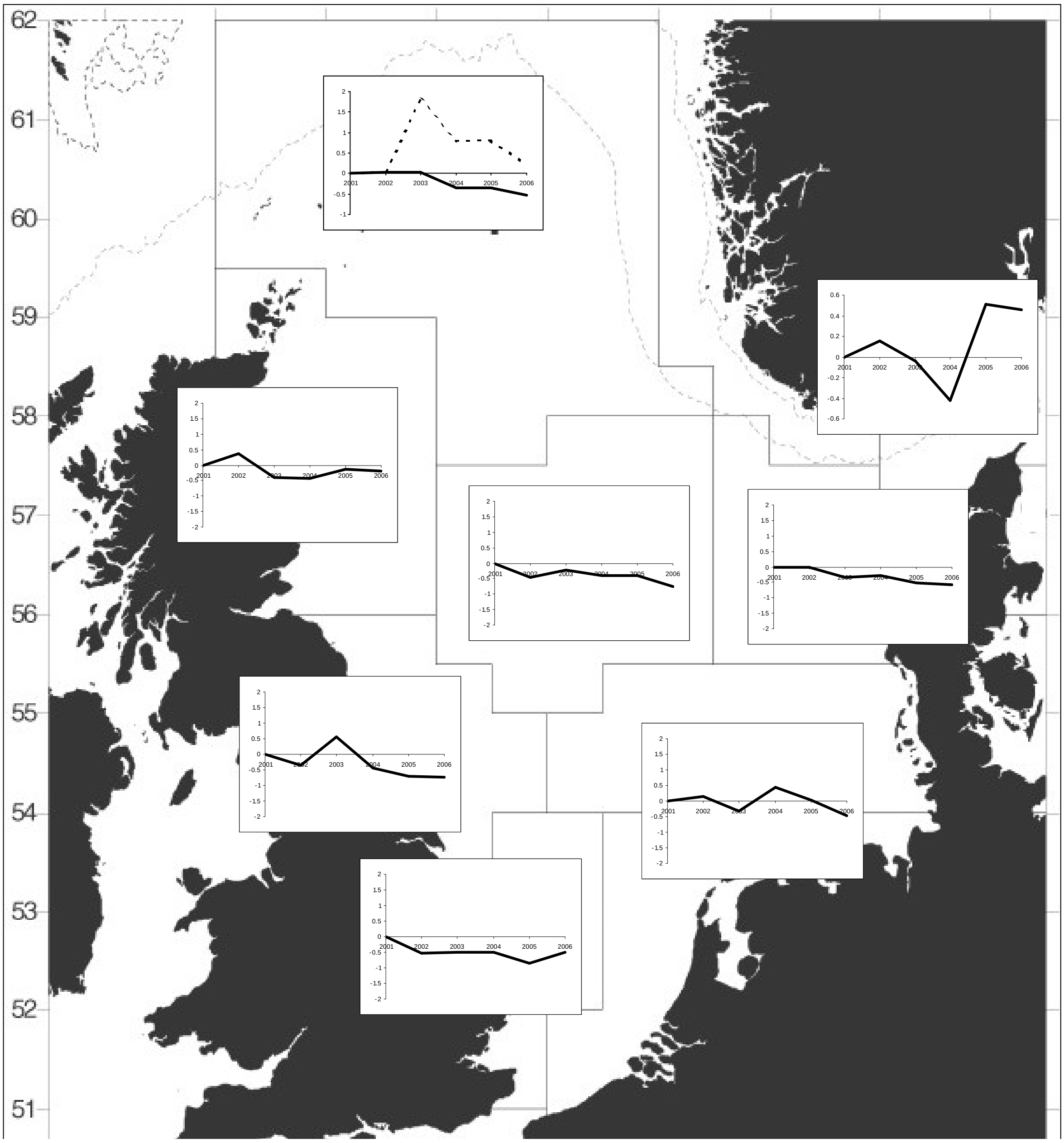


Figure 14.27 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The time trends in the 2+ (and 4+ in area 1) biomass recorded by the 2000 – 2006 quarter 1 IBTS surveys.

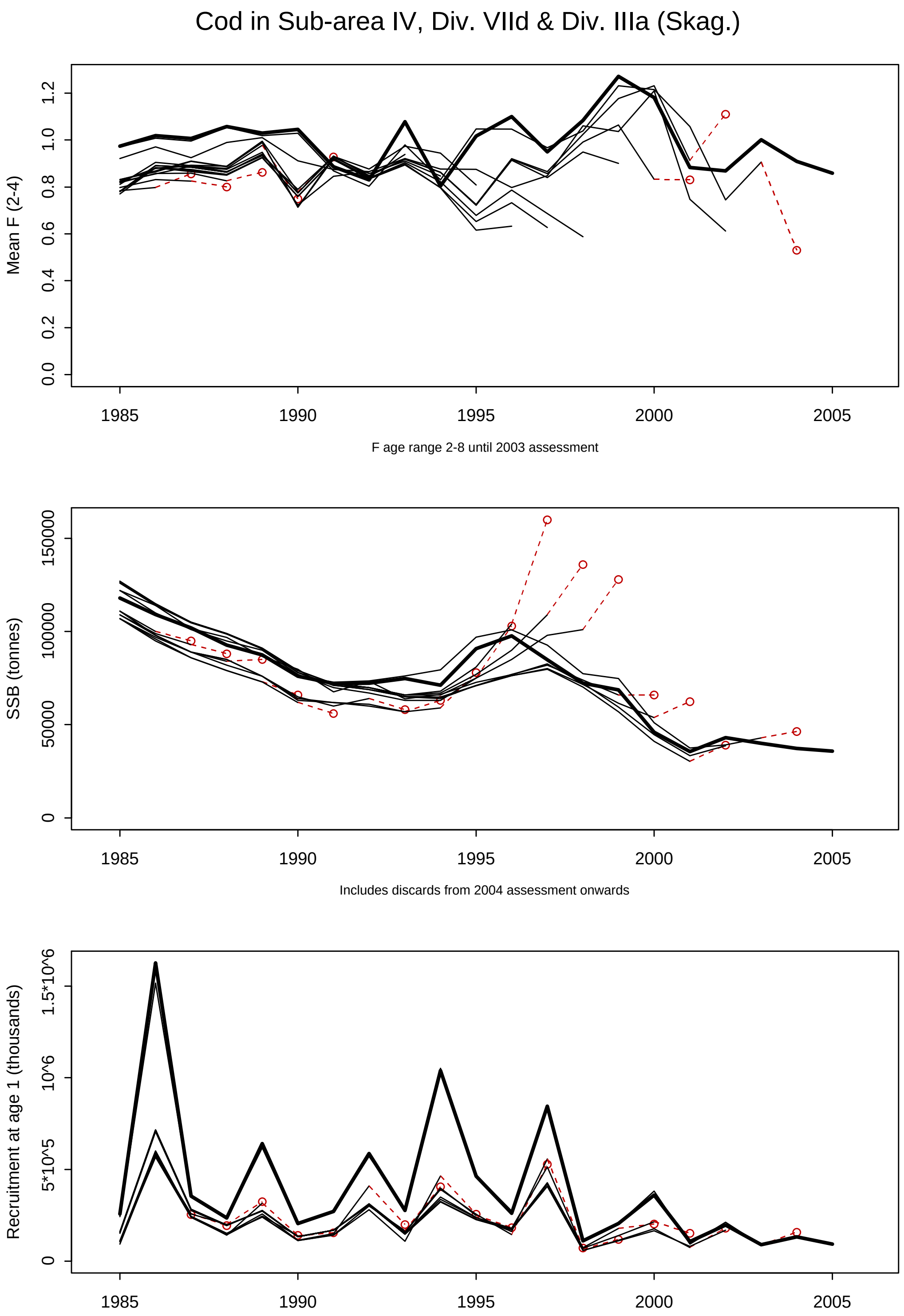


Figure 14.28. Cod in Sub-Area IV and Divisions IIIa and VIId. Historical performance of the assessment. Circles indicate forecasts.

15 Mixed fisheries

15.1 INTRODUCTION

The issue of mixed fisheries is not a new topic in fisheries science; the subject first came to prominence in relation to ICES areas VII and VIII in the late 1980s. However interest in the topic was revived around 2002, specifically in relation to the North Sea demersal fisheries. At that point the North Sea cod stock was in a very poor state, to the extent that ICES advice was for zero catch of cod. At the same time, the haddock stock was increasing to the highest level observed in 30 years. As both species are often caught together, there was a clear need to address this specific mixed fishery issue. The initial result was the development of the MTAC methodology (Vinther et al 2004) which was implemented for use at the first meeting of the STECF subgroup on mixed fisheries in October 2002 (STECF 2002). These initial analyses used data compiled at that year's meeting of WGNSSK (ICES-WGNSSK 2002). In response to the same issue ICES established the Study Group on the Development of Fishery-based Forecasts (SGDFF) which met for the first time in February 2003 (ICES-SGDFF 2003). This SG reviewed the methodology available for fishery-based forecasts and concluded with some reservations that MTAC was the most suitable tool available for this purpose. The SG also defined a file format for mixed-fishery data. The STECF mixed fishery group met again in 2003 (STECF 2003), while SGDFF had their second and last meeting in January of 2004 (ICES-SGDFF 2004) at which point they noted: "The shift towards the routine provision of data and advice on a fishery basis is proving to be a substantial task, with implications for national sampling schemes as well as how data are compiled. […] Many of the limitations on making further progress on these issues relate to availability of data to national institutions, or to limitations of staff time available to work on data extractions and analysis, and are thus factors which are beyond the control of the present SG". This comment remains a useful summary of the current situation.

In an effort to address these data issues and the need for mixed fishery advice, ICES established the Workshop on simple models for mixed fishery management (ICES-WKMIXMAN 2006) which met in January 2006. This group reviewed the history of MTAC with particular emphasis on the problems associated with the approach. Based on a review of MTAC, and other candidate approaches, WKMIXMAN identified the Fcube approach (Ulrich et al, 2006) as a more appropriate framework for future development in relation to fleet and fishery-based management advice. 2006 also saw a series of STECF subgroup meetings which were intended to review the impact of recent effort regulations introduced in association with cod recovery plans. The data requirements for these reviews have been extensive, involving catch and effort data by gear and mesh-size category, including age data for both landings and discards where available. The final meeting in this series is scheduled to take place in early October 2006.

In parallel with these multi-fleet analyses, the European Commission has been in the process of revising its data collection regulation (DCR) so that the sampling it funds reflects the fleet and fishery structure of the relevant area. This process culminated in a meeting on fleet & fishery-based sampling in Nantes in June 2006 (EC 2006). The segmentation of fishing activities proposed for the North Sea area is given in Table 15.1.1.

There are clearly three interlinked strands to the developments within the area of mixed fisheries: (i) Fcube and methodological developments within ICES, (ii) the STECF review of effort regulations and (iii) the fleet segmentation defined in relation to future sampling under the EU DCR. The inter-relationships of these strands raise a number of issues, but here we are most concerned with those of most direct relevance to WGNSSK.

Most of the mixed-fisheries work undertaken at the current WG meeting resulted from the work of WKMIXMAN, as it represented an attempt to perform a ‘dry run’ of the Fcube methodology through an exploratory implementation for the North Sea demersal fisheries. The objectives were primarily to test the method with available data, understand its behaviour and outcomes and evaluate its suitability to address mixed-fisheries issues, rather than to provide finalised mixed-fisheries advice. Particular attention was paid on the suitability of Fcube to evaluate the current days-at-sea limitations regulating some demersal fisheries in the North Sea. **The methodological and exploratory nature of the analyses means that it would be inappropriate to associate outcomes with particular nations. It also implies that the general results presented should not be used for management considerations this year.**

15.2 Fleet-based modelling of technical interactions

15.2.1 Method – The Fcube model

Fcube (Fleet and Fisheries Forecast) is a simple deterministic and non-age-based method, aiming at modelling the consequences of conflicting single-species management objectives when technical interactions occur in mixed-fisheries. Its main focus deals with the difference between what single fleets do actually catch and what they have the right to land through their quota share. Its main units are the fleets rather than the fisheries. Fleets can engage in several fisheries each year, and fisheries catch several stocks.

The model estimates the forecast catches and landings by fleet, from single-species F estimates and forecasts and assumptions about effort distribution and relationship between effort and mortality. Fleets are linked to fisheries through an activity matrix (proportion of annual effort spent in each fishery) and fisheries are linked to stocks through the catchability matrix. Key points of the method are that (i) the catchability of each fleet for each stock is not constant, but is calculated as the average catchability of each fishery weighted by the activity over fisheries, which can be estimated from data, (ii) each fleet owns a fixed quota share of the total landings for each stock (proxy for relative stability and national quota allocation procedures), and a corresponding stock-specific level of effort can be estimated for each fleet, and (iii), if these levels differ across stocks within each fleet, assumptions are made about economically-driven or management-driven rules on final fleet effort allocation. The maximum effort corresponds to the fleet continuing fishing until the last of its quota is exhausted, while the minimum effort corresponds to the fleet stopping fishing as soon as the first of its quota is exhausted. All catches by fleet larger than the quota share are considered as non-allocated catches which cannot be legally landed (quota overshooting). Discarding overquota catches is not an illegal behavior in Community waters, but it is difficult to quantify as they cannot be sampled. These catches are not referred to as discards here, as it is assumed that discarding is primarily induced by undersize catches rather than TAC limitations. Age-based discards data are not accounted for in the model at the time being.

The details of the method are developed in ICES-WKMIXMAN (2006). The conceptual flowchart is presented Figure 15.2.1. Trial runs were performed by the WGHMM in 2006 (ICES-WGHMM, 2006; Ulrich et al., 2006), which spotted a conceptual problem when running the method on cases with advice on zero catch. WGHMM proposed a correction using the catch equation on total stock biomass, and compared the outcomes of the method for scenarios including ICES advice, actual TACs and Southern Hake management plan. However, the correction proposed by WGHMM has not been considered by WGNSSK as fully consistent, and the original method was used instead, thus without running advice on zero catch.

15.2.2 Data

Model runs have been performed covering main demersal stocks in the North Sea (area IV only), cod, haddock, whiting, saithe, plaice, sole and *Nephrops*.

15.2.2.1 Landings and effort data

A request was made to WG members to provide total landings and effort data by fleet, metier and species based on the new DCR segmentation of fishing activities and the STECF-EIAA fleet segments. Few countries provided (or could provide) these data. There were a variety of reasons for the failure to supply data, but one common theme was that national institutes had already allocated substantial amounts of staff time in preparing data in response to the STECF request.

As it proved not to be possible to compile a dedicated Fcube dataset, an alternative approach was used. This involved adapting the data compiled for the 2006 STECF meetings for use in Fcube. This was not the ideal approach, as the data were compiled for a different purpose, and it was also necessary to seek permission from the contributing nations in order to use the data in this context. Permission was granted from Belgium, Denmark, England, France, Germany, Netherlands and Scotland, and data were made available at the beginning of the WG.

Summarising this comprehensive database into a simpler aggregated format suitable to Fcube has been a difficult and time-consuming task. This has been performed during the WG, reducing considerably the time left to performing and analysing runs. The STECF data provided to the WG contained extensive records covering a wide range of species, areas, gears, mesh size classes and specific gear conditions addressing present and potential derogations to the current effort management system with days at sea limitations. Specific R programs were developed to extract landings and effort data 2003-2005 covering North Sea demersal stocks only, and aggregate them to meaningful fisheries (gear and mesh size class).

One major difference between the STECF database and the Fcube requirements is the absence fleet level. Fcube models processes at the fleet level, where the fleet represent a physical group of vessels engaging in several fisheries, and thus requires that vessels are first pooled together in order to derive annual effort matrices by fleet and fishery. The fleet level is absent from the STECF data, which only collect data at the fishery level (gear, mesh size and area). The assumption was made that fleets could be approximated through the gear of each fishery, ie. all fisheries using the same gear type were pooled. As a result, fleets were defined as Otter trawlers, Beam trawlers, Demersal seiners, Pelagic and Static gears, but no further disaggregation could be made with regards to e.g. vessel length or main activity (e.g. *Nephrops* trawlers vs. demersal trawlers).

All data with missing information were pooled into one “other” fleet, which also included for each stock the difference between WG landings estimates and STECF estimates in order to cover all sources of landed fishing mortality (e.g. nations not present in the STECF data). Final datasets include 7 countries, 21 national fleets and 75 national fisheries, plus the “other” fleet (Table 15.2.1). Effort is expressed in nominal kWdays and landings are expressed in tonnes.

The coefficient of fixed quota share by fleet and stock is calculated as the average landing share over 2003-2004.

15.2.2.2 F estimates

Forecasts were not run by the WG on several demersal stocks because of uncertainties on stock status, and thus it is not possible to run Fcube forward as a projection method. Therefore, it was used to simulate the system in 2005 based on 2003-2004 inputs. Fbar estimates 2003-2005 were provided by stock coordinators for all stocks. For cod, haddock, whiting and plaice, only Fbar corresponding to the landings share (including industrial by-catch for haddock) was used. A major issue was the provision of Fbar for *Nephrops*, first because of the lack of analytical assessments for this species, and second because of the existence of several functional units in the North Sea. The landings and effort data by fleet are only specified by area and not by rectangle, and it is therefore not possible to allocate them across *Nephrops* FU. A single average Fbar estimate was thus provided for the whole North Sea, but it is considered as being a meaningless value.

15.2.3 Model runs

As no forecast is provided, observed total landings and Fbar landings in 2005 are used as proxies for the single-stock management objectives (TAC and target F). Catchability by fishery in 2005 is set at the average 2003-2004. Runs are performed first using the MAXEFFORT option (yearly fishing effort corresponding to last quota share exhausted) and second using the MINEFFORT option (yearly fishing effort corresponding to first quota exhausted), in order to estimate the range of likely fleet effort levels in 2005 A maximum variation of fleet effort from 2004 to 2005 is capped at 50%, allowing the model to behave as less constrained as possible while avoiding unrealistic estimates. Model outcomes (fleet effort and landings) are compared with observed values for 2005 from the STECF data.

Fcube has been developed primarily with the focus on fleet behaviour and effort allocation, and is therefore fully suitable for simulating the combination of TACs and effort management (days at sea limitations in certain fisheries) currently in place for North Sea demersal stocks. To illustrate this, a number of runs dealing with effort management are performed:

- Scenario 1: Constant activity matrix. The proportion of effort spent by each fleet in each fishery in 2005 is equal to the average observed over 2003-2004.
- Scenario 2: As part of the cod recovery plan, the effort of all towed gears using mesh sizes equal to or larger than 100 mm is decreased by 10%.
- Scenario 3: Same as scenario 2, but assumption is made that fleets will reallocate their effort to their other non-restricted fisheries proportionally to their importance over 2003-2004. As such, the total effort of the fleet is the same as in scenario 1 but allocated differently across fisheries.

15.2.4 Results

15.2.4.1 Scenario 1

The results of scenario 1 for both MAX and MIN options are presented on figures 15.2.2 to 15.2.7. At the stock level, the MAX option reproduces observed landings better than the MIN option (Figure 15.2.2), where the overall effort of fleets would not be sufficient to catch observed landings of mostly saithe and haddock. In terms of fishing mortality (Figure 15.2.3), the predicted F is always higher than the observed F in the MAX option. This observed F is used as a model input for reflecting target F with corresponding TAC, so the difference between the predicted and observed F is the share of catches which cannot be landed because of management restrictions (overquota catches summed over all fleets). It appears clearly that cod and plaice are the most limiting stocks, i.e. a large amount of their catches would overshoot the legal quota if the fleets were to go on fishing after their quotas for other stocks. On the contrary, quotas for haddock, *Nephrops*, sole and saithe are less restrictive, as they would correspond to more fishing days before being exhausted. On the opposite, F catch would be much lower than observed in the MIN option, where only plaice catches will correspond to management objectives.

Figures 15.2.4 to 15.2.7 show more detailed results at the fleet level. National fleets show substantial differences in their catch profiles, even though using similar gear and mesh sizes ranges. Furthermore, analyses show different types of behavior. A number of fleets show little difference between their minimum and maximum effort (e.g. Otter trawlers from countries C and E, Beam trawlers from countries A and C, Static fleets from countries C, E and G). This indicates either that they catch only few stocks and have thus less flexibility to allocate their effort across them, or that their single-stock quota shares are well balanced and correspond to similar levels of annual effort. Some other fleets show larger differences between both runs, indicating a serious mismatch between their single-stock quota shares, and thus a more complex behavior, which can be interpreted with regards to expected profitability of continuing fishing. For some of these fleets, the observed effort in 2005 was close to their predicted maximum (e.g. Beam trawlers from country F), supporting the idea that fishermen will fish until their last quota is exhausted, regardless of potential quota overshooting for other stocks. This might be the case when the last quota is for most valuable species like sole. On the contrary, if the observed effort in 2005 was closer to the predicted minimum (e.g. Otter trawlers from countries B and D), this indicates that the fleets stopped fishing even though some of their quota share was not taken up. This might be the case when these remaining shares are for small quantities or low value species which would not be worth additional fishing costs. Finally, some fleets showed an actual effort in between their predicted minimum and maximum (e.g. Otter trawlers from country G and Static fleets from country B). These results are more difficult to interpret, given that predicted landings correspond to observed ones with the MAX effort. More investigation would be necessary to know if some other factors such as changes in catchability or behavior have been observed in 2005.

15.2.4.2 Scenarios 2 and 3

In the scenario 2, all effort of towed fisheries using mesh size equal or larger than 100mm is decreased by 10%, and in scenario 3 the same is simulated but some reallocation is assumed towards other fisheries available to the fleets. Decreasing the effort of these fisheries leads to a decrease between 2 and 9% of the total effort for the fleets involved, and a decrease of 3% of total effort at the whole North Sea demersal scale. It mostly affects Otter trawlers fleets (Beam trawlers and static fleets are hardly affected and the results are not presented). The effects on the stocks are thus low, and do not prevent overshooting quotas for the most limiting stocks (figure 15.2.8). However, some reductions are observed in all trawlers fleets, especially with regards to cod and saithe.

Assuming effort reallocation in scenario 3 does not directly affect the demersal fish stocks, which are not targeted by the fisheries with increased effort. However, clear effects are observed for the main fleets catching *Nephrops*, whose catch and quota overshooting increase in return.

15.2.5 Conclusions on Fcube runs

With regards to the North Sea case study, the general hypothesis that fleets would go on fishing as long as they have some quotas left, in spite of quota overshooting for some sensitive stocks such as cod and plaice, appeared closer to observed patterns than the reverse hypothesis of stopping fishing when first quotas are reached. However some fleets showed opposite patterns. This means that at the stock scale, the combined technical interactions occurring between fleets and fisheries prevent reaching single-stock management objectives simultaneously, and quotas overshooting are more than likely, even if not recorded in the usual catch and effort data. Reaching management objectives for all stocks would require political decisions focusing on most sensitive stocks. Some steps have been taken in this direction through recovery plans and management plans, but the exploratory analyses presented here have indicated that (i) more significant effort reductions would be required for preventing quota overshooting for some stocks, but (ii) that such reductions would result in substantial losses in terms of lower quota uptakes for other stocks. However, fleet dynamics is driven by economic incentives as much as by biological factors, and these factors have not been considered here. These results thus illustrate the nature and extent of the mixed-fishery problem in the North Sea, and the need for political input given the trade-off between restricting fishing on more vulnerable species, while allowing fishing on other species.

Implementing these dry runs of Fcube during the WG has been a very useful test, both with regards to understanding the use and behaviour of the model, and with regards to data availability, reliability and suitability. The WG considered that significant progresses has been made towards providing mixed-fisheries advice, even if the results presented here should not be used in that context. As underlined by ICES-WKMIXMAN (2006), the strengths of Fcube are its mathematical and conceptual simplicity, and its attempt to model actual processes creating the situations of technical interactions, rather than implementing statistical estimates with weak theoretical basis. Some observed patterns could be reproduced, underlying the fact that all fleets react differently to management actions, depending on their local catch composition and their flexibility to switch between fisheries. Modelling processes down to the individual fleet (or average vessel) level thus allows the representation of a much wider range of situations and scenarios, including complex effort-based management rules directed towards selected fisheries as it is the case in the North Sea. The behaviour rules of effort (re)allocation implemented here were fairly simplistic, but more complex economically-driven or management-driven behaviours could be addressed. Another strength of the method is that each fleet segment is modelled independently from the others, and its behaviour in the model is only driven by its own effort levels and quota shares, irrespective of data availability of other segments. This means that model outcomes are robust to aggregation levels, and the model can be run as well even if data are missing on some fleet segments. The inclusion of the non-specified “other” fleet allows pulling all non-allocated landings together, and the behaviour of this non specified fleet does not affect the behaviour of other fleets.

It had been advocated that the need of forecast advice was a limitation to the usefulness of the method. However, it has been demonstrated here that Fcube could also be used without forecasts, as a tool for explaining observed catches and effort patterns, thus reinforcing its suitability to address mixed-fisheries issues.

Issues of data availability have been dealt with using STECF data, and they have proven to be very useful for this exercise. No major flaws were found out with regards to consistency with WG estimates, and even though the data aggregation differs substantially from the original request, it has still been possible to address this request with suitable aggregation choices.

As a conclusion, the WG considered that the results from these trial runs of Fcube were encouraging and that the approach may offer an effective way of including fleet- and fishery-based approaches into the work of WGNSSK and into the ICES advisory process.

15.3 Age-based data versus age-aggregated data

A number of additional analyses were conducted using the STECF data. One of the key differences between the STECF data and the data requirements of Fcube, is that the former data require age composition data where available. This requirement adds considerable complexity to the data compilation process. Age data may be essential to account for cases where different fleets have very different exploitation patterns but it is not clear to what extent this is true of the North Sea demersal fisheries. The target stocks typically have rather restricted age compositions, and most fish are caught with towed nets that are relatively unselective. To look more closely at this question, age composition by fleet and metier were extracted from the STECF data. However, it became apparent that there are problems in attempting to use the data at this fine a scale. While some data showed a coherent pattern (e.g. increasing catches of younger fish with smaller mesh sizes of the same gear), in other cases no discard data were available, making comparison difficult. There were also problems with limited sampling leading to very noisy estimates, and with data showing very similar exploitation patterns for a large range of mesh sizes and gears. This latter effect was thought to be an artefact of the national sampling scheme rather than a true result. It is not the intention here to highlight or criticise national sampling schemes, so these analyses are not presented here. However, these analyses do suggest that including the present age data may in some cases not merit the considerable overhead involved in preparing the data.

Non-age disaggregated data are useful about general interactions in the fishery. It can also be instructive to present basic fleet data to illustrate aspects of the fishery. Examples of this are catch data by species broken down by fleet (Figure 15.3.1) and metier (Figure 15.3.2a-d) as well as effort trends by these same units (Figure 15.3.3). Note that the landings and effort plots are not strictly comparable, as the former include data from Norway whereas the latter do not. These represent very simple presentations of the data, but nonetheless they can provide much information about the fisheries. To select one example, it is clear that during 2005 the large majority of *Nephrops* were caught by otter trawlers using mesh sizes of between 80 and 89mm. Since 2000 there has been a substantial reduction in total effort by otter trawlers from EU member states, but despite this overall reduction there has actually been an increase in effort by vessels using the 80-89mm mesh size. Hence, quite large scale changes in fishing activity are apparent from relatively simple presentation of data.

15.4 Conclusions

Age data are routinely used aggregated to the total catch level within the single species stock assessments. This usage reflects the type of models based on following individual age-classes through the fishery. Hence the age composition is essentially an attribute of the stock, though it can also help shed light on fleet and fishery processes such as increased discarding due to the recruitment of a strong year class.

It is perhaps most instructive to recognise that tools such as Fcube are complementary to the routine stock assessments as they are intended to look at different aspects of the system. The focus of stock assessments is biological; the purpose is to describe trends and possible future developments in a single fish stock. The description is largely in terms of biological attributes of the stock (SSB, recruitment etc.) with the technical aspects of the fishery all covered under the overall heading of ‘fishing mortality’. By analogy, how Fcube and other such tools can be used may be considered as part of a fleet and/or fishery assessment, which describes trends and possible future developments in the technical aspects of the fishery. Here the detail would concern the fishing vessels and their activity in some way, with biological details kept to a minimum. By presenting both stock and fishery assessments together it should be possible to obtain a much more comprehensive picture of the system than if the two were presented in isolation

The two mixed-fishery approaches investigated at the current WG meeting reflected the two areas of development identified by ICES-WKMIXMAN (2006), i.e. the Fcube modelling approach, and the visualisation of data to provide a simple way of presenting information about fishing activities. Both of these approaches could prove to be useful additions to the WG toolbox, and may be useful in future for providing mixed-fisheries advice. A future challenge will be to integrate these approaches more closely with the stock assessments so that information on developments in fishing activity can be used to interpret changes in stock development and *vice versa*.

Table 15.1.1. The segmentation of fishing activities identified for future sampling of fisheries in the North Sea area under the EU Data Collection Regulation.

Adapted from EC (2006).

Level 1 Activity	Level 2 Classes of gear	Level 3 Gear Groups	Level 4 - EU level	Level 5 - Fishing activity North Sea and Eastern Arctic
FISHING ACTIVITY	Dredges	Dredges	Boat Dredge [DRB]	Molluscs
			Mechanised/Suction Dredge [HMD]	Molluscs
	TRAWLS	BOTTOM TRAWLS	Bottom otter trawl [OTB]	Molluscs
				Crustaceans
				Demersal fish
				Mixed crustaceans and demersal fish
				Mixed cephalopods and demersal fish
				Small pelagic fish
				Deep water species
				Mixed pelagic and demersal fish
				Mixed demersal and deep water species
			Multi-rig otter trawl [OTT]	Molluscs
				Crustaceans
				Demersal fish
				Deep water species
				Mixed crustaceans and demersal fish
				Mixed pelagic and demersal fish
			Bottom pair trawl [PTB]	Demersal fish
				Crustaceans
				Small pelagic fish
			Beam trawl [TBB]	Crustaceans
				Demersal fish
				Mixed crustaceans and demersal fish
		PELAGIC TRAWLS	Midwater otter trawl [OTM]	Small pelagic fish
				Demersal fish
			Pelagic pair trawl [PTM]	Small pelagic fish
				Demersal fish
FISHING ACTIVITY	HOOKS AND LINES	ROD AND LINES	Hand and pole lines [LHP] [LHM]	FinFish
			Set longlines [LLS]	
				Demersal fish
	TRAPS	TRAPS	Pots and traps [FPO]	Molluscs
				Crustaceans
				Finfish
			Fyke nets [FYK]	Catadromous species
	NETS	NETS	Trammel net [GTR]	Demersal fish
			Set gillnet [GNS]	Small pelagic fish
				Demersal fish
				Crustaceans
			Driftnet [GND]	Small pelagic fish
				Demersal fish
	SEINES	Surrounding nets	Purse seine [PS]	Small pelagic fish
		Seines	Fly Shooting seine [SSC]	Demersal fish
			Anchored Seine [SDN]	Demersal fish
			Pair Seine [SPR]	Demersal fish
			Beach and boat seine [SB] [SV]	Finfish
	OTHER GEAR	OTHER GEAR	Glass eel fishing	Glass eel
	MISC. (SPECIFY)	MISC. (SPECIFY)		
OTHER ACTIVITY THAN FISHING				Other activity than fishing
INACTIVITY				inactive

Table 15.2.1. Fcube fleets and fisheries units. Average landings and effort over 2003-2004.

Average of Landings			Stock							
Country	Fleet	Metier	COD_4	HAD_4	NEP_4	PLE_4	POK_4	SOL_4	WHG_4	"Effort(kWdays)
A	BEAM	BEAM_80-89	1343.22	350.57	16.24	4094.78	22.67	1446.86	117.64	3787703.50
	BEAM Total		1343.22	350.57	16.24	4094.78	22.67	1446.86	117.64	3787703.50
A Total			1343.22	350.57	16.24	4094.78	22.67	1446.86	117.64	3787703.50
B	BEAM	BEAM_>=120	58.60	19.97	0.00	1418.83	1.12	7.41	0.01	643075.23
	BEAM Total		58.60	19.97	0.00	1418.83	1.12	7.41	0.01	643075.23
	DEM_SEIN	DEM_SEINE_>=120	413.58	619.47	0.06	1268.54	163.13	0.81	1.74	569990.07
		DEM_SEINE_100-119	8.90	5.63		373.96	0.68	0.17	0.00	87818.70
		DEM_SEINE_80-89	0.55	0.05		2.81	0.00	0.01	4.52	9929.25
	DEM_SEINE Total		141.01	250.05	0.06	548.44	65.52	0.33	2.08	222579.34
	OTTER	OTTER_<16	9.20	15.06	3.21	4.50	120.94	0.02	0.30	8523475.98
		OTTER_>=120	1302.94	1264.92	738.85	2138.75	3726.20	6.54	43.31	4534967.97
		OTTER_100-119	46.75	51.54	22.11	852.07	9.92	4.79	2.01	505431.55
		OTTER_16-31	9.04	7.27	3.19	6.77	102.20	0.03	1.75	1455431.67
		OTTER_32-54	49.16	14.67	24.44	0.76	135.23	0.78	3.59	1933560.00
		OTTER_55-69	0.32	0.64	2.00	1.05	1.04	0.08	0.03	14691.61
		OTTER_80-89	108.51	23.09	773.13	1070.98	7.37	25.69	7.53	1486316.79
		OTTER_90-99	59.53	32.48	270.65	876.73	4.25	12.33	3.35	733800.63
	OTTER Total		198.18	187.91	262.14	660.14	547.55	6.70	7.73	2398459.52
	STATIC	NETS_>=220	34.58	0.38	0.01	16.18	0.36	2.15		112549.89
		NETS_100-109	25.67	0.62	0.00	37.87	0.06	222.66	0.10	174780.54
		NETS_10-30	5.06	0.25		0.82	0.62	0.83		4449.78
		NETS_110-119	6.60	1.31		28.60	0.14	14.58	0.00	18166.85
		NETS_120-219	2520.83	140.19	0.01	3788.71	73.64	167.57	0.42	1328700.61
		NETS_60-69	2.09	0.01		2.20	0.00	0.61		1574.71
		NETS_70-79	26.59	0.43		16.62	1.48	0.42	0.00	10259.49
		NETS_80-89	10.41	0.26	0.92	1.96	0.53	0.04		5190.42
		NETS_90-99	28.56	0.09	0.02	9.44	0.03	190.91	0.04	169073.06
	STATIC Total		295.60	16.87	0.11	433.60	9.57	66.64	0.14	202749.48
B Total			225.12	112.71	146.84	581.35	228.85	32.12	4.29	1063011.18
C	BEAM	BEAM_<16	2.06	0.84	0.02	89.18	0.17	3.26	0.30	75453.50
		BEAM_>=120	39.08	11.61	0.18	1927.57	1.13	31.61	0.51	1620242.50
		BEAM_100-119	21.93	6.40	0.10	2058.19	2.82	21.39	1.22	1466210.50
		BEAM_16-31	0.15			2.15		0.42		412300.00
		BEAM_80-89	60.27	23.01	3.64	2102.17	0.09	238.21	12.79	1731313.00
	BEAM Total		27.21	11.84	1.12	1235.85	1.18	58.98	3.70	1061103.90
	DEM_SEIN	DEM_SEINE_>=120	4.24	58.29	0.32	53.39	0.02	0.01	2.37	37158.50
		DEM_SEINE_100-119	0.10	0.16		123.72		0.01		39752.50
		DEM_SEINE_90-99	0.90	0.78		116.26		0.04	0.03	39026.50
	DEM_SEINE Total		1.75	23.66	0.32	97.79	0.02	0.02	1.59	38645.83
	OTTER	OTTER_<16	5.20	0.86	1.65	0.37	0.04	0.06	1.28	4736.50
		OTTER_>=120	956.88	863.51	33.57	106.86	597.51	2.97	389.23	1247888.00
		OTTER_100-119	59.20	134.66	32.22	247.78	226.65	1.27	71.78	469780.00
		OTTER_80-89	112.78	224.08	1006.57	117.04	3.50	49.93	229.39	1084110.00
		OTTER_90-99	49.47	84.79	226.97	389.19	0.85	2.03	71.57	583265.00
	OTTER Total		236.70	261.58	260.19	172.25	184.12	11.25	152.65	677955.90
	STATIC	NETS_>=220	4.25	0.01		0.05	0.05	0.02	0.07	172225.50
		NETS_100-109	1.89			0.02	0.00	0.92	0.23	11929.00
		NETS_120-219	323.52		0.01	0.56	0.59	0.23	0.60	104007.00
	STATIC Total		109.89	0.01	0.01	0.21	0.31	0.39	0.30	96053.83
C Total			105.86	122.48	130.51	458.40	79.36	23.49	57.88	568712.38
D	BEAM	BEAM_16-31	0.19			1.21		0.51	0.95	11259.00
		BEAM_70-79	2.98			41.02		29.65	2.92	49384.50
		BEAM_90-99	0.21			17.29		16.65	0.56	12188.00
	BEAM Total		1.12			19.84		15.60	1.48	24277.17
	OTTER	OTTER_>=120	4.44	16.77		0.15	271.30	0.06	1.46	90720.50
		OTTER_100-119	39.23	798.01		0.30	15580.10	0.19	233.00	3234223.50
		OTTER_70-79	271.92	8.72		70.59		7.87	1691.81	1710448.00
		OTTER_90-99	0.72			12.79		4.57	8.22	22948.00
	OTTER Total		79.07	274.50		23.93	7925.70	4.19	552.50	1264585.00
	STATIC	NETS_110-119	20.16	0.01		5.87	0.01	2.83	2.02	16406.50
		NETS_80-89	45.81			70.05		486.93	2.33	406789.00
	STATIC Total		32.98	0.01		37.96	0.01	244.88	2.17	211597.75
D Total			42.85	235.28		25.78	6340.56	68.64	228.53	617151.89
E	BEAM	BEAM_>=120	2.67	1.97	0.05	32.39	0.05	5.15	0.93	46724.50
		BEAM_100-119	0.80	0.23		40.13	0.00	0.23	0.04	24613.50
		BEAM_16-31	0.92		0.19	9.02	0.03	6.73	0.33	7080381.00
		BEAM_80-89	55.81	1.75	16.01	1451.72	0.02	698.53	47.77	1990894.00
		BEAM_90-99	1.05	0.19	0.20	39.72	0.00	0.11	0.01	19984.00
	BEAM Total		12.25	1.03	4.67	314.59	0.02	142.15	9.82	1832519.40
	DEM_SEIN	DEM_SEINE_>=120	683.13	367.04		5.68	249.60	0.00	0.86	272818.00
	DEM_SEINE Total		683.13	367.04		5.68	249.60	0.00	0.86	272818.00
	OTTER	OTTER_>=120	940.79	889.42	0.58	32.49	6746.87	0.14	36.42	1931407.50
		OTTER_100-119	27.12	73.29	0.53	232.11	1954.40	0.28	3.10	391366.00

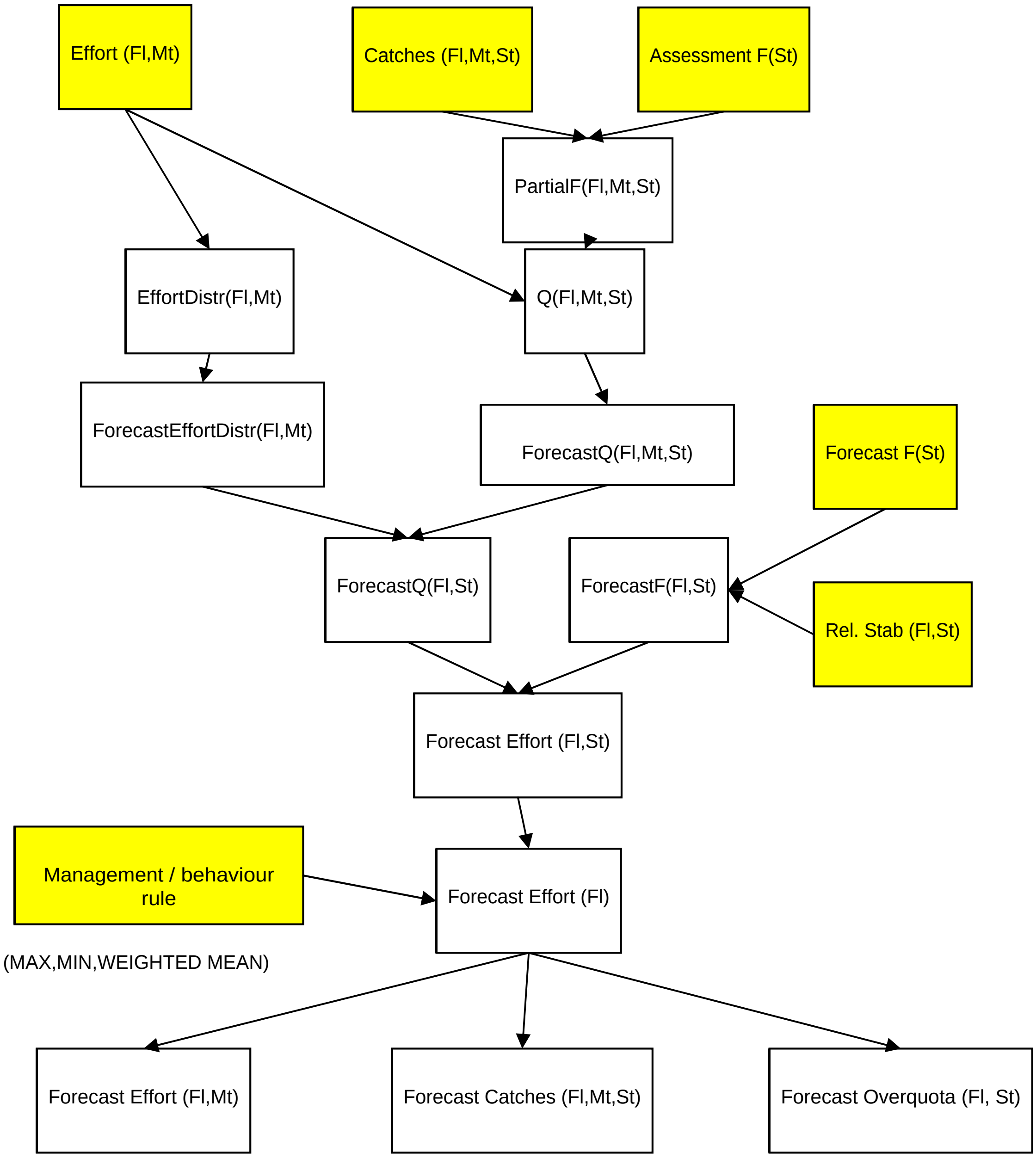


Figure 15.2.1. Fcube Flowchart Fl=Fleet, Mt=Metiers (fisheries), St=Stock. Boxes in grey are inputs required.

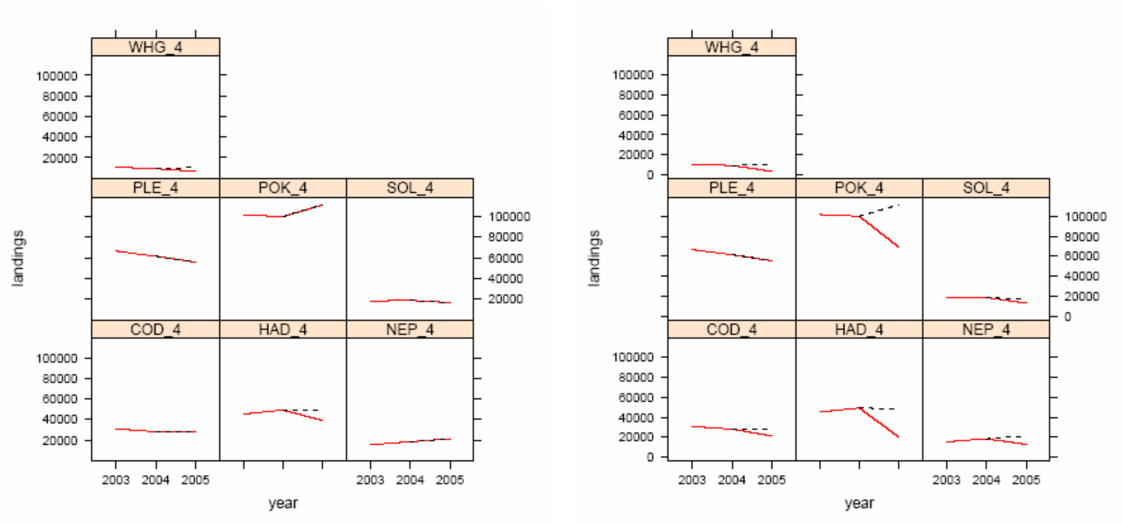


Figure 15.2.2. Mixed fisheries Fcube scenario1. Predicted (plain line) vs. observed (dotted line) 2005 landings by stock. Left: MAXEFFORT level, Right: MINEFFORT level

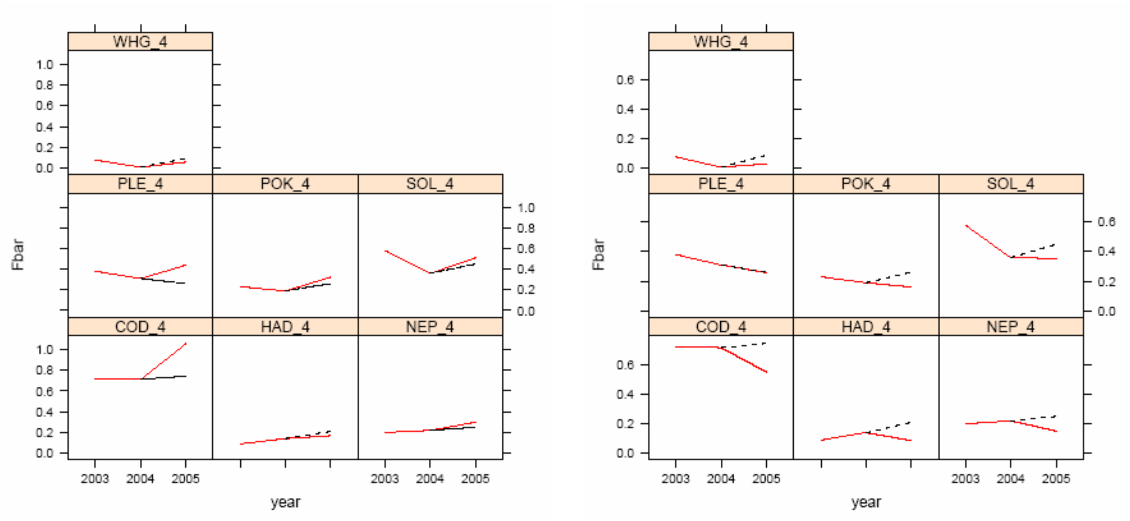


Figure 15.2.3. Mixed fisheries Fcube scenario1. Predicted (plain line) F Catch (landings + overquota) vs. observed (dotted line) F landings 2005 by stock. Left: MAXEFFORT level, Right: MINEFFORT level

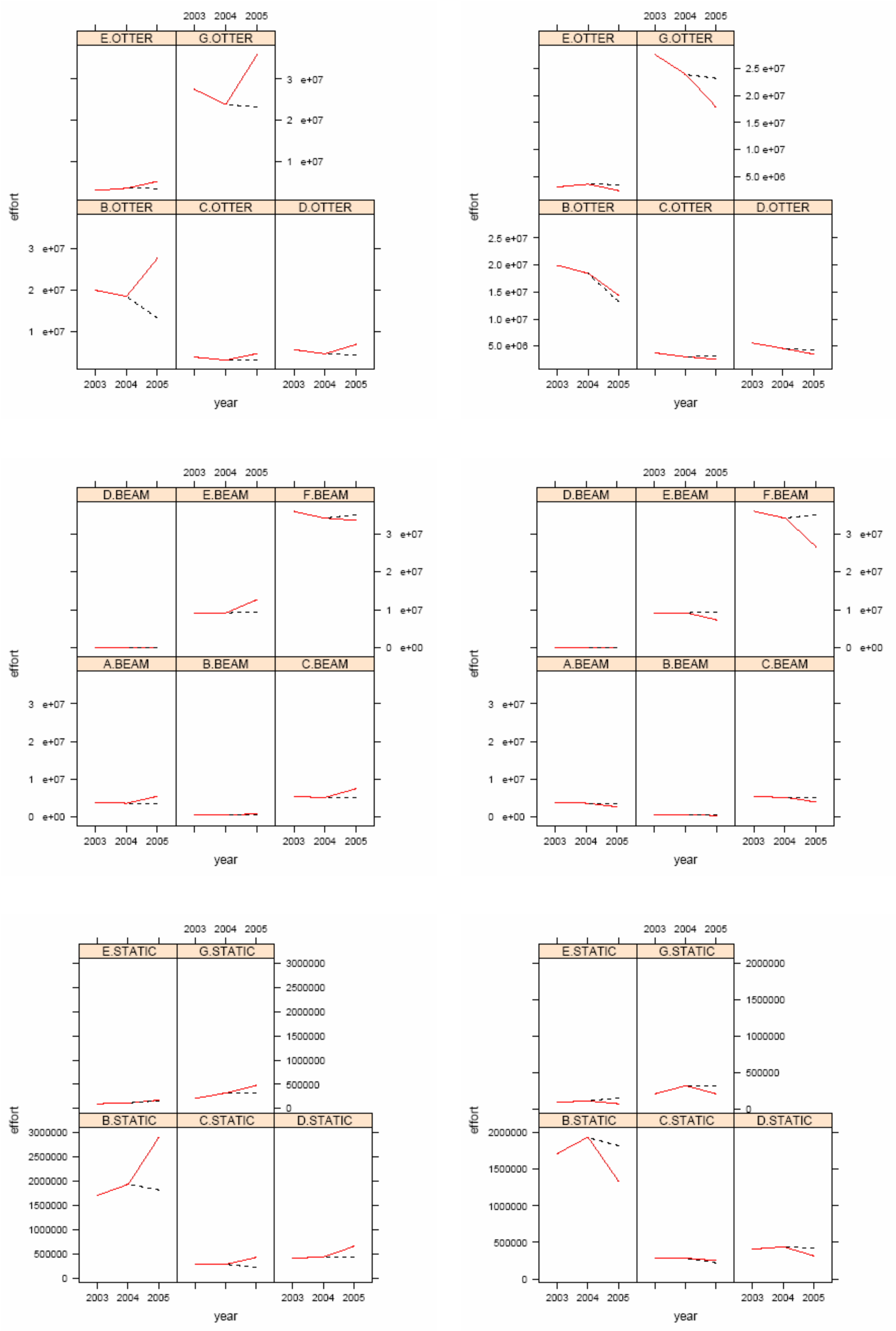


Figure 15.2.4. Mixed fisheries Fcube scenario1. Predicted (plain line) vs. observed (dotted line) 2005 effort by fleet, Up : Otter trawlers, Middle : Beam trawlers, Bottom : Static fleets. Left: MAXEFFORT level, Right: MINEFFORT level.

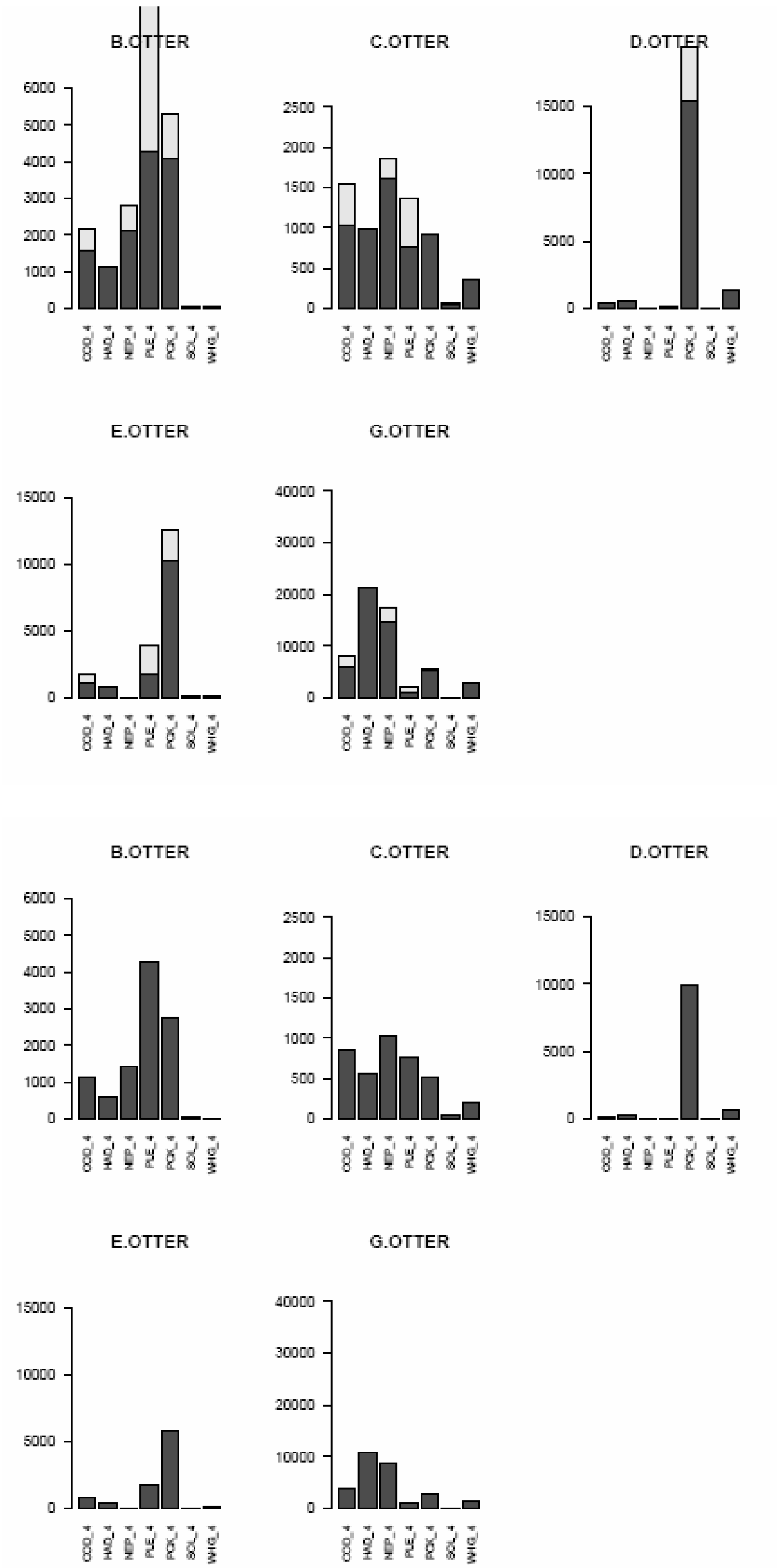


Figure 15.2.5. Mixed fisheries Fcube scenario1. Predicted 2005 landings (black) and overquota catches (grey) by fleet, Otter trawlers. Up : MAXEFFORT level, Bottom : MINEFFORT level. Predicted landings in MAXEFFORT correspond to observed landings.

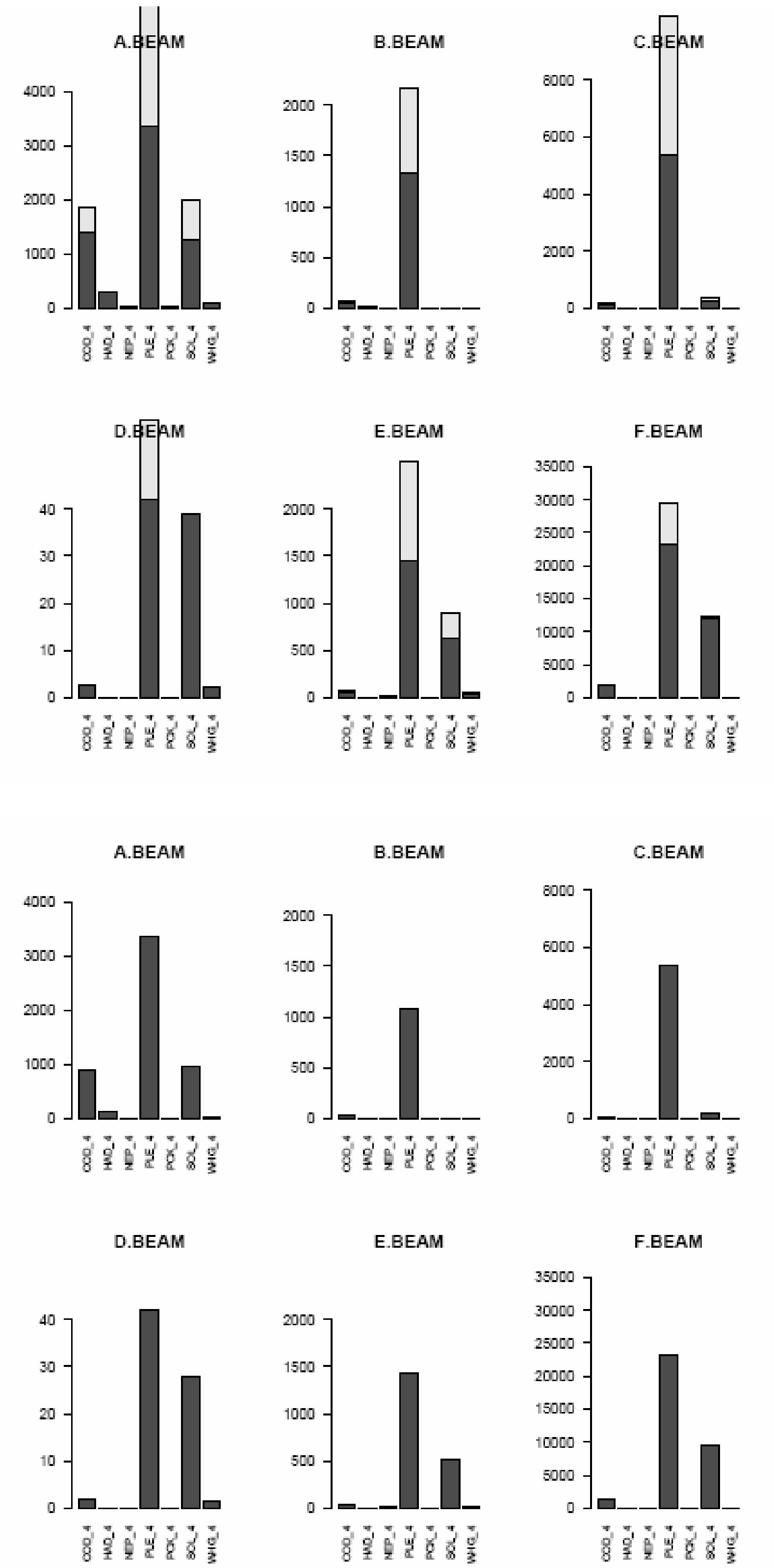


Figure 15.2.6. Mixed fisheries Fcube scenario1. Predicted 2005 landings (black) and overquota catches (grey) by fleet, Beam trawlers. Up : MAXEFFORT level, Bottom : MINEFFORT level

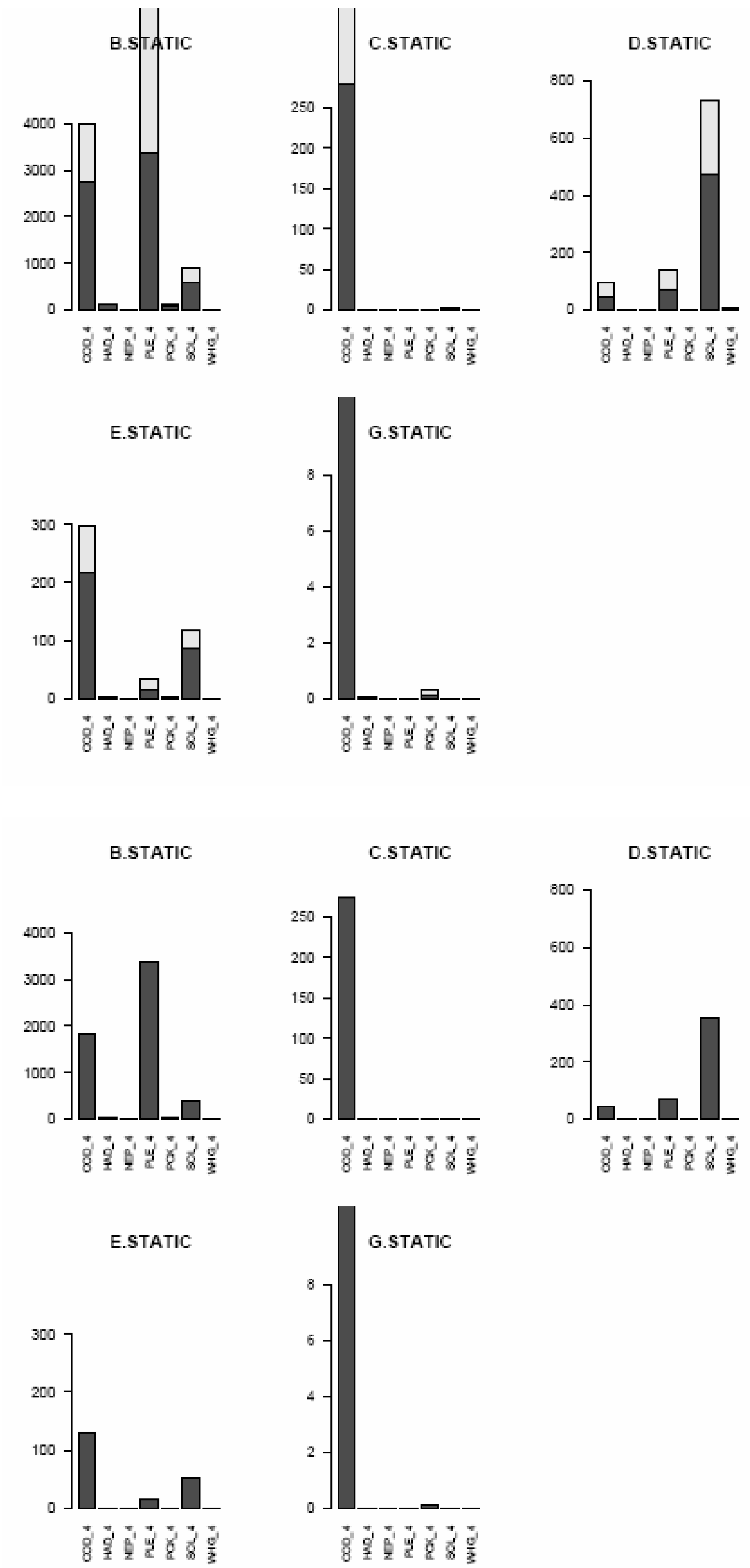
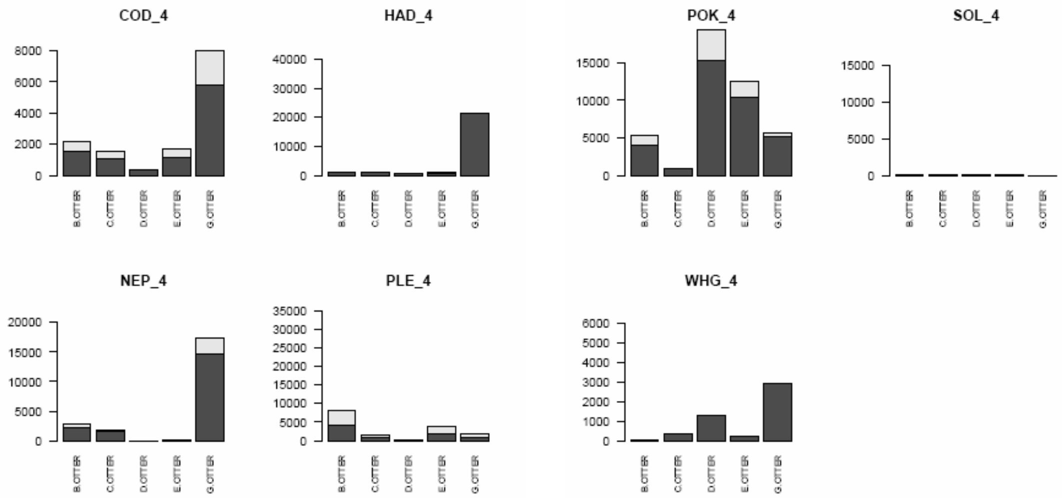
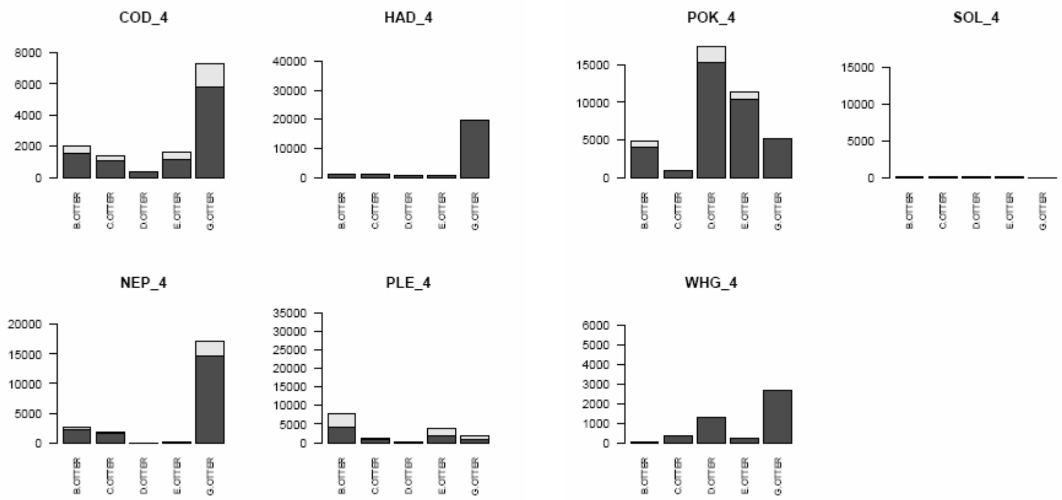


Figure 15.2.7. Mixed fisheries Fcube scenario1. Predicted 2005 landings (black) and overquota catches (grey) by fleet, Static fleets. Up : MAXEFFORT level, Bottom : MINEFFORT level

Scenario 1



Scenario 2



Scenario 3

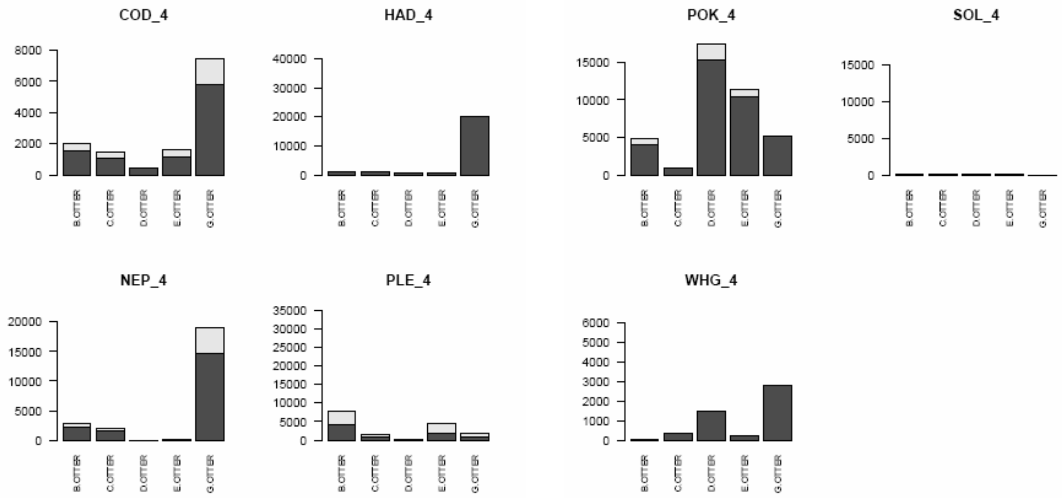
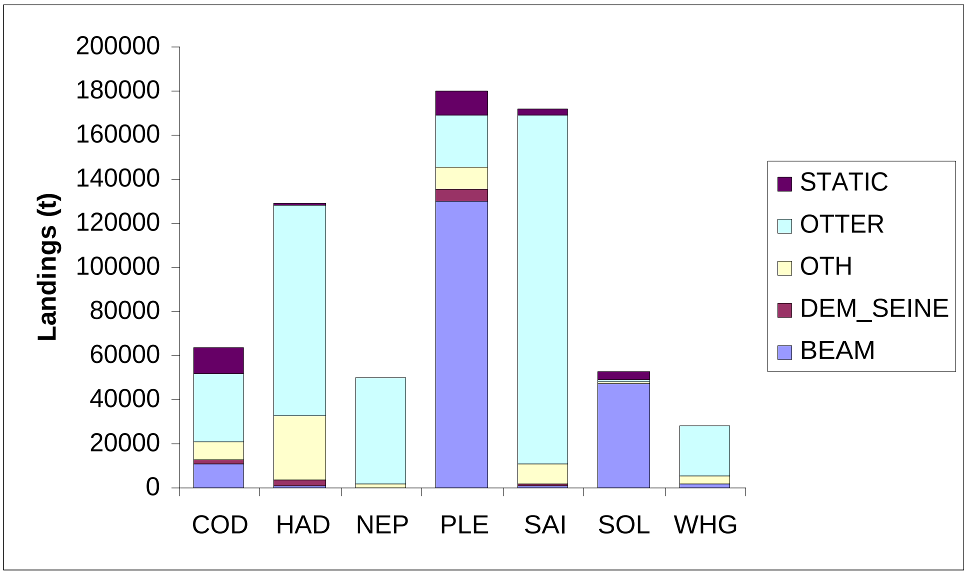


Figure 15.2.8. Mixed fisheries. Predicted 2005 landings (black) and overquota catches (grey) by stock, Otter trawlers, for scenarios 1, 2 and 3.



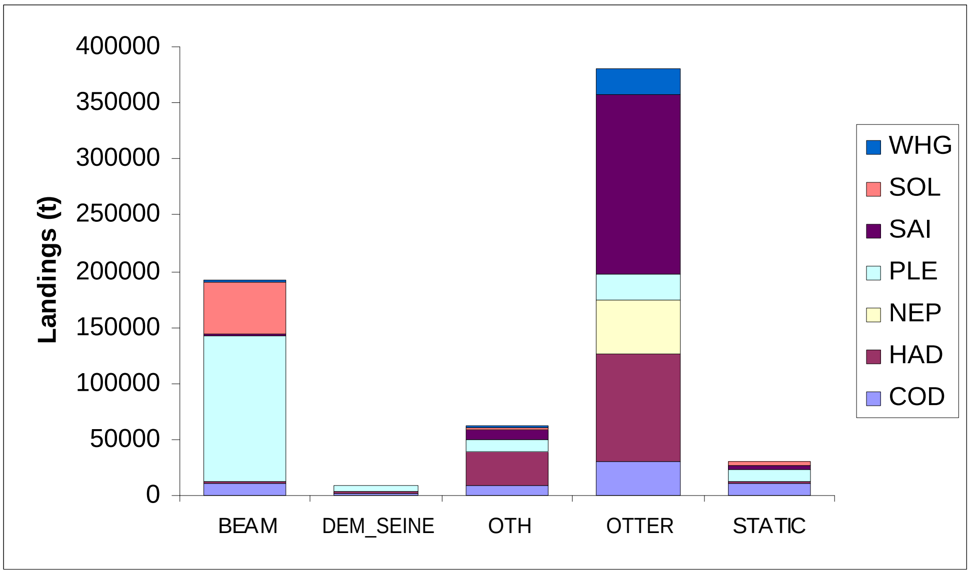
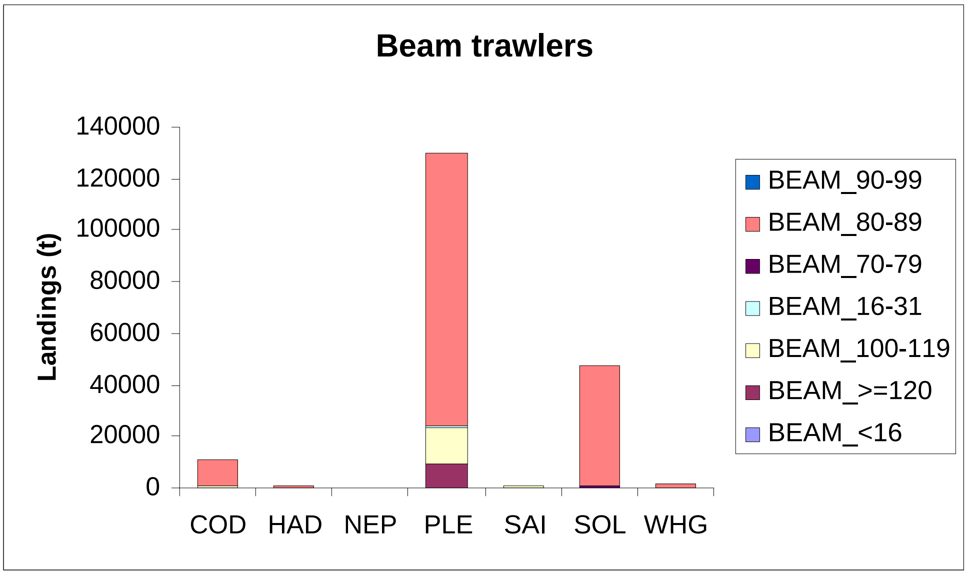


Figure 15.3.1. Landings of North Sea demersal species in 2005 disaggregated by gear-type. Data are landings from the North Sea only as supplied to STECF by Belgium, Denmark, France, Germany, the Netherlands and the UK and used with permission. Data supplied by Norway to WGNSSK are also included.



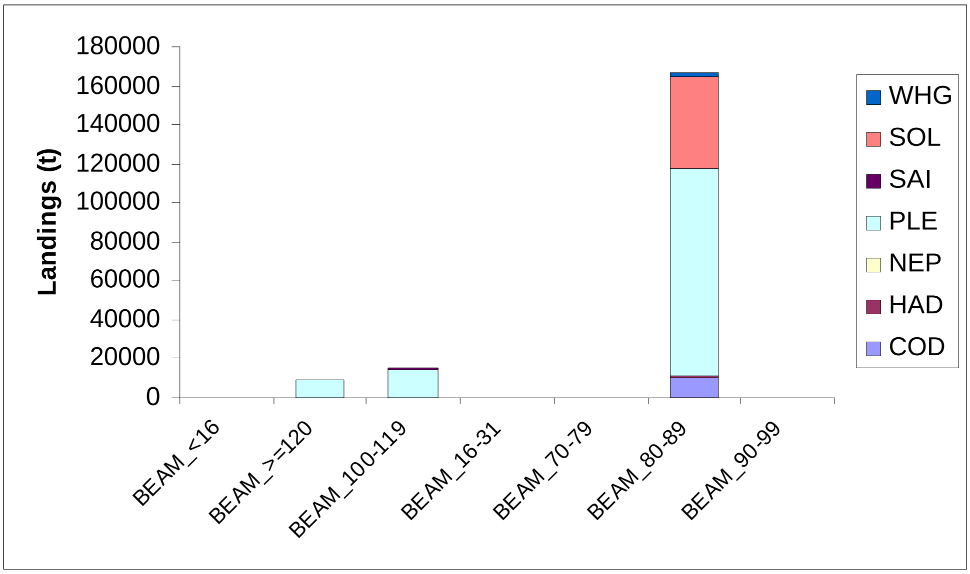
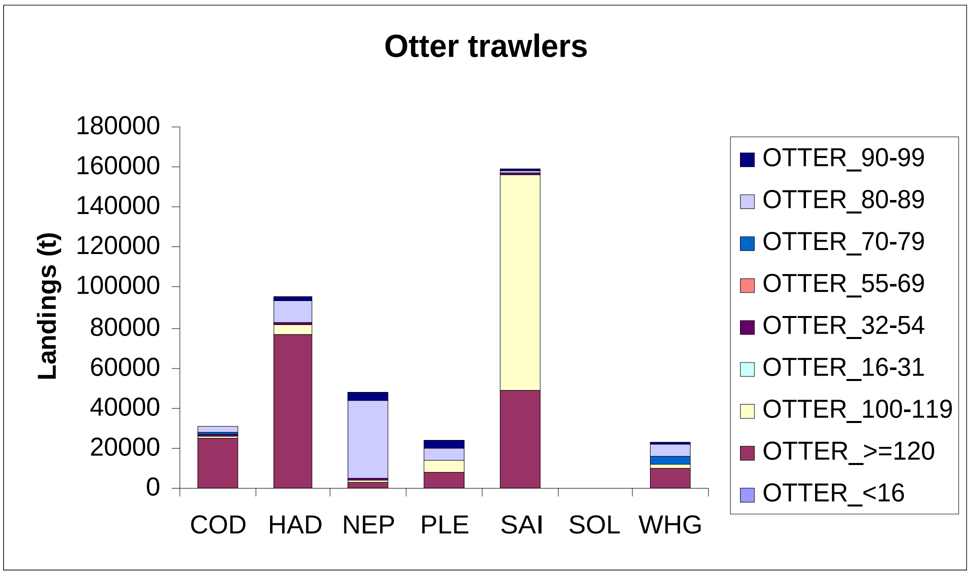


Figure 15.3.2a. Landings of North Sea demersal species in 2005 by Beam trawlers disaggregated by mesh-size category. Data are landings from the North Sea only as supplied to STECF by Belgium, Denmark, France, Germany, the Netherlands and the UK and used with permission. Data supplied by Norway to WGNSSK are also included.



