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1-8 May 2007

ICES Copenhagen

By Correspondence – September 2007

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0 Executive summary

The ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) met at ICES Headquarters in Copenhagen, Denmark, during 1-8 May 2007. There were 22 participants from 9 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

Prior to the meeting a great deal of attention was given to difficult logistics of scheduling the WG and giving it any chance of meeting its objectives as a result of:

a) the reduced time made available to the WG for its meeting, 7 working days

b) no reduction in the groups TOR in line with the reduced meeting time

c) the rescheduling of the meeting to May from September imposing severe stresses at national laboratories as a result of the concentration of several ICES assessment working groups into the first half of the year affecting data quality

d) a lack of appropriate software available to the group for raising data

e) the requirement to submit a report to the ACFM review group for evaluation one week after the close of the meeting.

Several proposals were made by the Chair during the initial preparations for the meeting in order to address the problems, involving removing TOR from the meeting or deferring them until a second correspondence meeting in September.

As in the previous two years, the system of benchmark/update assessments was not closely followed by the WG. The change to the timing of the meeting resulted in pressures on data compilation and potentially introduced processing errors; therefore a detailed review of input data was carried out for each stock. 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 for the majority of assessments. 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 inter-sessional work was done on an assessment, it became *de facto* a benchmark assessment, otherwise it was viewed as an update.

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*** (Section 2) stocks, there were no new assessments performed this year and new catch advice is not provided. Updates of the landings in the FUs are provided together with a brief commentary. While making landings data extractions, some countries also summarised effort data and these are included where available. A limited amount of updated mean size

information was also supplied. Where observations from the landings update was considered relevant to management, a note of these are included in brief sections covering management considerations at the end of each section.

Landings in the directed fishery for **Norway pout in Sub-area IV** (Section 3) have been low since 2001, and the 2003-2004 landings were the lowest on record. The targeted Norway pout fishery was closed for 2005 and in the first half year of 2006. The fishery was opened by at the beginning of August 2006 for the second half year of 2006 with a quota on 95.000 t based on the 2005 year class being on the long term average level. Based on the relatively weak 2006 Norway pout year class the fishery was closed again for the first half year 2007.

Stock biomass (SSB) is estimated to be above Bpa in 1st quarter of 2007 and, based on the below average 2006 year class, the spawning stock will, even if recruitment in 2007 is on the long-term average, just achieve Bpa by 1st of January 2008. 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, as a result of the fishery closure in 2005 and the first part of 2006 the fishing mortality has been low during this period.

An assessment of **sandeel in Sub-area IV** was not carried out during the WG May meeting, an analysis of the 2006 and 2007 data will be prepared for the September meeting of the group. A review of information available from recent research was summarised and an analysis of the performance of the historical forecasts carried out in order to examine whether the systematic bias resulting from the approach could be reduced.

Discrepancies between catch-at-age based analyses and survey-based analyses have prevented the WG from assessing the state of **plaice in Division VIId**. Following the recommendations from the review group, more investigations have been carried out to attempt solving the recurrent issues raised during the previous years. Fishing mortality estimated in 2006 has decreased from the last 4 years to the Fpa value. The spawning stock biomass has followed a stepped decline in the last 10 years, following a peak generated by the strong 1996 year class. The current level of SSB is stable at a low level below Blim, and this confirms the fisher's impression assessed by a survey in France in 2006. The 2005 year class which recruited to the fishery in 2006, is among the lowest in the time series. Stock projections, at the current level of recruitment and with a value of F at the low 2006 level, indicate a slow rebuilding.

It has been postulated that a mismatch between the biological entity of the **Plaice** stock in **Division IIIa** and the defined management area might exist. An analysis of tagging information has indicated that movements of fish between management areas are relatively small and it is unlikely that this will affect the quality of the assessment. Unfortunately the limited survey coverage of main fishing grounds has prevented the presentation of a stock assessment. The available surveys take plaice in the Skagerrak, with limited coverage in the area around Skagen in Northern Denmark; most of the fisheries take plaice in the North Western area close to the North Sea border and therefore the provenance of the catches needs to be examined. There is evidence for increased biomass in the Kattegat and in Eastern Skagerrak, where the populations intermingle between both areas. But the status of the stock in the Southwestern Skagerrak, where most catches occur, cannot be determined.

As in previous 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 human consumption fishing mortality has declined. Recent year-class strength has been poor. On this basis, short-term forecasts at current fishing levels indicate a fall in landings in 2008 (to around 51 kt) and an increase in discards (to around 56 kt). For SSB to reach above B_{pa} by the start of 2009, landings in 2008 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 just below F_{pa} The SSB has increased to well above B_{pa} (8000t) following improved recruitment in recent years, particularly of the 2001 and 2003 year classes.

The reported landings for **sole in Subarea IV** in 2006 (12.6 kt) were the lowest in the time series, well below the TAC which has not been restrictive for two years. SSB has fluctuated around a moderate-to-low level for several years, although at *status quo* fishing mortality it is forecast to be below B_{lim} at the start of 2008. As a result of improved recruitment the short-term forecast at *status quo F* suggests an increase in landings (to around 14.8 kt in 2008) and a corresponding increase in SSB to the level of B_{pa}.

Reported landings for **saithe in Subareas IV and VI and Division IIIa** in 2006 (126 kt) were around the recent average. Fishing mortality has now remained at or below 0.3 for six years (F ~ 0.25 in 2006) while SSB continues a steady increase (298 kt in 2006). Recruitment is fluctuating about the mean level. The TAC has been unrestrictive for five years. The short-term forecast as *status quo F* indicates landings of 126 kt in 2007 and 122 kt in 2008, along with a further increase in SSB to around 320 kt in both years.

Catches of **whiting in Subarea IV and DivisionVIId** increased from the historic low of 26 kt in 2006 to 32 kt in 2007. Historic estimates from the whiting assessment are uncertain due to conflicting information from the data sources but recent time series are consistent in showing a rapid decline in the SSB as a result of a series of weak recruitments. 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 to illustrate the strong decline in the stock estimates (in the full knowledge that this was rejected by ACFM). The final assessment indicates historically low estimates of SSB (97 kt) in 2006 and recruitment (~400 million) during the last four years. Fishing mortality is estimated to have increased from the recent low levels (~0.3) to 0.5, in line with the increased catches and low stock abundance. Continued at the current level will lead to a halving of the already low SSB to 44 kt in 2009 with human consumption landings predicted to be at 8 kt. The working group considers the status of the stock unknown with respect to biological reference points. 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 and without good recruitment the stock is unlikely to recover.

The strong 1999 year-class again dominated the catches of **haddock in Subarea IV and Division IIIa**, which were the lowest in the available time-series. The assessment indicated a continued decline in SSB (from 350 kt in 2002 to 169 kt in 2006) as the 1999 year-class reduces in number. Until 2006, recent fishing mortality had declined and was estimated to have been well below Fpa (0.7) for the last four years, around the management plan target of 0.3. However, it has risen to 0.54 in 2006, still below Fpa. Recruitment in 2005 was moderate in size, much larger than those in 2001–2004, but still only a third of the size of the 1999 year class. The most recent recruitment (2006) is estimated to be very low. 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 and 2008 is landings of around 65 kt tonnes and discards of 22 kt.

The estimated yield (reported landings and discards) in 2006 for **cod in Subarea IV and Divisions IIIa and VIId** (27 kt) was low. A modified assessment has been used 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 (~ 30 kt). Fishing mortality is now estimated to have declined since 2000 (median estimate for 2006 ~ 0.76). Recruitment of the

2000-2004 year-classes was poor, but indications from Q1 and Q3 surveys in 2006 and 2007 are that the 2005 year-class is somewhat stronger. Results from a number of forecast scenarios covering different changes in TAC in 2009 indicate that SSB will increase following a historic low in 2008. The short-term forecast as *status quo F* indicates that continued fishing at the 2006 level in 2007 will enable SSB to rise to B_{lim} (70 kt) by the start of 2009 but even with no fishing SSB will not achieve B_{pa}.

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.

0.4 Mixed-fisheries data collation and modelling

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 as a result of the reduced meeting time mixed fisheries issues were not considered at the meeting as a specific topic but were raised in management considerations where appropriate.

0.5 Management plan evaluations

A number of requests were received by ICES for the evaluation of management plans during 2007. Those regarding North Sea saithe and Norway pout were passed onto the WG for consideration. A review of the North Sea pout management proposals was undertaken and the results and conclusions are provided in Section 16. A review of the North Sea saithe EU – Norway management plan will be carried out in the September meeting of the group.

1 General

1.1 Terms of reference

The Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak [WGNSSK] (Chair: Chris Darby, UK) will meet from 1-8 May 2007 at ICES HQ and by correspondence in September 2007 to:

a) update assessments of the status and provide management options for 2008 for the following species and areas:

1. cod in Subarea IV and Division IIIaN (Skagerrak), and Division VIId,
2. haddock in Subarea IV and Division IIIa,
3. whiting in Subarea IV, Division IIIa, and Division VIId,
4. plaice 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,
7. Norway pout in Subarea IV and Divisions IIIa and VIa
8. sandeel stocks in Subarea IV and Divisions IIIa and VIa

b) Update catch information for Nephrops stocks in Subarea IV, Division IIIa, and Division VIId;

c) 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;

d) 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);

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

The following Terms of Reference are generic, and each individual assessment group should prioritise them according to the detailed rolling planning developed by AMAWGC and to take account of regional developments.

WGNSSK will, in addition to the specific tasks listed by individual group in 2007:

1) set appropriate deadlines for submission of data. Data submitted after the deadline can be disregarded at the discretion of the WG Chair.

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

3) assess the state of the stocks according to the schedule for benchmark and update assessments as shown below.

4) provide specific information on possible deficiencies in the 2007 assessments and forecasts,

- any major inadequacies in the data on landings, effort or discards;
- any major expertise that was lacking
- any major inadequacies in research vessel surveys data,
- any major difficulties in model formulation or available software.

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

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

6) consider existing knowledge of important impacts of fisheries on the ecosystem;

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

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

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

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

11) present an overview of the sampling on a national basis of the basic assessment data for the stocks considered according to the template that is supplied by the Secretariat

12) implement the roadmap for medium and long term strategy of the group as developed in AMAWGC.

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 9 and 10, and ToR a7 in Section 5. A second correspondence meeting of the WGNSSK is scheduled to occur in September 2007 to update forecasts based on new survey data and to address ToR a8. ToR b is addressed in Section 3, ToR c in the appropriate species sections ToR d was deferred until the September meeting in order to manage the change in the timing and length of time made available to the meeting.

Of the additional ToRs to be addressed by all assessment WGs, ToR 1 and 2 were carried out to the prior to the WG meeting with various degrees of success and are discussed in section 1.1.2. ToR 3 and 4 were covered at the WG meeting, ToR 5 and 6 were 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 7 is covered for Norway pout in Section 16, the saithe management plan will be will be evaluated in during the September correspondence meeting. Due to the reduced length of the meeting more general data and analyses on mixed fisheries (ToR 8) were not considered at the May meeting. Technical measures (ToR 9), misreporting, discarding or other sources of unaccounted removals (ToR 10) and the are considered in several stock sections. An overview of sampling rates and data availability for basic assessment data (ToR 11) was not presented due to lack of time at the meeting and will be addressed for the September correspondence meeting.

1.1.1 Special requests

In addition to its specific and generic ToR the WGNSSK was asked to undertake analysis and present reports to ACFM in order for it to meet two special requests for advice from the EC:

Norway Pout in ICES Sub-area IV and Division IIIa

ICES ACFM is requested to provide an updated assessment and a mid-year revision of the TAC taking into account the estimates of incoming recruitment.

Saithe Sub-Area IV, VI and Division IIIa

The Community and Norway have implemented long-term management plans concerning herring of North Sea origin and saithe in the North Sea, west of Scotland and the Skagerrak. These arrangements are to be reviewed in 2007.

ICES is requested to evaluate the management plans agreed between Norway and the European Community (Annex A) concerning saithe and herring of North Sea origin with particular respect to :

(a) achieving the highest yields long-term from these stocks;

(b) ensuring conformity with the precautionary approach;

(c) achieving yields as stable as possible, consistent with achieving a high yield from the stocks and achieving conformity with precautionary principles.

ICES is invited to provide recommendations on any appropriate alterations to the target fishing mortality rate(s) (para. 2), the rule concerning stability of TACs (para 5), or the degressive rate of fishing mortality at lower stock sizes (para. 3). Concerning North Sea herring, ICES is requested to consider what (if any) limits on TAC variations could be applied to the TAC for herring by-catches in the North Sea.

ICES is requested to advise on the circumstances in which para. 6 should apply, and the action to be taken in such circumstances.

ICES is further invited comment on any other pertinent aspect of the management plan.

Norway pout special request is addressed in Sections 5 and 16, the saithe management plan will be will be evaluated in during the September correspondence meeting.

1.1.2 Working Group work programme and conduct

The workload of WGNSSK has been steadily increased in recent years. In 2007, in addition to the traditional assessment and forecast requirements, the WG was asked to address twelve generic ToR, two special requests to ICES, to manage the rescheduling of its main meeting to the first half of the year and to reduce the length of its main meeting to, effectively, seven working days; excluding a no plenary “rest” day during which the majority of participants worked a full day.

The relocation to the beginning of the year at a time when other meetings are taking place and there is a heavy workload on laboratories, raising landings for a number of concurrent WG, resulted in a pressurised compilation of the assessment data during which two complications arose that hindered the process and resulted in the WG having to develop its own data collation programs in the two weeks prior to the meeting:

a) The Scottish programs previously used for raising the North Sea gadoids were no longer available to the WG therefore the WG had planned to rely on the ICES INTERCATCH program, however

b) Significant discrepancies between results generated when data is raised using INTERCATCH and the standard software such as FishBase have been recorded during testing of INTERCATCH in the first quarter of 2007. These differences ensured that the WG could not rely on the output from the program and therefore the program cannot be used by the WG until these have been resolved.

Flatfish stocks were therefore raised using the FishBase software. For gadoid stocks there was a requirement to develop bespoke software in a short time. Timing limitations resulted in the reduction of data from quarterly to annual estimates of numbers and weights at age (for gadoids) and the need for increased vigilance during the screening of the catch numbers and weights. The development of programs and checking of data delayed the transmission of data to assessors and the amount of analysis that could be completed prior to the meeting.

The Group understands that it formed part of an "experiment" within the current process of reform that ICES is undergoing. However, the reduction in the length of time allocated to the Working Group meeting was considered to be rushed and flawed arrangement, given the decision not to reduce the Group's ToR workload, compounded by the predictable increase in the requirement for quality assurance screening of data and a lack of appropriate raising software.

The justification for the change in the timing of the Working Group assessment meeting from September to May was that the Group would be able to develop preliminary advice for the May ACFM meeting, allowing ICES clients to develop earlier proposals for management options in 2008. The focus of the May 2007 meeting was therefore directed towards ensuring a smooth transition of the data collation to the beginning of the year, analysis of the available information in order to meet ToR (a) – (e) and to provide analysis advice for the special request on Norway pout. Lack of guidance as to which ToR were to take priority within the new advisory system and to the utilization of the output from the September update meeting hampered useful discussions and will not bring about effective change in the groups working practices until these are available. One factor in the groups favor was that the nephrops stocks were not assessed at the spring 2007 meeting, had this been the case the quality of the WG's ability to complete its main tasks would almost certainly have been impaired further.

Given the time required for a full analysis of the saithe EU Norway management plan (special request 2) it was agreed that this work would be deferred until after the May meeting and will be carried out during the summer. The analysis will be included within the September report of the WG following the scheduled correspondence meeting that will update stock forecasts using survey information collected during the second half of 2007.

As in previous years, a number of subgroups were set up in order to run parallel sessions within the meeting. The groups acted as a discussion, data and analysis quality assurance and text-writing forum. The parallel processing of the analysis and report writing enabled substantially more to be achieved than if the meeting had been conducted in full plenary. Full plenary sessions were only used for progress reports, resolving difficult issues and agreement of the more important advisory sections for each species.

1.1.3 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.

1.1.3.1 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. As in previous years, concerns about the quality of North Sea cod landings data 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.

1.1.3.2 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 are based on sampling that is too sparse to permit their inclusion in the assessment. 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.

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 haddock and whiting, total annual international discard estimates by age group were derived largely by extrapolation from the Scottish discard sampling programme. For cod a similar procedure was applied to all countries data apart from Denmark, which provided discard information for the North Sea and IIIa. 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.

1.1.3.3 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, 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).

1.1.3.4 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. 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.

1.1.4 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.

1.1.4.1 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).

1.1.4.2 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.

1.1.4.3 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.

1.1.5 Nephrops

1.1.5.1 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 led 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*.

1.1.5.2 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.

1.1.5.3 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.

1.1.5.4 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 for 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.

1.1.6 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.

1.1.7 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 recent 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).

Two complications arose that hindered the process and resulted in the WG having to develop its own data collation programs in the two weeks prior to the meeting:

a) The Scottish programs previously used for raising the North Sea gadoids were no longer available to the WG therefore the WG had planned to rely on the ICES INTERCATCH program, however

b) Significant discrepancies between results generated when data is raised using INTERCATCH and the standard software such as FishBase have been recorded during testing of INTERCATCH in the first quarter of 2007. These differences ensured that the WG could not rely on the output from the program and therefore the program cannot be used by the WG until these have been resolved.

Flatfish stocks were therefore raised using the FishBase software. For gadoid stocks there was a requirement to develop bespoke software in a short time. Timing limitations resulted in the reduction of data from quarterly to annual estimates of numbers and weights at age (for gadoids) and the need for increased vigilance during the screening of the catch numbers and weights. The development of programs and checking of data delayed the transmission of data to assessors and the amount of analysis that could be completed prior to the meeting.

The Group understands that INTERCATCH is still being tested and recommends that it receives regular reports on progress.

1.1.8 Fishers Information (Update from September meeting)

This section presents new information on the fishery and perceptions of stock status for 2007 provided by fishers to the working group, in the form of working documents.

1.1.8.1 Cod

Results from the North Sea annual fishers' survey (Laurenson, 2007), indicate that perceptions in more than half the areas were significantly different in 2007 compared to 2006. In broad terms, responses to the survey indicate that the abundance of cod has remained relatively stable in the south, has increased marginally in 2007 in the central to western areas, and has had year-on-year increases in the north-eastern to northern areas. Except for the south (areas 5 and 6b), perceptions of cod abundance are more positive in 2007 than in any previous year over the time series, with the majority of respondents from all vessel size-categories and gears indicated that cod were "more" or "much more" abundant in 2007, in contrast to perceptions in 2006, where modal responses were "same" or "more". As in 2006, the modal response in all areas in 2007 was for "all sizes" of cod being caught, but there has been an increase in the percentage of respondents indicating "mostly small" cod being caught in the southern areas (5, 6a and 6b). The area and gear type that reported the highest proportion of "mostly small" cod were area 6b (33%) and beam trawls (22%), respectively. The seine group reported the highest proportion of "mostly large" cod (35%). In all areas except area 9, the percentages of respondents reporting "more" or "much more" cod discards has increased. Although responses categorised by vessel size indicated no change in discarding, a categorisation by gear type indicated a more complex pattern: while beam and gillnet modal responses were "same", trawl and Nephrops trawl responses were more evenly split between "same", "more" and "much more". Excluding the "don't know" responses (12-46%), modal responses for 2007 from half the areas were that recruitment was "high", which is much more positive than in 2006 (where only area 8 indicated a modal response of "high"). However, the percentage of responses indicating "high" recruitment in 2007 was never more than 50% in any area.

Comparison between the fishers' survey and the IBTS survey data has shown in previous years that the time series are broadly in agreement in recording a stable overall stock abundance, with increased abundance in the northern areas (due to the stronger 2005 year class), although the IBTS survey has more variability due to the inherent variability in survey results.

Additional information was also submitted to the WG in the form of UK (England and Wales) Fisheries Science Partnership project interim report: "North Sea Codwatch". The project is scheduled for completion in March 2008 and aims to describe the fine-scale distribution and abundance in time and space of the 2005 and 2006 year-classes during 2007 and 2008, and to better understand the spatial and temporal distribution of aggregations of cod of all ages. The WG reviewed the interim report and is supportive of the project, particularly as an alternative source of information from the fishery that supplements existing fisheries-based information, such as the North Sea Commission Fisheries Partnership annual fishers' survey described above. These two sources of information are in broad agreement for 2007, indicating an increase in cod abundance in the northern areas linked to the stronger 2005 year class, which is consistent with the cod assessment and indications of better survival of the 2005 year class from the IBTS surveys (leading to a need to update the cod forecast). However, there are some differences that may need to be investigated further, such as Codwatch indicating higher catch rates in the south where the fishers' survey indicates catch rates to be static. With regard to discarding, Codwatch indicates that in 2007 (April to July), discarding of the 2005 year-class was light, but heavy (100%) for the 2006 year-class (although actual catches of this year-class were modest).

1.1.8.2 Haddock

The report of the North Sea stock survey (Laurenson, 2007), based on questionnaires distributed amongst fishermen, indicates that haddock in 2007 was largely at similar abundance levels to 2006. In the northern North Sea, the area with the highest percentage of respondents, 46% of respondents indicated that haddock were less abundant than in 2006. The only area where abundance had significantly increased was off the east coast of the north of England. In terms of the size ranges caught, there were indications that the proportion of “mainly small” haddock had increased relative to 2006. The overall perception on discards is that levels have remained the “same” since 2006, although there was an increase in the percentage of respondents reporting “more” or “much more” discards in all areas. Of those that did offer an opinion on recruitment (39% of respondents did not), the level in 2007 was largely “moderate”.