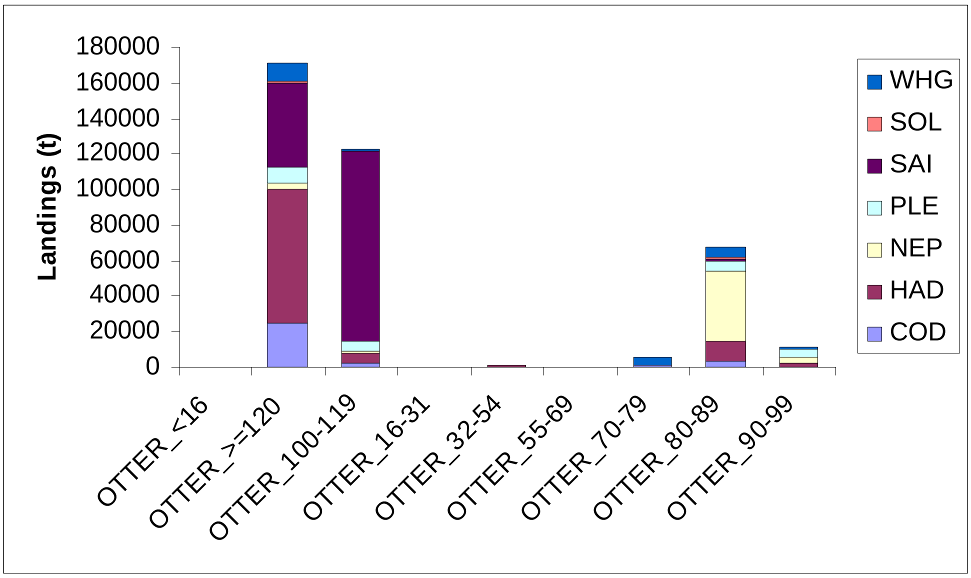
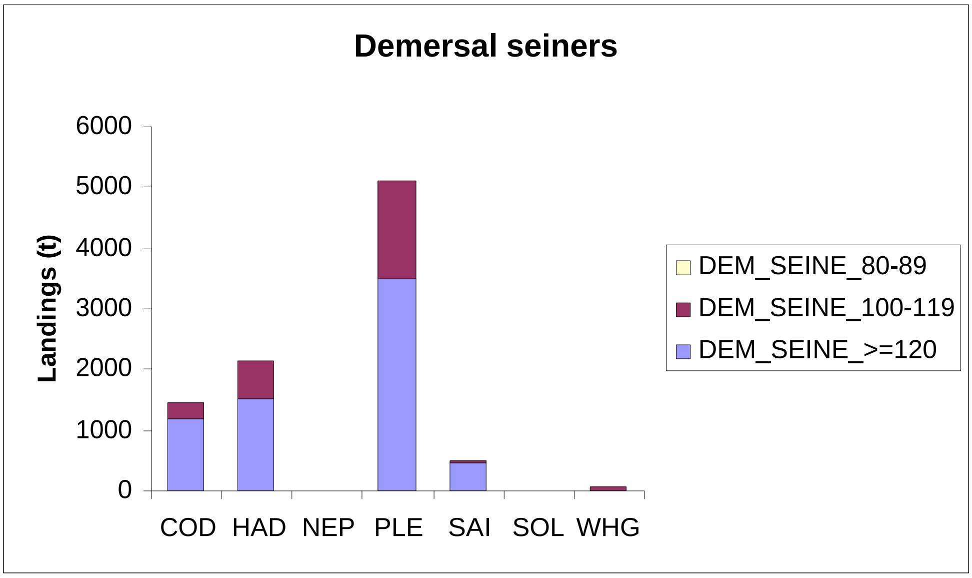


Figure 15.3.2b. Landings of North Sea demersal species in 2005 by otter trawlers disaggregated by mesh-size category. Data are landings from the North Sea only as supplied to STECF by Belgium, Denmark, France, Germany, the Netherlands and the UK and used with permission. Data supplied by Norway to WGNSSK are also included.



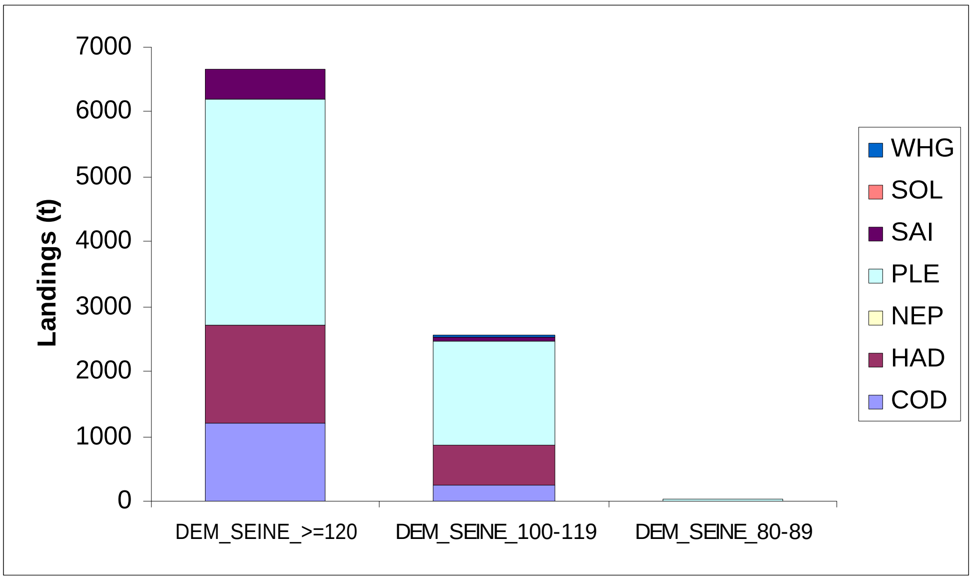
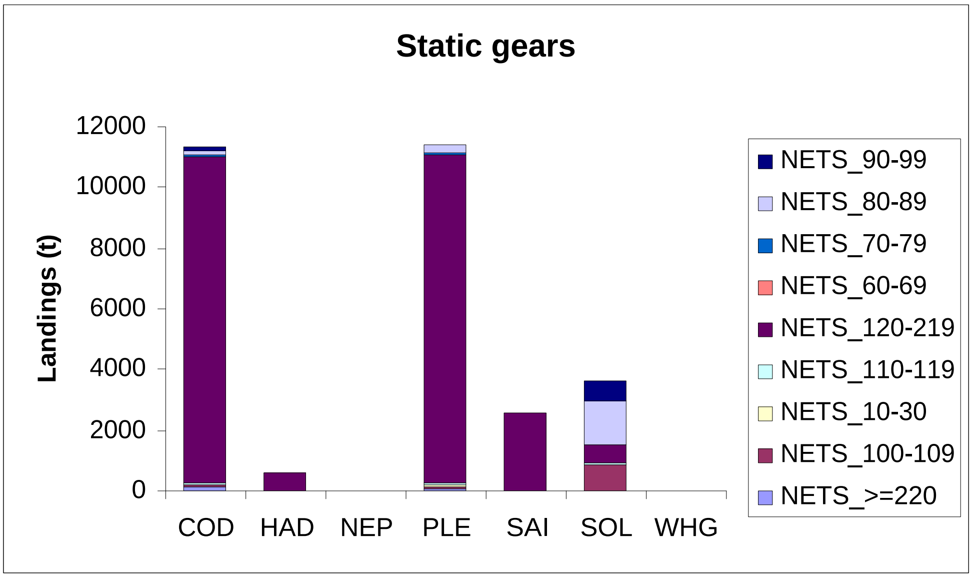


Figure 15.3.2c. Landings of North Sea demersal species in 2005 by demersal seiners disaggregated by mesh-size category. Data are landings from the North Sea only as supplied to STECF by Belgium, Denmark, France, Germany, the Netherlands and the UK and used with permission. Data supplied by Norway to WGNSSK are also included.



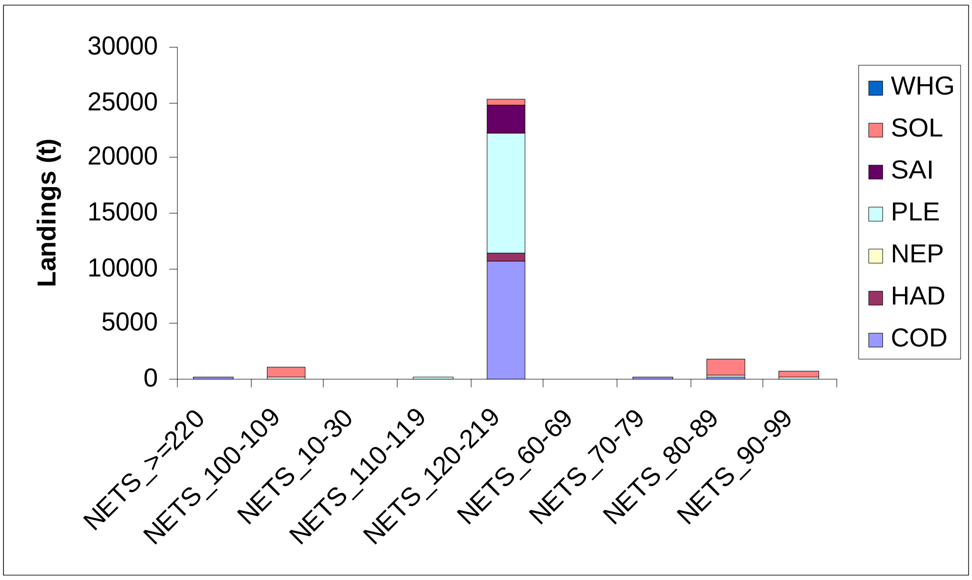
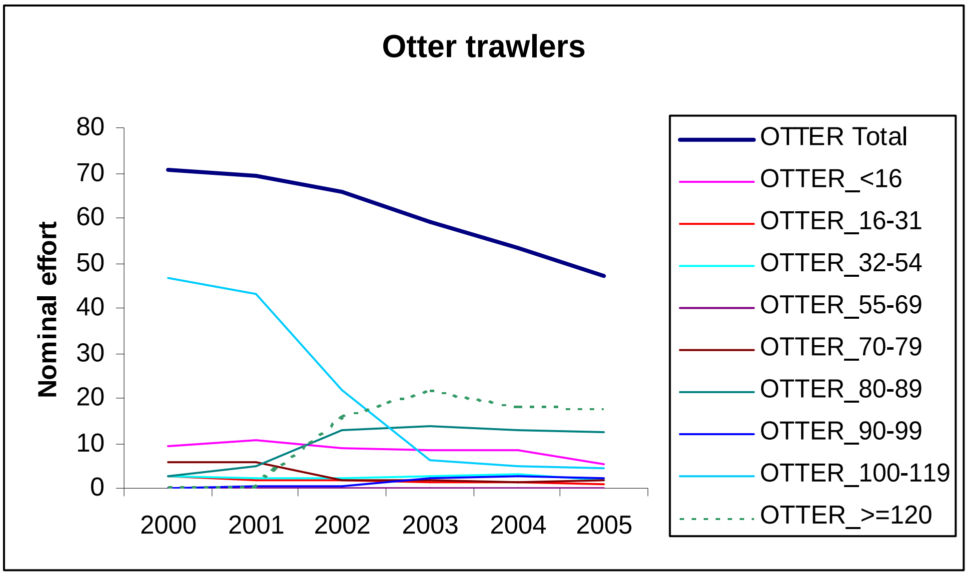


Figure 15.3.2d. Landings of North Sea demersal species in 2005 by static gears disaggregated by mesh-size category. Data are landings from the North Sea only as supplied to STECF by Belgium, Denmark, France, Germany, the Netherlands and the UK and used with permission. Data supplied by Norway to WGNSSK are also included.



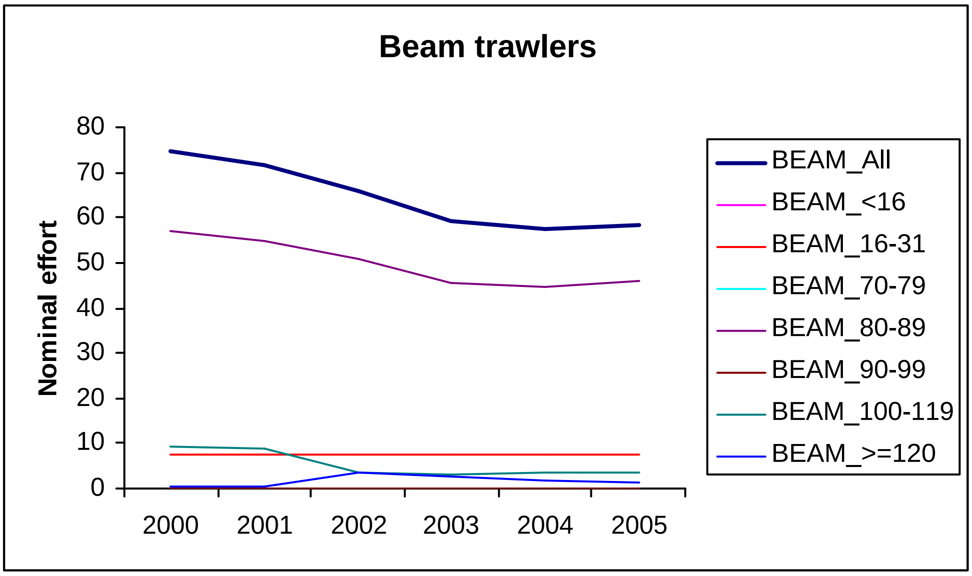
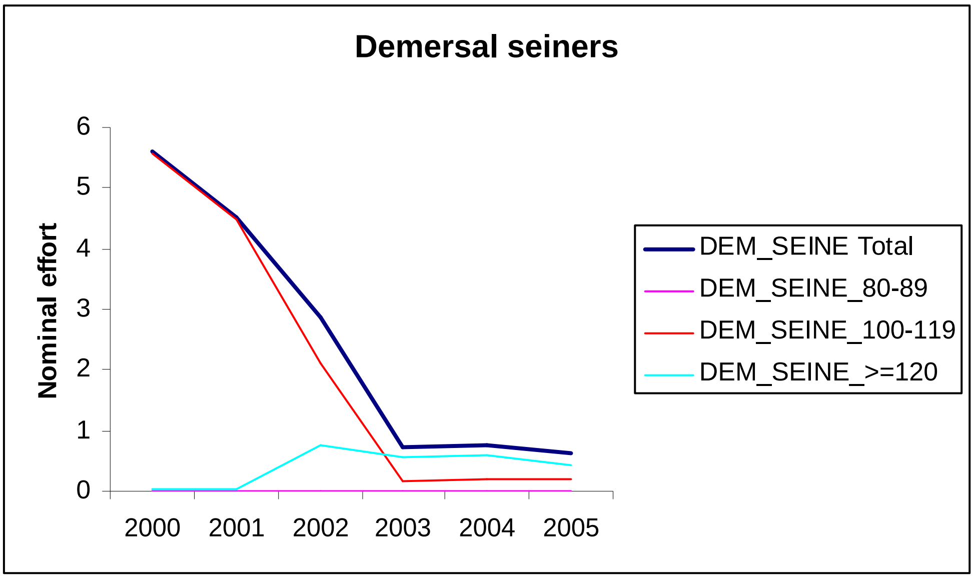


Figure 15.3.3. Recent trends in nominal effort (10^6 kilowatt days) by gear type in the North Sea. Data are effort in the North Sea only as supplied to STECF by Belgium, Denmark, France, Germany, the Netherlands and the UK and used with permission.



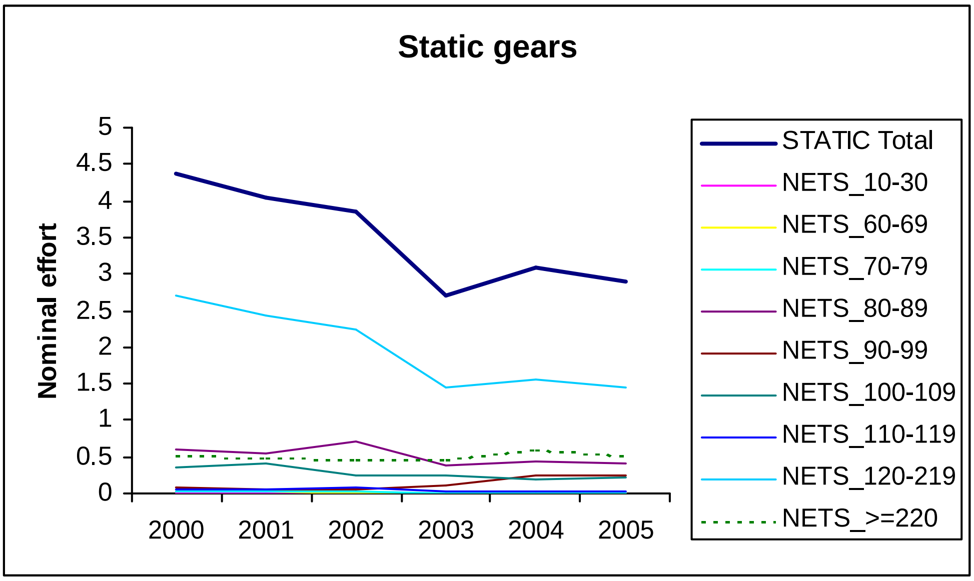


Figure 15.3.3, Recent trends in nominal effort (10^6 kilowatt days) by gear type in the North Sea (continued).

16 Management plan evaluations

16.1 North Sea haddock

16.1.1 Introduction

North Sea haddock are currently managed under the EU-Norway management plan, the text of which is as follows (repeated from Section 13.1.4):

1. *Every effort shall be made to maintain a minimum level of Spawning Stock Biomass (SSB) greater than 100,000 tonnes (B_{lim}).*
2. *For 2005 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.30 for appropriate age groups (F_{target}).*
3. *Should the SSB fall below a reference point of 140,000 tonnes ¡Bpa¢, the fishing mortality rate referred to under paragraph 2, shall be adapted in the light of scientific estimates of the conditions then prevailing. Such adaptation shall ensure a safe and rapid recovery of SSB to a level in excess of 140,000 tonnes.*
4. *In order to reduce discarding and to enhance the spawning biomass of haddock, the Parties agreed that the exploitation pattern shall, while recalling that other demersal species are harvested in these fisheries, be improved in the light of new scientific advice from inter alia ICES.*
5. *A review of this arrangement shall take place no later than 31 December 2006.*
6. *This arrangement enters into force on 1 January 2005.*

In April 2006 ICES received the following request for evaluation of this plan, sent by the European Commission and Norway:

EC-Norway Scientific Request to Evaluate Options to Improve Stability in Haddock Catches

The European Community and Norway have agreed to exploit the stock of North Sea haddock on the basis of a TAC consistent with a fishing mortality rate of no more than 0.3 for appropriate age-groups. However, scientific advice from ICES has led to unexpectedly large variations in the forecast catch that corresponds to this fishing mortality rate.

It is also relevant that for the stock the stability of catches (according to ICES estimates) may be substantially greater than the stability of the adopted TACs.

ICES is requested to:

Develop and evaluate the consequences of alternative options and methods to provide improved stability in TACs, while maintaining the fishing mortality rate on the stock on average close to the level decided by managers, and avoiding a high risk of depletion of the spawning biomass outside safe biological limits.

ICES should develop these options and alternative methods on its own initiative, but should also evaluate the consequences of applying a 15% limit on interannual variation in TACs.

ICES agreed to this request, and further that the evaluation of the existing plan and any proposed modifications would be carried out by WGNSSK. The review is to be prepared subsequently during the October meeting of ACFM.

The following analysis and evaluation are drawn from Needle (2006a,b), being respectively a working paper to the Working Group on Methods of Fish Stock Assessment (ICES-WGMG 2006) and a discussion document from FRS (Aberdeen).

16.1.2 Methods

The 2006 meeting of the Methods WG (ICES-WGMG 2006) proposed a three-step evaluation loop for management plans, which may be paraphrased as:

1. Translate the management proposal into a structured decision diagram. This will serve as a basis for the design of simulations and reveal holes and ambiguities in the managers' proposals.
2. Convert the decision diagram into an algorithmic flowchart.
3. Implement the flowchart in computer code and check that is produces the correct results.

The loop is illustrated in Figure 16.1.1. It is clear that feedback and discussion with managers and stakeholders are essential at every stage in the procedure; there is little to be gained by evaluating a plan that it not what managers intended, or does not perform as they would wish.

Figure 16.1.2 shows a decision diagram for the North Sea haddock management plan (or, as it is called in Figure 16.1.1, a high-level conceptual flowchart). This illustrates the fact that the management plan has a number of ambiguities, such as when SSB should be measured and what age range mean *F* is to be calculated over. There are also two key points on which a numerical evaluation will founder; the plan says nothing about what should be done if SSB < B_{pa} or B_{lim}. In reality this would lead to negotiation, but this is impossible to simulate.

The evaluations summarised below do not therefore attempt to evaluate the North Sea haddock management plan as written, but rather a set of simpler harvest-control rules (HCRs) which encapsulate its main features. The 10-year simulations are coded in R (R Development Core Team 2005) using the FLR library (FLR Team 2006). The method is presented in detail in Needle (2006a,b). The key assumptions made, and comments on them, are as follows.

- Management can operate on the basis of effort regulation or catch regulation. The analyses presented here show only catch regulation; in reality a combination of the two are used.
- Recruitment is generated on the basis of a 10-year geometric mean with a CV from same period. On this is imposed an upper limit, equal to the size of the 1999 year-class. Negative autocorrelation is included to prevent successive large year-classes, which have not been observed for haddock. This is a rather crude approach which does however appear to give recruitment distributions similar to what has been observed in the recent past.
- Weights, maturity, and natural mortality are fixed for the duration of the simulations.
- Selection (exploitation) is set as the three-year mean, and is fixed in time for catch-based simulations.
- Two catch components are modelled: landings and discards. The proportion landed of total catch is assumed fixed through the simulation. Industrial bycatch has not been implemented, although at current low levels (see Sections 4 and 5) this is unlikely to be deleterious to the analysis.

Three HCRs were simulated: a target F, a fixed TAC, and a target F with a limit in the amount of interannual change possible in TACs. Additionally, intended F could only vary by 25% from current F (otherwise exponential increase in F is possible following a series of low recruitments). The specific scenarios analysed are summarised in Table 16.1.1. It should be noted that these simulations are based on the final assessment presented in the 2005 meeting of the WG (ICES-WGNSSK 2005), rather than the assessment given in Section 13 of the current report. The reason for this is that the analyses were carried out intersessionally, before the 2006 assessment was available.

16.1.3 Results

Illustrative results for catch-based management with a TAC constraint HCR (target F = 0.3 with ±15% limit on TAC variation) are given in Figures 16.1.3 (single realization), 16.1.4 (box-and-whisker summaries of distributions), 16.1.5 (median and 50% confidence intervals of distributions) and 16.1.6 (risk summaries). The effect of a combination of a target F and TAC constraint can be seen in these plots. Under the assumptions of the simulations, the HCR appears to be able to maintain F at around 0.3, which leads in turn to a slow rise in SSB. There is no risk of exceeding F reference points, while biomass falls below SSB reference points in some years (albeit with a low probability: <20% for B_{pa}, <5% for B_{lim}).

Table 16.1.2 summarises the analyses for each HCR in terms of the risk of exceeding reference points during the simulation. HCRs which allow high fixed TACs or high target Fs lead to a high risk of exceeding reference points, as might be expected. Conversely, low TACs and low target Fs lead to a low risk. As mentioned above, the HCR illustrated in Figures 16.1.3 to 16.1.6 (target F = 0.3 with ±15% limit on TAC variation) leads to some risk (<20%) of falling below B_{pa}, but no risk to any other reference point.

16.1.4 Conclusion

The approach presented above is relatively simple, but encapsulates the main features of the current management plan for North Sea haddock (along with proposed modifications). It evaluates simple HCRs in terms of risk of exceeding or falling below pre-defined biomass and mortality reference points. It is sensitive to the trigger risk level (assumed here to be 10%), the particular reference points used for testing, and assumptions about recruitment, growth, and so on.

Following this evaluation (which has also been reviewed by ICES-WGMG, 2006), and given the assumptions outlined above, **the WG concludes that several of the HCRs tested are unlikely to lead to a >10% risk of exceeding management reference points**. These are fixed TACs in the range 20 000 tonnes to 40 000 tonnes; target Fs between 0.3 and 0.4; and a target F is conjunction with a TAC constraint of ±15% or ±20%.

It must be borne in mind that this does not constitute a formal review of the complete management plan, as this cannot be done yet (for reasons outlined in Section 16.1.2). Specifically, the evaluation is only really appropriate when biomass is greater than Bpa. Such evaluations must be done in collaboration with managers and stakeholders in order to avoid the problems caused by ambiguous interpretation of the management plan. In addition, management plans must be very specific; negotiations cannot be simulated in a numerical framework.

16.2 North Sea cod

16.2.1 Methods and results

Holmes (WD 18) presented an evaluation of the cod recovery plan (see Section 14 for details of the plan). This builds on methods applied in the context of cod in Division VIa in ICES-WGNSDS (2006). The structure of this evaluation was similar to that presented for North Sea haddock in Section 16.1, with some differences in implementation as listed below.

- The particular FLR operating model being developed by the EU-FISBOAT project was used (EU-FISBOAT 2006).

- No assessment was performed during the management cycles. Instead, measurement error (CV = 11%, based on preliminary work) was applied to the true SSB to generate “measured” SSB.
- Rather than a fixed discard proportion, discards were modeled with a linear relationship with landings.
- Recruitment was assumed to follow a Ricker model, with autocorrelation.
- Implementation bias of 33% was applied. This was derived from the mean BADAPT multiplier given in last year’s assessment (ICES-WGNSSK 2006).
- Upper bounds were imposed on recruitment and allowed TAC.

Two scenarios were presented, the first with no interannual limit in variation in TAC, the secod with a restriction of ±15%. Summary results from these runs are given in Figures 16.2.1 and 16.2.2. These show that cod recovery is possible, given some fairly crude assumptions about growth, mortality and recruitment. It is also clear that the application of a TAC constraint slows recovery. In both scenarios, there is a high probability of several years with zero TAC.

16.2.2 Conclusions

These results agree broadly with the conclusions of Horwood et al. (2006), who have also investigated the future prognosis of cod under the recovery plan although under an assumption of continued low recruitment. Given that the recovery plan has not been in place for very long, it is thought to be premature to look for signs of recovery yet. Neither Holmes (WD 18) nor Horwood et al. (2006) incorporated the possible effect of future climate change scenarios in their models, principally because the causal links between climate and cod population dynamics are not well understood (ICES-WGREDS 2006).

This section does not constitute a formal review of the cod recovery plan. The paper from Holmes (WD 18) was submitted during the meeting,and it was not possible for the WG to consider the analysis in detail. **The WG is therefore unable to reach a conclusion on this evaluation of the cod recovery plan.** Work is continuing to address this issue, and results are included here as a record of the discussion only.

16.3 North Sea plaice and sole

According to ICES, the stocks of plaice and sole in the North Sea are currently being fished at unsustainable levels. The Commission of the European Community has therefore proposed a long-term management plan for the fisheries exploiting these stocks, which is designed to gradually adjust the level of fishing activity so as to achieve greater catches, larger and more stable stocks and more profitable fisheries (5403/06 PECHE 14). The plan defines target levels of annual fishing mortality of 0.3 for plaice and 0.2 for sole. These are values which, according to scientific advice, will allow higher yields for a given level of recruitment, reduce discarding, and allow a reduced biological risk to the fish stocks. The tools to achieve these objectives are the same as those in the other long-term plans already in place. According to the plan, fishing mortality will be reduced by 10% year-on-year until the target levels have been reached, while annual variations in TACs will be kept within limits (15% up or down). Other measures will involve the regulation of fishing effort via fishing days at sea which are supposed to change in proportion with the change in sole fishing mortality (before the 15% TAC change limitation). The implementation of the management plan implies a change in management strategy from a risk avoidance strategy (to stay within safe biological limits) to a strategy of optimal harvesting of the resource. This new strategy is in accordance with the commitments made at the World Summit on Sustainable Development at Johannesburg (2002).

Machiels et al. (WD 6) evaluated this plan in a simulation study using the FLR package. Results show that through the plan proposed by the EC, F target levels can be reached in a time frame of 15 years, under the assumptions used in the model. At the same time the effort allowed (maximum number of days at sea) reduces to about 50% of its current (=2006) level. SSB of both species will on average increase. Assumptions have been made on the behaviour of fishers in response to the measures. It is noted that the proposed Regulation aims to control landings and not catches. Fishermen have the choice either to stop fishing when their quotas are depleted, or to discard over-quota fish. This behaviour is not illegal in waters under Community legislation. To some extent, it may be possible to avoid catches of a target species, by selecting different fishing grounds or periods, or by modification to the gear. The results are robust with respect to varying scenarios of fishers' behaviour, e.g. continue fishing until the last of the two TACs is exhausted, while over-quota catches of the other species are either taken or entirely avoided, or stop fishing when the first TAC is exhausted and not using the full fishing opportunity for the other species. These scenarios are probably unrealistic, but represent the extremes of possible behaviour. Average TACs and landings from 2006 to 2014 vary depending on the scenario of fishers' behaviour used for a run. TACs and landings for sole seem to level of at 14000-15000 tons. For plaice TAC and landings increase on average with 4000 tons per year at the end of the simulation period (2014). The social and economic impacts of the proposed management measures, over both the short and the long term were not assessed in this study.

Another assumption made was that the beam trawl fleet is the only fleet exploiting North sea plaice and sole. This is not true. About 30% of the plaice is caught with other gears such as otter trawl, twin trawl and gill nets while 10% of the sole is caught by gill nets. It is noted that the annual adjustment (reductions) in fishing mortality, following from the management plan harvest control rule applies to the entire stocks (article 4 and 5) , while the adjustment of fishing effort only applies to the beam trawl fleet (article 6[3]). Pending the implementation of the effort reduction in practice (by ship or by fleet) this may lead to different developments which are mainly triggered by different associated economics. In the worst case, further restriction in fishing days of the beam trawl fleet may lead to a switch to other gears which are not restricted by the effort measure. In that case fishing mortality will not reduce and the penalty at the end of the year would be a further reduction of the beam trawl effort. In that case fishing mortality imposed by the beam trawl fleet will be in misbalance with the effort reduction of the fleet. The extreme continuation of this behaviour could lead to the disappearance of the beam trawl fleet.

It was noted that when observed fishing mortalities approach the target Fs, which are close to the level of natural mortality, assessment of the fishing mortalities becomes highly uncertain. Moreover, the harvest control rule allows fishing effort to increase once the observed fishing mortalities fall below the targets. The effort multipliers can then become quite high, leading to annual fluctuations of allowed days at sea (up to increases of 50%). In practice the fleet would not be able to adjust to such large annual changes in allowed effort (i.e. fleet capacity).

The WG notes that the Commission's proposal does not explicitly mention on what scientific basis the target F values have been set, but that its reference to the Johannesburg declaration suggests that these target F values are assumed to be close to the F levels resulting in MSY (Maximum Sustainable Yield). However, MSY is difficult to estimate, because it depends on multiple variables (e.g. growth, mesh size, natural mortality). Every change in one of these variables results in changes in MSY. Moreover, MSY is influenced by density dependence and multi-species effects (ICES-WGMG 2004). Any consideration of reference points concerned with long-term yield needs also to consider the wider ecosystem context of the stock.

The WG furthermore notes that the technical interactions of this mixed fishery should be taken into account: do the respective target F levels for the two species imply similar fleet efforts?

The simulation study shows that the two F levels are well in balance throughout the simulation period, resulting in relatively small over-quota catches in all the scenarios studied.

In conclusion: the objectives are feasible, but social and economic consequences need to be investigated. Changes in fleet behaviour have not been investigated, but could have important implications. In addition, it is not known to what extent the target *F*s would lead to maximum sustainable yield.

16.4 Saithe

In 2004 EU and Norway *"agreed to implement a long-term plan for the saithe stock in the Skagerrak, the North Sea and west of Scotland, which is consistent with a precautionary approach and designed to provide for sustainable fisheries and high yields. The plan shall consist of the following elements:*

1. *Every effort shall be made to maintain a minimum level of Spawning biomass (SSB) greater than 106 000 tonnes (B_{lim}).*
2. *Where the SSB is estimated to be above 200 000 tonnes the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.30 for appropriate age groups.*
3. *Where the SSB is estimated to be below 200 000 tonnes but above 106 000 tonnes The TAC shall not exceed a level which, on the basis of a scientific evaluation by ICES, will result in a fishing mortality rate equal to 0.30-0.20*(200 000-SSB)/94 000.*
4. *Where the SSB is estimated by the ICES to be below the minimum level of SSB of 106 000 tonnes the TAC shall be set at a level corresponding to a fishing mortality rate of no more than 0.1.*
5. *Where the rules in paragraphs 2 and 3 would lead to a TAC which deviates by more than 15% from the TAC the preceding year the Parties shall fix a TAC that is no more tha 15% greater or 15% less than the TAC of the preceding year.*
6. *Notwithstanding paragraph 5 the Parties may where considered appropriate reduce the TAC by more than 15% compared to the TAC of the preceding year.*
7. *A review of this arrangement shall take place no later than 31 December 2007.*

This arrangement enters into force on 1 January 2005."

In June 2004 a EU-Norway ad hoc scientific working group evaluated a range of different harvest rules for saithe with respect to yield, stability in yield and with respect to risk of being below Blim (EU-Norway 2004). The rules were evaluated through simulations, taking as a starting point the state of the stock on 1 January 2003. The main conclusions from this work were:

Precautionary management of the saithe fishery can be achieved by several combinations of long term F and constraints on year-to-year variation in yield. The stricter the constraint, the lower F must be. There are no benefits in terms of increased long term yield to increase F above 0.3. Several possible HCRs may increase SSB to levels not observed so far, where the effects on recruitment cannot be anticipated. The stock-recruitment issue will have to be revisited if the stock increases above previously observed levels. The perception of risk from this study is contingent on the assumed Blim value. This value is currently set near some of the lowest observed SSBs, rather than based on population dynamics considerations. Since the saithe stock is in a good condition, at the current F constraints in year to year variation in yield can be introduced in the fishery, without substantially increasing the risk.

The agreed management plan for saithe is in accordance with the type of HCR explored in (EU-Norway 2004). Moreover, the agreed management plan is in accordance with simulated management scenarios in (EU-Norway 2004) that carry little risk of falling below Blim in the long term.

The WG was not in the position to evaluate further the agreed management plan this year.

16.5 Sandeel and Norway pout

The European Community and Norway have request ICES for advice on management measures for the Sandeel and Norway Pout fisheries in the North Sea and Skagerrak in 2007. This section evaluates and suggests Harvest Control Rules (HCR) and management measures for both stocks in 2007.

16.5.1 Sandeel

The request to ICES concerning Sandeel:

a. *Harvest control rules for sandeel in the North Sea and Skagerrak that:*

   i. *Allow the Maximum Sustainable Yields to be obtained and are consistent with the precautionary approach.*

   ii. *Prevent any local depletion of sandeel aggregations, and*

   iii. *Take into account the function of sandeel in the ecosystem.*

   It may be expected that the management of the sandeel fishery will include the setting of preliminary catch and/or fishing effort limits at beginning of the year until scientific information is available allowing for the fixing of the final maximum fishing effort and/or catch levels. The harvest rules should therefore include rules for setting preliminary and final fishing effort levels (expressed as a percentage of the reference level in kW-days) and/or catch levels.

b. *The monitoring systems and assessment methodologies required to implement the advised harvest control rules;*

c. *The possible negative effects on the reproductive success and incoming year class strength due to bottom towed gears undertaking fisheries other than sandeel fisheries and operating on the various sandeel fishing grounds during the spawning season; and*

d. *The possible effects of bottom towed gears on the alteration of physical and biological characteristics of the sandeel essential habitats as well as whether and how any such alterations may affect the dynamic of the sandeel stock.*

ICES is requested to submit its report on points a) and b).

There is strong evidence that once settled after a pelagic larvae stage, larger juveniles and adult sandeel are resident in the same area throughout its lifetime. This make the species vulnerable to local depletion as indicated by request point a) ii. Right now, the present knowledge on defining subpopulations are too limited for establishing HCR for 2007, which fully takes the population structure into account. Section 16.5.1.2 presents ongoing work on how to define local sub-population such that the scale of "local depletion" can be defined and made operational for a North Sea wide implementation in a future HCR.

Sandeel is an important prey species for many fish, bird and marine mammal species. Section 16.5.1.3 gives a short review of the function of sandeel in the ecosystem and potential implications for defining HCR. It was not possible to take ecosystem considerations into account in the HCR suggested for 2007.

Advice is requested for an HCR to be used 2007. This very short deadline excludes a full implementation of a spatial explicit HCR, as knowledge is simply too limited for establishing such. As a consequence, the HCR suggested for 2007 relies on the dynamic pool assumption and very much on the experiences from the present EU real-time monitoring of the sandeel fisheries applied for 2004-2006. The findings from the Norwegian experimental fishery in 2006 and the pronounced decline of sandeel stock in the Northern North Sea is however taken into account by suggesting a special condition for Norwegian Economic Zone.

The HCR used in EC-waters in 2004-2006 and the Norwegian Economic Zone in 2006 are described in Section 4.

16.5.1.1 Suggestion for a HCR for 2007

Several *ad hoc* working groups to define and evaluate harvest control rules for sandeel in the North Sea have been organized by STECF. At the "*ad hoc* Working Group on Sandeel Fisheries" (STECF 2005b) held in November 2005, a comprehensive evaluation was made of the present real-time monitoring applied for the Danish fishery. The group met to evaluate the Commission's current HCR and to make recommendations regarding a potential sandeel fishery next year. The conclusions drawn from a range of simulations made during this meeting using the available data is still considered valid. Updated data were available to WGNSSK this year; however, these indicate that the method is biased in most recent years. The Sandeel group concluded that the Commission's current HCR will perform adequately in the long term with respect to maintaining the population above $B_{lim,}$ with 95% probability. There are, however, alternatives which enable the fishery to be more stable whilst simultaneously achieving the B_{lim} criterion, in particular the setting of a TAC such that SSB in the following year achieves a target (e.g. B_{pa}). This minimum escapement strategy was chosen early in the WGNSSK meeting as a first choice for the suggested HCR.

Review of the EU real-time monitoring system.

Real-time monitoring in EU-waters has now been applied for three years. With the annual update of the sandeel assessment the real-time estimates can now be compared, at least for the years 2004 and 2005 where the VPA estimate of age-group one is fairly closed to the converged value.

The real time estimates of age 1 abundance in 2004 and 2005 were an overestimate compared to the VPA value (Figure 16.5.1). For 2004 the real-time estimate is 1.48 times higher than the VPA result, and the factor is 1.58 for 2005. This conclusion is based on an updated regression log(VPA N1) ~log (CPUE N1) including data up to 2005.

Figure 16.5.1 panel b) shows the effect of using the regression including data up to 2003, or a regression using data up to 2005. Data for 2006 are not included as the VPA estimate of the one-group is far from converging. It can be seen that the two regression lines have the same slope but the updated regression has a slightly lower intercept. The regression including data up to 2003 was used in real time monitoring in 2005 and 2006.

The stock numbers of the 1-group in 2004 and 2005 have consistently been overestimated in the previous year's assessment, while age 1 in 2003 has been underestimated, however this year class is very low (Figure 16.5.2). The first VPA estimate of the 2003 year-class is almost twice as big as the most recent VPA estimate. The real-time estimate showed the same tendency to overestimate 1-groups (48% overestimate in 2004 and 58% in 2005), however these overestimates are somewhat lower, compared to the bias in the terminal year estimate of the one-group.

The HCR used in 2004-2006 set a TAC on basis of the real-time estimate of age 1. No other data are used. The *ad hoc* STECF WG (STECF 2005b) suggested that the "minimum escapement" strategy might be a better alternative to the present HCR. Such approach requires additional data for the stock data for age 2 and older to actually calculate the SSB (equivalent to the biomass of age 2+) on the 1st January the year after the fishery has taken place. This SSB is mainly determined by the 2-group (the real time estimate of 1-group the year before), but does also rely on the stock numbers estimate of age 3+ (derived from the assessment estimate of age 2+). Traditional ICES forecasts have shown that estimated stock numbers of age 2+ in the beginning of the TAC year (equivalent to SSB) have been overestimated by a factor 2-3 as compared to the SSB estimated by SXSA in 2006 (see table below).

FORECAST YEAR	SSB YEAR	FORECAST SSB (1000 TONNES)	SXSA 2006	OVERESTIMATION OF SSB (%)
2004	2005	501	166	202
2005	2006	446	210	112

This big deviance seems mainly due to an underestimation of F in the terminal year, also seen in the retrospective (Figure 4.3.2.2) and assessment quality plot (Figure 4.3.2.4) for sandeel.

The very poor assessment performance with respect to estimating age 1+ indicates that the current HCR (in which just the real-time estimate of 1-group is used) might perform better than an HCR based on the minimum escapement strategy. Both approaches should have been evaluated during the WGNSSK but time constrains permitted just evaluation of the minimum escapement strategy.

Suggested upper level of effort in 2007

Mean F_{1-2} (un-weighted and weighted by stock numbers) from the SXSA assessment and effort and number of vessels participating in the sandeel fishery is presented below.

				Denmark		Norway
Year	**F(1-2)**	**F(1-2) weighted**	**Standardised international effort**	**Kilo watt days (thousands)**	**Number of vessels**	**Number of vessels**
2002	0.75	0.79	12.84	7867	207	53
2003	0.68	0.69	15.29	7306	171	35
2004	0.75	0.86	15.64	7334	200	40
2005	0.65	0.54	6.12	3390	98	22
05 Sep. 2006	0.31	0.31	6.87	3946	124	6

This overview shows a relative stable F and effort for the period 2002-2004; however taking 2005-2006 into account there is no clear relation between F and effort. Other analyses (STECF 2005a) of the relation between effort and F confirm that conclusion.

The weak relation between effort and F highlights that an HCR cannot be purely effort based. However, an upper effort level might prevent severe over-fishing. F estimated for 2005-2006 indicates that even a relative modest effort can inflict F in the range 0.31-0.65.

Taking the present low SSB, and the lower than average 2005 year-class into account, a maximum effort level as applied in 2005 is suggested for the HCR for 2007.

Effort for real-time monitoring must be as low as possible, but give a reliable real-time estimate. Using data up to week 19 stabilizes uncertainty in the CPUE. Based on the experience for 2005 and 2006 about 30% of the yearly effort was applied in week 19, and 30% of 2005 effort is suggested for the HCR as real-time effort.

Suggested level of maximum TAC in 2007

Given the suggested low maximum effort for 2007, and the suggested MSY around 400 kt (see later in this section) a maximum TAC is suggested at 400kt.

Closure of the fishery 1st August

Historically, the proportion of 0-group has been high in the end of the fishing season. For protection of 0-groups, for which no estimates exist when the fishery begins, the fishery is suggested closed on the 1stAugust.

Stock depletion in the Norwegian EEZ

The present HCR assumes a clear relation between CPUE and stock size. The fishery and probably also the stock in the northern part of North Sea, mainly in the Norwegian Economic Zone have been reduced considerably and is now concentrated to a very few fishing banks, compared to the historical fishing pattern. Due to this concentration, CPUE data from the commercial fishery are only available from a small area in Norwegian Economic Zone. And, as assessment as well as the CPUE HCR is based on a dynamic pool assumption for sandeel in the North Sea, the severe contraction of the sandeel in the northern part of the North Sea is likely to have resulted in overestimate of the stock in recent years. How much the sandeel stock has been overestimated is however difficult to evaluate.

Suggested HCR for 2007

1. The total Kilowatt-days for fisheries for sandeel in 2007 may not exceed 30% of the total Kilowatt-days applied in 2005.

2. A TAC for 2007 shall be determined, and the maximum number of kilowatt-days referred to in point 1 shall be revised, as early as possible based on advice from the ICES on the size of the 2006 year class of North Sea sandeel in accordance with the following rules:

   With the aim of maintaining SSB in 2008 above Blim with 95% probability TAC for 2007 shall be calculated from

   a. TAC= -597 + 4.073 *N_1 (N_1 is real time estimate of age group one in billions and TAC is in 1000 tonnes)

   b. If the TAC calculated in point 2a) exceeds 400 000 the TAC shall be 400 000 t

   The number of kilowatt-days for 2007 shall in any case not exceed the effort in 2005.

   The fishery shall be closed 1. August 2007.

3. Irrespective of the TAC referred to in point 2, the TAC in Norwegian Economic Zone shall be revised, as early as possible based on advice from the ICES on spatial distribution of sandeel in the Norwegian EEZ, in accordance with the following rule:
   a. If XX% of the total sandeel population is distributed in less than YY% of the historical stock distribution area the fisheries shall be prohibited for the remainder of 2007

16.5.1.1.1 Comments to the HCR suggested for 2007

Comments to point 2)

The setting of the final TAC for 2007 aims to maintain a SSB in 2008 above Blim with a high probability (corresponding to Bpa as target). The actually given regression for estimating TAC in point 2 a) requires establishment of the following input and methods:

- Estimated stock numbers 1. January 2007 from ICES assessment
- Forecast input values by half-year of 2007 including weight at age in the stock and in the sea, proportion mature at age, natural mortality at age, and exploitation pattern at age

- Observed CPUE of 1-group sandeel from the real time fishery in the beginning of the 2007 sandeel fishing season
- Regression parameters to transform the CPUE of 1-group sandeel from the real-time fishery into estimated stock numbers of 1-groups
- A value for estimated SSB in 2008 such that the true SSB in the sea is above Blim with a high probability. This value of SSB corresponds to Bpa.

When the best estimate of the population numbers (1-group estimate from real time monitoring, and age 2 and older from stock assessment) are available the actual TAC for 2007 can be calculated from an F scaling factor and the fixed exploitation pattern such that SSB in 2008 becomes higher than Bpa. Figure 16.5.3 shows an example of the relation between number of 1-group sandeel in 2007 and the resulting mean F and TAC to reach SSB at Bpa in 2008. A linear regression between number of 1-group and TAC fits very well, as shown on the figure. This regression (with updated input values from sandeel forecast) is eventually used in the suggested HCR.

Comments to point 3)

Recognising the collapse of the sandeel fishery in Norwegian Economic Zone combined with the significant contraction of the fishery on very few fishing banks, a substantial effort was used to formulate an additional HCR for 2007 to be used in the Norwegian economic zone. Several approaches were taken during the WGNSSK to analyse the distribution of total landings in Norwegian Economic Zone. The main input data (summarised in Figure 16.5.4) to these analyses were the number of ICES rectangles from which the catches contribute significantly to the total landings. It was however, not possible to come up with a properly tested, justified and operational HCR for the Norwegian Economic Zone during the WGNSSK.

An outline of one such possible rule is presented below:

The results of the Norwegian scientific sandeel survey in April-May 2007 must show that:

1) no more than 40 % of the stock (in biomass) must be distributed within one single ICES rectangle

2) no more than 65 % of the stock (in biomass) must be distributed within two ICES rectangles

3) no more than 79 % of the stock (in biomass) must be distributed within three ICES rectangles

4) no more than 86 % of the stock (in biomass) must be distributed within four ICES rectangles

5) no more than 90 % of the stock (in biomass) must be distributed within five ICES rectangles

The WG were unable to reach a conclusion on the likely efficacy of this proposal.

16.5.1.1.2 Evaluation of the suggested HCR

Methodology

The evaluation was done using the SMS (**S**tochastic **M**ulti **S**pecies model; Lewy and Vinther, 2004) assessment model and forecast. The approach taken with respect to evaluation of HCR is based on the framework for evaluation of management strategies as described by ICES study group on management strategies (ICES-SGMAS 2005, 2006). Details of the SMS implementation of HCR can be found in STECF (2005b).

Basically the method mimics that decisions on e.g. TAC are taken on the basis of imperfect knowledge (equivalent to stock numbers estimated from stock assessment). The approach does not simulate the full annual cycle of assessment and projection. Instead, it is assumed that the true stock size can be "observed" with some bias and noise and it is this "perceived" stock that makes the basis for the use of HCR and estimation of a TAC. The true stock size is assumed known in the first projection year and is later updated annually by recruitment and true catches derived from application of HCR on the "perceived" stock.

Initial stock numbers

Starting values for population size and F were obtained from a historical analysis performed using SMS with 2005 as terminal year. This assessment was also presented to ICES-WGNSSK (2005). The results of the SMS run are slightly different to the results generated by 2006 final assessment produced by the SXSA model, but the two models give quite similar results. To bring the two method results in accordance, the SXSA estimated recruitment at 425 10^9 for 2005 was used in the SMS simulations. SMS calculates SSB on the 1st January 2007 to 516 kt while the default sandeel assessment gives a value of 509 kt. The exploitation pattern from SMS was used equivalent to the long term mean of exploitation pattern.

Recruitment

A hockey-stick stock-recruitment model with inflexion point at 430kt (B_{lim}) was fitted to the SMS and has been used to project recruitment in the future. The STCEF *ad hoc* sandeel WG (STECF, 2005b) concluded that the hockey-stick model gives a fairly good representation of the historical recruitment, however with some under-representation of the very high recruitments observed.

Uncertainties in Stock assessment, real time monitoring and TAC implementation

The SMS assessment suggests a 25% CV of the stock number in the terminal year of the assessment (see STECF 2005b for details). This number was used to link true and perceived stock (assessment noise). With respect to bias in the assessment result, the retrospective pattern of SSB and F (Figure 4.3.2.2) shows a tendency to overestimate SSB and underestimate F in the most recent years with a declining stock.

The precision of the estimate of age-1 sandeel from real time monitoring depends on how early in the fishery season the estimate is given. The *ad hoc* sandeel group (STECF 2005a, 2005b) concluded that a stock estimate could be given with an acceptable uncertainty after week 17. The regression statistics from the log(stock number) ~log(CPUE) regression give a standard deviation of the observations of around 0.35, which was used in the HCR simulations. Updating the regression with data for the 2005 real time estimate and stock numbers from the 2006 VPA did not change the regression very much (Figure 16.5.1), so it was decided to leave the standard deviation unchanged at 0.35 for the simulations presented here.

As discussed in section 16.5.1.1, the very limited dataset indicates bias in the real time estimate of around a factor of 1.5.

Uncertainties on the implementation of the TAC are not considered to be of importance in the simulation done. Landings are concentrated to a few factories and irregularities in the landings statistic are not considered an issue.

Other Options:

Cap F is an option to set an upper level of the true F. This is to prevent F taking values above an assumed maximum capacity in the fishery.

The suggested HCR set an upper level for effort in 2007 to the effort level in 2005 which had an F between 0.54-0.65. Cap F was set to 0.65 in the baseline scenario.

CAP TAC is the upper level of implemented TAC. As no implementation uncertainties is assumed the suggested TAC at 400 kt is copied to cap TAC.

Real-time F is the fishing mortality to obtain the real-time estimate of stock size. It has been set to 0.18 to reflect 30% of the effort in 2005 (and 30% of the F at 0.60).

Scenario 1. Yield per recruit

The request mentions explicitly "Maximum Sustainable Yield" as basis for the management plan. Defining MSY is often done on the basis of yield-per-recruit analysis. To emphasize that such approach is not applicable for a short-lived species like sandeel a simulation, which mimics a yield-per recruit (or more correctly yield per GM recruits), was made.

The result (Figure 16.5.5) shows an increasing yield for increasing F. The figure includes F up to 1.0, but the yield will continue to increase at even higher Fs. From an F at around 0.4 the SSB becomes lower than Bpa. Applying F_{max} will clearly lead to recruitment overfishing.

Scenario 2. MSY, Constant F strategy

This scenario shows the long term equilibrium using a constant F. Recruitment is from a stochastic hockey-stick model and 25% CV is used for assessment uncertainty.

Yield (Figure 16.5.6) peaks at 550 kt for F at 0.7, however such F will lead to a high probability of SSB<Blim. Fishing mortality at 0.4 gives a yield of around 475 kt and a probability of SSB>Blim at 95%. An F at 0.4 can be considered as F_{MSY} given the current SSB reference values.

The constant F scenario represents the utopia of sandeel fishery management, as F cannot be implemented directly as effort due to the weak relation between effort and fishing mortality. Likewise, using the F_{MSY} to set a TAC requires a reliable assessment, which is presently not the case for sandeel.

Scenario 3. Baseline HCR

This scenario evaluates the HCR suggested in Section 16.5.1.1 with the assumption of no bias in assessment or real-time monitoring. The results from implementing the base case are shown in three set of graphs in Figures 16.5.7-16.5.9 The first set shows median and 25^{th} and 75^{th} percentiles in 2000 simulations for annual SSB, yield, mean F and recruits for the period of the predictions. The probability of fishery closure and of SSB being below 600 kt (continuous line) and below 430 kt (dotted line) are also shown. The second set of graphs (Figures 16.5.8) shows the cumulative probability distribution and the frequency distribution of SSB, yield and F in the years 2007 and 2008. The same output is presented (Figure 16.5.9) for the period 2010-2020 years of the projections, a period when output is assumed to represent an equilibrium. For the same parameters, the distribution of the change from one year to the next in a given trajectory (expressed as a ratio so that 1 equates to no change) is also shown.

In the simulations, the target SSB of 600 kt is reached relatively quickly (Figure 16.5.7) and the stock stabilises well above the target. Recruitment in 2006 is lower than for the rest of the period as SSB is less than Blim; recruitment is modelled here using the SSB-R hockey stick relation with an inflection at Blim. The probability of closure (an F lower than 0.18 for the full year) is around 15% for the first year, falling to less than 10% after the stock is recovered. The distribution of F in year 2007 (Figure 16.5.8) shows relative higher frequency in the ends of the F-range 0.18-0.45. The low F corresponds to the effort on the monitoring fishery in years of closure and a mode at 0.45 showing that for the given conditions the fishery would not be limited by cap F=0.65. The distribution of F in 2008 has a peak around 0.35 and shows a very small probability of being limited by cap F. Comparison of the results with the constant MSY strategy suggest that the present scenario is too restrictive for use after a stock recovery, as median equilibrium F (Figure 16.5.9) at 0.25 is much lower than F_{MSY} .

Scenario 4. Assessment bias

The sandeel assessment has a clear over-estimation of stock size in the terminal assessment year. To explore the sensitivity of assessment bias to the HCR a number of projections were made with different bias levels. The result from this scenario (Figure 16.5.10) shows that median F, yield and SSB are relatively stable and independent of the bias level. The probability of having SSB<Blim does however, increase with increasing bias and the probability of SSB<Blim is more than 5% for bias factor levels greater than 1.4 and 10% for bias a factor of 2.0.

Scenario 5. Real time bias

Bias in real time monitoring result is also significant and the HCR sensitivity to such is explored in this scenario. The results (Figure 16.5.11) are very similar to the results from the assessment bias scenario presented above.

Scenario 6. Assessment and real bias

The effect of simultaneous bias factor of 1.5 for both assessment and real time bias is explored in this scenario. The risk of a closure of the fishery after the monitoring fishery is less than 3% for the whole period (Figure 16.5.12) and the limiting factor is in reality the TAC at 400 kt, both in 2007 and 2008 (Figure 16.5.13) and at equilibrium (Figure 16.5.14). The probability of SSB<Blim is around 10%.

Scenario 7. Assessment and real bias with varying TAC

The previous scenario shows that with a very biased assessment and real time estimate, it is the maximum TAC that determines the performance of the HCR. Figure 16.5.15 shows that given a TAC below 325 kt the probability of SSB<Blim is less than 5% in a scenario with a bias factor of 1.5 for both assessment and real time estimate.

Discussion and conclusion of HCR evaluations

The presented scenarios show that the minimum escapement strategy is sensitive to high levels of bias in assessment and real time monitoring. In the short-term forecast section for sandeel (section 4.6), assessment bias is explored further and the bias on stock numbers is estimated to a factor 1.02-1.27 for age 2+. Assessment bias on the age 1 numbers is estimated to 1.79. This bias is relevant for the initial stock size used in the scenarios, but age 1 bias is not relevant in the projections, as the abundance for the age group is estimated from real time monitoring. The simulations suggest that the HCR is robust, defined as a probability of (SSB>Blim)>0.95, to assessment bias up to a factor 1.4 and thereby robust to the estimated assessment bias for age 2+.

Bias on the real time estimate of age 1 abundance is estimated (from two data points) to be a factor around 1.5. The suggested HCR is robust for such level of bias. An *ad hoc* method for actually reducing real time bias would be to use data points from only 2003-2005 (Figure 16.5.1) as the basis for the regression applied for real time estimate. This “bias corrected” regression includes only the years with a very low stock size and might better represent the present situation. This approach will require a higher CPUE for a given stock estimated compared to the regression used in 2005-2006, but the estimate might be considered more realistic and without obvious bias.

When assessment and real time bias are applied simultaneously, the outcome of the HCR is mainly determined from the maximum TAC, however with a TAC in the range 300-400 kt, a modified HCR is robust to the present estimate of bias.

Even though the baseline HCR can be modified to actually handle the observed bias, the performance of a modified HCR in 2007 depends on the stock numbers for which just a very uncertain estimate exists. Due to lack of time, the HCR evaluation has not explored the effect of a very small initial stock size. Section 4.6 defines a modified forecast where the best estimate of bias in stock number and F estimate are taken into account. The modified forecast is used in section 4.6 to derive TAC as function of recruitment (age 0) in 2006, using the same HCR as evaluated here. This forecast gives the regression to be used in point 2a of the suggested HCR.

The applied stock recruitment relationship in the scenarios is fitted to the full data series of SSB and recruits. It is thereby assumed that the historical pattern of recruitment is repeated in the future. Time constraints did not permit HCR evaluation with a shift in recruitment dynamics.

Under the "dynamic pool" assumption, WGNSSK suggest to apply the HCR using the regression parameters **(**TAC= -597 + 4.073 *N_1 **)** from the revised forecast presented in section 4.6. The real-time monitoring estimate should be based on a "bias corrected" regression using CPUE observations from 2003-2005 and the updated VPA estimates of age 1 stock numbers. WGNSSK has not sufficient information to evaluate whether the HCR suggested for 2007 is precautionary, mainly because the consequences of a violation of the "dynamic pool" assumption cannot be quantified. Therefore, **the WG concludes that the presented HCR must be considered as a suggestion only**.

The HCR applied in EU-waters 2004-2006 does not require a stock estimate; the HCR just set a TAC from the number of 1-group. This HCR is however not precautionary for a combination of low SSB and recruitment just above 300E9 (given as 0-group) as shown in section 4.6.

16.5.1.2 Prevent of any local depletion of sandeel aggregations

The lesser sandeel (*A. marinus*) is the dominating sandeel species in the North Sea, constituting by far the largest part of the sandeel catches. It spawns in December – January at the sandbanks where the eggs stick to the sediment until hatch (Macer 1966, Reay 1970, Winslade 1971). During the initial phase, sandeel larvae are assumed to follow the drift pattern of passive particles, but gradually adopt active vertical migration behaviour (Jensen et al. 2003). After metamorphosis at about 40mm sandeels are able to submerge in suitable sandy sediments (Jensen 2001). There is strong inference that larger juveniles and adult sandeel are resident on a sandbank local scale (Madsen unpublished data, Jensen et al. unpublished).

Earlier (Wright et al. 1998) and ongoing work (Jensen et al. unpublished) indicate that sandeel population structure in the North Sea may contain a number of relatively isolated sub-populations defined by the major hydrographical currents and the distribution of available sand bank habitats, of which more than 200 individual grounds have been identified (Jensen and Rolev 2004).

Area specific population analyses at the most appropriate scale including in year estimates of local recruitment are required to meet the needs for management of sandeel fisheries on a local scale. However, a model for the population structure ready for use in fisheries management is still not available, due to a lack of realistic modelling of the transportation of the early life stages between the habitat areas.

A conceptual model for sandeel population dynamics may be suggested that includes a mosaic of local populations with dispersal during the larval drift stage and therefore isolated by distance (Figures 16.5.16 and 16.5.17). The recruitment on an area scale is therefore a function of egg production in the total source area (Boulcott et al submitted), net transportation and survival during the drift stage (Christensen et al submitted), plus possible density dependent effects during the recruitment phase (Arnott & Ruxton 2002). Preliminary estimates with an arbitrary subdivision of the North Sea into five major bank areas indicate that at this scale retention is high (>80%) and that variation in recruitment is equally due to variation in transportation and egg production (Christensen et al submitted).

Given that a number of sub-populations of sandeels exist in the North Sea local depletion implies overfishing of the local sandeel population to a degree where it is detrimental to local recruitment or negatively affects the trophic links in the local ecosystem. Because the population structure of sandeels in the North Sea still have to be defined, it is presently not possible to take account of local depletion effects in the management of the North Sea sandeel fishery.

There is no fishery independent time series of sandeel abundance in the North Sea because the ICES co-ordinated surveys are not suited to measuring densities of this species and there are no other annual dedicated research sampling programmes. Consequently information about sandeel distribution and abundance all come from commercial fisheries data. However, four European fishery research institutes (CEFAS, DIFRES, FRS, and IMR) have employed a modified scallop dredge to obtain estimates of relative density of sandeels in the sand for the some specific areas and times. This sampling approach is useful because sandeels tend to lie dormant in the sediment during the nighttime and late autumn and winter. Such surveys have since 1997 been carried out off the Firth of Forth, The Little Fisher Bank area and the grounds to the South down to and including the Dogger Bank area. Further, in the last two years grounds in the Northern part of the North Sea have been included. The information available for tuning assessment models however suffer from a lack of standardisation of survey methodology between research institutes, and a lack of monitoring for a large number of grounds, due to the limited effort used and a lack of participation from some of the nations fishing sandeels in the North Sea. Consequently, relative indices are presently only available for certain parts of the North Sea. However, given an implemented standardisation, these surveys have the potential to provide relative indices of sandeels of all age groups for the areas that are covered by such surveys, and thereby information that can be used to warn about local depletion.

For example, based on provisional information from dredge surveys that covered the grounds from Little Fisher bank down to the southwestern part of the Dogger Bank area DIFRES predicted each year of 2004 and 2005 in December that recruitment was poor in 2004 and significantly higher in 2005. This was confirmed by data from the fishery in 2005 and 2006, respectively. DIFRES will carry out the next survey in December 2006, to provide information about the strength of the 2006 year class. In addition, IMR has initiated a hydro-acoustic survey time-series in 2006.

16.5.1.3 Sandeel, ecosystem considerations

Sandeel as food for sea birds and marine mammals.

Sandeels as forage fish in the ecosystem was reviewed by WGECO in 2006 (ICES-WGECO 2006), the following section is a revisit of this review with some minor updates and changes.

Many seabirds species are highly dependent on sandeels for prey, and for the species that are not sandeel specialists, other small fish species targeted by the small meshed fisheries, such as sprat and Norway pout, constitute some of the main alternative prey (Furness 2002; Wanless et al. 1998). Although the precise mechanism remains unclear, seabird breeding success has repeatedly been linked to the abundance of sandeels (Monaghan, 1992; Hamer et al. 1993; Rindorf et al. 2000). Even where environmental conditions have been shown to strongly influence breeding success, additional detrimental fishing effects have been demonstrated with confidence for the black legged kittiwake and with some likelihood for sandwich tern (Frederiksen et al. 2004, 2005). It is important to consider the spatial and temporal overlap of seabird foraging range during the breeding season and fishery distributions at this time (Furness and Tasker 1997, Wright and Begg 1997; ICES-WGEEFA 2003). If local prey resources are depleted by fisheries, forcing seabirds to forage over longer distances, this will result in increased foraging energetic costs (Krebs & Davies 1993). Although the main sandeel fisheries in the North Sea occur relatively far offshore in the central and southern North Sea a potential for competition between seabirds and small meshed fisheries exists at some localities.

Several EC and national research projects have investigated the diets and breeding success of common guillemots (*Uria aalge*), European shags (*Phalacrocorax aristotelis*), and black-legged kittiwakes (*Rissa tridactyla*) at an important seabird colony, the Isle of May, in the Firth of Forth. Data were also collected on local hydrographical conditions and the abundance, distribution, behaviour and size/age composition of the local sandeel population. These studies showed that relatively small changes in the timing of peak sandeel availability in June were a major determinant of seabird breeding success. The kittiwakes were especially vulnerable to changes in sandeel availability as they did not switch to prey on other species (e.g. Rindorf *et al*., 2000). The timing of two events in the sandeel lifecycle appears to be critical for the success of bird populations. These are: 1) the onset of burrowing behaviour for 1+ sandeels and 2) the arrival of 0-group fish on the seabirds' feeding ground, both of which are primarily driven by environmental factors (Greenstreet et al. in press).

Industrial feed fish species are present in the diet of harbour porpoise *Phocoena phocoena*, bottlenose dolphin *Tursiops truncatus*, white-beaked dolphin *Lagenorhynchus albirostris* and minke whale *Balaenoptera acutorostrata* in the North Sea (Borjesson *et al*., 2003). The proportion of these fish reported in the diet varies by season and by geographic location. In Scottish waters, sandeels may constitute up to 58% by weight of the stomach content in harbour porpoises. Sandeels can form more than 80% to the diet by weight of minke whale in the North Sea, but further north the diet of minke whales can be dominated by herring (Olsen and Holst, 2001). As with other 'opportunistic' predators, differences in the diet composition reflect the local occurrence of potential prey. Unlike seabirds which predominantly target the smaller (0-, 1- group) sandeels, marine mammals can take the older and larger fish. Sandeel fisheries may therefore impact marine mammal populations by altering their food supply in certain areas. A direct link of fishing for sandeels to cetaceans, however, has yet to be demonstrated in any population.

Sandeels (mainly *Ammodytes marinus*) can form an important part of the diets of both grey *Halichoerus grypus* and harbour *Phoca vitulina* seals, particularly in the summer months (Prime & Hammond 1987; Thompson *et al* 1996; Tollit *et al* 1997). Both seal species have a wide range of foods and there is little to suggest that either of these species is particularly dependent on the fish targeted by the small mesh fisheries (Hall et al 1998; Hammond et al 1994; Pierce et al 1991; Prime & Hammond 1990; Tollit & Thompson 1996).

The general conclusion from this review is that localised depletion of sandeel aggregation at a scale less than 100 km from seabird colonies may affect some species, especially black-legged kittiwake and sandwich tern, whereas the more opportunistic marine mammal may be less vulnerable to local sandeel depletion.

Sandeel as food for fish species

The following text is based on a preliminary answer from SGMSNS (ICES-SGMNS 2006)) on a recommendation from AMAWG and WGRED: "that the SGMSNS group investigates the weight at age in the predator species in relation to the abundance of prey species"

The available model for the North Sea multispecies Assessment (MSVPA) does not allow for 'bottom up' effects of prey availability on the condition, weight-at-age and hence recruitment of predator species. However, such issues were addressed by the Study Group on Growth, Maturity and Condition in Stock Projections (SGGROMAT) which unfortunately disbanded in 2005 (see ICES-SGGROMAT 2004, 2005). Consequently, very limited long-term weight-at-age data were available to the group for comparison with estimated prey densities and predation mortality estimates.

SGMSNS suggest that whiting, which is the most piscivorous of the species for which diet data are available, will probably be little affected by a decline in Norway pout since recent survey results reveal that whiting distribution has largely contracted into Roundfish Area 4 along the north English coast (i.e. away from Norway pout). Whiting might be affected to some extent by a decline in sandeel availability, however they might also switch prey to consume greater quantities of herring and sprat, since populations of these species have increased in recent years, as has the apparent spatial overlap between whiting and sprat distributions.

Cod is a more flexible feeder consuming large quantities of benthic invertebrates. Given a shortage of sandeel and Norway pout, cod might switch diet towards non-target fish, as well as herring, sprat, other gadoids, shrimps and invertebrates. The availability of some benthic invertebrate groups are thought to have increased substantially in recent decades (Heath 2005). Equally, haddock might be impacted by a decline in Norway pout and sandeel but this species consumes even larger quantities of ‘other food’, the majority of the diet consisting of invertebrates with very few fish prey. Norway pout is a major prey of saithe in the North Sea and hence this species may be affected by a reduction in prey abundance although the availability of diet information for this species is much more limited compared to that available for other gadoid species.

In 1991 and 1992, the ICES Multispecies Assessment Working Group (ICES-MAWG 1991, 1992) enguaged in a series of comparative studies, contrasting 6 "cod-rich ecosystems" namely the Baltic Sea, North Sea, Barents Sea, Iceland, Newfoundland-Labrador Shelf, and Georges Bank / Gulf of Maine. MAWG considered whether cod growth and weight-at-age is influenced by changes in prey availability and concluded that “boreal systems are functionally different from highly-networked feeding webs such as the North Sea”. MAWG found that cod growth in ‘boreal’ systems (e.g. Barents Sea and Iceland) was influenced by the availability of capelin, since there is little potential for cod to compensate for low capelin abundance with any other alternate prey type. In more diverse systems such as the North Sea and Baltic, where there are many alternative prey types, the working group found less variability in cod growth and weight-at-age and hence little evidence that these are influenced by the availability of any particular prey type.

16.5.2 Norway pout

The request to ICES concerning Norway pout:

a. *Harvest control rules for Norway pout in the North Sea and Skagerrak that:*

    i. *Allow the Maximum Sustainable Yields to be obtained and are consistent with the precautionary approach; and*

    ii. *Take into account the function of Norway pout in the ecosystem*

It may be expected that the management of the Norway pout fishery will include the setting of preliminary catch and/or fishing effort limits at the beginning of the year until scientific information is available in spring allowing for the final maximum fishing effort and/or catch levels to be fixed. The harvest rules should therefore include rules for setting preliminary and final fishing effort levels (expressed as a percentage of the reference level in kW-days) and/or catch levels.

b. *The monitoring systems and assessment methodologies required to implement the advised harvest control rules.*

c. *Level of by-catches in Norway pout fisheries separated for Division IIIa and Sub-area IV; and*

d. *Appropriate technical measures, including possible closed areas, to reduce by-catches, in particular, of cod, haddock, saithe, whiting and herring.*

ICES is requested to submit its report on points a) to d). If point d) cannot be addressed at this time, ICES is requested to submit its advice to the Parties on the next possible occasion and in case no later than 2007.

16.5.2.1 Norway pout, ecosystem considerations

See Sections 5.1.1 and 16.5.1.3 for reviews on information regarding Norway pout as food for fish species.

16.5.2.2 By-catches in Norway pout fisheries

Demersal fisheries in the North Sea are mixed fisheries, with many stocks exploited together in various combinations in different fisheries. Small-mesh industrial fisheries for Norway pout takes place in the northern and northeastern North Sea and has by-catches of haddock, whiting, herring, saithe and blue whiting. Some cod is also taken as a by-catch, predominantly at ages 0 and 1 (ICES-ACFM 2005). With respect to un-intended by-catch in the commercial, small-meshed Norway pout trawl fishery in the North Sea and Skagerrak conducted by Denmark and Norway for reduction purposes, ICES-ACFM (2005) commented that management advice must consider both the state of individual stocks and their simultaneous exploitation. Stocks at reduced reproductive capacity should be the overriding concern for the management of mixed fisheries where these stocks are exploited either as a targeted species or as a by-catch (e.g. ICES-ACFM 2005).

Existing by-catch regulations:

In the agreed EU Council and EU-Norway Bilateral Regulation of Fisheries by-catch regulations in the Norway pout fishery have been established (e.g. EU Regulation No 850/98, EU 1998). The by-catch regulations in force at present for small meshed fishery (16-31mm in mesh size) in the North Sea is that catch retained on board must consist of i) at least 90% of any mixture of two or more target species, or ii) at least 60% of any one of the target species, and no more than 5% of any mixture of cod, haddock, saithe, and no more than 15% of any mixture of certain other by-catch species. Provisions regarding limitations on catches of herring which may be retained on board when taken with nets of 16 to 31 mm mesh size are stipulated in EU Community legislation fixing, for certain fish stocks and groups of fish stocks, total allowable catches and certain conditions under which they may be fished (EU 1998). Currently 40% herring is allowed in the Norway pout fishery.

Important by-catch species

By-catch of the following species in the commercial, small meshed Norway pout fishery has been a concern for fisheries management: Cod, Haddock, Saithe, Whiting, Monkfish, Herring, and Blue Whiting, where especially by-catch of juvenile haddock and cod as well as larger saithe has been in focus.

By-catch levels from landings statistics

In Tables 16.5.2.1-16.5.2.2 are presented recent (2002-2005) by-catch levels by species in Danish and Norwegian small meshed industrial trawl fishery in the North Sea and Skagerrak areas targeting Norway pout. For Norway the landings used for human consumption purposes in the small meshed fishery can only be allocated to industrial fishery for the last two years. Due to low Norway pout landings in recent years the Norwegian by-catch estimates are rather uncertain.

By-catch levels and factors affecting them from commercial fishing trials 2005:

Danish-Norwegian fishing trials and pilot investigations were performed in autumn 2005 in order to explore by-catch- levels in the small meshed industrial trawl fishery in the North Sea targeting Norway pout. The results are given in Degal et al (WD 22). The trial fishery was performed by two Norwegian commercial trawlers and a Danish commercial trawler traditionally involved in the small meshed industrial trawl fishery in the North Sea and Skagerrak targeting Norway pout. The investigation was in cooperation between the fisheries research institutes DIFRES and IMR. The South Norwegian Trawl Association (SNTA) and the Danish Fishermen's Association (DF) provided the contact to the fishing vessels used.

The fishery was carried out in autumn 2005 within periods and areas of conducting traditional fishery for Norway pout. It should be noted that the Norway pout fishery was closed in 2005 due to low stock size, which might bias the by-catch proportions. The Norwegian vessels conducted each a survey to the area vest of Egersund on the edge of the Norwegian Trench. The Danish vessel conducted two surveys at Fladen Ground in and around the closed box for Norway pout fishery in the North Sea. Comparison fishery between one of the Norwegian vessels and the Danish vessel was performed on a patio-temporally overlapping scale at the Patch Bank, a closed box for Norway pout fishery in an area between the Egersund Bank and Fladen Ground. The Norwegian vessels conducted both day and night fishery while the Danish vessel only fished during daytime. Since the trial fishery was conducted in closed areas and during a period when the ordinary fishery was closed, the results will not be directly comparable to a "normal fishery" situation.

The results (except for the figure and table showing the diurnal variation in the fishery) comprise only hauls from daytime fishery conducted with standard trawl gears used in the commercial small meshed industrial fishery targeting Norway pout. The skipper at the Danish vessel decided the positions and fishing design on a smaller fraction of the conducted hauls based on his evaluation of optimizing the fishery economically, while the rest of the hauls were allocated and pre-distributed in two selected ICES statistical squares.

In general the ratio between the Norway pout target species and the sum of by-catch of certain selected species indicate that the by-catch ratio is high in the commercial Norway pout fishery. However, statistical analyses reveal that the fishermen can significantly minimize the by-catch ratio by targeting in the fishery (temporal-temporal targeting, way of fishing, etc.), i.e. when they determine the fishing stations and the fishery performed. The pilot investigations show no general significant temporal-temporal patterns in the by-catch ratio. However, there are from the results obvious geographical and diurnal differences in the species composition of the by-catch between areas and between day and night fishery. The length distributions of the catch rates by species indicate spatial patterns between some of the species caught. These fishing trials and pilot investigations are based on only very few observations, and data are obviously rather uncertain, variable and noisy. In addition, the trials were conducted in area, closed with the purpose to reduce by-catch, and during a period when the ordinary fishery was closed. In general, it can be concluded that relatively high by-catches can be reduced by specific targeting in the fishery, both with respect to allocation of the fishery in time and space but also in relation to fishermen knowledge about the fishery and resource availability. This demands though that the skippers/fishermen act accordingly when fishing, and a proper at-sea control. The conclusions above relate to using the Turbotrawl and the Expo1300. The few experiments with Jordfraeser and Kolmuletrål 1100 indicate a different species composition, with unchanged or higher by-catch rates of most species and general significant lover catch rates of Norway pout.

With regard to diurnal differences in the catch rates of Norway pout and by-catches of other species, the few results at present indicate significant lower by-catch of Blue whiting during night hauls. The rest of the by-catch species show no diurnal differences

With regard to possible depth differences in the catch rates of Norway pout and by-catches of other species, this matter relates primarily to the areas close to the Norwegian Deep, and more investigations are about to be carried out to document this better.

16.5.2.3 Technical measures to reduce by-catches

Regulation of temporal-temporal effort allocation (closed seasons and areas):

The above investigations indicate spatio-temporal differences in catch levels by species in the commercial small meshed fishery for Norway pout as well as an effect of targeting and use of fishing method on the by-catches. However, these patterns are only based on results from pilot investigations. Knowledge about spatio-temporal patterns in catch rates of target species and by-catch species in the fishery are at present not adequate to implement management measures with respect to regulations on spatio-temporal allocation of fishing effort to reduce by-catches.

During the 1960s a significant small meshed fishery developed for Norway pout in the northern North Sea. This fishery was characterized by relatively large by-catches, especially of haddock and whiting. In order to reduce by-catches of juvenile roundfish, the “Norway pout box” was introduced where fisheries with small meshed trawls were banned. The “Norway pout box” has been closed for industrial fishery for Norway pout since 1977 onwards (EC Regulation No 3094/86). The box includes roughly the area north of 56° N and west of 1° W. In the Norwegian economic zone, the Patch bank has been closed since 2002. It is not possible to fully quantify the effect of the closure of the fishery inside the Norway pout box both with respect to catch rates of target and by-catch species as well as effects on the stocks (EU 1985, 1987a, 1987b; ICES-NPS 1979). There has not been performed fully covering evaluation of the effect of closed areas in relation to interacting effects of technological development in the fishery including changed selectivity and fishing behaviour over time in relation to by-catch rates. These effects cannot readily be distinguished.

Gear technological by-catch reduction devices:

Investigations of gear specific selective devices and gear modifications to reduce un-wanted by-catch in the small meshed Norway pout fishery in the North Sea and Skagerrak have been performed in a number of studies. It was recently investigated based on sea trials in year 2000 and reported through an EU Financed Project (EU, 2002), and the results from here have been followed up upon in a scientific paper from DIFRES and CONSTAT, DK (Eigaard and Holst, 2004). Previous investigations of size selective gear devices in the Norway pout trawl fishery in the North Sea was performed by IMR Norway during sea trials in 1997-1999 also published in a scientific paper (Kvalsvik *et al*., 2006), as well as in a number of other earlier studies on the issue. Main results of previous investigations have been reviewed and summarized in Nielsen and Madsen (WD 23).

Early Scottish and Danish attempts to divide haddock, whiting and herring from Norway pout by using separator panels, square mesh windows, and grids were all relatively unsuccessful. More recent Faeroese experiments with grid devices have been more successful. A 74 % reduction of haddock was estimated (Zachariassen and Hjalti, 1997) and 80% overall reduction of the by-catch (ICES-SGGSS 1998).

Eigaard and Holst (2004) and EU (2002) found that when testing a trawl gears with a sorting grid with a 24 mm bar distance in combination with a 108 mm (nominal) square mesh window through experimental, commercial fishery the results showed improved selectivity of the commercial trawl with catch weight reductions of haddock and whiting of 37 and 57%, but also a 7 % loss of Norway pout. The study showed that application of these reduction percents to the historical level of industrial by-catch in the North Sea lowered on average the yearly haddock by-catch from 4.3 to 2.7% of the equivalent spawning stock biomass. For whiting the theoretical reduction was from 4.8 to 2.1%. The purpose of the sorting grid was to remedy the by-catch of juvenile gadoids in the industrial fishery for Norway pout, while the purpose of square mesh window was to retain larger marketable consume fish species otherwise sorted out by the grid. By-catches in this study were mainly evaluated for haddock, whiting and cod, i.e. not for all above mentioned by-catch species of concern in the Norway pout fishery. However, the experiments have shown that the by-catch of important human consumption species in the industrial fishery for Norway pout can be reduced substantially by inserting a grid system in front of the cod-end. The study also demonstrated that it is possible to retain a major part of the larger marketable fish species like whiting and haddock and at the same time maintain substantial reductions of juvenile fish of the same species. The study also gave clear indications that further improvement of the selectivity is possible. This can be obtained by adjusting the bar distance in the grid and the mesh size in the selective window, but further research would be necessary in order to establish the optimal selective design.

The results reported in Kvalsvik *et al*. (2006) include results for more species of concern in the Norway pout fishery. They carried out experimental fishing with commercial vessels first testing a prototype of a grid system with different mountings of guiding panel in front of the grid and with different spacing (25, 22 and 19 mm) between bars, and then, secondly, testing if the mesh size in the grid section and the thickness of the bars influenced the selectivity of the grid system. Two different mesh sizes and three different thicknesses of bars were tested. Based on the first experiments, only a bar space of 22mm were used in the later experiments. These showed respectively that a total of 94.6% (weight) of the by-catch species was sorted out with a 32.8% loss of the industrial target species, where the loss of Norway pout was around 10%, and respectively that 62.4% of the by-catch species were sorted out and the loss of target species was 22%, where the loss of Norway pout was around 6%. When testing selectivity parameters for haddock, the main by-catch species, the parameters indicated a sharp size selection in the grid system.

In conclusion, the older experiments indicate that there is no potential in using separator devices and square mesh panels. Recent and comprehensive experiments with grid devices indicate a loss of Norway pout at around 10% or less when using a grid with a 22-24 mm bar distance. It is also indicated that there is a considerable loss of other industrial species being blue whiting, Argentine and horse mackerel. A substantial by-catch reduction of saithe, whiting, cod, ling, hake, mackerel, herring, haddock and tusk have been observed. The reduction in haddock by-catch is, however, lowered by the presence of smaller individuals. The Danish experiment indicates that it is possible to retain larger valuable consume fish species by using a square mesh panel in combination with the grid. Selectivity parameters have been estimated for haddock, whiting and Norway pout. These can be used for simulation scenarios including estimates of the effect of changing the bar distance in the grid. Selectivity parameters for more by-catch species would be relevant. However, the grid devices have shown to work for main by-catch species.

A general problem by implementing sorting grids in industrial fisheries is the very large catches handled. Durability and strength of the grid devices used under fully commercial conditions are consequently very important and needs further attention. Furthermore, handling of heavy grid devices can be problematic from some vessels. Grid devices are, nevertheless, used in most Pandalus fisheries, where catches often are large.

Conclusions from section 16.5.2.2-16.5.2.3

In conclusion, the commercial, exploratory fishery and provision of recent by-catch information has shown by-catch-ratios to be significant in the fishery, however, spatio-temporal differences in catch levels by species has been observed and by-catches can be reduced through targeting and fishing method. Recent scientific research based on at sea trials in the commercial fishery has shown that use of gear technological by-catch devices can reduce by-catches of among other juvenile gadoids significantly. Accordingly, **the WG conclude that the use of these gear technological by-catch reduction devices (or modified**

forms of those) in the fishery may be beneficial. Introduction of those should be followed up upon by adequate landings or at sea catch control measures to assure effective implementation of the existing by-catch measures.

16.5.2.4 Suggestion for a HCR for 2007

Suggested HCR for 2007

1. A preliminary TAC for 2007 shall be set such that the spawning stock in the beginning of 2008 is estimated above Bpa.
2. No more than 25 % of this preliminary TAC may be taken during the first half of 2007.
3. A final TAC for 2007 shall be set during the first half of 2007 on the basis of advice from ICES in spring 2007 based on:
   a) the criterion mentioned in point 1,
   b) the most recent survey information,
   c) complete catch information from 2006 and
   d) an assumed recruitment of the 2007 year class of 25 % of the long-term geometric mean

Comments:

(Point 1) The reason for setting a preliminary TAC for 2007 is that this will be based on a very uncertain forecast. Norway pout is a short-lived species, and catches are dominated by 1-group. In addition, significant amounts of 0-group may be caught towards the end of 2007. The only information in autumn 2006 about the number of 1-group in the start of 2007 is the 0-group index from the most recent Scottish groundfish survey. The number of 0-group entering the stock in 2007 will have to be assumed, and a suitable candidate for this 25 % of the long-term geometric mean.

(Point 2) If the preliminary TAC is higher than the final TAC, the latter can be over-fished if the (entire) preliminary TAC is taken during the first half of 2007. To keep the probability low that this happens, a restriction for the first half of 2007 is introduced. The maximum proportion of 25 % corresponds approximately to the average proportion of the Norway pout landings taken during the first half of the year during 2002-2004.

(Point 3a) This refers to the spawning stock in the beginning of 2008 being above Bpa.

(Point 3b) The most recent survey information refers to the IBTS quarter 3 indices from 2006 and the IBTS quarter 1 indices from 2007. The 1-group index from the IBTS quarter 1 survey is particularly important for the revised forecast (that the final TAC will be based on).

(Point 3c) This refers to the catch at age and total landings for 2006.

(Point 3d) The reason for using the conservative assumption of 25 % of the long-term mean, and not the more common assumption of the geometric mean, is that the recruitment seems to have changed to a lower level in recent years compared to earlier.

Evaluation of the suggested HCR

The WG was not in the position to evaluate the suggested HCR for Norway pout.

Table 16.1.1. North Sea haddock harvest control rules analysed in Needle (2006a,b). TAC and F^{target} indicate the landings and fishing mortality intended by managers, while ΔTAC and ΔF denote the maximum permitted interannual change in TAC and F, respectively.

HCR type	Name	TAC (kt)	ΔTAC	F^{target}	ΔF
Fixed TAC	TAC 20kt	20	na	na	±25%
Fixed TAC	TAC 30kt	30	na	na	±25%
Fixed TAC	TAC 40kt	40	na	na	±25%
Fixed TAC	TAC 50kt	50	na	na	±25%
Fixed TAC	TAC 60kt	60	na	na	±25%
Target F with TAC change limit	F 0.3 TAC +/- 15\%	na	±15%	0.3	±25%
Target F with TAC change limit	F 0.3 TAC +/- 20\%	na	±20%	0.3	±25%
Target F	F 0.3	na	na	0.3	±25%
Target F	F 0.4	na	na	0.4	±25%
Target F	F 0.7	na	na	0.7	±25%

Table 16.1.2. A summary of North Sea haddock HCR suitability. A tick indicates that the risk of the relevant reference point being exceeded remained less than 10% throughout the simulation period.

Name	$B < B_{pa}$	$B < B_{lim}$	$F > F_{pa}$	$F > F_{lim}$
TAC 20kt	✓	✓	✓	✓
TAC 30kt	✓	✓	✓	✓
TAC 40kt		✓	✓	✓
TAC 50kt				
TAC 60kt				
F 0.3 TAC +/- 15\%		✓	✓	✓
F 0.3 TAC +/- 20\%		✓	✓	✓
F 0.3	✓	✓	✓	✓
F 0.4		✓	✓	✓
F 0.7				

Table 16.5.2.1 Landings (tons) per species in the Danish small meshed Norway pout fishery in the North Sea by year and quarter. Landings are divided into the part used for reduction purposes and the part used for human consumption purposes. The latter landings are included in catch in numbers of human consumption landings.

Year	Species	Purpose	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Blank	Total	% of total catch
2005	Norway pout	Reduction						0	0
2004		Reduction	504		1474	5877		7855	87.5
2003		Reduction		45	1556	6322		7923	87.8
2002		Reduction	2,546		5,603	25,567	9,508	43224	78.6
2005	Blue whiting	Reduction						0	0
2004		Reduction	66					66	0.73
2003		Reduction		19	23	8		50	0.55
2002		Reduction	1966		589	950	1171	4676	8.50
2005	Herring							0	0
2004			11		422	304		737	8.21
2003				1	113	222		336	3.73
2002					217	2337	639	3193	5.81
2005	Cod	Reduction						0	0
		Hum. Con.						0	0
2004		Reduction				1		1.3	0.01
		Hum. Con.	0.3		0.2	0.3		0.8	0.01
2003		Reduction				3		3	0.03
		Hum. Con.			0.5	0.8		1.3	0.01
2002		Reduction				3		3	0.01
		Hum. Con.	2		15.4	22.7		40.1	0.07
2005	Haddock	Reduction						0	0
		Hum. Con.						0	0
2004		Reduction	5		49	3		57	0.63
		Hum. Con.	0.2		0.2	0.5		0.9	0.01
2003		Reduction				16		16	0.18
		Hum. Con.			0.1	1.8		1.9	0.02
2002		Reduction			408	1137		1545	2.81
		Hum. Con.	0.7		4.3	9.8		14.8	0.03
2005	Whiting	Reduction						0	0
		Hum. Con.						0	0
2004		Reduction	32		59	141		232	2.58
		Hum. Con.	0.4		0.3	0.2		0.9	0.01
2003		Reduction			51	214		265	2.94
		Hum. Con.			0.3	2		2.3	0.03
2002		Reduction			239	1436		1675	3.05
		Hum. Con.			5.4	5.5		10.9	0.02
2005	Saithe	Reduction						0	0
		Hum. Con.						0	0
2004		Reduction						0	0
		Hum. Con.	0.7		5.8	4.2		10.7	0.12
2003		Reduction		0.4	4	22.8		27.2	0.30
		Hum. Con.						0	0
2002		Reduction			45	201		246	0.45
		Hum. Con.	30		84.3	66.3		180.6	0.33
2005	Other human	Hum. Con.						0	0
2004	Cons. Species	Hum. Con.	0.9		2.7	2.5		6.1	0.07
2003		Hum. Con.		0.6	2.2	6.2		9	0.10
2002		Hum. Con.						0	0
2005	All species	All						0	0
2004		All	626		2023	6331		8980	100
2003		All		66	2025	6929		9020	100
2002		All	4511		6815	31887	11767	54980	100

Table 16.5.2.2. Landings and by-catches in the Norwegian Norway pout fishery 2002-2004 (only for reduction). In 2005 Norway pout was only landed as by-catch in the blue whiting fishery

Year	Unit	Norway pout	Blue whiting	Herring	Cod	Haddock	Whiting	Saithe	Other	Sum
2002	%	72,6	12,2	3,3	0,0	1,8	3,0	5,3	1,8	100
	Tonnes	17151	2881	779	10	432	700	1257	428	23638
2003	%	52,9	6,7	6,6	0,0	5,9	5,1	18,8	3,9	100
	Tonnes	6027	764	755	0	675	576	2139	447	11383
2004	%	86,9	3,2	0,9	0,5	1,6	0,9	3,1	2,8	100
	Tonnes	4344	158	45	26	78	47	157	142	4998

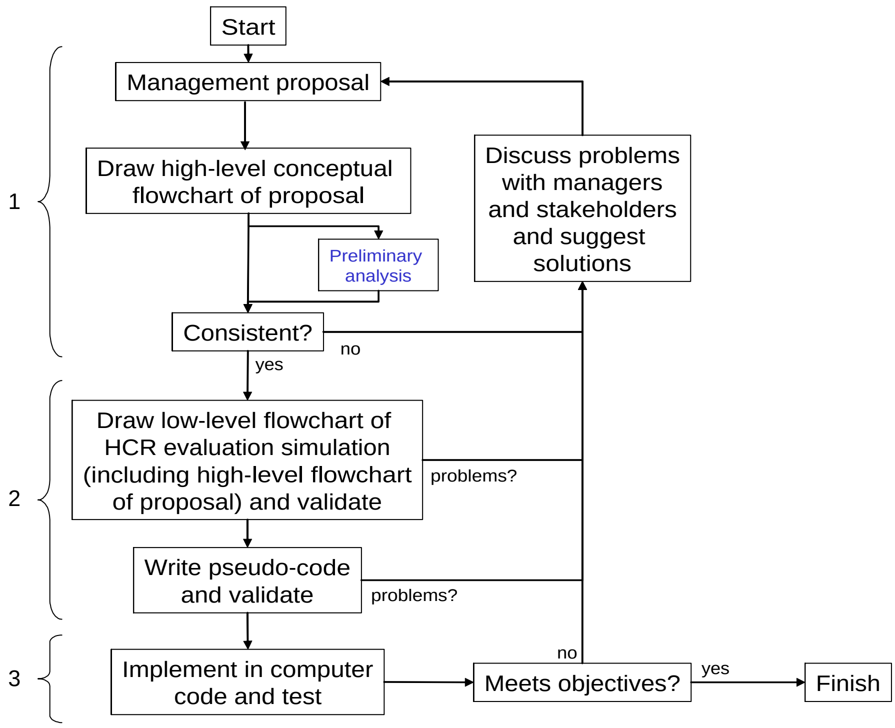


Figure 16.1.1. Management plan evaluation loop.

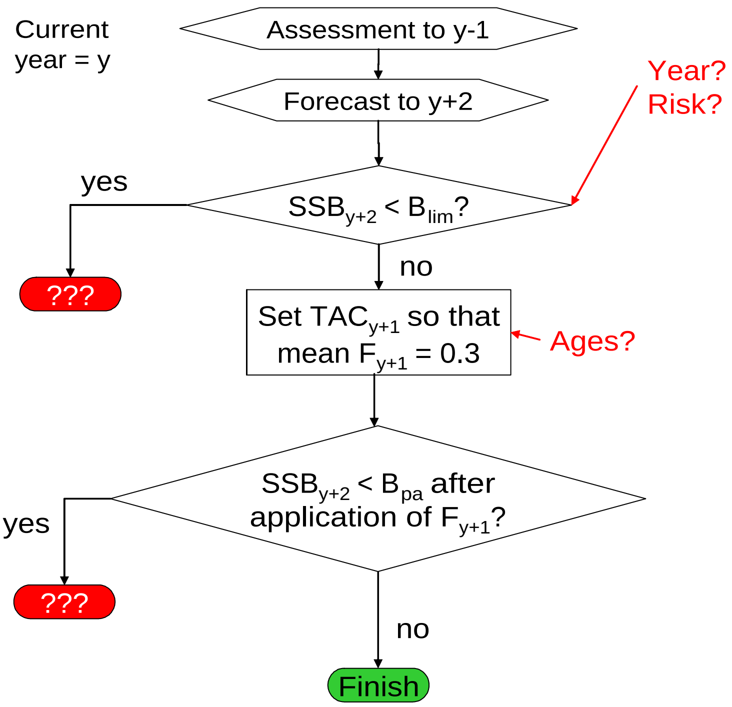


Figure 16.1.2. High-level conceptual flowchart (or decision diagram) of the EU-Norway management plan for North Sea haddock.

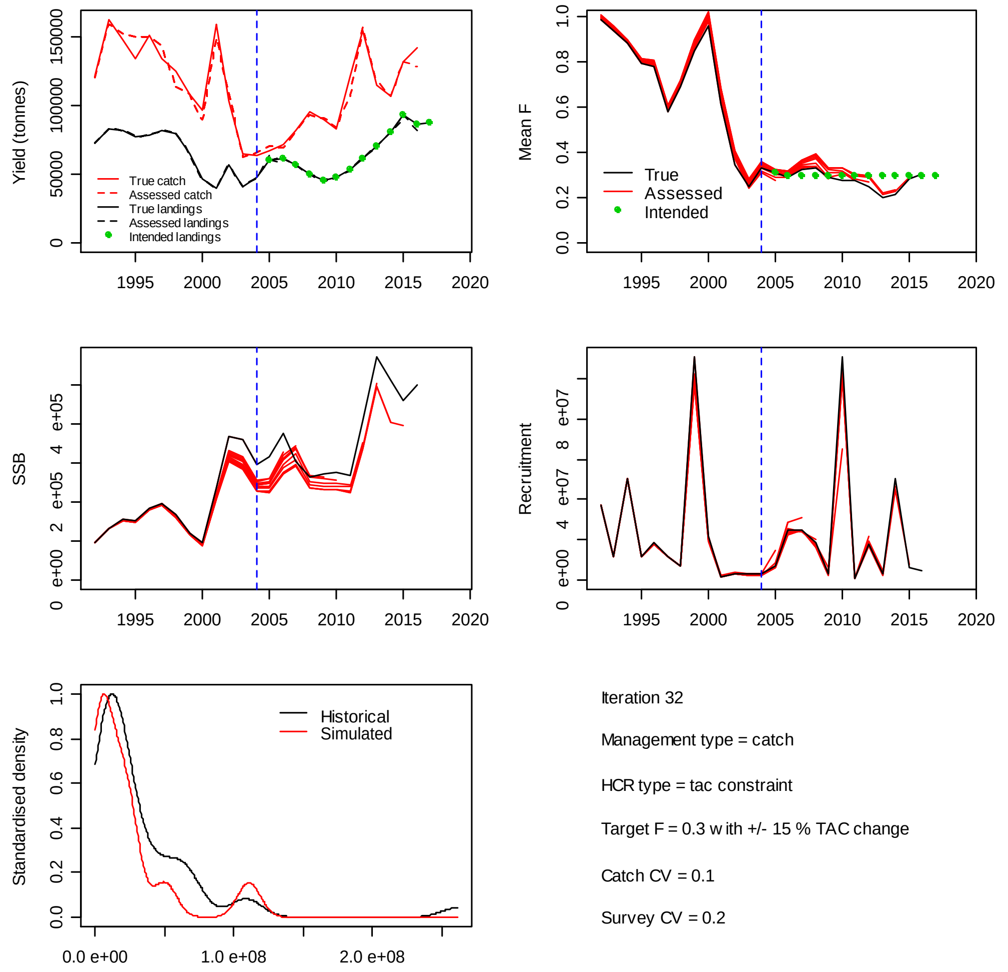


Figure 16.1.3. North Sea haddock. Analysis summaries for one particular iteration (number 32 of 50) for catch-based management with a TAC constraint HCR (target F = 0.3 with ±15% limit in TAC variation). For yield, the red lines show the true (solid) and measured (dashed) catch yield, while the black lines show the true (solid) and measured (dashed) landings yield. Green points show the intended landings for y+1 determined by management decisions occuring in y. For mean F, the black line shows the true values, the red lines show the estimates in each assessment year, and the green points show the intended fishing mortality. For SSB and recruitment, the black line shows the true values while the red lines show the estimates in each assessment year. For these four plots, the vertical line indicates the final historical year (2004). The final plot compares the standardised density distributions of historical and simulated recruitment.

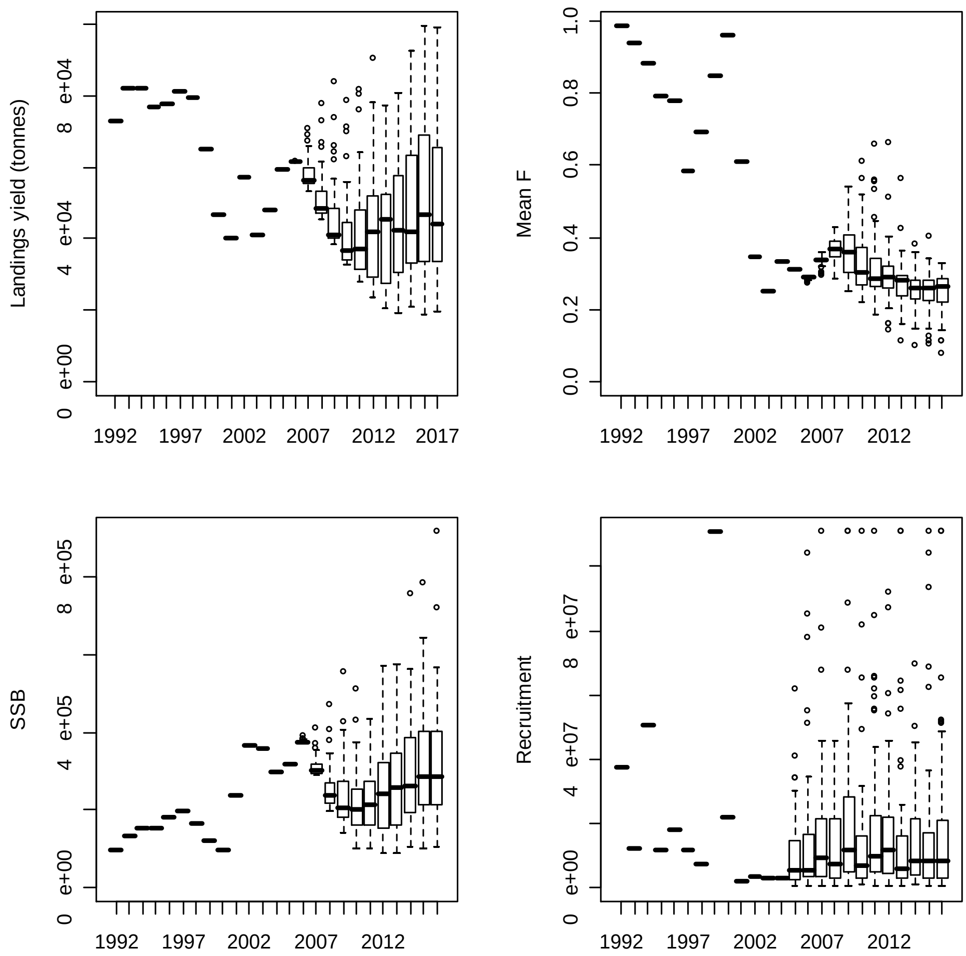


Figure 16.1.4. North Sea haddock. Box-and-whisker time-series summaries for catch-based management with a TAC constraint HCR HCR (target F = 0.3 with ±15% limit in TAC variation). Solid lines give medians (50th %ile) of distributions of estimates for each year, boxes show approximate first and third quartiles (25th and 75th %ile), while whiskers and points indicate outliers.

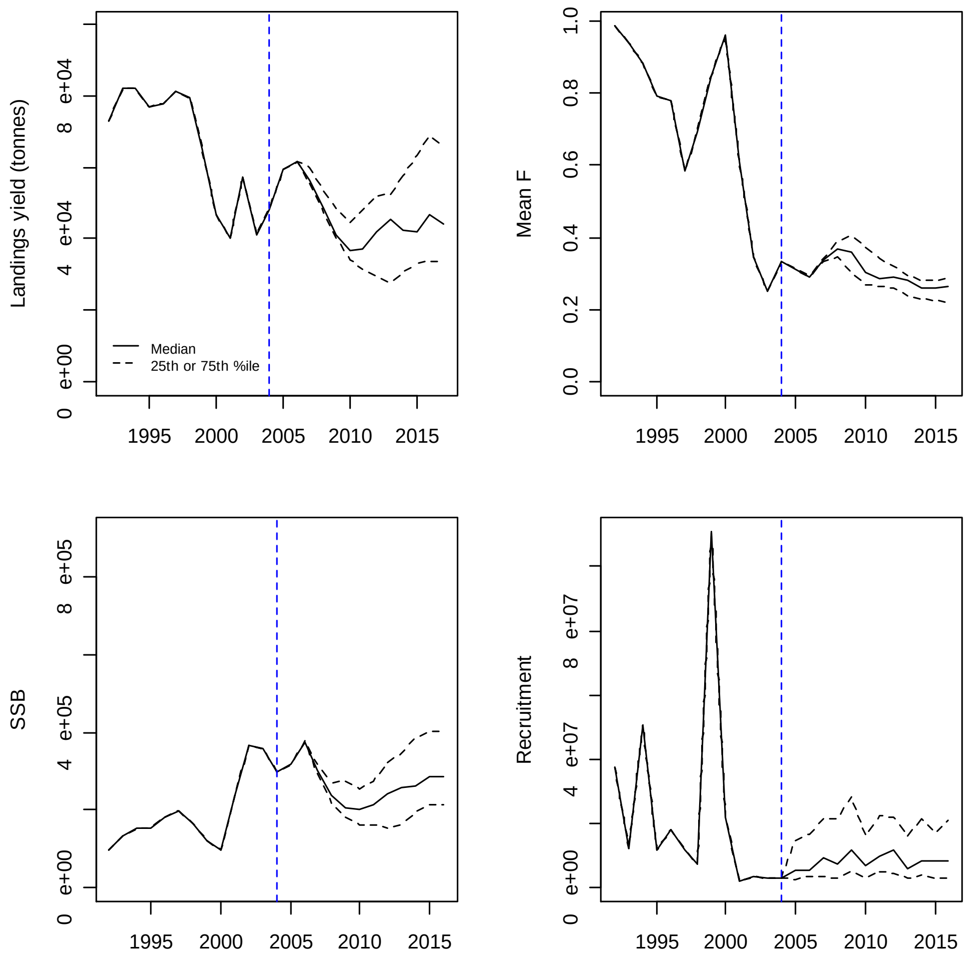


Figure 16.1.5. North Sea haddock. Approximate 50% confidence intervals about median estimates for catch-based management with a TAC constraint HCR (target F = 0.3 with ±15% limit in TAC variation). Solid lines give medians (50th %ile) of distributions of estimates for each year, while dashed lines show approximate first and third quartiles (25th and 75th %ile). The vertical line indicates the final historical year (2004).

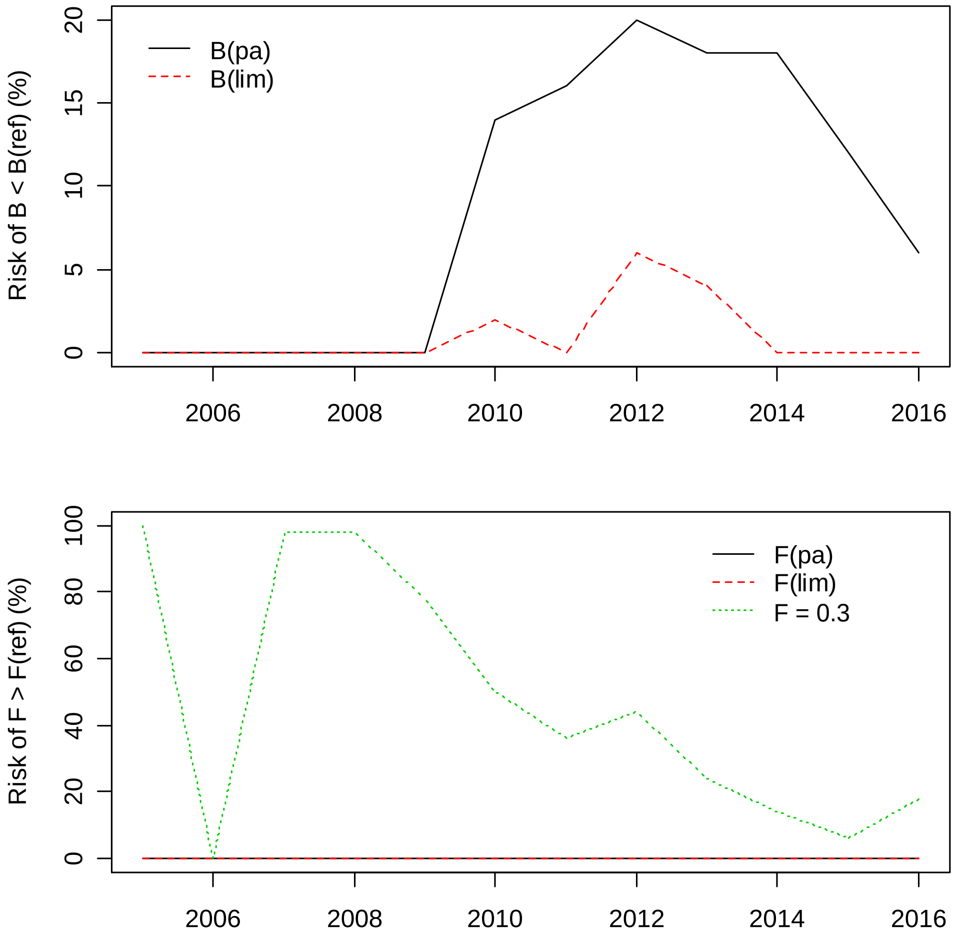


Figure 16.1.6. North Sea haddock. Risk summaries for catch-based management with a TAC constraint HCR. Upper plot: percentage of iterations in each year for which $B_y < B_{pa}$ (solid black line) and $B_y < B_{lim}$ (dashed red line). Lower plot: percentage of iterations in each year for which $F_y > F_{pa}$ (solid black line), $F_y > F_{lim}$ (dashed red line), and $F_y > F_{target}$ (dotted green line).

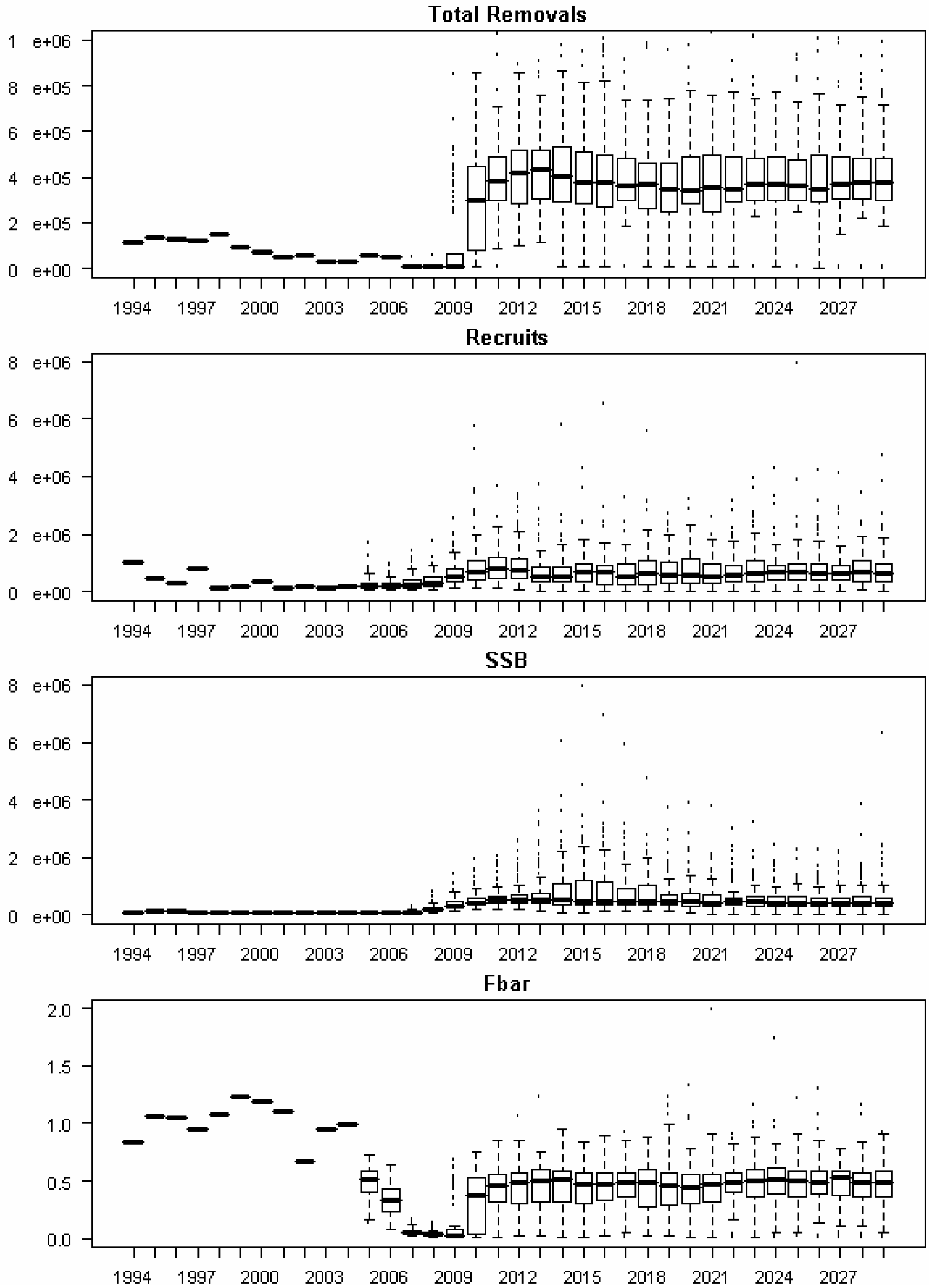


Figure 16.2.1. North Sea cod. Summary of outputs for scenario 1: Reduction in TAC unrestricted until SSB_{y+2} predicted to be > B_{lim}. The HCR attempts to limit mean F to 0.4 once SSB_{y+2} is predicted to be > B_{pa} with no restriction on any necessary reductions in TAC. Discards added to TAC up to a maximum of 500 000 tonnes. Implementation error of 33% applied until TAC set ≥ 200 000 tonnes.

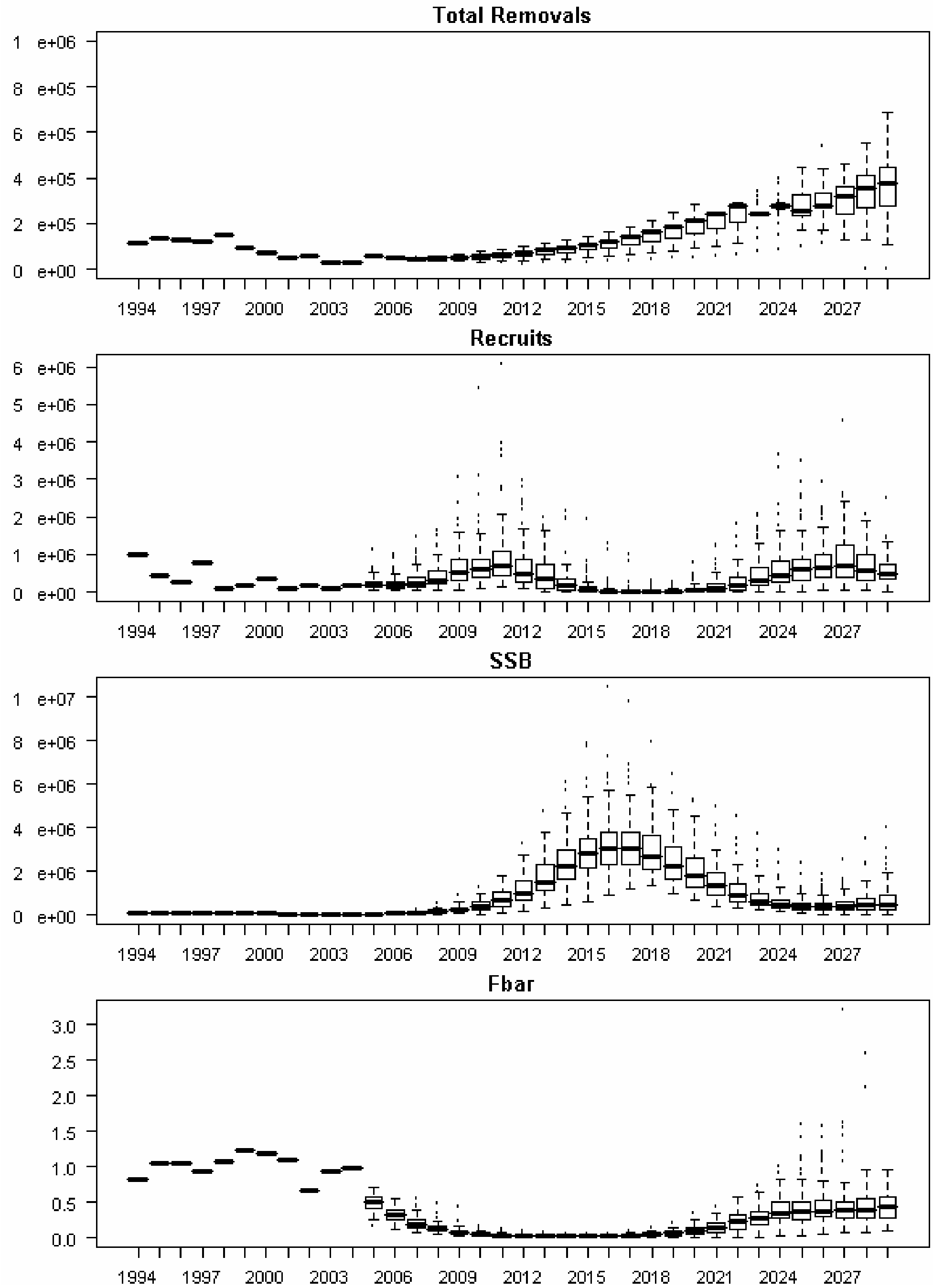


Figure 16.2.2. North Sea cod. Summary of outputs for scenario 2: Reduction in TAC unrestricted until SSB_{y+2} predicted to be > B_{lim}. The HCR attempts to limit mean F to 0.4 once SSB_{y+2} is predicted to be > B_{pa} with no restriction on any necessary reductions in TAC. Discards added to TAC up to a maximum of 500 000 tonnes. Implementation error of 33% applied until TAC set ≥ 200 000 tonnes.

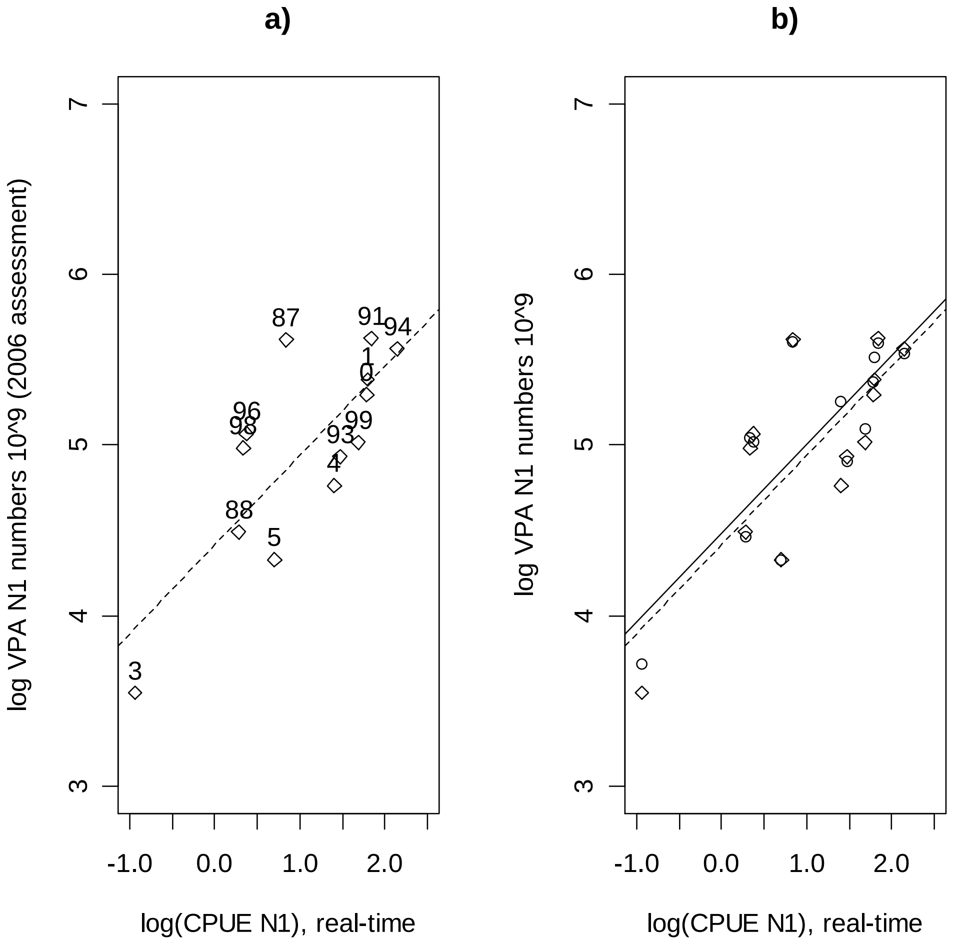


Figure 16.5.1. Panel a) shows the stock numbers (age 1) estimated by VPA this year against observed log of CPUE of age 1 using cumulated data including week 17 of for the years including 2004. CPUE for 2005 is for week 19, where a stable CPUE estimate was obtained. The regression line shown uses all data points. Panel b) shows the same information but the VPA estimate is from the 2004 assessment (data points by circles and solid regression line) or from the 2006 assessment (data points by diamonds and dashed regression line)

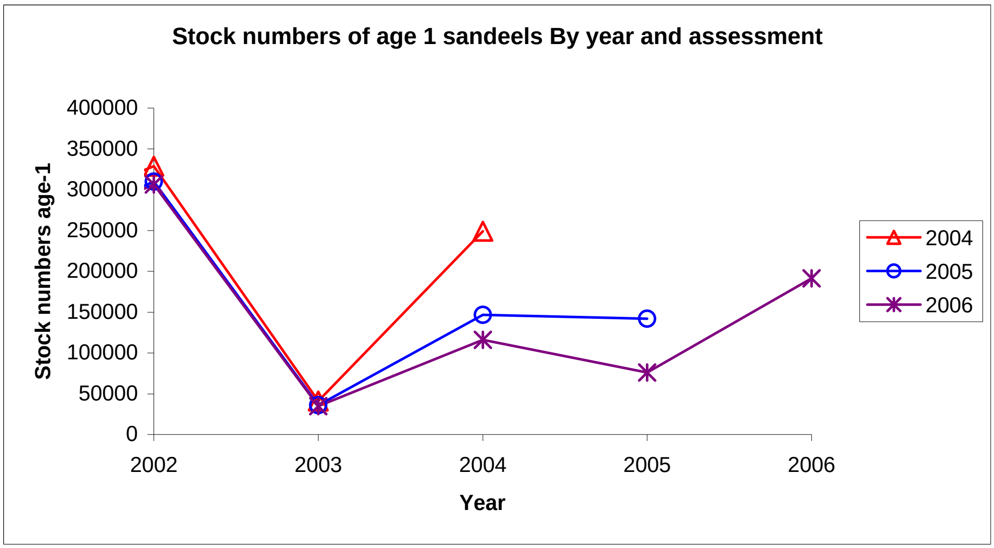


Figure 16.5.2 Estimates of 1-group by various assessment year

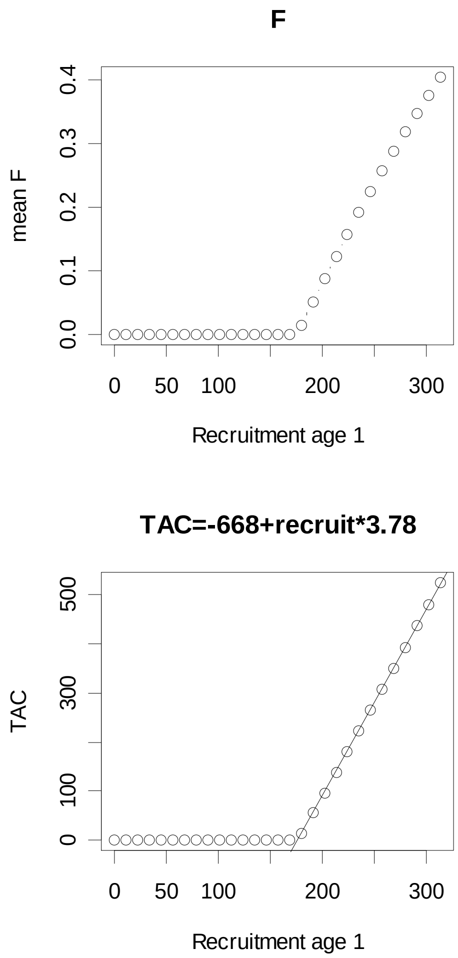


Figure 16.5.3 Upper panel. EXAMPLE of relation between F and real time estimate of age 1 numbers using and minimum escapement strategy leaving SSB in 2008 above Bpa. Lower panel converts F into a TAC value and show a fitted regression line thru TAC values > 0.

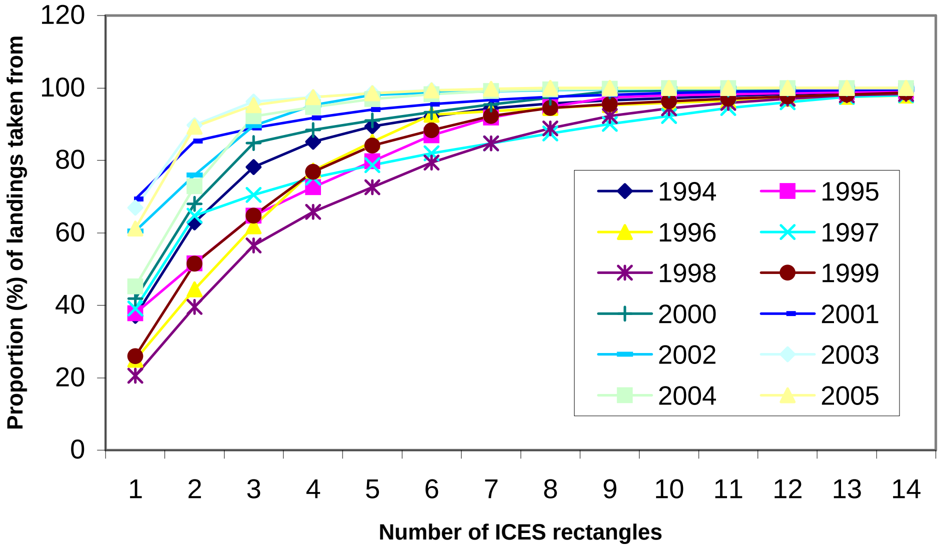
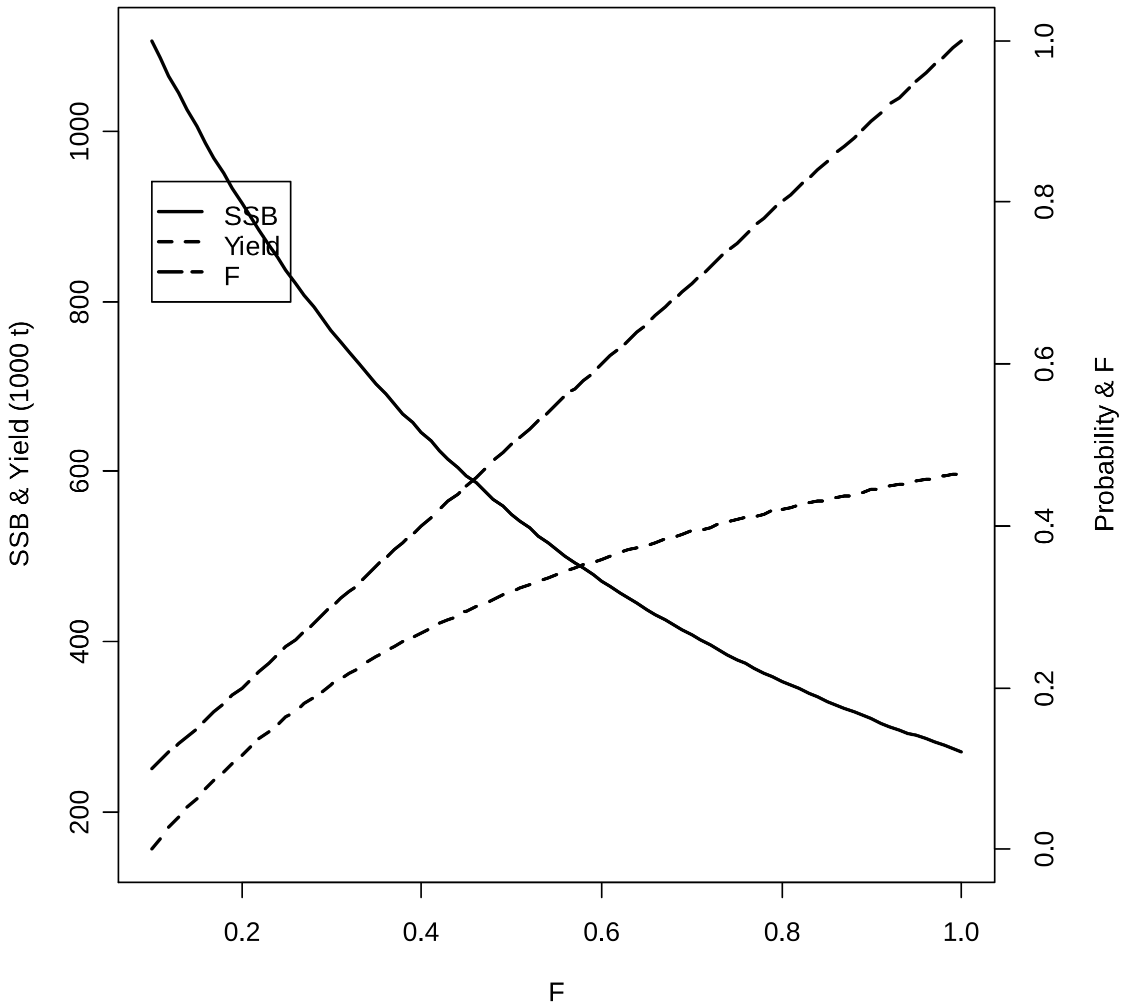


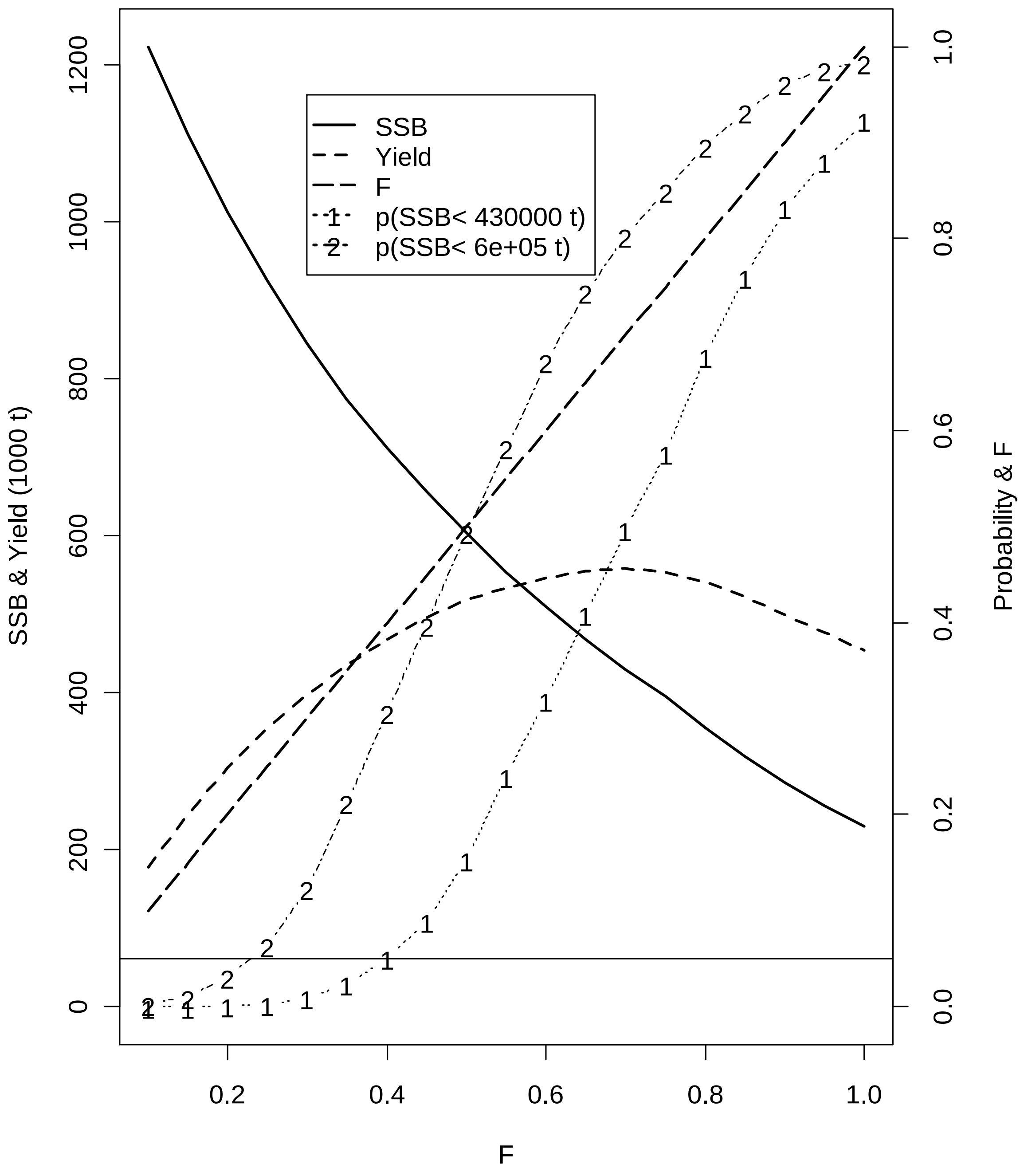
Figure 16.5.4 The proportion of the landings (in quarter 2) reported from x number of ICES rectangles.



Settings:

Assessment uncertainty: no	SSB-R: Geometric mean, deterministic
Real time uncertainty: no	Real time F: none
Cap F: none	Target SSB: none
Cap TAC: none	

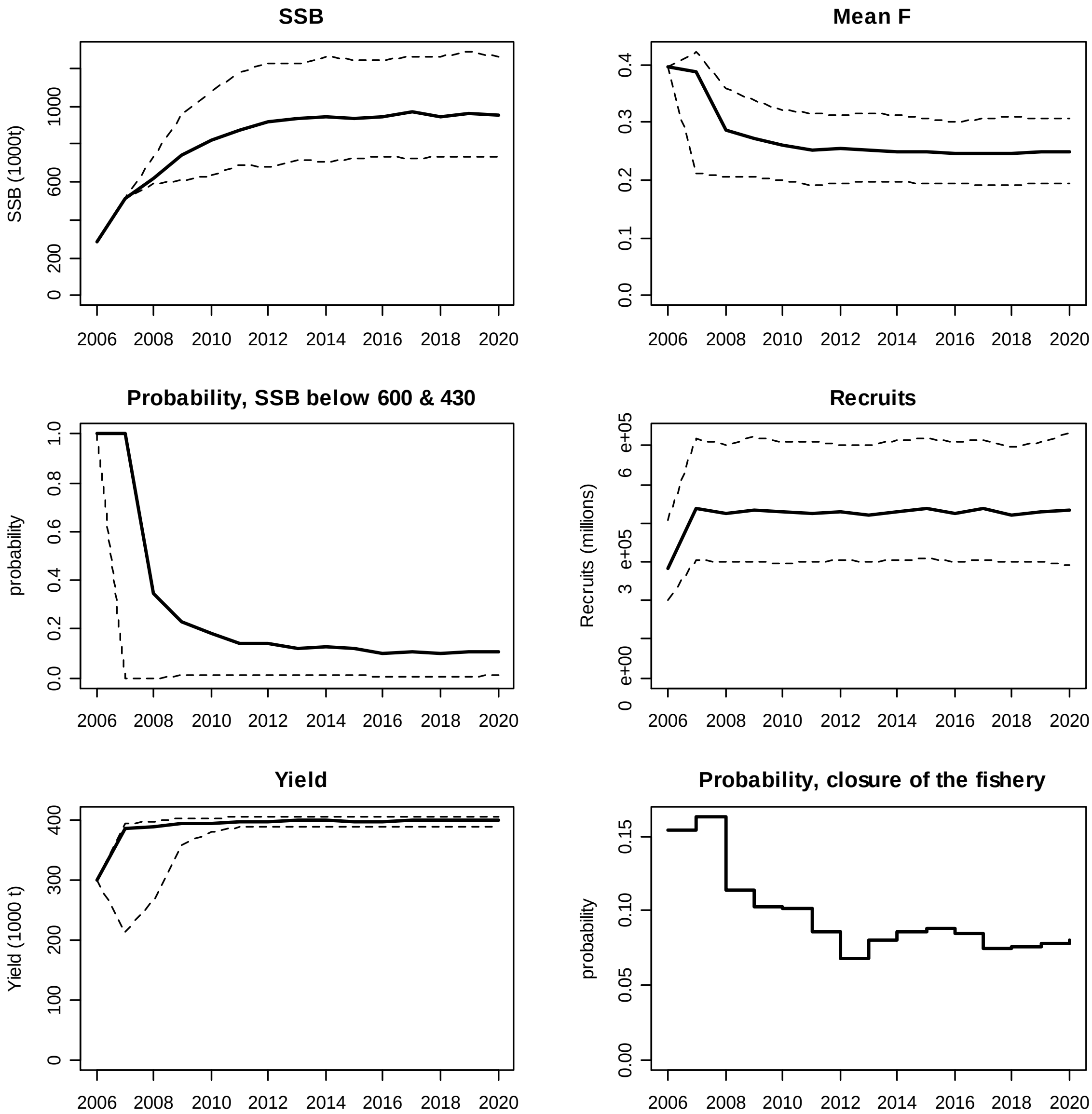
Figure 16.5.5 Scenario 1: Yield per GM recruit



Settings:

Assessment uncertainty: 25%CV, no bias	SSB-R: Hockey stick, Stochastic
Real time uncertainty: no	Real time F: none
Cap F: none	Target SSB: none
Cap TAC: none	

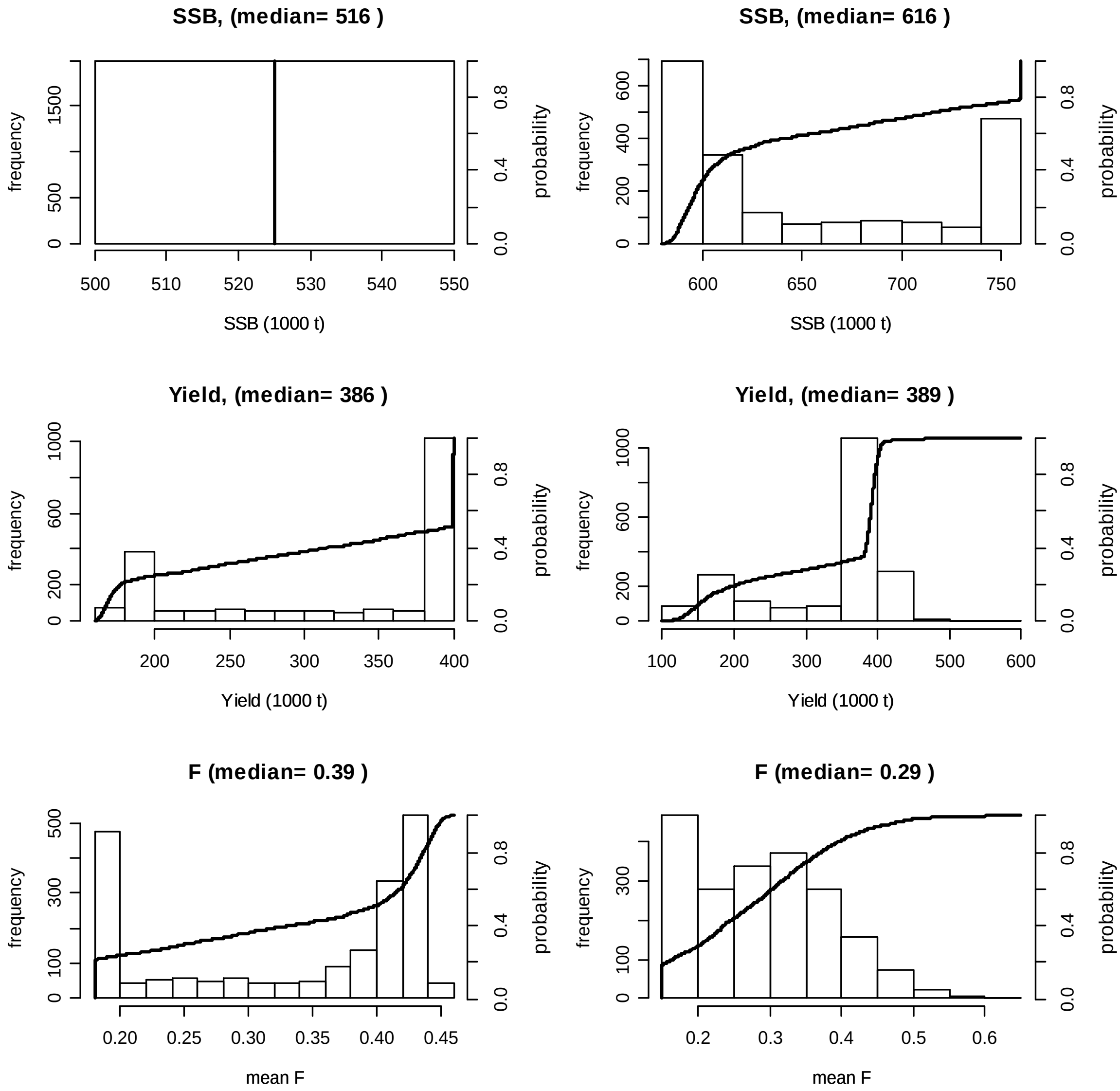
Figure 16.5.6 Scenario 2, MSY, constant F strategy. Effect of managing North Sea sandeel with a range of fixed F value. The figure presents median values of SSB, Yield and F together with the probability of a SSB below Bpa (600 kt) or Blim (430 kt). Metrics presented for population at equilibrium.



Settings:

Assessment uncertainty: 25%CV, no bias	SSB-R: Hockey stick, Stochastic
Real time uncertainty: 35%CV, no bias	Real time F: 0.18
Cap F: 0.65	Target SSB: 600 kt (Bpa)
Cap TAC: 400 kt	

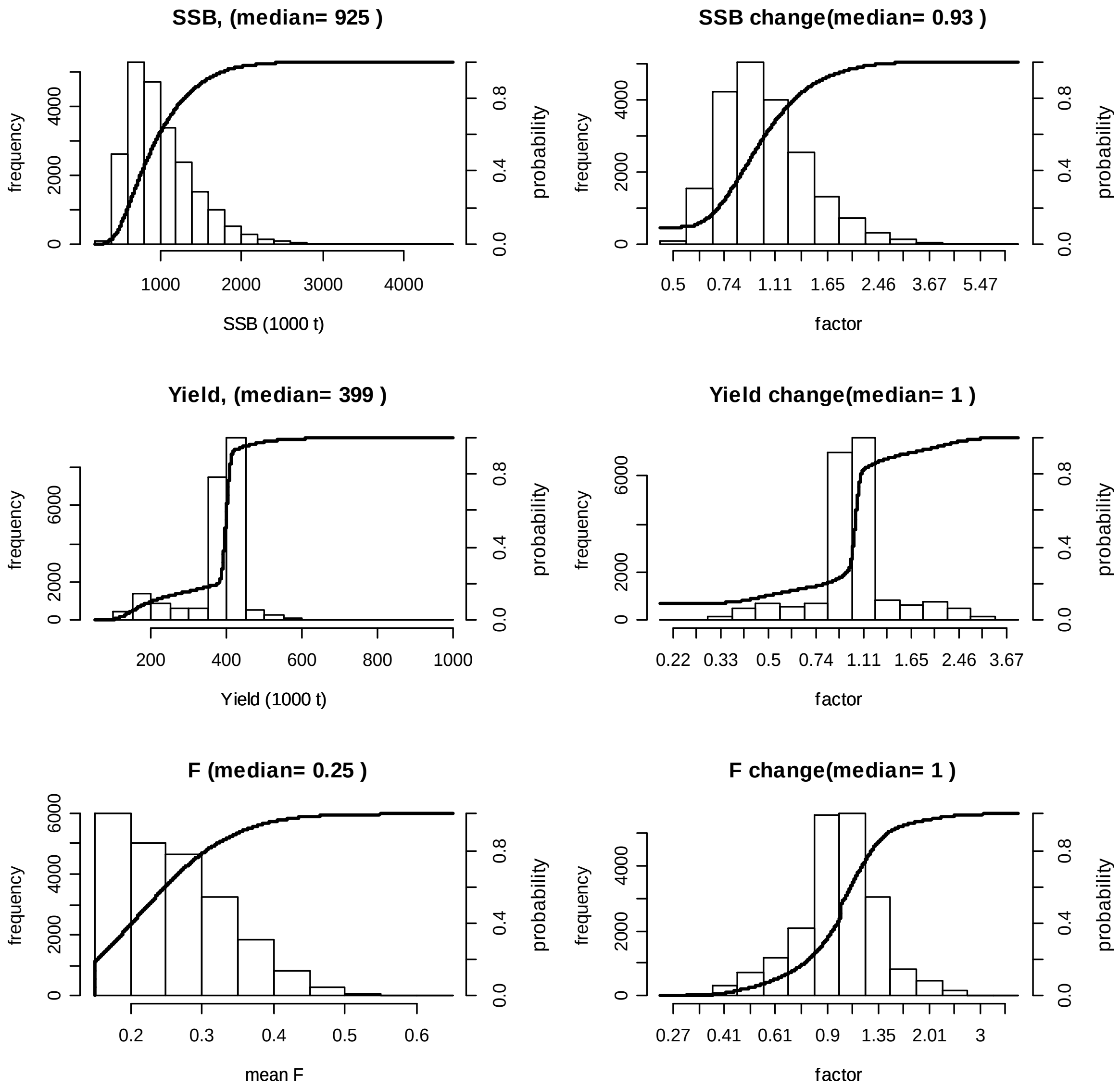
Figure 16.5.7 Scenario 3, Baseline. Mean trajectory of sandeel SSB, yield, mean F and recruit (25, 50 and 75 percentiles), and probability of a fishery closure after the real time monitoring period, and the probability of the SSB being below Bpa (600 kt) and Blim (430 kt)



Settings:

Assessment uncertainty: 25%CV, no bias	SSB-R: Hockey stick, Stochastic
Real time uncertainty: 35%CV, no bias	Real time F: 0.18
Cap F: 0.65	Target SSB: 600 kt (Bpa)
Cap TAC: 400 kt	

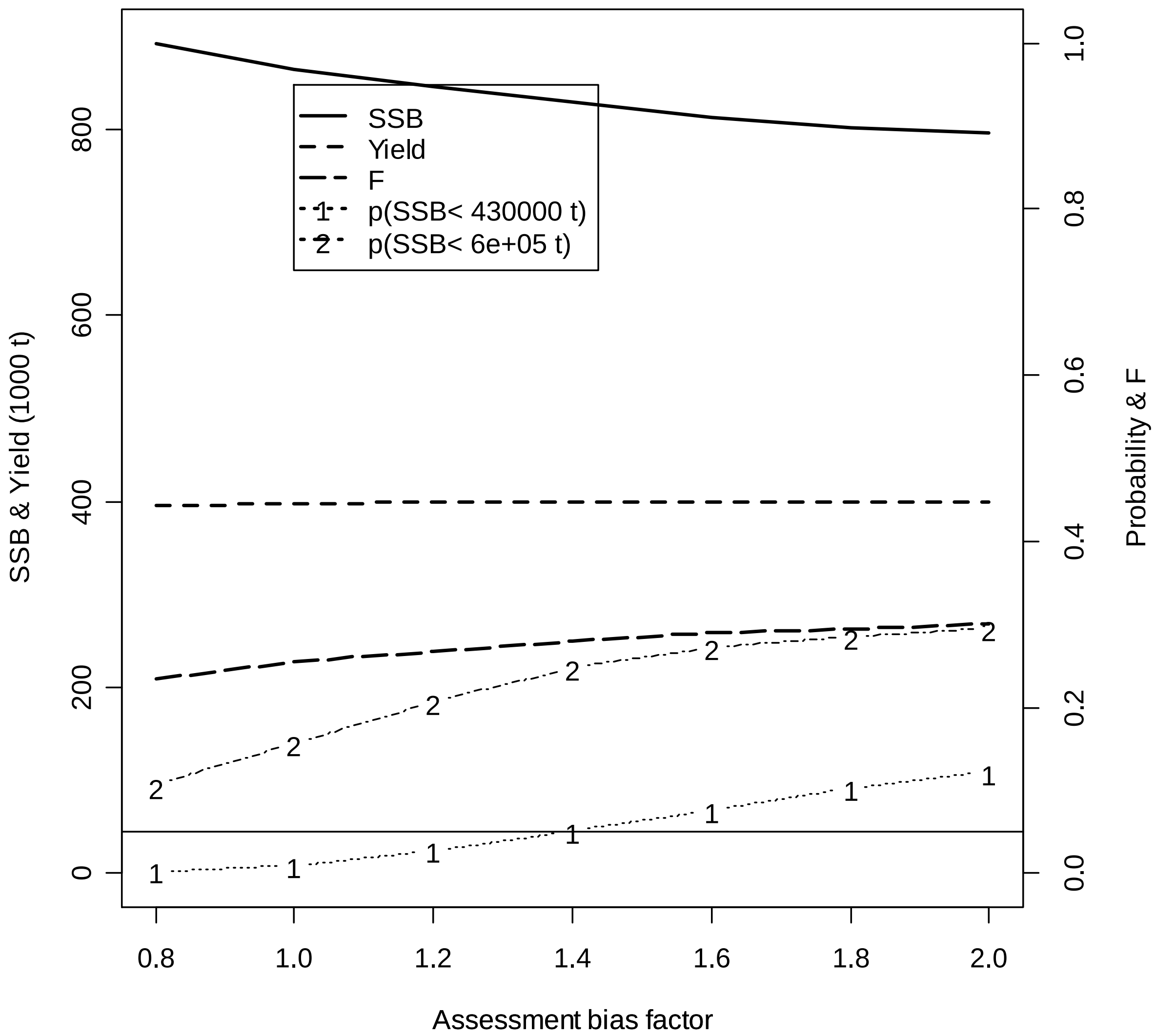
Figure 16.5.8 Scenario 3, Baseline. Distribution and cumulative probability of population metrics in 2007 (left column) and 2008 (right column).