The results of the survey are broadly in line with the assessment of the stock, with a slight decrease in abundance associated with the outgoing large 1999 year class and the influx of the moderate 2005 year class still to have a major impact on the fishery.

1.1.8.3 Whiting

Indications from the fishers survey vary by area. In general, that whiting in the southern area are considered to be relatively more abundant in recent years, whereas those in the central and northern area have remained stable or declined. The stock component in area 4 is the only one perceived to be increasing year on year. The IBTS Q1 and Q3 for age 3+ show a stable distribution but contrary to the fishers survey both indicate declining abundance over this time period. The assessment estimates that SSB has been declining since 2001.

1.1.8.4 Plaice

The results from the North Sea Fishers' Survey comparing plaice abundance perceptions in 2007 with those in 2006 indicate different perceptions of stock trends. As in the 2006 survey, data for areas 1 and 3 have modal peaks indicating that the abundance of plaice had not changed. Modal responses of “more” were obtained for the other areas except for areas 4 and 6a where the modal perceptions were that plaice were “much more” abundant. This is a more positive picture than that obtained in 2006. The observed increase has strong modes at “all sizes” are present for each area except area 3 where the modal response was for “mostly small” plaice. The percentages reporting “mostly small” plaice were considerably higher in areas 1, 3, 5 and 6b in this survey compared to the 2006 survey. The increase in perception of abundance observed in 2007 for all size ranges may be caused by the strong reduction in TAC in 2007, that would result in lower fishing mortality and higher survival. In contrast, the assessment results (up to 2006) show a more or less stable SSB. The majority of the respondents providing an opinion indicated that recruitment had been “high” in all areas except area 1, 3 and 5. This may be related to a strong 2006 year class of North Sea plaice, which is estimated to be higher than average in the BTS1 (in 2007) and SNS0 (in 2006) surveys.

1.1.8.5 Sole

The results from the North Sea Fishers Survey indicate that perceptions of the sole abundance are 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 modal responses for an unchanged ("same") abundance while areas in the east and southeast (areas 6a, 6b and 7) showed responses indicating a increase in abundance ("more" & "much more"). 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 2006 compared to 2005, caused by the a below average year class 2003 (45 million) and the average 2002 year class (90 million) being caught. Year class 2005 recruitment estimate was above average (145 million).

1.1.8.6 Saithe

The North Sea Stock Survey 2007 reflects the fishers' perception of the state of the stock, and in all areas except areas 5 and 8 the responses indicating no change in abundance since 2006. There was a weak modal response for saithe being "more" abundant in area 8 and the one respondent for area 5 indicated "less" saithe. In comparison to 2006, the proportions indicating "more" or "much more" saithe were lower in areas 1 and 2 and the proportion indicating "much more" was reduced in areas 7 and 8.

As in 2006 the response from the trawl group is skewed towards an increase in abundance. The XSA assessment showed a relatively stable SSB and an increase total biomass in 2006 compared to 2005, consistent with the fishers perception of the stock dynamics.

1.1.8.7 Nephrops

Fishers perceptions are that Nephrops abundance was higher in 2006 than the previous year in most areas covered by the survey and that recruitment has been high in most areas. In those areas exhibiting a different pattern, notably area 4, abundance was considered to be the same and recruitment moderate. The 2007 meeting of WGNSSK did not present new stock assessments information, only an update of basic fishery data. The increase in the 2006 North Sea TAC for Nephrops makes interpretation of fishery data difficult but for most of the Nephrops stocks where landings LPUE data were available, these showed increases which are not inconsistent with the fisher's survey findings. Considering the time series of abundance data, the fisher's surveys indicate a general increasing trend which has been observed for a number of North Sea Nephrops stocks where underwater television surveys are conducted. A better comparison of the fisher's survey and assessment results will be possible at the 2008 WGNSSK when survey data for 2006 and 2007 will be presented. The fishers generally report that all sizes of Nephrops are well represented, an observation consistent with length composition information available to the ICES working group.

1.2 Working procedures

1.2.1 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 - 2007. 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.

1.2.2 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 in the future.

1.2.3 Assessment and forecast software

Annex 3 provides details of the models used for fitting the stock assessments described within this report and provides references to the software, algorithms and fitting procedures.

1.2.4 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 and 2007. This group has 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.

Mixed-fisheries work undertaken at the September 2006 WG meeting demonstrated the ability of Fcube to address a wide range of issues. 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.

Discussions between the WGNSSK chair and the chairs of ICES-WKMIXMAN highlighted the need for further development and testing of the Fcube model and agreement that the appropriate place for such work was within the ICES-WKMIXMAN meeting. Given the lack of time available at the WGNSSK in 2007 it was agreed that no mixed fishery work would be carried out at the WGNSSK in 2007 but that the group would follow developments in ICES-WKMIXMAN and provide the required input data with an objective of including the model analyses when the model had been evaluated further.

1.2.5 Management plan evaluations

ICES have a standing requirement 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.

1.2.6 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. No re-estimations were deemed necessary during the 2007 meeting.

1.3 Working papers and relevant reports

1.3.1 Working documents

10 working documents were submitted to the 2007 meeting of WGNSSK. The following brief sections summarise these papers, and where relevant, the WG discussions about them.

WD 1: Quirijns et al. Catch and effort data of sole and plaice in the North Sea

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; ICES, 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 nineties. The commercial CPUE was calculated as the ratio of the total annual landings over the total number of fishing days of the fleet. At that time, however, it was realised that commercial plaice 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 changed their targeting behaviour, because they lacked the fishing rights, by leaving productive fishing grounds and moving to areas with lower catch rates of the restricted species with a by-catch of non-quota, or less restricted species. These issues were mainly relevant for plaice, so it was decided not to include commercial plaice CPUE data in stock assessment anymore. CPUE for sole has never been removed from the assessments.

Wageningen IMARES carried out a research project (F-project, 2002-2007), in which one of the objectives was to re-introduce commercial CPUE in stock assessments as a tuning series. In order to achieve that, CPUE was improved as an indicator for developments in stock sizes of sole and plaice.

Since 2003, annually a working document was sent to the ICES WGNSSK, including a request to use CPUE as a tuning series in stock assessment for sole and plaice (Quirijns, 2005; Quirijns, 2006; Quirijns et al., 2004; Quirijns and Rijnsdorp, 2003). None of these times the request was granted, for different reasons. Every year corrections have been made in order to make the series suitable for use in the subsequent year. According to the ICES WGNSSK in 2006, the objection against using the data was that separation of age classes was impossible. This year, a preliminary series of landings per market category is included. The methods for combining CPUE with catch per market category still needs more effort to result in a series of good quality.

The series provided are suitable for comparison with model outputs. It is very important that this comparison takes place. Not only it is a valuable source of information on developments in the sole and plaice stock, also it is important for communication with fishermen. Fishermen demand commercial data to be used in stock assessment. If their data cannot be used, they need to know why the data could not be used.

WD 2: Boogaards et. al. Bayesian analysis of research vessel surveys:trends in North Sea plaice abundance

For a number of years, fishery management authorities have tried to limit fishing mortality on many fished stocks through a total allowable catch (TAC) regime. ICES provides annual advice on TACs, derived from stock assessments. While data from research vessel surveys are used to calibrate the margins of the age-structured population matrix, conventional ICES VPA assessment is dominated by the commercial catch-at-age data. Consequently, estimated stock trends may be misleading whenever official landings figures are not representative of the true catches - e.g. due to illegal landings, discards or by-catch in other fisheries - or whenever significant changes in fishing effort have not been taken into account. The proportion of the catch not included in the official landings figures is likely to increase with a restrictive TAC regime.

Research vessels tend to perform routine hauls at specified locations. Although not affected by misreporting or changes in fishing effort, they are sensitive to changes in spatial distribution of a fish stock from year to year. Also, because the fishing effort of surveys constitutes only a fraction of the commercial fishing effort, research vessel data are inherently less precise (in the sense that observed numbers-at-age are more affected by measurement error) as compared to commercial catch data. Even though there are usually multiple independent surveys that can serve as input for assessment, they often do not agree with each other. Each survey has distinct characteristics regarding geographic area, time of year and fishing gear used, which are all likely to affect the measurements.

Cook (1997) first presented an analytical model for survey-based stock assessment, which has formed the basis for surba, a Fortran-based package for the analysis of research vessel data (Needle, 2003). Although the method does not allow estimation of absolute population size, it can reveal fisheries-independent trends in fish stocks. Also, surba yields an estimate of fishing mortality which (provided that the catchability is specified correctly) should be comparable to that of conventional assessments. However, surba estimates of fishing mortality are well-known to be sensitive to noise in the data and adequate specification of catchability remains elusive. For this reason, Cook (1997) recommended the investigation of alternative parameterizations, but developments have been scarce in recent years.

A serious drawback of surba is its inability to provide a quantification of uncertainty for relevant parameters. For example, estimation of fishing mortality is facilitated by assuming separable temporal and age effects. Even though standard errors can be provided for the point estimates of these separable effects, the standard error of their product is not defined. Since the precautionary approach has become a key concept in fisheries management, uncertainties in assessment, be it survey-based or not, have to be taken into account. Numerous stochastic assessment methods have been proposed (see Lewy and Nielsen, 2003, plus references contained therein), of which those that fall within the Bayesian framework have the advantage that prior beliefs about parameters can be incorporated into the estimation procedure (Punt and Hilborn, 1997). Although Bayesian methods have been criticized for their potential to give too much weight to vested interests (Cotter et al., 2004), they have proved very insightful when applied to virtual population analysis (Virtala et al., 1998).

The purpose of this paper is to apply surba in a Bayesian framework. Specifically, we investigate the effect of an alternative parameterization for fishing mortality. Sensitivity to variability in natural mortality and catchability is also assessed. We use research vessel data on North Sea plaice (Pleuronectes platessa) from two beam trawl surveys (BTS-I and BTS-T, by the research vessels Isis and Tridens respectively) and from the sole net survey (SNS). The BTS-I supplies information on the southern North Sea, the BTS-T on the central North Sea and the SNS on the coastal zones. Together, the three surveys cover the distribution area of the North Sea plaice stock.

WD 3: Quirijns et al, Sampling of plaice discards by the fishing industry in 2004 and 2005

Within the framework of the management plan of North Sea plaice, agreements were made between the minister of LNV and the fishery to accelerate the recovery of the plaice stock. Part of this management plan is a self-sampling discards program by the fishery. From the end of 2004 samples of plaice discards and landings are taken by fishermen on about 20 demersal vessels. Productschap Vis (PV) requested IMARES to analyze these data and answer three questions:

- Is the sampling program statistically sufficient to obtain a good estimate of the total quantity of plaice discards.
- What are the spatial and temporal patterns in discards percentage.
- How do the discards percentages from this program compared with the discards percentages from the IMARES discards sampling program

The discards data from the self-sampling program by the fishery gave clear interpretable results. Trends in time, spatial patterns, but also differences between gears and individual vessels became clear. A program with researchers going onboard cannot achieve such a degree of detail.

The discards percentage in volume over all vessels and areas combined differed between 0% and 100%, with an over-all observed mean of 31%. From the statistical analysis it can be said with reasonable certainty that the over-all discards percentage in volume lies between 30% and 32%. Between different areas less data are available and as a result difference can be determined less certain. Even so, differences between gears can be determined less precise, as is the case for ships, weeks etc. For individual areas, ships, weeks or gears, the certainty lies between approximately 26% - 37%.

The largest differences in discards percentages are found between vessels, but this can also be largely explained by differences between areas. The discards percentage varies also over weeks, but the variance is small compared in comparison with differences between ships, areas or gear. Areas with relative high and areas with relative little discards are sometimes close to each other. In general the discards percentages are considerably lower in areas far away compared to areas close by.

Comparison between the PV program and the IMARES discards program, sampling mostly beam trawl vessels fishing with 80 mm mesh size, indicates that the IMARES program shows higher discards percentages than the PV program. Earlier comparisons between the PV and IMARES program, based on 3 trips, showed no differences between both programs. Because of anonymous character of the data, the cause cannot be determined at the moment.

WD 4: Rindorf, A and Vinther, M The distribution of North Sea cod

The distribution of North Sea cod has changed over the past 20 years as increasing temperatures have been followed by a shift to a more northern distribution (Perry et al. 2005, Rindorf and Lewy 2006). However, as these studies concentrated on the distribution of cod within the North Sea proper, no investigation has been performed on the development in the proportion of the total North Sea and Skagerrak cod stock residing in Skagerrak. Average catch rates within roundfish areas were estimated as the average between squares within the roundfish area. The temporal developments were investigated for trends by estimating the Pearson correlation coefficient with year.

There has been a severe decrease in the number of 4+-cod in all. In spite of this, the number of 1-year olds has decreased significantly only in areas 6 and 7 and showed a slight increasing trend in area 8. These opposing trends in the index of the number of cod in the different roundfish areas have led to a sustained increase in the proportion of all 1-year olds found in area 8. Further, though the number of older fish has decreased in area 8, this decrease has been less severe than in other areas and the proportion of older cod has increased in area 8 as well.

WD 5: Darby, C and Parker-Humphries, M. Comparative analysis of the 2006 North Sea English Groundfish Survey gear parameter and species catch rate data

20m sweeps were used instead of the standard 50m sweeps on the 2006 North Sea English Groundfish Survey – part of the international 3rd quarter North Sea IBTS International Bottom Trawl Survey. This review describes:

- The error in the gear configuration
- The effects of the change in configuration on the gear parameters recorded whilst fishing, by comparison with previous years
- The effect on the 2006 survey catch rates of commercial species by comparison with previous years catches and the catch rates from other surveys conducted during 2006.

The analysis indicates that incorrect rigging reduced door spread and headline height but increased wing spread. Catch rates for cod, haddock, whiting, saithe and plaice from the 2006 survey were found to be in agreement with values predicted from previous English groundfish surveys and from comparisons with other IBTS surveys. It is concluded that an effect of the change to the sweep length is not detectable within the natural variation in the recorded data.

WD 6: Darby, C. English fleet catch rates from the whiting stock in ICES Sub-area IV

Recent high levels of reported whiting catch rates by trawlers fishing in the area appear to have peaked and have started to decline. Relative to the average of 2000 – 2004, the English fleet catch rates in recent years (2005 – 2007) have been higher than the survey and assessment indices for the same period. The degree of difference is dependent on the age catches used in the analysis, there is more divergence for catches of 5+ whiting than for 6+.

IBTS survey whiting catch rate distributions for 2007 indicate that ages 3+ whiting are located around the North east coast of England and the East coat of Scotland and that the current spatial distribution of North Sea whiting is likely to be resulting in the elevated levels of CPUE experience by the English fleet.

The Cefas – Industry Fisheries Science partnership survey carried out in 2006 reported that the majority of the catch (63%) in the area comprises whiting age 5 and older. Comparison with the biomass estimated from the recent ICES assessment indicates that the 5+ age group is a relatively minor component of the total stock biomass. Therefore catch rates of these age groups are not representative of the total stock dynamics. However, the abundance of whiting has increased throughout the area exploited by the northeast coast fleet; whiting cannot be avoided without considerable displacement of vessels.

WD 7: Armstrong. M, Dann. J and Sullivan, K. Fisheries Science Partnership: 2006/07 Programme 1: North East Cod

The trawler Emulator was chartered in October 2006 to carry out the fourth in a series of FSP surveys of cod and other gadoids off the NE coast of England. Surveys since 2005 have utilised tows spread out over the survey area, with additional tows in defined areas with coarser seabed types (“hard” ground) where cod abundance is expected to be greatest. As in previous FSP surveys, cod and whiting were most abundant on the “hard” ground, whereas haddock were predominantly on the softer seabed sediments offshore.

Cod and haddock catches in 2006 were dominated by 1-year-olds of the 2005 year class of each species, which surveys and fishermen’s reports indicate are relatively strong. The large increase in abundance of whiting noted in the FSP survey in 2005 was also reflected in high catch rates in 2006. The catches of whiting in recent years have been dominated by fish of the 2001 and earlier year classes, represented as 5–7+ year olds in 2006.

WD 8: Parker-Humphreys M., Velterop, R. and Bush, R. Fisheries Science Partnership: 2006/07 Programme 11: North Sea lemon sole and plaice.

The UK FSP surveys in 2004, 2005 and 2006 have provided information on the distribution and age composition of plaice off the NE coast of the United Kingdom. Plaice are widespread on the sandy sediments along the coast. The 2005 report noted relatively large proportion of plaice aged 10 and more in the FSP catches compared with the ICES forecasts for the international catches throughout the North Sea, and the 2006 results are consistent with these findings. In 2004, plaice up to 18 years of age were recorded in the FSP catches, and eight of 185 plaice aged from the 2005 FSP catches were 18 years of age or older, reaching 22 years old in one case. The 2006 results are seemingly even more extreme, with 9 out of 207 aged fish being older than 18, 5 of these being older than 24, and the maximum age reaching 33 years old. Throughout the time-series plaice older than 10 comprised 7-12% of the total numbers caught (Table 3). Although this is based on a comparatively small collection of otoliths, it is suggestive of greater survival of plaice off the NE coast of England than in the North Sea as a whole.

WD 9: Darby, C. Catch rates of cod recorded by English vessels fishing in the North Sea during the 1st quarter 1995 – 2007.

The temporal dynamics of the catch rates of the fishery exploiting North Sea cod is examined. Catch per unit effort by trawlers and gill netters fishing in the first quarter of the year is compared with stock assessment estimates of biomass and biomass indices from the first quarter IBTS survey for the years 1995 - 2007.

English trawlers catch rates have exhibited similar trends in time to the survey and assessment estimates of 2+ biomass. In recent years catch rates from all time series have shown a slight improvement following the recruitment of the 2005 year class of cod. However, current catch rates are still well below the levels recorded during the late 1990's when the stock was closer to safe biological limits.

English gill-netters fishing in the Southern North Sea have been reporting higher catch rates of large cod in recent years. Therefore data retrievals from their landing were also compared to the time series of assessment and IBTS survey data. Unfortunately age compositions from the boats could not be obtained in order to ascertain the ages groups that the boats are landing therefore comparisons have been made with the estimates of 4+ and 5+ biomass. The English boats catch rates have exhibited similar historic trends to the survey and assessment estimates of 4+ and 5+ biomass. In recent years catch rates from both vessels have been increasing since a low in 2002/2003 with catch rates that are above the relative increase in the level of the survey and assessment in 2006. The catch rates are still below the levels recorded between 1985 – 1990 but are indicative of an improvement in the rate of catch by this subset of vessels that are targeting older fish.

WD10: Nielsen E, Boje J and Nicolaisen H, Plaice tagging in Danish waters 1903-1964

From plaice tagging 1903-1964 in the North Sea, Skagerrak, Kattegat and the Belt Sea of about 40 000 adult fish, information from recapture of about 12 000 plaice revealed information on migration within the areas in relation to appropriateness of management areas. Plaice from the Belt Sea rarely migrated into Kattegat, but seemed resident. Plaice in Kattegat often migrated into Skagerrak and occasionally also into the North Sea, but not into the Belt Sea. Plaice in Skagerrak did mix with plaice in the Kattegat and also with North Sea plaice. Plaice tagged in the North Sea did not mix with IIIa plaice. The overall trend in the tagging-recapture data were a net flow of plaice in a westerly direction. The data indicate a homing of plaice tagged in the assumed spawning grounds in Kattegat after being released more than a year, while this was not the case for plaice in assumed spawning grounds in Skagerrak. The overall trend from the tag-recapture experiments supports the present management areas for plaice into Subarea IV and Division IIIa.

1.4 Data for other Working Groups

1.4.1 WGECO

Data on species composition of target and by-catches in the industrial fisheries in the North Sea will be provided in the September report of this group.

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

The report of 2006 and 2007 meetings of the ICES Annual Meeting of Assessment Working Group Chairs (ICES-AMAWGC 2006/2007) include "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; they have been followed, as far as has been practicable given the problems associated with relocating the meeting to the beginning of the year and the lack of suitable raising software for gadoids.

Generic ToR 12 calls for further development of this road-map. This was not attempted during the 2007 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.

1.6 Recommendations

The future status of WGNSSK is unclear, and the following recommendations apply only if WGNSSK maintains its current structure in 2007.

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 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.

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 1985-2006 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.

The ICES - FAO Working Group on Fishing Technology & Fish Behaviour (WGFTFB)

Annex 8A of the 2007 WGFTFB providing fishery development information specific to the North Sea is repeated below and commented on within each of the individual stock sections.

Annex 8A: FTFB Report to WGNSSK

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 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 Scotland, England-UK, Northern Ireland, France, Belgium, Netherlands, Sweden and Norway.

Changes in Fleet Dynamics between 2005 and 2007

- There is a gradual shift in the Dutch fleet from beam trawling for flatfish to twin trawling on other species e.g. *Nephrops*, guards etc. in the fleet. This is driven by TAC limitations for plaice and sole and rising fuel costs. (Netherlands; Quota and Fuel)
- There has been a move by up to 10 of the larger powered vessels in the Scottish whitefish fleet to *Nephrops* in the late summer of 2006. This shift in effort is largely driven by the days at sea regulations and also the limited quota for deepwater species and Rockall haddock. The number of vessels involved is relatively small but the efficiency of these vessels makes this shift in terms of effort high. (UK-Scotland; Days at Sea Regulations/Quota restrictions).
- There has been a shift in the Scottish inshore fleet from squid back to *Nephrops*. This was due to a reduction of squid on the inshore grounds during the 2006 fishery. The number of vessels involved is very high. (UK-Scotland; Lack of Squid).
- Some whitefish trawlers are using 130mm mesh on the eastern side of the North Sea to ensure they comply with regulations (UK-Scotland; Move to TCM).
- Irish inshore fishermen have increased the number of pots in order to make up for lost earnings as a result of the salmon drift net fishery. This action will be widespread and will have a major impact on crab and lobster as well as increasing numbers of these vessels, potentially diversifying into handling for mackerel and white pollack during the summer months. Putting further pressures on quotas for these species. There are approx. 900 licences in Ireland so the cumulative effect could be high. (Ireland; Closure of a fishery).
- In Sweden 70mm diamond mesh codends were banned in IIIa in 2005. Swedish demersal trawlers now either use 90 mm (often in combination with a 120mm square mesh window) or the *Nephrops* grid trawl. 40% of *Nephrops* trawl effort

in IIIa is made with sorting grid equipped trawls (Logbook and pers. obs. This is driven by the ban of 70–89 mm diamond and effort restrictions (more days/unlimited days at sea available for SMP/grid trawls) and the obligatory grid use on coastal waters. (Sweden; Changes in Regulations).