Settings:

Assessment uncertainty: 25%CV, no bias	SSB-R: Hockey stick, Stochastic
Real time uncertainty: 35%CV, no bias	Real time F: 0.18
Cap F: 0.65	Target SSB: 600 kt (Bpa)
Cap TAC: 400 kt	

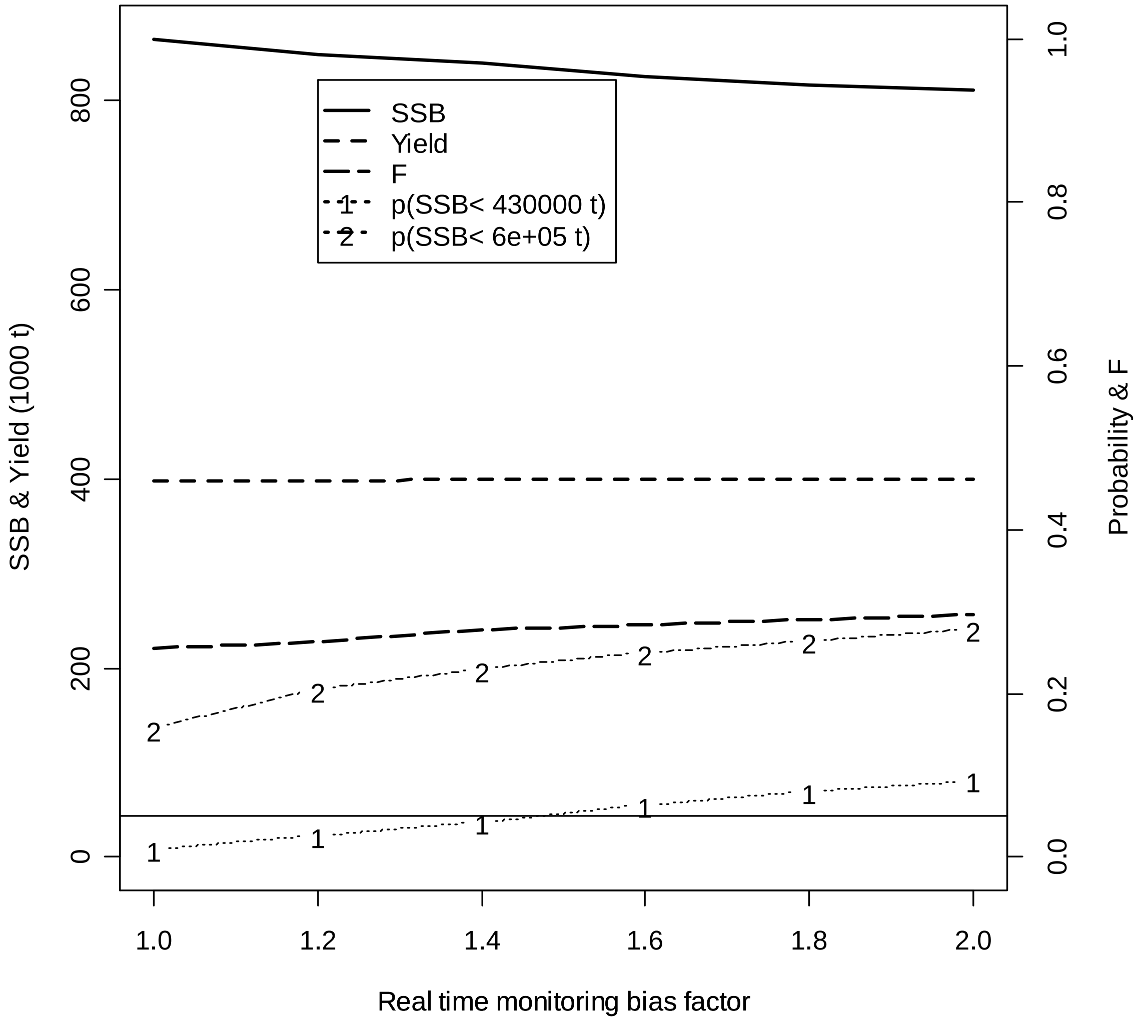
Figure 16.5.9 Scenario 3, Baseline. Distribution and cumulative probability of population metrics at equilibrium.



Settings:

Assessment uncertainty: 25%CV, bias factor in the range 0.8 to 2.0	SSB-R: Hockey stick, Stochastic
Real time uncertainty: 35%CV, no bias	Real time F: 0.18
Cap F: 0.65	Target SSB: 600 kt (Bpa)
Cap TAC: 400 kt	

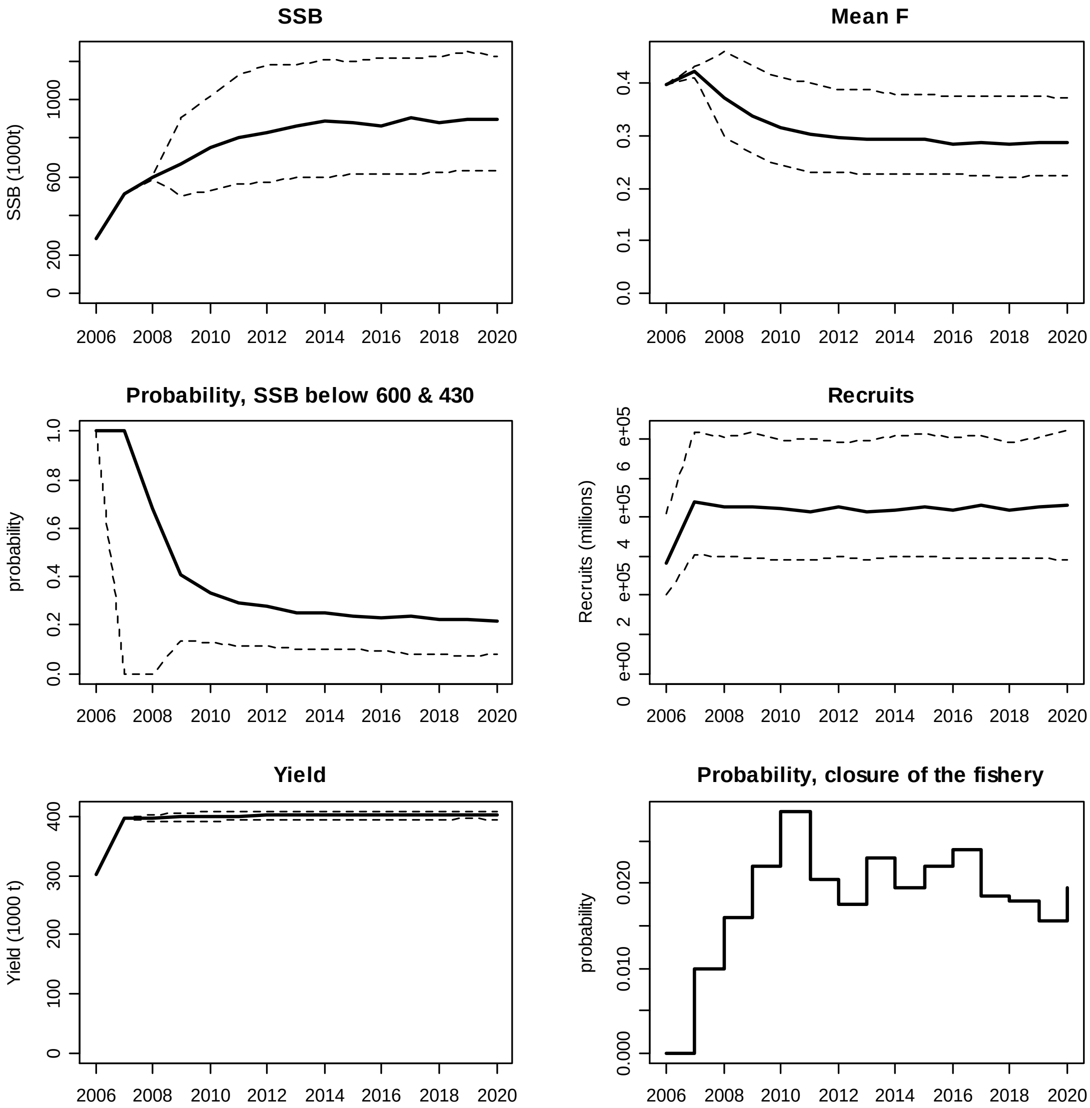
Figure 16.5.10 Assessment bias scenario. Median values of SSB, Yield and F together with the probability of a SSB below Bpa (600 kt) or Blim (430 kt). Metrics presented for population at equilibrium.



Settings:

Assessment uncertainty: 25%CV, no bias	SSB-R: Hockey stick, Stochastic
Real time uncertainty: 35%CV, bias factor in the range 1.0 to 2.0	Real time F: 0.18
Cap F: 0.65	Target SSB: 600 kt (Bpa)
Cap TAC: 400 kt	

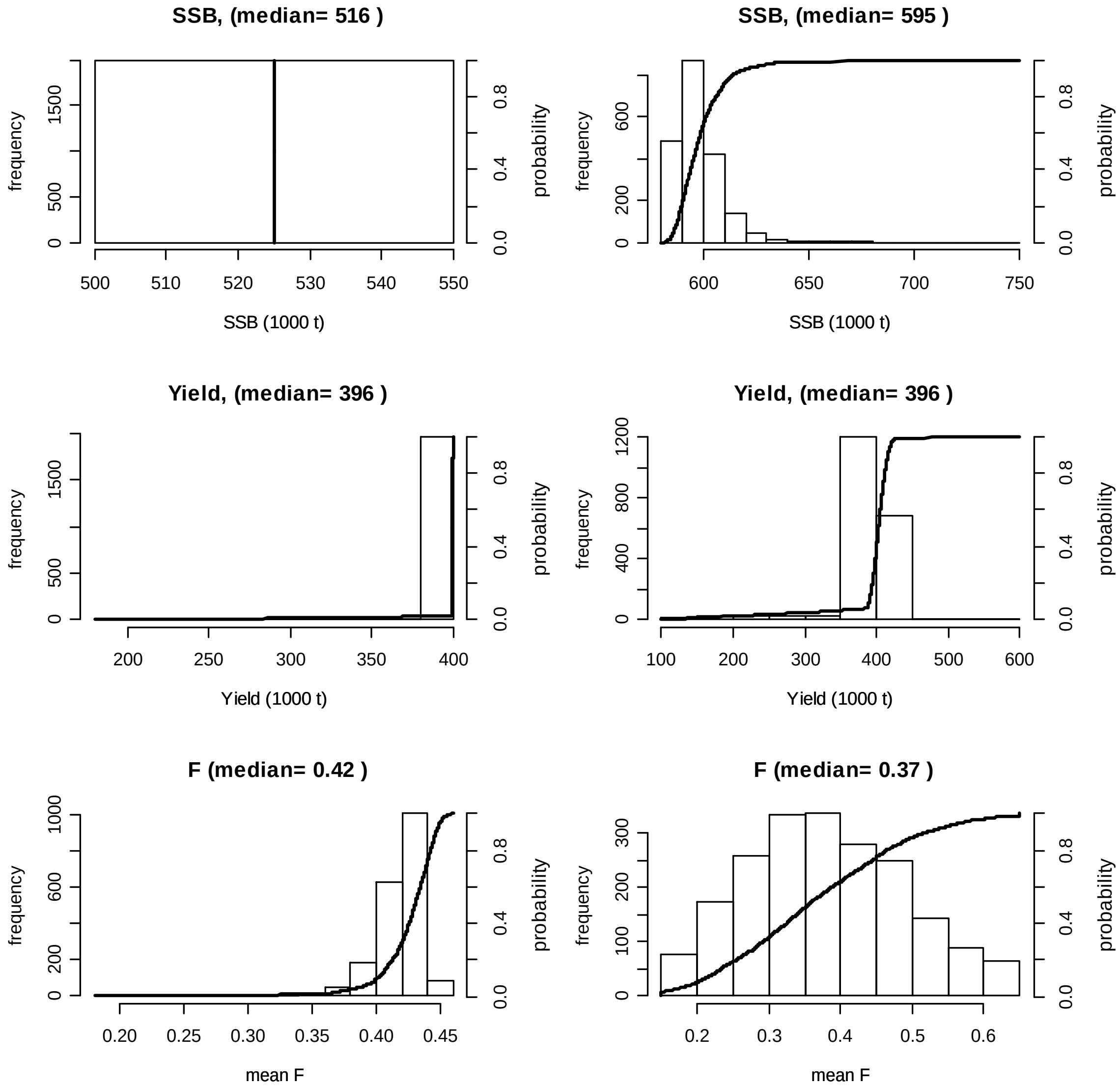
Figure 16.5.11 Real time bias scenario. Median values of SSB, Yield and F together with the probability of a SSB below Bpa (600 kt) or Blim (430 kt). Metrics presented for population at equilibrium.



Settings:

Assessment uncertainty: 25%CV, Bias factor 1.5	SSB-R: Hockey stick, Stochastic
Real time uncertainty: 35%CV, Bias factor: 1.5	Real time F: 0.18
Cap F: 0.65	Target SSB: 600 kt (Bpa)
Cap TAC: 400 kt	

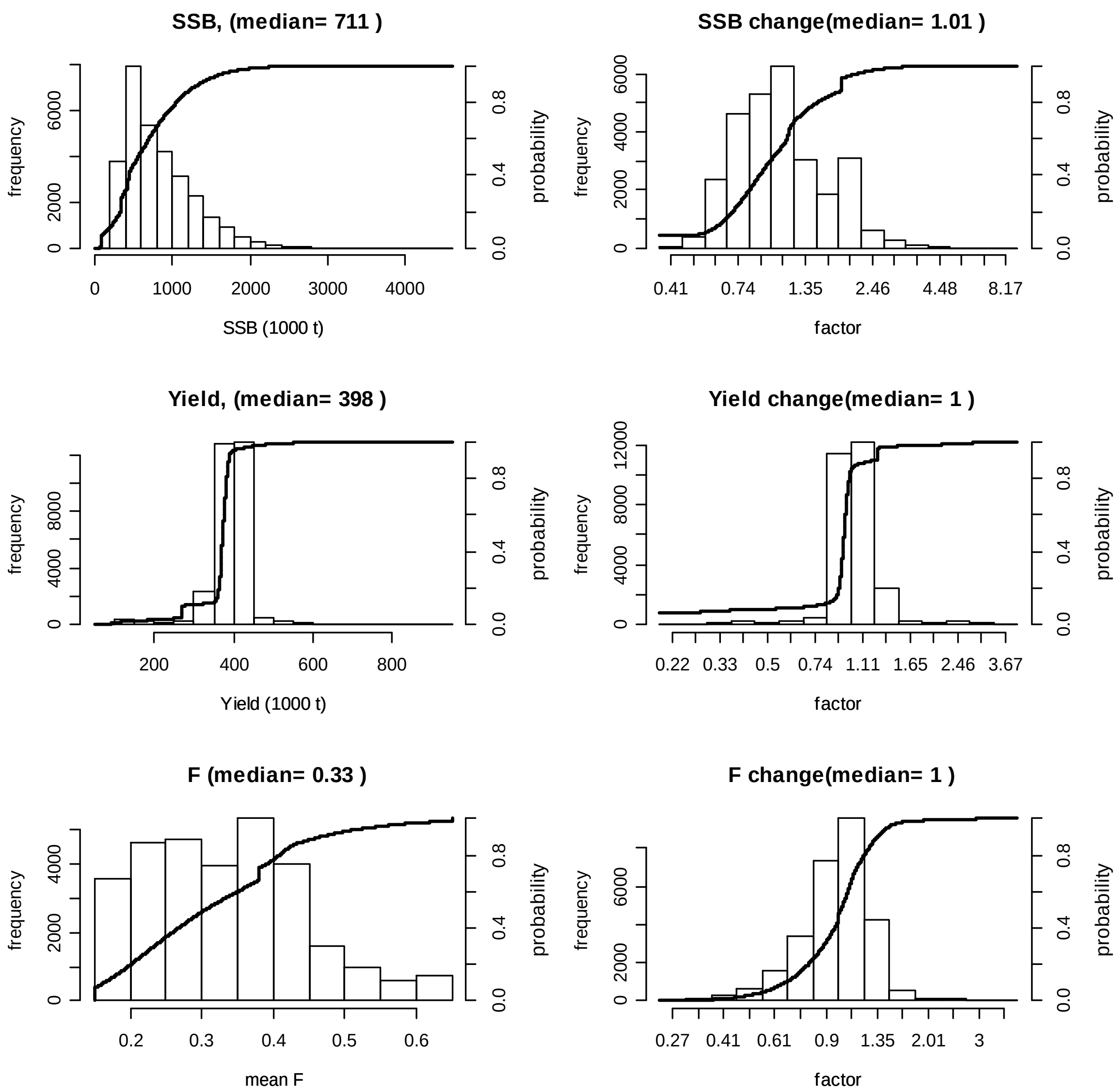
Figure 16.5.12 Assessment and real time bias scenario. Mean trajectory of sandeel SSB, yield, mean F and recruit (25, 50 and 75 percentiles), and probability of a fishery closure after the real time monitoring period, and the probability of the SSB being below Bpa (600 kt) and Blim (430 kt).



Settings:

Assessment uncertainty: 25%CV, bias factor 1.5	SSB-R: Hockey stick, Stochastic
Real time uncertainty: 35%CV, Bias factor: 1.5	Real time F: 0.18
Cap F: 0.65	Target SSB: 600 kt (Bpa)
Cap TAC: 400 kt	

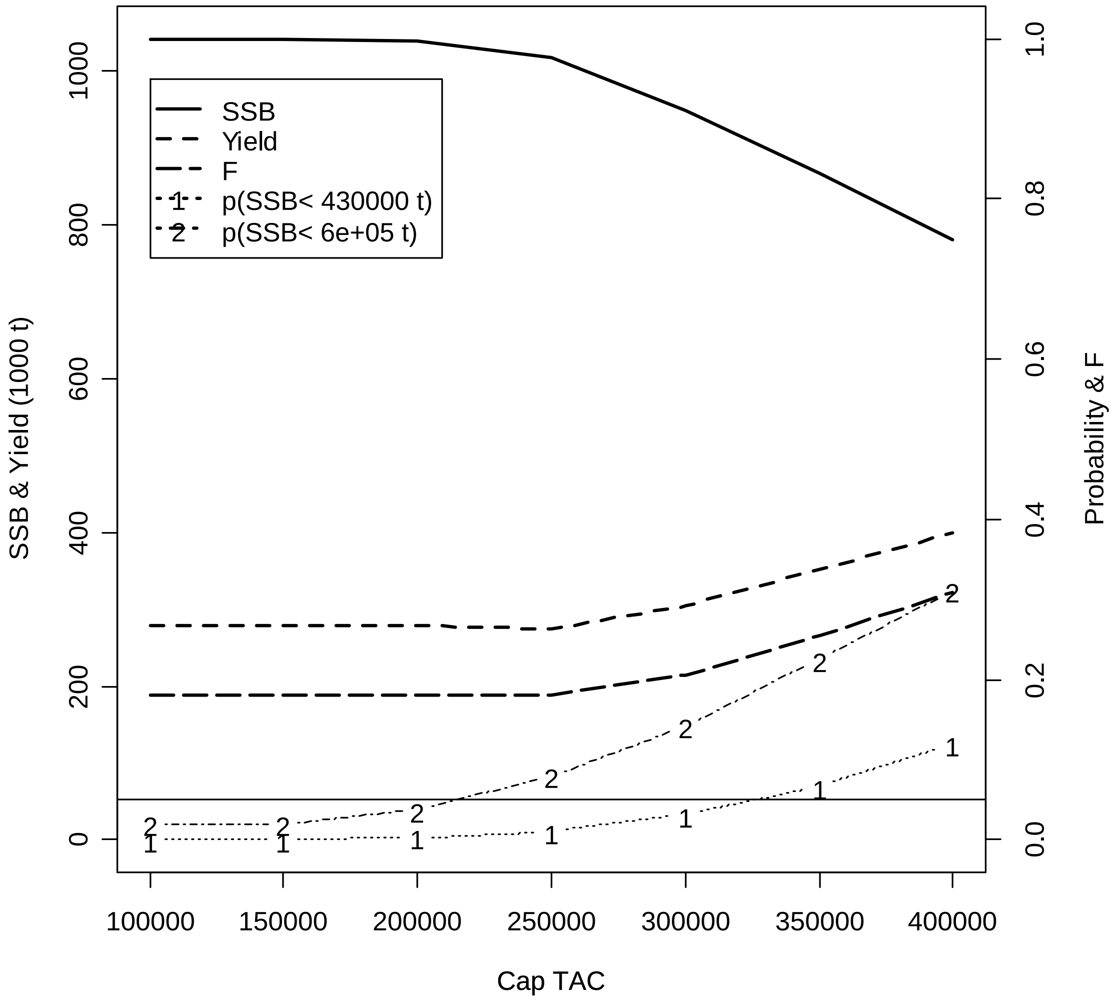
Figure 16.5.13 Assessment and real time bias scenario. Distribution and cumulative probability of population metrics in 2007 (left column) and 2008 (right column).



Settings:

Assessment uncertainty: 25%CV, bias factor 1.5	SSB-R: Hockey stick, Stochastic
Real time uncertainty: 35%CV, Bias factor: 1.5	Real time F: 0.18
Cap F: 0.65	Target SSB: 600 kt (Bpa)
Cap TAC: 400 kt	

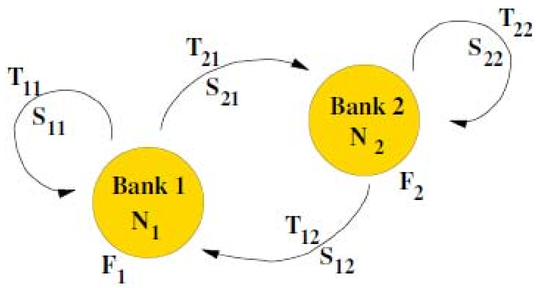
Figure 16.5.14 Assessment and real time bias scenario. Distribution and cumulative probability of population represents metrics at equilibrium.



Settings:

Assessment uncertainty: 25%CV, bias factor 1.5	SSB-R: Hockey stick, Stochastic
Real time uncertainty: 35%CV, Bias factor: 1.5	Real time F: 0.18
Cap F: 0.65	Target SSB: 600 kt (Bpa)
Cap TAC: varying 100-400 kt	

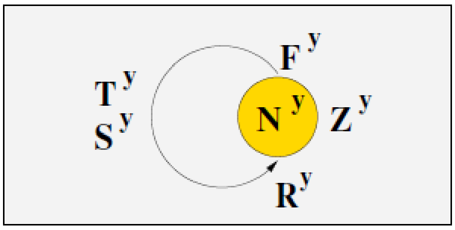
Figure 16.5.15 Assessment and real time bias with varying TAC scenario. Distribution and cumulative probability of population represents metrics at equilibrium.



- N_i^y: Number of adults at bank i for year y
- T_{ij}^y: Transport probability from bank $j \rightarrow i$ for year y
- S_{ij}^y: Survival probability from bank $j \rightarrow i$ for year y (given transport from $j \rightarrow i$)
- F_i^y: Average egg productivity at bank i for year y
- Recruitment at bank i for year y :

$$\begin{aligned} R_i^{y+1} &= \sum_j \underbrace{S_{ij}^y F_j^y}\, T_{ij}^y N_j \\ &= \sum_j \alpha_{ij}^y T_{ij}^y N_j \end{aligned}$$

Figure 16.5.16. Conceptual recruitment model including transportation among banks and bank specific egg production



- z_i^{y+1} : adult dead rate on bank i during year y

$$\begin{aligned} N_i^{y+1} &= R_i^{y+1} + e^{-z_i^{y+1}} N_i^y \\ &= \sum_j \underbrace{(\alpha_{ij}^y T_{ij}^y + \delta_{ij} e^{-z_i^{y+1}})}\, N_i^y \\ &= \sum_j L_{ij}^y N_i^y \end{aligned}$$

- Demographic matrix L_{ij}^y from process-models (T, S) and assessment/survey data (S, z)
- Demographic matrix L_{ij}^y independent on assesment errors on N_i^y

Figure 16.5.17. Conceptual model of bank specific population dynamics

17 References

Note: several references to ICES documents are incomplete. These are marked with XXXX.

Arnott, S. A. and Ruxton, G. D. (2002) Sandeel recruitment in the North Sea: demographic, climatic and trophic effects. Marine Ecology Progress series, 238, 199-210.

Bagge, O. and Munch-Petersen, S. (1979). Some possible factors governing the catchability of Norway lobster in the Kattegat. *Rapports et proces-verbaux des reunions. Conseil international pour l'exploration de la mer* **175**:143-146.

Bagge, O., Nielsen, E., Mellergaard, S. and Dalsgaard, I. (1990). Hypoxia and the demersal fish stock in Kattegat (IIIa) and Subdivision 22. ICES C.M. 1990/E:4.

Bailey N., Chapman C.J., Kinnear J., Bova D. and Weetman A. (1993) Estimation of *Nephrops* stock biomass on the Fladen Ground by TV survey. ICES CM 1993/**K:34**.

Bell, M., Dann, J., Lawler, A., Lovewell, S., Cutchey, S., Palmer, D., Smith, M., McCubbin, D. and Armstrong, M. (2005). Programme 6: NE Nephrops; 6a: Nephrops survey. CEFAS/NFFO Fisheries Science Partnership 2004/05 Final Report.

Blegvad, H. (1934). Omplantering af rødspætter fra Nordsøen til Bæltfarvanene 1928-1933. Beretning fra den Danske Biologiske Station XXXIX:9-83

Boje, J and Nielsen, E. (2006). 0-group survey for plaice in Kattegat (IIIaS) 1985-2005. Working paper #12 for WGNSSK 2006. [WD12]

Boje, J. and Nielsen, E. (2006). 0-group survey for plaice in Kattegat (IIIaS) 1985-2005. [WD12]

Borges, L., Kraak, S. B. M. and Machiels, M. A. M. (2006). Stock assessment of North Sea plaice using a Bayesian catch-at-age model. [WD7]

Bromley, P. J., Watson, T., and Hislop, J. R. G. (1997). Diel feeding patterns and the development of food webs in pelagic 0-group cod (*Gadus morhua* L.), *haddock (Melanogrammus aeglefinus* L.), whiting (*Merlangius merlangus* L.), saithe (*Pollachius virens* L.), and Norway pout (*Trisopterus esmarkii* Nilsson) in the northern North Sea. *ICES J. Mar. Sci.*, **54:** 846-853.

Casini, M, Cardinale, M, Hjelm, J. and Vitale, F. (2005). Trends in cpue and related changes in spatial distribution of demersal fish species in Kattegat and Skagerrak, eastern North Sea, between 1981 and 2003.

CEFAS (1999) *PA Software User's Guide.* CEFAS, Lowestoft.

Chapman, C.J. & Bailey, N. (1987). Biological research on fish and shellfish stocks. Recent progress in Norway lobster research. In: Developments in fisheries research in Scotland. eds. Bailey, R.S. & Farrish, B.B., Fishing News Books Ltd., Farnham. pp. 99-111.

Cook, R. M. (2004). Estimation of the age-specific rate of natural mortality for Shetland sandeels, *ICES Journal of Marine Science* **61**: 159–164.

Cook, R.M. (1997) Stock trends in six North Sea stocks as revealed by an analysis of research vessel surveys. *ICES J. Mar. Sci.*, **54:** 924-933.

Cryer, M. (1998) Coromandel and Northland scallop stock assessments for 1997. New Zealand Fisheries Research Document 98/7.

Darby C.D. (2004). Estimating systematic bias in the North Sea cod landings data. Working document to the ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 7 – 16 September 2004

Darby, C. D. (2006). Regional differences in the dynamics of the whiting "stock" in ICES Sub-area IV and Division VIId. [WD20]

Darby, C. D. and Flatman, S. (1994). Lowestoft VPA Suite Version 3.1 User Guide. MAFF: Lowestoft.

de Veen, J. F. (1978). On selective tidal transport in the migration of North Sea plaice (Pleuronectes platessa L.) and other flatfish species. Netherlands Journal of Sea Research 12: 115-147.

Degel, H., Nedreaas, K. and Nielsen, J. R. (2006). Summary of results from the Danish-Norwegian fishing trials autumn 2005 exploring by-catch levels in the small-meshed fishery in the North Sea targeting Norway pout. [WD 22]

Deriso, R. B., Quinn II, T. J. and Neal, P. R. (1985). Catch-age analysis with auxiliary information, *Canadian Journal of Fisheries and Aquatic Sciences* **42**: 815–824.

Deriso, R.B. (1987). Optimal F0.1 criteria and their relationship to maximum sustainable yield. Can. J. Fish. Aquat. Sci. 44 (Suppl. 2):339-348.

Dickey-Collas M., Fox C. J., Nash R. D. M. , and O'Brien C. M. (2003). Plaice egg mortality: can we determine survivorship? *Journal Of Sea Research* **50**(2-3): 211-225 NOV 2003

Dickey-Collas, M., Pastoors, M. A. and van Keeken, O. A. (2006). Precisely wrong or vaguely right: simulations of the inclusion of noisy discard data and trends in fishing effort on the stock assessment of North Sea plaice. [WD16]

Dobby, H. and Bailey, N. (2006). Harvest rates for Nephrops. [WD11]

EC (1985). Report of the Working Group on the by-catches in the Norway pout fishery. Submitted to EU STECF, September 1985, DISK. STCF 9 (N. Pout).

EC (1987a). Bioeconomic evaluation of the Norway pout box. EU Commission. Internal Information on Fisheries: 16.

EC (1987b). The consequences of increased North Sea herring, haddock and whiting abundances for the fishery for Norway pout in the North Sea. EU Commission Report, Contract No 1946, 12.06.87 between Marine Resources Assessment Group, London, and Danish Institute for Fisheries and Marine Research, Charlottenlund.

EC (1998). Council Regulation (EC) No. 850/98 for the conservation of fishery resources through technical measures for the protection of juveniles of marine organisms. No. 850/98.

EC (1998). EU Council Regulation (EC) No. 850/98. Official Journal of the European Communities L 125 of 30 March 1998, Vol. 41 of 27th April 1998: 36 pp. ISSN 0378-6988.

EC (2001). Commission Regulation (EC) No 2056/2001 of 19 October 2001 establishing additional technical measures for the recovery of the stocks of cod in the North Sea and to the west of Scotland. No. 2056/2001.

EC (2002a). Council Regulation (EC) No 2341/2002 of 20 December 2002 fixing for 2003 the fishing opportunities and associated conditions for certain fish stocks and groups of fish stocks, applicable in Community waters and, for Community vessels, in waters where catch limitations are required. No 2341/2002.

EC (2002b). Development and testing of a grid system to reduce by-catches in Norway pout trawls. Final Consolidated Report, EU Study Project No. 98/002: 32pp + 75 pp. EU Commission DG Fisheries, Bruxelles.

EC (2003). Council Regulation (EC) No 671/2003 of 10 April 2003 amending Regulation (EC) No 2341/2002 fixing for 2003 the fishing opportunities and associated conditions for certain fish stocks and groups of fish stocks, applicable in Community waters and, for Community vessels, in waters where catch limitations are required. No 671/2003.

EC (2005). Council Regulation (EC) No 27/2005 of 22 December 2004 fixing for 2005 the fishing opportunities and associated conditions for certain fish stocks and groups of fish stocks, applicable in Community waters and, for Community vessels, in waters where catch limitations are required.

EC (2006). Council Regulation No 51/2006 of 22 December 2005 fixing for 2006 the fishing opportunities and associated conditions for certain fish stocks and groups of fish stocks, applicable in Community waters and, for Community vessels, in waters where catch limitations are required.

EC (2006a). Report of the Ad Hoc Meeting of independent experts on Fleet-Fishery based sampling, Nantes, 12-16 June 2006. Commission staff Working Paper.

EC (2006b). EC No. 898/2006. Council Regulation (EC) No. 898/2006 of 19. June 2006.

Eigaard, O.R., and Holst, R. (2004). The effective selectivity of a composite gear for industrial fishing: a grid in combination with a square mesh window. Fish. Res. 68: 99-112.

EMAS 2001 Evaluation of market sampling strategies for a number of commercially exploited stocks in the North Sea and development of procedures for consistent data storage and retrieval (EMAS). RIVO CEFAS DIFRES SOAEFD CLO-DZ, CFP Study Project 98/075

EU (2006). Report of the Ad Hoc Meeting of Independent Experts on Fleet-Fishery Based Sampling. Commission Staff Working Paper. Nantes, 12-16 June 2006 [BD15].

EU-FISBOAT (2006). FISBOAT: fishery independent survey based operational assessment tools. http://www.ifremer.fr/drvecohal/fisboat/index.htm.

EU-Norway (2004). Report of the EU-Norway ad hoc scientific working group on multi-annual management plans for stocks shared by EU and Norway, Brussels 14-18 June 2004 (available at: http://fish.jrc.cec.eu.int/fisheries/stecf/eu-norway/multiannual.html).

EU-STECF Subgroup SGRST (2006a). March 2006. Citation pending. [BD11]

EU-STECF Subgroup SGRST (2006b). June 2006. Citation pending. [BD12]

FLR Team (2006). FLR: Fisheries modelling in R. Version 1.2.1. Initial design by L. T. Kell and P. Grosjean. http://www.flr-project.org/doku.php

Folmer, O. (2006). Description and revision of Kattegat survey indices for plaice in IIIa. [WD8]

Fox , C., Taylor M., Dickey-Collas, M., van Damme C.J.G., Bolle, L., Daan, N., Rohlf, N., Kraus, G., Munk, P., Fossum, P., Bailey, N. (2004). Initial results from the 2004 ichthyoplankton survey of the North Sea ICES CM 2005/AA:04.

Fox, C. J., Geffen A. J., Blyth R., and Nash R. D. M. (2003). Temperature-dependent development rates of plaice (Pleuronectes platessa L.) eggs from the Irish Sea. *Journal Of Plankton Research* 25 (11): 1319-1329.

Frederiksen M, Wright PJ, Heubeck M, Harris MP, Mavor RA, Wanless S (2005) Regional patterns of kittiwake Rissa tridactyla breeding success are related to variability in sandeel recruitment. *Mar Ecol Prog Ser* **300**: 201-211.

Frederiksen, M., Wanless, S., Rothery, P. and Wilson, L. J. (2004). The role of industrial fisheries and oceanographic change in the decline of North Sea black-legged kittiwakes. *Journal of Applied Ecology*, **41**, 1129-1139.

Froglia, C., Atkinson, R.J., Tuck. I. and Arneri, E. (1997). Underwater television survey, a tool to estimate *Nephrops* stock biomass on the Adriatic trawling grounds. In: *Tisucu godina prvoga spomena ribarstva u Hrvata* (ed. B. Finka). Hrvatska Akademija Ananosti i Umjetnosti, Zagreb 1997.

Furness RW, Tasker ML (1997) Seabird consumption in sand lance MSVPA models for the North Sea, and the impact of industrial fishing on seabird population dynamics Forage Fishes in Marine Ecosystems. Lowell Wakefield Fisheries Symposium Series. American Fisheries Society, pp 147-169

Furness, R.W. (2002) Management implications of interactions between fisheries and sandeel-dependent seabirds and seals in the North Sea. ICES Journal of Marine Science, 59, 261-269.

Gavaris, S, and Van Eeckhaute L, 1998. Diagnosing Systematic Errors in Reported Fishery Catch in Proceedings of the International Symposium on Fishery Stock Assessment Models for the 21st Century, October 8-11, 1997. Alaska Sea Grant College Program AK-SG-98-01.

Greenstreet, S.P.R., Armstrong, E, Mosegaard, H., Jensen, H., Gibb, I.M., Fraser, H.M., Scott, B., Holland, G. and Sharples J. (in press) Variation in the abundance of sandeels Ammodytes marinus off southeast Scotland: an evaluation of area-closure fisheries management and stock abundance assessment methods. ICES Journal of Marine Science.

Grift, R. E., Rijnsdorp, A.D., Barot, S., Heino, M. and Dieckmann, U. (2003). Fisheries-induced reaction norms for maturation in North Sea plaice. Mar Ecol Prog Ser 257: 247-257.

Grift, R.E., I. Tulp, L. Clarke, U. Damm, A. McLay, S. Reeves, J. Vigneau and W. Weber. (2004). Assessment of the ecological effects of the Plaice Box. Report of the European Commission Expert Working Group to evaluate the Shetland and Plaice boxes. Brussels: 121 p.

Gudmundsson, G. (1986). Statistical considerations in the analysis of catch-at-age observations, *Journal du Conseil Internationl pour l'Exploration de la Mer* **43**: 83–90.

Hall, A.J., Watkins, J. and Hammond P.S. (1998). Seasonal variation in the diet of harbour seals in the south-western North Sea: prey availability and predator preferences. *Marine Ecology Progress Series*, **170**, 269-281.

Hamer, K.C., Monaghan, P., Uttley, J.D., Walton, P., Burns, M.D. (1993). The influence of food supply on the breeding ecology of kittiwakes Rissa tridactyla in Shetland. Ibis, 135, 255-263.

Hammond, P.S., Hall, A.J. and Prime, J.H. (1994). The diet of grey seals around Orkney and other island and mainland sites in north eastern Scotland. *Journal of Applied Ecology*, **31**, 340 350.

Hamon, K. and Ulrich, C. (2006). Effect of changes in stock delimitation for the plaice IIIa. [WD14]

Hoarau G, Piquet AM-T, van der Veer HW, Rijnsdorp AD, Stam WT, Olsen JL (2004). Population structure of plaice (Pleuronectes platessa L.) in northern Europe: a comparison of resolving power between microsatellites and mitochondrial DNA data. Journal of Sea Research 51:183-190

Holmes, S. J. (2006). Simulation based evaluation of the cod recovery plan with respect to the North Sea and Skagerrak. [WD18]

Horwood, J., O'Brien, C. M. and Darby, C. D. (2006) North Sea cod recovery? *ICES Journal of Marine Science*, 63: 961-968. [BD1]

Hutchinson, W. F., G. R. Carvalho and S. I. Rogers (2001). Marked genetic structuring in localised spawning populations of cod *Gadus morhua* in the North Sea and adjoining waters, as revealed by microsatellites. Marine Ecology Progress Series, 223, 251-260

ICES (1979). Report of an ad hoc working group on the Norway pout box problem. ICES C.M. 1979/G:2.

ICES (2002) CM 2002/ACFM:01, ICES Co-op. Res. Rep 2001/246 (cod section).

ICES, 1979. Report of the Flatfish Working Group. ICES CM 1979/G:10

ICES. 2006. Report of the Working Group on Beam Trawl Surveys (WGBEAM). ICES CM 2006/LRC:11.

ICES-ACE (2003) Report of the Advisory Committee on Ecosystems, June 2003, Section 11.

ICES-ACFM (2001) Report of the Advisory Committee on Fisheries Management, October 2001.

ICES-ACFM (2005). Report of the ICES Advisory Committee on Fishery Management, Advisory Committee on the Marine Environment and Advisory Commit tee on Ecosystems, 2005. ICES ADVICE 2005 AVIS DU CIEM Volumes IV.

ICES-ACFM (2006). ICES ACFM Advice May 2006. Norway pout in the North Sea. International Council for Exploration of the Sea (ICES), Copenhagen, Denmark. Available from http://www.ices.dk/committe/acfm/comwork/report/asp/advice.asp

ICES-AFWG (1992). Report of the Arctic Fisheries Working Group. ICES CM 1992/ACFM:XXXX.

ICES-AFWG (2006) Report of the Arctic Fisheries Working Group. ICES CM 2006/ACFM:25.

ICES-AMAWGC (2006). Report of the Annual Meeting of Assessment Working Group Chairs. ICES CM 2006/ACFM:17. [BD5]

ICES-FWG (1979). Report of the Flatfish Working Group. ICES CM 1979/G:10.

ICES-IROC (2006). ICES Report on Ocean Climate 2005. *ICES Cooperative Research Report No. 280*. 53 pp. [BD4]

ICES-MAWG (1989). Report of the ICES Multispecies Assessment Working Group. ICES CM 1989/XXXX.

ICES-MAWG (1991). Report of the ICES Multispecies Assessment Working Group. ICES CM 1991/XXXX.

ICES-MAWG (1992). Report of the ICES Multispecies Assessment Working Group. ICES 1992/XXXX.

ICES-NPS (1977). Review of the Norway pout and sandeel within the NEAFC convention area. Appendix to ICES report C.M. 1977/F:7.

ICES-NSRWG (1971) Report by the North Sea Roundfish Working Group on North Sea Cod. ICES/Demersal Fish Comm F:5:1-35.

ICES-NWWG (2004). Report of the North Western WG. ICES CM 2004/ACFM:25.

ICES-PGCCDBS (2006). Report of the Planning Group on Commercial Catch, Discards and Biological Sampling. ICES CM 2006/ACFM:18. [BD8]

ICES-SGAMHBW (2004). Report of the Study Group on Assessment Methods Applicable to Assessment of Norwegian Spring-Spawning Herring and Blue Whiting Stocks (SGAMHBW), 19-22 February 2004, Lisbon: ICES CM 2004/ACFM:14.

ICES-SGDFF (2003). Report of the study group on the development of fishery-based forecasts, ICES CM 2003/ACFM:08

ICES-SGDFF (2004). Report of the study group on the development of fishery-based forecasts, ICES CM 2004/ACFM:11

ICES-SGGROMAT (2002) Report of the Study Group on Growth, Maturity and Condition in Stock Projections. ICES CM 2003/D:01.

ICES-SGGROMAT (2004) Report of the Study Group on Growth, Maturity and Condition in Stock Projections. ICES CM 2005/D:XXXX.

ICES-SGGSS (1998). Report of the Study Group on Grid (Grate) Sorting Systems in Trawls, Beam Trawls and Seine Nets. ICES CM 1998/B:2.

ICES-SGLHN (1998). Report of the Study Group on Life Histories of *Nephrops*. ICES, Doc. Living Resources Comm., CM 1998/G:9 (mimeo).

ICES-SGMAS (2005). Report of the Study Group on Management Strategies. ICES CM 2005/ACFM:09.

ICES-SGMAS (2006). Report of the Study Group on Management Strategies. ICES CM 2006/ACFM:15. [BD19]

ICES-SGMSNS (2005). Report of the Study Group on Multispecies Assessments in the North Sea (SGMSNS). ICES CM 2005/D:06.

ICES-SGRAMA (2006). Report of the Study Group on Risk Assessment and Management Advice. ICES CM 2006/RMC:04. [BD6]

ICES-SGRECVAP (2006). Report of the Study Group on Recruitment Variability in North Sea Planktivorous Fish. ICES CM 2006/LRC:03. [BD14]

ICES-SGSIMUW (2005). Report of the ICES Study Group on Stock Identity and Management Units of Whiting. ICES CM 2005/G:03.

ICES-WGBEAM (2006). Report of the Working Group on Beam Trawl Surveys (WGBEAM). ICES CM 2006/LRC:11.

ICES-WGBFAS (2005). Report of the Baltic Fisheries Assessment Working Group. ICES CM 2005/ACFM:19.

ICES-WGECO (2006). Report of the Working Group on Ecosystem Effects of Fishing Activities. ICES CM 2006/ACE:05.

ICES-WGEEFA (2003). Report of the Working Group on the Ecosystem Effects of Fishing Activities. ICES C.M. 2003/ACE:05, Ref. D,E,G.pp.193.

ICES-WGFTFB (2006). Report of the Working Group on Fish Technology and Fish Behaviour. ICES CM 2006/FTC:06. [BD9]

ICES-WGHMM (2006). Report of the ICES Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim. ICES CM 2006/ACFM:29.

ICES-WGMG (2004). Report of the ICES Working Group on Methods of Fish Stock Assessment. Lisbon. ICES CM 2004/D:03.

ICES-WGMG (2006). Report of the Working Group on Methods of Fish Stock Assessment. ICES CM 2006/RMC:07. [BD18]

ICES-WGMHMSA (2005). Report of the WG on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2005/ACFM:08.

ICES-WGNEPH (1997). Report of the Working Group on *Nephrops* Stocks. ICES CM 1997/XXXX.

ICES-WGNEPH (2003). Report of the Working Group on *Nephrops* Stocks. ICES CM 2003/XXXX.

ICES-WGNEPH (1999). Report of the WG on *Nephrops* Stocks. ICES, Doc. CM 1999/Assess:16 (mimeo).

ICES-WGNSDS (2006). Report of the Working Group on the Assessment of Northern Shelf Demersal Stocks. ICES CM 2006/ACFM:30.

ICES-WGNSSK (1998). Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak. ICES CM 1999/ACFM:3.

ICES-WGNSSK (2000). Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, October 2000. ICES CM 2001/ACFM:7.

ICES-WGNSSK (2001). Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak. ICES CM 2002/ACFM:01.

ICES-WGNSSK (2002). Report of the Working Group on the Assessment of the Demersal Stocks in the North Sea and Skagerrak.. ICES CM 2003/ACFM:2.

ICES-WGNSSK (2003). Report of the Working Group on the Assessment of the Demersal Stocks in the North Sea and Skagerrak.. ICES CM 2004/ACFM:07.

ICES-WGNSSK (2004). Report of the Working Group on the Assessment of the Demersal Stocks in the North Sea and Skagerrak. ICES CM 2005/ACFM:07

ICES-WGNSSK (2005). Report of the Working Group on the Assessment of the Demersal Stocks in the North Sea and Skagerrak. ICES CM 2006/ACFM:09

ICES-WGRED (2006). Report of the Working Group on Regional Ecosystem Descriptions. ICES CM 2006/ACE:06. [BD2]

ICES-WKDRCS (2006). Report of the Workshop on the Decline and Recovery of Cod Stocks throughout the North Atlantic, including trophodynamic effects. ICES CM 2006/OCC:12. [BD17]

ICES-WKMIXMAN (2006). Report of the Workshop on Simple Mixed Fisheries Management Models. ICES CM 2006/ACFM:14. [BD7]

ICES-WKNEPH (2006). Report of the Workshop on *Nephrops* stocks. ICES CM 2006/ACFM:12. [BD13]

Jensen and Nielsen (2005). Reference missing.

Jensen H. and Rolev A.M. (2004). The Sandeel fishing grounds in the North Sea. Information about the foraging areas of the lesser sandeel Ammodytes marinus in the North Sea. Working document prepared for the BECAUSE project, November 2004.

Jensen H.; Rindorf A.; Horsten M.B.; Mosegaard H.; Brogaard P.; Lewy P.; Wright P.J.; Kennedy F.M.; Gibb I.M.; Ruxton G.; Arnott S.A. and Leth J.O. (2001). Modelling the population dynamics of sandeel (Ammodytes marinus) populations in the North Sea on a spatial resolved level. DG XIV no. 98/025.

Jensen, H. (2001). Settlement dynamics in the lesser sandeel Ammodytes marinus in the North Sea. A thesis submitted for the degree of Doctor of Philosophy at the University of Aberdeen.

Jensen, H., Wright, P. J., and Munk, P. (2003). Vertical distribution of pre-settled sandeel (Ammodytes marinus) in the North Sea in relation to size and environmental variables. ICES Journal of Marine Science, 60: 1342-1351.

Johansen, A.C (1908). Contributions to the biology of the plaice with special regards of the danish plaice-fishery. Meddelelser fra kommissionen for havundersøgelser. Serie: Fiskeri, bind III, 4 48pp.

Johnson, S. J. and Quinn II, T. J. (1987). Length frequency analysis of sablefish in the Gulf of Alaska, Technical Report UAJ-SFS-8714, University of Alaska, School of Fisheries and Science, Juneau, Alaska. Contract report to Auke Bay National Laboratory.

Kraak, S. B. M. and Daan, N. (2006). The performance of XSA when exploitation varies between sub-areas. [WD3]

Kraak, S. B. M., Bolle, L. J. and Rijnsdorp, A. D. (2005). The determination of biomass reference points for North Sea plaice: The influence of assumptions about discards, weight, maturity and stock-recruitment relationships. ICES CM 2005/V:18. [WD2]

Kraak, S. M. B., M. A. Pastoors and A. D. Rijnsdorp. (2002). Effecten van discarding en high-grading op de toestandsbeoordeling van schol: een quick-scan. CVO report 02.019. IJmuiden: 13p. [In Dutch].

Kraak, S.B.M., F. C. Buisman, M. Dickey-Collas, J. J. Poos, M. A. Pastoors, J. G. P. Smit, N. Daan and L. T. Kell. (2004). A simulation study of the effect of management choices on the sustainability and economic performance of a mixed fishery. ICES C.M. 2004 / FF:11.

Krebs JR and Davies NB (1993) An Introduction to Behavioural Ecology. Blackwell Scientific Publications, Oxford.

Kvalsvik, K., Huse, I., Misund, O.A., and Gamst, K. (2006). Grid selection in the North Sea industrial trawl fishery for Norway pout: Efficient size selection reduces by-catch. Fish. Res. 77: 248-263.

Larsen, L.I., Lassen, H., Nielsen, J.R., and Sparholt, H. (2001). Spatial distribution and maturity of Norway pout in the North Sea. Working Document to the 2000 meeting of the WGNSSK, 19 pp. ICES C.M.2001/ACFM:07.

Laurenson, C. (2006). North Sea Stock Survey 2006. [WD17]

Lewy, P. and M. Vinther (2004). A stochastic age-length-structured multispecies model applied to North Sea stocks. ICES CM 2004/FF:20.

Loo, L.O., Baden, S.P. & Ulmstrand, M., (1993). Suspension feeding in adult Nephrops norvegicus (L.) and Homarus gammarus (L.), (Decapoda). Netherlands Journal of Sea Research, 31, 291-297.

Macer C.T. (1966). Sand eels (Ammodytidae) in the south -western North Sea; their biology and fishery. Fish. Invest., Lond. Ser. 2, 24(6): 1-55.

Machiels, M. A. M., Kraak, S. B. M. and van Beek, F. A. (2006). Evaluation of a management plan as proposed by the European Commission in 2006 for fisheries exploiting stocks of plaice and sole in the North Sea. [WD6]

Marchal et al (2003). Reference missing.

Marrs, S.J., Atkinson, R.J.A., Smith, C.J. and Hills, J.M. (1996). *Calibration of the towed underwater TV technique for use in stock assessment of Nephrops* norvegicus. Report to the EC for Study Project in support of the CFP, 94/069. 155pp.

Maxwell, D. L. and Mitchell, R. P. (2006). North Sea Haddock maturity from the 3rd quarter UK (England and Wales) Groundfish Survey - can DCR estimates help the working group? [WD9]

Mollet, F.M., Kraak, B.M. and Rijnsdorp A.D. 2006. Fisheries-induced evolutionary changes in maturation reaction norms in North Sea sole (Solea Solea) ICES CM 2006/H:14

Monaghan, P. (1992) Seabirds and sandeels: the conflict between exploitation and conservation in the northern North Sea. Biodiversity and Conservation, 1, 98-111.

Morrison, M and Cryer, M. (1999) Stock assessment of cockles on Snake and McDonald Banks, Whangarei Harbour, 1998. New Zealand Fisheries Research Document 99/7.

Morrison, M and Cryer, M. (1999) Stock assessment of cockles on Snake and McDonald Banks, Whangarei Harbour, 1998. New Zealand Fisheries Research Document 99/7.

Needle, C. L. (2006a) Evaluating harvest control rules for North Sea haddock using FLR. Working Paper for the ICES Working Group on Methods of Stock Assessment, Galway, Ireland, 21-26 June 2006.

Needle, C. L. (2006b) Further evaluations of harvest control rules for North Sea haddock using FLR. Discussion document for FRS and SEERAD. FRS Marine Laboratory, Aberdeen.

Nielsen et al. (2003). Reference missing.

Nielsen, E. and Boje, J. (2006). Maturity at age for plaice in Skagerrak and Kattegat (IIIa). [WD15]

Nielsen, E., Boje, J., Ulrich-Rescan, C. and Støttrup, J. (2006). A brief summary of plaice biology and stock relations in the Kattegat-Skagerrak area. [WD 21]

Nielsen, J. R. and Madsen, N. (2006). Gear technological approaches to reduce un-wanted by-catch in commercial Norway pout fishery in the North Sea. [WD 23]

Olsen E and Holst JC (2001) A note on common minke whale (Balaenoptera acutorostrata) diets in the Norwegian Sea and the North Sea. *J. Cetacean Res. Manage*. 3(2):179–183.

Patterson, K. R. and Melvin, G. D. (1996). Integrated Catch-at-age Analysis Version 1.2. *Scottish Fisheries Research Report* **56.**

Perry, A., P. Low, J. Ellis and J. Reynolds (2005). Climate Change and Distribution Shifts in Marine Fishes, Science May 13 2005.

Pierce, G.J., Thompsom, P.M., Miller, A., Diack, J.S.W., Miller, D. and Boyle, P.R. (1991) Seasonal variation in the diet of common seals (Phoca vitulina) in the Moray Firth area of Scotland. Journal of Zoology, 223, 641 646.

Pihl, L., Modin, J. and Wennhage, H. (2005). Relating plaice (Pleuronectes platessa) recruitment to deteriorating quality habitat: effects of macroalgal blooms in coastal nursery grounds. Canadian Journal of Fisheries and Aquatic Science, 62: 1184-1193.

Pope, J. G. (1980). Some consequences for fisheries management of aspects of the behaviour of pelagic fish. Rapp. P.-v. Reun. Cons. Explor. Mer 177, 466-476.

Pope, J. G. and Shepherd, J. G. (1982). A simple method for the consistent interpretation of catch-at-age data, *Journal du Conseil International pour l'Exploration de la Mer* **40**: 176–184.

Poulsen, E. M. (1939). On the Migration and racial character of the plaice. Danish Biol. Sta. XLIII, 78 pp

Prager, M. H. 1994. A suite of extensions to a nonequilibrium surplus-production model. Fishery Bulletin 92: 374–389.

Prager, M. H., C. P. Goodyear, and G. P. Scott. 1996. Application of a surplus production model to a swordfish-like simulated stock with time-changing gear selectivity. Transactions of the American Fisheries Society 125: 729–740.

Prime, J.H. and Hammond, P.S. (1987) Quantitative assessment of grey seal diet from faecal analysis. *Approaches to Marine Mammal Energetics.* (eds A.C. Huntley, D.P. Costa, G.A.J. Worthy, and M.A Castellini) (Society of Marine Mammalogy Special Publication, 1.) Allen Press, Lawrence, Kansas, pp. 161 181.

Prime, J.H. and Hammond, P.S. (1990). The diet of grey seals from the south-western North Sea assessed from analyses of hard parts found in faeces. *Journal of Applied Ecology*, **27**, 435-447.

Quinn II, T. J. and Deriso, R. B. (1999). *Quantitative Fish Dynamics*, Oxford University Press, Oxford.

Quirijns, F. (2006). Catch and Effort data of plaice and sole in the North Sea: bringing different data sources together. [WD4]

R Development Core Team (2005). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org.

Rätz, H.-J. and Kafemann, R. (2006). German otter trawl board fleet as tuning series for the assessment of saithe in IV, VI and IIIa, 1995–2005. [WD1]

Reay P.J. (1970). Synopsis of biological data on North Atlantic sandeels of the genus Ammodytes. FAO Fisheries Synopsis, No. 82.

Redant, F. (1994). Sexual maturity of female Norway lobster, Nephrops norvegicus, in the central North Sea. ICES CM 1994/K:43.

Rijnsdorp, A. D. and M. A. Pastoors (1995). Modelling the spatial dynamics and fisheries of North Sea plaice (Pleuronectes platessa L.) based on tagging data. ICES Journal of Marine Science 52: 963-980.

Rijnsdorp, A. D., Daan, N, and Dekker, W. (2006). Partial fishing mortality per fishing trip: a useful indicator of effective fishing effort in mixed demersal fisheries. ICES Journal of Marine Science 63: 556-566.

Rijnsdorp, A. D., Daan, N. and Dekker, W. (in press) Partial fishing mortality per fishing trip: a useful indicator of effective fishing effort in mixed demersal fisheries. *ICES Journal of Marine Science*. [BD2]

Rijnsdorp, A.D., O.A. Van Keeken and L.J. Bolle. (2004). Changes in the productivity of the southeastern North Sea as reflected in the growth of plaice and sole. ICES C.M. 2004/K:13.

Rindorf, A., Wanless, S. and Harris, M.P. (2000). Effects of changes in sandeel availability on the reproductive output of seabirds. Marine Ecology Progress Series, 202, 241-252

Shand, C.W. and Priestly, R. (1999). A towed sledge for benthic surveys. Scottish Fisheries Information Pamphlet, No. 22.

Shepherd, J. G. (1997). Prediction of year-class strength by calibration regression analysis of multiple recruit index series. *ICES Journal of Marine Science*, **54**, 741–752.

Simonsen, V. Nielsen, E., Bagge, O. (1988). Discrimination of stocks of plaice in the Kattegat by electrophoresis and meristics characters. ICES CM 1988/G29.

Skagen, D. (1993). A seasonal extended survivors analysis (SXSA) with optional estimation of unknown catches at age. Report of the Working Group on the Assessment of Norway Pout and Sandeel. ICES CM 1994/Assess:7, Appendix I.

Sparholt, H., Larsen, L.I., Nielsen, J.R. (2002a). Verification of multispiesces interactions in the North Sea by trawl survey data on Norway Pout (*Trisopterus esmarkii*). ICES Journal of Marine Science 59:1270-1275.

Sparholt, H., Larsen, L.I., Nielsen, J.R. (2002b). Non-predation natural mortality of Norway pout (*Trisopterus esmarkii*) in the North Sea. ICES Journal of Marine Science 59:1276-1284.

STECF (2002). Report of the Subgroup on Resource Status (SGRST) of the Scientific, Technical and Economic Committee for Fisheries (STECF). Mixed Fisheries. Brussels, 22-26 October 2002. (at : http://europa.eu.int/comm/fisheries/doc_et_publ/factsheets/...legal_texts/docscom/en/sec_2002_1373_en.pdf)

STECF (2003). Report of the Ad Hoc Working Group on Mixed Fisheries, Brussels, 21-24 October, 2003. (at: http://europa.eu.int/comm/fisheries/doc_et_publ/factsheets/...legal_texts/docscom/en/sec_2003_1428_en.pdf).

STECF (2004). Report of the Scientific, Technical and Economic Committee For Fisheries. Evaluation of the report of the Ad Hoc Working Group on Sandeel Fisheries “Estimate of the Abundance of the 2003 Year-class of North Sea Sandeel”.

STECF (2005). Report of the Scientific, Technical and Economic Committee for Fisheries. Review of Scientific Advice for 2005. 19th STECF Brussels, 1-5 November 2004. STECF-SGRST Brussels, 25-29 October 2004. STECF (2005) 266. http://ec.europa.eu/fisheries/publications/factsheets/legal_texts/sec_2005_266_en.pdf

STECF (2005a). Report of the ad-hoc Working Group on sandeel fisheries. Feb 8-10, 2005, Charlottenlund, Denmark. 40 pp.

STECF (2005a). Report of the Scientific, Technical and Economic Committee For Fisheries. Evaluation of the report of the Ad Hoc Working Group on Sandeel Fisheries "Estimate of the Abundance of the 2004 Year-class of North Sea Sandeel".

STECF (2005b). Report of the ad-hoc Working Group on Sandeel fisheries (ADHOC-05-03) of STECF, Charlottenlund, 7-9 November 2005. 69pp

STECF (2006). Report of the Scientific, Technical and Economic Committee For Fisheries. Evaluation of the report of the Ad Hoc Working Group on Sandeel Fisheries "Estimate of the Abundance of the 2005 Year-class of North Sea Sandeel". [BD16]

STECF-SGRST (2005). Evaluation of the cod recovery plan. JRC, Ispra, June 2005.

Storr-Paulsen, M. and Hamon, K. (2006). Weight-at-age relation between survey and landings for plaice in IIIa+22 1991-2005. [WD13]

Thompson, P.M., Tollit, D.J., Greenstreet, S.P.R., Mackay, A. and Corpe, H.M. (1996). Between-year variations in the diet and behaviour of harbour seals Phoca vitulina in the Moray Firth: causes and consequences. pp 44-52 in Aquatic Predators and their Prey (eds. S.P.R. Greenstreet and M.L. Tasker). Fishing News Books, Blackwell Science, Oxford.

Tollit, D.J. and Thompson, P.M. (1996) Seasonal and between year variations in the diet of harbour seals in the Moray Firth, Scotland. Canadian Journal of Zoology, 74, 1110-1121.

Tollit, D.J., Greenstreet, S.P.R. and Thompson, P.M. (1997). Prey selection by harbour seals Phoca vitulina in relation to variations in prey abundance. Canadian Journal of Zoology, 75, 1508-1518.

Tuck, I.D., Chapman, C.J., Atkinson, R.J.A., Bailey, N. and Smith, R.S.M. (1997). A comparison of methods for stock assessment of the Norway lobster, *Nephrops norvegicus*, in the Firth of Clyde. *Fish. Res*., 32:89-100.

Turrell, W. R and C. Bannister (2003). Ocean climate in relation to North Sea cod. Working paper to WGNSSK, September 2003.

Ulltang, Ø. (1980). Factors affecting the reaction of pelagic fish stocks to exploitation and requiring a new approach Rapp. P.-v. Reun. Cons. Explor. Mer 177, 489-504.

Ulrich, C. and Hamon, K. (2006). Effects of changes in commercial tuning fleets for the plaice IIIa. [WD10]

Ulrich, C. and Hamon, K. (2006). Effect of changes in stock delimitation for the plaice IIIa. [WD14]

Ulrich, C., and Andersen, B. S. (2004). Dynamics of fisheries, and the flexibility of vessel activity in Denmark between 1989 and 2001. Ices Journal of Marine Science, 61: 308-322.

Ulrich, C., Andersen, B.S., Hovgård, H., Sparre, P., Murta, A., Garcia, D., and Castro, J., (2006). Fleet-based short-term advice in mixed-fisheries, the Fcube approach. Presentation at the ICES symposium on management strategies, 27th-30th June 2006, Galway, Ireland. http://www.ices06sfms.com/presentations/index.shtml

Ulrich-Rescan, C. and Nielsen, E. (2005) Should western Baltic plaice be included in plaice IIIa assessment? Working Paper to the 2005 meeting of the ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak. [BD3]

Van Beek, F. A. (1998). Discarding in the Dutch beam trawl fishery. ICES CM 1998/BB:5.

van Damme, C., Bolle, L., Dickey-Collas, M., Mimpen, R., Fox, C., Munk, P., Fossum, P. and Kraus, G. (2006). Annual egg production estimates of North Sea plaice. [WD5]

Van Keeken, O. A., M. Dickey-Collas, S. M. B. Kraak and M. A. Pastoors (2003). The use of simulations of discarding to investigate the potential impact of bias, due to growth, on the stock assessment of North Sea plaice (Pleuronectes platessa). ICES C.M. 2003/X:17.

Van Keeken, O.A., M. Van Hoppe, R.E. Grift and A.D. Rijnsdorp (2004). The effect of changes in the spatial distribution of juvenile plaice (Pleuronectes platessa) in the North Sea on the management of its stocks. ICES C.M. 2004/K:25.

Verver, S., I.J. De Boois, J.J. Poos and A.D. Rijnsdorp (2001). Onderzoek naar de veranderingen van de noordgrens in de verspreiding van tong in de Noordzee. RIVO rapport C044/01. IJmuiden. [In Dutch].

Verver, S., I.J. De Boois, J.J. Poos and A.D. Rijnsdorp 2001. Onderzoek naar de veranderingen van de noordgrens in de verspreiding van tong in de Noordzee. RIVO rapport C044/01. IJmuiden

Vigneau, J. (2006). Preliminary analysis of Plaice VIId stock. [WD19]

Vinther, M. and Reeves, S. A. and Patterson, K. R. (2004) From single-species advice to mixed-species management: taking the next step, ICES Journal of Marine Science, 61, 1398-1409.

Vorberg, R., Bolle, L, Jager, Z, and Neudecker, T. (2005). Chapter 8.6. Fish. In: Wadden Sea Quality Status Report 2004 (K. Essink et al. Eds.), Wadden Sea Ecosystem No. 19, 2005, pp. 219-236.

Winslade P. (1971). Behavioural and embryological studies on the lesser sandeel Ammodytes marinus (Raitt). PhD Thesis. University East Anglia.

WR Gilks, S Richardson, D Spiegelhalter (1996). *Markov Chain Monte Carlo In Practice*. Chapman and Hall.

Wright P., Verspoor E., Andersen C., Donald L., Kennedy F., Mitchell A., Munk P., Pedersen S.A., Jensen H., Gislason H. and Lewy P. (1998). Population structure in the lesser sandeel (Ammodytes marinus) and its implications for fishery-predator interactions. DG XIV no. 94/071.

Wright P.J., Jensen H., Mosegaard H., Dalskov J. and Wanless S. (2002). European Commission's annual report on the impact of the Northeast sandeel fishery closure and status report on the monitoring fishery in 2000 and 2001.

Wright, P.J. and Begg, G.S. (1997) A spatial comparison of common guillemots and sandeels in Scottish waters. ICES Journal of Marine Science, 54, 578-592.

Zachariassen, K. and Jákupsstovu, S.H., (1997). Experiments with grid sorting in an industrial fishery at the Faeroes. Working Paper. FTFB Working Group, ICES. Available from the Fisheries Laboratory of the Faroes, Thorshavn, April 1997.

Zuur, A.F., Fryer, R.J., and Newton, A.W. (2001). The comparative fishing trial between *Scotia II* and *Scotia III*. Fisheries Research Services (FRS) Marine Laboratory Rep. No. 03/01.

Annex 1: List of participants

Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak
ICES, Headquarters, 5–14 September 2006

NAME	ADDRESS	TELEPHONE	FAX	EMAIL
Nick Bailey	Fisheries Research Services Marine Laboratory P.O. Box 101 375 Victoria Road Aberdeen AB11 9DB United Kingdom	+44 1224 295398	+44 1224 295511	baileyn@marlab.ac.uk
Ewen Bell	Cefas Lowestoft Laboratory Lowestoft Suffolk NR33 0HT United Kingdom	+44 1 502 524 238	+44 1 502 562 244	ewen.bell@cefas.co.uk
Jesper Boje	Danish Institute for Fishery Research (DIFRES) Charlottenlund Slot DK-2920 Charlottenlund Denmark	+45 339 63300	+45 339 63333	jbo@difres.dk
Neil Campbell	Fisheries Research Services Marine Laboratory P.O. Box 101 375 Victoria Road Aberdeen AB11 9DB United Kingdom	+44 1224 295693	+44 1224 295511	campbelln@marlab.ac.uk
Max Cardinale	National Board of Fisheries Institute of Marine Research Box 4 SE-453 21 Lysekil Sweden	+46 523 18750	+46 523 13977	massimiliano.cardinale@fiskeriverket.se
Uli Damm	Bundesforschungsanstalt f. Fischerei Institut für Seefischerei Palmaille 9 D-22767 Hamburg Germany	+49 40 38905 268	+49 40 38905 263	ulrich.damm@ish.bfa-fisch.de
Chris Darby	Cefas Lowestoft Laboratory Lowestoft Suffolk NR33 0HT United Kingdom	+44 1502 524329	+44 1502 513865	chris.darby@cefas.co.uk
José de Oliveira	Cefas Lowestoft Laboratory Lowestoft Suffolk NR33 0HT United Kingdom	+44 1502 527727	+44 1502 524 511	jose.deoliveira@cefas.co.uk

NAME	ADDRESS	TELEPHONE	FAX	EMAIL
Jon Elson	Cefas Lowestoft Laboratory Lowestoft Suffolk NR33 0HT United Kingdom	+44 1 502 524 243	+44 1 502 562 244	jon.elson@cefas.co.uk
Katell Hamon	Danish Institute for Fishery Research (DIFRES) Charlottenlund Slot DK-2920 Charlottenlund Denmark			kat@difres.dk
Andrzej Jaworski	Fisheries Research Services Marine Laboratory P.O. Box 101 375 Victoria Road Aberdeen AB11 9DB United Kingdom			jaworskia@marlab.ac.uk
Henrik Jensen	Danish Institute for Fishery Research (DIFRES) Charlottenlund Slot DK-2920 Charlottenlund Denmark	+45 33963370	+45 33963333	hj@difres.dk
Tore Johannessen	Institute of Marine Research Flødevigen Marine Research Station N-4817 His Norway	+47 37 05 90 21	+47 37 05 90 01	torejo@imr.no
Espen Johnsen	Institute of Marine Research P.O. Box 1870 Nordnes N-5817 Bergen Norway	+47 55 23 53 55	+47 55 23 86 87	espen.johnsen@imr.no
Rudolf Kafemann	Bundesforschungsanstalt f. Fischerei Institut für Seefischerei Palmaille 9 D-22767 Hamburg Germany	+49 40 389 05166	+49 40 389 05263	rudolf.kafemann@ish.bfa-fisch.de
Sarah Kraak	IMARES Institute for Marine Research and Ecosystem Studies Haringkade 1 P.O. Box 68 NL-1970 AB IJmuiden Netherlands	+31 255 564783	+31 255 564644	sarah.kraak@wur.nl

NAME	ADDRESS	TELEPHONE	FAX	EMAIL
Marcel Machiels	IMARES Institute for Marine Research and Ecosystem Studies Haringkade 1 P.O. Box 68 NL-1970 AB IJmuiden Netherlands	+31 255 564708		Marcel.Machiels@wur.nl
Colin Millar	Fisheries Research Services Marine Laboratory P.O. Box 101 375 Victoria Road Aberdeen AB11 9DB United Kingdom	+44 1224 295575	+44 1224 295511	millarc@marlab.ac.uk
Coby Needle (chair)	Fisheries Research Services Marine Laboratory P.O. Box 101 375 Victoria Road Aberdeen AB11 9DB United Kingdom	+44 1224 295456	+44 1224 295511	c.needle@marlab.ac.uk
Rasmus Nielsen	Danish Institute for Fishery Research (DIFRES) Charlottenlund Slot DK-2920 Charlottenlund Denmark	+45 33 963381	+45 33 963333	rn@difres.dk
Sten Munch-Petersen	Danish Institute for Fishery Research (DIFRES) Charlottenlund Slot DK-2920 Charlottenlund Denmark	+ 45 33063390	+ 45 33963333	smp@difres.dk
Jan-Jaap Poos	IMARES Institute for Marine Research and Ecosystem Studies Haringkade 1 P.O. Box 68 NL-1970 AB IJmuiden Netherlands	+31 255 564 694	+31 255 564 644	Janjaap.Poos@wur.nl
Stuart Reeves	Cefas Lowestoft Laboratory Lowestoft Suffolk NR33 0HT United Kingdom	+44 (0)1502 524510	+44 (0)1502 513865	stuart.reeves@cefas.co.uk
Are Salthaug	Institute of Marine Research P.O. Box 1870 Nordnes N-5817 Bergen Norway	+47 55 23 86 73	+47 55 23 53 93	are.salthaug@imr.no

NAME	ADDRESS	TELEPHONE	FAX	EMAIL
Odd Smedstad	Institute of Marine Research P.O. Box 1870 Nordnes N-5817 Bergen Norway	+47 55 238500	+47 55 23 86 87	odd.smedstad@imr.no
Marie Storr-Paulsen	Danish Institute for Fishery Research (DIFRES) Charlottenlund Slot DK-2920 Charlottenlund Denmark			mso@difres.dk
Clara Ulrich-Rescan	Danish Institute for Fishery Research (DIFRES) Charlottenlund Slot DK-2920 Charlottenlund Denmark	+45 3396 3395	+45 3396 3333	clu@dfu.min.dk
Mats Ulmestrand	National Board of Fisheries Institute of Marine Research Box 4 SE-453 21 Lysekil Sweden	+46 52318700	+46 52313977	mats.ulmestrand@fiskeriverket.se
Willy Vanhee	ILVO Sea Fisheries Ankerstraat 1 B-8400 Oostende Belgium	+32 59 56 98 29	+3259330629	willy.vanhee@dvz.be
Morten Vinther	Danish Institute for Fishery Research (DIFRES) Charlottenlund Slot DK-2920 Charlottenlund Denmark	+45 33 96 33 53	+45 33 96 33 33	mv@difres.dk

Annex 2: Quality handbook: Stock Annexes

1 *Nephrops* in Functional Unit 3 (Skagerrak)

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 11/12/2005: Coby Needle (needlec@marlab.ac.uk)

16/11/2006: Coby Needle (needlec@marlab.ac.uk)

1.1 General

1.1.1 Stock definition

1.1.2 Fishery

1.1.3 Ecosystem aspects

1.2 Data

1.2.1 Commercial catch

1.2.2 Biological

Natural mortality

Maturity

Weight at age

Proportion mortality before spawning

1.2.3 Surveys

1.2.4 Commercial CPUE

1.2.5 Other relevant data

1.3 Historical Stock Development

1.3.1 Deterministic modelling

1.3.2 Uncertainty analysis

1.3.3 Retrospective analysis

1.4 Short-term projection

1.5 Medium-term projections

1.6 Long-term projections, yield per recruit

1.7 Biological reference points

1.8 Other issues

1.9 References

2 *Nephrops* in Functional Unit 4 (Kattegat)

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 11/12/2005: Coby Needle (needlec@marlab.ac.uk)

16/11/2006: Coby Needle (needlec@marlab.ac.uk)

2.1 General

2.1.1 Stock definition

2.1.2 Fishery

2.1.3 Ecosystem aspects

2.2 Data

2.2.1 Commercial catch

2.2.2 Biological

Natural mortality

Maturity

Weight at age

Proportion mortality before spawning

Surveys

2.2.3 Commercial CPUE

2.2.4 Other relevant data

2.3 Historical Stock Development

2.3.1 Deterministic modelling

2.3.2 Uncertainty analysis

2.3.3 Retrospective analysis

2.4 Short-term projection

2.5 Medium-term projections

2.6 Long-term projections, yield per recruit

2.7 Biological reference points

2.8 Other issues

2.9 References

3 Quality handbook: *Nephrops* in Functional Unit 5 (Botney Gut)

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 11/12/2005: Coby Needle (needlec@marlab.ac.uk)

16/11/2006: Coby Needle (needlec@marlab.ac.uk)

3.1 General

3.1.1 Stock definition

3.1.2 Fishery

3.1.3 Ecosystem aspects

3.2 Data

3.2.1 Commercial catch

3.2.2 Biological

Natural mortality

Maturity

Weight at age

Proportion mortality before spawning

3.2.3 Surveys

3.2.4 Commercial CPUE

3.2.5 Other relevant data

3.3 Historical Stock Development

3.3.1 Deterministic modelling

3.3.2 Uncertainty analysis

3.3.3 Retrospective analysis

3.4 Short-term projection

3.5 Medium-term projections

3.6 Long-term projections, yield per recruit

3.7 Biological reference points

3.8 Other issues

3.9 References

4 *Nephrops* in Functional Unit 6 (Farn Deeps)

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 15/09/2005: Ian Tuck (tucki@marlab.ac.uk)

11/12/2005: Coby Needle (needlec@marlab.ac.uk)

16/11/2006: Coby Needle (needlec@marlab.ac.uk)

4.1 General

4.1.1 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 Farn Deeps area the Nephrops stock inhabits a large continuous area of muddy sediment extending North from 54° 45’ - 54° 35’N and 0° 40’ - 1° 30’N with smaller patches to the east and west.

4.1.2 The fishery

Restrictions on fishing for other stocks through quota and closed areas increased the number of vessels visiting this fishery and landing into England from around 90 in 2000 to about 200 in 2003. In 2004 the number was just around 130. The increase was apparent not only in the number of the local fleet turning to Nephrops but in the increase in the number of visiting Scots and Northern Irish vessels that consistently made up about 30 to 40% of the fleet and 20 to 30% of the landings in a season. Since 2000 there has been an increase in the effort of vessels using multi rig trawls although they only account for about 10% of the landings. Reported landings also suggest these vessels have switched from 100 mm cod end mesh to 95 mm over the last couple of years. The single trawl fleet has been affected by technical measures and the Cod Recovery Plan and switched, in general, from a 70mm to an 80 mm cod end mesh in 2002. The average vessel size of the visitors has remained relatively stable but with decommissioning the average size and power of the local fleet has declined slightly. Currently the average size of the English fleet is 11m with an average engine power of around 150 kW.

The fishery is exploited throughout the year, with the highest landings made between October and March. Fishing is usually limited to a trip duration of one day with 2 hauls of 3-4 hours being carried out. The main landing ports are North Shields, Blyth, Amble and Hartlepool where, respectively, on average 36, 26, 18 and 15% of the landings from this fishery are made.

The minimum landing size for Nephrops in the Farn Deeps is 25 mm CL. Discarding generally takes place at sea, but can often continue alongside the quay. Landings are made by category for whole animals, often large, medium and small, and a single category for tails. Depending on the number of small, the category of tails is often roughly sorted as whole and left on deck for tailing once alongside. This category is only landed once tailed.

The main by-catch species are whiting, cod and haddock. Of the commercial species, discarding is greatest for whiting, but large numbers of common and long rough dab are also caught and discarded.

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

Under EU legislation, a maximum of 120 meshes round the cod-end circumference is permissible for all mesh sizes less than 90mm. For this mesh size range, an additional panel must also be inserted at the rear of the headline of the trawl. UK legislation also prohibits twin or multiple rig trawling with a diamond cod end mesh smaller that 100mm in the north Sea south of 57o30'N.

Legislation on catch composition for fishing N or S of 55° along with other cod recovery measures may have affected where and when effort is targeted which in turn could affect catch length distributions. This latitude bisects the Farn Deeps Nephrops fishery.

4.1.3 Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

4.2 Data

4.2.1 Commercial catch

Length and sex compositions of Nephrops landed from the Farn Deeps are estimated from port sampling at North Shields, Blyth, Amble and Hartlepool. Length data from English sampling are applied to all catches and raised to total international landings. Directed discard sampling started in 1985 but was curtailed in 1999 owing to uncertainties about the assumptions underlying identification of the discarded portion of total catches. Before then discards were estimated using both catch and discard sampling data. In 2001 catch data were used to re-estimate discard size distributions and quantities for all years from 1994 onwards. This method estimates discards by matching catch and landings size distributions, using weightings for previous retention at size in the landings, which has been fairly constant from year to year.

Removals at size were calculated assuming a discard survival of 25% up to 1991. At WGNEPH 1997 it was decided to set the discard survival at 0% from 1991 because of the practice of tailing and discarding ashore.

In the absence of routine methods of direct age determination in Nephrops, age compositions of removals can be inferred from length compositions by means of 'slicing'. This procedure, introduced at the WGNEPH 1991, 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.

4.2.2 Biological

Natural mortality

A natural mortality rate of 0.3 was assumed for all age classes and years for males and immature females, with a value of 0.2 for mature females based on Morizur, 1982. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation.

Maturity

The time-invariant values used for proportion mature at age are: males age 1+: 100%; females age 1: 0%; age 2+: 100%. The source of the value for females is based on observations on 50% berried CL.

Weight at age

Mean weights-at-age for this stock are estimated from fixed weight-length relationships derived from samples collected from this fishery (Macer, unpublished data)

Growth

Growth parameters are estimated from observations from this fishery (Macer, unpublished data) and comparison with adjacent stocks.

Discard survival

Discard survival (previously set at 25 %) was set to zero from 1991 as detailed in the previous section.

4.2.3 Surveys

Abundance indices are available from the following research-vessel surveys:

- Underwater TV survey: years 1996 – present. Surveys have been conducted in Spring and/or Autumn each year series but only consistently in Autumn from 2001. 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 from burrow density raised to stock area. The survey was designed around random stratified sampling on the basis of sediment strata and a regular grid. A statistical analysis showed there was no evidence of differences in trends in burrow density between different strata in this fishery (ICES WGNEPH, 2000b). So abundance estimates are based on an average burrow density raised to the survey area. The survey provides a total abundance estimate for the period of the survey, and is not age or length structured.

4.2.4 Commercial CPUE

Catch-per-unit-effort time-series are available from the following fleets:

- UK Nephrops trawl gears. Landings at length and age and effort data for UK Nephrops trawl gears are used to generate a CPUE index. Catch at age are estimated from raising length samples of landings and estimated discards 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 English and Scottish Nephrops trawlers, single trawl and multiple trawl is raised to the total landings reported by the four gear goups listed above. Discard estimates are available from 1985 for this fishery. There is no account taken of any technological creep in the fleet.

4.2.5 Other relevant data

None.

4.3 Historical Stock Development

This section is in the Working Group report.

4.4 Short-Term Projection

This section is in the Working Group report.

4.5 Medium-Term Projections

This section is in the Working Group report.

4.6 Long-Term Projections, Yield and Biomass per Recruit

This section is in the Working Group report.

4.7 Biological Reference Points

This section is in the Working Group report.

4.8 Other Issues

None.

4.9 References

Refer to References section in Working Group report

Morizur, Y., 1982. Estimation de la mortalité pour quelques stocks de la langoustine, Nephrops norvegicus (L.). ICES, Doc. Shellfish Comm., CM 1982/K:10 (mimeo).

5 *Nephrops* in Functional Unit 7 (Fladen)

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 15/09/2005: Ian Tuck (tucki@marlab.ac.uk)

11/12/2005: Coby Needle (needlec@marlab.ac.uk)

16/11/2006: Coby Needle (needlec@marlab.ac.uk)

5.1 General

5.1.1 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 Fladen area the Nephrops stock inhabits a generally continuous area of muddy sediment extending from 57o30’N to 60oN, and from 1oW to 1o30’E, with other smaller patches to the north. The Fladen Ground is the largest known Nephrops ground, with around 28 200 km2 of suitable mud substrate, and is the only major offshore ground in Scottish waters.

5.1.2 The fishery

Although the Fladen Ground is extensive, fishing effort is primarily directed to the region that can be reached within 12 hrs steaming from ports along the NE coast of Scotland. The fleet fishing the Fladen Ground for Nephrops comprises approximately 215 trawlers, which are predominantly Scottish (> 97 %), based along the Scottish NE coast, with very few landings made in the UK by foreign vessels. The average age of vessels fishing the region is about 20 years, and nearly 80 % of the fleet was built between 1970 and 1990. Fewer than 10 % are more than 30 years old, and about 25 vessels have been built since 1990. The bulk (95 %) of the fleet are vessels between 15 m and 25 m, with a mean length of 20 m. 70 % of the vessels have an engine power between 250 kW and 500 kW (average 370 kW). With the exception of a small number of vessels landing into Buckie, engine power varies little from the mean regardless of fishing method/gear.

In recent years, over 95 % of the Nephrops landings from the Fladen Ground have been by Scottish vessels. Just under two thirds are landed into Fraserburgh, and about one third into Peterhead. The remaining 5 % are mainly landed into the neighbouring districts of Aberdeen and Buckie, with small landings also made to Lerwick, Shetland.

About 67 % of the landings are reported as made by single rig vessels, two thirds of which are taken with 100 mm meshes and about one third with 70-80 mm meshes. Twin-rig vessels account for the remaining 33 % of the landings. As with the single rig vessels, approximately two thirds of these are taken using 100 mm meshes, and the remainder with 70-80 mm meshes. There are concerns over the accuracy of reporting to gear type, however, and the vast majority of landings are thought to be made by twin rig vessels.

Nearly 40 % of the Nephrops landings are reported as by-catch, where fish are the main target species. This may however be an artefact of the method of reporting to the Fishery Offices, since the mesh sizes used on the Fladen Ground tend to be larger (i.e. 100 mm) than in other areas. The consequence being that vessels using a 100 mm mesh are sometimes regarded as whitefish directed, even if they actually have been targeting Nephrops.

The minimum landing size for Nephrops in the Fladen Ground is 25 mm CL. Discarding takes place at sea, but because of the larger mesh sizes used proportionally fewer undersized animals need to be discarded than in other areas. Landed animals are categorised as small, medium and large whole, as well as tails. Where landings are made directly to processors, whole animals are not categorised, since grading is carried out ashore.

The main by-catch species are haddock, whiting and cod. Of the commercial species, discarding is greatest for whiting and haddock, but large numbers of Norway pout are also caught and discarded.

The fishery is exploited year-round with the highest landings usually being reported between August and November. Trips often last 5-6 days, with smaller vessels fishing the area near to the Moray Firth during shorter trips. Hauls are usually of 5-7 hours' duration with 4 hauls per day. Many vessels fish throughout the week, leaving late Sunday/early Monday and returning on Saturday night.

A description of the Danish Nephrops fisheries in Sub-areas IIIa and IV (including the one on the Fladen Ground) is given in the 1999 WG report (ICES, 1999a).

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

Under EU legislation, a maximum of 120 meshes round the cod-end circumference is permissible for all mesh sizes less than 90mm. For this mesh size range, an additional panel must also be inserted at the rear of the headline of the trawl.

5.1.3 Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

5.2 Data

5.2.1 Commercial catch

Length and sex compositions of Nephrops landed from the Fladen Ground 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.

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.

5.2.2 Biological

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.

5.2.3 Surveys

Abundance indices are available from the following research-vessel surveys:

- Underwater TV survey: years 1992 – 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 sediment strata and a regular grid. The survey provides a total abundance estimate, and is not age or length structured.

5.2.4 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 2000 for this fishery, and for years prior to this, an average of the 2000 and 2001 values is applied. There is no account taken of any technological creep in the fleet.

5.2.5 Other relevant data

None.

5.3 Historical Stock Development

This section is in the Working Group report.

5.4 Short-Term Projection

This section is in the Working Group report.

5.5 Medium-Term Projections

This section is in the Working Group report.

5.6 Long-Term Projections, Yield and Biomass per Recruit

This section is in the Working Group report.

5.7 Biological Reference Points

This section is in the Working Group report.

5.8 Other Issues

None.

5.9 References

Refer to References section in Working Group report

6 *Nephrops* in Functional Unit 8 (Firth of Forth)

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 15/09/2005: Ian Tuck (tucki@marlab.ac.uk)

11/12/2005: Coby Needle (needlec@marlab.ac.uk)

16/11/2006: Coby Needle (needlec@marlab.ac.uk)

6.1 General

6.1.1 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 Firth of Forth area the Nephrops stock inhabits a single continuous area of muddy sediment extending from Leith in the Firth of Forth to Eyemouth close top the English border.

6.1.2 The fishery

About 150 vessels contribute to the Firth of Forth Nephrops fishery, with about 80 % of the landings taken by 80 vessels from the districts of Eyemouth and Pittenweem. Only one creel vessel reports Nephrops landings from this area. Visiting Scottish vessels come from both the W and the E coast, and about 5 % of the landings are made by English vessels.

Virtually all landings in 1999 were taken by single rig trawlers targeting Nephrops and using a 70 mm mesh. In 2000, two high powered < 10 m vessels entered the fishery, using twin rig gear, and since this time a low level of landings has been reported The mean size of vessels in the Firth of Forth is 12 m, with an average engine power of 147 kW. Most vessels were built between the 1960s and 1980s.

The fishery is exploited throughout the year, with the highest landings usually made between July and September. Vessels usually have a trip duration of one day, and carry out 2-3 hauls of 3 4 hours per trip. Vessels fish during the hours of darkness from late spring to autumn, but during daylight in winter and early spring. The main landing ports are Pittenweem, Eyemouth and Port Seton.

The minimum landing size for Nephrops in the Firth of Forth is 25 mm CL. Discarding takes place at sea and landings are made by category for whole animals (small and large) and as tails. Observation of the minimum landing size is good for whole animals, but sampling suggests that 15 % of the tails are under size, and overall, 5 % of the individuals landed are under size.

The main by-catch species are haddock, whiting and cod. Of the commercial species, discarding is greatest for whiting and haddock, but large numbers of Norway pout, and common and long rough dab are also caught and discarded.

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

Under EU legislation, a maximum of 120 meshes round the cod-end circumference is permissible for all mesh sizes less than 90mm. For this mesh size range, an additional panel must also be inserted at the rear of the headline of the trawl. UK legislation also prohibits twin or multiple rig trawling with a diamond cod end mesh smaller that 100mm in the north Sea south of 57o30’N.

6.1.3 Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

6.2 Data

6.2.1 Commercial catch

Length and sex compositions of Nephrops landed from the Firth of Forth 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.

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.

6.2.2 Biological

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.

6.2.3 Surveys

Abundance indices are available from the following research-vessel surveys:

- Underwater TV survey: years 1993 – present. The survey usually occurs in August. 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 sediment strata and a regular grid. The survey provides a total abundance estimate, and is not age or length structured.

6.2.4 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 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.

6.2.5 Other relevant data

None.

6.3 Historical Stock Development

This section is in the Working Group report.

6.4 Short-Term Projection

This section is in the Working Group report.

6.5 Medium-Term Projections

This section is in the Working Group report.

6.6 Long-Term Projections, Yield and Biomass per Recruit

This section is in the Working Group report.

6.7 Biological Reference Points

This section is in the Working Group report.

6.8 Other Issues

None.

6.9 References

Refer to References section in Working Group report

7 *Nephrops* in Functional Unit 9 (Moray Firth)

Working Group:	ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)
Updates:	15/09/2005: Ian Tuck (tucki@marlab.ac.uk)
	11/12/2005: Coby Needle (needlec@marlab.ac.uk)
	16/11/2006: Coby Needle (needlec@marlab.ac.uk)

7.1 General

7.1.1 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 Moray Firth area the Nephrops stock inhabits a single continuous area of muddy sediment extending from north of Fraserburgh to Inverness.

7.1.2 The fishery

The fleet exploiting the Moray Firth is comprised almost entirely of Scottish vessels. In some years other UK vessels have taken small quantities of the Nephrops landings (less than 1 %) but this has not happened recently.

About 150 Scottish vessels report landings of Nephrops from the Moray Firth, with around 16 % of the landings made as a by-catch of whitefish trawlers. Some of these vessels are based in the Moray Firth area, but the majority (>90) mainly target the Fladen Ground but fish in the Moray Firth in poor weather. The remaining vessels (about 40) are visitors from other parts of Scotland, and take about 10 % of the Nephrops landings.

About three quarters of the landings are made by single rig trawlers, a high proportion of which use a 70 mm mesh. In 1999, twin-rig vessels predominantly used a 100 mm mesh, with 90 % of the twin-rig landings made using this mesh size. Legislative changes in 2000 permitted the use an 80 mm mesh.

The Moray Firth vessels almost exclusively employ single rig gear and primarily target Nephrops, working with a single skipper/crew, and mostly fishing in the upper Firth. These vessels take about a fifth of the Nephrops from the Moray Firth and are considerably smaller and less powerful (mean length 10.4 m, mean engine power 121 kW) than the Fladen Ground vessels (mean length 18.4 m, mean engine power 346 kW). Both fleets are comprised of vessels of about the same age, with over half of the fleets built in the 1970s or 1980s. The whitefish fleet comprises more powerful vessels than the Nephrops fleet, although the difference is smaller for the twin-rig vessels (mean engine power of 341 kW compared to 315 kW) than for the single trawl boats (mean engine power of 397 kW compared to 263 kW).

The major landing ports are Burghead, Fraserburgh, Macduff, Buckie, Peterhead and Helmsdale, with small landings also being made at Cromarty.

The dedicated inner Moray Firth vessels usually have a trip duration of one night (sailing in the evening and fishing during the night to land in the morning), further east (around Macduff fishing is undertaken during daylight too. The number of hauls varies but is mainly 2-3 (sometimes only 1 long tow is made). Following periods of high rainfall when local rivers are in spate, the dark colour of the sea surface waters makes that fishing can also take place during the day. The vessels normally targeting the Fladen Ground have a trip duration of 5-6 days, with four or five 4-5 hour hauls per day.

The minimum landing size for Nephrops in the Moray Firth is 25 mm CL, and about 5 % of the animals are landed under size. Nephrops grow to relatively large sizes in this stock, although densities are low. On Moray Firth vessels, discarding normally takes place at sea, and landings are made by category for whole animals (small, medium and large) and as tails. In poor weather, sorting of the catch may take place in the harbour, with discards dumped the following day, and high resultant mortality. Some of the Fladen vessels that visit the Moray Firth, do not always split whole animals into categories, since the landings are graded by the processors.

The main commercial by-catch species are haddock, whiting, plaice and lemon sole, with whiting, haddock and plaice featuring most heavily in the discards. Long rough dab and common dab, grey gurnard and dragonet and crustaceans other than Nephrops are the commonest non-commercial by-catch species.

The fishery is exploited throughout the year, with the highest landings usually being made between July and September. Both landings and discards have been well sampled for this stock in recent years. Many of the vessels in the area often switch to targeting squid for a few weeks during August or September, when a fishery for this valuable species develops.

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

Under EU legislation, a maximum of 120 meshes round the cod-end circumference is permissible for all mesh sizes less than 90mm. For this mesh size range, an additional panel must also be inserted at the rear of the headline of the trawl.

7.1.3 Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

7.2 Data

7.2.1 Commercial catch

Length and sex compositions of Nephrops landed from the Moray Firth 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.

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.

7.2.2 Biological

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.

7.2.3 Surveys

Abundance indices are available from the following research-vessel surveys:

- Underwater TV survey: years 1993 – present. The survey usually occurs in August. 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 sediment strata and a regular grid. The survey provides a total abundance estimate, and is not age or length structured.

7.2.4 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 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.

7.2.5 Other relevant data

None.

7.3 Historical Stock Development

This section is in the Working Group report.

7.4 Short-Term Projection

This section is in the Working Group report.

7.5 Medium-Term Projections

This section is in the Working Group report.

7.6 Long-Term Projections, Yield and Biomass per Recruit

This section is in the Working Group report.

7.7 Biological Reference Points

This section is in the Working Group report.

7.8 Other Issues

None.

7.9 References

Refer to References section in Working Group report

8 *Nephrops* in Functional Unit 10 (Noup)

Working Group:	ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)
Updates:	15/09/2005: Ian Tuck (tucki@marlab.ac.uk)
	11/12/2005: Coby Needle (needlec@marlab.ac.uk)
	16/11/2006: Coby Needle (needlec@marlab.ac.uk)

8.1 General

8.1.1 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 Noup area the Nephrops stock inhabits a small continuous area of muddy sediment about 30 miles NW of Orkney.

8.1.2 The fishery

This fishery is located to the West of Orkney, in an area which has few local ports normally associated with Nephrops fishing. About three quarters of the landings from the Noup Nephrops fishery are made by trawlers targeting Nephrops, while the remainder are made as a by-catch of whitefish vessels.

Two thirds of the Nephrops landings from this FU are made by about 50 vessels from the Buckie, Fraserburgh and Peterhead districts, but contributions are also made from other areas around Scotland. In recent years, 80 vessels have exploited this fishery, with two thirds of the landings taken with meshes of 100 mm or greater.

In the Nephrops fleet, about one tenth of the landings are taken by twin-rigs, while this proportion is only a fifth for the whitefish fleet. Both twin-rig fleets predominantly use 100 mm meshes, but while the whitefish fleet also uses 100 mm meshes in single rig gear, about a third of the landings made by the Nephrops single rig fleet are made with 70 mm meshes.

The whitefish fleet comprises slightly larger and more powerful vessels (mean length 19.5 m, mean engine power 415 kW) than the Nephrops fleet (mean length 18 m, mean engine power 310 kW). Almost half the vessels exploiting the Noup area were built in the 1980s, with those targeting Nephrops slightly older than those targeting whitefish. In 1999, all but one of the vessels landing Nephrops from the Noup were Scottish, and landings were made at Scrabster and Buckie. Vessels usually have a trip duration of 3-5 days, carrying out 4 hauls per day.

The minimum landing size for Nephrops from the Noup is 25 mm CL, and about 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 fishery is exploited throughout the year, with the highest landings usually being made between July and September. Catches of fish in the Noup area can be good, but the area has been thought to be subject to over-reporting of monkfish in the past.

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

Under EU legislation, a maximum of 120 meshes round the cod-end circumference is permissible for all mesh sizes less than 90mm. For this mesh size range, an additional panel must also be inserted at the rear of the headline of the trawl.

8.1.3 Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

8.2 Data

8.2.1 Commercial catch

Length and sex compositions of Nephrops landed from the Noup are estimated from port sampling in Scotland. Discard sampling has not been possible for this fishery. The isolated and vary variable nature of this fishery has meant that sampling has been poor, and is not considered appropriate to raise the data to landings.

8.2.2 Biological

Mean weights-at-age for this stock are estimated from fixed Scottish weight-length relationships (Howard et al 1988 – citation required).

8.2.3 Surveys

Abundance indices are available from the following research-vessel surveys:

- Underwater TV survey: years 1994 and 1999 only. 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.

8.2.4 Commercial LPUE

Landings and effort data are available from the Scottish Nephrops trawler fleet, but sampling is not considered sufficient to raise length composition data to fleet landings.

8.2.5 Other relevant data

None.

8.3 Historical Stock Development

This section is in the Working Group report.

8.4 Short-Term Projection

This section is in the Working Group report.

8.5 Medium-Term Projections

This section is in the Working Group report.

8.6 Long-Term Projections, Yield and Biomass per Recruit

This section is in the Working Group report.

8.7 Biological Reference Points

This section is in the Working Group report.

8.8 Other Issues

None.

8.9 References

Refer to References section in Working Group report

9 *Nephrops* in Function Unit 32 (Norwegian Deeps)

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 11/12/2005: Coby Needle (needlec@marlab.ac.uk)

16/11/2006: Coby Needle (needlec@marlab.ac.uk)

9.1 General

9.1.1 Stock definition

9.1.2 Fishery

9.1.3 Ecosystem aspects

9.2 Data

9.2.1 Commercial catch

9.2.2 Biological

Natural mortality

Maturity

Weight at age

Proportion mortality before spawning

9.2.3 Surveys

9.2.4 Commercial CPUE

9.2.5 Other relevant data

9.3 Historical Stock Development

9.3.1 Deterministic modelling

9.3.2 Uncertainty analysis

9.3.3 Retrospective analysis

9.4 Short-term projection

9.5 Medium-term projections

9.6 Long-term projections, yield per recruit

9.7 Biological reference points

9.8 Other issues

9.9 References

10 *Nephrops* in Functional Unit 33 (Off Horn Reef)

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 11/12/2005: Coby Needle (needlec@marlab.ac.uk)

16/11/2006: Coby Needle (needlec@marlab.ac.uk)

10.1 General

10.1.1 Stock definition

10.1.2 Fishery

10.1.3 Ecosystem aspects

10.2 Data

10.2.1 Commercial catch

10.2.2 Biological

Natural mortality

Maturity

Weight at age

Proportion mortality before spawning

10.2.3 Surveys

10.2.4 Commercial CPUE

10.2.5 Other relevant data

10.3 Historical Stock Development

10.3.1 Deterministic modelling

10.3.2 Uncertainty analysis

10.3.3 Retrospective analysis

10.4 Short-term projection

10.5 Medium-term projections

10.6 Long-term projections, yield per recruit

10.7 Biological reference points

10.8 Other issues

10.9 References

11 Quality handbook: Sandeel in Sub-Area IV

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 15/09/2004: Henrik Jensen (hj@dfu.min.dk)

12/12/2005: Coby Needle (needlec@marlab.ac.uk)

11.1 General

11.1.1 Stock definition

For assessment purposes, the European continental shelf was divided into four regions for sandeel assessment purposes up to 1995: Division IIIa (Skagerrak), northern North Sea, southern North Sea, and Shetland Islands and Division VIa. These divisions were based on regional differences in growth rate and evidence for a limited movement of adults between divisions (e.g. ICES CM 1977/F:7, ICES CM 1991/Assess:14.). The two North Sea divisions were revised in 1995, and it was decided to amalgamate the two stocks into a single stock unit with two fleets, one fleet in the northern North Sea and one in the southern North Sea. The Shetland sandeel stock is assessed separately. ICES assessments have used these stock definitions since 1995.

Sandeels are largely stationary after settlement and the North Sea sandeel fishery must be considered as exploiting a complex of local populations. Recruitment to local areas may not only be related to the local stock, as interchange between areas seems to take place during the early phases of life before settlement.

Based on the distribution and simulated dispersal of larval stages, Wright et al. (1998) suggest that the North Sea stock could be split into six areas, including the Shetland as a separate population. Assessments have tentatively been made for some of these areas (Pedersen et al. 1999) and there was high correlation between the results from the study and the assessment made by the WG for the whole North Sea. Presently there are insufficient information about sandeel biology, especially about the intermixing of the early life stages between spawning aggregations, to allow for and alternative separation of the North Sea into separate population units to be assessed.

11.1.2 Fishery

Sandeel is taken by trawlers using small meshed trawls with mesh sizes < 16 mm. The fishery is seasonal. The geographical distribution of the sandeel fishery varies seasonally and annually, taking place mostly in the spring and summer. In the third quarter of the year the distribution of catches generally changes from a dominance of the west Dogger Bank area back to the more easterly fishing grounds.

Most of the sandeel catch consists of the lesser sandeel Ammodytes marinus, although small quantities of other Ammodytoidei spp. are caught as well. There is little by-catch of protected species (ICES 2004).

In most years and particularly prior to 1998, most landings of sandeels in March were taken from the eastern North Sea banks whilst sandeel landings in April-June were mainly from the west Dogger Bank. As there can be regional differences in the age composition this seasonal expansion of the fishery can result in a change in the age composition in the fishery. In some years a relatively large part of the sandeel landings are taken from the central and eastern North Sea along the Danish west coast. From 1991, grounds off the Scottish east coast have been targeted particularly in June. However, since 2000 the banks in the Firth of Forth area have been closed to fishing.

Technical measures for the sandeel fishery include a minimum percentage of the target species at 95% for meshes < 16 mm, or a minimum of 90% target species and maximum 5% of the mixture of cod, haddock, and saithe for 16 to 31 mm meshes.

11.1.3 Ecosystem aspects

ACFM consider that there is a need to ensure that the sandeel stock remains high enough to provide food for a variety of predator species.

In 1999 the U.K called for a moratorium on sandeel fishing adjacent to seabird colonies along the U.K. coast and in response the EU requested advice from ICES. An ICES Study Group, was convened in 1999 to assess whether removal of sandeel by fisheries has a measurable effect on sandeel, whether establishment of closed areas and seasons for sandeel fisheries could ameliorate any effects, and to identify possible spatial and/or temporal restrictions of the fishery as specifically as possible. The ICES Advisory committees (ACFM and ACE) accepted the advice from the study group. STECF (1999) agreed with this ICES advice and the EU advised to close the fishery whilst maintaining a commercial monitoring. A 3-year closure, from 2000 to 2002, was decided. All commercial fishing was excluded, except for a maximum of 10 boat days in each of May and June for stock monitoring purposes. The closure was maintained for three years (see e.g. Wright et al. 2002) and has been extended until 2006, with a small increase in the effort of the monitoring fishery, after which the effect of the closure will be evaluated.

11.2 Data

11.2.1 Commercial catch

In the last 20 years the landings of sandeels in IV have been taken by 5 countries: Denmark (78%), Norway (19%) UK/Scotland (1%), Sweden (1%) and Faroes Isl. (1%). In the 1950's also Germany and the Netherlands participated in this fishery, but since the start of the 1970's no landings have been recorded for these countries.

Age, length and weight at age data are available for Denmark and Norway to estimate numbers by age in the landings. Prior to 1996, the Norwegian age composition data were based on Danish ALK's. Catch numbers and weight at age for the southern North Sea are based only on Danish age compositions.

Denmark

Industrial species are not sorted by species before processing and it is assumed that the landings consist of one species only in the calculation of the official landings. The WG estimate of landings is based on samples for species composition taken by the Fishery Inspectors for control of the by-catch regulation. At least one sample (10-15 kg) per 1000 tons landings is taken and these samples are used to estimate average species composition by area (ICES rectangles) and month. This species/area/period key, logbook data (spatial distribution) and landings slip data (quantity) are used to derive the Danish WG estimates of landings of sandeel and by-catch of other species (further information can be found in ICES, 1994/Assess:7; Dalskov, 2002).

Norway

For Norway and Sweden, the official landings and the WG estimated landings are the same.

UK/Scotland

Sweden

The text table below shows which country supplies which kind of data:

	DATA				
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Denmark	x	x	x		x
Norway	x	x	x		x
UK/Scotland	x				
Sweeden	x				
Faroe Islands	x				

All input files are Excel spreadsheet files.

The national data sets have been imported in a database aggregated to international data by DIFRES.

The combined Danish and Norwegian age composition data and weight at age data are applied on the landings of UK, Sweeden and Farao Isl., assuming catches from these countries have the same age composition and weight at age as the Danish and Norwegian landings. Excel spreadsheet files can be found with the Danish stock co-ordinator and in the ICES computer system under w:\acfm\WGNSSK**.

The result files can be found at ICES and with the stock co-ordinator as ASCII files on the Lowestoft format under w:\acfm\WGNSSK**.

11.2.2 Biological

Historically, assessments were done separately for the Northern and Southern North Sea. In recent years, the assessment has been done for the whole North Sea, but data are still compiled separately for the two areas. The catch numbers and weight at age data for the Northern North Sea are constructed by combining Danish and Norwegian data by half-year.

The catch numbers and weight-at-age data for the northern North Sea were constructed by combining Danish and Norwegian data by half-year. Prior to 1996, the Norwegian age composition data were based on Danish ALK's. Catch numbers and weight-at-age for the southern North Sea are based on Danish age compositions. The mean weight at age in the catch used in the assessment is the mean weights at age in the catch for the Southern and Northern North Sea weighted by catch numbers. The mean weight at age in the stock is copied from the mean weight in the catch first half-year, and an arbitrary chosen weight at 1 gram was used for the 0-group.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Values for natural mortalities are the same as used since 1989 (ICES CM 1989/Asssess:13). MSVPA (ICES CM 2002/D:04) estimates of natural mortalities are relatively stable in the period covered by this assessment. The values used in this assessment are quite similar to the MSVPA M, except for the 0-group where MSVPA estimates a value of approximately 1.2 for the second half of the year. The assessment uses a value of 0.8 for the whole year for the 0-group, 1.2 for the 1-group, and 0.6 for the 3-group and 4+-group.

The proportion mature is assumed constant over the whole period with 100% mature from age 2 and 0% of age 0 and 1. Recent research indicates however, that there are large regional variations in age at maturity of Ammodytes marinus in the North Sea (see e.g. Jensen et al. 2001). Whilst sandeels in some areas seem to spawn at age 2 or older, sandeels in other regions seem to mature and spawn at age 1. As the decision to spawn at age 1 or 2 is an annual event, it is likely that there are large regional and annual variations in the fraction of the populations of the sandeels that contribute to the spawning. The age at maturity keys used in the assessment might thus considerably underestimate the spawning biomass of sandeels in the North Sea.

The fishing fleet catch sandeels in different parts of the North Sea during the year, and the fishing pattern changes from year to year. Because sandeels, Ammodytes marinus, in the North Sea possibly consist of a number of sub populations (see section **) the industrial fishery target different part of the sandeel populations during the year and between years. There seem to be significant spatial and temporal variations in emergence behaviour (e.g. Rindorf et al. 2000) and growth (e.g. Pedersen et al. 1999; Wright et al. 1998) of sandeels in the North Sea. Further, there are age/length dependent variations in the burrowing behaviour of sandeels (Kvist et al. 2001). The information about age compositions in the catches and the age and weight relationships thus represent average values over time and space and reflect the variability in emergence behaviour and growth. For example, weight at age of sandeels seems to vary both between years and between Danish and Norwegian catches.

The effect of variations in the biological data on the performance of the assessments has not yet been analysed. Such an analysis requires information about spatial and temporal variations in emergence and growth. A new sampling programme for such data for the Danish industrial fleet was initiated in 1999 in which a part of the fleet is monitored in detail (Jensen et al. 2001). In 1999, information about catches of sandeel was collected on a trawl haul basis from 17 Danish vessels. In total 231 samples was taken from 49 grounds, corresponding to 2.6% of the Danish landings of sandeel in the North Sea in 1999. This sampling programme was continued in 2000 to 2003 with about the same sampling level. Basic analysis of the data from 1999-2003 is not completed. However, the data have been used for estimation of assessment catch at age numbers. Due to the new sampling program, the number of fish measured and aged has since 1999 increased by a factor of around 10 compared to previous years.

11.2.3 Surveys

There are no survey time series available for this stock.

11.2.4 Commercial CPUE

Effort data from the commercial fishery in the northern and southern North Sea are treated as two independent tuning fleets, separated into first and second half year.

The effort data for the southern North Sea prior to 1999 are only available for Danish vessels, but since 1999 Norwegian vessels have also provided effort data. These data for the first half year has since 2003 been included in tuning series. The effect of this on the assessment is analysed in this year’s assessment. The reason for including the Norwegian effort data for first half year for the southern North Sea into the tuning fleet is that in recent years Norwegian catches in the southern North Sea in first half year constitute a significant part of Norwegian landings in the North Sea. The tuning fleet used for the northern North Sea is a mixture of Danish and Norwegian vessels. A separation of the Danish and Norwegian fleets is presently not possible, due to the lack of Norwegian age-length keys for the period before 1996. Separate national fleets would have been preferable because this would have made procedure for the generation of the tuning series more transparent. This issue should be addressed at the next benchmark assessment.

The size distribution of the fleet has changed through time. Therefore effort standardisation is required. The assumption underlying the standardisation procedure is that CPUE is a function of sandeel abundance and vessel size. Standardised effort is calculated from standardised CPUE and total catch. CPUE is standardized to a vessel size of 200 Gross Tonnes (GR) using the relationship:

CPUE=a*GRb (1)

where a and b are constants and GR is vessel size in GR

The constants a and b were prior to 2003 estimated for each year by performing the regression analysis:

Ln(C/e)=ln(a)+b*ln(GR) (2)

where C=catch in ton, e=effort in days spend fishing, and the rest of the parameters are as in (1).

Since 2003 the parameters in (2) have estimated using catch and effort data on single trip level, instead of average values of catch and effort for each vessel size category (see ICES 2004). The data used for the regression is logbook data for the Danish industrial fleet for the years 1984 to 2003 and first half year of 2004. General linear models were used to estimate the parameters in:

ln(CPUE) = dy+ fy*ln(GR) (3)

where y=year, GR=vessel size in GR as defined in Table 1, and the remaining factors are constants. Log transformation was required to stabilise the variance in CPUE to fit the model although it does result in a more skewed distribution of GT leading to the smaller vessels receiving a higher weight in the subsequent regression. The GLM was carried out by half year (first and second half year) and area (northern and southern North Sea) to generate estimates of effort for the fleets presently used in the assessment of sandeels in IV. Type III analysis was used to test for significance of parameters. All analyses were weighted by the number of days spend fishing, as the variation on the average catch per day fishing decreases with the number of days fished. The results of the analysis and the parameter estimates are given in Table 13.1.3.2.

The parameters estimated in (3) were used to estimate CPUE for a vessel size of 200 GR from:

CPUE=edy*200fy (4)

Mean CPUE of Danish and Norwegian fleets, after the Norwegian CPUE had been standardised to a vessel size of 200 GR, was estimated as a weighted mean weighted by the catches sampled used to estimate CPUE. Total standardised effort was afterwards estimated from the combined Danish and Norwegian CPUE and total international catches.

As no recruitment estimates from surveys are available, recruitment estimates are based exclusively on commercial catch-at-age data. The tuning diagnostics indicate that the 0-group CPUE is a poor predictor of recruitment.

There is a relatively poor correlation between the tuning indices and the stock, which may be due to the fact that several sub-stocks are assessed as a single unit.

11.3 Other relevant data

None.

11.4 Estimation of Historical Stock Development

The Seasonal XSA (SXSA) developed by Skagen (1993) was up to 2001 used for stock assessment of sandeel in IV. Annual XSA was tried in 2002 WG where it was concluded that the two approaches gave similar results. For a standardization of methodology, it was decided to shift to XSA in 2003. For analysis of alternative procedures see WG reports from previous years (ICES 1986, … 2003 **to be updated with references prior to 1986). In 2004 SXSA was used again, as a supplement to the XSA, the reason being that data were available for the first half year of 2004 for the assessment.

The assessment of sandeels in IV now use the XSA method with the following settings for tuning:

STOCK	SANDEEL	
area	IV	
Assessment model	XSA	
Combined Northern 1st half-year	1983-2001	0-4+
Combined Northern 2nd half-year	1983-2001	0-4+
Combined Southern 1st half-year	1983-2001	0-4+
Combined Southern 2nd half-year	1983-2001	0-4+
Time series weights	none	
Power model used for catchability	not used	
Catchability plateau age	2	
Surv. est. shrunk towards mean F	5 years / 2 ages	
s.e. of the means	1.5	
Min. stand. error for pop. estimates	0.3	
Prior weighting	none	

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1974 – last data year	0 – 4+	Yes
Canum	Catch at age in numbers	1974 – last data year	0 – 4+	Yes
Weca	Weight at age in the commercial catch	1974 – last data year	0 – 4+	Yes
West	Weight at age of the spawning stock at spawning time.	1974 – last data year	0 – 4+	Yes
Mprop	Proportion of natural mortality before spawning	1974 – last data year	0 – 4+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1974 – last data year	0 – 4+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1974 – last data year	0 – 4+	No (see section **)
Natmor	Natural mortality	1974 – last data year	0 – 4+	No (see section **)
Tuning data:				
Type	Name	Year range	Age range	
Tuning fleet 1	Northern North Sea first half year	1976 – last data year	1 – 4+	
Tuning fleet 2	Northern North Sea second half year	1976 – last data year	0 – 4+	
Tuning fleet 3	Southern North Sea first half year	1982 – last data year	1 – 4+	
Tuning fleet 4	Southern North Sea second half year	1982 – last data year	0 – 4+	

The low number of age groups makes the assessment highly sensitive to estimated terminal fishing mortalities for the oldest age (age 3). This in combination with an assumed constant and poorly determined proportion mature makes the SSB estimate highly uncertain.

11.5 Short-Term Projection

Not done

The high natural mortality of sandeel and the few year classes in the fishery make the stock size and catch opportunities largely dependent on the size of the incoming year classes. Quantitative estimates of recruits (age 0) in the year of the assessment are not available at the time of the WG. Traditional deterministic forecasts are therefore not considered appropriate.

11.6 Medium-Term Projections

Not done

11.7 Long-Term Projections, Yield per recruit

Not done

11.8 Biological Reference Points

There is no management objective set for this stock. There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. Management of fisheries should try to prevent local depletion of sandeel aggregations, particularly in areas where predators congregate.

In 1998 ACFM proposed that Blim be set at 430,000 t, the lowest observed SSB. The Bpa was estimated at 600,000 t, approximately Blim * 1.4. This corresponds to that if SSB is estimated to be at Bpa then the probability that the true SSB is less than Blim will be less than 5% (assuming that estimated SSB is log normal distributed with a CV of 0.2). No fishing mortality reference points are given. These reference points are based on an assessment using another tuning method than used from 2002 (see section 1.2.4). Due to the few age-groups, SSB is highly dependent on the terminal F and thereby tuning method. Even though the previously used SXSA and XSA give similar results, an update of the reference points is needed.

The TAC was set to 1,020,000 tonnes for 2002 and 918.000 t for 2003. The ACFM advice for 2003 was that the stock can sustain the current fishing mortality and that the fishing mortality should not be allowed to increase because the consequences of removing a larger fraction of the food-biomass for other biota are unknown.

11.9 Other Issues

None

11.10 References

ICES 1986. Report of the Industrial Fisheries Working Group. ICES C.M. 1986/Assess:15.

ICES 1987. Report of the Industrial Fisheries Working Group. ICES C.M. 1987/Assess:17.

ICES 1988. Report of the Industrial Fisheries Working Group. ICES C.M. 1988/Assess:15.

ICES 1989. Report of the Industrial Fisheries Working Group. ICES C.M. 1989/Assess:13.

ICES 1990. Report of the Industrial Fisheries Working Group. ICES C.M. 1990/Assess:13.

ICES 1991. Report of the Industrial Fisheries Working Group. ICES C.M. 1991/Assess:14.

ICES 1992. Report of the Industrial Fisheries Working Group. ICES C.M. 1992/Assess:9.

ICES 1994. Report of the Working Group on the Assessment of Norway Pout and Sandeel. ICES C.M. 1994/Assess:7.

ICES 1995. Report of the Working Group on the Assessment of Norway Pout and Sandeel. ICES C.M. 1995/Assess:5.

ICES 1996. Report of the Working Group on the Assessment of the Demersal Stocks in the North Sea and Skagerrak. Part 1 to 3. ICES C.M. 1996/Assess:6.

ICES 1997. Report of the Working Group on the Assessment of the Demersal Stocks in the North Sea and Skagerrak. Part 1 and 3. ICES C.M. 1997/Assess:6.

ICES 1998. Report of the Working Group on the Assessment of the Demersal Stocks in the North Sea and Skagerrak. Part 1 and 3. ICES C.M. 1998/Assess:7.

ICES 1999. Report of the Study group on effects of sandeel fishing. ICES 1999/ACFM:19.

ICES 1999b. Report of the Working Group on the Assessment of the Demersal Stocks in the North Sea and Skagerrak. Part 1 to 3. ICES C.M. 1999/ACFM:8.

ICES 2000. Report of the Working Group on the Assessment of the Demersal Stocks in the North Sea and Skagerrak. Part 1 to 3. ICES C.M. 2000/ACFM:7.

ICES 2001. Report of the Working Group on the Assessment of the Demersal Stocks in the North Sea and Skagerrak. Part 1 to 2. ICES C.M. 2001/ACFM:7.

ICES 2003. Report of the Working Group on the Assessment of the Demersal Stocks in the North Sea and Skagerrak. Part 1 to 3. ICES C.M. 2003/ACFM:2.

ICES 2004. Report of the Working Group on the Ecosystem Effects of Fishing Activities. ICES C.M. 2004/ACE:0*, Ref. D,E,G.

Jensen H.; Rindorf A.; Horsten M.B.; Mosegaard H.; Brogaard P.; Lewy P.; Wright P.J.; Kennedy F.M.; Gibb I.M.; Ruxton G.; Arnott S.A. and Leth J.O. 2001. Modelling the population dynamics of sandeel (Ammodytes marinus) populations in the North Sea on a spatial resolved level. DG XIV no. 98/025..

Jensen H., Mosegaard H., Rindorf A., Dalskov J. and Brogaard P. 2002. Indsamling af detaljerede oplysninger om tobisfiskeriet i Nordsøen. DFU rapport no. 97-02.

Jensen and Vinther. 2003. Estimation of fishing effort for the Danish sandeel fishery in the North Sea based on catch per unit effort data. Working document for the 2003 ICES WGNSSK meeting in Bolougne.

Pedersen, S.A., Lewy, P. and Wright, P., 1999. Assessment of the lesser sandeel (Ammodytes marinus) in the North Sea based on revised stock divisions. Fisheries Research, 41: 221-241.

Proctor, R., Wright, P.J. and Everitt, A. (1998). Modelling the transport of larval sandeels on the north west European shelf. Fisheries Oceanography.7, 347-354.

Rindorf, A, Wanless, S and Harris, MP (2000) Effects of changes in sandeel availability on the reproductive output of seabirds. Marine Ecology Progress Series 202:241-252.

Wright P., Verspoor E., Andersen C., Donald L., Kennedy F., Mitchell A., Munk P., Pedersen S.A., Jensen H., Gislason H. and Lewy P. 1998. Population structure in the lesser sandeel (Ammodytes marinus) and its implications for fishery-predator interactions. DG XIV no. 94/071.

Wright P.J., Jensen H., Mosegaard H., and Dalskov J. 2002. European Commission’s annual report on the impact of the Northeast sandeel fishery closure and status report on the monitoring fishery in 2000 and 2001.

12 Quality handbook: Norway pout in Sub-Area IV

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 15/09/2005: Rasmus Nielsen (rn@dfu.min.dk)

11/12/2005: Coby Needle (needlec@marlab.ac.uk)

15/09/2006: Rasmus Nielsen (rn@dfu.min.dk)

17/11/2006: Coby Needle (needlec@marlab.ac.uk)

12.1 General

12.1.1 Stock definition

Norway pout is a small, short-lived gadoid species, which rarely gets older than 5 years (Sparholt, Larsen and Nielsen 2002a). The species is mainly distributed from the west of Ireland to Kattegat, and from the North Sea to the Barents Sea.

The distribution for this stock is in the northern North Sea (>57°N) and in Skagerrak at depths between 50 and 250 m (Raitt 1968; Sparholt, Larsen and Nielsen 2002b).In the North Sea shelf area, it is mainly distributed in the northern part (largely to the north of 57°N) and in Skagerrak at depths between 50 and 250 m (Raitt 1968, Sparholt et al. 2002a). Figures Q5.1 and Q5.2 show geographical distribution of the stock obtained from the ICES IBTS surveys. The IBTS Surveys only cover areas within the 200 m depth zone. However, very few Norway pout are caught at depths greater than 200 m in the North Sea and Skagerrak on shrimp trawl survey (Sparholt et al. 2002b). For the Norwegian Trench, Albert (1994) found Norway pout at depths greater than 200 m, but very few deeper than 300 m.

At present, there is no evidence for separating the North Sea component into smaller stock units. Norway pout in the eastern Skagerrak is only to a very small degree a self-contained stock. The main bulk drifts as larvae from more western areas to which they return mainly during the latter part of their second year of life before becoming mature (Poulsen 1968). ICES ACFM (October 2001) asked the ICES WGNSSK to verify the justification of treating ICES Division VIa as a management area for Norway pout (and sandeel) separately from ICES areas IV and IIIa. Preliminary results from an analysis of regionalized survey data on Norway pout maturity, presented in a Working Document to the 2000 meeting of the ICES WGNSSK Working Group (*Larsen, Lassen, Nielsen and Sparholt,2001* in ICES C.M.2001/ACFM:07), gave no evidence for a stock separation in the whole northern area.

Spawning distribution: Spawning in the North Sea takes place mainly in the northern part in the area between Shetland and Norway in coastal waters.

Larvae and juvenile distribution: The species is not generally considered to have specific nursery grounds, but pelagic 0-group fish remain widely dispersed in the northern North Sea close to spawning grounds. The main bulk drifts as larvae from more western areas to which they return mainly during the latter part of their second year of life before becoming mature (Poulsen 1968). The IBTS CPUE map (Figure Q5.2) shows, however, a relative high CPUE in the Skagerrak area in the third quarter, where the 0-group dominates the catches.

Adult migration: There is an adult spawning migration out of Skagerrak and Kattegat as no spawning occurs in this area. Otherwise there is no indication of adult migration. Based on

IBTS data, the main aggregations of settled fish are distributed around the 150 m contour, with a slight preference for deeper water for the older fish.

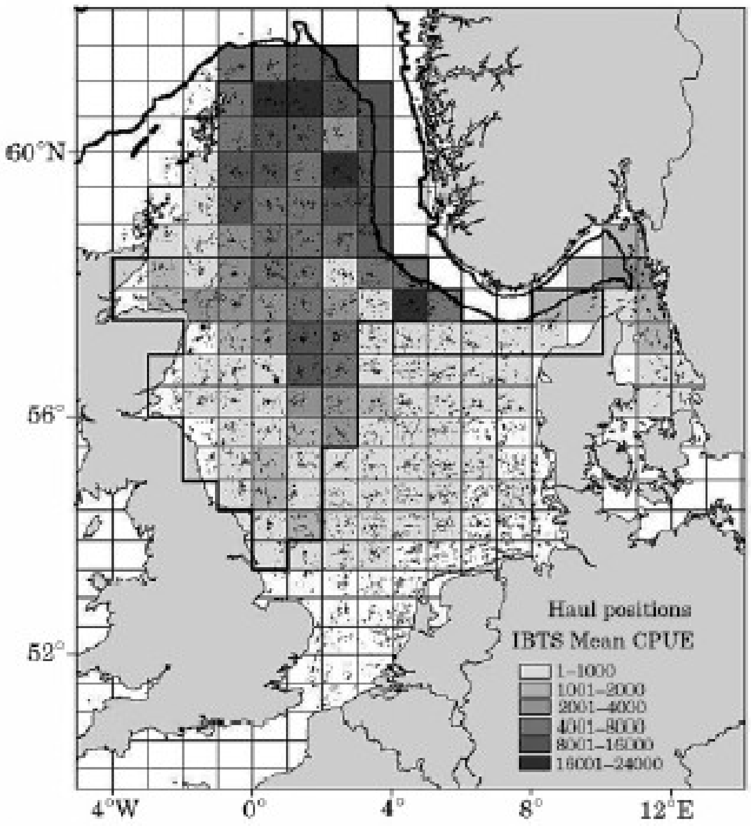


Figure Q5.1. Positions fished at the International Bottom Trawl Survey (IBTS) first quarter and mean CPUE (numbers) of Norway pout by rectangle, 1981–1999. The standard area used to calculate abundance indices and the 200 m depth contour is also shown [from Sparholt et al., 2002b].

12.1.2 Fishery

The fishery is mainly carried out by Danish and Norwegian (large) vessels using small-mesh trawls in the north-western North Sea especially at the Fladen Ground and along the edge of the Norwegian Trench in the north-eastern part of the North Sea. Main fishing seasons are 3rd and 4th quarters of the year with also high catches in 1st quarter of the year especially previous to 1999. Norway pout is caught in small meshed trawls (16-31 mm) in a mixed fishery with blue whiting, i.e. in addition to the directed Norway pout fishery, the species is also taken as by-catch in the blue whiting fishery. The fishery is mainly carried out by Denmark (~70-80%) and Norway (~20-30%) at fishing grounds in the northern North Sea especially at Fladen Ground and along the edge of the Norwegian Trench. Norway pout is landed for reduction purposes (fish meal and fish oil).

With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery. The Norway pout fishery is regulated by technical measures such as minimum mesh size in the trawls, fishing area closure in the Norway pout box in the North-Western part of the North Sea, and by-catch regulations to protect other species. An overview of relevant technical regulations for the Norway pout fishery and stock is given below in section f. By-catch in the fishery is described in detail in Annex 1.

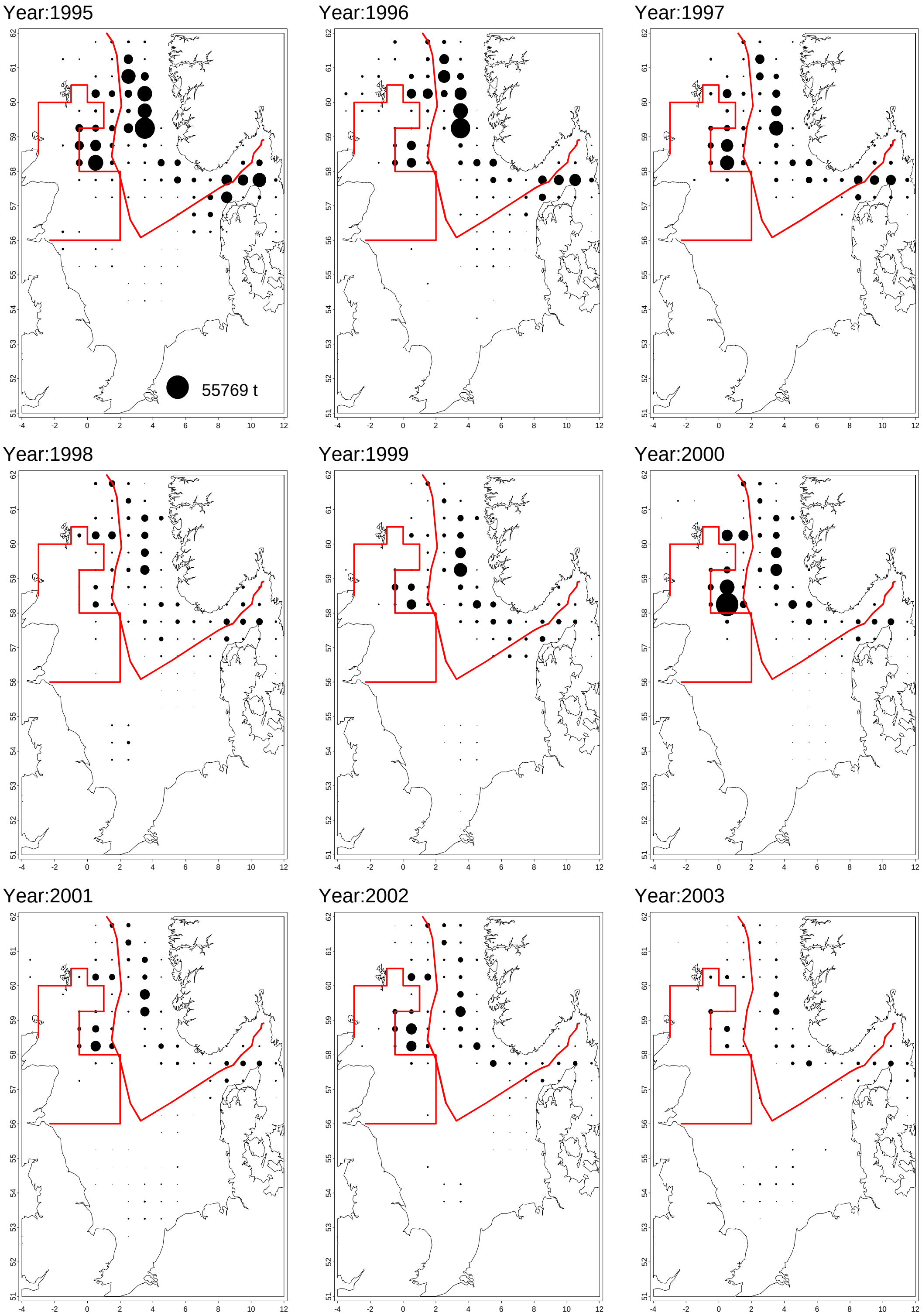


Figure Q5.2. Landings of Norway pout by year and ICES rectangles for the period 1995-2003. Landings include Danish and Norwegian landing for the whole period. The area of the circles represents landings by rectangle. All rectangle landings are scaled to the largest rectangle landings shown at the 1995 map. The "Norway pout box" and the boundary between the EU and the Norwegian EEZ are shown on the map.

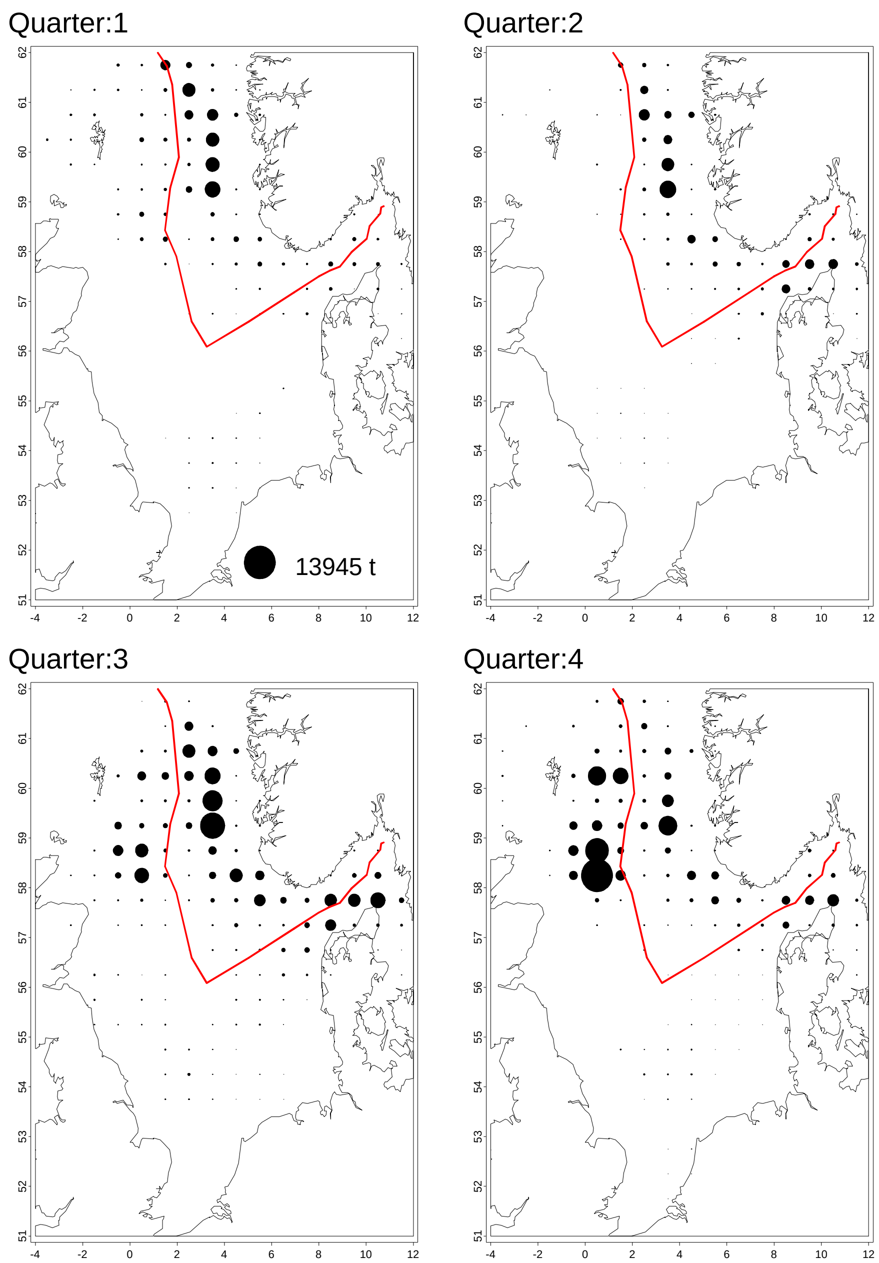


Figure Q5.3. Average Danish and Norwegian landings of Norway pout by quarter of the year and ICES rectangles for the period 1994-2003. The area of the circles represents landings by rectangle. All rectangle landings are scaled to the largest rectangle landings shown at the quarter 1 map

12.1.3 Ecosystem aspects

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. By-catches of other species should also be taken into account in management of the fishery. Existing technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been maintained. By-catch of herring, saithe, cod, haddock, whiting, and monkfish at various levels in the small meshed fishery in the North Sea and Skagerak directed towards Norway pout has been documented (Degel, Nedreaas, and Nielsen (2006), Work. Doc. No. 22, ICES WGNSSK (2007)). Scientific documentation reveals that by-catch reduction gear selective devices can be used in the fishery reducing by-catch of among other juvenile gadoids significantly (Nielsen and Madsen (2006), Work. Doc. No. 23, ICES WGNSSK (2007)).

The population dynamics for Norway pout in the North Sea and Skagerrak are very dependent on changes caused by recruitment variation and variation in predation mortality (or other natural mortality causes) and less by the fishery (Sparholt et al. 2002a,b). Recruitment in Norway pout is highly variable and influences spawning stock biomass and total stock biomass rapidly due to the short life span of the species. The fishing mortality is generally lower than the natural mortality, and this stock is important as food source for other species.

12.2 Data

12.2.1 Commercial catch and effort data

The assessment uses the combined catch and effort data from the commercial Danish and Norwegian small meshed trawler fleets fishing mainly in the northern North Sea.

For the Danish and Norwegian commercial landings sampling procedures of the commercial landings, which vary between the countries, were described in detail in the report of the WGNSSK meeting in September 2004 (ICES WGNSSK (2005)).

From 2002 onwards, an EU regulation (1639/2001) was endorsed which affects the market sampling procedures. First, each country is obliged to sample all fleet segments, including foreign vessels landing in their country. Second, a minimum number of market samples per tonnes of landing are required. The national market sampling programmes have been adjusted accordingly.

Method of effort standardization of the commercial fishery tuning fleet

Results and parameter estimates by period from the yearly regression analysis on CPUE versus GRT for the different Danish vessel size categories are used in the effort standardization of both the Norwegian and Danish commercial fishery vessels included in the assessment tuning fleet.

Background descriptions of the commercial fishery tuning series used and methods of effort standardization of the commercial fishery between different vessel size categories and national commercial fleets are given in the 2004 working group report (ICES WGNSSK (2005)) and the 1996 working group report (ICES CM 1997/Assess:6). Previous to the 2001 assessment the effort has been standardized by vessel category (to a standard 175 GRT vessel) only using the catch rate proportions between vessel size categories within the actual year. In 2002 the assessment was run both with and without the new standardization method (regression). The differences in results of output SSB, TSB and F between the two assessment runs were small.

With respect to further exploration of the effect of using effort standardization and using a combined Danish and Norwegian commercial fishery tuning fleet in the Norway pout assessment different analyses have been made in relation to the benchmark assessment in 2004. This was done to investigate alternative standardization methods and alternative division of the commercial fishery assessment tuning fleet used in the assessment. The results of these analyses were presented to and discussed by the working group in 2004 and presented in the 2004 report of this working group in section 12.

In the 2004 (as well as in the 2001-2003) assessments the output of the regression analyses using time series from 1987-2004 has been applied to the Danish and Norwegian commercial fishery as well. Effort standardization of both the Danish and the Norwegian part of the commercial fishery tuning series is performed by applying standardization factors to reported catch and effort data for the different vessel size categories. The standardization factors are obtained from regression of CPUE indices by vessel size category over years of the Danish commercial fishery tuning fleet. The number of small vessels in the Danish Norway pout fishing fleet has decreased significantly and the relative number of large vessels has increased in the latest years. Furthermore, there was found no trends in CPUE between vessel categories over time. For these reasons the CPUE indices used in the regression has been obtained from pooled catch and effort data over the years 1994-present assessment year by vessel category in order to obtain and include estimates for all vessel categories also for the latest years where no observations exists for the smallest vessels groups.

The conclusion of the discussion in the working group of these analysis results was that further analysis and exploration of data is necessary before suggesting an alternative standardization method and alternative division of commercial fishery tuning fleets to be used in the assessment. This should be done in a coming benchmark assessment of the stock.

Parameter estimates from regressions of ln(CPUE) versus ln(average GRT) by period together with estimates of standardized CPUE to the group of Danish 175 GRT industrial fishery trawlers is shown for the period 1994-2004 in this quality control handbook below.

The regression model used in effort standardisation is the following:

Regression models: $CPUE=b*GRT^{a}$ => ln(CPUE)=ln(b)+a*ln((GRT-50))

Parameter estimates from regressions of ln(CPUE) versus ln(average GRT) by period together with estimates of standardized CPUE to the group of Danish 175 GRT industrial fishery trawlers is used to standardize effort in the commercial fishery tuning fleet used in the Norway pout assessment. Parameter estimates for the period 1994-2004 is the following:

YEAR	SLOPE	INTERCEPT	R-SQUARE	CPUE(175 TONNES)
1994-2004	0.18	18.88	0.77	32.86

Norwegian effort data

In 1997, Norwegian effort data were revised as described in sections 13.1.3.1 and 1.3.2 of the 1997 working group report (ICES CM 1998/Assess:7). Furthermore, in the 2000 assessment Norwegian average GRT and Effort data for 1998-99 were corrected because data from ICES area IIa were included for these years in the 1998-99 assessments. Observed average GRT and effort for the Norwegian commercial fleets are given in the input data to the yearly performed assessment. This information has been put together in the report of the ICES WGNSSK meeting in 2004 (ICES WGNSSK (2005)).

Danish effort data

In each yearly assessment the input data as CPUE data by vessel size category and year for the Danish commercial fishery in area IVa is given. This is based on fishing trips where total catch included at least 70 % Norway pout and blue whiting per trip, and where Norway pout was reported as main species in catch in the logbook per fishing day and fishing trip. There has been a relative reduction in the number and effort of small vessels and an increase for the larger vessels in the fleet in the latest years. Furthermore, it appears clearly that there is big difference in CPUE (as an indicator of fishing power) between different vessel size categories (BRT). Accordingly, standardization of effort is necessary when using a combined commercial fishery tuning fleet in the assessment including several vessel categories. Minor revisions (up-dating) of the Danish effort and catch data used in the effort standardization and as input to the tuning fleets have been made for the 2001 assessment.

Exploration of methods for effort standardization

With respect to further exploration of the effect of using effort standardization and using a combined Danish and Norwegian commercial fishery tuning fleet in the Norway pout assessment different analyses have been made in relation to the benchmark assessment in 2004. This was done to investigate alternative standardization methods and alternative division of the commercial fishery assessment tuning fleet used in the assessment. The results of these analyses were presented to the working group and were discussed here in 2004.

Analysis of variance (GLM-analyses) of catch, effort and log transformed CPUE data on trip basis for the Danish commercial fishery for Norway pout during the period 1986 to 2004 showed statistical significant differences in catch rates between different GT-groups, years, quarters of years (seasons), and fishing areas, as well as statistical significant first order interaction effects between all of these variables. The detailed patterns in this variation are not clear and straight forward to conclude on.

It has not yet been possible to obtain disaggregated effort and catch data by area and vessel size (GT-group) from the Norwegian Norway pout fishery to perform similar analyses for the Norwegian fishery.

Also it is not possible to regenerate the historical time series (before 1996) of catch numbers at age in the commercial fishery tuning fleet by nation which is only available for the combined Danish and Norwegian commercial tuning fleet. The reason for this is partly that there is no documentation of historical allocation of biological samples (mean weight at age data) to catch data (catch in weight) in the tuning fleet in order to calculate catch number at age for the period previous to 1996 for both nations, and partly because it seems impossible to obtain historical biological data for Norway pout (previous to 1996) from Norway. Alternative division of the commercial fishery tuning fleet would, thus, need new allocation of biological data to catch data for both the Danish and Norwegian fleet, and result in a significantly shorter Norwegian commercial fishery tuning fleet time series, and a historically revised Danish commercial fishery tuning fleet with new allocation of biological data to catch data. Revision of the tuning fleet would, furthermore, need analyses of possible variation in biological mean weight at age data to be applied to different fleets, as well as of the background for and effect of this possible variation.

Standardized effort data

The resulting combined and standardized Danish and Norwegian effort for the commercial fishery used in the assessment is presented in the input data to the yearly performed assessment, as well as the combined CPUE indices by age and quarter for the commercial fishery tuning fleet.

The seasonal variation in effort data is one reason for performing a seasonal VPA.

12.2.2 Biological data

Age reading

There are no reports of age reading problems of Norway pout otoliths, no indications of low quality of the age length keys used in the assessment of this stock.

Weight at age

Mean weight at age in the catch is estimated as a weighted average of Danish and Norwegian data. Historical levels and variation in mean weight at age in catch by quarter of year is shown in Figure 12.2.1 in the 2004 benchmark assessment in the 2004 ICES WGNSSK Report (ICES WGNSSK (2005)). In general, the mean weights at age in the catches are variable between seasons of year. The same mean weight at age in the stock is used for all years. Mean weight in catch is not used as estimator of weight in the stock partly because the smallest 0-group fish are not fully recruited to the fishery in 3rd quarter of the year.

Maturity and natural mortality

Spawning in the North Sea takes place mainly in the northern part in the area between Shetland and Norway. Around 10 % of the Norway pout reach maturity already at age 1, however, most individuals reach maturity at age 2.

The same proportion mature and natural mortality are used for all years in the assessment. The natural mortality is set to 0.4 for all age groups in all seasons that result in an annual natural mortality of 1.6 for all age groups. The proportion mature used is 0% for the 0-group, 10% of the 1-group and 100% of the 2+-group independent of sex.

In the 2001 and 2002 assessment exploratory runs were made with revised input data for natural mortality based on the results from two papers presented to the working group in 2001, (*both papers published in ICES J. Mar. Sci. in 2002, Sparholt, Larsen and Nielsen 2002a,b).* This was not explored further in the 2003 up-date assessment but this year benchmark assessment of the stock includes an exploratory run with revised natural mortalities. These revised natural mortalities are given in Table 12.2.3 in the 2004 ICES WGNSSK Report (ICES WGNSSK (2005)).

The resulting SSB, TSB (3rd quarter of year), TSB (1st quarter of year) and F for the final exploratory run was compared to those for the accepted run with standard settings. It appears that the implications of these revised input data are very significant. The working group in 2002 suggested that an assessment with partly the traditional settings (constant M) and a new assessment with the revised values for M were made for at least a 3 year period in order to compare the output and the performance of the assessments before the working group decided on final adoption of the revised values for M to be used in the assessment. This attitude was adopted by the Working Group again in the 2004 benchmark assessment where a exploratory run with revised values for M was performed as well. The results of the exploratory runs have been consistent throughout the 3 years of exploratory runs.

Research results on population dynamics parameters (e.g. natural mortality and maturity)

Investigations on population dynamics (natural mortality, distribution, and spawning and maturity as well as growth patterns) of Norway pout in the North Sea are ongoing. Exploratory runs of the SXSA model was presented in the 2001 and 2002 assessment reports as well as in the 2004 assessment (Norway pout benchmark assessment) with revised input data for natural mortality by age based on the results from two papers presented to the working group in 2001, (later published in *Sparholt, Larsen and Nielsen, 2002a,b*). The resulting SSB, TSB (3^{rd} quarter of year), TSB (1^{st} quarter of year) and F for the final exploratory run was compared to those for the accepted run with standard settings. It appears that the implications of these revised input data are very significant. The working group in 2002 suggested that an assessment with partly the traditional settings (constant M) and a new assessment with the revised values for M were made for at least a 3 year period in order to compare the output and the performance of the assessments before the working group decided on final adoption of the revised values for M to be used in the assessment. This attitude was adopted by the working group again in the 2004 benchmark assessment where a exploratory run with revised values for M was performed as well. The results of the exploratory runs have been consistent throughout the 3 years of exploratory runs.

Preliminary results from an analysis of regionalized survey data on Norway pout maturity is presented in a Working Document to the 2000 meeting of the Working Group (*Larsen, Lassen, Nielsen and Sparholt,2001* in ICES C.M.2001/ACFM:07).

12.2.3 Assessment tuning fleet data and indices (general)

Revision of assessment tuning fleets (survey CPUE data and commercial fishery CPUE data) in the 2004 benchmark assessment:

Revision of the Norway pout assessment tuning fleets was performed during the 2004 benchmark assessment. The background for this, the results and the conclusions from the analyses in relation to this are described here in the stock quality handbook as well as in the benchmark assessment in the working group report from 2004.

Revision of the Norway pout assessment tuning fleets during benchmark assessment have been based partly on cohorte analyses and analyses of correlations within and between the different tuning fleet indices by age group, as well as on the results from a row of exploratory assessment runs described under section 12.3 of the 2004 benchmark assessment (ICES WGNSSK (2005)) which analyses the performance of the different tuning fleets in the assessment. The exploratory assessment runs also give indications of possible catchability patterns and trends in the fishery over time within the assessment period. The analyses of the tuning fleet indices are presented in the benchmark assessment 2004 (ICES WGNSSK (2005)) Figures 12.2.3-12.2.8 and Tables 12.2.9-12.2.12.

An overview over the resulting tuning data and fleets used in the assessment during different time periods are shown in the table over tuning data in section C below.

12.2.4 Survey data

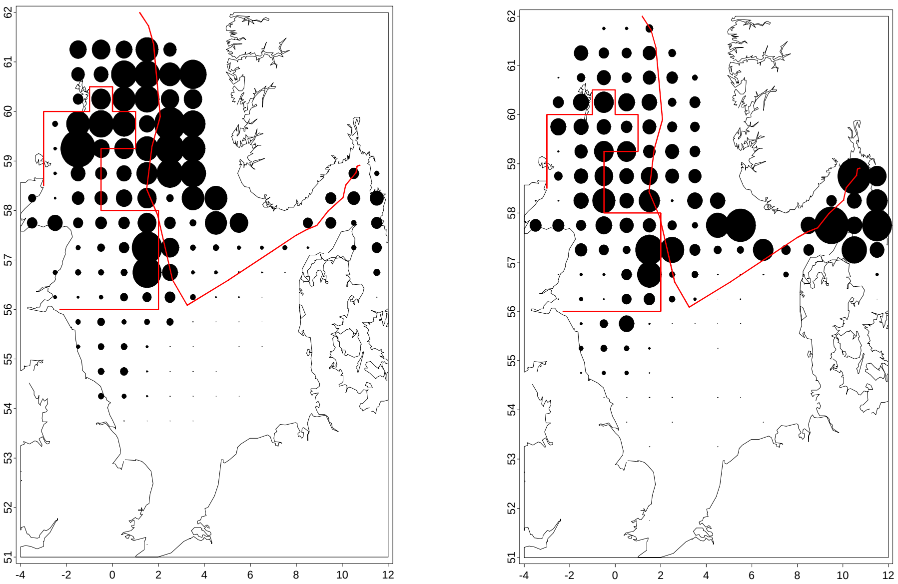
Survey index series of abundance of Norway pout by age and quarter are for the assessment period available from the IBTS (Q1 and Q3) and the EGFS (Q3) and the SGFS (Q3). The SGFS data from 1998 onwards should be used with caution due to new survey design (new vessel from 1998 and new gear and extended survey area from 1999). The 0-group indices from this survey have accordingly not been used in the assessment tuning fleet for this survey previous to the 2004 benchmark assessment. The index for the 0-group from SGFS changed with an order of magnitude in the years after the change in survey design compared to previous years (Table 12.2.8, ICES WGNSSK (2005)). The EGFS data from previous to 1992 should be used with caution as the survey design shifted in 1992. This change in survey design has until 2004 been accounted for by simply multiplying all indices with a factor 3.5 for all age groups in the years previous to 1992 in order to standardize it to the later indices. The EGFS survey indices for Norway pout has been revised in the 2004 assessment compared to the previous years assessment for the 1996, 2001, 2002, and 2003 indices. In previous years assessments (before 2004) the full EGFS survey time series for all age groups have been included as an assessment tuning fleet. Time series for IBTS Q3 are only available from 1991 and onwards. The 3rd quarter IBTS and the EFGS and SGFS are not independent of each other as the two latter is a part of the first. Accordingly, the following changes have been made for the survey tuning index series in the 2004 benchmark assessment (also shown in the tuning series overview table in section C):

1. The IBTS Q3 for the period 1991-2003 has been included in the assessment. This survey has a broader coverage of the Norway pout distribution area compared to the EGFS and SGFS isolated. However, as this survey index is not available for the most recent year to be used in the seasonal assessment it has been chosen to exclude the 0- and 1-group indices from the IBTS Q3 in order to allow inclusion of the 0- and 1-group indices from the SGFS and EGFS which are available for the most recent year in the assessment. Accordingly, the IBTS Q3 tuning fleet for age 2 and age 3 has been included in the assessment as a new tuning fleet. The SXSA demands at least two age groups in order to run which is the reason for including both age 0 and age 1 under the EGFS and SGFS tuning fleets and not including age 1 in the IBTS Q3 tuning fleet.

2. The SGFS for age group 0 and 1 for the period 1998 and onwards has been used as tuning fleet in the assessment. The short time series is due to the change in survey design for SGFS as explained above. The quarter 3 0-group survey index for SGFS is back-shifted to the final season of the assessment in the terminal year, i.e. to quarter 2 of the assessment year in order to include the most recent 0-group estimate in the assessment.

3. The EGFS for age group 0 and 1 for the period 1992 and onwards has been used as tuning fleet in the assessment. The shorter time series is due to the change in survey design for EGFS as explained above. Furthermore, there is a good argument for excluding the age 2-3 of the EGFS as the within survey correlation between the age groups 1-2 and 2-3 is very poor while the within correlation between age groups 0-1 is good. The quarter 3 0-group survey index for EGFS is back-shifted to the final season of the assessment in the terminal year, i.e. to quarter 2 of the assessment year in order to include the most recent 0-group estimate in the assessment.

4. The IBTS Q1 tuning fleet has remained unchanged compared to previous years assessment.



IBTS Quarter 1 IBTS Quarter 3

Figure Q5.4. IBTS mean CPUE (numbers per hour) by quarter during the period 1991-2004. The area of the circles is proportional to CPUE. The IBTS surveys do only cover areas within the 200 m depth zone. The “Norway pout box” and the boundary between the EU and the Norwegian EEZ are shown on the map. The maps are scaled individually.

12.2.5 Commercial CPUE data

Combined CPUE indices by age and quarter for the Danish and Norwegian commercial fishery tuning fleet is calculated from effort data obtained from the method of effort standardization of the commercial fishery tuning fleet described under section B.1 and vessel category specific catches by area. CPUE is estimated on a quarterly basis for the Danish and Norwegian commercial fleets.

The resulting combined, commercial fishery CPUE data by age and quarter used in tuning of the assessment based on the combined and standardized Danish and Norwegian effort data and on catch data for the commercial fishery is presented in the input data to the yearly performed assessment.

Commercial fishery tuning fleets

In addition to the analyses of the commercial fishery assessment tuning fleet as described above (effort standardization) the quarterly CPUE indices of the commercial fishery tuning fleet were analyzed during the 2004 benchmark assessment.