- There were temporary shifts observed in the Dutch Beam trawl fleet within the North Sea due to the cod closure some years ago but with the removal of these boxes, vessels have reverted back to previous fishing areas. (Netherlands; Temporary shift)
- Scottish single seiners have been working more inshore waters in IVa to target smaller haddock and whiting. This allows more landings for days at sea. Up to 75% of the Scottish sine fleet are involved. (UK-Scotland; Days at sea)
- More Swedish coastal vessels in IIIa are targeting *Nephrops* 2006 and in the winter of 2006/2007 driven largely by days at sea regulations. (Sweden; Days at sea).
- Approximately 20% of the Northern Irish *Nephrops* fleet transfer activity to the Farne Deeps (IVb) during Q4 (2006) and Q1 (2007). These vessels (along with approximately 10 Scottish vessels) typically use multi-rig trawls whereas the local English fleet typically use single rig nets. (UK-Northern Ireland; Days at sea/Quota restrictions).
- There has been a partial switch from demersal fish towards *Nephrops* and *Pandalus* in the Swedish fleet although this switch is not considered significant at present. (Sweden; Moving Fisheries).
- The Norwegian industrial trawling fleet has reduced effort targeting Norway pout, and increased effort targeting blue whiting in the Norwegian trench with larger trawls. Bycatch of saithe occurs in the blue whiting fishery and trials will be carried out in 2007 using grid to reduce the bycatch problem. (Norway; Moving Fisheries).
- There is a tendency of late in the Dutch fleet to opt for smaller multipurpose vessels replacing the conventional beam trawlers. This is due to increasing fuel costs, quota shortage and pressure from fish buyers hot to buy beam trawl caught fish. (Netherlands; Vessel design).
- No active decommissioning has taken place in Sweden, but the number of *Nephrops* vessel, effort and landings increased in 2006 with high catch rates from a historical perspective. The increase in number of vessels may be attributed to input of new capital due to an introduction of an ITQ-system for pelagic species. (Sweden; Increased effort).
- There has been limited decommissioning of older French vessels previously fishing for anchovy. (France; Decommissioning).

Technology Creep

- A number of Dutch beam trawlers are investigating towing two sets of smaller trawls from each beam in order to reduce fuel consumption, referred to as 'outrigging'. Similar work is being carried out in Belgium. (Netherlands and Belgium; New gear).
- A group of Dutch skippers have experimented with alternative beam shapes e.g. 'fly-beam', and wheels replacing beam trawl shoes to reduce the drag of trawls in order to save fuel. Fuel savings reported are in order of magnitude of 10–15%. Many boats start using fuel economy meters and try to optimise speed to save fuel. All in development phase. (Netherlands; Environmentally Friendly/Fuel Efficient Gear).
- Scottish whitefish vessels have switched from twin trawl to Pair trawl/seine and from twin whitefish to twin *Nephrops* trawling on the Fladen grounds. (UK-Scotland; Gear change for different species)
- There is increased use of double bag trawls to give increased groundgear coverage. The use of the double bag/increase bosom nets is increasing particularly for the new vessels switching to *Nephrops* and some traditional

vessels. The indication is that they see approx 33% increase in catches. These trawls are being used primarily for *Nephrops* although possibly 20% of Scottish whitefish trawlers are switching to double bags trawls. (UK-Scotland; New trawl design).

- There is an increase in Sweden in *Nephrops* creel landings in the Eastern Skagerrak was observed since trawling was banned on some national waters in 2004 (creel landings has increased from 139 tonnes in 2003 to 220 tonnes in 2005). (Sweden; New fishing gear)
- Norwegian seine netters in the Norwegian Sea are using smaller gear with more weights on the groundgear to secure proper bottom contact. The effect on the catching efficiency is not quantified, but underwater observation indicates a far higher catching efficiency. (Norway; Modified gear).
- In Norway there is increased use of Danish seines for the coastal fleet traditionally used gillnets and longlines. Main reason is that fish caught with Danish seines generally have higher quality than fish caught by gillnets and that the price for longline bait has increased. (Norway; Alternative fishing method).
- Most Norwegian trawlers are now using twin trawls for cod, haddock and saithe increases. Experiments indicate no difference in length composition for the three species between single and twin trawl. The increased catch rates found for twin trawl compared to single trawl is approximately proportional to the increase in door spread. (Norway; New gears).
- Norwegian trawlers in the 1800–3000 hp range are using single nets with 400mm mesh in sections of the Top wings and special cutting rates in the belly sections Vessels are switching to these trawls from twin-trawls in periods of bad weather and also to improve fuel efficiency. (Norway; New trawl design).
- The Dutch beam trawler UK153 is currently fishing with electrified pulse trawl, and expansion is possible to more vessels pending positive ICES-advice. The steering board of this project recently gave a negative advice on continuing, because of lower catches and earnings for the new system. The future is uncertain, but the interest remains, also for electrified outriggers. (Netherlands; Environmentally Friendly Gear).
- There is reported widespread use of “compacted twines” (e.g. Cotesi redline) particularly in the Scottish single seine fleet. This twine is considered to increase fuel efficiency (less drag) and also believed to give better retention especially for *Nephrops* and less distortion of meshes. (UK-Scotland; Fuel Efficiency).
- Belgium beam trawlers are increasingly being equipped with 3D mapping sonar which has opened up new areas to fishing (close to wrecks): this was mentioned last year and is most likely still applicable. This 3d system opens more grounds that were previously unfishable. (Belgium; New technologies).
- Norwegian purse seines are using an acoustic instrument to measure distance of the ground line/lead line from the seabed has been developed. This sensor is used by many seiners while fishing for saithe and herring in areas with strong currents and rough seabed (reduced wear and tear). This reduces damage and increases catch efficiency. (Norway; New technologies).
- Norwegian and French demersal trawls are using sensors that measure roll, pitch and stability of trawl doors are developed. The trawlers to optimise the trawl door performance while towing increasingly use the sensor. (Norway/France; New technologies).

Technical Conservation Measures

- Dutch National regulation on reducing bycatches in the brown shrimp fisheries in 2002 have re-enforced the use of ‘sieve’ nets or sorting grids. (Netherlands; Enforcement of TCM).
- There has been no uptake of the 120mm SMP at 4–9 m from the codline for the *Nephrops* fishery by the Scottish fleet. The loss of marketable haddock and whiting far outweighs the benefit even though the adoption of the measure allows

11 extra days per year. It should be noted that No uptake as there are approx 70 vessels limited by the 5% cod bycatch and only 4 were struggling for days during 2006. (UK-Scotland; Uptake of TCM).

- In Sweden there is a steady increase of *Nephrops* grid uptake since the introduction in legislation in 2004. Approximately 75% of the *Nephrops* trawlers operating in IIIa used the grid at some time of the year during 2006 (40% of *Nephrops* trawl landings). Approximately 50% of the *Nephrops* trawl effort (without grid) has opted to use 120mm SMP in their 90mm trawls as a consequence of extra days at sea. Few vessels use larger mesh sizes than 90mm for demersal species (no limits on catch composition for 90mm trawls in IIIa). The vessels that do use larger mesh sizes mainly target witch, cod, haddock and to some extent saithe. Increased interest from demersal (fish and *Nephrops*) trawlers to switch to *Pandalus* trawling, as this fishery is not limited by the cod recovery plan. The use of the *Nephrops* grid is mandatory on coastal waters and unlimited days at sea. It must be stressed that the incentive structure (in terms of numbers of days at sea) is very different in IIIa than in the North Sea. In IIIa the maximum number of days at sea for a vessel using a 90mm trawl was 103 days, whereas a vessel using an identical trawl in the North Sea was allowed 227 days in 2006. 227 days cannot be limiting for the vast majority of *Nephrops* vessels. (Sweden; Uptake of TCM).
- The Norwegian shrimp fishery in the Barents Sea is conducted by large trawlers operating two or three trawls (presently 3 vessels). Sorting grids are mandatory in the shrimp fishery north of 62ºN. Plastic grids are becoming more popular than grids made from steel. Bycatch of juvenile redfish, cod and haddock sometimes results in closure for shrimp fishing grounds in the Barents Sea. In the shrimp fishery in the North Sea and in Skagerrak, trawlers are using sorting grids voluntarily during periods of high bycatch rates. (Norway; Voluntary use of TCM).
- Approximately 4 UK vessels are using species selective trawls voluntarily in the Farne deeps *Nephrops* fishery, the gears used reduce discarding of haddock and whiting in excess of 50%. Improved catch quality and value. (England: Implication reduced discarding of whiting and haddock). (UK-England; Voluntary use of TCM).
- The Netherlands beam trawl fleet is coming under increased pressure of the market not wanting to buy fish caught with beam trawls due to the bad reputation. This incentive is stimulating the debate on selective nets and diminishing impact, but actual measures still need to be taken. (Netherlands; Voluntary use of TCM).
- Trials in Scotland have shown the 120mm SMP, placed 4–9 m from the codline in *Nephrops* trawls have show that major improvements in L50 for cod, haddock and whiting can be achieved, however, uptake currently is low. (UK-Scotland; TCMs).

Ecosystem Effects

- In the Netherlands the bycatch of benthic fauna and several non-target fish species (e.g. gobies) in beam trawls, are becoming of increasing importance and the marine mammals in pelagic trawls. Voluntarily use of longitudinal release holes in the lower side of the trawl, which open when nets are filled with benthos. Fish excluder and square mesh panels in pelagic trawls, used voluntarily. Effectiveness and optimum design still under study in close cooperation with the industry. (Netherlands; Benthic impact and Marine Mammal bycatch).
- Reduced impact in the Belgium and UK beam trawl fleets through a combination of small round fish from T90 codend; benthos bycatch from Benthic Release panels; round fish catch reduction from big meshes; reduced bottom impact from experimental roller gear, usage of outrigger instead of beam trawls with chain matrix. As uptake is very minor at present, reduction in impact is minimal but numbers of vessels testing this gear voluntarily is increasing. (Belgium and UK-England; Reduced benthic impact).

- The Norwegian's have an annual retrieval programme for lost gillnets in the Greenland halibut and blue ling fisheries in deep waters. There are recent reports by Norwegian vessels of ghost nets in Tampen Bank area of IVa. These are monkfish nets discarded, lost or abandoned and the problem is increasing with increasing effort. (Norway; Ghost Nets).
- Irish vessels have reported a fleet of Russian vessels prosecuting a small mesh fishmeal fishery for haddock both inside and outside the EU 200 mile limit at Rockall including inside the Haddock Box. (Ireland; Small Mesh Fisheries).
- Danish trials have shown the effectiveness of acoustic deterrents for harbour porpoises is maintained with 450m spacing using Aquatech pingers. The regulation states a maximum spacing of 200m. As a consequence of the above, that a derogation has been agreed for Danish fishermen to use AQUAmark 100 pingers at the increased spacing. (Denmark, Acoustic deterrents).

Development of New Fisheries

- Exploitation of cuttlefish in mainly the Eastern English Channel in wintertime by beam trawlers from the UK. There has been an effort shift (<5%) of the fleet (rough estimates: 10 vessels). Landings in 2004: 974 tonnes; 2005: 694 tonnes; 2006: unknown but probably more than 2005. Best catches are expected in period November – February. (UK-England; New fishery).
- Catch composition in Belgium trials with the outrigger trawl have indicated a high bycatch of rays. (Belgium; bycatch species).
- In Belgium 1 catamaran is targeting bass with trammel nets/handline in summer time (May – October): (Not new, same as 2004, 2005, 2006). This is part of a National project for longlining/handlining on seabass ongoing in IVc. This maybe extended to target cod and rays in the future, but very uncertain because of cod stock in IVc and problems with marketing of rays. (Belgium; New fisheries).
- The UK bass fishery has recently been extended into the North Sea. No details are available on the extent. (UK-England; New fishery).

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 and 2007 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 and N°41/2007). The allocations are summarised in full in Table 2.1.6a and 2.1.6b.

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.

2.1.3 Environmental considerations

The WG considers that 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

Estimates of discarding rates from the Scottish and Danish observer sampling programme were used in the assessments of cod, haddock and whiting in the North Sea, to raise landings to 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 (~ 37 kt). Fishing mortality is now estimated to have declined since 2000 (median estimate for 2006 ~ 0.63). Recruitment of the 2000-2004 year-classes was poor. Indications from Q1 and Q3 surveys are that the 2005 year-class is somewhat stronger but still below the long-term average and recent reductions in realised fishing mortality should enable biomass to increase in the short-term future.

Haddock catches in Sub-area IV and Division IIIa in 2006 were just below those of 2005: the decline in abundance of the dominant 1999 year-class has been offset to a certain extent by an improved 2005 year class. However, this has not prevented a continued decline in SSB (from 222 kt in 2005 to 169 kt in 2006). Fishing mortality has increased in 2006 to 0.54 as a result of the higher levels of catch on the less abundant 2000 – 2004 year classes. The 2005 year-class is estimated to be quite abundant (36 000 million) and the largest since the 1999 year-class.

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 low (or nearly so) estimates of yield (landings 18.6 kt) and recruitment (394 million), historically low SSB (97 kt) and an increasing level of fishing mortality (0.52). Without good recruitment the stock is unlikely to recover. This assessment must be considered in the light of industry reports that older whiting are more abundant than for several years, particular off the north-east coast of England. However, there are indications from surveys and the fishery that the stock is undergoing a strong decline in the southern and eastern North Sea and the Channel.

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 seven years (*F* ~ 0.25 in 2006) while SSB has stabilised at just beloww 300 kt (299 kt in 2006). Recruitment is fluctuating about the mean level.

The reported landings for **sole** in Subarea IV in 2006 (12.6 kt) below the landings of recent years and well below the TAC for the second year. SSB has fluctuated around a moderate-to-low level for several years and in 2006 is estimated to be between Blim and Bpa (28 kt); at *status quo* fishing mortality it is forecast to remain below B_{pa} during 2008.

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. There was no update of the assessments in 2007. Indications in 2006 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 and 2007 have also been substantially lower than historic values. 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.

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. Due to the low recruitment in 2006 the fishery was closed again at the 1st of January 2007. Estimated SSB for this stock in 2006 was well below B_{lim} and fishing mortality was 0.22. The size of the 2005 year-class was the largest since 1999, the 2006 year-class was moderately abundant but the 2007 year class is estimated to be the second highest in the time series. The potential for a fishery in 2007 will be dependent on the survival and growth of this year-class which will be re-examined following the IBTS survey in the spring of 2008.

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; data are available for 1989-2004 only.

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.

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 2006 were 3366 tonnes in the human consumption fishery, which is similar to 2003 to 2005. 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 1536 tonnes in 2006 (double the landings for 2005 (764kt) and similar to the levels recorded in 2003 and 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 114 tonnes in 2005, similar levels of human consumption catch were recorded for Denmark in 2006 (59kt compared to 49kt in 2005) but data for Norway and Sweden were not available. Denmark recorded 907kt of industrial whiting catch in 2005 and 290kt in 2006. Recent catches have been 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 in 2006 were 9405 tonnes similar to the levels from 2002 – 2004 and well above the historic low (6941 t) recorded in 2005. The available quota has never been restrictive for this stock. About 82% of the landings are taken in the Skagerrak. The source of the assessment data assessment is uncertain with the majority of landing being recorded close to the North Sea. Survey information indicate that the stock has increased in recent years following improved recruitment.

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 2006 amounted at around 729 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 2006 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.

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	nop-nsea	ple-nsea	sai-3a46	san-nsea	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	88326		33439	
1968	288368	105830		111534	113751		33179	
1969	200760	331419		121651	130588		27559	
1970	226124	525325		130342	234962		19685	
1971	328098	237340		113944	265381		23652	
1972	353976	195494		122843	261877		21086	
1973	239051	181518		130429	242499		19309	
1974	214279	153116		112540	298351		17989	
1975	205245	151386		108536	271584		20773	
1976	234169	172607		113670	343967		17326	
1977	209154	145083		119188	216395		18003	
1978	297022	91674		113984	155141		20280	
1979	269973	87094		145347	128360		22598	
1980	293644	105071		139951	131908		15807	100810
1981	335497	138731		139747	132278		15403	89524
1982	303251	176635		154547	174351		21579	80549
1983	259287	167353	475746	144038	180044	530640	24927	87972
1984	228286	134504	376555	156147	200834	750040	26839	86281
1985	214629	165672	227450	159838	220869	707105	24248	62127
1986	204053	169157	180376	165347	198596	685950	18201	64114
1987	216212	111779	148856	153670	167514	791050	17368	68300
1988	184240	107978	109294	154475	135172	1007304	21590	56103
1989	139936	80288	166559	169818	108877	826835	21805	45189
1990	125314	55558	138719	156240	103800	584912	35120	46896
1991	102478	48731	190194	148004	108048	898959	33513	53025
1992	114020	74614	302365	125190	99742	820140	29341	52188
1993	121749	81539	181256	117113	111491	576932	31491	53196
1994	110634	82730	183585	110392	109622	770747	33002	49242
1995	136096	77503	231772	98356	121810	915043	30467	46442
1996	126320	79176	156079	81673	114997	776126	22651	41074
1997	124158	82496	156938	83048	107327	1114044	14901	35920
1998	146014	81070	73974	71534	106123	1000375	20868	28464
1999	96225	65569	92276	80662	110716	718668	23475	30412
2000	71371	47569	184969	81148	91322	692498	22641	28807
2001	49694	40861	64372	81963	95042	858619	19944	25216
2002	54865	58308	77109	70217	115395	806921	16945	21716
2003	30872	44087	24574	66502	105569	309725	17920	16372
2004	28188	48697	13488	61436	104237	359361	18757	13583
2005	28708	48380	0	55700	124532	172100	16355	15304
2006	26768	37565	46626	57943	125681	287900	12594	18589
2007						206300		
Grand Total	7836572	5525650	3803132	5538375	6257079	17168294	1099768	1317415

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		536				2194
2007						
Grand Total		1305112				552227

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
2006	256	107	13	48	82	0	2	7	15	530
Avg 75-06	675	197	57	219	66	12	34	8	31	1288

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
2006 q1	0	37	1	0	3	0	0	0	1	42
2006 q2	235	1	1	3	34	0	0	1	8	283
2006 q3	20	42	7	9	31	0	0	4	4	117
2006 q4	0	28	4	36	14	0	2	2	2	88

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 morhua	544	710	1092	1404	2988	2948	570	1044	1052	876
Scomber scombrus	4	534	2663	6414	8013	5212	7466	4631	4386	3576
Trachurus trachurus	22789	16658	7391	18104	22723	14918	5704	6651	6169	4886
Trigla sp.	0	888	4534	5394	9391	2598	5622	4209	1593	1139
Limanda limanda	187	3209	4632	3781	7743	4706	5578	3986	4871	528
Argentina spp.	8714	5210	3033	1918	778	2801	3434	2024	2874	2209
Hippoglossoides platessoides	59	718	1173	946	2160	1673	1024	1694	1428	529
Pleuronectes platessa	34	119	109	372	582	566	1305	218	128	143
Merluccius merluccius[4]	349	165	261	242	290	429	28	359	109	10
Trisopterus minutus	0	68	0	5	48	121	79	111	36	0
Molva molva[3]	51	1	40	39	37	13	65	10	28	0
Glyptocephalus cynoglossus	236	132	341	44	255	251	1439	195	246	40
Gadiculus argenteus[3]	1210	729	3043	2494	741	476	801	0	0	0
Others	31715	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	2003	2004
Gadus morhua	955	366	1688	1281	532	383	192	29	49	44
Scomber scombrus	2331	2019	3153	1934	2728	2443	1749	1260	2549	6515
Trachurus trachurus	2746	2369	3332	2576	5116	5312	1159	2338	5791	10272
Trigla sp.	2091	897	2618	1015	2566	1343	2293	1071	847	1101
Limanda limanda	1028	1065	2662	6620	4317	441	1441	321	596	386
Argentina spp.	292	3101	2604	5205	3580	333	397		1376	786
Hippoglossoides platessoides	617	339	1411	2229	1272	493	431	112	208	174
Pleuronectes platessa	33	90	73	91	88	64	56	51	28	1
Merluccius merluccius[4]	0	3625	2364	33	211	231	167	6	301	423
Trisopterus minutus	9	30	181	261	922	518	0	196	5	91
Molva molva[3]	0	0	31	31	125	19	49	0	42	169
Glyptocephalus cynoglossus	0	97	394	860	437	154	246	58	437	286
Gadiculus argenteus[3]	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	2006
Gadus morhua	22	72
Scomber scombrus	2195	2313
Trachurus trachurus	5226	1390
Trigla sp.	597	1849
Limanda limanda	287	839
Argentina spp.	1348	2025
Hippoglossoides platessoides	61	302
Pleuronectes platessa	38	10
Merluccius merluccius[4]	254	597
Trisopterus minutus	0	0
Molva molva[3]	34	131
Glyptocephalus cynoglossus	87	68
Gadiculus argenteus[3]	909	1926
Others	1964	3295
Total	13022	14815