1. The indices for the 0-group in 3rd quarter of the year have been excluded from the commercial fishery tuning fleet. The main argumentation for doing that is that this age group indicate clear patterns in trends in catchability over the assessment period as shown in the single fleet/quarter assessment runs in section 12.3 (Figure 12.3.7), ICES WGNSSK (2005). Secondly, there is no correlation between the commercial fishery quarter 3 0-group index and the commercial fishery quarter 4 0-group index, and no correlation between the quarter 3 commercial fishery 0-group index in a given year with the 1-group index of the 3rd quarter commercial fishery 1-group index the following year.

2. The 2nd quarter indices for all age groups of the 2nd quarter have been excluded from the commercial fishery tuning fleet. This is mainly because of indications of strong trends in catchability over time in the assessment period for this part of the tuning fleet for all age groups as indicated by single fleet tuning runs in the section 12.3 (Figure 12.3.7), ICES WGNSSK (2005).. Also, the within quarter and between quarter correlation indices are in general relatively poor. The cohorte analyses of the 2nd quarter commercial fishery indices indicate as well relative changes over time.

12.3 Historical Stock Development

From September 2006 the SMS (**S**tochastic **M**ulti **S**pecies model; Lewy and Vinther, 2004) has been used to estimate quarterly stock numbers and fishing mortalities for Norway pout in the North Sea and Skagerrak as the standard assessment method. The catch at age analysis was carried out according to the specifications given in the present stock quality handbook.

SMS

SMS (**S**tochastic **M**ulti **S**pecies model; Lewy and Vinther, 2004) is an age-structured multi-species assessment model which includes biological interactions. However, the model can be used with one species only. In “single species mode” the model can be fitted to observations of catch-at-age and survey CPUE. SMS uses maximum likelihood to weight the various data sources assuming a log-normal error distribution for both data sources. The likelihood for the catch observation is then as defined below:

$$L_C = \prod_{a,y,q} \frac{1}{\sigma_{catch}(aa)\sqrt{2\pi}} \exp(-(\ln(C(a,y,q)) - \ln(\hat{C}(a,y,q)))^2 / (2\sigma^2_{catch}(aa)))$$

where C is the observed catch-at-age number, $\hat{C}$ is expected catch-at-age number, y is year, q is quarter, a is age group, and aa is one or more age groups.

SMS is a “traditional” forward running assessment model where the expected catch is calculated from the catch equation and F-at-age, which is assumed to be separable into an age selection, a year effect and a season (year, half-year, quarter) effect.

As an example, the F model configuration is shown below for a species where the assessment includes ages 0–3+ and quarterly catch data and quarterly time step are used:

$$F = F(a_a) \times F(y_y) \times F(q_q),$$

with F-components defined as follows:

F(*a*):

Age 0	Fa_0
Age 1	Fa_1
Age 2	Fa_2
Age 3	Fa_3

F(*q*):

	q1	q2	q3	q4
Age 0	0.0	0.0	Fq	0.25
Age 1	$Fq_{1,1}$	$Fq_{1,2}$	$Fq_{1,3}$	0.25
Age 2	$Fq_{2,1}$	$Fq_{2,2}$	$Fq_{1,3}$	0.25
Age 3	$Fq_{3,1}$	$Fq_{3,2}$	$Fq_{3,3}$	0.25

F(*y*):

Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	…
1	Fy_2	Fy_3	Fy_4	Fy_5	Fy_6	Fy_7	Fy_8	Fy_9	….

The parameters $F(a_a)$, $F(y_y)$ and $F(q_q)$ are estimated in the model. $F(q_q)$ in the last quarter and $F(y_y)$ Fy in the first year are set to constants to obtain a unique solution. For annual data, the $F(q_q)$ is set to a constant 1and the model uses annual time steps.

One *F*(*a*) vector can be estimated for the whole assessment period, or alternatively, individual *F*(*a*) vectors can be estimated for subsets of the assessment periods. A separate *F*(*q*) matrix is estimated for each *F*(*a*) vector.

For the CPUE time series the expected CPUE numbers are calculated as the product of an assumed age (or age group) dependent catchability and the mean stock number in the survey period.

The likelihood for CPUE observations, L_S, is similar to L_C, as both are assumed lognormal distributed. The total likelihood is the product of the likelihood of the catch and the likelihood for CPUE ($L = L_C * L_{\text{CPUE}}$,). Parameters are estimated from a minimisation of -log(*L*).

The estimated model parameters include stock numbers the first year, recruitment in the remaining years, age selection pattern, and the year and season effect for the separable *F* model, and catchability at age for CPUE time series.

SMS is implemented using ADmodel builder **(**Otter Research Ltd.), which is a software package to develop non-linear statistical models. The SMS model is still under development, but has extensively been tested in the last year on both simulated and real data.

SMS can estimate the variance of parameters and derived values like average *F* or SSB from the Hessian matrix. Alternatively, variance can be estimated by using the built-in functionality of the AD-Model builder package to carry out Markov Chain Monte Carlo simulations (Gilks et al. 1996), MCMC, to estimate the posterior distributions of the parameters. For the historical assessment, period uniform priors are used. For prediction, an additional stock/recruitment relation including CV can be used.

SXSA

Until April 2006 the SXSA (Seasonal Extended Survivors Analysis: Skagen (1993)) was used to estimate quarterly stock numbers and fishing mortalities for Norway pout in the North Sea and Skagerrak as the standard assessment method. The catch at age analysis was carried out according to the specifications given in the present stock quality handbook.

The SXSA (Seasonal Extended Survivors Analysis: Skagen (1993)) is used to estimate quarterly stock numbers and fishing mortalities for Norway pout in the North Sea and Skagerrak. The assessment is analytical using catch-at-age analysis based on quarterly catch and CPUE data. The assessment is considered appropriate to indicate trends in the stock and immediate changes in the stock because of the seasonal assessment taking into account the seasonality in fishery. The seasonal model makes it possible to include and use the most recent information from the fishery and from the surveys at the assessment in , and provides a gives at the assessment time an The seasonal variation in effort data is one reason for performing a seasonal VPA.

In the options chosen in the SXSA for the Norway pout assessment the catchability, r, per age and quarter and fleet is assumed to be constant within the period 1983-2005 where the estimated catchability, rhat, is a geometric mean over years by age, quarter and tuning fleet. In the 2004 benchmark assessment exploration of trends in tuning fleet catchabilities was investigated by single fleet runs with the SXSA. The accepted assessment with revised tuning fleets in the 2004 benchmark assessment assume constant catchability.

Tuning is performed over the period 1983 to present producing log residual (log(Nhat/N)) stock numbers and survivor estimates by year, quarter, age and tuning fleet. The contributions from the various age groups to the survivor estimates by year and quarter and fleet are in the SXSA combined to an overall survivors estimate, shat, estimated as the geometric mean over years of log(shat) weighted by the exponential of the inverse cumulated fishing mortality as described in Skagen (1993).

Comparison of SXSA and SMS model output and assessment model evaluation:

The September 2006 limited benchmarking considered the most appropriate assessment model to be used and considered in order to describe the dynamics of the stock.

Previously, the SXSA (Seasonal Extended Survivors Analysis) model has been used in the assessment of Norway pout. The method is described in the quality control handbook.

The SMS is like the SXSA a seasonal based model being able to deal with assessment of a short lived species (where there are only few age groups in the VPA) and seasonality in fishing patterns.

The SMS (Stochastic Multi Species model; see section 1.3.3 and the stock quality handbook) objective functions (in "single species mode") for catch at age numbers and survey indices at age time series are minimized assuming a log-normal error distribution for both data sources. The expected catch is calculated from the catch equation and F at age, which is assumed to be separable into a year effect, an age selection, and an age-season selection. The SMS assumes constant seasonal and age-dependent F-pattern. SMS uses maximum likelihood to weight the various data sources. For years with no fishery (here 2005 and 2006 in this assessment) SMS simply set F to zero and exclude catch observations from the objective function. In such case only the survey indices are used in the model. The SXSA needs catch input for all quarters, all years, and in years with no catch infinitive small catch values have to be put into the model as an approximation. SXSA handles catch at age observation as exact, i.e. the SXSA does not rely on the assumption of constant exploitation pattern in catch at age data as for example the SMS does. As a stochastic model, SMS uses catch observations as observed with noise, but assumes a separable F. Both assumptions are violated to a certain degree.

SMS being a stochastic model can estimate the variance of parameters and derived values like average F and SSB. The SXSA is a deterministic model.

The Norway pout assessment includes normally catches from the first and second quarter of the assessment year. SMS uses survey indices from the third quarter of the assessment year under the assumption that the survey is conducted the very beginning of the third quarter. SXSA model has not that option and data from the third quarter of the assessment year can only be used by "back-shifting" the survey one quarter back in time.

The SMS model has so far assumed recruitment in 3rd quarter of the year and not in the start of the 2nd quarter of the year which the SXSA use. Actual recruitment is in the 2nd quarter of the year. Consequently, the assumed natural mortality of 0.4 for the 0-group in first and second quarter of the year is not included in the SMS compared to use of this in 2nd quarter of the year for the SXSA for the 0-group.

The diagnostics and results of the exploratory runs for comparison between SXSA and SMS assessment are shown in the WGNSSK September 2006 report (ICES WGNSSK, 2007). The models give comparable results and the same perception of the Norway pout stock dynamics, which have been documented in the 2004 benchmark assessment, the September 2005 and April 2006 update assessments (see above), as well as in the September 2006 exploratory runs. However, as SMS is a stochastic model it also provides uncertainties of the results. Accordingly, SMS was in September 2006 chosen as the new standard assessment model for Norway pout. However, it was decided that near future assessments should also include a comparative, exploratory SXSA assessment.

Comparison of output from a seasonal based assessment model (the SXSA model) and an annual based (the XSA model):

In the 2004 benchmark assessment of the Norway pout stock a comparison of the output, performance and weighting of tuning tuning fleets of the seasonal based SXSA model and the annual based XSA model was performed. The results are in detail presented in the 2004 ICES WGNSSK Report (ICES WGNSSK (2005)). The differences in results of output SSB, TSB and F between the two assessment runs were small. Both model runs gave in general similar weighting to the different tuning fleets used. This was based on comparison of runs of the accepted assessment (by the WG and ACFM) in 2003.

Summary of conclusions from the exploratory catch at age analyses in the 2004 benchmark assessments:

A number of exploratory runs were carried out as part of the benchmark assessment in 2004 in order to evaluate performance of stock indices as tuning fleets and also to compare performance of the seasonal XSA (SXSA) to the 'conventional' XSA. The exploratory runs are described in the 2004 working group report. The conclusions of the explorative runs in the 2004 benchmark assessment were the following:

1) Catch and CPUE data for the assessment of Norway pout are very noisy, but internally consistent. The assessment, using SMS, gave very similar results irrespective of the CPUE time series used. Four of the seven CPUE series are data from the commercial fishery and these data are already included in the catch data. Therefore, these commercial fleets will not give a signal very different from the catch data. None of the scientific surveys had a clear signal different form the signal in the catch data.

2) A comparison of the revised 2004 assessment with new tuning fleets compared to the previous 2003 assessment showed that the estimates of the SSB, recruitment and the average fishing mortality of the 1- and 2-group for the revised, accepted assessment

were in general consistent with the estimates of previous years assessment. Only historical F seemed to slightly deviate from the previous years assessment.

3) The overall performance and output for the XSA model was similar to the SXSA model, so the working group in 2004 decided to continue using SXSA. Both methods did overall not show insensible to the tuning fleet indices used in the assessment.

In the up-date assessment in 2005 output of the SXSA model was compared to output from the SMS and SURBA model to evaluate the use of the SXSA model in a situation with having zero catches in the terminal year of the assessment. The results showed similar output of the different models and the same perception of the stock. The results are in detail presented in the 2005 ICES WGNSSK Report (ICES WGNSSK (2006)).

Software used:

SMS program available from Morten Vinther, DIFRES, Copenhagen (Final assessment run September 2006; Exploratory run, 2004 and 2005 and April 2006).

(SXSA program available from ICES. Used for the final assessment until (and including) April 2006; Exploratory run, September 2006).

(XSA program available from ICES; Exploratory run, 2004)

(SURBA program available from Coby Needle, FRS, Aberdeen, needlec@marlab.ac.uk: Exploratory run, 2005)

The XSA and SURBA cannot perform quarterly based assessment.

Model Options chosen

The parameter settings and options of the SMS and SXSA has been the same in all recent years assessments, except that recruitment season to the fishery has been backshifted from 3rd quarter of the year to 2nd quarter of the year when running SXSA in order to gain benefit from the most recent 0-group indices from the 3rd quarter surveys (SGFS and EGFS as explained above) in the assessment. This has not been necessary in the SMS assessment in September 2006.

No time taper or shrinkage is used in the catch at age analysis. The three surveys and the seasonally (by quarter) divided commercial fleets are all used in the tuning.

The following parameters were used:

```
Year range:
       1983 - 2006
Seasons per year:                                                   4
The last season in the last year is season:              3
Youngest age:                                                       0
Oldest true age:
       3
Plus group:                                                         No
plus group in SMS (4+-group in SXSA)
Recruitment in season:                                              3
Spawning in season:                                                 1
Single species mode:                                                Yes,
number of species = 1
```

The following fleets were included:

```
Fleet  1: (Q1: Age 1-3; Q2: None; Q3: Age 1-3; Q4: Age 0-2) commercial
q134
Fleet  2:                                                   ibtsq1
       (Age 1-3)
Fleet  3:                                                   egfsq2
       (Age 0-1)
```

```
Fleet  4:                                                 sgfsq2
       (Age 0-1)
Fleet  5:                                                 ibtsq3
       (Age 2-3)
```

Data were input from the following files:

```
Catch in numbers:                                         canum.in
Weight in catch:                                          weca.in
Weight in stock:                                          west.in
Natural mortalities:                                      natmor.in
Maturity ogive:                                           propmat.in
Tuning data (CPUE):                                       fleet_catch.in
Tuning fleet names:                                       fleet_names.in
Tuning fleet settings:                                    fleet_info.dat
```

The following tuning fleet options were used in the SMS model (summary from fleet_info.dat):

```
Minimum CV of CPUE observations:            0.2

Fleet specific options:
1-2, First year last year,
3-4. Alpha and beta - the start and end of the fishing period for the fleet
given as
     fractions of the season (or year if annual data are used)
5-6  First and last age,
7.   last age with age dependent catchability,
8.   last age for stock size dependent catchability (power model), -1 indicated
no
     ages uses power model
9.   season for survey,
10.  number of variance groups for estimated catchability
     by species and fleet
1 commercial q1:                                          1983 2004 0 1 1 3 3
-1 1 3
1 commercial q3:                                          1983 2004 0 1 1 3 3
-1 3 3
1 commercial q4:                                          1983 2004 0 1 0 2 2
-1 4 3
2 IBTS q1:                                                1983 2006 0 1 1 3 3
-1 1 3
3 EGFS q 3:                                               1992 2005 0 1 0 1 1
-1 3 2
4 SGFS q3:                                                1998 2006 0 0 0 1 1
-1 3 2
5 ibts_q3:                                                1991 2005 0 1 2 3 3
-1 3 2
Variance groups:
Fleet: 1 season 1:                                 1 2 3
Fleet: 1 season 3:                                 1 2 3
Fleet: 1 season 4:                                 0 1 2
Fleet: 2:                                                 1 2 3
Fleet: 3:                                                 0 1
Fleet: 4:                                                 0 1
Fleet: 5:                                                 2 3
```

The following SMS model settings were used in the SMS model (summary from SMS.dat):

```
SSB/R relationship:                                       Geometric mean

Object function weighting:
First=catch observations                                                 1.0
Second=CPUE observations                                                 1.0
Third=SSB/R relations                                                    1.0
Minimum CV of commercial catch at age
observations option min.catch.CV):                                0.20
Minimum CV of S/R relation (option min.SR.CV):            0.20
No. of separate catch sigma groups by species:            4 (one variance
group by age)
Exploitation pattern by age and season:                   Age 0 (3rd-4th
quarter)
                                                   Age 1 (1st, 3rd, 4th quarter)
```

Ages 2-3 (1^{st}, 3^{rd}, 4^{th} quarter)

If tuning survey index has the value 0 then 5% of the
average of the rest of the observations are used
because the logarithm to zero can not be taken:
Minimum "observed" catch, negative value gives
percentage (-10 ~ 10%) of average catch in age-group
if option>0 and catch=0 then catch=option
if option<0 then catch=average(catch at age)*(-option)/100 -5

Assuming fixed exploitation pattern by age and season

Number of years with zero catch: 2 (2005, 2006)

In the SXSA used until April 2006 the following options were used:

The following options were used:
1: Inv. catchability:
2
  (1: Linear; 2: Log; 3: Cos. filter)
2: Indiv. shats:
2
  (1: Direct; 2: Using z)
3: Comb. shats:
2
  (1: Linear; 2: Log.)
4: Fit catches:
0
  (0: No fit; 1: No SOP corr; 2: SOP corr.)
5: Est. unknown catches:
0
  (0: No; 1: No SOP corr; 2: SOP corr; 3: Sep. F)
6: Weighting of rhats:
0
  (0: Manual)
7: Weighting of shats:
2
  (0: Manual; 1: Linear; 2: Log.)
8: Handling of the plus group:
1
  (1: Dynamic; 2: Extra age group)

Factor (between 0 and 1) for weighting the inverse catchabilities
at the oldest age versus the second oldest age (factor 1 means that
the catchabilities for the oldest age are used as they are):
0

Specification of minimum value for the survivor number (this is
Used instead of the estimate if the estimate becomes very low):
0

Iteration until convergence (setting 0):
0

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1983-present	0-3+	Yes
Canum	Catch at age in numbers	1983-present|	0-3+	Yes
Weca	Weight at age in the commercial catch	1983-present|	0-3+	Yes
West	Weight at age of the spawning stock at spawning time.	1983-present|	0-3+	No
Mprop	Proportion of natural mortality before spawning	Not relevant in SXSA|		
Fprop	Proportion of fishing mortality before spawning	1983-present|	0-1	Yes
Matprop	Proportion mature at age	1983-present|	1-3+	No, 10%age 1, 100% 2+
Natmor	Natural mortality	1983-present|	0-3+	No, 0.4 per quarter per age group

		2003 ASSESSMENT	2004, 2005, April 2006 ASSESSMENT	Sept. 2006 ASSESSMENT
Recruiting season		3rd quarter	2nd quarter (SXSA)	3rd quarter (SMS); 2nd quarter (SXSA)
Last season in last year		3rd quarter	2nd quarter (SXSA)	3rd quarter (SMS); 2nd quarter (SXSA)
Plus-group		4+	4+ (SXSA)	None (SMS); 4+ (SXSA)
FLT01: comm Q1				
	Year range	1982-2003	1982-2004	1982-2004
	Quarter	1	1	1
	Ages	1-3	1-3	1-3
FLT01: comm Q2			NOT USED	NOT USED
	Year range	1982-2003		
	Quarter	2		
	Ages	1-3		
FLT01: comm Q3				
	Year range	1982-2003	1982-2004	1982-2004
	Quarter	3	3	3
	Ages	0-3	1-3	1-3
FLT01: comm Q4				
	Year range	1982-2003	1982-2004	1982-2004
	Quarter	4	4	4
	Ages	0-3	0-3	0-2 (SMS); 0-3 (SXSA)
FLT02: ibtsq1				
	Year range	1982-2003	1982-2006	1982-2006
	Quarter	1	1	1
	Ages	1-3	1-3	1-3
FLT03: egfs				
	Year range	1982-2003	1992-2005	1992-2005
	Quarter	3	Q3 -> Q2	Q3 -> Q2
	Ages	0-3	0-1	0-1
FLT04: ibtsq3		NOT USED		
	Year range		1991-2005	1991-2005
	Quarter		3	3
	Ages		2-3	2-3
FLT05: sgfs				
	Year range	1982-2003	1998-2006	1998-2006
	Quarter	3	Q3 -> Q2	Q3 -> Q2
	Ages	0-3	0-1	0-1

Tuning data

12.4 Short-Term Projection

A deterministic short-term forecast is given for the stock. This was done for the Norway pout stock for the first time in 2004. In 2004 and 2005 the forecast is calculated as a stock projection up to 1st of January the following year. The projection up to 1st of January is based on the assessment estimate of recruitment in the assessment year. Mean catch weight at age are averaged over the last three years. Different F-scenarios are evaluated. A sensitivity analysis around the recruitment estimated was made in the 2005 forecast corresponding to a range of 75-125% of estimated recruitment in 2005. This was because the recruitment estimate in 2005 was only based on one index.

From April 2006 deterministic short-term prognoses were performed for the Norway pout stock. The forecast was calculated as a stock projection up to 1st of January 2008. The purpose of the forecast is to calculate possible catch of Norway pout in the year after the assessment year leaving a SSB at or above Bpa 1st of January the following year (B_{pa} = 82 000 t).

The projection is based on the SMS assessment estimate of stock numbers at age at the start of the assessment year. The forecast is using a geometric mean for the stock-recruitment relationship. The forecast is using the estimated average exploitation pattern for the whole period 1983-2004 from the SMS assessment output for the fishery in the year after the assessment year (as well as in the rest of the assessment year). The weight at age in catch used in the forecast is a 10 year average for the weight at age per quarter of year up to 2003 (2003 included). The constant weight at age by year and quarter of year used in the SMS assessment is also used in the forecast.

Ten percent of age 1 is mature and is included in SSB. Therefore, the recruitment in the year after the assessment year does influence the SSB in the following year.

Usually the recruitment in the year after the assessment year is assumed to be at 25% level of the long term geometric mean for the period 1984-2006. This conservative level has been chosen to take into account that the frequency of strong year classes seems to have decreased in the recent 10-15 year period compared to previously.

A management table is presented from the forecast. The objective set in relation to this is to set the fishing mortality and catch on a level that maintain spawning stock biomass above B_{pa} by 1st of January two years after the assessment year with a high probability (95% level).

Catch predictions for 0- and 1-groups are important as the fishery traditionally target the 0-group already in 3rd and (especially in) 4th quarter of the year as well as the 1-group in the 1st quarter of the following year. In the 2004 benchmark assessment it was shown that Survey indices in the 3rd quarter seems to predict strong 0-group year classes relatively well when comparing with 0-group indices from commercial fishery (4th quarter) and to 1-group survey indices the following spring.

The deterministic forecast is off course affected by that: (a) the potential catches are largely dependent on the size of a few year classes, (b) the large dependence on the strength of the recruiting 0-group year classes, and (c) added uncertainty (in assessment and potential forecast) arising from variations in natural mortality. However, the forecast is not dependent on any assumption about the strength of the new year class.

12.5 Biological Reference Points

Precautionary Approach reference points:

ICES CONSIDERS THAT:	ICES PROPOSES THAT:
B_{lim} is 50 000 t	B_{pa} be established at 82 000 t. Below this value the probability of below average recruitment increases.
	Note:

Technical basis:

$B_{lim} = B_{loss}$ = 50 000 t.	$B_{pa} = B_{lim}\, e^{1.645\, S}$: 82 000 t.
F_{lim} None advised.	F_{pa} None advised.

Biomass based reference points have in September 2006 (previously unchanged since 1997) been re-calculated and changed because B_{loss} has changed and because it has been decided to use the SMS assessment model compared to the previously used SXSA assessment model as the standard assessment method. The latter changes the absolute level of recruitment. The calculation of the new reference points has taken into consideration these changes.

B_{lim} is defined as B_{loss} and is based on the observations of stock developments in SSB (especially in 1989 and 2005) been set to 50 000 t. B_{pa} has been calculated from

$B_{pa} = B_{lim}\, e^{1.645\, S}$, where S is standard deviation (SD).

The SMS assessment model estimates (from the Hessian Matrix) a coefficient of variation (CV) of the SSB in the terminal year of 15 % (approximately equivalent to a SD of 0.15 in a log normal error distribution). A SD estimate around 0.15 is, however, not considered to reflect the real uncertainty in the assessment. Accordingly, a double value (2*SD = 0.3) has been chosen as the S-value for calculating B_{pa}. This SD-level of 0.3 also corresponds to the level for SD around 0.2-0.3 recommended to use in the manual for the Lowestoft PA Software.

The scenarios of B_{pa} using different SD-levels are the following: SD’s at 0.1, 0.2, 0.3 and 0.4 results in B_{pa}-values of respectively 59 000 t, 69 000 t, 82 000 t and 97 000 t, respectively.

The relationship between the previous Blim and Bpa (90 000 and 150 000 t) and the new values (50 000 and 82 000 t) are both 0.6, and accordingly, this relationship has not changed.

B_{lim} is 50 000 t, the lowest observed biomass

F_{lim} None advised.

F_{pa} None advised.

The scientific background for fisheries management:

There is no specific management objective set for this stock.

The population dynamics of Norway pout in the North Sea and Skagerrak are very dependent on changes caused by recruitment variation and variation in predation mortality (or other natural mortality causes). Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species. With present fishing mortality levels in recent years the status of the stock is more determined by natural processes and less by the fishery.

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species.

In managing this fishery, by-catches of other species should be taken into account.

Existing measures to protect other species should be maintained. See also Appendix 1.

12.6 Other Issues

There is no management objective set for this stock. With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery. There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. In managing this fishery by-catches of other species have been taken into account. Technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been used in managing this stock and the fishery.

Overview of some recent management measures and regulations relevant for the Norway pout fishery and stock (from STCEF, 2005):

In the agreed EU Council and EU-Norway Bilateral Regulation of Fisheries by-catch regulations in the Norway pout fishery have been established (e.g. EU Regulation No 850/98 (EU, 1998)). The by-catch regulations in force at present for small meshed fishery (16-31mm in mesh size) in the North Sea is that catch retained on board must consist of i) at least 90% of any mixture of two or more target species, or ii) at least 60% of any one of the target species, and no more than 5% of any mixture of cod, haddock, saithe, and no more than 15% of any mixture of certain other by-catch species. Provisions regarding limitations on catches of herring which may be retained on board when taken with nets of 16 to 31 mm mesh size are stipulated in EU Community legislation fixing, for certain fish stocks and groups of fish stocks, total allowable catches and certain conditions under which they may be fished. (EU, 1998) At current 40% herring is allowed in the Norway pout fishery.

12.7 Mesh size regulations in the North Sea and adjacent areas

Use of towed nets of any size mesh is permitted, however according to the mesh size in use there is an obligation to retain only particular species of fish. These tables are a simplified synopsis of measures in Council Regulation 850/98 and Commission Regulation 2056/2001.

	Conditions for use of towed gear (North Sea and West Scotland)	
Mesh size	**Main target species in North Sea**	**Synopsis of required catch percentages**
b.) 16 to 31mm	Norway pout, sprat	Minimum 60% of one species of Norway pout, sardine, sandeel, anchovy, eels, smelt and some non-human consumption species (with no more than 5% of cod, haddock or saithe, and some upper limits on the percentages of other species such as mackerel, squids, flatfish, gurnards, Nephrops), or at least 90% of any two or more of those species.

12.8 Areas closed to some fishing activities

During the 1960s a significant small meshed fishery developed for Norway pout in the northern North Sea. This fishery was characterized by relatively large by-catches, especially of haddock and whiting. In order to reduce by-catches of juvenile roundfish, the “Norway pout box” was introduced where fisherries with small meshed trawls were banned. The “Norway pout box” has been closed for industrial fishery for Norway pout since 1977 onwards (EC Regulation No 3094/86). The box includes roughly the area north of 56° N and west of 1° W.

(It is not possible to fully quantify the effect of the closure of the fishery inside the Norway pout box. Before closure, the Danish and Faeroes fisheries mainly took place in the northwestern North Sea and the Norwegian fishery in the Norwegian Trench (ICES 1977). Based on IBTS samples for the period 1991-2004 (Figure 6.2), 30.0% and 27.5% of Norway pout numbers were estimated to be inside the Norway pout box for the first and third quarter, respectively. It should be noted that the IBTS survey does not cover depths >200 m along the Norwegian Trench, and that no fishery inside the Norway pout box may contribute to overestimation of the abundance relative to area outside).

Area	**Characteristics, Location and Seasonality**	**Purpose**	**Defined in Regulation (EC):**
North-West of Scotland	Annual, closed to all fishing except static gear and pelagic fishing	Reduction of fishing mortality on VIa cod	Annex III 27/2004 (annual measure in place since 2004).
Norway pout box	Prohibited to retain more than 5% of the catch as Norway pout if they are caught within an area boounded by 56°N and the UK coast, 58°N 2°E, 58°N 0°30' W, 59°15' N 0°30'W, 59°15' N 1° E, 60° N 1° E, 60°N 0°, 60°30'N 0°, 60°30'N and the coast of the Shetland Islands, 60°N and the coast of the Shetland Islands, 60°N 3°W, 58°30'N 3°W	Protection of juvenile gadoids (cod, haddock) caught in mixtures with Norway pout)	Article 26 of Regulation 850/98

	58°30'N and the coast of the mainland UK.		

12.9 Minimum landing sizes

These sizes are defined in Annex XII to Regulation 850/1998, though some changes are in effect for 2005 by means of the TAC and quota regulation (Regulation 27/2005). Here sizes for some of the main commercial species only are stated.

Species	Minimum Landing Size in 2005, as North Sea/IIIa	Regulation
Norway pout	None	850/1998

12.10 Quotas relevant to the European Community

Quotas have been established by the Community as follows for the relevant species. These figures refer to Total Allowable Catches in Community waters and to quotas for the Community in Norwegian waters.

Year	Sandeel, IIa+IIIa+IV EC zone	Sandeel, IVa, Norway zone	Norway Pout IIa+IIIa+IV, EC zone	Norway pout, Norway zone	Angler-fish, IIa+IVa, EC zone	Angler-fish, IVa Norway Zone
2000	1020000	150000	220000	50000[1]	17660	in 'others'
2001	1020000	150000	211200	50000[1]	14130	in 'others'
2002	918000	150000	198000	50000[1]	10500	in 'others'
2003	918000	131000	198000	50000[1]	7000	in 'others'
2004	826200	131000	198000	50000[1]	7000	in 'others'
2005	660960	10000	0	5000[2]	10314	1800

[1] Including mixed horse mackerel.

[2] Including mixed horse mackerel, and only as by-catches.

Year	Anglerfish Vb, VI, XII, XIV (EC)	Horse mackerel, IIa (EC), IV(EC)	Horse mackerel, Vb (EC waters), VI, VII, VIIIa,b,d,e, XII, XIV	Industrial fish, IV (Norwegian waters)	Other species, IIa, IV, VIa N of 56°30, allocation to NO, FAR, no restriction for EC.	Other species, Norwegian waters of IV
2000	8000	51000	240000	800[1]	5400	11000
2001	6400	51000	240000	800[1]	5400	11000
2002	4770	58000	150000	800[1]	5400	11000
2003	3180	50267	130000	800[1]	5400	11000
2004	3180	50267	137000	800[1]	5400	11000
2005	4686	42727	137000	800[1]	5120	7000

[1] Of which maximum 400 tonnes of horse mackerel.

12.11 Effort limits

Days-at-Sea

Since 2003, the Community has limited the number of days that a fishing vessel can be out of port and fishing in the North Sea and adjacent areas. This is implemented through annexes to the TAC and Quota Regulations (2341/2002, 2287/2003, 27/2005). Days at sea may be transferred between vessels with an adjustment for differences in engine power between the vessels. Additional days have been allocated to some member states in respect of decommissioning taking place since 2001.

The baseline days-at-sea allocations (i.e. before additions to take account of decommissioning) were as follows:

Gear type	**Otter trawl, 100mm (90mm in IIIa) or over**	**Beam trawls, 80mm or over**	**Static demersal nets**	**Demersal longlines**	**Otter trawls 70-99mm (70-89mm in Skagerrak)**	**Trawl fishery 16-31mm**
Typical target species	Cod, haddock, whiting	Plaice and sole	Cod, turbot	Cod	Nephrops	Norway pout, sandeel
2003	9	15	16	19	25	23
2004	10	14	14	17	22	20
2005	10 *	13	13	16	21	19

(*) - including one additional day allowable where administrative sanctions are in place.

Technical measures by Norway

12.12 TACs and effort limits

Norway has no national quotas on anglerfish, sandeel, Norway pout or horse mackerel, for Norwegian vessels in the Norwegian economic zone. These fisheries are regulated by technical measures and effort regulations.

12.13 Technical Measures

The Norwegian technical regulations are generally designed to avoid catches of non-targeted species and/or fish below the minimum size. The discard ban on commercially important species is considered a cornerstone of this policy. Other important elements are the surveillance, monitoring and inspections at sea by the Coastguard, the obligation to change fishing grounds, prohibition against fishing for particular species during specific periods or in specific areas, and the development of, and the requirement to use selective fishing gear. The philosophy behind the Norwegian technical regulations is to enable the fishermen to meet their obligation to avoid illegal catches.

The technical regulations are summarised in “Regulations relating to sea-water fisheries” of 22 December 2004.This stipulates the discard ban, the percentage composition of the catch that may be legally caught according to area and type of fishing gear being used, the characteristics of fishing gear that may be used in the fishery on certain species or in different areas, the minimum catching sizes and specific measures to limit catches of fish under the minimum catching size, regulations of mesh design, mesh sizes, selectivity devices etc.

When fishing demersal species for human consumption in the North Sea with trawl or Danish seine, it is prohibited to use gear where the mesh size of any part of the gear is less than 120 mm. In the Norwegian saithe fishery in the EU zone 110 mm may be used in accordance to the EU regulation in the EU zone.

In the North Sea gill net fisheries for cod, haddock, saithe, plaice, ling, pollack and hake it is prohibited to use gill nets where the full mesh size is less than 148 mm. In the fishery for anglerfish the minimum mesh size is 360 mm and in the halibut fishery the minimum mesh size is 470 mm.

Only the most relevant regulations with regard to anglerfish, sandeel, Norway pout and horse mackerel will be highlighted below.

12.14 Sandeel and Norway pout

Summary of the Norwegian regulations for sandeel and Norway pout:

- The sandeel fishery is closed from 25 June to 31 March
- Norway pout may only be fished as bycatch in the mixed industrial fishery in all areas under Norwegian fisheries jurisdiction
- Two areas (the Patch bank and the Egersund bank) in the Norwegian economic zone are closed to fishing for Norway pout, sandeel, and blue whiting
- Licensing scheme for vessels fishing with small mesh trawl
- Reduction capacity scheme for vessels fishing with small mesh trawl.

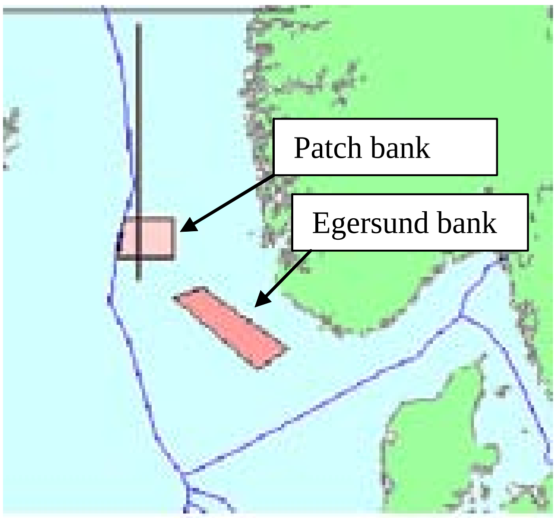
ACFM recommended that effort in 2005 should not exceed 40 % of the effort in 2004. Based upon this advice, the sandeel season in the Norwegian economic zone was further shortened in 2005. The sandeel season, defined as the period when smaller mesh size than 16 mm can be used, was 8 months (March – October) in 2003 and earlier. This season was reduced to April – September in 2003 and to the period 1 April to 23 June in 2005.

Furthermore, as a consequence of the advice on effort reduction Norway and the EU agreed to reduce the exchange of sandeel quotas dramatically compared with previous years. Due to the same reason, Norway did not allocate a traditional quota of sandeel to the Faeroes in 2005.

As a result of the recommendation from ACFM, Norway and the EU have agreed that Norway pout only may be fished as bycatch in 2005. Consequently, Norway pout was excluded from the exchange of quotas between Norway and the Faroes in 2005.

Areas closed to fishing for Norway pout, sandeel and blue whiting

Two areas in the Norwegian economic zone have been closed for fishing on Norway pout, sandeel and blue whiting. The approach has been to close areas were the probability of illegal by-catches of juveniles and not-targeted species, such as cod, saithe, haddock, are considered unacceptable high. This measure could therefore also be mentioned as a measure to protect juveniles of other species than Norway pout and sandeel. As of 1 January 2002 the Patch bank was permanently closed. Before the closure of the Patch bank an annual average of approximately 2.000 tonnes of Norway pout were fished in this area by Norwegian vessels. As from 1 May 2005 a seasonal closure of the Egersund bank in the period 1 December to 31 May was determined (map below). Other areas are under evaluation for permanent or seasonal closure.



12.14.1 Capacity reduction scheme for vessels fishing for sandeel and Norway pout

A small mesh trawl license is required to use a smaller mesh size than 16 mm in the directed fishery for sandeel in the season 15 April – 23 June. The same licence is required in order to participate in the mixed industrial fishery for blue whiting and Norway pout.

The number of vessels holding such a license has been reduced substantially the latter years as a result of the capacity reduction scheme put in place in 2002. The potential number of participating vessel was about 75 vessels in 2001. By May 2005 the number of potential participants has been reduced to about 50. In 2004 38 vessels participated in the sandeel fishery. The number of participating vessels so far in 2005 was 22 as of 24 May 2005.

Additional Danish regulations of the industrial fisheries apply: see section 5, sandeel, STCEF 2005.

12.15 References

Albert, O. T. 1994. Biology and ecology of Norway pout [Trisopterus esmarki, Nilsson, 1885] in the Norweigian Deep, ICES Journal of Marine Science, 51: 45-61

Degel, H., Nedreaas, K., and Nielsen, J.R. 2006. Summary of the results from the Danish-Norwegian fishing trials autumn 2005 exploring by-catch-levels in the small meshed industrial trawl fishery in the North Sea targeting Norway pout. Working Document No. 22 to the 2006 meeting of the WGNSSK, 13 pp. ICES C.M.2007/ACFM:XXXX.

ICES 1977. Review of the Norway pout and sandeel within the NEAFC convention area. Appendix to ICES report C.M. 1977/F:7.

ICES 1996. Report of the Working Group on the Assessment of the Demersal Stocks in the North Sea and Skagerrak. ICES C.M. 1996/Assess:6.

ICES 1998. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, October 1997. ICES CM 1998/Assess :7

ICES 1999. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, October 1998. ICES CM 1999/ACFM :8

Larsen, L.I., Lassen, H., Nielsen, J.R., and Sparholt, H. 2001. Working Document to the 2000 meeting of the WGNSSK. ICES C.M.2001/ACFM:07).

Nielsen, J.R., and Madsen, N. 2006. Gear technological approaches to reduce un-wanted by-catch in commercial Norway pout fishery in the North Sea. Working Document No. 23 to the 2006 meeting of the WGNSSK, 11 pp. ICES C.M.2007/ACFM:XXXX.

Poulsen, E.M. 1968. Norway pout: Stock movement in the Skagerrak and in the north-eastern North Sea. Rapports et Proces-Verbaux des Reunions du Conseil International pour l'Exploration de la Mer, 158: 80-85.

Raitt, D.F.S. 1968. The population dynamics of Norway Pout in the North Sea. Marine Research 5 : 1-23.

Skagen, D. 1993. Revision and extension of the Seasonal Extended Survivors Analysis (SXSA). Working document for Norway pout and Sandeel Working Group. Unpublished

Sparholt, H., Larsen, L.I., Nielsen, J.R. 2002a. Verification of multispiesces interactions in the North Sea by trawl survey data on Norway Pout (*Trisopterus esmarkii*). ICES Journal of Marine Science 59:1270-1275.

Sparholt, H., Larsen, L.I., Nielsen, J.R. 2002b. Non-predation natural mortality of Norway pout (*Trisopterus esmarkii*) in the North Sea. ICES Journal of Marine Science 59:1276-1284.

STCEF, 2005. Report of the *ad hoc* scientific working group on management measures for sandeel, Norway pout, anglerfish and horse mackerel in the North Sea and Skagerrak.

Charlottenlund, Denmark, 23 to 27 May 2005. STCEF Working Group Report, EU Commission.

Appendix 1. By-catch in Norway pout fisheries and possible reduction of by-catch

By-catches in Norway pout fisheries

Demersal fisheries in the North Sea are mixed fisheries, with many stocks exploited together in various combinations in different fisheries. Small-mesh industrial fisheries for Norway pout takes place in the northern and north-eastern North Sea and has by-catches of haddock, whiting, herring and blue whiting. Some cod is also taken as a by-catch, predominantly at ages 0 and 1 (ICES, 2006). With respect to un-intended by-catch in the commercial, small-meshed Norway pout trawl fishery in the North Sea and Skagerrak conducted by Denmark and Norway for reduction purposes ICES ACFM writes that management advice must consider both the state of individual stocks and their simultaneous exploitation. Stocks at reduced reproductive capacity should be the overriding concern for the management of mixed fisheries where these stocks are exploited either as a targeted species or as a by-catch (e.g. ICES, 2006).

Existing by-catch regulations:

In the agreed EU Council and EU-Norway Bilateral Regulation of Fisheries by-catch regulations in the Norway pout fishery have been established (e.g. EU Regulation No 850/98 (EU, 1998)). The by-catch regulations in force at present for small meshed fishery (16-31mm in mesh size) in the North Sea is that catch retained on board must consist of i) at least 90% of any mixture of two or more target species, or ii) at least 60% of any one of the target species, and no more than 5% of any mixture of cod, haddock, saithe, and no more than 15% of any mixture of certain other by-catch species. Provisions regarding limitations on catches of herring which may be retained on board when taken with nets of 16 to 31 mm mesh size are stipulated in EU Community legislation fixing, for certain fish stocks and groups of fish stocks, total allowable catches and certain conditions under which they may be fished. (EU, 1998) At current 40% herring is allowed in the Norway pout fishery.

Important by-catch species:

By-catch of the following species in the commercial, small meshed Norway pout fishery has been un-wanted and a concern for fisheries management: Cod, Haddock, Saithe, Whiting, Monkfish, Herring, and Blue Whiting, where especially by-catch of juvenile haddock and cod as well as larger saithe has been in focus.

By-catch levels from landings statistics:

In Tables A1 and A2 below are presented recent (2002-2005) by-catch levels by species in Danish and Norwegian small meshed industrial trawl fishery in the North Sea and Skagerrak areas targeting Norway pout. For Norway the landings used for consume purposes in the small meshed fishery can only be allocated to industrial fishery for the last two years. IMR does not have access to logbooks from industrial vessels. The Norwegian data are evaluated rather un-certain.

By-catch levels and factors affecting them from commercial fishing trials 2005:

Danish-Norwegian fishing trials and pilot investigations were performed in autumn 2005 in order to explore by-catch- levels in the small meshed industrial trawl fishery in the North Sea targeting Norway pout. The results are given in Working Document No. 22 to the WGNSSK (2006) by *Degel, Nedreaas and Nielsen (2006)*. The trial fishery was performed by two Norwegian commercial trawlers and a Danish commercial trawler traditionally involved in the small meshed industrial trawl fishery in the North Sea and Skagerrak targeting Norway pout. The investigation was in cooperation between the fisheries research institutes DIFRES and

IMR. The South Norwegian Trawl Association (SNTA) and the Danish Fishermen's Association (DF) provided the contact to the fishing vessels used.

The fishery was carried out in autumn 2005 within periods and areas of conducting traditional fishery for Norway pout. The Norwegian vessels conducted each a survey to the area vest of Egersund on the edge of the Norwegian Trench. The Danish vessel conducted two surveys at Fladen Ground in and around the closed box for Norway pout fishery in the North Sea. Comparison fishery between one of the Norwegian vessels and the Danish vessel was performed on a spatio-temporally overlapping scale at the Patch Bank, a closed box for Norway pout fishery in an area between the Egersund Bank and Fladen Ground. The Norwegian vessels conducted both day and night fishery while the Danish vessel only fished during day time.

The results (except for the figure and table showing the diurnal variation in the fishery) comprise only hauls from day time fishery conducted with standard trawl gears used in the commercial small meshed industrial fishery targeting Norway pout. The skipper at the Danish vessel decided the positions and fishing design on a smaller fraction of the conducted hauls based on his evaluation of optimizing the fishery economically, while the rest of the hauls were allocated and pre-distributed in two selected ICES statistical squares.

In general the ratio between the Norway pout target species and the sum of by-catch of certain selected species indicate that the by-catch ratio is high in the commercial Norway pout fishery. However, statistical analyses reveal that the fishermen can significantly minimize the by-catch ratio by targeting in the fishery (spatio-temporal targeting, way of fishing, etc.), i.e. when they determine the fishing stations and the fishery performed. The pilot investigations show no general significant spatio-temporal patterns in the by-catch ratio. However, there are from the results obvious geographical and diurnal differences in the species composition of the by-catch between areas and between day and night fishery. The length distributions of the catch rates by species indicate spatial pattens between some of the species caught. These fishing trials and pilot investigations are based on only very few observations, and data are obviously rather uncertain, variable and noisy. In general, it can be concluded that relatively high by-catches can be reduced by specific targeting in the fishery, both with respect to allocation of the fishery in time and space but also in relation to fishermen knowledge about the fishery and resource availability. This demands though that the skippers/fishermen act accordingly when fishing, and a proper at-sea control. The conclusions above relate to using the Turbotrawl and the Expo1300. The few experiments with Jordfraeser and Kolmuletrål 1100 indicate a different species composition, with unchanged or higher by-catch rates of most species and general significant lover catch rates of Norway pout.

With regard to diurnal differences in the catch rates of Norway pout and by-catches of other species, the few results at present indicate significant lower by-catch of Blue whiting during night hauls. The rest of the by-catch species show no diurnal differences

With regard to possible depth differences in the catch rates of Norway pout and by-catches of other species, this matter relates primarily to the areas close to the Norwegian Deep, and more investigations are about to be carried out to document this better.

Technical measures to reduce by-catches.

Regulation of spatio-temporal effort allocation (closed seasons and areas):

The above investigations indicate spatio-temporal differences in catch levels by species in the commercial small meshed fishery for Norway pout as well as an effect of targeting and use of fishing method on the by-catches. However, these patterns are only based on results from pilot investigations. Knowledge about spatio-temporal patterns in catch rates of target species and by-catch species in the fishery are at present not adequate to implement management measures with respect to regulations on spatio-temporal allocation of fishing effort to reduce by-catches.

During the 1960s a significant small meshed fishery developed for Norway pout in the northern North Sea. This fishery was characterized by relatively large by-catches, especially of haddock and whiting. In order to reduce by-catches of juvenile roundfish, the “Norway pout box” was introduced where fisheries with small meshed trawls were banned. The “Norway pout box” has been closed for industrial fishery for Norway pout since 1977 onwards (EC Regulation No 3094/86). The box includes roughly the area north of 56° N and west of 1° W. In the Norwegian economic zone, the Patch bank has been closed since 2002. It is not possible to fully quantify the effect of the closure of the fishery inside the Norway pout box both with respect to catch rates of target and by-catch species as well as effects on the stocks (EU, 1985; 1987a; 1987b; ICES, 1979). There has not been performed fully covering evaluation of the effect of closed areas in relation to interacting effects of technological development in the fishery including changed selectivity and fishing behavior over time in relation to by-catch rates. These effects can not readily be distinguished.

Gear technological by-catch reduction devices:

Investigations of gear specific selective devices and gear modifications to reduce un-wanted by-catch in the small meshed Norway pout fishery in the North Sea and Skagerrak have been performed in a number of studies. It was recently investigated based on sea trials in year 2000 and reported through an EU Financed Project (EU, 2002), and the results from here have been followed up upon in a scientific paper from DIFRES and CONSTAT, DK (Eigaard and Holst, 2004). Previous investigations of size selective gear devices in the Norway pout trawl fishery in the North Sea was performed by IMR Norway during sea trials in 1997-1999 also published in a scientific paper (Kvalsvik *et al*., 2006), as well as in a number of other earlier studies on the issue. Main results of previous investigations have been reviewed and summarized in Working Document No. 23 to the WGNSSK (2006) by *Nielsen and Madsen (2006).*

Early Scottish and Danish attempts to divide haddock, whiting and herring from Norway pout by using separator panels, square mesh windows, and grids were all relatively unsuccessful. More recent Faeroese experiments with grid devices have been more successful. A 74 % reduction of haddock was estimated (Zachariassen and Hjalti, 1997) and 80% overall reduction of the by-catch (Anon., 1998).

Eigaard and Holst (2004) and EU (2002) found that when testing a trawl gears with a sorting grid with a 24 mm bar distance in combination with a 108 mm (nominal) square mesh window through experimental, commercial fishery the results showed improved selectivity of the commercial trawl with catch weight reductions of haddock and whiting of 37 and 57%, but also a 7 % loss of Norway pout. The study showed that application of these reduction percents to the historical level of industrial by-catch in the North Sea lowered on average the yearly haddock by-catch from 4.3 to 2.7% of the equivalent spawning stock biomass. For whiting the theoretical reduction was from 4.8 to 2.1%. The purpose of the sorting grid was to remedy the by-catch of juvenile gadoids in the industrial fishery for Norway pout, while the purpose of square mesh window was to retain larger marketable consume fish species otherwise sorted out by the grid. By-catches in this study was mainly evaluated for haddock, whiting and cod, i.e. not for all above mentioned by-catch species of concern in the Norway pout fishery. However, the experiments have shown that the by-catch of important human consumption species in the industrial fishery for Norway pout can be reduced substantially by inserting a grid system in front of the cod-end. The study also demonstrated that it is possible to retain a major part of the larger marketable fish species like whiting and haddock and at the same time maintain substantial reductions of juvenile fish of the same species. The study also gave clear indications that further improvement of the selectivity is possible. This can be obtained by adjusting the bar distance in the grid and the mesh size in the selective window, but further research would be necessary in order to establish the optimal selective design.

The results reported in Kvalsvik *et al*. (2006) include results for more species of concern in the Norway pout fishery. They carried out experimental fishing with commercial vessels first testing a prototype of a grid system with different mountings of guiding panel in front of the grid and with different spacing (25, 22 and 19 mm) between bars, and then, secondly, testing if the mesh size in the grid section and the thickness of the bars influenced the selectivity of the grid system. Two different mesh sizes and three different thicknesses of bars were tested. Based on the first experiments, only a bar space of 22mm were used in the later experiments. These showed respectively that a total of 94.6% (weight) of the by-catch species was sorted out with a 32.8% loss of the industrial target species, where the loss of Norway pout was around 10%, and respectively that 62.4% of the by-catch species were sorted out and the loss of target species was 22%, where the loss of Norway pout was around 6%. When testing selectivity parameters for haddock, the main by-catch species, the parameters indicated a sharp size selection in the grid system.

In conclusion, the older experiments indicate that there is no potential in using separator devices and square mesh panels. Recent and comprehensive experiments with grid devices indicate a loss of of Norway pout at around 10% or less when using a grid with a 22-24 mm bar distance. It is also indicated that there is a considerable loss of other industrial species being blue whiting, Argentine and horse mackerel. A substantial by-catch reduction of saithe, whiting, cod, ling, hake, mackerel, herring, haddock and tusk have been observed. The reduction in haddock by-catch is, however, lowered by the presence of smaller individuals. The Danish experiment indicates that it is possible to retain larger valuable consume fish species by using a square mesh panel in combination with the grid. Selectivity parameters have been estimated for haddock, whiting and Norway pout. These can be used for simulation scenarios including estimates of the effect of changing the bar distance in the grid. Selectivity parameters for more by-catch species would be relevant. However, the grid devices have shown to work for main by-catch species.

A general problem by implementing sorting grids in industrial fisheries is the very large catches handled. Durability and strength of the grid devices used under fully commercial conditions are consequently very important and needs further attention. Furthermore, handling of heavy grid devices can be problematic from some vessels. Grid devices are, nevertheless, used in most shrimp fisheries, where catches often are large.

Conclusions

In conclusion, the commercial, exploratory fishery and provision of recent by-catch information has shown by-catch-ratios to be significant in the fishery, however, spatio-temporal differences in catch levels by species has been observed and by-catches can be reduced through targeting and fishing method. Recent scientific research based on at sea trials in the commercial fishery has shown that use of gear technological by-catch devices can reduce by-catches of among other juvenile gadoids significantly. Accordingly, it is recommended that these gear technological by-catch reduction devices (or modified forms of those) are brought into use in the fishery. Introduction of those should be followed up upon by adequate landings or at sea catch control measures to assure effective implementation of the existing by-catch measures.

References

Anon 1998. Report of the study group on grid (grate) sorting systems in trawls, beam trawls and seine nets. ICES CM 1998/B: 2.

Degel, H., Nedreaas, K., and Nielsen, J.R. 2006. Summary of the results from the Danish-Norwegian fishing trials autumn 2005 exploring by-catch-levels in the small meshed industrial trawl fishery in the North Sea targeting Norway pout. Working Document No. 22 to the 2006 meeting of the WGNSSK, 13 pp. ICES C.M.2007/ACFM:XX.

Eigaard, O.R., and Holst, R. 2004. The effective selectivity of a composite gear for industrial fishing: a grid in combination with a square mesh window. Fish. Res. 68: 99-112.

EU, 1985. Report of the Working Group on the by-catches in the Norway pout fishery. Submitted to EU STECF, September 1985, DISK. STCF 9 (N. Pout).

EU, 1987a. Bioeconomic evaluation of the Norway pout box. EU Commission. Internal Information on Fisheries: 16.

EU, 1987b. The consequences of increased North Sea herring, haddock and whiting abundances for the fishery for Norway pout in the North Sea. EU Commission Report, Contract No 1946, 12.06.87 between Marine Resources Assessment Group, London, and Danish Institute for Fisheries and Marine Research, Charlottenlund.

EU, 1998. EU Council Regulation (EC) No. 850/98. Official Journal of the European Communities L 125 of 30 March 1998, Vol. 41 of 27th April 1998: 36 pp. ISSN 0378-6988.

EU, 2002. Development and testing of a grid system to reduce by-catches in Norway pout trawls. Final Consolidated Report, EU Study Project No. 98/002: 32pp + 75 pp. EU Commission DG Fisheries, Bruxelles.

ICES 1977. Review of the Norway pout and sandeel within the NEAFC convention area. Appendix to ICES report C.M. 1977/F:7.

ICES, 1979. Report of an ad hoc working group on the Norway pout box problem. ICES C.M. 1979/G:2.

ICES, 2006. ICES ACFM Advice May 2006. Norway pout in the North Sea. International Council for Exploration of the Sea (ICES), Copenhagen, Denmark. Available from http://www.ices.dk/committe/acfm/comwork/report/asp/advice.asp

Kvalsvik, K., Huse, I., Misund, O.A., and Gamst, K. 2006. Grid selection in the North Sea industrial trawl fishery for Norway pout: Efficient size selection reduces by-catch. Fish. Res. 77: 248-263.

Nielsen, J.R., and Madsen, N. 2006. Gear technological approaches to reduce un-wanted by-catch in commercial Norway pout fishery in the North Sea. Working Document No. 23 to the 2006 meeting of the WGNSSK, 11 pp. ICES C.M.2007/ACFM:XX.

Zachariassen, K., Jákupsstovu, S.H., 1997. Experiments with grid sorting in an industrial fishery at the Faeroes. Working Paper. FTFB Working Group, ICES. Available from the Fisheries Laboratory of the Faroes, Thorshavn, April 1997.

13 Quality handbook: Plaice in Division VIId

Working Group:	ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)
Updates:	05/09/2003: Richard Millner (r.s.millner@cefas.cu.uk) and Joel Vigneau (joel.vigneau@ifremer.fr) 01/12/2005: Coby Needle (needlec@marlab.ac.uk)

13.1 GENERAL

13.1.1 Stock Definition

There is mixing of plaice between the North Sea and VIId both as adults and juveniles. Analysis of tagging data shows that around 40% of the juvenile plaice in VIId come from nursery grounds in the North Sea. The eastern Channel supplies very few recruits to the North Sea. There is also an adult migration between the North Sea and Channel with 20-30% of the plaice caught in the winter in VIId were from migratory North Sea fish. Separation between VIId and the western Channel (VIIe) is much clearer. VIId does not receive significant numbers of juvenile plaice from VIIe but contributes around 20% of the recruits to VIIe. Similarly, around 20% of the adult plaice spawning in VIId may have spent part of the year in VIIe but few plaice tagged in VIIe during the spawning period are recaptured in VIId. It can be concluded that there is considerable interchange of plaice from the North Sea into VIId but a much smaller interchange between VIId and VIIe. Since the exploitation patterns between the three areas are very different, it has been concluded that separate assessments should be carried out.

The management area for channel plaice is a combined one between VIId and VIIe. TACs are obtained by combining the agreed TAC from each area.

13.1.2 Fishery

Plaice is mainly caught in beam trawl fisheries for sole or in mixed demersal fisheries using otter trawls. There is also a directed fishery during parts of the year by inshore trawlers and netters on the English and French coasts. The main fleet segments are the English and Belgian beam trawlers. The Belgian beam trawlers fish mainly in the 1st and 4th quarters and their area of activity covers almost the whole of VIId south of the 6 mile contour from the English coast. There is only light activity by this fleet between April and September. The second offshore fleet is mainly large otter trawlers from Boulogne, Dieppe and Fecamp. The target species of these vessels are cod, whiting, plaice mackerel, gurnards and cuttlefish and the fleet operates throughout VIId. The inshore trawlers and netters are mainly vessels <10m operating on a daily basis within 6 miles of the coast. There are a large number of these vessels (in excess of 400) operating from small ports along the French and English coast. These vessels target sole, plaice, cod and cuttlefish.

The minimum landing size for plaice is 27cm. Demersal gears permitted to catch plaice are 80mm for beam trawling and 100mm for otter trawlers. Fixed nets are required to use 100mm mesh since 2002 although an exemption to permit 90mm has been in force since that time.

There is widespread discarding of plaice, especially from beam trawlers. The 25 and 50% retention lengths for plaice in an 80mm beam trawl are16.4cm and 17.6cm respectively which are substantially below the MLS. Routine data on discarding is not available but comparison with the North Sea suggests that discarding levels in excess of 40% by weight are likely.

Discard survival from small otter trawlers can be in excess of 50% (Millner et al., 1993). In comparison discard mortality from large beam trawlers has been found to be between less than 20% after a 2h haul and up to 40% for a one-hour tow (van Beek et al 1989).

13.1.3 Ecosystem Aspects

No information is available.

13.2 Data

13.2.1 Commercial Catch

The landings are taken by three countries France (55% of combined TAC), England (29%) and Belgium (16%). Quarterly catch numbers and weights were available for a range of years depending on country; the availability is presented in the text table below. Levels of sampling prior to 1985 were poor and these data are considered to be less reliable. In 2001 international landings covered by market sampling schemes represented the majority of the total landings.

Belgium

Belgian commercial landings and effort information by quarter, area and gear are derived from log-books (CHECK).

Sampling for age and length occurs for the beam trawl fleet (main fleet operating in Belgium).

Quarterly sampling of landings takes place at the auctions of Zeebrugge and Oostende (main fishing ports in Belgium). Length is measured to the cm below. Samples are raised per market category to the catches of both harbours.

Quarterly otolith samples are taken throughout the length range of the landings (sexes separated). These are aged and combined to the quarterly level. The ALK is used to obtain the quarterly age distribution from the length distribution.

In 2003 a pilot study started on on-board sampling with respect to discarded and retained catch.

France

French commercial landings in tonnes by quarter, area and gear are derived from log-books for boats over 10m and from sales declaration forms for vessels under 10m. These self declared production are then linked to the auction sales in order to have a complete and precise trip description.

The collection of discard data has begun in 2003 within the EU Regulation 1639/2001. This first year of collection will be incomplete in term of time coverage, therefore the use of these data should be investigated only from 2005.

The length measurements are done by market commercial categories and by quarter into the principal auctions of Grandcamp, Port-en-Bessin, Dieppe and Boulogne. Samplings from Grandcamp and Port-en-Bessin are used for raising catches from Cherbourg to Fecamp and samplings from Dieppe and Boulogne are used to raise the catches from Dieppe to Dunkerque

Otoliths samples are taken by quarter throughout the length range of the landed catch for quarters 1 to 3 and from the october GFS survey in quarter 4. These are aged and combined to the quarterly level and the age-length key thus obtained is used to transform the quarterly length compositions. The length not sampled during one quarter are derived from the same year close quarter.

Weight, sex and maturity at length and at age are obtained from the fish sampled for the age-length keys.

England

English commercial landings in tonnes by quarter, area and gear are derived from the sales notes statistics for vessels under 12m who do not complete logbooks. For those over 12m (or >10m fishing away for more than 24h), data is taken from the EC logbooks. Effort and gear information for the vessels <10m is not routinely collected and is obtained by interview and by census. . No information is collected on discarding from vessels <10m. Discarding from vessels >10m has been obtained since 2002 under the EU Data Collection Regulation.

The gear group used for length measurements are beam trawl, otter trawl and net.

Separate-sex length measurements are taken from each of the gear groupings by trip. Trip length samples are combined and raised to monthly totals by port and gear group. Months and ports are then combined to give quarterly total length compositions by gear group; unsampled port landings are added in at this stage. Quarterly length compositions are added to give annual totals by gear. These are for reference only, as ALK conversion takes place at the quarterly level. Otoliths samples are taken by 2cm length groups separately for each sex throughout the length range of the landed catch. These are aged and combined to the quarterly level, and include all ports, gears and months. The quarterly sex-separate age-length-keys are used to transform quarterly length compositions by gear group to quarterly age compositions.

A minimum of 24 length samples are collected per gear category per quarter. Age samples are collected by sexes separately and the target is 300 otoliths per sex per quarter. If this is not reached, the 1st and 2nd or 3rd and 4th quarters are combined.

The text table below shows which country supplies which kind of data:

Country	Numbers	Weights-at-age
Belgium	1981-present	1986-present
France	1989- present	1989- present
UK	1980- present	1989- present

Data are supplied as FISHBASE files containing quarterly numbers at age, weight at age, length at age and total landings. The files are aggregated by the stock co-ordinator to derive the input VPA files in the Lowestoft format. No SOP corrections are applied to the data because individual country SOPs are usually better than 95%. The quarterly data files by country can be found with the stock co-ordinator

The resulting files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under w:\acfm\nsskwg\2002\data\ple_eche or w:\ifapdata\eximport\nsskwg\ple_eche.

13.2.2 Biological

Natural mortality

Natural mortality was assumed constant over ages and years at 0.1 as in the North Sea.

Maturity

The maturity ogive used assumes that 15% of age 2, 53% of age 3 and 96% of age 4 are mature and 100% for ages 5 and older.

Weight at age

Prior to 2001, stock weights were calculated from a smoothed curve of the catch weights interpolated to the 1st January. From 2001, second quarter catch weights were used as stock weights in order to be consistent with North Sea sole. The database was revised back to 1990.

Proportion mortality before spawning

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

13.2.3 Surveys

A dedicated 4m beam trawl survey for plaice and sole has been carried out by England using the RV Corystes since 1988. The survey covers the whole of VIId and is a depth stratified survey with most samples allocated to the shallower inshore stations where the abundance of sole is highest. In addition, inshore small boat surveys using 2m beam trawls are undertaken along the English coast and in a restricted area of the Baie de Somme on the French coast. In 2002, The English and French Young Fish Surveys were combined into an International Young Fish Survey. The dataset was revised for the period back to 1987. The two surveys operate with the same gear (beam trawl) during the same period (September) in two different nursery areas. Previous analysis (Riou et al, 2001) has shown that asynchronous spawning occurs for flatfish in Division VIId. Therefore both surveys were combined based on weighting of the individual index with the area nursery surface sampled. Taking into account the low, medium, and high potential area of recruitment, the French YFS got a weight index of 55% and the English YFS of 45%.

A third survey consists of the French otter trawl groundfish survey (FR GFS) in October. Prior to 2002, the abundance indices were calculated by splitting the survey area into five zones, calculating a separate index for each zone each zone, and then averaging to obtain the final GFS index. This procedure was not thought to be entirely satisfactory, as the level of sampling was inconsistent across geographical strata. A new procedure was developed based on raising abundance indices to the level of ICES rectangles, and then by averaging those to calculate the final abundance index. Although there are only minor differences between the two indices, the revised method was used in 2002 and subsequently.

13.2.4 Commercial CPUE

Three commercial fleets have been used in tuning. UK inshore trawlers, Belgian beam trawl fleet and French otter trawlers as well as three survey fleets.

The effort of the French otter trawlers is obtained by the log-books information on the duration of the fishing time weighted by the engine power (in KW) of the vessel. Only trips where sole and/or plaice have been caught is accounted for.

13.2.5 Other Relevant Data

None.

13.3 Historical Stock Development

13.3.1 Deterministic Modelling

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

Survivor estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages

S.E. of the mean to which the estimate are shrunk = 0.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Catch data available for 1982-present year. However, there was no French age compositions before 1986 and large catchability residuals were observed in the commercial data before 1986. In the final analyses only data from 1986-present were used in tuning

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1980 – last data year	2– 10+	Yes
Canum	Catch at age in numbers	1980 – last data year	2– 10+	Yes
Weca	Weight at age in the commercial catch	1980 – last data year	2– 10+	Yes
West	Weight at age of the spawning stock at spawning time.	1980 – last data year	2– 10+	Yes - assumed to be the weight at age in the Q1 catch
Mprop	Proportion of natural mortality before spawning	1980 – last data year	2– 10+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1980 – last data year	2– 10+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1980 – last data year	2– 10+	No – the same ogive for all years
Natmor	Natural mortality	1980 – last data year	2– 10+	No – set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	English commercial Inshore trawl	1985 – last data year	2 – 10
Tuning fleet 2	Belgian commercial Beam trawl	1981 – last data year	2-10
Tuning fleet 3	French trawlers	1989 – last data year	2 - 10
Tuning fleet 4	English BT survey	1988 – last data year	1 – 6
Tuning fleet 5	French GFS	1988 – last data year	1 - 5
Tuning fleet 6	International YFS	1987 – last data year	1 - 1

13.3.2 Uncertainty Analysis

13.3.3 Retrospective Analysis

13.4 Short-Term Projection

Model used: Age structured

Software used: IFAP prediction with management option table and yield per recruit routines

Initial stock size: Taken from XSA for age 3 and older. The number at age 2 in the last data year is estimated using RCT3. The recruitment at age 1 in the last data year is estimated using the geometric mean over a long period (1980 – last data year)

Natural mortality: Set to 0.1 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Average weight of the three last years

Weight at age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years, scaled by the Fbar (2-6) to the level of the last year

Intermediate year assumptions:

Stock recruitment model used: None, the long term geometric mean recruitment at age 1 is used

Procedures used for splitting projected catches: Not relevant

13.5 Medium-Term Projections

The segmented stock/recruitment relationship is considered not significant (ICES, 2003a). There is therefore no consistent basis to build a medium term projection.

13.6 Long-term projections, yield per recruit

13.7 Biological Reference Points

Blim = 5400 t.

Bpa = 8000 t.

Flim = 0.54

Fpa = 0.45

13.8 Other Issues

None.

13.9 References

Beek, F.A. van, Leeuwen, P.I. van and Rijnsdorp, A.D. 1989. On the survivalof plaice and sole discards in the otter trawl and beam trawl fisheries in the North Sea. ICES C.M. 1989/G:46, 17pp

ICES 2003a. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, October 2002. ICES CM 2003/ACFM:02

ICES 2003b. Report of the Study Group on Precautionary Reference Points For Advice on Fishery Management ICES CM 2003/ACFM:15

Millner, R.S., Whiting, C.L and Howlett, G.J. 1993. Estimation of discard mortality of plaice from small otter trawlers using tagging and cage survival studies. ICES C.M. 1993/G:24, 6pp

Riou et al. 2001. Relative contributions of different sole and plaice nurseries to the adult population in the Eastern Channel : application of a combined method using generalized linear models and a geographic information system. Aquatic Living Resources. 14 (2001) 125-135

14 Quality handbook: Plaice in Division IIIa

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 15/09/2003: Clara-Ulrich Rescan (clu@dfu.min.dk)

11/12/2005: Coby Needle (needlec@marlab.ac.uk)

11/09/2006: Katell Hamon (kat@difres.dk) and Marie Storr-Paulsen (msp@difres.dk)

17/11/2006: Coby Needle (needlec@marlab.ac.uk)

14.1 General

14.2 Stock definition

The stock boundaries are arbitrary and more for management purposes than based on a biological recognised stock separation. Meristic character indicated that plaice in IIIa is interacting between the Kattegat and the Skagerrak component and the Belt Sea component (Simonsen et al., 1988). The influence of the North Sea stock component, especially via transport of eggs or larvae, and a spawning migration back to the North Sea, contributes to the uncertainty of the plaice IIIa stock boundaries (see Ecosystem aspects).

14.3 Fishery

The IIIa area is an ICES management area with two subdivisions: Skagerrak in the Northern part and Kattegat in the Southern part (see Figure 1). Currently, five countries share the catches in IIIa: Sweden, Germany, Norway, The Netherlands and Denmark, who dominates the fishery. The main plaice fishery in IIIa is dominated in Skagerrak which represents between 75 and 85% of the total landings.

The fishery exploits traditionally three age classes (ages 4 to 6). Minimum mesh size is 90 mm for towed gears, and 100 mm for fixed gears. The minimum landing size is 27 cm. Danish fleets are prohibited to land females in area IIIa from January 15th to April 30th.

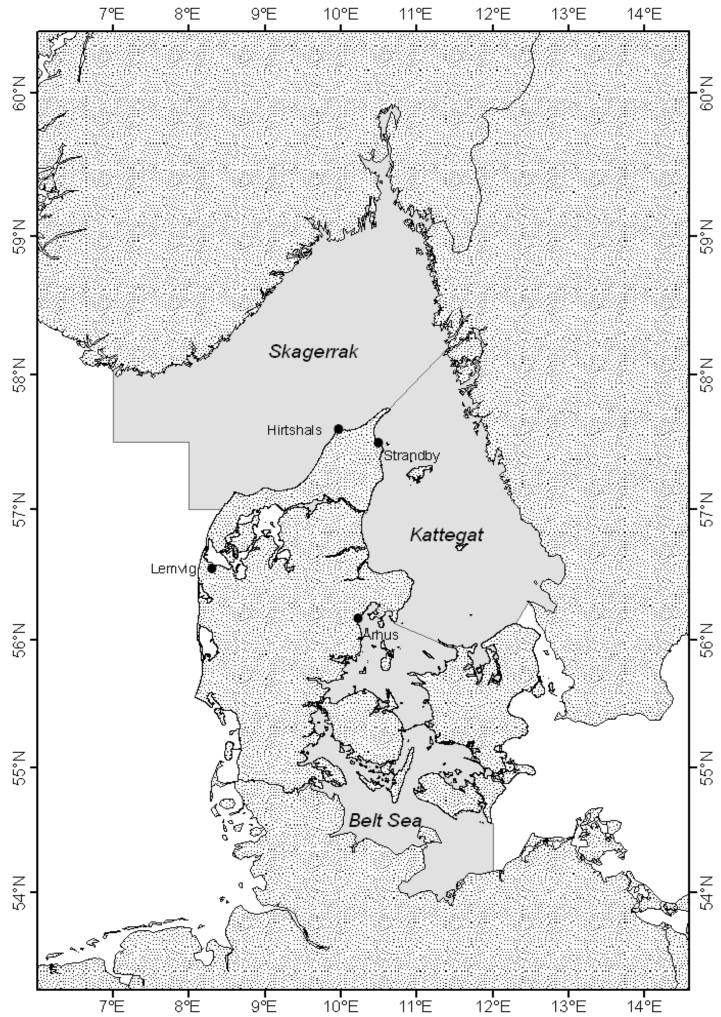


Figure Q7.1 Kattegat and Skagerrak with main plaice landing harbours.

14.3.1 History in landings

The main part of plaice in IIIa (Skagerrak and Kattegat) is caught by Denmark (> 90%, until 2002) (Figure 2.). However, since 2003 a Dutch beam-trawler have caught around 1500t in Skagerrak. Nevertheless Danish landings in IIIa still represent more than 75% of the total landings.

Since 1978, landings have declined from 27 000t to 9 000t in the late 90s, and have reached a historically low level (less than 7 000t) in 2005.

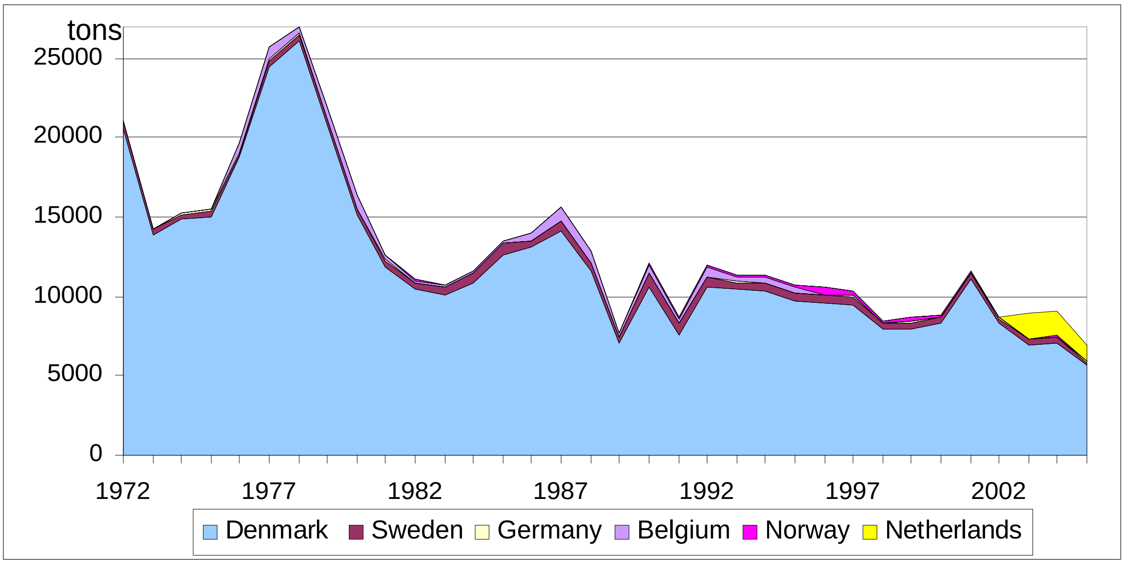


Figure 2 Total plaice landings (WG estimates) in IIIa: Catch by country from 1972 to 2005 (data-sources: ICES,WGNSSK 2006. and national landings for year 2005)

This decrease in total landings is unequally distributed over the area (Figure 3). After a peak in 1978, landings in Kattegat have been divided by four in four years but have been stable around 2 000t per year since. Landings in Skagerrak have only decrease from 13 000t in 1978 down to 7 000t since the late 1990s

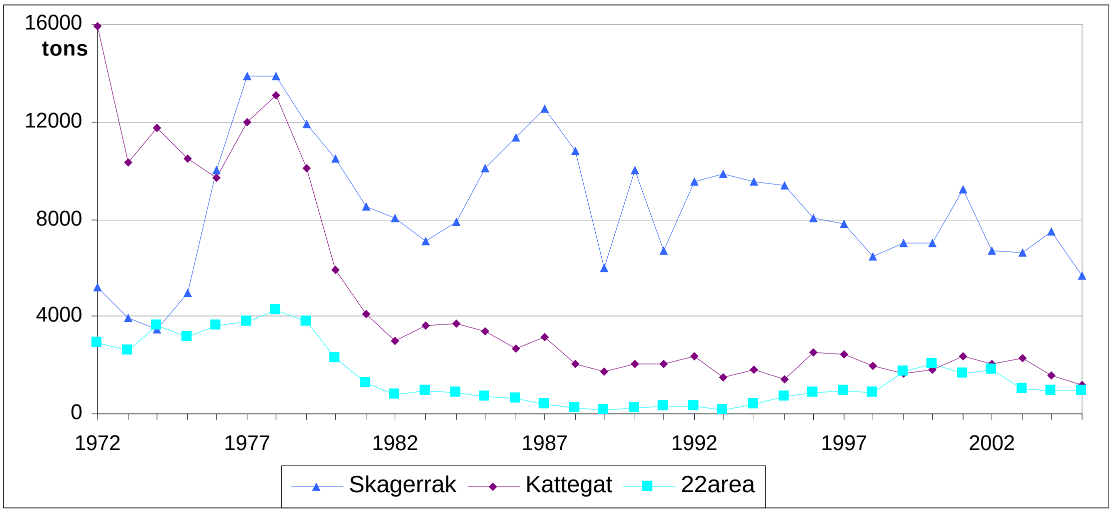


Figure 3 Plaice landings (WG estimates) in IIIa and 22 area from 1972 to 2005 (data-sources: ICES,WGNSSK 2006. and national landings for year 2005)

Landings in 22-area followed same pattern as in IIIa. A decline after 1978, down to extremely low catch-levels (less than 350t per year in the early 1990s). Plaice in Kattegat and in 22-area is caught by Denmark, Sweden and Germany, whereas in catches in Skagerrak also is caught by Norway, Belgium until 1995 and the Netherlands since 2003.

The fishery has not been restricted since 1992 were catches have been lower than TACs (Figure 4). Although, catches can have been restricted do to high by-catches of cod. Landings represent usually between 60 and 80% of the TAC. However, as no assessment has been accepted by the WG for the latter two years, the TACs is based on direction and not quantitative analysis. For 2005 a TACs of 9500t has been set as “the average of landings in the last four years”.

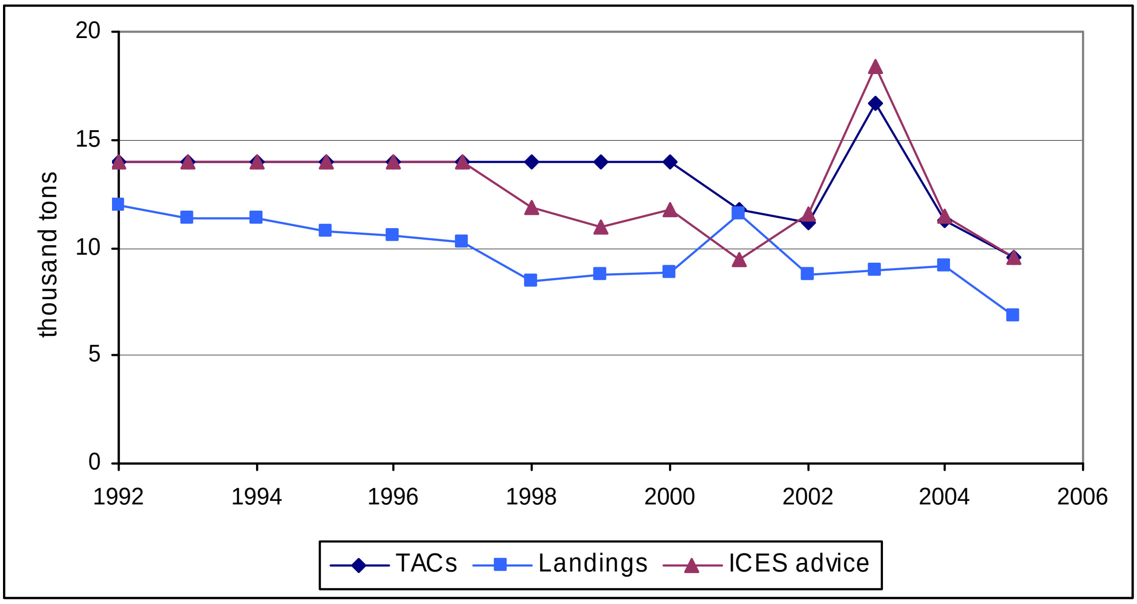


Figure 4 TACs, Landings and ICES advice on plaice IIIa since 1992

14.3.2 Danish plaice-fishery description

Denmark is dominating the plaice fishery in the area catching 82% of the total landings in 2005. Danish fishery has been studied as highly representative of the area.

14.3.3 Data

Data were taken from the EFLALO database, which is the international standard format for trip-based data developed and used during the research project TECTAC (Marchal et al., 2006b). Catch and effort data are taken from the DIFRES DFAD database, which collates data from log-books, sale slips and vessel register. In addition to that, a number of variables were added during this project. In particular, fleet segments were identified based on vessel registered type, length class and area of origin, and we defined fisheries based on multivariate analyses (Ulrich and Andersen, 2004).

14.3.4 Fishery description

The IIIa is divided geographically between Kattegat and Skagerrak, but also in term of fishery. The two areas are described then separately.

Landings quarter-distribution is variable inter-areas. Basically, catch in Skagerrak is more important for the third quarter (approx. 40% of the yearly catches the last three years) whereas the catch in the first quarter are quite low (only 13% of the yearly catches), this is a recurrent pattern over the time series. Further analysis is needed to fully understand this pattern, but hypothesis can be hold: Nephrops fishery is a summer fishery and the intensification of Nephrops-trawler effort could lead to increase in plaice landings as by-catch. Moreover cod fishery is more important in winter, and the effort may be reported on plaice once the quota is caught. This pattern is found at the IIIa area scale as well, but it is due to the dominating position of Skagerrak in the plaice IIIa fishery. The Kattegat seasonal pattern is slightly different and more focused on third and fourth quarters (respectively 31 and 34% in average for the last three years). But given the minor importance of Kattegat in plaice IIIa landings, the effect of this is to raise the proportion of plaice caught during the forth quarter.

The 22 subdivision shows however a completely different seasonal pattern: the main part is fished in the first quarter (35% of the yearly catches) whereas the rest of the year shares homogenously the remaining catches.

The vessels catching plaice in IIIa division mostly come from four harbours. Around 60% of the total Danish catches of plaice are made by vessels from Århus (eastern Jutland), Lenvig (western Jutland), Strandby and Hirtshals (respectively eastern and western part of Skagen). Catches of vessels from those harbours obviously change according to the fishing subdivision (Kattegat and Skagerrak). Thus, the major part of Kattegat landings (60% of Danish landings in Kattegat) is made by vessels from two harbours: Århus and Strandby, while in Skagerrak, the major part of landings is made by vessels from Strandby, Hirtshals and Lenvig.

Plaice in IIIa is essentially caught by four gears: gillnet, Danish seine, otter trawl and beam trawl. However, there are differences between the two subdivisions in the gear distribution as beam trawlers are forbidden in Kattegat but represent an important part of Skagerrak landings (between 10 to 40%). Except for beam trawlers and trawlers, both areas show the same pattern regarding plaice-landings per gear.

Within each gear type there are different metiers, depending on the mesh size and de facto on the target species. The trawler fishery especially is composed of several metiers: the Nephrops trawlers (with mesh size lower than 105mm) whom catch plaice as a by-catch. This fishery is responsible of the major part of trawler-landings as well as effort on plaice. Plaice is also caught in the ground fish trawling, which is usually called cod-plaice mixed fishery, this represent only few trips given the highly restrictive TACs on cod.

The seiners are considered as targeting plaice, and the gillnetters are divided as sole or plaice gillnetters but differentiated according to the mesh size net.

The mesh-size classes for each gear have first been defined according to Ulrich and Andersen (2004) and are given in Table 1. Then the relevance of these classes has been tested for each gear weighted by plaice landings in kg.

Gear	**Mesh size classes in mm**		
Trawl	<90	90-<105	>=105
Gillnet	<120	120-<220	>=220
Danish Seine	<80	80-120	>120
Beam trawl	<80	>=80	

Table 1,: Mesh-size classes per gear according to Ulrich and Andersen (2004)

After 2003 the trawler with mesh size larger than 105mm seems to have decrease regarding to plaice landings. For trawlers, landings have increase in the classes of mesh-size smaller than 100mm (class 90-105 mm) at the expense of the immediate larger mesh-size classes. Since 2003 a large part of landings are reported as being caught with mesh sizes between 95 and 99m, although the actually mesh size were larger. The net-sales in 2003 have not increased for the mesh sizes under 100mm indicating that this is an artefact.

This change in mesh-size has been induced by a new European regulation in 2003 which limited the number of days at sea down to 9 per month for gear with mesh size equal to or greater than 100mm, whereas gear with mesh size between 80 and 99mm was allowed to fish 25 days per month (official journal of European Union L97/12). The regulation has been set in order to monitor the recovery of cod stock and the fleets using mesh size lower than 100mm are supposed not to have high cod by-catches. In 2004 and 2005 new regulations have been enforced which set those allowed days at sea around the same levels.

14.3.5 Ecosystem aspects

The large scale circulation pattern in the Northern Kattegat depends mainly on interaction between Baltic runoffs and local variation due to wind stress. Nielsen et al., (1998) demonstrated that the abundance of settled 0-group plaice along the Danish coast of the Kattegat depends on transport from the Skagerrak. The 0-group abundance measured in July-

August was significantly higher in years when wind conditions during the larval development period (March-April) were moderate to strong. This might imply that larval plaice are food-limited in years when calm conditions prevail during the larval drift period (Nielsen et al., 1998).

14.4 Data

14.4.1 Commercial catch

ICES official landings are available from Norway and Germany, and national statistics are available from Denmark, Sweden and the Netherlands. The age-disaggregated indices were derived by merging logbook statistics supplying catch weight per market category with the age distribution within these categories available from the market sampling. Catch-at-age and mean weight-at-age in the catch information were traditionally provided mainly by Denmark. For 2003-2005 data were also provided by Sweden. The sampling scheme is broken down by quarter, landing harbours, and fishing area. The total international catches-at-age have been estimated for Kattegat and Skagerrak separately since 1984.

14.4.2 Biological

Weight at age in the stock has previously been assumed equal to weight at age in the catch due to unavailable data on stock weights. This year data were made available from IBTS (1991-2005) and KASU (1997-2005 in IIIa) for age groups 1-4 and weighted against the total length distribution in the survey. Only 1st quarter surveys were used to calculate mean weights in order to generate the stock at the beginning of the year. Mean weight at age for ages 5 and 6 were considered too noisy and inconsistent between surveys and were therefore excluded in further analysis. For older age groups, weight at age in 1st quarter were computed from landings sampling in the time period 1995-2005. Before 1995 no information on weights per quarters was available and therefore an average was applied for years before 1995. In summary compilation of stock at age are as follows:

- For age 1-4 (1997-2005) an average with equal weight between the mean weight in the KASU and IBTS survey was used.
- Age 1-4 (1991-1996) mean weight from the IBTS survey was applied.
- Age 1-4 (1978-1991) an average from 1991-1995 (IBTS) was used as fixed value.
- Age 5-11 (1995-2005) mean weight from the commercial fleet.
- Age 5-11 (1978-1994) an average from (1995-1998) was used as fixed value.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

A fixed natural mortality of 0.1 per year was assumed for all years and ages.

Previously, maturity was assumed knife-edge distributed: age group 2 was considered immature whereas age 3 and older plaice were considered mature. This year a maturity-at-age was established based on IBTS 1st quarter data. Maturity data has been estimated in IBTS from 1991, but the first three years data were considered to noisy. As especially age group 2 shows a high variability between years and this age group to a large extent contributes to the stock a fixed average value per age were applied. An average from the time period 1994-2005 were used for the entire timeframe.

14.4.3 Surveys

Four surveys are annually conducted. IBTS survey data for Kattegat and Skagerrak for the 1st and 3rd quarter are provided by Sweden as numbers-per-age and hour on a haul-by-haul basis for the period 1991–2006 and 1995-2005 respectively (no survey was performed in third quarter 2000). Two Danish bottom trawl surveys ('KASU') are conducted by the vessel 'Havfisken' in Kattegat, Belt Sea, and Western Baltic in the 1st and 4th quarter of each year. The indices available from these surveys cover the period 1996-2006 for the first quarter survey (except 1998), and 1994-2005 for the fourth quarter survey. The survey indices of the IBTS and KASU surveys first quarter is shifted from February to the preceding December to allow for full use of the available data.

NS-IBTS is the standardised national surveys for North Sea, Kattegat and Skagerrak. A standard IBTS haul is made with a 36/47 GOV-Trawl, with haul duration at 30 minutes and a trawl speed of 4 knots. The purpose of this survey is to provide an annual abundance index for cod, haddock, juvenile herring, whiting, Norway pout, and the survey provides information on the by-catches species plaice and sole. The rubber discs (20cm in diameter) on the groundrope may lift the ground panel of the trawl and enable flatfish escape. IBTS in area IIIa is conducted by the Swedish research vessel 'RV Argos', at Fiskeriverket.

IBTS samplings take place in both the Kattegat and the Skagerrak with an equal number of hauls; final indices are however combined over the whole area. All individuals from are chosen in further analysis. When individuals of a given size are missing, an estimated weight from the weight length relationship of the same year and area is used. For ages 6+ the numbers caught is very low and is therefore excluded from the estimations.

The KASU survey is a standard BITS, which belongs to another group of standardised surveys. The trawl is a standard TV3-520 with rubber discs of 10cm diameter on the groundrope and with a trawl speed at 3 knots. This trawl target flatfish better than IBTS and is designed provide an annual abundance indices for cod, plaice and sole and is distributed further to the Danish cost compared to the IBTS.

KASU data have been revised in 2006, due to changes in database combined with a change of extraction programs in 2005. The revision of last year indices highlighted data treatment errors and the new time series is considered improved compared to the old one. Information on individual basis is available for age 1-6.

Commercial data:

Weight-at-age data from the Danish commercial fleet have been compiled by DIFRES, Denmark in the time frame 1995-2005. Harbour samplings were collected randomly and pooled and no information on fleet, gear or sex are available.

Weight-at-age data from 2003-2005 are available from the Swedish fleet and from the Dutch fleet in 2004-2005.

14.4.4 Commercial CPUE

Three Danish fleets, i.e., trawlers, gillnetters, and Danish seiners, are available. The age-disaggregated indices were derived by merging logbook statistics supplying catch weight per market category with the age distribution within these categories available from the market sampling. Fishing effort has been defined as standardised days fishing. The standardisation of effort by vessel length is obtained by modelling Log-CPUE using a GLM approach, with (Log-) vessel length (continuous variable), year (discrete variable) and quarter (discrete variable) taken as external factors. A 15 m vessel is used as the reference fishing unit. The fishing effort appears to have been fairly stable over the last decade. There has been a decrease in the fishing effort of towed-geared fleets since 1990, but this trend has been reversing since

1998. The fishing effort of gillnetters has steeply increased over 1990-1994, and steadily decreased since then. All commercial fleets show increase in both the yield and the CPUE in 2001. Highest values and increases are observed for the Danish seiners.

14.4.5 Other relevant data

Since 1985 a survey has been conducted to monitor the 0-group abundance at the East coast of Jutland in Kattegat by DIFRES research vessel HAVKATTEN.

14.5 Historical Stock Development

14.5.1 Deterministic modelling

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting applied, power = 3 over 20 years

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 8

Survivor estimates shrunk towards the mean F of the final 5 years or the 5 oldest ages

S.E. of the mean to which the estimate are shrunk = 0.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1978 – last data year	2 – 11+	Yes
Canum	Catch at age in numbers	1978 – last data year	2 – 11+	Yes
Weca	Weight at age in the commercial catch	1978 – last data year	2 – 11+	Yes
West	Weight at age of the spawning stock at spawning time.	1978 – last data year	2 – 11+	Yes- fixed value before 1991
Mprop	Proportion of natural mortality before spawning	1978 – last data year	2 – 11+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1978 – last data year	2 – 11+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1978 – last data year	2 – 11+	No – an average from 1994-2005
Natmor	Natural mortality	1978 – last data year	2 – 11+	No – set to 0.1 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Danish Gillnetters_metier_kw_fishdays	1995 – last data year	2 – 11+
Tuning fleet 2	Danish seiners_kw_fishdays	1995 – last data year	2 – 11+
Tuning fleet 3	IBTS Q1	1991 – last data year	1 – 6
Tuning fleet 4	KASU Q4	1994 – last data year	1 – 6
Tuning fleet 5	KASU Q1	1995 – last data year	1 – 6
Tuning fleet 6	IBTS Q3	1995 – last data year	1 – 6

14.5.2 uncertainty analysis

14.5.3 Retrospective analysis?

14.6 Short-Term Projection

Model used: Age structured

Software used: WGFRANSW

Initial stock size. Stock sizes for age 3 and older are taken from the estimated number of survivors from the XSA. The age 2 recruitments are taken as the geometric average over the entire period.

Natural mortality: Set to 0.1 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Assumed to be the same as weight at age in the catch

Weight at age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years, scaled by the Fbar (3-6) to the level of the last year

Intermediate year assumptions: TAC constraint

Stock recruitment model used: None, the long term geometric mean recruitment at age 2 is used

Procedures used for splitting projected catches: Not relevant

14.7 Medium-term projections

14.8 Long-term projections, yield per recruit

14.9 Biological reference points

14.10 Other issues

14.11 References

15 Quality handbook: Plaice in Sub-Area IV

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 15/09/2005: Martin Pastoors (Martin.Pastoors@wur.nl) and Jan-Jaap Poos (janjaap.Poos@wur.nl).

11/12/2005: Coby Needle (needlec@marlab.ac.uk)

15.1 General

15.2 Data

The text table below show the countries and the kind of data they provide to the Working Group.

COUNTRY	CATCH WEIGHTS	CATCH NUMBERS AT AGE	WEIGHT IN CATCH	LENGTH COMPOSITION
The Netherlands	X	X (by sex)	X (by sex)	X (by sex)
Scotland	X			
UK (E & W)	X	X	X	X
UK (NI)	X			
Germany	X	X	X	
Belgium	X	X	X	X
France	X	X	X	
Denmark	X	X	X	
Norway	X			
Sweden	X			

The catch weights are based on official logbook data corrected with unallocated landings, which represent the difference between official landings and the figures supplied by the WG members. Catch numbers at age are derived from market sampling programmes. The age compositions were combined on a quarterly basis and then raised to the annual international total.

Data are supplied as FISHBASE files containing quarterly numbers at age, weight at age, length at age and total landings. The files are aggregated by the stock coordinator to derive the input VPA files in the Lowestoft format. No SOP corrections are applied to the data, because individual country SOPs are usually better than 95%. The quarterly data files by country as well as the input files can be found with the stock co-ordinator (Sieto Verver, RIVO, The Netherlands, sieto.verver@wur.nl).

From 2002 onwards, following EU regulation (1639/2001), each country is obliged to sample landings from foreign vessels that land in their country. These samples from flag vessels are now included in the Dutch age composition

15.3 Historical Stock Development

Model used: XSA

Software used: Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability independent on stock size for all ages

Regression type = C

Minimum of 5 points used for regression

Catchability independent of age for ages >= 6

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 estimates are shrunk = 2.000

Minimum standard error for population estimates derived from each fleet = .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	1957 – 2004	1-10+	Yes
Canum	Catch at age in numbers	1957 – 2004	1-10+	Yes
Weca	Weight at age in the commercial catch	1957 – 2004	1-10+	Yes
West	Weight at age of the spawning stock at spawning time.	1957 – 2004	1-10+	Yes
Mprop	Proportion of natural mortality before spawning	1957 - 2004	1-10+	No
Fprop	Proportion of fishing mortality before spawning	1957 – 2004	1-10+	No
Matprop	Proportion mature at age	1957 – 2004	1-10+	No
Natmor	Natural mortality	1957 – 2004	1-10+	No

Tuning data:

Type	Name	Year range	Age range
Survey fleet 1	NL-BTS ISIS	1985-2004	1 - 9
Survey fleet 2	NL-SNS	1970 – 2004 (no 2003 survey)	0–4
Survey fleet 3	NL-BTS TRIDENS	1996 – 2004	2-9

15.4 Short-Term Projection

Model used: age structured

Software used: WGFRANSW

Model options chosen:

Fishing mortality at age were the average over the last 3 years, scaled to the reference F(2-6). Weight at age in the catch and in the stock are averages for the last 3 years.

Initial stock size is taken from the XSA for age 3 and older and from RCT3 for age 2. The long-term geometric mean recruitment is used for age 1 in all projection years.

Natural mortality: Set to 0.1 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Average weight over the last 3 years

Weight at age in the catch: Average weight over the last 3 years

Stock recruitment model used: Long term geometric mean for age 1 is used

Procedures used for splitting projected catches: None

15.5 Medium-Term Projection

15.6 Long-term projections, yield per recruit

To be specified.

15.7 Biological reference points

The biological reference points and the basis for the management reference point are:

Blim = 160 000 tonnes

Bpa = 230 000 tonnes

Flim = 0.74, which is the sum of the appropriate FHC and Fdiscards.

15.8 Other issues

None.

15.9 References

16 Quality handbook: Sole in Division VIId

Working Group:	ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)
Updates:	03/09/2003: Richard Millner (r.s.millner@cefas.cu.uk) and Wim Demaré (wim.demare@dvz.be)
	11/12/2005: Coby Needle (needlec@marlab.ac.uk)

16.1 GENERAL

16.1.1 Stock Definition

The sole in the eastern English Channel (VIId) are considered to be a separate stock from the larger North Sea stock to the east and the smaller geographically separate stock to the west in VIIe. There is some movement of juvenile sole from the North Sea into VIId (ICES CM 1989/G:21) and from VIId into the western Channel (VIIe) and into the North Sea. Adult sole appear to largely isolated from other regions except during the winter, when sole from the southern North Sea may enter the Channel temporarily (Pawson, 1995).

16.1.2 Fishery

There is a directed fishery for sole by small inshore vessels using trammel nets and trawls, who fish mainly along the English and French coasts and possibly exploit different coastal populations. Sole represents the most important species for these vessels in terms of the annual value to the fishery. The fishery for sole by these boats occurs throughout the year with small peaks in landings in spring and autumn. There is also a directed fishery by English and Belgian beam trawlers who are able to direct effort to different ICES divisions. These vessels are able to fish for sole in the winter before the fish move inshore and become accessible to the local fleets. In cold winters, sole are particularly vulnerable to the offshore beamers when they aggregate in localised areas of deeper water. Effort from the beam trawl fleet can change considerably depending on whether the fleet moves to other areas or directs effort at other species such as scallops and cuttlefish. A third fleet is made up of French offshore trawlers fishing for mixed demersal species and taking sole as a by-catch.

The minimum landing size for sole is 24cm. Demersal gears permitted to catch sole are 80mm for beam trawling and 90mm for otter trawlers. Fixed nets are required to use 100mm mesh since 2002 although an exemption to permit 90mm has been in force since that time.

16.1.3 Ecosystem Aspects

No information is available.

16.2 Data

16.2.1 Commercial Catch

The landings are taken by three countries France (50%), Belgium (30%) and England (20%). Age sampling for the period before 1980 was poor, but between 1981 and 1984 quarterly samples were provided by both Belgium and England. Since 1985, quarterly catch and weight-at-age compositions were available from Belgium, France, and England.

Belgium

France

England

English commercial landings in tonnes by quarter, area and gear are derived from the sales notes statistics for vessels under 12m who do not complete logbooks. For those over 12m (or >10m fishing away for more than 24h), data is taken from the EC logbooks. Effort and gear information for the vessels <10m is not routinely collected and is obtained by interview and by census. .No information is collected on discarding from vessels <10m but it is known to be low. Discarding from vessels >10m has been obtained since 2002 under the EU Data Collection Regulation and is also relatively low.

Length samples are combined and raised to monthly totals by port and gear group for each stock. Months and ports are then combined to give quarterly total length compositions by gear group; unsampled port landings are added in at this stage. Quarterly length compositions are added to give annual totals by gear. These are for reference only, as ALK conversion takes place at the quarterly level. Age structure from otolith samples are combined to the quarterly level, and generally include all ports, gears and months. For sole the sex ratio from the randomally collected otolih samples are used to spli the unsexed length composition into sex-separate length compositions. The quarterly ses separate age-length-keys are used to transform quarterly length compositions by gear group to quarterly age compositions. At this stage the age compositions by gear group are combined to give total quarterly age compositions.

A minimum of 24 length samples are collected per gear category per quarter. Age samples are collected by sexes separately and the target is 300 otoliths per sex per quarter. If this is not reached, the 1st and 2nd or 3rd and 4th quarters are combined.

Weight at age is derived from the length samples using [to be completed].

The text table below shows which country supply which kind of data:

KIND OF DATA SUPPLIED QUARTERLY

Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Belgium	x	x	x		x
England	x	x	x		x
France	x	x	x		x

Data are supplied as FISHBASE files containing quarterly numbers at age, weight at age, length at age and total landings. The files are aggregated by the stock coordinator to derive the input VPA files in the Lowestoft format. No SOP corrections are applied to the data because individual country SOPs are usually better than 95%. The quarterly data files by country can be found with the stock co-ordinator

The resulting files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under w:\acfm\nsskwg\2002\data\sol_eche or w:\ifapdata\eximport\nsskwg\sol_eche.

16.2.2 Biological

Natural mortality

Natural mortality was assumed constant over ages and years at 0.1.

Maturity

The maturity ogive used was knife-edged with sole regarded as fully mature at age 3 and older as in the North Sea.

Weight at age

Prior to 2001 WG, stock weights were calculated from a smoothed curve of the catch weights interpolated to the 1st January. Since the 2002 WG, second quarter catch weights were used as stock weights in order to be consistent with North Sea sole.

Proportion mortality before spawning

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

16.2.3 Surveys

A dedicated 4m beam trawl survey for plaice and sole has been carried out by England using the RV Corystes since 1988. The survey covers the whole of VIId and is a depth stratified survey with most samples allocated to the shallower inshore stations where the abundance of sole is highest. In addition, inshore small boat surveys using 2m beam trawls are undertaken along the English coast and in a restricted area of the Baie de Somme on the French coast. In 2002, The English and French Young Fish Surveys were combined into an International Young Fish Survey. The dataset was revised for the full period back to 1981. The two surveys operate with the same gear (beam trawl) during the same period (September) in two different nursery areas. Previous analysis (Riou et al, 2001) has shown that asynchronous spawning occurs for flatfish in Division VIId. Therefore both surveys were combined based on weighting of the individual index with the area nursery surface sampled. Taking into account the low, medium, and high potential area of recruitment, the French YFS got a weight index of 55% and the English YFS of 45%.

16.2.4 Commercial CPUE

Three commercial fleets have been used in tuning. The Belgian beam trawl fleet (BEL BT), the UK Beam Trawl fleet (UK BT) and a French otter trawl fleet (FR OT). The two beam trawl fleets carry out fishing directed towards sole but can switch effort between ICES areas. The UK BT CPUE data is derived from trips where landings of sole from VIId exceeded 10% of the total demersal catch by weight on a trip basis. Effort from both the BT fleets is corrected for HP. The French otter trawl fleet is description needed.

16.2.5 Other Relevant Data

None.

16.3 Historical Stock Development

16.3.1 Deterministic Modelling

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

Survivor estimates shrunk towards the mean F of the final 5 years or the 5 oldest ages

S.E. of the mean to which the estimate are shrunk = 0.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Catch data available for 1982-present year. However, there was no French age compositions before 1986 and large catchability residuals were observed in the commercial data before 1986. In the final analyses only data from 1986-present were used in tuning

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1982 – last data year	2 – 11+	Yes
Canum	Catch at age in numbers	1982 – last data year	2 – 11+	Yes
Weca	Weight at age in the commercial catch	1982 – last data year	2 – 11+	Yes
West	Weight at age of the spawning stock at spawning time.	19682 – last data year	2 – 11+	Yes - assumed to be the same as weight at age in the Q2 catch
Mprop	Proportion of natural mortality before spawning	1982 – last data year	2 – 11+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1982 – last data year	2 – 11+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1982 – last data year	2 – 11+	No – the same ogive for all years
Natmor	Natural mortality	1982 – last data year	2 – 11+	No – set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Belgian commercial BT	1986 – last data year	2-10
Tuning fleet 2	English commercial BT	1986 – last data year	2-10
Tuning fleet 3	English BT survey	1988 – last data year	1-6
Tuning fleet 4	International YFS	1994 – last data year	1-1

16.3.2 Uncertainty Analysis

16.3.3 Retrospective Analysis

16.4 Short-Term Projection

Model used: Age structured

Software used: WGFRANSW

Initial stock size is taken from the XSA for age 3 and older and from RCT3 for age 2. The long-term geometric mean recruitment is used for age 1 in all projection years.

Natural mortality: Set to 0.1 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Average weight over the last three years

Weight at age in the catch: Average weight over the three last years

Exploitation pattern: Average of the three last years, scaled to the level of Fbar (3-8) in the last year

Intermediate year assumptions: F status quo

Stock recruitment model used: None, the long term geometric mean recruitment at age 1 is used

Procedures used for splitting projected catches: Not relevant

16.5 Medium-Term Projections

Model used: Age structured

Software used: WGMTERMc

Settings as in short term projection except for the weights in the catch and in the stock which are averaged over the last 10 years

16.6 Long-Term Projections, yield per recruit

Model used: Age structured

Software used: WGMTERMc

Settings as in short term projection except for the weights in the catch and in the stock which are averaged over the last 10 years

16.7 Biological Reference Points

Biological reference points

Bpa	Fpa	Flim
8000 t	0.4	0.55

16.8 Other Issues

None.

16.9 References

CEFAS 1999. PA software users guide. The Centre for Environment, Fisheries and Aquaculture Science, CEFAS, Lowestoft, United Kingdom, 22 April 1999.

17 Quality handbook: Sole in Sub-Area IV

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 14/09/2004: Sieto Verver (sieto.verver@wur.nl).

11/12/2005: Coby Needle (needlec@marlab.ac.uk)

17.1 General

17.1.1 Stock definition

The sole in the North Sea (area IV) are considered to be a separate stock from the smaller stock in the Eastern Channel (area VIId). There is some movement of juvenile sole from the North Sea into the Eastern Channel (ICES CM 1989/G:21) and from the Eastern Channel into the North Sea. Adult sole appear to largely isolated from other regions, except during the winter when sole from the southern North Sea may enter the Channel temporarily.

17.1.2 Fishery

Sole is mainly taken by beam trawlers in a mixed fishery with plaice in the southern part of the North Sea.

The Netherlands: A high proportion of the fishing effort in the southern part of the North Sea is by Dutch beam trawlers fishing for plaice and sole, using 80 mm mesh size. A small proportion of the Dutch beam trawl fleet is fishing for only plaice, using larger mesh size.

UK: The English fleet consists of a large number of small otter trawlers fishing in the southern North Sea for sole mainly in the 2nd and 3rd quarter of the year. Prior to 2002, sole was also taken as by-catch in the English beam trawl fishery fishing for plaice with 120mm mesh, but these vessels do not participate in the fishery any more.

Belgium: The majority of the Belgian fleet use beam trawls exclusively and fish for sole and plaice, mostly in the central and southern North Sea.

Denmark: The main Danish fishery is a directed one for sole using fixed nets although there is also a little effort using beam trawling, and some by-catch in otter trawlers.

Germany: The German sole fishery can be divided into three segments: large beam-trawl vessels (7 vessels), 20-30 Euro-cutters and a varying number of small shrimp beam-trawl vessels catching sole during the 2nd and 3rd quarter.

17.1.3 Management reference points

The management reference points for this stock are presented in the text table below:

FLIM	FPA	BLIM	BPA
undefined	0.40	25 000t	35 000t

17.2 Data

The text table below show the countries and the kind of data they provide to the Working Group.

COUNTRY	CATCH WEIGHTS	CATCH NUMBERS AT AGE	WEIGHT IN CATCH	LENGTH COMPOSITION
The Netherlands	X	X (by sex)	X (by sex)	X (by sex)
Scotland	X			
UK (England,Wales)	X	X	X	X
UK (Northern Ireland)	X			
Germany	X	X	X	
Belgium	X	X	X	X
France	X	X	X	
Denmark	X	X	X	
Norway	X			

The catch weights are based on official logbook data corrected with unallocated landings, which represent the difference between official landings and the figures supplied by the WG members. Catch numbers at age are derived from market sampling programmes. The age compositions were combined on a quarterly basis and then raised to the annual international total.

Data are supplied as FISHBASE files containing quarterly numbers at age, weight at age, length at age and total landings. The files are aggregated by the stock coordinator to derive the input VPA files in the Lowestoft format. No SOP corrections are applied to the data, because individual country SOPs are usually better than 95%. The quarterly data files by country as well as the input files can be found with the stock co-ordinator (Sieto Verver, RIVO, The Netherlands, sieto.verver@wur.nl).

Despite the data regulation that came into action in 2002, no structural sampling takes place to collect samples from national vessels, which land abroad and this constitutes for a substantial part of the total landings by some countries. Some samples are taken but there is no international exchange system for this information available.

17.3 Historical Stock Development

Model used: XSA

Software used: Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability dependent on stock size for ages < 2

Regression type = C

Minimum of 5 points used for regression

Survivor estimates shrunk to the population mean for ages < 2

Catchability independent of age for ages >= 7

Survivor estimates shrunk towards the mean F of the final 5 years or the 5 oldest ages.

S.E. of the mean to which the estimates are shrunk = 2.000

Minimum standard error for population estimates derived from each fleet = .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	1957 – 2004	1-10+	Yes
Canum	Catch at age in numbers	1957 – 2004	1-10+	Yes
Weca	Weight at age in the commercial catch	1957 – 2004	1-10+	Yes
West	Weight at age of the spawning stock at spawning time.	1957 – 2004	1-10+	Yes
Mprop	Proportion of natural mortality before spawning	1957 - 2004	1-10+	No
Fprop	Proportion of fishing mortality before spawning	1957 – 2004	1-10+	No
Matprop	Proportion mature at age	1957 – 2004	1-10+	No
Natmor	Natural mortality	1957 – 2004	1-10+	No

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Survey fleet	NL-BTS ISIS	1985-2004	1 - 9
Tuning fleet 2	NL-SNS	1970 – 2004	
(no 2003 survey)	0 - 4		
Tuning fleet 3	NL Comm BT	1990 - 2004	2 - 9

17.4 Short-Term Projection

Model used: RCT3

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

Fishing mortality at age were the average over the last 3 years, scaled to the reference F(2-6). Weight at age in the catch and in the stock are averages for the last 3 years. The maturity ogive and natural mortality were the same as XSA.

Model used: Age structured.

Software used: WGFRANSW.

Initial stock size: Taken from XSA for age 3 and older. The number at age 1 in the last data year is estimated using the geometric mean over a long period (1957 –last data year), while for age 2 recruitment estimates were used, derived with RCT3.

Maturity: Set to 1 for age 3 and older in all years, same as in XSA.

F and M before spawning: Set to 0 for al ages in all years.

Weight at age in the stock: Average weight over the last 3 years.

Weight at age in the catch: Average weight over the last 3 years.

Stock recruitment model used: Long term geometric mean for age 1 is used

Procedures used for splitting projected catches: none.

17.5 Medium-term projections

17.6 Long-term projections, yield per recruit

17.7 Biological reference points

17.8 Other issues

17.9 References

ICES. 1989. Report of ad hoc study group on juvenile sole tagging, Ostende, 10-12 March 1989. ICES CM 1989/G:21.

18 Quality handbook: Saithe in Sub-Areas IV and VI and Division IIIa

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 15/09/05:Are Salthaug (are.salthaug@imr.no) and Odd Smedstad (odd.smedstad@imr.no)

11/12/2005: Coby Needle (needlec@marlab.ac.uk)

18.1 General

18.1.1 Stock definition

The geographical distribution of juveniles (< age 3) and adults differs. Typical for all saithe stocks are the inshore nursery grounds. Juveniles are therefore mainly distributed along the west and south coast of Norway, the coast of Shetland and the coast of Scotland. Around age 3 the individuals gradually migrate from the costal areas to the northern part of the North Sea (57°N - 62°N), where the feeding grounds of the adult part of the stock are situated. The age at maturity is between 4 and 6 years, and spawning takes place in January-March at about 200 m depth along the Northern Shelf edge and the western edge of the Norwegian deeps. Larvae and post-larvae are widely distributed in Atlantic water masses across the northern part of the North Sea, and around May the 0-group suddenly appear along the coast (of Norway, Shetland and Scotland). The west coast of Norway is probably the most important nursery ground for saithe in the North Sea.

When saithe exceed 60-70 cm in length the diet changes from plankton (krill, copepods) to fish (mainly Norway pout, blue whiting, haddock and herring). Large saithe (>70 cm) has a highly migratory behaviour and the feeding migrations extend from far into the Norwegian Sea to across the Norwegian deeps to the coast. Because of its life-history, saithe in the North Sea is partly “geographically” protected from heavy exploitation as juveniles and as large adults.

Before 1999 saithe in Sub-area IV and Division IIIa and saithe in Sub-area VI was treated as a separate stock units. These stock boundaries were more for management purposes than a biological basis for stock separation. Present biological knowledge shows no evidence that saithe in Division IVa and Via belong to separate stock units. There seems to be a similar recruitment pattern and the spawning areas in these divisions are not separated (ICES 1995).

Tagging experiments by various countries have shown that exchange between all saithe stock components in the north-east Atlantic takes place to a variable extent (ICES 1995). For example, a substantial migration of immature saithe from the Norwegian coast between 62°N and 66°N to the North Sea has been shown to occur (Jakobsen 1981). 0-group saithe, on the other hand, drifts from the northern North Sea to the coast of Norway north of 62°N.

18.1.2 Fishery

Saithe in the North Sea are mainly taken in a direct trawl fishery in deep water near the Northern Shelf edge and the Norwegian deeps. The majority of the catches are taken by Norwegian, French, and German trawlers. In the first half of the year the fishery are directed towards mature fish, while immature fish dominate in the catches the rest of the year. In recent years the French fishery deployed less effort along the Norwegian deeps, while the German and Norwegian fisheries have maintained their effort there. The main fishery developed in the beginning of the 1970s. Recently trawlers have also been targeting deep sea fish, and it is necessary to take account of that when tuning series are established. The fishery in Area VI consists largely of a directed French, German, and Norwegian deep-water fishery operating on the shelf edge, and a Scottish fishery operating inshore. In both areas most of the saithe do not enter the main fishery before age 3, because the younger ages are staying in inshore waters. A small proportion of the total catch is taken in a limited purse seine fishery along the west coast of Norway targeting juveniles (age 2 and 3). Minimum landing size for saithe is currently 35 cm in the EU zone and 32 cm in the Norwegian zone (south of 62□N). Since the fish are distributed inshore until they are 2-3 years old, discarding of young fish is assumed to be a small problem in this fishery. Problems with by-catches in other fisheries when saithe quotas are exceeded may cause discarding. Data from SGDBI and Scotland indicate that the discard in the UK fleets in 2000 and 2001 was about 22 000 t and 15 000 t, respectively, mainly age 3 and age 4. French and German trawlers are targeting saithe and they have larger quotas, so the problem may be less in these fleets. The Norwegian trawlers move out of the area when the boat quotas are reached, and in addition the fishery is closed if the seasonal quota is reached.

18.1.3 Ecosystem Aspects

18.2 Data

18.2.1 Commercial Catch

Catch at age data by fleet are supplied by Denmark, Germany, France, Norway, UK (England), and UK (Scotland) for Area IV and only UK(Scotland) for Area VI. Aberdeen (FRS) is responsible for the database with catch at age data from the different countries.

18.2.2 Biological

Weights

Average weights at age in the stock are assumed to be equal to average weights at age in the catches. Average weights at age by fleet are supplied by Denmark, Germany, France, Norway, UK (England), and UK (Scotland) for Area IV and only UK(Scotland) for Area VI.

Aberdeen (FRS) is responsible for the database with weights at age in the catches from the different countries.

Natural mortality

A natural mortality rate of 0.2 is used for all ages in all years. A constant maturity ogive based on historic biological sampling is used for all years:

AGE	1	2	3	4	5	6	7+
Proportion mature	0.0	0.0	0.0	0.15	0.7	0.9	1.0

18.2.3 Surveys

A Norwegian acoustic survey is conducted in conjunction with the Norwegian part of the IBTS quarter 3 survey, covering the area north of 56o30□ N up to 62o N. The time series from this survey extends back to 1995.

Time series from the English and Scottish Groundfish surveys are also available for tuning but saithe is considered to be poorly represented in these.

Abundance indices of saithe in the North Sea are also available from the IBTS quarter 1 and IBTS quarter 3 surveys. It should be noted that data from the Norwegian acoustic survey and the English and Scottish Groundfish surveys are used in the calculation of the IBTS quarter 3 indices.

18.2.4 Commercial CPUE

Three time series of CPUE are used in the tuning: Norwegian bottom trawl, German bottom trawl and French fresh fish trawlers. All fleets are targeting saithe along the Northern Shelf edge and along the western edge of the Norwegian deep, primarily at depths between 150 - 250 m. A more detailed description of the CPUE time series follows.

Norwegian bottom trawl: This time series extends back to 1980. The resolution of the logbook data is day-by-day (i.e. a record comprises total daily catch and total hours trawled for each vessel). Only records where the weight proportion of saithe exceeds 50 % and records from vessels larger than 30 m are used to calculate CPUE (kg/h). Samples of age compositions in commercial trawl catches are used to age disaggregated the CPUE time series.

German bottom trawl: This age disaggregated CPUE time series extends back to 1995, and it is described in (Rätz et al. 2005)

French fresh fish trawlers: This time series extends back to 1978, however, only data from 1990 onwards is considered as usable used for tuning purposes. The French saithe fishery has developed in the seventies, during the gadoid outburst. At the beginning of the nineties, the saithe stock reached its lowest historical level. Part of the French vessels reacted by fishing in different areas and in deeper waters. The remaining vessels have been harvesting saithe, almost exclusively in the North Sea, and with by-catches of deep-water species (blue ling) west of Scotland. The French fleet targeting saithe is now made up of large trawlers and freezer trawlers over 50 m. The vessels are registered in Boulogne and Lorient.

Series of CPUE (kg/h) at age were not supplied for the French freezers after 2002, as the landings from this fleet were neither length- nor age-sampled. The French tuning fleet is therefore made up of the non-freezer trawlers. Data are restricted to the fishing trips with more than 10% of saithe landings.

Scottish lighttrawl: This time series extends back to 1989. Due to historic problems with effort recording, this fleet is rejected from other assessments. This fleet also primarily target other species than saithe.

18.2.5 Other Relevant Data

18.3 Historical Stock Development

18.3.1 Deterministic Modelling

Model used: XSA (Darby and Flatman 1994)

Software used: Lowstoft VPA suite.

The settings of the final runs in 2004 and 2005 are given in the following table:

YEAR OF ASSESSMENT:	2004	2005
Assessment model:	XSA	XSA
Fleets:	FRAtrb (age range: 3-9, 1990 onwards)	FRAtrb (age range: 3-9, 1990 onwards)
	GERotb (age range: 3-9, 1995 onwards)	GERotb (age range: 3-9, 1995 onwards)
	NORtrl (age range: 3-9, 1980 onwards)	NORtrl (age range: 3-9, 1980 onwards)
	NORacu (age range: 3-7, 1995 onwards)	NORacu (age range: 3-6, 1995 onwards)
		IBTSq3 (age range: 3-6, 1991 onwards)
Age range:	1-10+	3-10+
Catch data:	1967-2994	1967-2994
Fbar:	3-6	3-6
Time series weights:	Tricubic over 20 years	Tricubic over 20 years
Power model for ages:	No	No
Catchability plateau:	Age 7	Age 7
Survivor est. shrunk towards the mean F:	5 years / 3 ages	5 years / 3 ages
S.e. of mean (F-shrinkage):	1.0	1.0
Min. s.e. of population estimates:	0.3	0.3
Prior weighting:	no	no
Number of iterations before convergence:	37	39

18.3.2 Uncertainty Analysis

Nothing here yet.

18.3.3 Retrospective Analysis

18.4 Short-Term Projection

Model used:

WGFRANSW (Reeves and Cook 1994)

Recruitment at age 3 in the terminal year is estimated as the geometric mean of the estimated number of age 3 from the period from1988 to terminal year-3. Stock numbers of the older age groups (> age 3) are estimated XSA survivors.

Mortality:

Natural mortality is 0.2 for all ages. Fishing mortalities at age is the mean of the XSA fishing mortalities at age for the 3 last years (the fishing pattern is not scaled to F3-6 for the last years.

Maturity:

The constant maturity ogive used (see section 2.2).

Mean weights at age in the stock and catch:

The average of mean weights at age for the last three years.

18.5 Medium-Term Projections

Initial stock size, maturity at age, natural mortality, fishing mortality and mean weights at age in the stock/catch are the same as in the short-term projection.

Recruitment:

A Ricker stock-recruitment curve is fitted to the historic data (SSB and age 1 from XSA).

18.6 Long-Term Projections, Yield-per-recruit

Nothing here yet.

18.7 Biological reference points

F0.1	0.10	Flim	0.60
Fmax	0.22	Fpa	0.40
Fmed	0.35	Blim	106 000 t
Fhigh	>0.54	Bpa	200 000 t

18.8 Other Issues

None

18.9 References

Darby, C.D. and Flatman, S. 1994. Virtual Population Analysis: version 3.1 (Windows/DOS) user guide. Info. Tech. Ser., MAFF Direct. Fish. Res., Lowestoft, (1): 85pp.

ICES 1995. Report of the saithe study group. ICES CM 1995/G:2.

ICES 2003. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, June 2002. ICES CM 2003/ACFM:02.

Jakobsen, T. 1981. preliminary results of saithe tagging experiments on the Norwegian coast. ICES CM 1981/G:35.

Reeves, S. and Cook, R. 1994. Demersal assessment programs, September 1994. WD in WGNSSK 1994.

Rätz, H.J., Panten, K. and Ulleweit, J. 2002 German Otter Trawl Board Fleet as Tuning Series for the Assessment of Saithe in IV, VI and IIIa, 1995-2001. WD:1 in ICES CM 2003/ACFM:02.

19 Quality Handbook: Whiting in Sub-Area IV and Division VIId

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 16/09/04: Liz Clarke (clarkel@marlab.ac.uk) and Steven Holmes (holmess@marlab.ac.uk)

01/12/2005: Coby Needle (needlec@marlab.ac.uk)

19.1 General

19.1.1 Stock definition

Whiting is known to occur exclusively in some localised areas, but for the most part it is caught as part of a mixed fishery operating throughout the entire year. Adult whiting are widespread in the North Sea, while high numbers of immature fish occur off the Scottish coast, in the German Bight and along the coast of the Netherlands.

Tagging experiments, and the use of a number of fish parasites as markers, have shown that the whiting found to the north and south of the Dogger Bank form two virtually separate populations (Hislop & MacKenzie, 1976). It is also possible that the whiting in the northern North Sea may contain 'inshore' and 'offshore' populations.

19.1.2 Fishery

19.1.3 Ecosystem aspects

Results from key runs of the North Sea MSVPA in 2002 and 2003 indicate three major sources of mortality. For ages two and above, the primary source of mortality is the fishery, followed by predation by seals, which increases with fish age. For ages 0-1, though more notable on 0-group, there is evidence for cannibalism. This is corroborated by Bromley et al. (1997), who postulate that multiple spawings over a protracted period may provide continued resources for earlier spawned 0-group whiting.

Results from key runs of the North Sea MSVPA in 2002 and 2003 indicate that, as a predator, whiting tend to feed on (in order of importance): whiting, sprat, Norway pout, sandeel and haddock.

19.2 Data

19.2.1 Commercial catch

For North Sea catches, human consumption landings data and age compositions were provided by Scotland, the Netherlands, England, and France. Discard data were provided by Scotland and used to estimate total international discards. Other discard estimates do exist (Section 1.11.4, 2002 WG), but were not made available to Working Group data collators. Since 1991 the age composition of the Danish industrial by-catch has been directly sampled, whereas it was calculated from research vessel survey data during the period 1985–1990. Norway provides age composition data for its industrial by-catch.

For eastern Channel catches, age composition data were supplied by England and France. No estimates of discards are available for whiting in the Eastern Channel, although given the relatively low numbers in the Channel catch compared to that in the North Sea, this is not considered to be a major omission. There is no industrial fishery in this area.

19.2.2 Biological

Natural mortality

Natural mortality values are rounded averages of estimates produced by previous key runs of the North Sea MSVPA (see Section 1.3.1.3 of the 1999 WG report: ICES CM 2000/ACFM:7). The values used in both the assessment and the forecast are :

AGE	1	2	3	4	5	6	7	8+
Natural Mortality	0.95	0.45	0.35	0.30	0.25	0.25	0.20	0.20

Maturity

The maturity ogive is based on North Sea IBTS quarter 1 data, averaged over the period 1981-1985. The maturity ogive used in both the assessment and forecast is:

AGE	1	2	3	4	5	6	7	8+
Maturity Ogive	0.11	0.92	1.00	1.00	1.00	1.00	1.00	1.00

Weight at age

Weight at age in the stock is assumed to be the same as weight at age in the catch.

Proportion mortality before spawning

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to zero.

19.2.3 Surveys

The Scottish Groundfish Survey (SCOGFS) is carried out in August each year, and covers depths of roughly 35 m to 200 m in the North Sea to the north of the Dogger Bank. It samples at most one survey station per statistical rectangle. In 1998 the coverage of this survey was extended into the central North Sea, but the index available to the Working Group has been modified so as to cover a consistent area throughout the time-series.

The English Groundfish Survey (ENGGFS) is carried out in August each year, and samples at most one station per rectangle. It covers depths of roughly 35 m to 200 m in the whole of the North Sea basin.

The time-series of the survey indices of whiting supplied by the French Channel Groundfish Survey (FRAGFS) was revised in 2002. In 2001, the Eastern Channel was split into five zones. Abundance indices were first calculated for each zone, and then averaged to obtain the final FRAGFS index. This procedure was not thought to be entirely satisfactory, as the level of sampling was inconsistent across geographical strata. In 2002, it was thought more appropriate first to raise abundance indices to the level of ICES rectangles, and then to average those to calculate the final abundance index. Previous to the 2002 WG, only the hauls in which whiting were caught were used to derive abundance indices. This procedure biased estimates, and therefore, the indices supplied from 2002 are calculated on the basis of all hauls.

The first quarter International Bottom Trawl Survey (IBTS Q1) is undertaken in February and March of each year, and covers depths of roughly 35 m to 200 m in the whole of the North Sea basin. It uses a higher density of survey stations than either the SCOGFS or the ENGGFS, with several hauls per statistical rectangle.

19.2.4 Commercial CPUE

Effort data are available for two Scottish commercial fleets: seiners (SCOSEI) and light trawlers (SCOLTR). Non-mandatory reporting of fishing effort for these fleets means that they cannot be viewed as strictly reliable for use for catch-at-age tuning.

Effort data are available for two French commercial fleets: otter trawl (FRATRO) and beam trawl (FRATRB). The same comment on non-mandatory reporting of fishing effort applies to these fleets.

19.2.5 Other relevant data

None

19.3 Historical Stock Development

N/A for the time being

19.4 Short-term Projection

N/A for the time being

19.5 Medium-Term Projections

N/A for the time being

19.6 Yield and Biomass per Recruit / Long-Term Projections

N/A for the time being

19.7 Biological Reference Points

The precautionary fishing mortality and biomass reference points agreed by the EU and Norway, (unchanged since 1999), are as follows:

Blim = 225,000 t; Bpa = 315,000 t; Flim = 0.90; Fpa = 0.65.

19.8 Other Issues

19.9 References

Bromley, P. J., Watson, T., and Hislop, J. R. G. (1997). Diel feeding patterns and the development of food webs in pelagic 0-group cod (Gadus morhua L.), haddock (Melanogrammus aeglefinus L.), whiting (Merlangius merlangus L.), saithe (Pollachius virens L.), and Norway pout (Trisopterus esmarkii Nilsson) in the northern North Sea. Ices Journal of Marine Science 54: 846-853.

Hislop, J. R. G & MacKenzie, K. (1976). Population studies of the whiting (Merlangius merlangus L.) of the northern North Sea. Journal du Conseil International pour l'Exploration de laMer. 37: 98-111.

20 Quality handbook: Haddock in Sub-Area IV and Division IIIa

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 10/09/2004: Martin Pastoors (martin.pastoors@wur.nl) and Ewen Bell (ewen.d.bell@cefas.co.uk).

13/09/2005: Colin Millar (c.millar@marlab.ac.uk)

01/12/2005: Coby Needle (needlec@marlab.ac.uk)

13/09/2006: Andrzej Jaworski (a.jaworski@marlab.ac.uk)

20.1 General

20.1.1 Stock definition

Haddock occur in many areas of the central and Northern North Sea and Skagerrak, and are prevalent as far south as the Humber estuary. They usually inhabit depths less than 200 metres. Results from tagging experiments and particle-tracking simulations suggest that there may also be links between the stocks of North Sea haddock and those to the north-west of Scotland. Spawning occurs from March until May and takes place in almost any area around the Scottish coasts to the Norwegian Deeps.

20.1.2 Fishery

In the North Sea, haddock are taken as part of a mixed demersal fishery along with cod and whiting. Saithe, ling and blue ling are also caught in this fishery. Other demersal species caught as a bycatch in this fishery include plaice, lemon sole, dogfish, skate species, witch, megrim, redfish, dab, hake and turbot with lesser quantities of catfish, forkbeard, grenadier species, tusk, halibut, turbot, Greenland halibut, brill and pollack.

The large majority of the haddock catch is taken by Scottish light trawlers, seiners and pair trawlers. Until 2001, these gears had a minimum legal mesh size of 100 mm, and smaller quantities were taken by other Scottish vessels, including *Nephrops* trawlers which used mesh sizes between 70 and 100mm mesh and hence may have had higher discard rates. New gear regulations were brought in for 2002 as a part of the North Sea cod recovery plan (Commission Regulation (EC) No 2056/2001). Vessels from other countries including England, Denmark and Norway also participate in the fishery, and haddock are also taken as a bycatch by Danish and Norwegian vessels fishing for industrial species. In Division IIIa, haddock are taken as a bycatch in a mixed demersal fishery, and in the industrial fishery. Landings from Division IIIa are small compared to those from the North Sea.

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) was changed from 100 mm to 120 mm from the start of 2002 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.

20.1.3 Ecosystem aspects

The haddock larvae feed on immature copepods, while euphausiids, appendicularians, decapod larvae, copepods and fish are food items for 0 age haddock (3-14cm). When the juvenile haddock become demersal, they still feed on pelagic organisms but more importantly prey on slow moving 15cm benthic invertebrates such as worms, small molluscs, sea urchins and brittle stars. The prey of a larger haddock include sandeel, Norway pout, long rough dab, gobies, sprat and herring. The haddock are predicted to feed in shoals as the majority of the stomach contents at different sampling stations contained similar prey. Haddock also feed heavily on the demersal egg deposits of herring.

20.2 Data

20.2.1 Commercial catch

Quarterly age composition data for the North Sea (Sub-area IV) human consumption landings are supplied by Denmark, Norway, England and Wales, France and Scotland. These nations accounted for 90% of the total human consumption landings. Sampling levels are given in Section 1.2.4, along with the procedures used to aggregate national data sets into total international landings. Germany, Norway and Sweden provided quarterly landings, Belgium supplied annual age compositions, and the Faroe Islands, Poland and the Netherlands provided official landings statistics only. Industrial bycatch age compositions for the North Sea were supplied by Denmark and Norway. Age composition data for the human consumption and industrial catches in the Skagerrak (Division IIIa) in 2002 were supplied by Denmark, which accounts for most of the human consumption landings and all of the industrial bycatch in this area.

Discard estimates are derived by raising a mean discard ogive from the Scottish sampling programme to the level of the national fleet landings. The Scottish discard programme follows a stratified random design, with fishing trips stratified by area, gear and quarter, and total Scottish discards are estimated by a stratified ratio estimator (Thompson, 1992). Given the cost of discard sampling, many strata are not sampled and currently *ad-hoc* filling rules are applied to those strata (e.g. empty inshore *Nephrops* trawl strata will be filled in with available inshore *Nephrops* trawl data from the same quarter). Given the *ad-hoc* nature of this approach and the large number of strata this *traditional* estimator can be both biased and imprecise. Stratoudakis *et al.* (1999) developed an alternative *collapsed-ratio* estimator that collapses the strata with similar discard ratios, and uses a more robust auxiliary variable than species landings. Total discards are then estimated by summing across collapsed strata. Collapsing strata has the effect of increasing the sample size in each stratum, and results in a collapsed ratio estimator that has reduced bias and increased precision as compared to a fully stratified ratio estimator. Work is still required to formalise the method, but in general historic estimates are revised downwards while more recent estimates are largely unchanged.

Landings and discard information is provided, variously, as quarterly age compositions, quarterly landings, and annual landings. Discard information is not always supplied, but is sometimes supplied disaggregated to fleet while corresponding landings are given as national totals, in this case discard age compositions and weights at age are combined to match the landings. Discard age compositions are used where possible and the resulting average discard ogive is applied to fleets where information only on landings is supplied, or where discard information is unusable. Where nations supply only values of total landings, age compositions are implied by the weighted average of the available information, as supplied by other nations.

North Sea

Country	HC	Disc	Ind BC
Belgium	QL		-
Denmark	AC	AC	AC
France	QL		-
Germany	QL	AC	-
Netherlands	QL		-
Norway	QL		AC
Poland	OS		-
Sweden	QL		-
UK E+W	AC		-
UK Scotland	AC	AC	-

Skagerrak

Nation	HC	Disc	Ind BC
Belgium	QL		
Denmark	AC		
Germany	included in IV		
Norway	QL		
Sweden	QL	AC	

AC - Quarterly Age compositions *QL - Quarterly landings*
OS - Official statistics.

20.2.2 Biological

Natural mortality

The values of natural mortality and proportion mature at age used in the assessment are unchanged from last year's meeting. The estimates of natural mortality originate from MSVPA (ICES-MSWG 1989). For roundfish, values of M are based on predation mortality estimated from MSVPA. They were first adopted by the Roundfish Working Group for the assessment of North Sea Cod, Haddock and Whiting in 1986 (ICES-NSRWG 1986). The values adopted were means at age over 1980–1982 as given by the MSWG (Section 3.1.1, ICES-MSWG 1986).

Subsequently, the Roundfish Working Group reviewed the values in use at its 1987 meeting (ICES-NSRWG 1987), based on the results of a key run in the 1986 MSWG (Table 2.8.2, ICES-NSRWG 1987). These used mean total Ms over the years 1978–1982. This review resulted in slight changes to the values used for Haddock and Whiting, but the values used for Cod were unchanged.

There was a further review by the Roundfish Working Group at its 1989 meeting (ICES-NSRWG 1990) which considered the values given by the 1989 MSWG (Table 2.8.2, ICES-MSWG 1989). This used means over 1981–1986. As these values did not differ greatly from the values already in use by the Roundfish WG, the values were not changed.

Maturity

The estimates of proportion mature are based on IBTS data. Both natural mortality and maturity are assumed constant with time. Biomass totals are calculated as at the beginning of the year.

Weight at age

The mean weight-at-age data for the Division IIIa catches do not cover all years and for earlier years are not split by catch category, so only North Sea weight-at-age data have been used. Weight-at-age data from the total catch is calculated as a weighted average of the human consumption, discards and industrial bycatch in the North Sea. Weight at age in the stock is assumed to be the same as weight at age in the catch.

Proportion mortality before spawning

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

20.2.3 Surveys

Three research vessel survey series are available:

- Scottish third-quarter groundfish survey (ScoGFS): ages 0–8, years 1982–2006. Only ages 0–5 are used for tuning, as there are several missing data points at older ages and very low catch rates. This survey is undertaken during August each year using a fixed station design and the GOV trawl. Coverage was restricted to the northern part of the North Sea corresponding to the more northerly distribution of haddock, but since 1998 it has been extended into the central North Sea. There are two versions of the series available, the first with the new areas ignored to ensure consistent coverage, the second with the new areas included. The catch rates as presented are corrected for the change in vessel and gear, on the basis of comparative trawl haul data (Zuur *et al* 2001). Nevertheless, the series with consistent area definitions are used for the assessment.
- English third-quarter groundfish survey (EngGFS): ages 0–10+ years 1977–2005. Only ages 0–5 are used for tuning, as catch rates for older ages are low. This survey covers the whole of the North Sea in August–September each year to about 200m depth, using a fixed station design of 75 standard tows and the GOV trawl from 1992 onwards. Prior to 1992 a different gear was used (WHICH) and therefore the series used in the assessment is truncated in 1992.
- International bottom-trawl survey (IBTS Q1): ages 1–6+, years 1967–2006. This survey covers the whole of the North Sea using fixed stations of at least two tows per rectangle with the GOV trawl. Previously this series covered only the years from 1982 onwards for ages 3–6+, and from 1973 onwards for ages 1–2. However, the methodology of the historical extension of the series has not been evaluated and is therefore not used in the assessment. The series is backshifted to the previous year and age so that the information collected in the spring of the current year can be used in the assessment.

20.2.4 Commercial CPUE

Two commercial Scottish CPUE series have been available in recent years for use in assessments of this stock, specifically light trawlers (ScoLTR) and seiners (ScoSEI). However, none have been used in the final assessment presented by the WG during any of its last three meetings, although they have been used in exploratory and comparative analyses. During preparations for the 2000 round of assessment WG meetings it became apparent that the 1999 effort data for the Scottish commercial fleets were not in accord with the historical series and specific concerns were outlined in the 2000 report of WGNSSK (ICES-WGNSSK

2001). Effort recording is still not mandatory for these fleets, and concerns remain about the validity of the historical and current estimates.

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

- Scottish seiners (ScoSEI): ages 0–13, years 1978–2005.
- Scottish light trawlers (ScoLTR): ages 0–13, years 1978–2005.

The definitions of these commercial fleets are the same as those given for the equivalent vessels fishing in Division VIa, which are given in the Report of the 1998 Working Group on the Assessment of Northern Shelf Demersal Stocks (ICES-WGNSSK 1999/ACFM:1, Appendix 2).

20.2.5 Other relevant data

None.

20.3 Historical Stock Development

20.3.1 Deterministic modelling

Model used: XSA

Software used: Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability dependent on stock size for ages < 1

Regression type = C

Minimum of 5 points used for regression

Survivor estimates shrunk to the population mean for ages < 1

Catchability independent of age for ages >= 3

Survivor estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = 2.000

Minimum standard error for population estimates derived from each fleet = .300

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1963 – last data year	0-7+	Yes
Canum	Catch at age in numbers	1963 – last data year	0-7+	Yes
Weca	Weight at age in the commercial catch	1963 – last data year	0-7+	Yes (except for IIIa)
West	Weight at age of the spawning stock at spawning time.	1963 – last data year	0-7+	Yes. assumed to be the same as weight at age in the catch
Mprop	Proportion of natural mortality before spawning	1963 – last data year	0-7+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1963 – last data year	0-7+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1963 – last data year	0-7+	No – the same ogive for all years
Natmor	Natural mortality	1963 – last data year	0-7+	No – fixed values at age for all ages in all years

```
Tuning data:

Fleet                   First,   Last, First, Last, Alpha,   Beta
ENGGFS_                  1992, year-1,   0,      5,   .500,   .750
SCOGFS consistent area   1982, year-1,   0,      5,   .500,   .750
IBTS_Q1 backshifted      1975, year-1,   0,      4,   .990,  1.000

Fbar is calculated over ages 2-4.
```

20.3.2 Uncertainty analysis

Scenario analysis using Fishlab Excel spreadsheet where alternative structural model assumptions can be explored.

20.3.3 Retrospective analysis

Retrospective analysis using Fishlab Excel spreadsheet with diminishing tuning series (cut off final years), or retrospective XSA runs within the Lowestoft software suite.

20.4 Short-Term Projection

Model used: Age structured

Software used: Excel.

Initial stock size. Taken from the XSA survivors for age 1 and older.

Recruitment: RCT3 for the first year of the forecast.

Natural mortality: same vector as in assessment.

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: Determined as the average from the three catch components (human consumption, discard and industrial bycatch, weighted by their proportions in the catch.

Weight at age in the catch: The relatively slow growth of the large 1999 yearclass is highly influential to the short term forecast. Reduced weight at age remains an issue only in the human consumption landings. Catch weights for the ’99 year class in the discard and industrial bycatch components remain within the bounds of previously observed weights. Weight at age in the human consumption fishery was modelled as an exponential function of age. The formulation is as follows.

$y = 1 / (1 + \exp(a - bx))$

where y is weight in kg at age x for the ’99 yearclass.

Exploitation pattern: Average of the three last years, scaled by the Fbar (2-4) to the level of the last year. Exploitation patterns for the different catch components (human consumption, discards and industrial bycatch) calculated based on the relative catch by component (partial F at age).

Intermediate year assumptions: 0.9*Fstatus quo to reflect reductions in the main fleets targetting haddock and the restrictive management measures in 2004. Multipliers on $\mathbf{F}_{sq}$ refer to human consumption and discard partial fishing mortality only. Bycatch F is assumed constant at 0.017.

Stock recruitment model used: Not used

Procedures used for splitting projected catches: The landings in Division IIIa are calculated from the long-term average of the Division IIIa (human consumption) landings expressed as a percentage of the combined IIIa–IV (human consumption) landings (1963-last year). The percentage of 1963-2005 was 3.4%.

20.5 Medium-Term Projections

No medium-term forecasts have been carried out for this stock using the usual software because of the difficulty of accounting for haddock recruitment dynamics. However, management simulations over the medium-term period have been performed for haddock.

20.6 Long-Term Projections, yield per recruit

To be specified

20.7 Biological Reference Points

	ICES considers that:	**ICES proposed that:**
Limit reference points	**B**lim is 100 000 t	**B**pa be set at 140 000 t
	Flim is 1.0	**F**pa be set at 0.7
Target reference points		**F**y not defined

Technical basis

$\mathbf{B}_{lim}$: Smoothed $\mathbf{B}_{loss}$.	$\mathbf{B}_{pa}$: 1.4*$\mathbf{B}_{lim}$.
$\mathbf{F}_{lim}$: 1.4* $\mathbf{F}_{pa}$	$\mathbf{F}_{pa}$: implies a long-term biomass > $\mathbf{B}_{pa}$ and a less than 10% probability that $SSB_{MT} < \mathbf{B}_{pa}$.

20.8 Other Issues

None.

20.9 References

ICES-NSRWG 1986. Report of the North Sea Roundfish Working Group. ICES CM 1986 / Assess: 16.

ICES-MSWG 1986. Report of the Ad hoc multispecies assessment working group, Copenhagen, 13-19 November 1985. ICES. CM 1986/Assess: 9, 141 p. (mimeo).

ICES-NSRWG 1987. Report of the North Sea roundfish working group. ICES CM 1987/Assess: 15.

ICES-MSWG 1989. Report of the Multispecies Assessment Working Group, ICES CM 1989/Assess: 20.

ICES-NSRWG 1990. Report of the North Sea roundfish working group. ICES CM 1990/Assess: 7, 93 pp. (mimeo).

ICES-WGNSSK 1999. Report of the Working Group on the Assessment of Northern Shelf Demersal Stocks, 1998. ICES CM 1999/ACFM:1

ICES-WGNSSK 2001. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, October 2000. ICES CM 2001/ACFM:7.

Stratoudakis, Y., Fryer, R. J., Cook, R. M. and Pierce, G. J. 1999. Fish discarded from Scottish demersal vessels: estimators of total discards and annual estimates for targeted gadoids. ICES J. Mar. Sci., 56, 592–605.

Thompson, S. K. 1992. Chapter 4: Ratio estimators. Sampling. John Wiley and Sons, New York, N.Y. 343pp.

Zuur, A.F., Fryer, R.J. and Newton, A.W. 2001. The comparative fishing trial between *Scotia* II and *Scotia* III. FRS Marine Laboratory, Report No 03/01.

CEFAS web pages on haddock:

http://www.cefas.co.uk/fishinfo/melanogrammus.htm

http://www.cefas.co.uk/fsmi/roundfish-haddock.htm

FRS Marine Laboratory web page on haddock:

http://www.frs-scotland.gov.uk/FRS.Web/Delivery/display_standalone.aspx?contentid=708

21 Quality handbook: Cod in Sub-Area IV and Divisions IIIa and VIId

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 11/12/2005: Coby Needle (needlec@marlab.ac.uk)

21.1 GENERAL

21.1.1 Stock definition

21.1.2 Fishery

21.1.3 Ecosystem aspects

21.2 DATA

21.2.1 Commercial catch

21.2.2 Biological

Natural mortality

Maturity

Weight at age

Proportion mortality before spawning

21.2.3 Surveys

21.2.4 Commercial CPUE

21.2.5 Other relevant data

21.3 Historical Stock Development

21.3.1 Deterministic modelling

21.3.2 Uncertainty analysis

21.3.3 Retrospective analysis

21.4 Short-term projection

21.5 Medium-term projections

21.6 Long-term projections, yield per recruit

21.7 Biological reference points

21.8 Other issues

21.9 References

Annex 3: TECHNICAL MINUTES WGNSSK - Review Group 1

WGNSSK - Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 2006

Present:

Review-group Chair: Einar Hjörleifsson

WG Chair: Coby Needle

Reviewers: Valentín Trujillo

Absentee: Sergey Golovanov.

Participants: Alain Biseau (RGNSSK2) and Gary Shepherd (RGNSSK2); part-time.

The Revision took place in the ICES headquarters, from the 2nd October to 4th October. The Chair of the WGNSSK presented the assessments of Plaices IIIa and all NS Nephrops stocks. It also had an overview presentation with the Review Group 2 of the general issues related to the WG

Plaice IIIa

Benchmark assessment: Rejected by the WG

Forecast: No forecast proposed

The WG group has put a commendable effort in reviewing and revising various measurements available as well as exploring various assessment methods. Despite the heavy effort the conflicting signals of various stock indicators, which have been observed for numerous years, where still prevalent, precluding an acceptable analytical assessment for plaice in this region.

The issue of the appropriateness of defining plaice in IIIa as a biological stock is raised repeatedly in the report. The review group questions the approach of the WG in trying to solve stock structure issues via exploratory analytical assessments. The review group recommends that the WG put priority in describing and summarizing the various available materials in relation to stock identity issue as this may have the overriding influence on the patterns observed in the data used in the assessment. Distributional maps of plaice abundance in IIIa and adjacent regions from the various surveys as well as maps showing the removal intensity would be a first step in such direction.

Landings and discard: Providing landings by country and area (Skagerrak/Kattegat) are welcomed. Further refinement of the spatial and seasonal distributions of removals (fisheries) would be a valuable. Discards seem to be very high, but discards samples are only made available to the WG by Sweden (which only takes 5% of the total international landings). The RG is of the understanding that discard measurements are available from the principal nation but these have not been made available to ICES.

Quality of the input data: The sampling intensity from the fisheries is relatively low given the number of gear involved and possible seasonality effect. It is not clear if the sampling intensity or the algorithm used in the various raising factors is the overriding cause in the often very noisy patterns observed in the catch (as seen by taking log catch rations, also F7.3.1) and some times in the catch weight at age matrix. Same concern applies to the quality of the stock weight (Fig. 7.2.1) and maturity weight at age matrix (Fig. 7.2.2) that are derived from surveys. Although the RG considers in general that it may be more appropriate to derive SSB estimates from survey information on stock weights and maturity, these need to be evaluated against the variability in the observation data as well as the length of the available time series. In addition, given that there may be time trends in maturity at age, a time series smoother may be more appropriate than taking an average.

Catch and effort data: The RG recognise the good job done on these issues improving the quality of information for commercial fleets, in terms of description and standardization which clearly are helpful in the interpretation of fishing strategies and exploitation, historical indicators' trends and tuning processes. This allows elucidating about source of problems for the stock assessment.

Survey indices: The revision process for Danish surveys is not well explained in the Report and it is referred to a WD; due to the difference detected for year-classes 2000 and 2001 and age 4 for 2004 it should be included in the main body of the Report to understand the reasons why it is observed such differences.

LPUE: In spite of the revision and standardization there is still a steadily increase in LPUE for Danish seiners and a steadily decrease for Danish gillnetters since mid-90's (Section 7.2.5.5 and Figure 7.2.5). The likely reasons for such discrepancy in the observations are not explained.

The RG shares the comments and the decision by the WG that the state of the stock and advice can not be based on the analytical assessments explored by the WG. Survey indices seem in the broad sense to be consistent showing an increasing trend recruitment and SSB.

Nephrops:

The main issue dealt with by the review group were related to the derivation of target F0.1 reference points and the proposal by the working group to adopt them as target reference point. In general F0.1 has been considered a prudent target reference point in fisheries. The derivation of the F0.1 for a stock in question is normally done in the same framework as the virtual population analysis using the selection pattern estimated from the VPA as well as same assumption of natural mortality. Within this virtual framework the same assumptions are made in the derivation of stock dynamics and the derivation of F0.1. The latter is then used to derive target catches. In that sense the approach is internally consistent.

The approach taken in deriving target catch for Nephrops is quite novel and untested. Here F0.1 is derived from the synthetic virtual framework andconverted to harvest biomass proportions using the length frequency distribution in catch measurements and then applied to survey indices. The survey indices are actually measurements of the mean number of burrows. To obtain estimates of biomass, the information of length distribution in the catches, extrapolated to weight by using the conventional length-weight model, are used to come up with an estimate of absolute biomass in the survey. In addition to the assumption that this entails, i.e. that the length distribution of the catches are the same as the length distribution in the stock, this necessitates the additional assumption that one burrow corresponds to one individual. Once the biomass estimates are obtained from the number of burrows, the harvest biomass proportion is then used to obtain catch estimates that supposedly are then the catch corresponding to F0.1. Given the various assumptions needed, the uncertainties that these derived catches actually correspond to the intended target fishing mortality of F0.1 are most likely greater than within the conventional framework. In addition the performance measure, the success of the approach in achieving the intended target fishing mortality can not be monitored within the framework proposed by the WG. Given the above, as well as the WG argument that a target exploitation rate lower than F0.1 may be prudent in the most important fishery on the Fladen ground, the review group considers the adoption of an harvest rule, based on F0.1 proxy and the assumption that the survey estimates are absolute abundance estimates to be premature at this moment.

Given no alternative the RG considers that a pragmatic approach could be considered when deriving catch rates based on available survey information. An adaptive management framework could for example be applied while additional biological informations are gathered. E.g. some sensible arbitrary exploitation ratio, based on the survey indices could used to derive advised catches and then the performance could be monitor by the survey indicesa. Effort control may also be a suitable management framework. Any approach however hinges on the requisite of an accurate monitoring of catches and efforts in the fisheries, which is presently not the case.

Despite the comments these comments, the review group supports the WG plan for further work on this issue. In addition to the issues raised above, further work should among other things include a sensitivity analysis to check the robustness of the estimates of F0.1 to various input parameters, particularly the sensitivity towards assumptions of growth rate and selectivity estimates. Given the high discard rate in the present fishery it may also be valuable to explore optimum selection pattern as an advice issue to managers. The robustness of the assumption of the 1:1 ratio of burrows and adoption of the frequency distribution of the catches to the survey is a further issue to explore. The distribution of the fishery in relation to the total survey area are at least in some cases not the same and anecdotal information indicate that serial spatial fishing pattern make take place.

Annex 4: Technical minutes – WGNSSK – Review Group 2

WG Chair: Coby Needle

RG Chair: Alain Biseau

Reviewers : Gary Shepherd and Bengt Sjostrand; and Einar Hjorleifsson

General:

The Working Group (WGNSSK) should be commended for their work in completing the update and benchmark assessments for thirteen species/stocks and the chair (Coby Needle) for his presentations and assistance to the Review Group. As in any body of work of this magnitude, completed over a short time period by a diverse group, there remain issues that should be addressed in subsequent Working Group meetings.

There is a need to spend more time on the exploration of input data e.g. scatter plot may not be sufficient to be sure that there is no problem with year effects in survey data.