[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 1994–2006 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	2006
Sandeel fishery	70	79	288	375	202	51	56	7	12	5	10	2	1
Sprat fishery	493	174	23	40	11	7	4	4	0	11	3	16	4
Norway pout fishery	201	680	4	242	161	11	0	81	3	3	1		19
Blue whiting fishery	0		24	37	20	28	0	0	14	0	0		0
"Others" fishery	14	23	2	94	6	4	1	4	1	2	1		0
Total	778	956	341	789	400	101	61	97	30	21	16	18	24

Haddock	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Sandeel fishery	528	534	1,600	524	202	364	1,226	1,557	220	103	33	0	97
Sprat fishery	685	1,097	18	11	6	62	66	223	27	15	0	4	25
Norway pout fishery	1,399	4,766	1,774	1,454	251	318	1,734	1,252	1,545	16	57		243
Blue whiting fishery	10		153	205	66	195	258	218	133	59	16	13	0
"Others" fishery	71	349	77	137	218	117	40	42	183	96	10	0	0
Total	2,693	6,745	3,622	2,331	744	1,055	3,324	3,292	2,108	289	116	18	0

Whiting	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Sandeel fishery	1,392	3,322	1,909	2,143	902	2,121	1,539	2,761	1,397	444	653	261	274
Sprat fishery	4,352	10,386	784	107	673	1,088	2,107	1,700	2,238	1,105	333	545	343
Norway pout fishery	3,121	7,291	1,373	2,235	178	331	2,935	1,559	1,675	265	232		1536
Blue whiting fishery	0		126	113	83	169	71	217	123	30	0		0
"Others" fishery	187	4,422	22	173	112	116	89	184	127	63	0	19	1
Total	9,053	25,422	4,214	4,771	1,948	3,825	6,740	6,420	5,560	1,907	1,218	825	2154

Saithe	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
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		14
Blue whiting fishery	0		20	80	11	8	2	84	72	17	51	7	27
"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	41

All species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
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	254,210
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	120,033
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		38,943
Blue whiting fishery	419		34,857	13,181	46,052	51,060	34,129	26,038	27,052	21,320	20,295	16867	2037
"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	137
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	408488	415361

Table 2.1.5. Quarterly Danish by-catch landings of cod, haddock and saithe in 2006 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		1	0		1
Blue whiting fishry			0		0
Sprat fishery	1		3		4
Norway pout fishery				19	19
"Others" fishery			0		0
Total	1	1	3	19	24

Haddock	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		97			97
Sprat fishery			8	16	25
Norway pout fishery				243	243
"Others" fishery					
Total		97	8	259	364

Whiting	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		238	35		274
Blue whiting fishery			0		0
Sprat fishery	13		206	124	343
Norway pout fishery			31	1505	1536
"Others" fishery			0	0	1
Total	13	238	273	1629	2154

Saithe	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery					
Blue whiting fishery	27				27
Sprat fishery					
Norway pout fishery				14	14
"Others" fishery					
Total	27			14	41

All species	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		234,491	19,718		254,210
Blue whiting fishery	1,971		67		2,037
Sprat fishery					
Norway pout fishery			739	38,204	38,943
"Others" fishery			18	119	137
Total	40,015	234,491	71,872	68,982	415,361

Table 2.1.6a. 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 2.1.6a. 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 condi-tion 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.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	Unlim-ited	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	Unlim-ited	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	Unlim-ited	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 2.1.6a. 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.b.iv	8.1.(c)	Beam trawls with mesh size ≥ 120 mm track records shall represent less than 5 % of cod	n.r.	155		Unl.	155	155
4.b.iv	8.1.(i)	Beam trawls with mesh size ≥ 120mm for vessels having used beam trawls of mesh < 100mm in 2003, 2004 or 2005.	n.r.	155		Unl.	155	155
4.b.iv	8.1.(e)	Beam trawls with mesh size ≥ 120 mm track records shall represent less than 5 % of cod and more than 60 % of plaice	n.r.	155		Unl.	155	155
4.c.i		Gillnets and entangling nets with mesh size < 110 mm	140	140			140	140
4.c.ii		Gillnets and entangling nets with mesh size ≥ 110 mm and < 220 mm	140	140			140	140
4.c.iii	8.1.(f)	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	162	140	162	140	140	140
4.d		Trammel nets	140	140			140	140
4.d	8.1.(g)	Trammel nets with mesh size < 110 mm. The vessel shall be absent from the port no more than 24 h.	140	140	205		140	140
4.e		Long-lines	173	173			173	173

([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 2.1.6b. Maximum days a vessel may be present in 2007 within an area, by fishing gear. Source: Council Regulation (EC) No 41/2007.

Table I

Maximum days a vessel may be present in 2007 within an area by fishing gear

			Areas as defined in point:					
Gear Point 4.1	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		
a.i		Trawls or Danish seines with mesh size ≥ 16 and < 32 mm	228	228 ([2])			228	228
a.ii		Trawls or Danish seines with mesh size ≥70 and <90 mm	n.r.	n.r.	204	221	204	227
a.iii		Trawls or Danish seines with mesh size ≥90 and <100 mm	95	95	209		227	227
a.iv		Trawls or Danish seines with mesh size ≥100 and <120 mm	103	95			105	84
a.v		Trawls or Danish seines with mesh size ≥120 mm	103	96			114	85
a.iii	8.1.(a)	Trawls or Danish seines with mesh size ≥90 and <100 mm with a 120 mm square mesh window	126	126	227		227	227
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
d	8.1.(g)	Trammel nets with mesh size < 110 mm. The vessel shall be absent from the port no more than 24 h.	140	140	205		140	140
e		Long-lines	173	173			173	173

([1]) Only the denominations in points 4.1 and 8.1 are used.
([2]) Application of Title V of Regulation (EC) No 850/98 where restrictions exist.

Table 2.1.6b. Maximum days a vessel may be present in 2007 within an area, by fishing gear. Source: Council Regulation (EC) No 41/2007.

			Areas as defined in point:					
Gear Point 4.1	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		
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
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
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 to Annex III	Unl.	Unlimited			Unl.	Unl.
a.ii	8.1.(c)	Trawls or Danish seines with mesh size ≥70 and <90 mm track records shall represent less than 5 % of cod	n.r	n.r	215	227	204	227
a.iii	8.1.(f)	Trawls or Danish seines with mesh size ≥90 and <100 mm complying with the conditions laid down in Appendix 3	132	132	238		238	238
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
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
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.
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.
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
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	252
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	Unl.	Unl.	280		280	280
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	Unl.	Unlimited			276	276
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	Unl.	Unlimited			Unl.	279

Table 2.1.6b. Maximum days a vessel may be present in 2007 within an area, by fishing gear. Source: Council Regulation (EC) No 41/2007.

			Areas as defined in point					
Gear Point 4.1	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		
a.v	8.1.(h) 8.1.(j)	Trawls or Danish seines with mesh size >120 mm with a 140 mm square mesh window and operating under a system of automatic suspension of fishing licenses	n.r.	n.r.	127		138	115
b.i		Beam trawls with mesh size ≥80 and < 90 mm	n.r.	132 (2)	Unl.		132	143 (2)
b.ii		Beam trawls with mesh size ≥90 and < 100 mm	n.r.	143 (2)	Unl.		143	143 (2)
b.iii		Beam trawls with mesh size ≥100 and < 120 mm	n.r.	143	Unl.		143	143
b.iv		Beam trawls with mesh size ≥ 120 mm	n.r.	143	Unl.		143	143
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
b.iii	8.1 (i)	Beam trawls with mesh size ≥100 and < 120 mm for vessels having used beam trawls in 2003, 2004, 2005 or 2006.	n.r.	155	Unl.		155	155
b.iv	8.1.(c)	Beam trawls with mesh size ≥ 120 mm track records shall represent less than 5 % of cod	n.r.	155	Unl.		155	155
b.iv	8.1 (i)	Beam trawls with mesh size ≥ 120mm for vessels having used beam trawls in 2003, 2004, 2005 or 2006.	n.r.	155	Unl.		155	155
b.iv	8.1.(e)	Beam trawls with mesh size ≥ 120 mm track records shall represent less than 5 % of cod and more than 60 % of plaice	n.r.	155	Unl.		155	155
c.i		Gillnets and entangling nets with mesh sizes < 110 mm	140	140			140	140
c.ii		Gillnets and entangling nets with mesh sizes ≥110 mm and < 150 mm	140	140			140	140
c.iii		Gillnets and entangling nets with mesh sizes ≥ 150 mm and < 220 mm	140	130			140	140
c.iv		Gillnets and entangling nets with mesh sizes ≥ 220 mm	140	140			140	140
d		Trammel nets	140	140			140	140
c.iii	8.1.(f)	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	162	140	162	140	140	140

Table 2.1.6b. Maximum days a vessel may be present in 2007 within an area, by fishing gear. Source: Council Regulation (EC) No 41/2007.

Corrigendum to Council Regulation (EC) No 41/2007 of 21 December 2006 fixing for 2007 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

(Official Journal of the European Union L 15 of 20 January 2007)

The Corrigendum published in *Official Journal of the European Union* L 67 of 7 March 2007 is hereby annulled and replaced by the following:

Page 126, Annex IIA, point 13, Table 1, the entries for 'Beam trawls' should read as follows:

			Areas as defined in point:					
Gear Point 4.1	Special condition Point 8	Denomination (1)	2.a Kattegat	2.b 1 — Skagerrak 2 — II, IVa,b,c, 3 — VIId			2.c VIIa	2.d VIa
				1	2	3		
(…)								
'b.i		Beam trawls with mesh size ≥ 80 and < 90 mm	n.r.	132 (2)		Unl.	132	143 (2)
b.ii		Beam trawls with mesh size ≥ 90 and < 100 mm	n.r.	143 (2)		Unl.	143	143 (2)
b.iii		Beam trawls with mesh size ≥ 100 and < 120 mm	n.r.	143		Unl.	143	143
b.iv		Beam trawls with mesh size ≥ 120 mm	n.r.	143		Unl.	143	143
b.iii	8.1.(c)	Beam trawls with mesh size ≥ 100 and < 120 mm track records shall represent less than 5 % of cod	n.r.	155		Unl.	155	155
b.iii	8.1.(i)	Beam trawls with mesh size ≥ 100 and < 120 mm for vessels having used beam trawls in 2003, 2004, 2005 or 2006	n.r.	155		Unl.	155	155
b.iv	8.1.(c)	Beam trawls with mesh size ≥ 120 mm track records shall represent less than 5 % of cod	n.r.	155		Unl.	155	155
b.iv	8.1.(i)	Beam trawls with mesh size ≥ 120 mm for vessels having used beam trawls in 2003, 2004, 2005 or 2006	n.r.	155		Unl.	155	155
b.iv	8.1.(e)	Beam trawls with mesh size ≥ 120 mm track records shall represent less than 5 % of cod and more than 60 % of plaice	n.r.	155		Unl.	155	155'

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

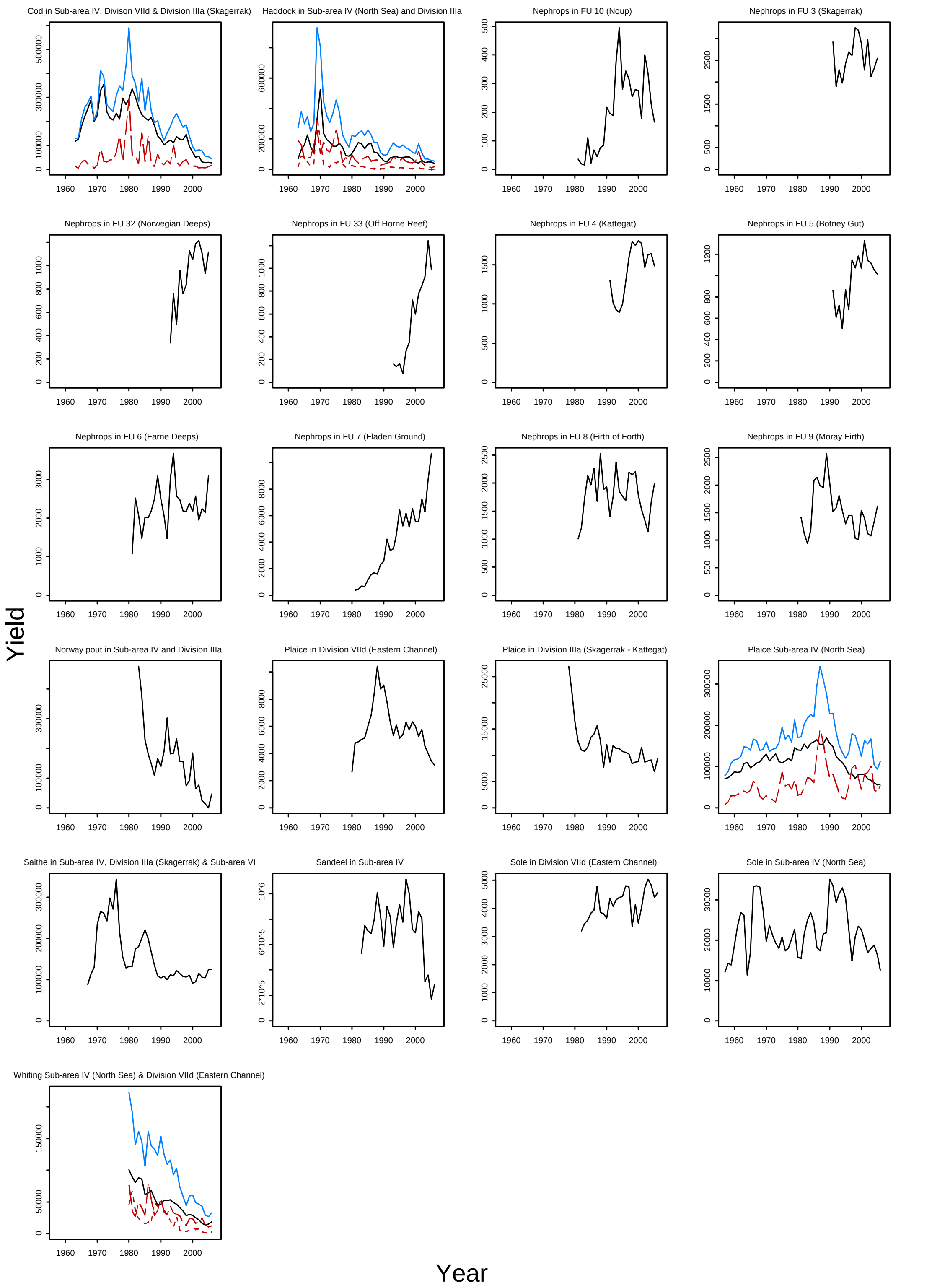

Figure 2.1.1. Historical yield by stock. Where available, time-series of total catch (solid blue lines), human consumption landings (solid black), discards (dashed red) and industrial bycatch (dotted red) are given.

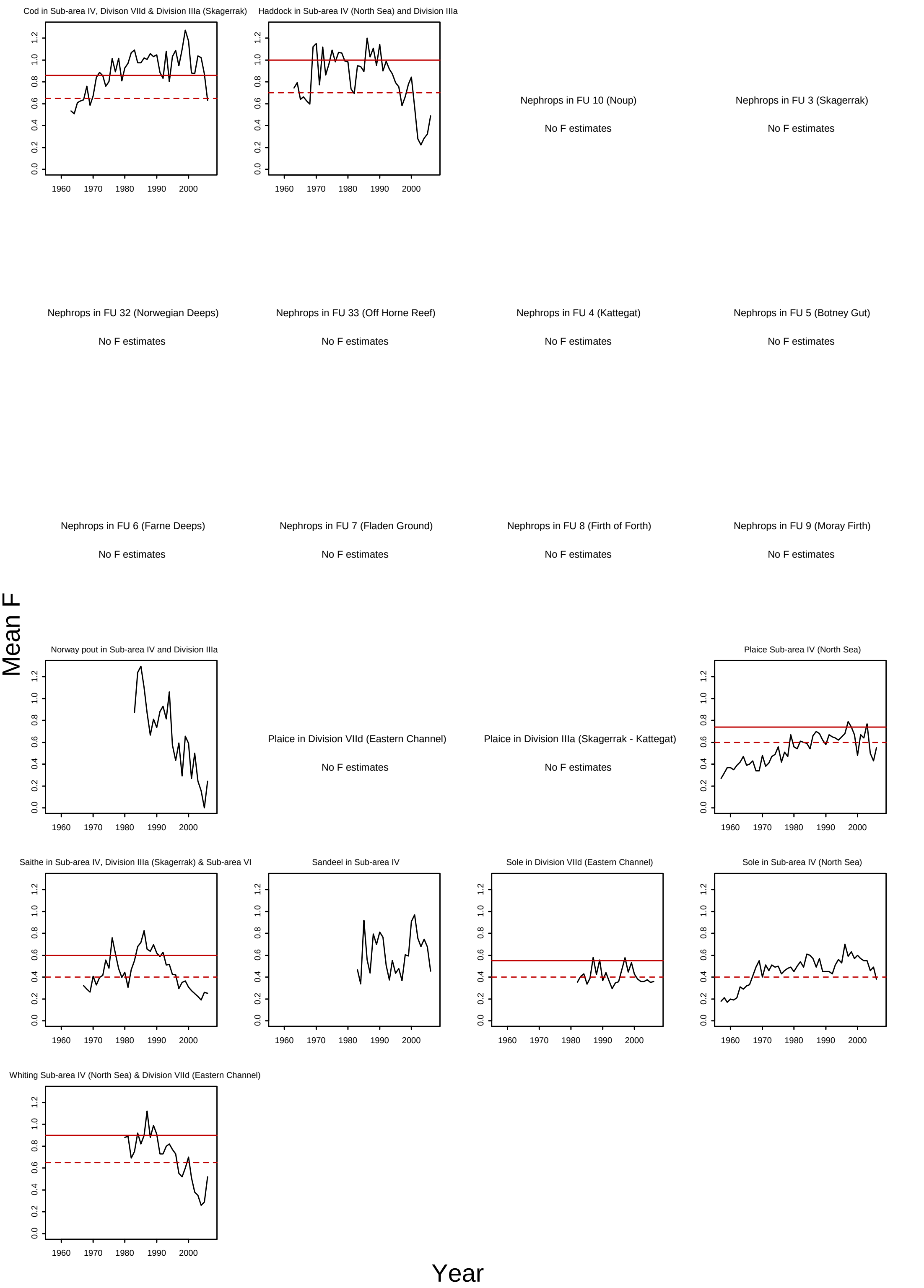

Figure 2.1.2. Historical estimated mean fishing mortality by stock (over age ranges defined in each stock section). Horizontal lines indicate F_{pa} (dotted) and F_{lim} (solid).

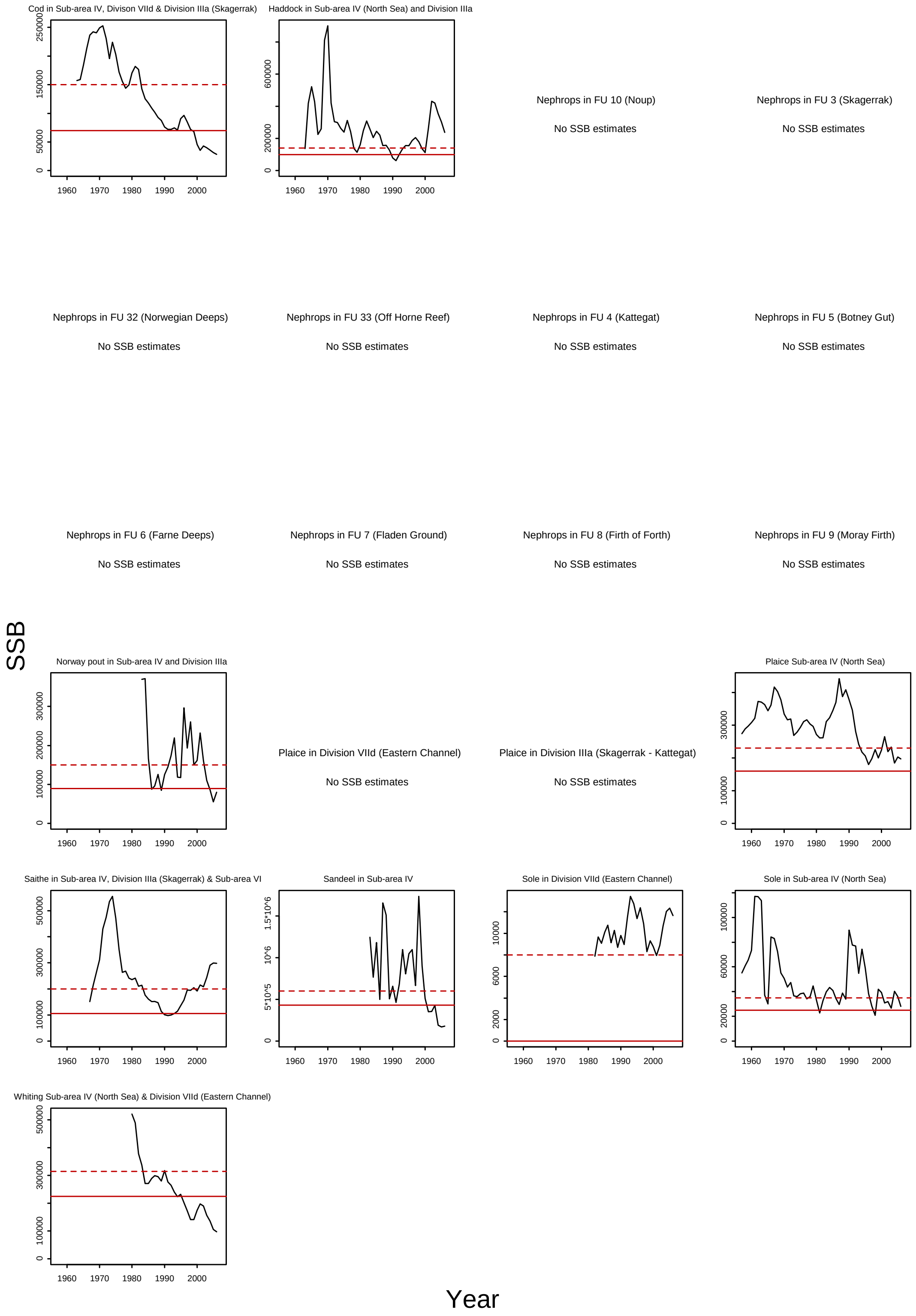

Figure 2.1.3. Historical estimated spawning stock biomass by stock (over age ranges defined in each stock section). Horizontal lines indicate B_{pa} (dotted) and B_{lim} (solid).