Description of landings trends should be made in the fishery or catches section, not in the Historic trends of the stock.

In some stock sections, there are a lot of ‘copy and paste’, resulting in twice or three times the same sentences or paragraph. The RG asked the WG to keep this to a minimum.

In some cases model selections should be more fully evaluated. For instance it is evident that the SURBA is not a preferred model for flatfish.

The RG recommended that a history of mesh size changes or other measures which could affect the selection pattern (especially when long series of discards) are presented.

The catch at age matrices should be explored thoroughly before any analysis is performed. Plots of log catch-numbers by cohort and correlation curves should be investigated. Any identified anomaly should be explained/justified before carrying out the assessment. Changes in the exploitation patterns should be examined in the results and also explained.

Recent changes in the fishery, due to oil price and effort regulations, are well explained. The summary of the previous years review comments and how they were resolved was well done.

Problems remain in many species/fisheries with estimation of discards. In many cases, discard observations were extrapolated from one fleet to the international fishery including different metiers or mesh sizes. Every effort should be made to sample discards throughout the fisheries and provide the information to the Working Group.

The distinction should be made between LPUE / CPUE and TAC/TAL. The terms are not interchangeable and should be used as appropriate.

Sole VIId

Sole VIId:	Update assessment :	Accepted by the RG
	Forecast:	Accepted by the RG

Landings have been corrected for misreporting by area (from VIIe into VIId). Even though this procedure might be detailed in the VIIe sole section, information on the basis for this correction should be included in that section as well. The RG did not check if the sum over all the ‘misreporting’ sums to zero.

There is no information on under-reporting which is thought to be considerable for small vessels.

Discards are thought to be negligible due to the high value of this species. However in some observed trips, discarding up to 40% in numbers has been measured. Discards appear to be very dependant on the fishery and of possible use of specific device (blinders).

Discards were not considered in the assessment.

The stock structure remains unclear. As for plaice, there is a need to clarify the link between all adjacent areas (from Kattegat to English Channel).

Estimate of survivors at ages 1-2 given by the two surveys are inconsistent. Any details on these surveys should be provided in order to better understand this inconsistency.

YFS is a combined UK and French inshore survey.

Age 0 index from this survey is used for RCT3.

Variability in the estimated weights at age may influence the short term forecast. Mean weights may need to be calculated from a longer time period than 2003-2005.

Plaice VIId

Plaice VIId: : Update assessment : No

Forecast: No

The RG agreed with the WG that there is still no firm basis for a final assessment.

However the RG considered that the status of the assessment (‘update’) is not relevant in this case and concerns raised last year should have been investigated.

This is particularly the case for discards, surveys, geographical distribution of the fishery and stock identity. The RG acknowledged that in the absence of French participants, concerns about the French GFS (such as area coverage and stock distribution) and some issues about the fishery could not be addressed. However it was felt that this information is essential and should be provided by the next WG.

The RG felt that where an assessment is problematic or has been previously rejected, it should be treated as a benchmark assessment whatever the current classification (update).

Of course a benchmark assessment should not be performed without having the responses to the previously un-answered questions. This is particularly the case for Plaice in VIId for which most of the points raised by last year RG were not addressed in this year’s assessment. The RG appreciated that the lack of French participant is particularly prejudicial for that stock, given the importance of the French fishery and French survey in the assessment. Anyway information should be provided to the group even in the absence of a national participant. Furthermore, when new information, such a new tuning fleets, is made available to the group, it should be considered, even if the assessment is classified as an update.

In such a fishery, where discards are reported to be high (50% for trawlers and 46% for gillnetters) a catch at age analysis based on landings only is not appropriate unless the discards ratio remains constant all over the series. Since information on discards are only available since 2003 (should say so), there is no evidence that this is the case. On the other hand, the time series of discards is too short to be used in an analytical assessment.

[A separable analysis suggests a relative consistency in the landings at age matrix but this cannot be considered as aclue to accept that discarding ratio remains more or less constant all over the time period if high recruitment are associated high F on discards?]

LPUE are available for 3 commercial fleets (UK, FR and B), and CPUE data come from 3 surveys: UK-BTS (in September, providing indices for ages 1-6), FR-GFS (in October, ages 0-5) and YFS (combination of French and UK inshore surveys using beam trawl conducted in September, for ages 0 and 1).

Note that, given that landings data are available for age 1 and older, indices for age 0 are not used in the assessment.

None of these surveys are well documented in the Stock Annex and maps showing the geographical coverage of each of them (with plaice abundance) should be provided.

This information would lead to better confidence in the reliability of the survey indices. In that case, the log-catchability residual plots show conflicting signals between fleets and surveys and the catch at age matrix (namely ‘landings’). This divergence, as mentioned by the WG should be investigated in an intercessional work. In such a case, if surveys are documented well enough to be believed, SURBA analysis could be the only alternative to assess the stock status.

Immediately after the review group, the ACFM drafting group met and the UK provided the requested details of their station locations on the eastern Channel and southern North Sea flatfish survey (Figure 1). This is a time series survey spanning 16 years and provides information on sole, plaice and juvenile rays.

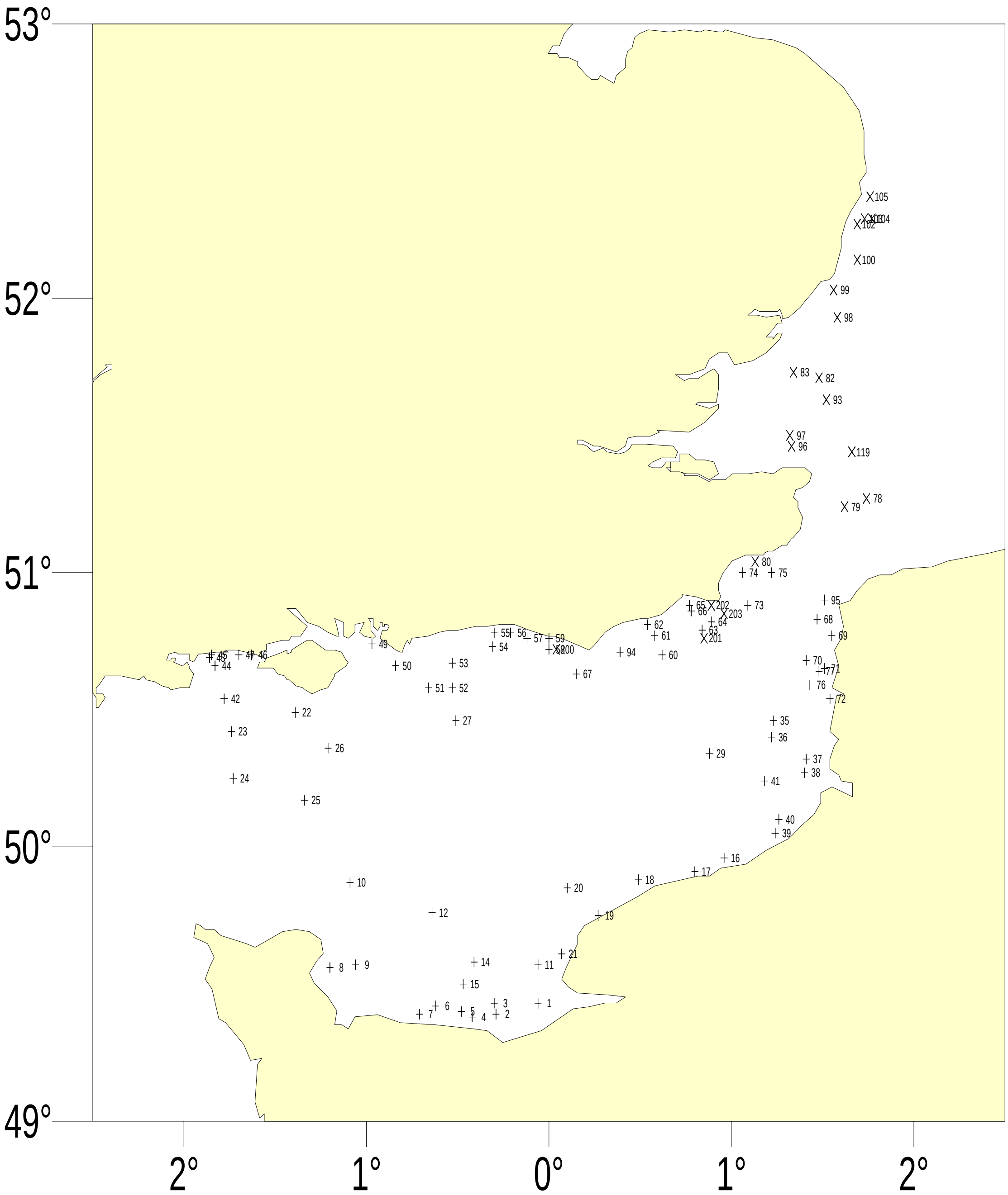


Figure 1: Positions of stations on the UK(E&W) flatfish survey in the eastern Channel and southern North Sea.

Examination of the cohort curves for the French GFS tends to raise concerns about the accuracy of this survey. This has to be thoroughly investigated before any use of this survey can be done.

Even though the SURBA and XSA results are less divergent than last year, the inconsistency between the two series remains a great matter of concern since there is no new information to conclude which one is the more realistic.

[note that Recruitments trends could not be compared since recruitment is estimated at age 0 for SURBA and at age 1 for XSA).

SURBA using only UK-BTS and YFS (age 0 and 1) should be tried.

Given the information on the BTS survey provided to it, ACFM sub-group considered that recent trends in SSB given by the SURBA analysis indicates a rather stability of the stock.

Plaice IV

Plaice IV: Assessment (observation list): Accepted by the RG although changes in recent fishing pattern not explained

Forecast: Accepted by the RG – Revised assessment provided to ACFM

The text could easily be made clearer. For instance, the text dealing with discards reconstruction should be placed at the end of the section presenting observed discards.

Another example could be the ageing problem for age 1 and 2 in the 1997 survey which is mentioned in the 'Final assessment' section. This should have been said well before in the Survey data section.

The 'comparison with NS stock Survey' should be a separate section (or within the Historic trends) but this should not be discussed in the 'Management consideration' section.

The survey section is not clear enough given the importance of surveys in the assessment. It is not immediately clear whether the Beam trawl survey is actually one survey or two.

No text is provided about the DFS which seems to be the more coastal of the surveys (thus providing the most interesting information on young fish).

The change in the distribution of age 1 (more off-shore) appeared have little impact on the reliability of the indices from SNS for that age.

Considerable effort has been made to correct LPUE for bias. But the RG noted than even though corrected, LPUE remains LPUE and given the huge amount of discards, total LPUE (not disaggregated by age) may not provide reliable index of abundance. This particularly true since discard ratios have changed over the period, and especially in recent years.

Discards are included: observed since 1999 + reconstructed previously (1957-1998).

The RG shared the WG views on the rather poor quality of observed discards based on scanty observations. Discards ratio is estimated to be very high (80% in number) and affects ages1-4.

The procedure used to derive discards should be tested for stocks for which observed discards data are available.

Last year, the RG recommended that a comparison between modelled and observed discards in recent years should be made. This was not done, and the RG reiterated this recommendation.

The inclusion of age 1 from BTS-Tridens was not clearly justified. The RG noted that log-catchability residuals are all positive in recent years for ages 1-3 and all negative in the early period. This is the opposite for SNS.

Conflicting signals from the three surveys for younger ages (for some years) give obvious inconsistencies in the survivor estimates given by XSA for ages 1-3.

The RG asked the WG to provide explanations about the apparent recent changes in selection pattern. It could be due to the variable observed discards which make F very variable (since 1999). The RG suggested a model run with landings only (to test if the problems come from discards estimates).

The RG noted that catches at ages 2 in 1999 are very low and much lower than catches at age 3 in 2000 (which is unusual). This is also apparent in the landings information. This has to be clarified.

The RG recommended that changes in age range to compute Fbar (currently 2-6, i.e. including discards) are investigated in order to prevent rapid oscillation in Fbar.

The RG noted that no long-term analysis has been performed. If there was a particular reason to do so, it has to be said.

The RG noted that in some years, catches are of the same amount as SSB. Furthermore, the RG had concerns about the plus-group which is set at 10. Given the low natural mortality rate assumed, much older fish would be expected.

The RG noted, as did the WG, that discards are forecasted to increase (due to GM, higher that recent past recruitment) and that this should be taken into consideration for management.

The RG did not share the WG's views on the consequence of having used a lower shrinkage. The way it is written in the Quality of the assessment section tends to contradict what is said in the exploratory section. If the surveys are appropriate then a low shrinkage is no problem. If they are not, the quality of the assessment cannot improve with a higher shrinkage.

The RG felt that F target (0.3) should not be presented as a proxy of FMSY which, according to ACFM05 could be on the range F0.1-Fmax [0.12 – 0.17]

During ACFM sub-group meeting, a revised forecast was provided based on a new estimate of the 2005 Year class, based on the latest surveys indices (SNS and BTS). This revised estimate, based on RCT3 analysis, is presented in Annnex 1.

Sole IV

Sole IV: Update assessment: Accepted by the RG

Forecast: Accepted by the RG – Revised assessment provided to ACFM

The main concerns for this assessment remain the use of a commercial LPUE series along with two surveys, and a large decline in F in 2004.

The RG appreciated the WG investigations on how to handle the changes in efficiency. It shared the WG views on the need to continue the analysis before using a corrected effort to compute LPUE, especially since no explanation for a decline in efficiency in recent years can be provided.

The retrospective biases appear to be lower than in the last year's assessment (but it is not obvious since the scales of the plots are different).

The RG felt that discards could be a matter of concern. Discards are reported to be up to 25% of the total catch in number. However available information tends to say that this ratio could have remained stable all over the period. In that case, and if the ratio is rather constant within each age group, then the absence of discards in the assessment would not affect the trends in F and SSB. The RG asked the WG to present more information on discards.

Examination of the rate of disappearance of ages along the cohorts, provides a quick check of the catch (landings) at age matrix. It shows that between age 4 and 5, the number of fish in the landings usually decreased by around 50%. Between 2004 and 2005, this ratio is only 20%.

The WG is kindly asked to provide any explanation of such anomaly.

Errors in the input data for predictions have been detected just before the RG meeting.

During ACFM sub-group meeting, a revised forecast was provided based on a new estimate of the 2005 Year class, based on the latest surveys indices (SNS and BTS). This revised estimate, based on RCT3 analysis, is presented in Annnex 2.

Haddock IV + IIIa

Haddock IV + IIIa: Update assessment : Accepted by the RG

Forecast: Accepted by the RG

Recent trends in the fishery indicate a decrease in effort.

The fishery is still dominated by the big 1999 year class. This YC has been highly discarded (and is still) and has a very slow growth probably due to density dependence.

Discards available from Scottish samples (since 1963) are considered reliable. Since the Scottish fishery is the biggest component, the RG felt that using the Scottish discards information to extrapolate to the international catches is relevant.

IBTS-Q1 is used from 1983, even though the survey starts in 1967. The Stock Annex should specify why this early part of the series is not used (combined ALK).

For that stock, and despite last year RG's comment, this survey was back-shifted. This RG made the same comment about the disadvantage of this practice (bias due to mortalities at the beginning of the year, prior to the survey, not taken into account in the backshift procedure), compared to advantages (having indices for the end of the preceding year).

The two surveys in Quarter 3 were kept separately (in contrast to cod). This is because each survey provides enough information on haddock abundance (this is not the case for cod due to its low stock abundance). Other reasons are that IBTS-Q3 series only start in 1992 (which makes the series shorter), and that IBTS-Q3 could not be made available at the time of the WG meeting (if at the ACFM meeting).

The assumptions made for the forecast are well explained and justified and the RG agreed on them.

- F2005 (to avoid low Fs on the 1999 YC)
- Use proportional increment to project weights at age
- Very low incoming recruitment (mean over the 5 lowest) because of observed very low R after a good YC (2005 YC is considered to be relatively good).

The RG noted that the assumption made that R has a small impact on the predicted SSB in 2008, since haddock is a rather late maturing fish.

The RG shared the views of the WG to reduce discards, especially when a good YC occurs.

The WG also noted that no improvement in the fishing pattern has been seen in the recent past despite changes in mesh size (from 100 to 120mm) for the roundfish fishery. This change may have been compensated by the increasing effort in a fishery where smaller mesh-sizes are allowed, and for which the limitation of days at sea is less restrictive.

The RG noted that a Yield per Recruit analysis have been carried out. However, the WG made no comment on the changes in the estimated values of Fmax (poorly estimated) and F0.1.

This year's results are very close to those from last year.

Saithe IV, VI and IIIa

Saithe IV, VI and IIIa: Update assessment : Accepted by the RG

Forecast: Accepted by the RG

The main issue for this stock assessment is the use of commercial LPUE which unlikely reflects stock abundance due to changes in efficiency and to hyperstability (since fishing mostly occurred on aggregations).

LPUE seems to be computed for trips with a certain amount of saithe. This could be problematic if the price drives the amount of fish retained thus reducing the proportion of saithe in the trip.

Significant discards are reported for the Scottish trawlers (due to TAC regulations) but no precise information (series of length or age distribution) was provided.

Surveys only cover ages 3-6 and thus could not be used by themselves to assess the SSB using a SURBA analysis.

More information on the Norwegian surveys are required.

The decrease in weight at older ages should be investigated (sampling problem ?)

The RG noted that the retrospective analysis shows a systematic bias… but not in the usual way (tendency to over estimate F).

Changes in F at age have been noted by the RG, but the text did not provide any explanation for that.

Trends in log catchability residuals for the survey (for younger ages) reflects the conflict between surveys indices and the catch (landings) at age matrix.

The RG asked the WG to investigate the SOP discrepancies since 2000 (corrections seem to have been done previously).

The RG appreciated the investigation of several parameters (+ group, shrinkage…) and liked the way the results are presented.

The results from changes in the combination of tuning fleets (not only surveys) should have been addressed in the text. In particular, it would have been interesting to know which fleets have the highest influence on the estimate of SSB.

The RG is pleased to find a yield per recruit analysis and that it gives the same values for Fmax and F0.1 (there are minor rounding errors in the text)

Cod (IV + VIId)

Cod (IV + VIId): Assessment (observation list): Accepted by the RG

Forecast: Accepted by the RG

Last year the assessment was considered indicative of trends in SSB and recruitment; estimates of F varied considerably (between 3 to 1.3) depending on which survey was used.

The RG appreciated the improvement made in the methodology for this assessment (B-ADAPT including a bootstrapping procedure).

In addition, the Scottish and English surveys indices in quarter 3 have been merged in the IBTS-Q3 indices. This provides less noisy indices but IBTS-Q3 indices for 2006 were not available at the date of the WG meeting.

The RG shared the request from the WG to have these indices available for the ACFM meeting (if in October).

Discards are based on Scottish information only (observations since 1978, modelled previously). They represent, on average, 50% of the total catch in numbers. The Scottish discard ogives are applied to the international landings at age for the whole fishery in IV and VIId.

Under-reporting appeared to be less important in recent years. On the other hand, discards increased when the quota is exhausted.

Definition of directed fishery may have changed in recent years: only a few days within a trip are now directed to cod. Cod is considered as a very high value by-catch. This has to be taken into account when computing LPUE.

Last year the RG asked for more investigation on the French survey indices in Division VIId. This year's WG could not address this issue due to the absence of participant from France.

B-ADAPT assumes errors in the catch and estimates total removals in the recent period (since 1993). These total removals comprise the observed landings, estimated discards, and unallocated removals (under-reported landings, unaccounted discards, extra mortality due to changes in natural mortality)

The RG noted that 2005 estimate of this multiplier was not well estimated (because IBTS-Q3 2006 was not available) and that occasionally the annual multiplier could be below 1 which means that surveys could give too pessimistic signals.

The RG kindly asked the WG to look at the increase in uncertainty in recent years and to investigate the possible link between the level of the multipliers and the constraint caused by TAC (the more restrictive TAC, the highest multiplier).

The RG noted that extra removals could be due to natural mortality, but since only 'catches' has been adjusted (and not M) thus, extra mortality was considered to be extra fishing mortality only.

The labelling of the forecast output should be 'removals' from fishing and extra natural mortality, without the key to split the two components.

The RG welcomed the stochastic projections run using each of the bootstrap iterations of the B-ADAPT model fits. The assumptions made by the WG are approved by the RG, including the fairly pessimistic assumption for the incoming recruitment. The RG would have been pleased to find an explanation on the assumption made of the B-ADAPT multiplier for the forecasted years.

The scenarios presented by the WG are based on reduction in 'F' (total removals). It is not clear if this reduction in F is directly linked to a reduction in TAC (which is applied for landings). The RG discussed the possibility to have a TAC based on projected 'reported' landings or in 'corrected' landings, without concluding.

The correcting multipliers also raised a discussion on the differences between official and 'as used by WG' landings figures. The RG felt that the way the data series has been built should be very well documented in the stock annex.

Some extra comments:

- Y/R should be performed for each of the bootstrap output…to obtain a probabilistic Y/R.
- Natural mortality estimate from MSVPA should be considered.
- Suggested look at transformation in calculating survey indices which may be heavily influenced by the increasing numbers of zero tows.

Sandeel IV

Sandeel IV : Update Assessment: Accepted by the RG

Forecast: Accepted by the RG (with some reservation on the way the bias correction has been done)

The sandeel stock in the North Sea is considered to be at or near its lowest allowing very short fishing season in 2005 and 2006. TAC has never been restrictive.

The fishery in the Norwegian zone has mostly disappeared.

Local sub-populations are likely to increase the risk of overexploitation on a particular zone.

On the other hand, if the local population recruits locally, there should be rapid effect of an area closure (see Firth of Forth… or just a coincidence?).

In the absence of time series from research surveys (Danish dredge survey could be long enough next year) only commercial CPUE for DK are used to tune the model.

The RG agreed that this would lead to bias since increases in efficiency are likely to occur, and since these changes have not been quantified yet (if even possible).

The RG had additional concerns about the split of the two tuning fleets, which obviously artificially improves the quality of the assessment. It was not clear on which *a priori* basis this split have been done.

The SXSA model was used (SMS tried in the past (not this year) gave similar results)

Forecast has been carried out with corrected data (due to retrospective bias). It is not clear to the RG why this correction has been done for this stock only (while retrospective bias occurs in many others) and if the correction made twice (once for N and once for F) is the proper way to do it. The RG wondered if it would make a difference if N is corrected first and then F recalculated afterwards. The RG considered that the next Method WG should address this issue.

The RG discussed how to emphasize on the need to keep a sufficient amount of biomass for predators (not only fish). The WG is asked to look if the historical amount of sandeel removed by natural mortality which could be considered in evaluating the demand as a prey species.

As the WG, the RG considered fisheries independent information essential to assess this stock (why not an acoustic survey?) and that using functional units, as for *Nephrops*, should be considered.

Norway pout IV

Norway pout IV : Assessment: Accepted by the RG on the basis of SXSA

Forecast: Accepted by the RG on the basis of SXSA

The RG felt that this stock section could be better-organised and clearer text. There are many references to Tables and Figures up or backwards, and sometimes unnecessarily. References to the Stock Annex should make the text clearer by referring to detailed explanation, while keeping the key messages in the main text.

The RG considered that the necessary discussion about natural mortality should be placed in a specific section dealing with natural mortality estimates and not in the Catch Analyses section. This is critical beyond just presentation (see later).

The RG was aware that considerable work has been done by the WG to address the additional ToRs concerning this stock after the assessment made in April 2006.

The RG felt that the basis to choose between those three estimates should not be based on the results of the assessment in term of SSB estimates, which are obviously very dependant on M values [the WG report could have eliminated a few pages of useless graphs]. The discussion should concentrate on *a priori* reasons. It would have been interesting to have in the main text some information on what basis the ‘baseline’ values for M have been estimated.

Despite that, the RG agreed with the WG in its choice of keeping the base line assumptions since they appear to be quite close to the estimates provided by MSVPA, with the exception of recent years.

The WG was asked to consider the standard assessment model, SXSA, and the experimental model, SMS. SXSA and SMS explorative runs gave similar results for the time trend of SSB, and the absolute levels differ between model configurations for only a few of the early years in the time series. The RG noted that no plus-group is used in SMS (catches at age 4 are simply not taken into account). This could explain some effects on the SSB estimate when catches at age 4 occur.

Results differed in the estimates of R because the recruitment is assessed at a different period in the two models. Apart from that, the two models give similar perceptions (F and SSB). However, SMS remains an experimental approach which nonetheless requires further development and an investigation of its properties before it can be adopted as the basis of advice within ICES.

The RG also noted that since M > F (and that according to MSVPA, M could have increased in recent years), there is no obvious response of the stock to the decrease in F.

The RG had concerns with commercial CPUE which appeared to decrease slower than the decline of the stock (even though the plots figure 5.2.2. could be a bit misleading). This means that efficiency has increased and that effort standardisation, which was performed using only GRT, was not sufficient to account for technological creep.

The RG agreed with the assumptions made for projections (mostly the very low R).

Short term predictions have been made assuming a seasonal pattern for the fishery,

The RG felt that if the stock is low, then it is possible to imagine that all the TAC can be caught during the first quarter, which could make the resulting SSB quite different than the expected one. It was discussed whether a seasonal TAC should be considered.

The RG asked the WG to provide guidance on how to deal with the objective of keeping a certain amount of biomass for predators. If a minimum biomass is found to be required, then natural mortality could not be kept constant in the prediction (if it does during the assessment period). It was suggested that variable M be examined to determine the amount of biomass removed via predation, to serve as a baseline biomass requirement for predators.

Minor concerns:

Bubble plots are very difficult to interpret as they stand. The WG is kindly requested to provide the tables of log q.

Since the final assessment has been done in April, this can explain why the 'Final assessment' section was before the 'Exploratory analysis'.

Survey indices (IBTS for instance) should be presented.

Is there any indication of a different dynamics within the pout box? (as for sandeel).

Whiting IV + VIId

Whiting IV + VIId:	Assessment:	Accepted by the RG as indicative of recent trends
	Forecast:	Rejected by the RG

A mistake in the input data of the English Survey has been discovered during the meeting of the RG, and a new assessment was provided. It is included at the end of these technical minutes.

Once again, the RG regretted the absence of French participants. Given the importance of France in this fishery (and particularly in DivisionVIId) information on the French fishery and French GFS are essential and should be provided by the next WG.

Discards are substantial and are derived for all the fleets and area (with the exception of Division VIId) from the Scottish series.

In order to address concerns about a possible population substructure, spatial information on landings and effort are needed.

The RG also agreed to the WG for recommending that the SGSIMUW be reconvened.

Information from the fishery indicates that the decline in catches were driven by the North component.

The RG appreciated that SURBA analyses have been performed on an area based. It noted that all (except the central part) show a decline.

The RG noted that the NS stock surveys results are not in complete accordance with the trends shown by the Scottish LPUE by area.

Given the conflicting signals between CPUE (surveys) and LPUE in the earlier period, the assessment is considered to be indicative of trends in recent (decade) period

The RG suggested that, among other issues, a change in M could be an explanation of the difference between XSA and SURBA...

The RG discussed the discrepancy between the predicted landings, TAC and actual landings.

Last year, for 2005, this discrepancy existed, with expected landings much lower than the TAC. However actual landings were very close to the predicted ones. Information from (some?) UK fleets tend to say that the quota could be up taken. It is not clear for the RG if this means that the TAC could be up taken, or whether the 2006 UK landings are reported to be above the predicted landings.

Given the uncertainties in the assessment, the RG did not consider that a forecast could be reasonably done.

Since the stock status in recent years appears to be consistently estimated, a long-term equilibrium analysis should be performed. This could provide guidance for management in the absence of reliable reference points.

The RG felt that using the ages 2-6 to compute Fbar is probably not accurate given apparent change in exploitation pattern. This should be investigated.

Other concerns:

Table 12.2.12: the labelling of ages should start at age 1 (since no back shift was done this year). Consequently, Figure 12.2.8. gives the wrong ages for the IBTS-Q1 survey.

The RG noted that:

- there are some internal inconsistencies within some surveys.
- CPUE by age show that abundance of ages 5-6 seems to increase, while decreasing for younger ages.
- the level of underreporting is not mentioned

The RG had concerns with some huge amount of young fish in the by catch from the industrial fishery, which are not seen in the discards information. It suggested the WG to make an exploratory assessment without these data to quantify the impact of this apparent discrepancy.

Appendix 1: North Sea Plaice: Revised estimate of 2005 YC.

Recruitment estimates

Input to the RCT3 analysis is presented in Table x.1 Estimates from the RCT3 analysis of age 1 are presented in Table x.2, and of age 2 in Table x.3. For year class 2005 (age 1 in 2006) the value predicted by the RCT3 was chosen for the short-term forecasts Table x.2). For year class 2004 (age 2 in 2006), the data coming from SNS 0-group and DFS 0-group are noisy (high s.e. of the predicted value, Table x.3.). Otherwise the RCT3 is based on the same data as the XSA; the WG decided that it is not desirable to use the same data twice (the RCT3 uses the information from the XSA), and therefore decides to accept the XSA estimate.

The recruitment estimates from the different sources are summarized in the text table below.

Year class	At age in 2006	XSA	RCT3	GM 1957-2003	Accepted estimate
2004	2	**431 150**	391 570	681 256	XSA
2005	1		**704 238**	911 711	RCT3
2006	0			**911 711**	GM 1957-2003

Table x.1. North Sea plaice. Input to RCT3 analysis.

North Sea Plaice

year class	XSA age 1	XSA age 2	SNS0	SNS1	SNS2	SNS3	SNS4	BTS1	BTS2	BTS3	BTS4	DFS0
1966	401281	343880	-11	-11	-11	-11	769.73	-11.00	-11.00	-11.00	-11.00	-11.00
1967	434257	322569	-11	-11	-11	3273	100.83	-11.00	-11.00	-11.00	-11.00	-11.00
1968	648830	506046	-11	-11	9732	1415	89.11	-11.00	-11.00	-11.00	-11.00	-11.00
1969	650536	471015	-11	9311	28164	4472	488.31	-11.00	-11.00	-11.00	-11.00	-11.00
1970	410216	305205	1200	13538	10785	1578	160.00	-11.00	-11.00	-11.00	-11.00	-11.00
1971	366523	262932	4456	13207	5046	1129	65.24	-11.00	-11.00	-11.00	-11.00	-11.00
1972	1311562	1059647	7757	65639	16509	9556	236.32	-11.00	-11.00	-11.00	-11.00	-11.00
1973	1132162	821466	7183	15366	8168	868	589.95	-11.00	-11.00	-11.00	-11.00	-11.00
1974	864263	548063	2568	11628	2403	1737	134.78	-11.00	-11.00	-11.00	-11.00	-11.00
1975	692030	448581	1314	8537	3424	345	161.22	-11.00	-11.00	-11.00	-11.00	-11.00
1976	985840	644850	11166	18537	12678	1575	180.43	-11.00	-11.00	-11.00	-11.00	-11.00
1977	908601	605241	4373	14012	9829	491	38.32	-11.00	-11.00	-11.00	-11.00	-11.00
1978	890114	525287	3267	21495	12882	834	87.86	-11.00	-11.00	-11.00	-11.00	-11.00
1979	1127636	804066	29058	59174	18785	1261	70.97	-11.00	-11.00	-11.00	-11.00	-11.00
1980	871004	660276	4210	24756	8642	249	41.67	-11.00	-11.00	-11.00	-11.00	-11.00
1981	2035523	1447399	35506	69993	13909	2467	328.04	-11.00	-11.00	-11.00	11.84	605.96
1982	1305294	931273	24402	33974	10413	1598	144.87	-11.00	-11.00	38.81	8.89	433.67
1983	1257091	841837	32942	44965	13848	1152	199.58	-11.00	179.90	51.00	4.77	431.72
1984	1850544	1288712	7918	28101	7580	1227	1350.13	115.58	131.77	33.07	9.99	261.80
1985	4747579	3231343	47256	93552	32991	13153	7126.43	667.44	764.29	182.31	47.30	716.29
1986	1929110	1401643	8820	33402	14421	4373	816.14	225.82	146.99	38.66	22.78	200.11
1987	1774162	1273733	21335	36609	17810	3160	1076.83	680.17	319.27	55.67	11.86	516.84
1988	1184972	868118	15670	34276	7496	1518	612.98	467.88	102.64	28.55	5.62	318.36
1989	1035975	797687	24585	25037	11247	2268	97.78	115.31	122.05	27.31	6.12	435.70
1990	910226	648022	9368	57221	13842	1006	75.94	185.45	125.93	38.40	10.87	465.47
1991	772166	563453	17257	46798	9686	856	96.99	176.97	179.10	35.24	8.11	498.49
1992	524548	379668	6473	22098	4977	381	44.71	124.76	64.22	14.22	4.83	351.59
1993	442017	339535	9234	19188	2796	1185	45.00	145.21	43.55	23.02	2.79	262.26
1994	1158562	927871	26781	24767	10268	1391	49.67	252.16	212.32	19.91	8.91	445.66
1995	1215952	993364	12541	23015	-11	5014	1058.21	218.28	-11.00	47.40	3.65	184.51
1996	1926329	1619787	84042	-11	30242	13783	982.56	-11.00	431.90	182.52	23.99	572.80
1997	607418	449988	14328	33666	10272	891	175.83	342.51	130.00	31.38	9.97	149.19
1998	819386	713834	25522	32951	2493	370	65.24	305.90	74.40	19.39	5.37	-11.00
1999	1301975	1058380	39262	22855	2898	265	-11.00	277.61	78.44	16.05	5.94	-11.00
2000	763591	656115	24214	11511	1103	-11	111.00	222.71	47.74	10.78	6.62	183.83
2001	1929165	1343751	99628	30813	-11	1944	808.71	541.25	170.08	66.60	13.59	499.05
2002	-11	-11	31350	-11	2103	449	50.00	126.11	41.75	7.00	3.21	213.17
2003	-11	-11	-11	22507	3850	385	-11.00	226.20	69.86	19.50	-11.00	361.14
2004	-11	-11	16004	11874	1571	-11	-11.00	161.60	38.99	-11.00	-11.00	199.93
2005	-11	-11	35656	12164	-11	-11	-11.00	135.11	-11.00	-11.00	-11.00	132.18

Table x.2. North Sea plaice. Results from RCT3 age 1 analysis.

```
Analysis by RCT3 ver3.1 of data from file :

 pleiv_1b.txt

 North Sea Plaice Age 1


 Data for   10 surveys over   40 years :  1966 - 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    .00
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Yearclass =   2003

I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope   Inter-   Std  Rsquare   No.  Index Predicted   Std     WAP
 Series            cept   Error           Pts  Value   Value    Error   Weights

 SNS0
 SNS1      1.39   -.31     .67   .390     32  10.02   13.62     .702     .129
 SNS2     1.40   1.05     .98   .231     32   8.26   12.64    1.050    .057
 SNS3     1.17   5.27   1.06   .214     34   5.96   12.24    1.142    .049
 SNS4
 BTS1     1.83   3.78     .91   .305     17   5.43   13.73     .995     .064
 BTS2     1.00   9.05     .45   .636     18   4.26   13.29     .503     .250
 BTS3     1.05  10.19     .52   .538     20   3.02   13.36     .573     .193
 BTS4
 DFS0     2.52   -.81   1.02   .247     19   5.89   14.01    1.109     .051

                                        VPA Mean =   13.79     .553     .207


 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

 SNS0      .81   6.23     .71   .368     32   9.68   14.07     .743     .138
 SNS1     1.39   -.31     .67   .390     32   9.38   12.74     .719     .148
 SNS2     1.40   1.05     .98   .231     32   7.36   11.38    1.107     .062
 SNS3
 SNS4
 BTS1     1.83   3.78     .91   .305     17   5.09   13.12    1.011     .075
 BTS2     1.00   9.05     .45   .636     18   3.69   12.72     .531     .271
 BTS3
 BTS4
 DFS0     2.52   -.81   1.02   .247     19   5.30   12.53    1.158     .057

                                        VPA Mean =   13.79     .553     .249
```

Continued. Table x.2. North Sea plaice. Results from RCT3 age 1 analysis.

Yearclass = 2005

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
SNS0	.81	6.23	.71	.368	32	10.48	14.71	.753	.206
SNS1	1.39	-.31	.67	.390	32	9.41	12.77	.718	.226
SNS2									
SNS3									
SNS4									
BTS1	1.83	3.78	.91	.305	17	4.91	12.79	1.028	.111
BTS2									
BTS3									
BTS4									
DFS0	2.52	-.81	1.02	.247	19	4.89	11.49	1.243	.076
					VPA Mean =		13.79	.553	.382

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2003	678192	13.43	.25	.15	.37		
2004	494106	13.11	.28	.29	1.11		
2005	704238	13.46	.34	.45	1.74		

Table x.3. North Sea plaice. Results from RCT3 age 2 analysis.

```
Analysis by RCT3 ver3.1 of data from file :

 pleiv_2b.txt

 North Sea Plaice Age 2


 Data for   10 surveys over   40 years :  1966 - 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    .00
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Yearclass =   2003

 I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 SNS0
 SNS1     1.35   -.23    .64   .410     32  10.02   13.31     .670     .143
 SNS2     1.53   -.43   1.10   .196     32   8.26   12.22    1.172     .047
 SNS3     1.13   5.24   1.02   .231     34   5.96   11.98    1.091     .054
 SNS4
 BTS1     1.73   4.06    .85   .309     17   5.43   13.46     .937     .073
 BTS2      .99   8.81    .47   .601     18   4.26   13.01     .522     .236
 BTS3     1.05   9.91    .54   .502     20   3.02   13.08     .593     .183
 BTS4
 DFS0     2.59  -1.52   1.07   .218     19   5.89   13.71    1.161     .048

                                        VPA Mean =    13.48      .548      .215


 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

 SNS0      .74   6.58    .60   .447     32   9.68   13.73     .635     .182
 SNS1     1.35   -.23    .64   .410     32   9.38   12.45     .687     .155
 SNS2     1.53   -.43   1.10   .196     32   7.36   10.85    1.236     .048
 SNS3
 SNS4
 BTS1     1.73   4.06    .85   .309     17   5.09   12.88     .953     .081
 BTS2      .99   8.81    .47   .601     18   3.69   12.45     .550     .242
 BTS3
 BTS4
 DFS0     2.59  -1.52   1.07   .218     19   5.30   12.19    1.212     .050

                                        VPA Mean =    13.48      .548      .244
```

Continued. Table x.3. North Sea plaice. Results from RCT3 age 2 analysis.

Yearclass = 2005

I-----------Regression----------I					I-----------Prediction---------I				
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
SNS0	.74	6.58	.60	.447	32	10.48	14.32	.643	.254
SNS1	1.35	-.23	.64	.410	32	9.41	12.48	.686	.223
SNS2									
SNS3									
SNS4									
BTS1	1.73	4.06	.85	.309	17	4.91	12.57	.969	.112
BTS2									
BTS3									
BTS4									
DFS0	2.59	-1.52	1.07	.218	19	4.89	11.12	1.302	.062
					VPA Mean =		13.48	.548	.350

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2003	508973	13.14	.25	.16	.38		
2004	391570	12.88	.27	.29	1.18		
2005	553921	13.22	.32	.44	1.85		

Appendix 2: North Sea Sole: Revised estimate of 2005 YC.

Recruitment estimates

Recruitment estimation was carried using RCT3. Input to the RCT3 model is presented in Table xx.1 for age-1 and Table xx.2 for age-2. Results are presented in Table xx.3 for age-1 and Table xx.4 for age-2. Average recruitment of 1-year-old-fish in the period 1957-2003 was around 97 million (geometric mean). For year class 2005 (age 1 in 2006) the value predicted by the RCT3 was 40% higher as the geometric mean (Table xx.2.), and the RCT3 was accepted for the short-term forecasts. For year class 2004 (age 2 in 2006), the data coming from DFS 1-group are noisy (high s.e. of the predicted value, Table xx.3.). Apart from DFS data the RCT3 estimate is based on the same data as the XSA; the WG finds it not desirable to use the same data twice and therefore accepts the XSA estimate. The year class strength estimates from the different sources are summarized in the text table below and the estimates used for the short-term forcast are underlined.

Year Class	Age in 2006	XSA Thousands	RCT3 thousands	GM(1957-2003) thousands
2004	2	**39 898**	45 100	85 353
2005	1		**134 000**	**96 733**
2006	Recruit			**96 733**

Table 10.5.1. Sole in sub area IV: Input RCT3 – age 1

Sole North Sea Age 1

8 38 2

Year	VPA1	DFS0	DFS1	SNS1	SNS2	SNS3	BTS1	BTS2	Sol3
1968	50652	-11.00	-11.00	-11.00	734.38	110.35	-11.00	-11.00	-11.00
1969	137683	-11.00	-11.00	5410.28	1843.79	148.55	-11.00	-11.00	-11.00
1970	42080	-11.00	-11.00	893.00	272.27	83.81	-11.00	-11.00	-11.00
1971	76484	-11.00	-11.00	1454.69	935.26	65.16	-11.00	-11.00	-11.00
1972	104789	-11.00	-11.00	5587.15	361.43	165.84	-11.00	-11.00	-11.00
1973	109891	-11.00	-11.00	2347.93	848.13	229.11	-11.00	-11.00	31.50
1974	40817	-11.00	2.86	528.85	73.56	103.84	-11.00	-11.00	16.30
1975	113279	168.84	6.95	1399.43	776.10	294.07	-11.00	-11.00	34.40
1976	140258	82.28	9.69	3742.94	1354.66	300.84	-11.00	-11.00	-11.00
1977	47166	33.80	2.13	1547.71	408.27	109.33	-11.00	-11.00	41.50
1978	11724	96.87	2.27	93.78	88.89	49.97	-11.00	-11.00	1.90
1979	151590	392.08	48.21	4312.89	1413.05	227.78	-11.00	-11.00	76.10
1980	148986	404.00	13.39	3737.20	1146.20	120.58	-11.00	-11.00	77.10
1981	152693	293.93	14.28	5856.46	1123.33	318.32	-11.00	-11.00	147.10
1982	142098	328.52	20.32	2621.14	1099.91	167.07	-11.00	-11.00	77.80
1983	70750	104.38	11.89	2493.11	715.60	69.24	-11.00	7.89	10.80
1984	80790	186.53	3.43	3619.44	457.61	64.82	2.65	4.49	29.80
1985	159600	315.03	10.47	3705.06	943.70	281.61	7.88	12.55	24.60
1986	72513	73.22	6.43	1947.85	593.83	207.56	6.97	12.51	20.30
1987	454313	523.86	35.04	11226.67	5005.00	914.25	83.11	68.08	66.90
1988	108279	50.07	11.59	2830.74	1119.50	513.84	9.02	22.36	86.40
1989	177673	77.80	11.25	2856.17	2529.10	360.41	22.60	23.19	54.10
1990	70463	21.09	8.26	1253.62	144.40	153.78	3.71	23.20	11.30
1991	353986	391.93	17.90	11114.01	3419.57	934.10	74.44	27.36	180.70
1992	69255	25.30	10.67	1290.78	498.25	142.85	4.99	4.99	-11.00
1993	57050	25.13	6.18	651.78	223.67	29.60	5.88	8.46	-11.00
1994	96090	69.11	9.82	1362.10	349.09	189.82	27.86	6.17	12.90
1995	49257	19.07	3.99	218.36	153.63	141.71	3.51	5.37	0.90
1996	270668	59.62	19.02	10279.33	3126.37	455.61	173.94	29.21	45.70
1997	113509	44.08	-11.00	4094.61	971.78	166.28	14.12	19.26	13.80
1998	82031	-11.00	-11.00	1648.85	125.88	106.67	11.41	6.53	-11.00
1999	124495	-11.00	4.53	1639.17	655.36	195.30	14.46	10.71	-11.00
2000	66740	15.51	3.40	970.31	379.04	-11.00	8.17	4.17	-11.00
2001	198090	84.62	18.36	7541.56	-11.00	393.00	21.90	10.55	-11.00
2002	-11	65.38	5.34	-11.00	624.40	124.00	10.76	4.40	-11.00
2003	-11	18.47	8.95	1369.00	162.90	-11.00	3.65	3.16	-11.00
2004	-11	54.51	8.85	563	381	-11.00	3.12	2.44	-11.00
2005	-11	48.76	-11.00	4167	-11	-11.00	16.82	-11.00	-11.00

Table 10.5.2. Sole in sub area IV: Input RCT3 – age 2

Sole North Sea Age 2

8 38 2

Year	VPA2	DFS0	DFS1	SNS1	SNS2	SNS3	BTS1	BTS2	Sol3
1968	45455	-11.00	-11.00	-11.00	734.38	110.35	-11.00	-11.00	-11.00
1969	123345	-11.00	-11.00	5410.28	1843.79	148.55	-11.00	-11.00	-11.00
1970	37676	-11.00	-11.00	893.00	272.27	83.81	-11.00	-11.00	-11.00
1971	68865	-11.00	-11.00	1454.69	935.26	65.16	-11.00	-11.00	-11.00
1972	94149	-11.00	-11.00	5587.15	361.43	165.84	-11.00	-11.00	-11.00
1973	99338	-11.00	-11.00	2347.93	848.13	229.11	-11.00	-11.00	31.50
1974	36682	-11.00	2.86	528.85	73.56	103.84	-11.00	-11.00	16.30
1975	101509	168.84	6.95	1399.43	776.10	294.07	-11.00	-11.00	34.40
1976	125249	82.28	9.69	3742.94	1354.66	300.84	-11.00	-11.00	-11.00
1977	42652	33.80	2.13	1547.71	408.27	109.33	-11.00	-11.00	41.50
1978	10599	96.87	2.27	93.78	88.89	49.97	-11.00	-11.00	1.90
1979	136558	392.08	48.21	4312.89	1413.05	227.78	-11.00	-11.00	76.10
1980	134406	404.00	13.39	3737.20	1146.20	120.58	-11.00	-11.00	77.10
1981	135632	293.93	14.28	5856.46	1123.33	318.32	-11.00	-11.00	147.10
1982	128206	328.52	20.32	2621.14	1099.91	167.07	-11.00	-11.00	77.80
1983	63835	104.38	11.89	2493.11	715.60	69.24	-11.00	7.89	10.80
1984	72944	186.53	3.43	3619.44	457.61	64.82	2.65	4.49	29.80
1985	144056	315.03	10.47	3705.06	943.70	281.61	7.88	12.55	24.60
1986	65523	73.22	6.43	1947.85	593.83	207.56	6.97	12.51	20.30
1987	411070	523.86	35.04	11226.67	5005.00	914.25	83.11	68.08	66.90
1988	97863	50.07	11.59	2830.74	1119.50	513.84	9.02	22.36	86.40
1989	159944	77.80	11.25	2856.17	2529.10	360.41	22.60	23.19	54.10
1990	63644	21.09	8.26	1253.62	144.40	153.78	3.71	23.20	11.30
1991	319367	391.93	17.90	11114.01	3419.57	934.10	74.44	27.36	180.70
1992	62613	25.30	10.67	1290.78	498.25	142.85	4.99	4.99	-11.00
1993	50938	25.13	6.18	651.78	223.67	29.60	5.88	8.46	-11.00
1994	82379	69.11	9.82	1362.10	349.09	189.82	27.86	6.17	12.90
1995	44406	19.07	3.99	218.36	153.63	141.71	3.51	5.37	0.90
1996	243398	59.62	19.02	10279.33	3126.37	455.61	173.94	29.21	45.70
1997	102475	44.08	-11.00	4094.61	971.78	166.28	14.12	19.26	13.80
1998	73952	-11.00	-11.00	1648.85	125.88	106.67	11.41	6.53	-11.00
1999	110412	-11.00	4.53	1639.17	655.36	195.30	14.46	10.71	-11.00
2000	59548	15.51	3.40	970.31	379.04	-11.00	8.17	4.17	-11.00
2001	178236	84.62	18.36	7541.56	-11.00	393.00	21.90	10.55	-11.00
2002	-11	65.38	5.34	-11.00	624.40	124.00	10.76	4.40	-11.00
2003	-11	18.47	8.95	1369.00	162.90	-11.00	3.65	3.16	-11.00
2004	-11	54.51	8.85	563	381	-11.00	3.12	2.44	-11.00
2005	-11	48.76	-11.00	4167	-11	-11.00	16.82	-11.00	-11.00

Table 10.5.3. Sole in sub area IV: Output RCT3 – age 1

```
Analysis by RCT3 ver3.1 of data from file :
 in_16b.txt
 Sole North Sea Age 1
 Data for    8 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    .00
 Minimum of   3 points used for regression
 Forecast/Hindcast variance correction used.
 Yearclass =   2003
          I-----------Regression----------I  I-----------Prediction---------I

 Survey/          Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series                   cept   Error          Pts  Value   Value    Error   Weights

 DFS0              1.27   5.79   1.16   .298     25   2.97    9.57    1.291     .021
 DFS1              1.35   8.40    .60   .618     26   2.30   11.51     .641     .084
 SNS1               .73   5.93    .34   .810     33   7.22   11.17     .356     .272
 SNS2               .78   6.41    .43   .725     33   5.10   10.40     .463     .161
 SNS3              1.12   5.68    .53   .638     33   4.39   10.62     .566     .108
 BTS1               .68   9.82    .38   .752     18   1.54   10.88     .427     .190
 BTS2              1.15   8.66    .53   .599     19   1.43   10.31     .617     .091
 Sol3
                                        VPA Mean =   11.49     .688     .073
 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

 DFS0              1.27   5.79   1.16   .298     25   4.02   10.90    1.244     .025
 DFS1              1.35   8.40    .60   .618     26   2.29   11.50     .641     .095
 SNS1               .73   5.93    .34   .810     33   6.34   10.54     .364     .295
 SNS2               .78   6.41    .43   .725     33   5.95   11.06     .453     .191
 SNS3
 BTS1               .68   9.82    .38   .752     18   1.42   10.79     .429     .212
 BTS2              1.15   8.66    .53   .599     19   1.24   10.09     .631     .098
 Sol3
                                        VPA Mean =   11.49     .688     .083
 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

 DFS0              1.27   5.79   1.16   .298     25   3.91   10.76    1.247     .039
 DFS1
 SNS1               .73   5.93    .34   .810     33   8.34   11.98     .357     .477
 SNS2
 SNS3
 BTS1               .68   9.82    .38   .752     18   2.88   11.80     .414     .355
 BTS2
 Sol3

                                        VPA Mean =   11.49     .688     .129

 Year     Weighted      Log      Int      Ext      Var      VPA      Log
 Class     Average      WAP      Std      Std     Ratio              VPA
          Prediction            Error    Error

 2003       52765     10.87      .19      .17      .80
 2004       50388     10.83      .20      .17      .72
 2005      133969     11.81      .25      .15      .38
```

Table 10.5.4. Sole in sub area IV: Output RCT3 – age 2

```
Analysis by RCT3 ver3.1 of data from file :
 in_26b.txt
 Sole North Sea-Age 2
 Data for    8 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    .00
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.
 Yearclass =   2003
         I-----------Regression----------I  I-----------Prediction---------I

 Survey/           Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series                    cept   Error          Pts  Value   Value    Error   Weights

 DFS0              1.27   5.70   1.16   .300     25   2.97    9.46    1.286     .021
 DFS1              1.35   8.30    .60   .620     26   2.30   11.40     .638     .085
 SNS1               .72   5.84    .34   .812     33   7.22   11.07     .354     .276
 SNS2               .78   6.31    .43   .727     33   5.10   10.30     .460     .164
 SNS3              1.12   5.58    .53   .639     33   4.39   10.51     .565     .108
 BTS1               .69   9.70    .39   .742     18   1.54   10.76     .438     .180
 BTS2              1.15   8.56    .53   .605     19   1.43   10.20     .611     .093
 Sol3
                                        VPA Mean =   11.39     .688     .073
 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

 DFS0              1.27   5.70   1.16   .300     25   4.02   10.79    1.239     .025
 DFS1              1.35   8.30    .60   .620     26   2.29   11.39     .638     .096
 SNS1               .72   5.84    .34   .812     33   6.34   10.42     .361     .300
 SNS2               .78   6.31    .43   .727     33   5.95   10.96     .450     .194
 SNS3
 BTS1               .69   9.70    .39   .742     18   1.42   10.68     .441     .201
 BTS2              1.15   8.56    .53   .605     19   1.24    9.98     .624     .101
 Sol3
                                        VPA Mean =   11.39     .688     .083
 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

 DFS0              1.27   5.70   1.16   .300     25   3.91   10.66    1.242     .040
 DFS1
 SNS1               .72   5.84    .34   .812     33   8.34   11.87     .355     .490
 SNS2
 SNS3
 BTS1               .69   9.70    .39   .742     18   2.88   11.69     .425     .340
 BTS2
 Sol3
                                        VPA Mean =   11.39     .688     .130


 Year     Weighted      Log     Int     Ext     Var     VPA      Log
 Class     Average      WAP     Std     Std     Ratio            VPA
          Prediction           Error   Error

 2003       47316     10.76     .19     .17     .81
 2004       45088     10.72     .20     .17     .73
 2005      120473     11.70     .25     .15     .38
```

Appendix 3: Revised Whiting (IV+VIId) assessment

See next page

Whiting in IV and VIId. Revised tuning series for Englis Ground Fish Survey II

ENGGFS(GOV)
1992 2005
1 1 0.5 0.75

1 6		0	1	2	3	4	5	6
	100	45.50	26.55	13.07	3.05	2.61	0.49	0.59
	100	25.24	25.10	9.63	3.75	1.16	0.74	0.19
	100	21.14	30.55	10.59	2.44	1.12	0.33	0.11
	100	36.28	35.51	23.74	7.36	1.87	0.25	0.14
	100	9.92	18.84	10.93	6.03	1.36	0.27	0.12
	100	48.97	15.47	8.71	7.51	2.27	0.86	0.48
	100	158.81	17.71	11.53	2.92	2.36	0.89	0.16
	100	105.79	44.57	10.01	3.76	1.43	0.78	0.16
	100	70.27	60.17	18.59	3.55	0.95	0.51	0.20
	100	99.90	54.45	14.71	5.08	1.26	0.33	0.38
	100	5.32	62.57	17.97	8.01	2.45	0.27	0.06
	100	**15.00**	**6.80**	**13.04**	**9.32**	**4.80**	**2.02**	**0.38**
	100	**63.96**	**5.80**	**4.00**	**6.08**	**2.77**	**1.37**	**0.59**
	100	7.15	12.57	3.83	2.55	5.00	5.57	2.16

Lowestoft VPA Version 3.1

3/10/2006 18:54

Extended Survivors Analysis

North Sea/Eastern Cha ages 0-8+

CPUE data from file whiivviidEF.dat

Catch data for 26 years. 1980 to 2005. Ages 1 to 8.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
ENGGFS(GOV)	1992	2005	1	6	0.5	0.75
SCOGFS(old)	1982	2005	1	6	0.5	0.75
SCOGFS(new)	1998	2005	1	6	0.5	0.75
IBTS	1983	2005	1	5	0	0.25

Time series weights :

Tapered time weighting applied
Power = 3 over 16 years

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 4

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 3 years or the 4 oldest ages.

S.E. of the mean to which the estimates are shrunk = 2.000

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting applied :

Fleet	Weight
ENGGFS(G	1.00
SCOGFS(o	1.00
SCOGFS(n	1.00
IBTS	1.00

Tuning had not converged after 40 iterations

Total absolute residual between iterations
39 and 40 = .00017

Final year F values

Age	1	2	3	4	5	6	7
Iteration 39	0.1197	0.3123	0.277	0.2114	0.252	0.2248	0.2024
Iteration 40	0.1197	0.3124	0.277	0.2114	0.252	0.2248	0.2025

1

Regression weights

0.555	0.67	0.769	0.85	0.911	0.954	0.98	0.994	0.999	1

Fishing mortalities

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.118	0.12	0.119	0.195	0.065	0.109	0.073	0.353	0.115	0.12
2	0.321	0.299	0.241	0.393	0.362	0.192	0.184	0.384	0.214	0.312
3	0.585	0.53	0.356	0.535	0.691	0.368	0.363	0.306	0.179	0.277
4	0.739	0.637	0.553	0.64	0.719	0.591	0.439	0.367	0.272	0.211
5	0.89	0.794	0.681	0.681	0.822	0.76	0.533	0.365	0.309	0.252
6	1.164	0.571	0.772	0.76	0.904	0.665	0.394	0.311	0.339	0.225
7	1.056	0.914	0.526	0.63	1.698	0.629	0.444	0.151	0.261	0.203

1

XSA population numbers (Thousands)

AGE

YEAR	1	2	3	4	5	6	7
1996	1.05E+06	5.20E+05	2.65E+05	1.08E+05	2.74E+04	7.74E+03	2.19E+03
1997	7.62E+05	3.60E+05	2.40E+05	1.04E+05	3.82E+04	8.75E+03	1.88E+03
1998	1.03E+06	2.62E+05	1.70E+05	9.97E+04	4.07E+04	1.35E+04	3.85E+03
1999	1.61E+06	3.52E+05	1.31E+05	8.40E+04	4.25E+04	1.61E+04	4.84E+03
2000	1.70E+06	5.13E+05	1.52E+05	5.41E+04	3.28E+04	1.67E+04	5.85E+03
2001	1.31E+06	6.17E+05	2.28E+05	5.35E+04	1.95E+04	1.12E+04	5.28E+03
2002	1.14E+06	4.56E+05	3.24E+05	1.11E+05	2.20E+04	7.11E+03	4.49E+03
2003	3.93E+05	4.08E+05	2.42E+05	1.59E+05	5.31E+04	1.00E+04	3.74E+03
2004	3.78E+05	1.07E+05	1.77E+05	1.25E+05	8.16E+04	2.87E+04	5.73E+03
2005	3.68E+05	1.30E+05	5.50E+04	1.04E+05	7.08E+04	4.67E+04	1.59E+04

Estimated population abundance at 1st Jan 2006

0.00E+00	1.26E+05	6.08E+04	2.94E+04	6.27E+04	4.29E+04	2.90E+04

Taper weighted geometric mean of the VPA populations:

8.87E+05	3.41E+05	1.85E+05	9.53E+04	3.91E+04	1.42E+04	4.71E+03

Standard error of the weighted Log(VPA populations) :

0.641	0.6219	0.5155	0.3549	0.4916	0.6166	0.5893

1

Log catchability residuals.

Fleet : ENGGFS(GOV)

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	99.99	99.99	99.99	99.99	99.99	99.99	-0.5	-0.67	-0.39	-0.11
2	99.99	99.99	99.99	99.99	99.99	99.99	-0.35	-0.45	-0.57	0.31
3	99.99	99.99	99.99	99.99	99.99	99.99	-0.67	-0.48	-0.73	0.08
4	99.99	99.99	99.99	99.99	99.99	99.99	-0.6	-0.42	-0.36	0.2
5	99.99	99.99	99.99	99.99	99.99	99.99	0.22	-0.79	-0.45	-0.62
6	99.99	99.99	99.99	99.99	99.99	99.99	1.15	0.54	-1.36	0.04

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	-0.36	-0.24	-0.4	0.11	0.28	0.47	0.73	-0.26	-0.52	0.28
2	-0.36	-0.23	0.33	-0.02	0.21	-0.31	0.18	0.1	0.15	-0.03
3	-0.07	0.21	-0.49	0.13	0.03	-0.22	-0.12	0.29	0.09	0.45
4	-0.44	0.04	0.07	-0.2	-0.12	0.09	-0.07	0.2	-0.17	0.56
5	-0.64	0.14	0.04	-0.13	-0.2	-0.17	-0.63	0.4	-0.45	1.06
6	-0.01	0.89	-0.49	-0.71	-0.41	0.47	-1.16	0.36	-0.22	0.51

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6
Mean Log q	-14.5041	-14.5338	-14.6453	-14.798	-14.798	-14.798
S.E(Log q)	0.4321	0.2593	0.3114	0.2814	0.5398	0.6795

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	0.84	0.814	14.37	0.77	14	0.37	-14.5
2	1.15	-0.91	14.8	0.83	14	0.3	-14.53
3	1.4	-1.482	15.66	0.64	14	0.41	-14.65
4	0.97	0.125	14.68	0.63	14	0.29	-14.8
5	0.67	1.392	13.48	0.7	14	0.34	-14.89
6	0.94	0.159	14.59	0.49	14	0.67	-14.9

1

Fleet : SCOGFS(old)

Age	1982	1983	1984	1985
1	99.99	99.99	99.99	99.99

	2	99.99	99.99	99.99	99.99
	3	99.99	99.99	99.99	99.99
	4	99.99	99.99	99.99	99.99
	5	99.99	99.99	99.99	99.99
	6	99.99	99.99	99.99	99.99

Age		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	1	99.99	99.99	99.99	99.99	-0.63	-0.87	-0.26	-0.3	-0.4	0.19
	2	99.99	99.99	99.99	99.99	-0.76	-0.7	-0.51	-0.38	-0.81	0.02
	3	99.99	99.99	99.99	99.99	-0.99	-0.87	-0.34	-0.63	-0.95	0.02
	4	99.99	99.99	99.99	99.99	-0.25	-1.13	0.02	-0.32	-1.23	0.06
	5	99.99	99.99	99.99	99.99	-0.74	-0.78	-0.02	-0.09	-0.62	0.03
	6	99.99	99.99	99.99	99.99	-0.44	-1.27	0.14	-0.79	-0.85	0.27

Age		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	1	0.2	0.06	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
	2	0.54	0.14	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
	3	0.37	0.41	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
	4	0.58	0.19	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
	5	-0.35	0.3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
	6	0.03	-0.34	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6
Mean Log q	-10.0385	-9.8049	-9.7739	-10.0019	-10.0019	-10.0019
S.E(Log q)	0.332	0.5898	0.6719	0.758	0.4595	0.6269

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age		Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
	1	1.63	-0.369	7.55	0.54	8	0.93	-10.04
	2	10.39	-0.286	-21.36	0	8	11.32	-9.8
	3	0.91	0.013	10	0.07	8	1.28	-9.77
	4	0.59	0.146	10.62	0.3	8	0.9	-10
	5	0.82	0.122	10.16	0.61	8	0.74	-10.1
	6	1.99	-0.34	11.27	0.28	8	1.92	-10.24
	1							

Fleet : SCOGFS(new)

Age		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	1	99.99	99.99	-0.03	-0.17	-0.1	-0.45	0.02	0.29	0.49	-0.12
	2	99.99	99.99	-0.06	0.22	0.29	-0.3	-0.02	-0.31	-0.25	0.45
	3	99.99	99.99	-0.15	0.16	0.21	-0.18	0.11	0.09	-0.41	0.17
	4	99.99	99.99	-0.24	0.01	0.01	-0.03	0.4	0.12	-0.07	-0.25
	5	99.99	99.99	-0.19	-0.25	0.11	-0.35	0	0.09	0.02	-0.22
	6	99.99	99.99	0.23	-0.02	0.36	0.09	0.29	-0.34	-0.36	0.03

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6
Mean Log q	-9.4226	-9.4316	-9.5808	-9.5755	-9.5755	-9.5755
S.E(Log q)	0.2971	0.2964	0.2256	0.2088	0.2018	0.2754

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.4	-2.03	7.75	0.83	8	0.34	-9.42
2	1.09	-0.45	9.14	0.81	8	0.35	-9.43
3	1.12	-0.64	9.28	0.84	8	0.27	-9.58
4	0.93	0.353	9.71	0.81	8	0.21	-9.58
5	0.93	0.543	9.74	0.92	8	0.17	-9.67
6	1.13	-0.65	9.54	0.81	8	0.33	-9.55
1							

Fleet : IBTS

Age	1982	1983	1984	1985
1	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99
6	No data for this fleet at this age			

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	99.99	99.99	99.99	99.99	-0.56	0.16	0.1	0.18	-0.12	-0.05
2	99.99	99.99	99.99	99.99	-0.3	0.34	0.26	0.18	0.21	-0.05
3	99.99	99.99	99.99	99.99	-0.07	0.02	0.15	0.05	-0.02	-0.02
4	99.99	99.99	99.99	99.99	-0.23	0.3	-0.12	-0.07	0.03	0
5	99.99	99.99	99.99	99.99	-0.79	0.17	-0.24	-0.09	-0.63	-0.5
6	No data for this fleet at this age									

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.05	-0.19	0.15	-0.08	-0.03	0.08	0.25	-0.28	0.07	0
2	0.15	0.16	-0.28	0.08	0.27	0.17	0.11	-0.09	0.04	-0.63
3	0.08	-0.24	-0.18	-0.18	0.35	0.4	-0.04	0.1	0.07	-0.44
4	-0.14	-0.25	-0.33	-0.09	0.28	0.89	-0.24	0.08	0.01	-0.38
5	0.14	-0.45	-0.68	-0.21	-0.19	0.57	0.28	0.16	-0.24	-0.39
6	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5
Mean Log q	-12.1648	-11.6346	-11.5539	-11.6887	-11.6887
S.E(Log q)	0.1568	0.2703	0.2557	0.3687	0.4044

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	0.94	0.805	12.26	0.95	16	0.15	-12.16
2	0.78	2.287	11.87	0.94	16	0.17	-11.63
3	0.8	1.669	11.67	0.9	16	0.19	-11.55
4	2.77	-2.17	12.08	0.16	16	0.85	-11.69
5	1.61	-1.545	12.56	0.45	16	0.57	-11.81
1							

Terminal year survivor and F summaries :

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 2004

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
ENGGFS(GOV)	167117	0.454	0	0	1	0.185	0.092
SCOGFS(old)	1	0	0	0	0	0	0
SCOGFS(new)	111847	0.316	0	0	1	0.381	0.134
IBTS	125787	0.3	0	0	1	0.423	0.12

F shrinkage mean	77164	2				0.011	0.189

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
126116	0.2	0.09	4	0.446	0.12

1
Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2003

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
ENGGFS(GOV)	51346	0.251	0.221	0.88	2	0.277	0.36
SCOGFS(old)	1	0	0	0	0	0	0
SCOGFS(new)	97118	0.224	0.023	0.1	2	0.34	0.207
IBTS	44945	0.213	0.347	1.63	2	0.377	0.403
F shrinkage mean	73475	2				0.006	0.265

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
60773	0.13	0.17	7	1.308	0.312

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2002

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
ENGGFS(GOV)	37012	0.202	0.166	0.82	3	0.29	0.226
SCOGFS(old)	1	0	0	0	0	0	0
SCOGFS(new)	31166	0.184	0.156	0.85	3	0.342	0.263
IBTS	23150	0.178	0.149	0.84	3	0.363	0.34
F shrinkage mean	28339	2				0.005	0.286

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
29395	0.11	0.1	10	0.907	0.277

1
Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2001

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
ENGGFS(GOV)	87931	0.171	0.147	0.86	4	0.318	0.155
SCOGFS(old)	1	0	0	0	0	0	0
SCOGFS(new)	48191	0.159	0.083	0.52	4	0.358	0.267
IBTS	60454	0.164	0.128	0.78	4	0.321	0.218
F shrinkage mean	33660	2				0.004	0.363

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
62655	0.1	0.09	13	0.992	0.211

Age 5 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2000

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
ENGGFS(GOV)	53211	0.166	0.195	1.17	5	0.281	0.208
SCOGFS(old)	1	0	0	0	0	0	0
SCOGFS(new)	37722	0.145	0.08	0.55	5	0.405	0.282
IBTS	41914	0.157	0.096	0.61	5	0.311	0.257

F shrinkage mean	24562	2					0.004	0.406

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
42858	0.09	0.08	16	0.841	0.252

1

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 1999

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
ENGGFS(GOV)	29109	0.171	0.138	0.81	6	0.253	0.224
SCOGFS(old)	1	0	0	0	0	0	0
SCOGFS(new)	29487	0.14	0.049	0.35	6	0.494	0.222
IBTS	28358	0.162	0.071	0.44	5	0.249	0.23
F shrinkage mean	17413	2				0.005	0.351

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
29037	0.09	0.05	18	0.506	0.225

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 1998

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
ENGGFS(GOV)	10649	0.182	0.099	0.54	6	0.247	0.202
SCOGFS(old)	1	0	0	0	0	0	0
SCOGFS(new)	10096	0.148	0.129	0.87	6	0.512	0.212
IBTS	12001	0.173	0.118	0.68	5	0.234	0.182
F shrinkage mean	8706	2				0.007	0.243

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
10640	0.1	0.07	18	0.667	0.203

1
1

Run title : North Sea/Eastern Channel Whiting
ages 0-8+

At 3/10/2006 18:57

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1980	1981	1982	1983	1984	1985
AGE						
1	0.1014	0.1652	0.1734	0.2103	0.2233	0.1901
2	0.4401	0.3294	0.2933	0.4552	0.5164	0.2494
3	0.8223	0.7515	0.5312	0.7466	0.8708	0.6352
4	0.975	0.9979	0.719	0.7345	1.0277	0.8736
5	1.2296	1.0954	0.8931	0.88	1.0479	1.1654
6	0.944	1.2779	1.0099	0.9178	1.122	1.1822
7	1.004	1.0426	0.7963	0.8282	1.0288	0.9749
+gp	1.004	1.0426	0.7963	0.8282	1.0288	0.9749
0 FBAR 2- 6	0.8822	0.8904	0.6893	0.7468	0.917	0.8212

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
1	0.2698	0.1405	0.3585	0.1296	0.2268	0.117	0.2385	0.1937	0.1592	0.1523
2	0.4252	0.5079	0.4304	0.4314	0.5519	0.4884	0.3882	0.4764	0.3441	0.35
3	0.7046	0.8694	0.6565	0.695	0.9121	0.5231	0.5799	0.759	0.6778	0.6239
4	1.1921	1.2436	0.9655	0.8242	0.9801	0.8869	0.6458	0.8328	0.9199	0.7532
5	1.0467	1.3455	1.147	1.4963	1.181	1.095	0.9433	0.8884	1.0193	1.0042
6	1.1564	1.6546	1.1916	1.5064	0.9679	0.6847	1.1095	1.0906	1.1637	1.1235
7	1.0367	1.2944	1.0014	1.144	1.0219	0.8071	0.8725	0.8261	0.9839	1.2766
+gp	1.0367	1.2944	1.0014	1.144	1.0219	0.8071	0.8725	0.8261	0.9839	1.2766
0 FBAR 2- 6	0.905	1.1242	0.8782	0.9906	0.9186	0.7356	0.7333	0.8094	0.8249	0.771
1										

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	FBAR **-**
AGE											
1	0.1183	0.1195	0.1188	0.1954	0.0652	0.1086	0.0732	0.3529	0.1146	0.1197	0.1957
2	0.3211	0.2988	0.2407	0.3927	0.3617	0.1923	0.1841	0.3843	0.2136	0.3124	0.3034
3	0.5851	0.5296	0.3559	0.5352	0.6911	0.3681	0.3631	0.3063	0.1787	0.277	0.254
4	0.7387	0.6369	0.553	0.6401	0.7191	0.5907	0.4393	0.367	0.2722	0.2114	0.2835
5	0.8903	0.7939	0.6809	0.6814	0.8225	0.7601	0.5325	0.3646	0.3086	0.252	0.3084
6	1.1637	0.5708	0.7722	0.7604	0.9039	0.6654	0.3937	0.3112	0.3392	0.2248	0.2917
7	1.0564	0.9136	0.5264	0.6299	1.6978	0.6295	0.4436	0.1512	0.2613	0.2025	0.205
+gp	1.0564	0.9136	0.5264	0.6299	1.6978	0.6295	0.4436	0.1512	0.2613	0.2025	
0 FBAR 2- 6	0.7398	0.566	0.5206	0.602	0.6997	0.5153	0.3826	0.3467	0.2625	0.2555	
1											

Run title : North Sea/Eastern Channel Whiting
ages 0-8+

At 3/10/2006 18:57

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1980	1981	1982	1983	1984	1985
AGE						
1	4423046	1719959	1945651	1743360	2598936	1888879
2	1463366	1545551	563874	632663	546340	803993
3	607921	600894	708926	268157	255881	207851
4	169230	188246	199713	293698	89566	75480
5	84825	47287	51410	72091	104386	23743
6	19941	19317	12315	16391	23288	28508
7	2010	6042	4192	3494	5098	5906
+gp	1314	546	959	1798	1036	1576
0 TOTAL	6771652	4127841	3487040	3031651	3624532	3035936

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
1	3921363	3275967	2296902	4388805	2010378	1870889	1817385	1986792	1787234	1564590
2	604065	1157892	1100876	620682	1491069	619696	643633	553735	633090	589451
3	399486	251755	444267	456463	257081	547489	242465	278361	219264	286152
4	77604	139160	74367	162385	160537	72766	228667	95678	91824	78449
5	23341	17453	29726	20979	52764	44629	22207	88807	30820	27113
6	5766	6382	3540	7353	3659	12614	11628	6734	28448	8661
7	6807	1413	950	837	1270	1082	4954	2986	1762	6920
+gp	956	1541	288	531	190	537	219	1492	798	710
0 TOTAL	5039389	4851563	3950915	5658034	3976948	3169704	2971156	3014584	2793241	2562047
1										

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	GMST 80-**	AMST 80
AGE													
1	1047029	762458	1025707	1613133	1702248	1314363	1135968	393208	377734	367583	0	1763846	2009761
2	519594	359753	261660	352262	513120	616794	456005	408320	106853	130264	126116	638570	710729
3	264849	240312	170139	131151	151664	227872	324471	241861	177279	55027	60773	293931	324364
4	108058	103969	99717	83990	54119	53548	111128	159026	125476	104482	29395	111824	123789
5	27365	38242	40740	42492	32807	19532	21975	53056	81618	70802	62655	37195	42408
6	7736	8749	13464	16059	16741	11225	7113	10048	28696	46685	42858	10941	12737
7	2193	1882	3850	4844	5847	5280	4494	3737	5732	15920	29037	3045	3660
+gp	1850	835	1087	1579	1664	2965	2305	3115	1426	2877	12564		
0 TOTAL	1978674	1516200	1616364	2245511	2478210	2251580	2063458	1272371	904814	793640	363399		

Run title : North Sea/Eastern Channel Whiting
ages 0-8+

At 3/10/2006 18:57

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECR Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2- 6
1980	4423046	837816	522370	223517	0.4279	0.8822
1981	1719959	636483	489007	192049	0.3927	0.8904
1982	1945651	492859	378623	140195	0.3703	0.6893
1983	1743360	512748	337432	161212	0.4778	0.7468
1984	2598936	485837	271619	145741	0.5366	0.917
1985	1888879	441807	271141	106363	0.3923	0.8212
1986	3921363	665501	288776	161744	0.5601	0.905
1987	3275967	537238	299243	138775	0.4638	1.1242
1988	2296902	419850	295657	133470	0.4514	0.8782
1989	4388805	560501	279723	123753	0.4424	0.9906
1990	2010378	482572	317018	153453	0.4841	0.9186
1991	1870889	456417	276334	124975	0.4523	0.7356
1992	1817385	407249	264576	109704	0.4146	0.7333
1993	1986792	375363	238978	116165	0.4861	0.8094
1994	1787234	358309	223027	92606	0.4152	0.8249
1995	1564590	360104	230863	103268	0.4473	0.771
1996	1047029	294698	201257	73957	0.3675	0.7398
1997	762458	239566	172703	59102	0.3422	0.566
1998	1025707	227330	140754	44312	0.3148	0.5206
1999	1613133	255792	141188	59179	0.4191	0.602
2000	1702248	354234	174829	60907	0.3484	0.6997
2001	1314363	290646	196841	49062	0.2492	0.5153
2002	1135968	262096	188837	46552	0.2465	0.3826
2003	393208	177556	155320	43208	0.2782	0.3467
2004	377734	172907	134581	29057	0.2159	0.2625
2005	367583	135176	103708	26795	0.2584	0.2555
Arith. Mean	1883830	401564	253631	104582	0.3944	0.7126
0 Units	(Thousands	(Tonnes)	(Tonnes)	(Tonnes)		