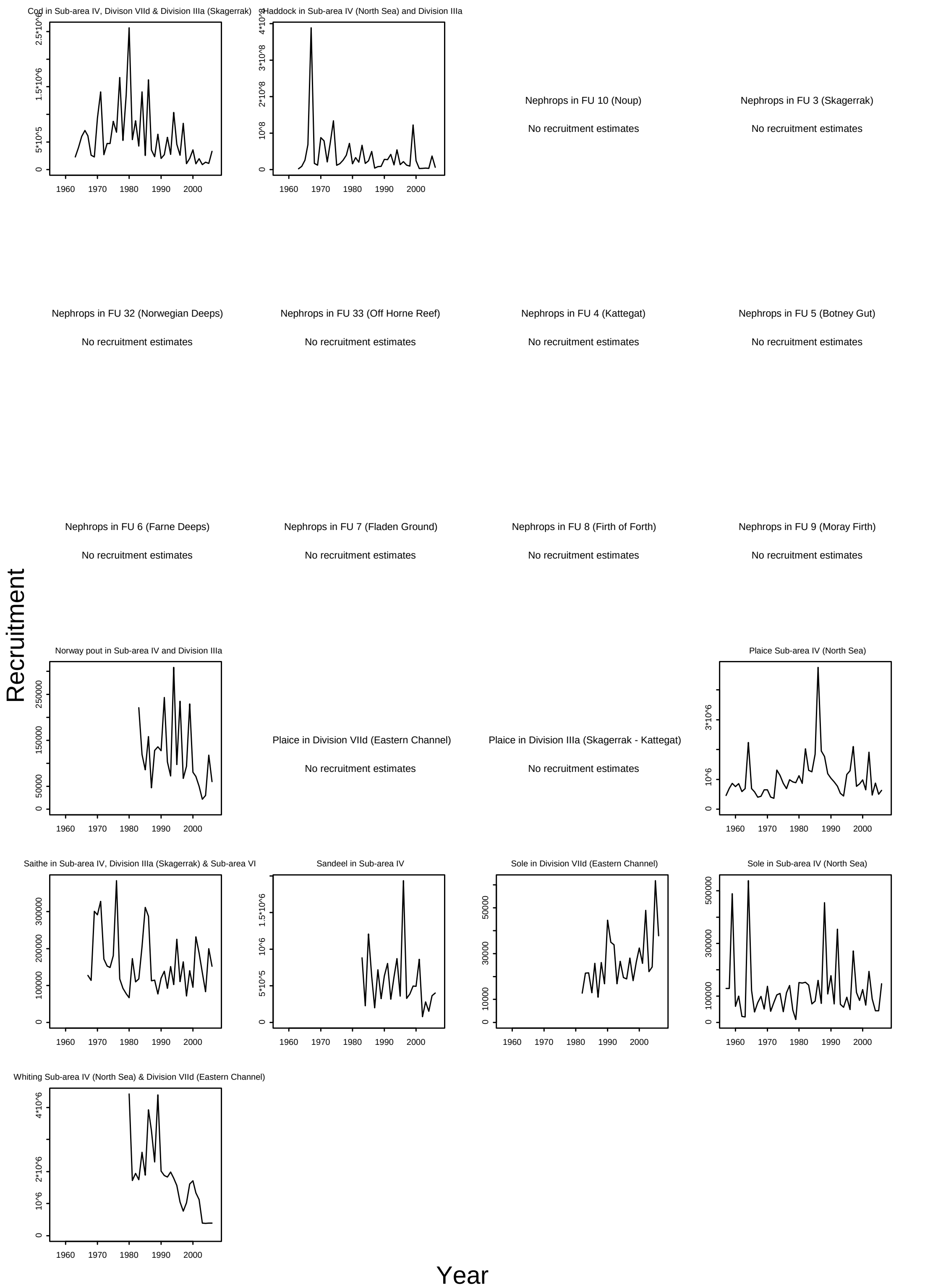

Figure 2.1.4. Historical estimated recruitment by stock (at ages defined in each stock section).

3 *Nephrops*(Norway lobster) in Division IIIa and Division 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.

Nephrops management operates at the Division level. Division IIIa is covered in Sections 3.2 and 3.3 and deals with Management Area E (FU3&4) in Section 3.2.1. Division IV is covered in Sections 3.4 and 3.5 and deals with 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 Division IV are discussed as a whole in Sections 3.3 and 3.5 respectively.

Landings are reported by Management area in Table 3.1.2. Overall there was slight drop in landings in IIIa and a marked increase in IV, largely as a result of increases in two of the inshore Management Areas F and I and also in the southern North Sea (MA H). General comments relating to the handling of Nephrops stocks at WGNSSK 2007 are covered in Section 3.1

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 a biennial circle. The advent of the area working groups, led to a resumption of annual assessments in 2005 and 2006. A continuing feature of most Nephrops stocks, however, appears to be their general stability and smaller year to year recruitment variability compared to most fish stocks. This is reflected in the TOR for 2007 which only request an update of Nephrops landings.

Information included in WGNSSK 2007

Each Management Area section contains a summary of ecosystem aspects specific to that area and a brief description of the Functional Units and Fisheries. Information on fishery developments will be updated at the 2008 meeting.

A summary of the 2006 ICES advice is provided together with the management outcomes operating in 2006 and 2007.

In response to the TOR, updates of the landings in the FUs are provided together with a brief commentary. Of particular note is the provision of new, detailed landing information from Germany covering a number of FUs. The implementation in the UK of 'buyers and sellers legislation' towards the end of 2005 and effective throughout 2006 is believed to have improved the quality of reported landings information.

While making landings data extractions, some countries also summarised effort data and these are included where available. A limited amount of updated mean size information was also supplied.

There were no new assessments performed this year and new catch advice is not provided. Where observations from the landings update are considered relevant to management, however, a note of these is included in brief sections covering management considerations at the end of each MA section.

Ongoing developments in methodology for future assessments of Nephrops

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.

In 2006 WGNSSK agreed that its approach 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 Division 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 in comparison to 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.

Various length based approaches are in the process of further development in ICES WGs (SGASAM) and other fora. Improvements in the quality of commercial data should mean that in a few years it will be possible to revisit the use of catch based methods to assess Nephrops stocks. Critically, this will most likely also depend on the acquisition of improved estimates of biological parameters, most notably growth.

In the meantime, fishery independent underwater TV surveys (UTV) continue to provide a way of assessing trends in Nephrops populations and offering guidance on catch possibilities. Several countries already have well established surveys but these are neither internationally coordinated nor operating to the same protocol as happens with other survey such as the IBTS. There is, however, considerable exchange of expertise between the laboratories regarding equipment and protocol but the need for standardisation remains. A special workshop, WKTVNEPH was convened in April 2007 with the following TOR.

a) review and report technological developments used in underwater TV surveys for *Nephrops*;

b) compare survey designs employed in different areas and evaluate, where possible, the relative performance of these;

c) report on work addressing outstanding issues influencing the accuracy and precision of TV estimates of abundance *inter alia* burrow identification, occupancy rate, counting method, survey data analysis, raising procedures;

d) document the protocols used to conduct surveys across the range of European stocks, highlighting standard practices and ‘norms’ adopted in UWTV work;

e) investigate and make recommendations on procedures for inter-calibration, quality assurance and the reporting of precision from TV surveys;

f) report on developments in the translation of survey estimates into stock assessment information and catch forecast advice, recommending where additional work is most urgently required;

g) consider the wider utility of the techniques employed in *Nephrops* UWTV surveys for estimation of other benthic species and habitat assessment.

The report of the meeting was not available to WGNSSK, although a verbal report was given. The workshop was of the view that these surveys provide good indications of population abundance trends and there was full support for the further development of the methodology. Significant progress was made in the collation of survey designs, equipment specifications and survey SOPs with recommendations regarding minimum standards and best practice.

The requirement for training, analyses and standardisation was emphasised and there are recommendations for the creation of reference datasets for the analysis of counting performance as well as the creation of a standard burrow-identification key to aid with the training and development of counters. Adoption of these practices would put the quality control of *Nephrops* burrow counting on a par with otolith reading.

A list of the areas of uncertainty regarding the estimation of population abundance was developed by the group with a view to refining and improving the methodology. This includes topics such as burrow occupancy, burrow species identification, video track width, video distance and variation in camera height. Each area is linked to an assessment of the likely impact upon abundance estimates and suggestions for how these areas might be tackled.

Based on the findings of the workshop it seems unlikely that the current perceptions of stocks assessed by UTV at the 2006 meeting of WGNSSK will change significantly. Update assessments based on UTV surveys (where available) will be provided at the 2008 WG meeting.

Overarching ICES advice from 2006

Stock specific ICES Nephrops advice from 2006 is summarised in Management Area Sections. ICES advice was also provided for all demersal fisheries based on mixed-fishery considerations; Nephrops fisheries come into this category.

"Fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2007 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 minium by-catch of spurdog (see Volume 9, section 1..6), porbeagle and thornback ray and skate."*

General Ecosystem considerations

Although specific quantitative data are not available for all stocks, qualitative observations suggests 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. Information is not 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. Total Nephrops landings by FU and country is shown in Table 3.2.1.2 and Table 3.2.1.3. When these two FU's are assessed they are treated together.

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). 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). A severe case was observed at the end of 1980s in the southern part of IIIa in late summer, where initially unusual high catch rates of *Nephrops* were observed. Eventually the increasing amount of dead specimens in the catches lead to the conclusion that there was severe oxygen deficiency especially in the southern part of IIIa (Kattegat) in late 1988 (Bagge et al., 1990).

No information is available on the extent to which larval mixing occurs between *Nephrops* stocks but the similarity in stock indicator trends between FU 3 and 4 for both Denmark and Sweden indicates that 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

Danish, Swedish and Norwegian *Nephrops* vessels operate in the Skagerrak (FU3) area, while the Kattegat (FU4) is prosecuted by Danish and Swedish fleets. Germany takes small catches in both areas. The fisheries are described in the 1999 WG report (ICES, 1999a) and there have been a number of changes in these fisheries in recent years.

For the Swedish fishery, twin trawling is now associated with a more mixed fishery for fish and *Nephrops*, while single trawlers continue to target mainly *Nephrops*. Since 2004 there have also been introductions of technical measures such as species selective grids and square meshed codends.

Restrictions in demersal fisheries, especially for cod have resulted in some significant changes in the Danish fisheries for *Nephrops*. In particular there have been moves away from the traditional 70-89 mm mesh sizes to the use of gears with larger mesh sizes >89mm (which previously have been used in the fishery for cod, plaice and other demersal fish species). EU legislation (Council Regulation 27/2005) restricts the use of mesh sizes between 70-89 mm unless the codend and the extension piece is constructed of square meshed netting with a sorting grid). Economically, *Nephrops* is one of the most important human consumption species in the Danish fishery in IIIa.

A full update of the fishery developments affecting this area will be given when the stocks are assessed in 2008.

3.2.1.1.3 ICES Advice

In 2006 ICES concluded that:

The available information is inadequate to evaluate spawning stock or fishing mortality relative to risk, so the state of the stock is unknown. Indices from the commercial fishery suggest that the stocks in this Management Area are exploited at sustainable levels. High rates of discards in particular years (1999 2000) may indicate strong recruitment.

and advised that:

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

"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). 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 by-catch species in these fisheries in IIIa, and even if data on catch including discards of the by-catch gradually become available, they have not yet been used in the management.

Discards of Nephrops are known to be very high and any improvement of the selectivity in the trawls would benefit the stock and medium-term yield.

3.2.1.1.4 Management

No management objectives have been set for this fishery. The 2006 and 2007 TAC for Nephrops in ICES area IIIa was 5170 tonnes. This figure arose from an adjustment by 10% of the 2005 TAC (set at 4700 t.). This change was not based on any new biological information but has remained in place since then.

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

Days at sea limits and various technical measures also apply in IIIa

3.2.1.2 The Skagerrak (FU3)

3.2.1.2.1 Update of Nephrops landings and effort data

Table 3.2.1.4 shows updated landings for FU3. A small decline in total landings to is noted. This is due to a 10% decline in Danish landings. Swedish landings increased by 10%.

Denmark, Sweden and Norway exploit this FU. Denmark and Sweden dominate this fishery, with 63 % and 33 % by weight of the landings in 2006. Landings by the Swedish creel fishery account for approximately 27% in the recent years. Norway takes smaller landings, and German landings are negligible.

The updated effort data are shown in Tables 3.2.1.5 and 3.2.1.6 and Fig.3.2.1.1. Swedish single trawl effort has increased recently while twin trawl effort and Danish effort has decreased. LPUE has been relatively constant in the last few years. Mean sizes, separated into sex and size categories are shown in Table 3.2.1.7 and Fig. 3.2.1.1 and are all fluctuating without trend.

3.2.1.3 The Kattegat (FU4)

3.2.1.3.1 Update of Nephrops landings and effort data

Updated landings are shown in Table 3.2.1.8. A decline in total landings in 2006 to 1281 (close to the 1996 level) is noted for FU4. Denmark and Sweden exploit this FU. In the recent years Denmark has accounted for 70-75% of the landings and Sweden the remaining part of the landings. German landings are negligible. Again here, the decline is due to a drop in Danish landings. Swedish landings increased by 10%.

The updated effort data are shown in Tables 3.2.1.9 and 3.2.1.10 and in Fig. 3.2.1.2 Effort and LPUE have been relatively stable. Mean sizes, separated into sex and size categories are shown in Table 3.2.1.11 and Fig. 3.2.1.2 and are all fluctuating without trend.

3.2.1.4 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

There is no new advice for Division IIIa.

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 recent years. The previous WG conclusions appear to still hold, that the *Nephrops* stocks in the Skagerrak and Kattegat area are fluctuating at a relatively stable level and show no signs of overexploitation.

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 but available data have been limited and so far have not been included in assessments of these species.

3.4 *Nephrops* IN Division IV

Official catch statistics for Division IV are presented in Table 3.4.1.1

Division 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 Division through the use of a TAC and an effort regime.

Management at ICES Division Level

The 2006 EC TAC for *Nephrops* in ICES area IV in EC waters was 28147 tonnes with an additional EC quota of 1300 tonnes in Norwegian waters. For 2007 the EC TAC in EC waters was reduced slightly to 26144 tonnes. The EC quota in Norwegian waters was maintained at 1300 tonnes).

The TAC outcome for 2007 differs from the 2006 ICES advice. ACFM based its advice on the time series of historic reported landings. EU STECF were asked to advise on whether this was appropriate and concluded that this did not always provide a reliable forecast of future catch. STECF reiterated its 2005 advice 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 latter approach formed the basis of the TAC outcomes for stocks where UTV surveys were available.

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* trawler activities to some extent and EU catch composition regulations apply to *Nephrops* trawlers.

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°30'N.

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 Division 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 o 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.

3.4.1.1.2 Functional Units and their Fisheries

There are two Functional Units in this Management Area, FU 9 Moray Firth and FU 10 Noup. Landings by FU and by country are shown in Tables 3.4.1.2 and 3.4.1.3 respectively.

The Moray Firth area is fished by a number of smaller local Nephrops boat (12-16m), joined occasionally by vessels from other parts of the UK. Some small vessels attempted twin trawling in 2005 but have reverted to single trawls. In 2004 and 2005 a squid fishery developed in the area that attracted some of the Nephrops boats but this didn't take place in 2006. The Noup grounds are 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.

A full update of the fishery developments affecting this area will be given when the stocks are assessed in 2008.

3.4.1.1.3 Advice

In 2006 ICES concluded that

"The available fishery information is inadequate to evaluate spawning stock or fishing mortality relative to precautionary reference points.

a) *Moray Firth: The TV survey estimate of abundance for Nephrops in the Moray Firth suggests that the population increased by around 40% in 2002, probably due to good recruitment in that year. Based on the surveys the stock has been relatively stable since 2002, while length compositions in the catch have been relatively stable for 10 years.*

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 recent data are available.*

c) *Small quantities of landings are made outside the statistical rectangles describing the Functional Unit, but within the Management Area."*

and advised that

The effort in this fishery should not be allowed to increase relative to the past three years. In addition to the ceiling on effort ICES advises that the harvest ratio in this stock should be no more than 15%, until such time that more reliable catch information becomes available. This corresponds to landings of less than 2400 tonnes for the Moray Firth stock.

The fishery in the Noup stock should be less than 240 t, the average of the last three years.

ACFM also provided a table of harvest rate options.

Overarching advice covering mixed-fishery considerations for all demersal fisheries is given in Section 3.1 above.

3.4.1.1.4 Management

No management objectives have been set for this fishery. TAC and effort management affecting this Functional Unit takes place at the ICES 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 Update of Nephrops landings and effort data

Landings from this Functional Unit are presented in Table 3.4.1.4 and are predominantly reported from Scotland, with very small contributions from England in the mid 1990s. The long term landings trends are shown in Figure 3.4.1.1. Total international reported landings in 2006 were 1771 tonnes, mostly by Scottish *Nephrops* trawlers. This estimate for total landings has increased in the most recent years, and is at the highest level since 1993. Reported effort by Scottish *Nephrops* trawlers has fluctuated around a relatively stable level since 1990, and in 2006 was slightly above the value of the previous year and close to the average of the recent period (Table 3.4.1.5 and Figure 3.4.1.1). LPUE calculations for Scottish Nephrops trawls are shown in Table 3.4.1.5 for single trawls, multiple trawls and combined. Examination of the long term 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.

3.4.1.3 Noup (FU 10)

3.4.1.3.1 Update of Nephrops landings and effort data

Landings from this fishery are solely reported from Scotland, and are presented in Table 3.4.1.6, together with a breakdown by gear type. Total international reported landings in 2006 was 133 tonnes, which represents a further 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, but has shown a general decline since this date Table 3.4.1.7 and Figure 3.4.1.2). Scottish *Nephrops* trawler LPUE has shown an increasing trend since the mid 1980's and has recently been very high. The Noup ground is located some distance from the main areas of Nephrops fishing and it appears that factors other than stock abundance have made the area less attractive to fishermen in recent years.

3.4.1.4 Management Area F Management considerations

There is no new assessment on which to base advice or management considerations. Updated landings and effort data do not point to any emerging problems in this area.

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 2 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. Uptake of a new derogation for 90mm mesh nets which requires a square mesh panel close to the codend and releases cod and small haddock and whiting has so far been slow.

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 Division 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 gadoid predators 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.

3.4.2.1.2 Functional Units and their Fisheries

There is one Functional Units in this Management Area, FU 7 the Fladen Ground. Landings by FU and other rectangles and by country are shown in Tables 3.4.2.1 and 3.4.2.2 respectively.

General information on the fishery can be found in the Stock Annex. The Fladen fishery (FU7), the largest Scottish Nephrops fishery, takes a mixed catch with ground and round fish (mainly haddock, whiting, and monkfish and flats), making an important contribution to the boats earnings. Most of the vessels are larger trawlers, many using twin trawling technique. The fishery traditionally exhibits some seasonal changes in spatial distribution but in some years (2004-2005) activity was more evenly distributed. In 2005, some Fladen vessels moved into the Moray Firth to fish for squid but this was 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).

A full update of the fishery developments affecting this area will be given when the stocks are assessed in 2008.

3.4.2.1.3 Advice

In 2006 ICES concluded that

The available fishery information makes it inadequate to use analytical methods to evaluate spawning stock or fishing mortality in relation to the precautionary approach. Results from TV surveys suggest that the stock is probably exploited at a sustainable level. The TV survey estimates of abundance for Nephrops on the Fladen Ground indicate that the stock has fluctuated around twofold since 1992. In the last four years it has declined by 40% and is currently of a size similar to that observed in the late 1990s. Small quantities of landings are made outside the main Fladen Ground Functional Unit, but within the Management Area.

and advised that

The effort in this fishery should not be allowed to increase relative to the past three years. In addition to the ceiling on effort ICES advises that the harvest ratio in this stock should be no more than 7.5%, until such time that more reliable catch information becomes available. This corresponds to landings of less than 10 882 tonnes for the Fladen stock. The fishery in adjacent squares should be limited to 105 t, the average of the last three years.

ACFM included a range of harvest rate options.

Overarching advice covering mixed-fishery considerations for all demersal fisheries is given in Section 3.4 above.

3.4.2.1.4 Management

No management objectives have been set for these fisheries. 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 Update of Nephrops landings and effort data

Landings from this fishery are predominantly reported from Scotland, with small contributions from Denmark and others. Table 3.4.2.3, presents a breakdown by gear type. Total international reported landings in 2006 was 10693 tonnes (97% by Scotland) this represents a small increase on the year before. Reported effort by Scottish *Nephrops* trawlers increased up to 2002, but declined sharply in 2003 (Table 3.4.2.4 and Figure 3.4.2.1). Since then it has been fairly stable and in 2006 was only slightly above the year before. Scottish *Nephrops* trawler LPUE fluctuates around a relatively high level, with a considerable increase from 2003 onwards. The 2006 figure was similar to the year before. Danish LPUE data was also updated and this also shows the recent increase evident in the Scottish fishery (Table 3.4.2.5).

3.4.2.3 Management Area G Management considerations

There is no new assessment on which to base advice or management considerations. Updated landings and effort data do not suggest any emerging problems with this stock.

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.

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. UK legislation restricts the use of this gear.

In 2005, high abundance of 0 group cod was recorded in Scottish surveys in the Moray Firth area. The abundance of these cod as 2 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 already appears to have led to increased discard numbers under the present exploitation pattern. It is important that efforts are made to ensure that unwanted small fish bycatch is avoided and technical measures that improve the exploitation pattern would be beneficial in the fisheries of this MA. Uptake of a new derogation for 90mm mesh nets which requires a square mesh panel close to the codend and releases cod and small haddock and whiting has so far been slow.

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 Functional Units and their fisheries

Traditionally, Danish and Norwegian fisheries exploit this stock, while small landings are also made by UK vessels. Denmark accounts for the majority of landings from this Management area, see Table 3.4.3.1

A full update of the fishery developments affecting this area will be given when the stocks are assessed in 2008.

3.4.3.1.3 Advice

In 2006 ICES noted for this stock

"that the available information was inadequate to evaluate spawning stock or fishing mortality relative to risk. Information on this stock is considered inadequate to provide advice based on precautionary limits. "

and added:

"The Danish LPUE figures for this FU increased dramatically from 1992 to 1994, and then levelled off. Since 1995 they have fluctuated around 200 kg/day. In the last 2 years an increasing trend is seen. It could be that only part of the stock is exploited at present. Sediment maps for this Management Area indicate that there are possibilities to let the fishery expand into new grounds, which have scarcely been fished to date".

ICES advised that

"Information on this stock is considered inadequate to provide advice based on precautionary limits."

No TAC was suggested for 2006. In previous years TACs based on historical landings have been suggested.

Overarching advice covering mixed-fishery considerations for all demersal fisheries is given in Section 3.4 above.

3.4.3.1.4 Management

No management objectives have been set for these fisheries. 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 2007 the agreed TAC for EC vessels was 1300 t.

3.4.3.2 Norwegian Deeps FU32

3.4.3.2.1 Update of Nephrops landings and effort data

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 fluctuated around 1000 tonnes and total landings in 2006 amounted to 1060 tonnes. Danish vessels take 80-90 % of total landings with Norwegian and UK vessels making up the remainder. Effort by the Danish fleet (from logbook data Table 3.4.3.2) has fluctuated in recent years and rose in 2006 from the previous year. LPUE in 2006 declined slightly but remains at a relatively high level (Figure 3.4.3.1)

3.4.3.3 Management considerations for Area S

There is no new assessment or advice for this stock. The trend in Danish LPUE figures do not indicate any decline in stock abundance.

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. It could be that only part of the stock is exploited at present. Sediment maps for this Management Area indicate that there are possibilities to let the fishery expand into new grounds, which have scarcely been fished to date.

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). 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.

3.4.4.1.2 Functional Units and their Fisheries

There are two Functional Units in this Management Area: Farn Deeps (FU 6) and Firth of Forth (FU 8). Landings by FU and by country are shown in Tables 3.4.4.1 and 3.4.4.2 respectively. General information on the fisheries in these areas can be found in the Stock Annex. More recently a significant twin-rig fishery has developed at the Devil's Hole located further offshore.

The fishery in the Farn Deeps is characteristically a winter fishery running from around September through to March. In the Firth of Forth the peak of the fishery is in the late summer and early autumn.

In 2006, buyers and sellers regulations have led to increased traceability of catches and greater confidence in the quality of landings data.

A full update of the fishery developments affecting this area will be given when the stocks are assessed in 2008.

3.4.4.1.3 Advice

In 2006 ICES concluded that

"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 stocks in this Management Area are exploited at a sustainable level.

a) *Farn Deeps: The TV fall survey estimates of abundance for Nephrops in the Farn Deeps indicate that the population has increased from 2002 to 2005. Effort currently appears to be at its lowest level since 1984 and LPUE appears to be at its highest in 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.*

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, but has increased since then and has been at a relatively high level in the last four years. 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."*

and advised that

"The effort in this fishery should not be allowed to increase relative to the past three years. In addition to the ceiling on effort ICES advises that the harvest ratio in these stocks should be no more than 15% until more reliable catch information becomes available. This corresponds to landings of less than 3500 tonnes for the Farn Deeps stock and 1500 tonnes for Firth of Forth stock. The fishery in other statistical squares in this area should be less than 600 t, the average of the last three years.

Overarching advice covering mixed-fishery considerations for all demersal fisheries is given in Section 3.4 above.

3.4.4.1.4 Management

No management objectives have been set for these fisheries. These stocks are managed at the ICES division level as described in 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 Update of Nephrops landings and effort data

Landings from the Farn Deeps are shown in Table 3.4.4.3. Since the beginning of the time-series, the UK fleet has accounted for virtually all of the landings with small quantities taken by Belgium, Netherlands and Denmark.

Total landings increased to a maximum in 1994 after which they were relatively stable around a mean of 2200 tonnes. Landings in 2005 rose markedly and in 2006 reached a new peak of 4835 tonnes through increases by England and Scotland (Figure 3.4.4.1, Table 3.4.4.3).

Fishing effort by UK trawlers (Table 3.4.4.4) declined in the 1990s but has recently increased again and is currently at about average levels for the period since 1985. The figure in 2006 was above that of 2005. Recent trends in LPUE have been upward with a new maximum reached in 2006. This may be attributed to increased abundance but also the implementation of buyers and sellers which has improved the quality of landings information available.

3.4.4.3 Firth of Forth (FU 8)

3.4.4.3.1 Update of Nephrops landings and effort data

Landings from the Firth of Forth fishery are presented in Table 3.4.4.5 and are predominantly reported from Scotland, with very small contributions from England. The Table also shows a breakdown by gear type. Total international reported landings in 2006 was 2425 tonnes. This estimate for total landings has increased by over 400 tonnes from 2005 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 3.4.4.6 and Figure 3.4.4.2) falling slightly in 2006. 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, the 2006 figure is highest in the series and suggests that the stock is currently abundant.

3.4.4.4 Management Area I Management considerations

There is no new assessment on which to base advice or management considerations. Updated landings and effort data do not point to any emerging problems in this area.

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.

Earlier WGs have indicated that the FUs in this Management Area have high Nephrops discard rates and there is a need to reduce these and to improve the exploitation pattern. An additional reason for suggesting improved selectivity in this area relates to bycatch. In 2005, high abundance of 0 group cod was recorded in Scottish surveys in the Moray Firth area. The abundance of these cod as 2 year olds still appears to be relatively high and they have spread into other areas. Similar comments can be made about the emerging 2005 haddock year class which will begin entering the fishery in 2007 and is already leading to higher 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. Uptake of a new derogation for 90mm mesh nets which requires a square mesh panel close to the codend and releases cod and small haddock and whiting has so far been slow.

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 comprises 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 and landings by contry are given in Table 3.4.5.2.

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

An extensive description of the *Nephrops* directed fisheries in the Botney Gut - Silver Pit area is given in the 2003 Report of WGNEPH (ICES, 2003). Recently, the Belgian *Nephrops* fishery in the area has declined while Dutch, German and UK activity has increased.

A description of the Danish *Nephrops* fishery Off Horn Reef is given in the 1999 Report of WGNEPH (ICES, 1999). Initially, this *Nephrops* fishery was carried out mainly by Danish vessels but there have been considerable increases recently in Dutch and German landings from this area.

A full update of the fishery developments affecting this area will be given when the stocks are assessed in 2008.

3.4.5.1.3 Advice

In 2006 ICES stated:

"The available information is inadequate to evaluate spawning stock or fishing mortality relative to risk.

a) *Botney Gut: Indications from landing per unit effort do not indicate a decline in stock density. The mean sizes of males in the landings show evidence of an overall long term downward trend, while mean sizes of females seem to have stabilised, albeit at a level that is lower than in the early 1990s.*

b) *Off Horn Reef: The upward trend in LPUE is noted for the recent years. A precautionary interpretation of this increase suggests that the stock level remains relatively stable. However, the marked shift in the size distribution for 2005 compared to previous years 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."*

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."

Overarching advice covering mixed-fishery considerations for all demersal fisheries is given in Section 3.4 above.

3.4.5.1.4 Management

No management objectives have been set for these fisheries. 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 Update of Nephrops landings and effort data

Landings for FU 5 are shown in Table 3.4.5.3.The declining Nephrops fleet in Belgium took 77 t of *Nephrops* landings in 2006. Up to 1995, the Belgian fleet used to take 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 is the most important player 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. New information on German landings were provided at this WG amounting to 99 tonnes in 2006. The remaining landings are by UK and Denmark, Table 3.4.5.2

Total international *Nephrops* landings from FU 5 in 2006 were at 986 t, a further decline compared to 2005 landings. Figure 3.4.5.1 shows the long term trend.

An update of Danish effort was available (Table 3.4.5.4) which suggested effort had dropped but that LPUE increased in 2006. Previous data for Belgium and the Netherlands suggest that the fishery is becoming much less important to Belgium but increasingly important to the Netherlands. LPUE observed by these fleets has also been showing recent upward trends.

3.4.5.3 Off Horn Reef (FU 33)

3.4.5.3.1 Update of Nephrops landings and effort data

The landings from FU 33 were marginal for many years. However, from 1996 to 2004, Danish landings increased considerably, from 74 to 1,097 t (Table 3.4.5.5). In 2006 total international landings rose to 1292 of which the Danish landings were 710 tonnes (about 55%). The other countries reporting landings from the area are Belgium, Netherlands, UK and at this WG new data was provided by Germany. According to logbook information, most of the Danish *Nephrops* directed fishery in FU 33 takes place in the 3rd quarter.

Table 3.4.5.6 and Figure 3.4.5.2 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. Since then, Danish effort has dropped but judging by the landings, Dutch effort has been rising. The Danish LPUEs were rather stable from 1998 to 2004, fluctuating around 200 kg.day^{-1}. 2005 and 2006 saw increases in LPUE and the stock seems to be abundant.

3.4.5.4 Management Area H Management considerations

There is no new assessment on which to base advice or management considerations. Updated landings and effort data do not suggest any emerging problems with this area.

3.5 Division IV *Nephrops* Management Considerations

Division IV contains 5 different management areas which differ in size, nature of Nephrops population biology, extent of fishery development and fleets involved in fishing them. Updates of landings and, in some cases, effort do not point to any emerging problems. Landings in IV have increased overall (Table 3.4.4.1) through increases in some of the constituent MAs – notably F, I and H. Available LPUE data suggest, however, that abundance remains high. To some extent the increased landings may reflect greater accuracy in landings as a result of a strengthening of reporting procedures.

Assessments in previous years 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. For the present, UTV surveys provide the best indication of the states of Nephrops populations Outcomes from WKNEPH will be used to refine the approach in readiness for assessments in 2008.

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, 1997a and 1999a), 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.

Judging by the updated effort data provided to this WG, there have not been major increases so far. It is important, however, that 'step-changes' in the effectiveness of fishing do not occur through the introduction of more efficient gears. The use of gears with multiple nets is developing in some parts of the North Sea and this should be discouraged.

Mixed fishery aspects

The overall position of stable or increasing Nephrops stocks in Division 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 continuing 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, M. et al, 2004, Fisheries Science Partnership2004/5 Programme 6: NE *Nephrops*) 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.

Bycatches of cod do occur in some Nephrops areas (most notable in parts of the Fladen Ground and IIIa) and traditionally young cod were found in many inshore areas. All efforts should be made to improve selectivity and species selection to avoid these fish. Other technical measures (eg seasonal and spatial closures) should be investigated.

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, 1991-2006 as used by the Working Group

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	1665	8807	934	4399	2621	18426	22379
2005	4032	1802	10791	1117	5619	2313	21642	25674
2006	3672	1948	10793	1060	7844	2799	24444	28116
* provisional								

Table 3.2.1.1 Nominal landings (tonnes) of *Nephrops* in Division IIIa, 1986 – 2006, as officially reported to ICES.

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Denmark	2840	2869	3022	3094	2790	2046	2251	2049	2419	2843	2959	3538	3487	3329	2868	3277	2752	2956	2918	2434
Germany	0	0	0	0	0	0	0	0	1	1	5	12	6	7	1	7	12	13	2	6
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	0
Norway	80	88	54	140	185	104	103	62	90	102	117	184	214	181	138	116	99	95	83	91
Sweden	1240	1062	829	1098	1249	772	863	763	913	1105	1129	1314	1259	1195	1040	1033	896	904	1044	1150
Total	4160	4019	3905	4332	4224	2922	3217	2874	3423	4051	4210	5048	4966	4712	4047	4433	3759	3969	4047	3681

Table 3.2.1.2 Management Area E (IIIa): Total *Nephrops* landings (tonnes) by Functional Unit plus Other rectangles, 1991-2006.

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	3253	1803	0	5056
1999	3197	1752	0	4949
2000	2896	1814	0	4710
2001	2282	1775	0	4057
2002	2978	1470	0	4448
2003	2126	1640	0	3766
2004	2315	1650	0	3965
2005	2546	1488	0	4034
2006	2392	1281	0	3672

Table 3.2.1.3 Management Area E (IIIa): Total Nephrops landings (tonnes) by country, 1991-2006.

Year	Denmark	Norway	Sweden	Germany	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	12	5056
1999	3486	214	1243	6	4949
2000	3325	181	1197	7	4710
2001	2880	138	1037	1	4056
2002	3293	116	1032	7	4448
2003	2757	99	898	13	3767
2004	2955	95	903	12	3965
2005	2901	83	1048	2	4034
2006	2432	91	1143	6	3672

Table 3.2.1.4 *Nephrops* Skagerrak (FU 3): Landings (tonnes) by country, 1991-2006.

Year	Denmark	Germany	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	5	184	864	145	1009	3253
1999	2070	3	214	793	117	910	3197
2000	1877	2	181	689	147	836	2896
2001	1416	0	138	594	134	728	2282
2002	2053	1	116	658	150	808	2978
2003	1421	0	99	471	135	606	2126
2004	1595	3	95	449	173	622	2315
2005	1727	0	83	538	198	736	2546
2006	1516	0	91	583	201	784	2392

Table 3.2.1.5 Nephrops Skagerrak (FU 3): Catches and landings (tonnes), effort ('000 hours trawling), CPUE and LPUE (kg/hour trawling) of Swedish *Nephrops* trawlers, 1991-2006 (data presented for single and twin trawls separately).

Single trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1991	676	401	71.4	9.5	5.6
1992	360	231	73.7	4.9	3.1
1993	614	279	72.6	8.4	3.8
1994	441	246	60.1	7.3	4.1
1995	501	336	60.8	7.8	5.2
1996	754	488	51.1	14.8	9.6
1997	643	437	44.4	14.4	9.8
1998	794	557	49.7	16.0	11.2
1999	605	386	34.5	17.5	9.3
2000	486	329	32.7	14.9	10.9
2001	446	236	26.2	17.0	10.4
2002	503	301	29.4	17.1	8.8
2003	310	254	21.5	13.9	11.4
2004	474	257	20.1	23.6	12.8
2005	760	339	29.7	25.6	11.4
2006	839	401	37.5	22.4	10.7

Twin trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1991	740	439	39.5	18.7	11.1
1992	370	238	34.1	10.9	7.0
1993	568	258	35.9	15.8	7.2
1994	444	248	34.1	13.1	7.3
1995	403	270	32.9	12.2	8.2
1996	187	121	13.0	14.4	9.3
1997	219	149	17.5	12.5	8.5
1998	254	178	16.7	15.2	10.6
1999	382	244	27.6	13.8	8.8
2000	349	237	31.3	11.1	10.1
2001	470	249	33.7	14.0	7.4
2002	392	244	33.3	11.8	7.1
2003	168	138	22.5	7.5	6.1
2004	217	118	21.7	10.0	5.4
2005	263	117	22.1	11.9	5.3
2006	253	121	19.6	12.9	6.2

Table 3.2.1.6 *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, 1991-2006.

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

Table 3.2.1.7 *Nephrops* Skagerrak (FU 3): Mean sizes (mm CL) of male and female *Nephrops* in catches of Danish, Swedish and Norwegian trawlers combined, 1991-2006

Year	Catches					
	Undersized		**Full sized**		**All**	
	Males	Females	Males	Females	Males	Females
1991	30.2	30.9	41.2	42.7	30.9	29.8
1992	33.3	32.3	43.3	44.7	33.3	32.2
1993	33.0	31.5	42.0	43.6	33.0	31.5
1994	31.7	29.6	41.7	43.6	31.7	29.6
1995	30.0	28.5	41.6	41.3	32.9	29.8
1996	33.2	31.9	42.9	44.0	37.6	37.0
1997	35.8	34.5	44.6	44.1	39.8	39.1
1998	34.8	34.4	46.1	43.9	40.7	37.3
1999	34.6	33.9	44.9	43.8	39.3	36.1
2000	30.6	30.5	45.6	45.0	32.5	34.1
2001	33.6	33.6	45.5	43.6	37.3	36.4
2002	33.9	33.7	44.0	42.5	37.2	37.3
2003	33.5	32.6	43.2	43.4	38.0	36.7
2004	34.3	33.4	44.6	45.2	38.7	36.6
2005	33.5	32.4	43.7	43.0	36.4	35.3
2006	33.2	32.9	44.7	42.7	37.1	36.1

Table 3.2.1.8 *Nephrops* Kattegat (FU 4): Landings (tonnes) by country, 1991-2006.

Year	Denmark	Germany	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	7	306	4	310	1803
1999	1416	3	329	4	333	1752
2000	1448	5	357	4	361	1814
2001	1464	1	304	6	309	1775
2002	1240	6	219	5	224	1470
2003	1336	12	287	5	292	1640
2004	1360	10	270	11	281	1650
2005	1175	2	303	8	311	1488
2006	916	6	347	11	358	1281

Table 3.2.1.9 Nephrops Kattegat (FU 4): Catches and landings (tonnes), effort (‘000 hours trawling), CPUE and LPUE (kg/hour trawling) of Swedish *Nephrops* trawlers, 1991-2006 (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
2006	234	154	15.1	15.5	10.2

Twin trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1991	93	55	8.8	10.6	6.2
1992	101	65	14.2	7.1	4.6
1993	187	85	17.8	10.6	4.8
1994	138	77	14.2	9.7	5.4
1995	125	84	11.0	12.2	7.7
1996	97	63	7.5	13.0	8.4
1997	183	124	12.7	14.3	9.7
1998	215	151	15.0	14.4	10.1
1999	306	195	20.1	15.2	9.7
2000	330	224	24.5	13.5	9.1
2001	353	187	25.1	14.1	7.4
2002	256	153	23.2	11.0	6.6
2003	222	181	24.8	9	7.3
2004	253	158	16.5	15.4	9.6
2005	198	135	15.3	12.9	8.8
2006	183	121	12.7	14.4	9.5

Table 3.2.1.10 *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, 1991-2006.

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

Table 3.2.1.11 *Nephrops* Kattegat (FU 4): Mean sizes (mm CL) of male and female *Nephrops* in discards, landings and catches of Danish trawlers, 1991-2006.

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
2006	33.2	33.6	45.1	42.8	37.9	37.4

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	2006
Belgium	437	500	574	610	427	384	418	304	410	185	311	238	350	252	283	284	229	213	183	211
Denmark	479	409	508	743	880	581	691	1128	1182	1315	1309	1440	1963	1747	1935	2154	2128	2244	2339	2021
Faeroe Islands	0	0	0	0	0	0	1	3	12	0	1	1	1	0	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	0
Germany	0	0	0	0	2	2	16	24	16	69	64	58	104	79	140	125	50	50	109	288
Germany, Fed. Rep	1	2	1	2	0	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	0
Netherlands	0	0	0	9	3	134	131	159	254	423	627	695	662	572	851	966	940	918	1019	982
Norway	2	17	17	46	117	125	107	171	74	83	64	93	144	147	115	130	100	93	131	96
Sweden	0	0	0	0	4	0	1	1	1	0	1	3	4	37	26	14	1	1	3	2
UK - Eng+Wales+N	0	0	2938	2332	1955	1451	2983	3613	2530	2462	2206	2094	2431	2210	2691	1964	2295	2241	3622	0
UK - England & Wa	2173	2397	0	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	0
UK																				21003
Total	8403	9852	11103	10613	10889	9575	12598	14253	14497	13518	15049	13602	16374	14878	15722	16682	15838	18674	21851	24603

Table 3.4.1.2 *Nephrops*, Management Area F: Total *Nephrops* landings (tonnes) by Functional Unit plus Other rectangles, 1981-2006.

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
2006*	1771	133	44	1948
* provisional				

Table 3.4.1.3 Management Area F : Total Nephrops landings (tonnes) by country, 1981-2006.

Year	UK	Other	Total
1981	1452	0	1452
1982	1140	0	1140
1983	956	0	956
1984	1284	0	1284
1985	2118	0	2118
1986	2255	0	2255
1987	2069	0	2069
1988	2080	0	2080
1989	2704	0	2704
1990	2323	0	2323
1991	1780	0	1780
1992	1822	0	1822
1993	2253	0	2253
1994	2171	0	2171
1995	1654	0	1654
1996	1896	0	1896
1997	1856	0	1856
1998	1360	0	1360
1999	1361	0	1361
2000	1880	0	1880
2001	1696	0	1696
2002	1588	0	1588
2003	1534	0	1534
2004	1643	0	1643
2005	1802	0	1802
2006	1948	0	1948

* provisional

Table 3.4.1.4 *Nephrops*, Moray Firth (FU 9), Nominal Landings of *Nephrops*, 1981-2006, 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
2006	1718	41	11	1770	1	1771

* provisional   na = not available

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

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, 1981-2006 (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
2006	1718	40.1	42.9	1477	36.5	40.5	241	3.6	66.8

Table 3.4.1.6 *Nephrops*, Noup (FU 10), Nominal Landings of *Nephrops*, 1981-2006, 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
2006	44	89	0	133	133

* provisional   na = not available

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

Table 3.4.1.7*Nephrops*, Noup (FU 10): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981-2006 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears 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	
2006	44	0.3	173.9	42	0.2	183.3	2	0.0	

Table 3.4.2.1 *Nephrops*, Management Area G: Total *Nephrops* landings (tonnes) by Functional Unit plus Other rectangles, 1981-2006 .

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	10685	107	10792
2006	10693	100	10793
* provisional			

Table 3.4.2.2 Management Area G : Total Nephrops landings (tonnes) by country, 1981-2006.

Year	Belgium	Denmark	Norway	UK	Total
1981	0	0	0	375	375
1982	0	0	0	422	422
1983	0	0	0	693	693
1984	0	0	0	653	653
1985	0	7	0	1159	1166
1986	0	50	0	1510	1560
1987	0	323	0	1387	1710
1988	0	81	0	1503	1584
1989	0	175	0	2155	2330
1990	2	240	1	2317	2560
1991	0	427	4	3842	4273
1992	3	364	28	3007	3402
1993	0	228	3	3301	3532
1994	0	395	6	4285	4686
1995	0	441	1	6182	6624
1996	0	287	1	5079	5368
1997	0	235	0	6031	6266
1998	0	173	0	5057	5230
1999	16	96	0	6584	6696
2000	6	105	0	5539	5650
2001	0	64	2	5573	5644
2002	0	173	5	7232	7410
2003	0	82	0	6320	6402
2004	0	136	0	8694	8830
2005	0	321	0	10471	10792
2006	0	285	0	10508	10793
* provisional na = not available					
very small landings by Germany in 1999					

Table 3.4.2.3 *Nephrops*, Fladen (FU 7), Nominal Landings of *Nephrops*, 1981-2006, 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	1	10685
2006	283	9396	1005	10401	9	10693

* provisional   na = not available

** Other countries includes Belgium, Norway and UK England

Table 3.4.2.4 *Nephrops*, Fladen (FU 7): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981-2006 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	304	8.6	35.3	304	8.6	35.3	na	na	na
1982	382	12.2	31.3	382	12.2	31.3	na	na	na
1983	548	15.4	35.6	548	15.4	35.6	na	na	na
1984	549	11.4	48.2	549	11.4	48.2	na	na	na
1985	1016	26.6	38.2	1016	26.6	38.2	na	na	na
1986	1398	37.8	37.0	1398	37.8	37.0	na	na	na
1987	1024	41.6	24.6	1024	41.6	24.6	na	na	na
1988	1306	41.7	31.3	1306	41.7	31.3	na	na	na
1989	1719	47.2	36.4	1719	47.2	36.4	na	na	na
1990	1703	43.4	39.2	1703	43.4	39.2	na	na	na
1991	3024	78.5	38.5	410	11.4	36.0	2614	67.1	39.0
1992	1794	38.8	46.2	340	9.4	36.2	1454	29.4	49.5
1993	2033	49.9	40.7	388	9.6	40.4	1645	40.3	40.8
1994	1817	48.8	37.2	301	8.4	35.8	1516	40.4	37.5
1995	3569	75.3	47.4	2457	52.3	47.0	1022	23.0	44.4
1996	2338	57.2	40.9	2089	51.4	40.6	249	5.8	42.9
1997	2713	76.5	35.5	2013	54.7	36.8	700	21.8	32.1
1998	2291	60.0	38.2	1594	39.6	40.3	697	20.5	34.0
1999	2860	76.8	37.2	1980	50.3	39.4	880	26.5	33.2
2000	2915	92.1	31.7	2002	62.9	31.8	913	29.2	31.3
2001	3539	108.2	32.7	2162	65.8	32.9	1377	42.4	32.5
2002	4513	109.6	41.2	2833	58.9	48.1	1680	50.7	33.1
2003	4175	53.7	77.7	3388	42.8	79.2	787	10.9	72.2
2004	7274	56.1	129.8	6177	47.5	130.2	1097	8.6	127.6
2005	8849	61.3	144.4	6834	43.4	157.5	2015	17.9	112.7
2006	9396	65.5	143.4	7100	50.1	141.7	2296	15.4	149.1

Table 3.4.2.5*Nephrops*, Fladen (FU 7): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching Nephrops with codend mesh sizes of 70 mm or above (1991-2006), and estimated total effort by Danish trawlers, 1993-2006.

Year	Logbook data		Estimated effort
	Effort	LPUE	
1991	3115	116	
1992	2289	130	
1993	820	130	1851
1994	1209	251	1620
1995	841	343	1604
1996	568	254	1187
1997	395	349	1100
1998	268	165	1323
1999	197	251	437
2000	292	170	828
2001	213	181	728
2002	335	368	1030
2003	194	308	271
2004	290	461	292
2005	607	482	666
2006	576	450	627
* provisional			

Table 3.4.3.1 *Nephrops* Norwegian Deep (FU 32): Landings (tonnes) by country, 1993-2006.

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
2006*	939	114	6	1060
* provisional				

Table 3.4.3.2 *Nephrops* Norwegian Deep (FU 32): Danish effort(days and LPUE, 1993 to 2006

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

Table 3.4.4.1*Nephrops*, Management Area I: Total *Nephrops* landings (tonnes) by Functional Unit plus Other rectangles, 1981-2006.

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	401	5006
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	3093	1990	529	5612
2006	4835	2425	584	7844

* provisional

Table 3.4.4.2 Management Area I : Total Nephrops landings (tonnes) by country, 1981-2006.

Year	Belgium	Denmark	UK	Total
1981	na	na	2153	2153
1982	na	na	3875	3875
1983	na	na	3902	3902
1984	na	na	3691	3691
1985	na	na	4103	4103
1986	0	na	4421	4421
1987	0	na	4012	4012
1988	0	10	5331	5341
1989	0	0	5142	5142
1990	5	2	4554	4561
1991	4	1	3818	3823
1992	1	7	3483	3491
1993	1	6	5654	5661
1994	0	1	5939	5940
1995	0	2	4702	4704
1996	0	3	4554	4557
1997	0	1	4721	4722
1998	0	2	4597	4599
1999	0	0	5006	5006
2000	1	0	4352	4353
2001	2	0	4733	4735
2002	15	0	3902	3917
2003	0	0	4024	4024
2004	0	0	4399	4399
2005	0	0	5612	5612
2006	0	15	7829	7844

* provisional na = not available

Germany and Belgium made landings of less than 1 tonne in 2006

Table 3.4.4.3 *Nephrops* Farn Deeps (FU 6): Landings (tonnes) by country, 1981-2006

Year	UK England	UK Scotland	Sub total	Other countries**	Total
1981	1006	67	1073	0	1073
1982	2443	81	2524	0	2524
1983	2073	5	2078	0	2078
1984	1471	8	1479	0	1479
1985	2009	18	2027	0	2027
1986	1987	28	2015	0	2015
1987	2158	33	2191	0	2191
1988	2390	105	2495	0	2495
1989	2930	168	3098	0	3098
1990	2306	192	2498	0	2498
1991	1884	179	2063	0	2063
1992	1403	60	1463	10	1473
1993	2941	89	3030	0	3030
1994	3530	153	3683	0	3683
1995	2478	90	2568	1	2569
1996	2386	96	2482	1	2482
1997	2109	80	2189	0	2189
1998	2029	147	2176	1	2177
1999	2197	194	2391	0	2391
2000	1947	231	2178	0	2178
2001	2319	255	2574	0	2574
2002	1739	215	1953	0	1953
2003	2031	214	2245	0	2245
2004	1952	201	2152	0	2152
2005	2936	158	3093	0	3093
2006*	4388	434	4822	13	4835

* provisional
** Other countries includes Ne, Be and Dk

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, 1985-2006.

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
2006*	6913	4623	96.9	71.3	47.7

* provisional

Table 3.4.4.5*Nephrops*, Firth of Forth (FU 8), Nominal Landings of *Nephrops*, 1981-2006, 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	2	4	1979	11	1990
2006*	2405	3	12	2420	5	2425

* provisional

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

Table 3.4.4.6*Nephrops*, Firth of Forth (FU 8): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981-2006 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	945	42.6	22.2	945	42.6	22.2	na	na	na
1982	1138	51.7	22.0	1138	51.7	22.0	na	na	na
1983	1681	60.7	27.7	1681	60.7	27.7	na	na	na
1984	2078	84.7	24.5	2078	84.7	24.5	na	na	na
1985	1908	73.9	25.8	1908	73.9	25.8	na	na	na
1986	2204	74.7	29.5	2204	74.7	29.5	na	na	na
1987	1582	62.1	25.5	1582	62.1	25.5	na	na	na
1988	2455	94.8	25.9	2455	94.8	25.9	na	na	na
1989	1833	78.7	23.3	1833	78.7	23.3	na	na	na
1990	1901	81.8	23.2	1901	81.8	23.2	na	na	na
1991	1359	69.4	19.6	1231	63.9	19.3	128	5.5	23.3
1992	1714	73.1	23.4	1480	63.3	23.4	198	8.5	23.3
1993	2349	100.3	23.4	2340	100.1	23.4	9	0.2	45.0
1994	1827	87.6	20.9	1827	87.6	20.9	0	0.0	0.0
1995	1708	78.9	21.6	1708	78.9	21.6	0	0.0	0.0
1996	1621	69.7	23.3	1621	69.7	23.3	0	0.0	0.0
1997	2137	71.6	29.8	2137	71.6	29.8	0	0.0	0.0
1998	2105	70.7	29.8	2105	70.7	29.8	0	0.0	0.0
1999	2192	67.7	32.4	2192	67.7	32.4	0	0.0	0.0
2000	1775	75.3	23.6	1761	75.0	23.5	14	0.3	46.7
2001	1484	68.8	21.6	1464	68.3	21.4	20	0.5	40.0
2002	1302	63.6	20.5	1286	63.3	20.3	16	0.3	53.3
2003	1115	53.0	21.0	1082	52.4	20.6	33	0.6	55.0
2004	1651	63.2	26.1	1633	62.9	26.0	18	0.4	49.7
2005	1973	66.6	29.6	1970	66.5	29.6	3	0.1	58.8
2006	2405	60.5	39.7	2400	60.2	39.9	5	0.4	12.5

Table 3.4.5.1 Nephrops Management Area H (North Sea South East): Total Nephrops landings (tonnes) by Functional Unit plus Other rectangles, 1991-2006.

Year	FU 5	FU 33	Other	Total
1991	862	74	88	1024
1992	612	76	48	736
1993	721	160	64	945
1994	503	137	41	681
1995	869	164	210	1243
1996	679	77	170	926
1997	1149	276	134	1559
1998	1111	357	248	1717
1999	1244	737	338	2319
2000	1121	610	364	2095
2001	1443	791	416	2650
2002	1231	861	514	2606
2003	1144	929	511	2585
2004	1070	1268	454	2792
2005	1066	1050	452	2568
2006	986	1292	521	2799
* provisional				

Table 3.4.5.2 Management Area H : Total Nephrops landings (tonnes) by country, 1991-2006.

Year	Belgium	Denmark	Netherl.	Germany	UK	Total
1991	704	305	0		15	1024
1992	589	115	0		32	736
1993	706	228	0		11	945
1994	515	146	0		20	681
1995	657	318	256		12	1243
1996	290	152	424		60	926
1997	491	377	629		62	1559
1998	380	519	708	57	53	1717
1999	475	893	670	103	178	2319
2000	391	767	613	79	245	2095
2001	432	812	945	139	322	2650
2002	312	932	1032	126	204	2606
2003	281	1039	1034	50	181	2585
2004	228	1258	1048	50	208	2792
2005	192	891	1027	108	350	2568
2006	227	776	989	287	520	2799
* provisional						

Table 3.4.5.3*Nephrops* Botney Gut - Silver Pit (FU 5): Landings (tonnes) by country, 1991-2006

Year	Belgium	Denmark	Netherl.	Germany	UK	Total **
1991	682	176	na	na	4	862
1992	571	22	na	na	19	612
1993	694	20	na	na	7	721
1994	494	0	na	na	9	503
1995	641	77	148	na	3	869
1996	266	41	317	na	55	679
1997	486	67	540	na	56	1149
1998	372	88	584	39	28	1111
1999	436	53	538	59	158	1244
2000	366	83	402	52	218	1121
2001	353	145	553	114	278	1443
2002	281	94	617	88	151	1231
2003	265	36	661	24	158	1144
2004	171	39	646	16	198	1070
2005	117	87	654	51	157	1066
2006*	77	24	444	99	342	986

* provisional na = not available

** Totals for 1991-94 and 1991-1997 exclusive of NL and Germany resp.

Table 3.4.5.4*Nephrops* 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 -2006

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	87	297	290.9
2006							24	66	365.6

* 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 3.4.5.5 *Nephrops* Off Horn Reef (FU 33): Landings (tonnes) by country, 1993-2006.

Year	Belgium	Denmark	Netherl.	Germany	UK	Total **
1993	0	159	na	na	1	160
1994	0	137	na	na	0	137
1995	3	158	3	na	1	164
1996	1	74	2	na	0	77
1997	0	274	2	na	0	276
1998	4	333	12	8	1	357
1999	22	683	12	14	6	737
2000	13	537	39	12	9	610
2001	52	667	61	11	+	791
2002	21	772	51	13	4	861
2003	15	842	67	4	1	929
2004	37	1097	109	24	1	1268
2005	16	803	191	31	9	1050
2006*	102	710	314	151	15	1292

* provisional   na = not available

** Totals for 1993-94 and 1993-1997exclusive of NL and Germany resp.

Table 3.4.5.6*Nephrops* 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, 1993-2006.

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
2006	2062	308	2288

* provisional   na = not available

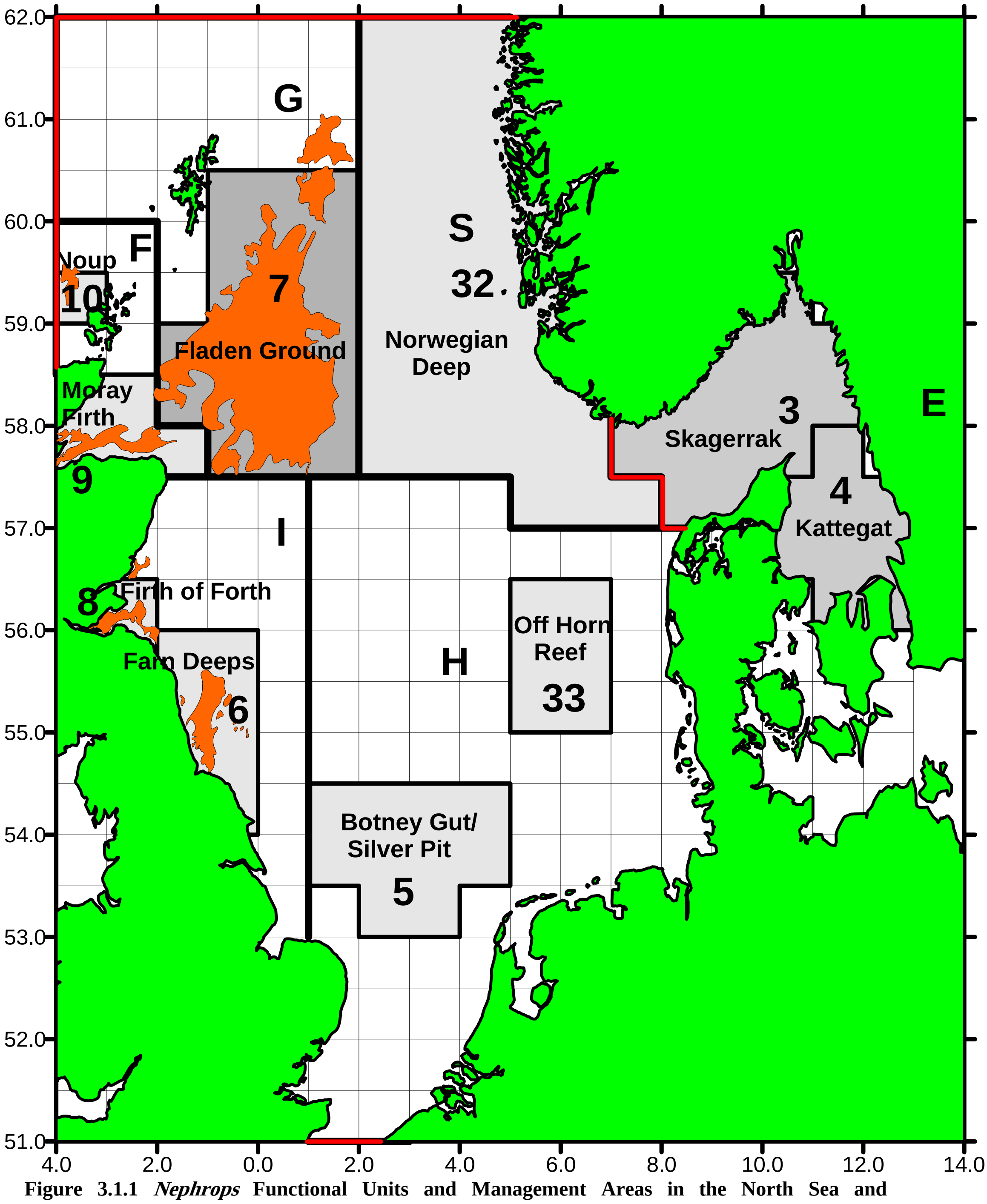

Figure 3.1.1 ***Nephrops*** **Functional Units and Management Areas in the North Sea and Skagerrak/Kattegat region.**

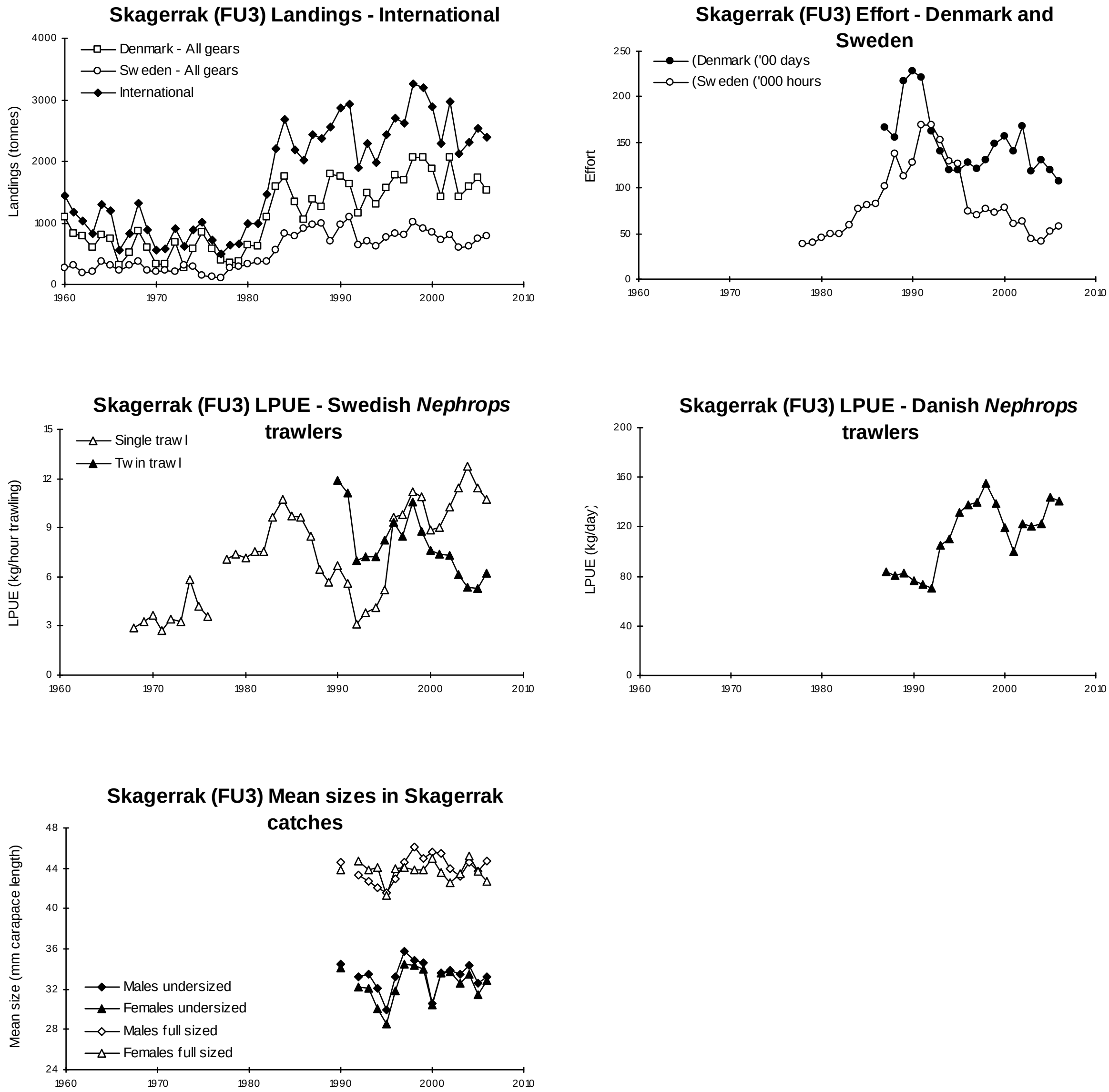

Figure 3.2.1.1 ***Nephrops*** **Skagerrak (FU 3): Long-term trends in landings, effort, LPUEs, and mean sizes of** ***Nephrops.***

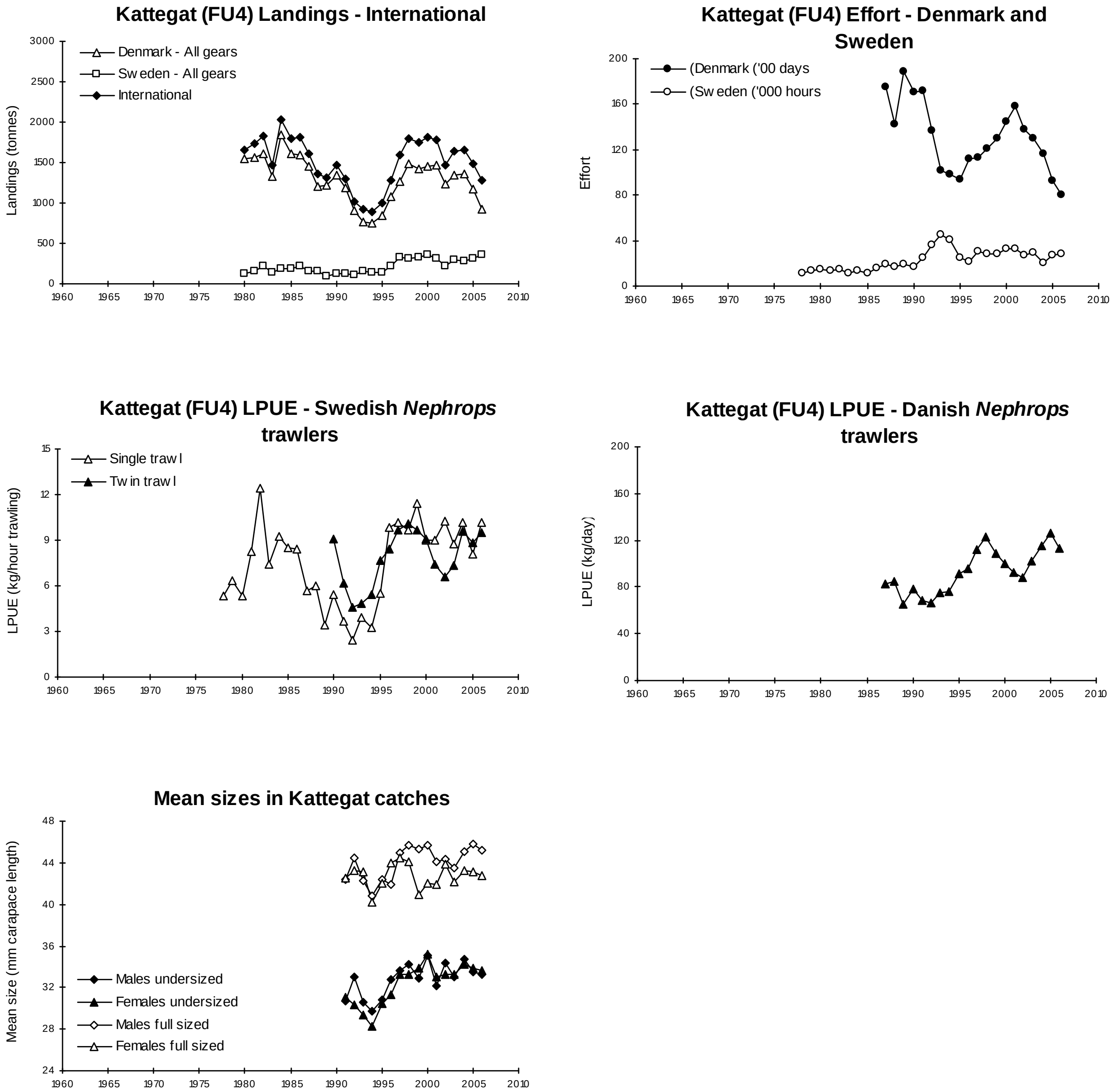

Figure 3.2.1.2 ***Nephrops*** **Kattegat (FU 4): Long-term trends in landings, effort, LPUEs, and mean sizes of** ***Nephrops.***

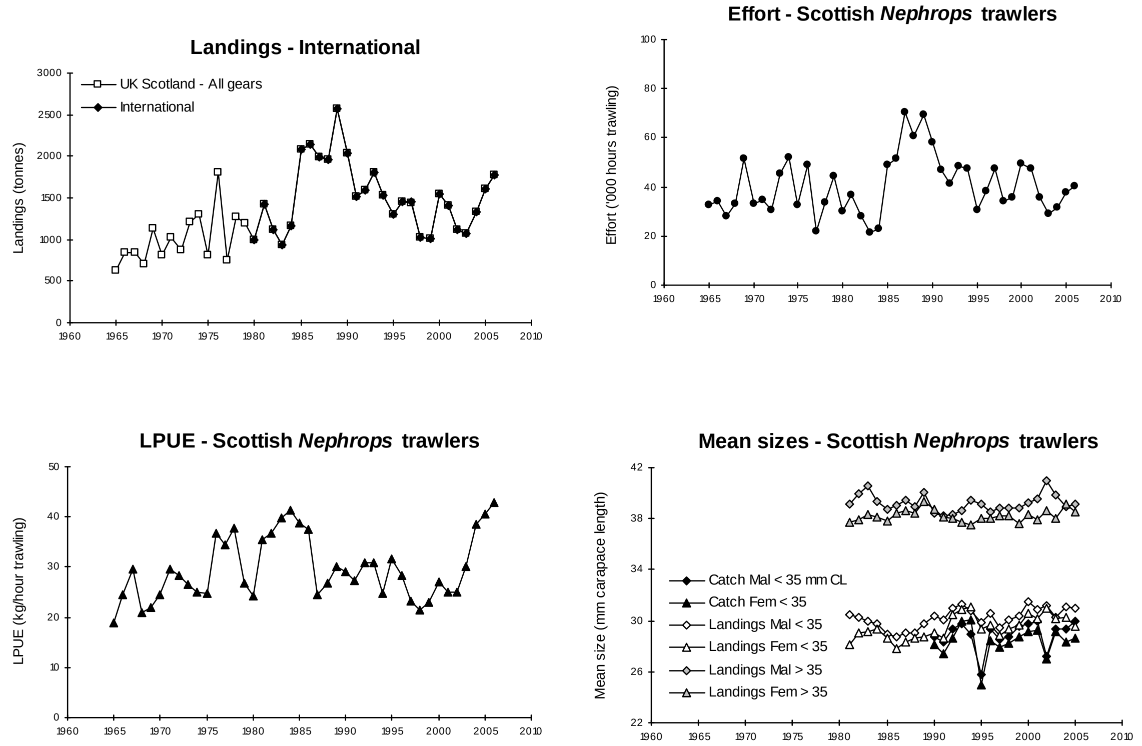

Figure 3.4.1.1 *Nephrops*, Moray Firth (FU 9), Long term landings, effort, LPUE and mean sizes.

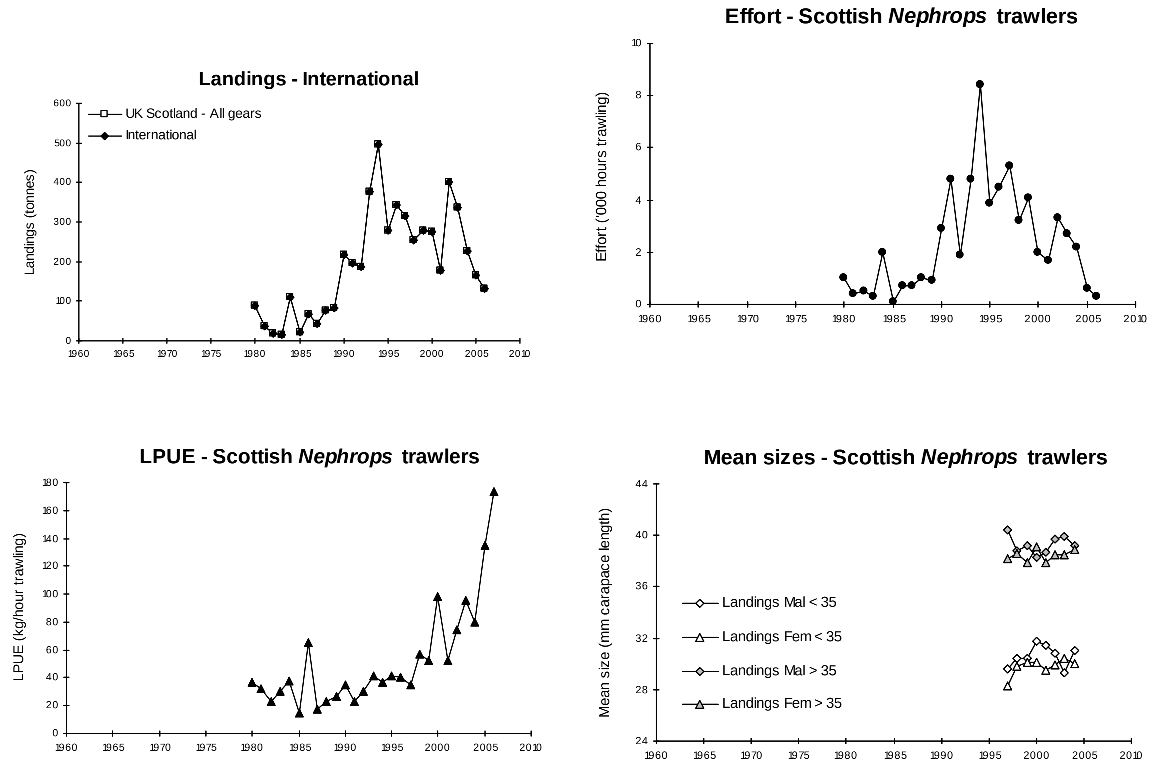

Figure 3.4.1.2 *Nephrops*, Noup (FU 10), Long term landings, effort, LPUE and mean sizes.

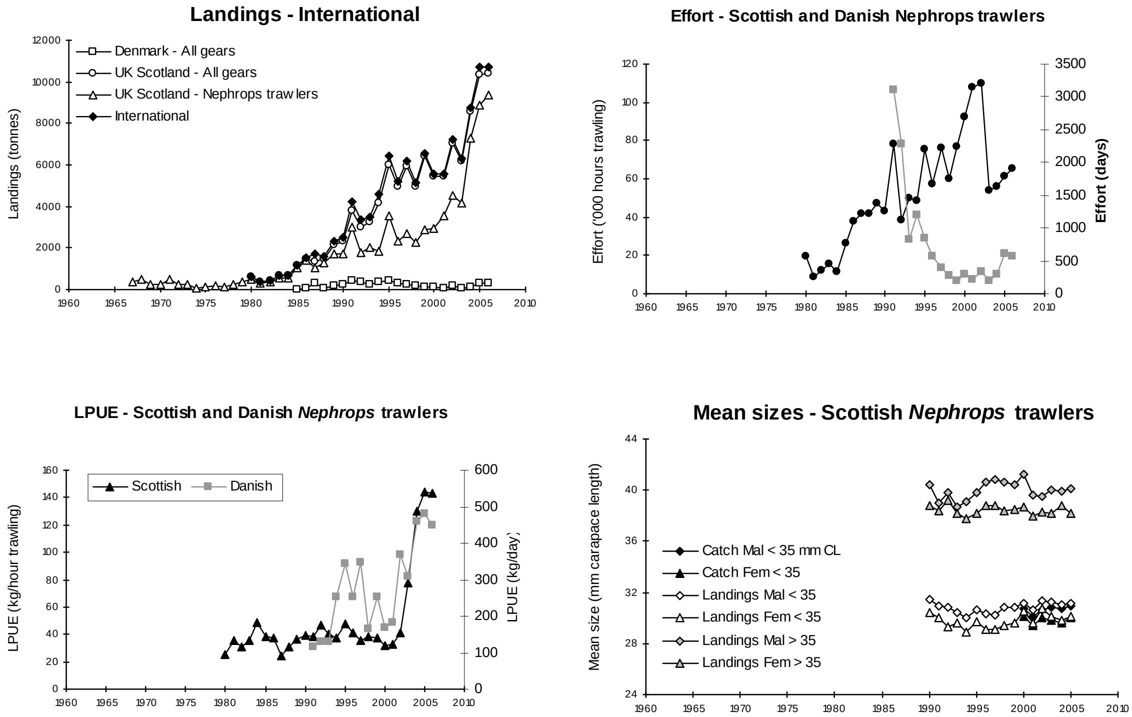

Figure 3.4.2.1 ***Nephrops*****, Fladen (FU 7), Long term landings, effort, LPUE and mean sizes.**

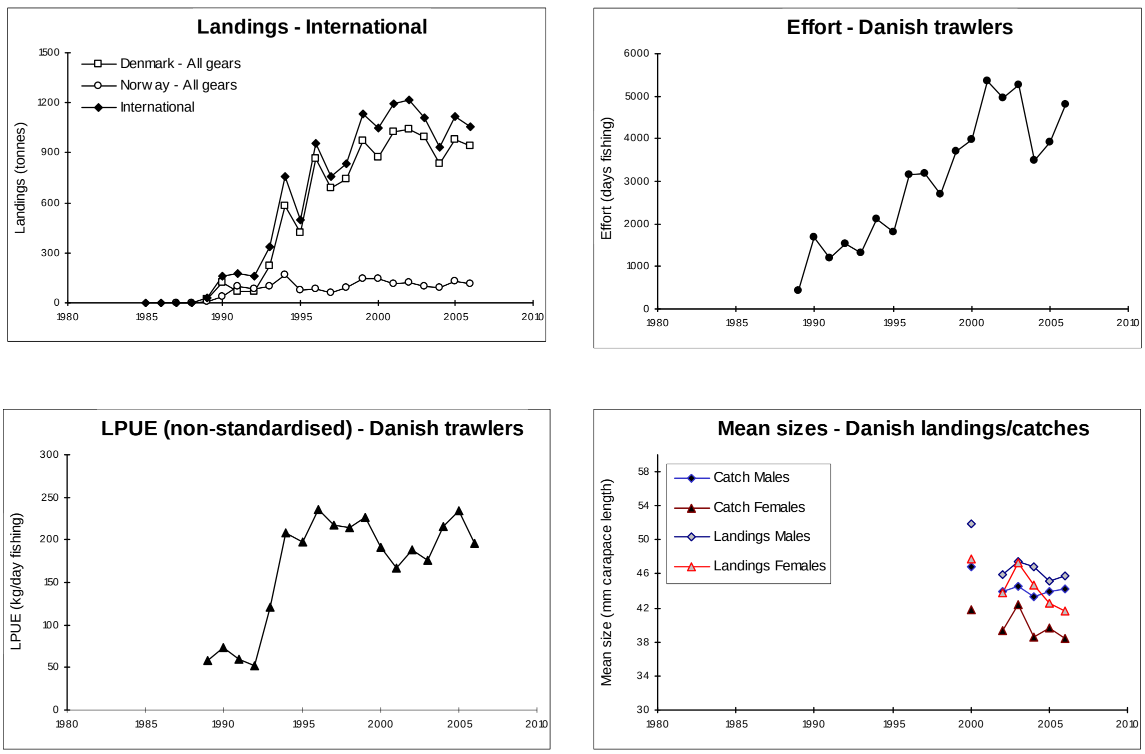

Figure 3.4.3.1 ***Nephrops*** **Norwegian Deep (FU 32): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of** ***Nephrops*****.**

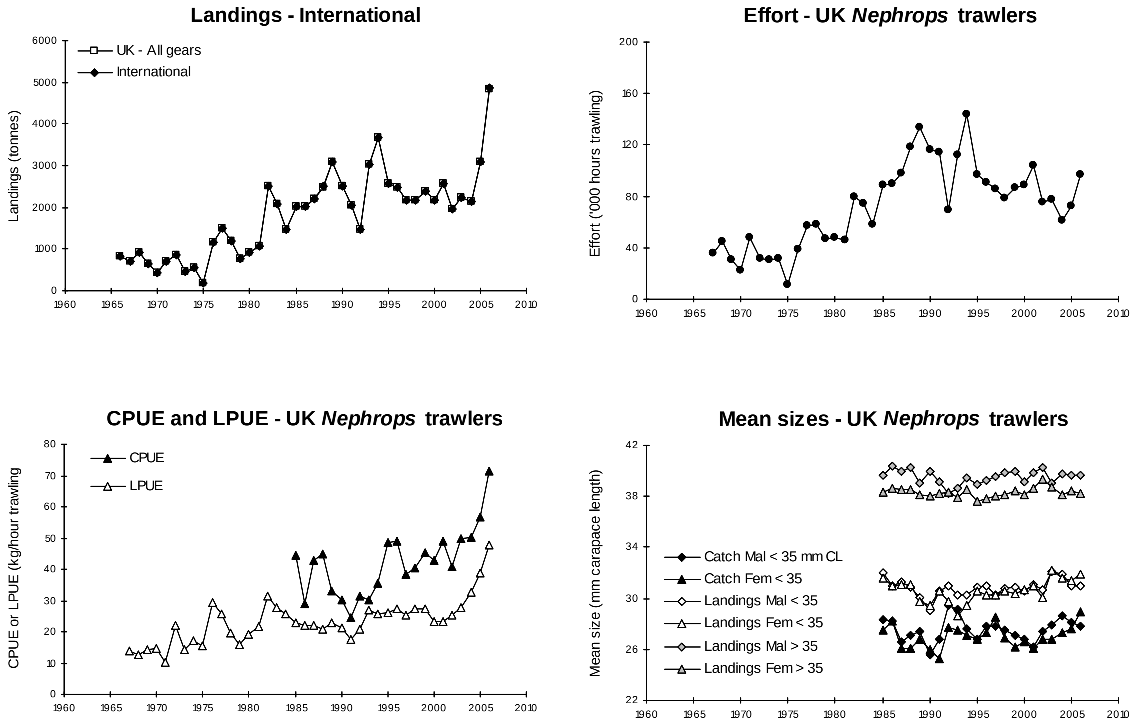

Figure 3.4.4.1 *Nephrops* Farn Deeps (FU 6): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of *Nephrops*

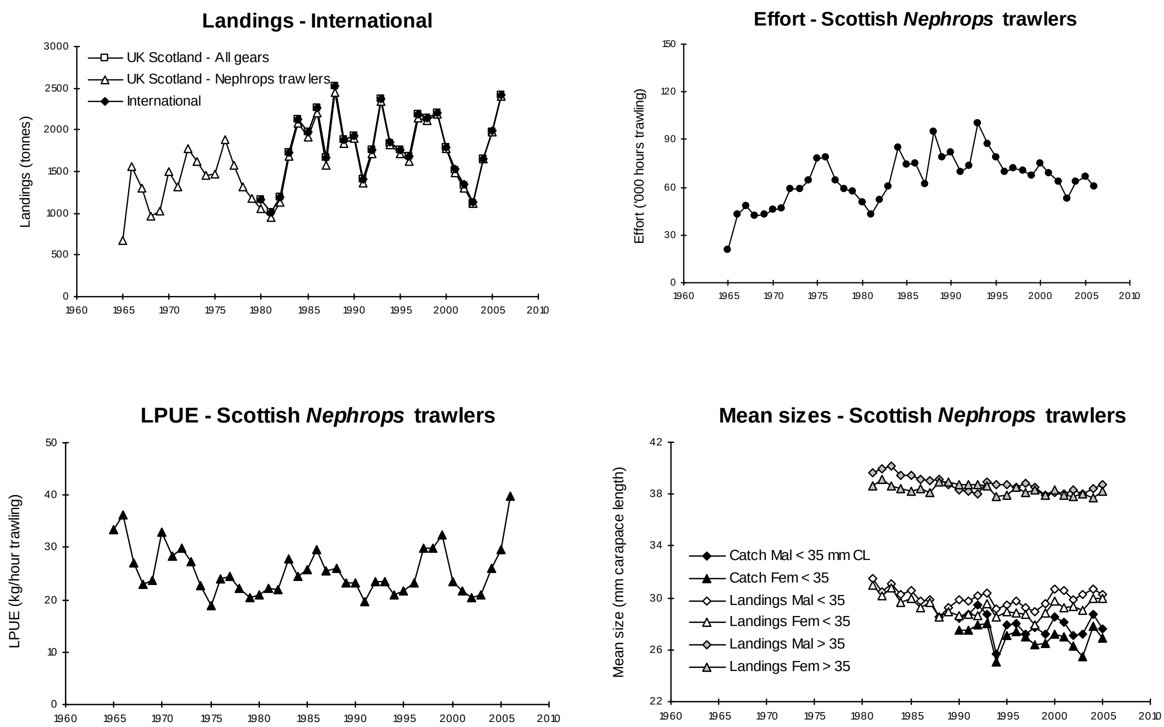

Figure 3.4.4.2 *Nephrops*, Firth of Forth (FU 8), Long term landings, effort, LPUE and mean sizes.

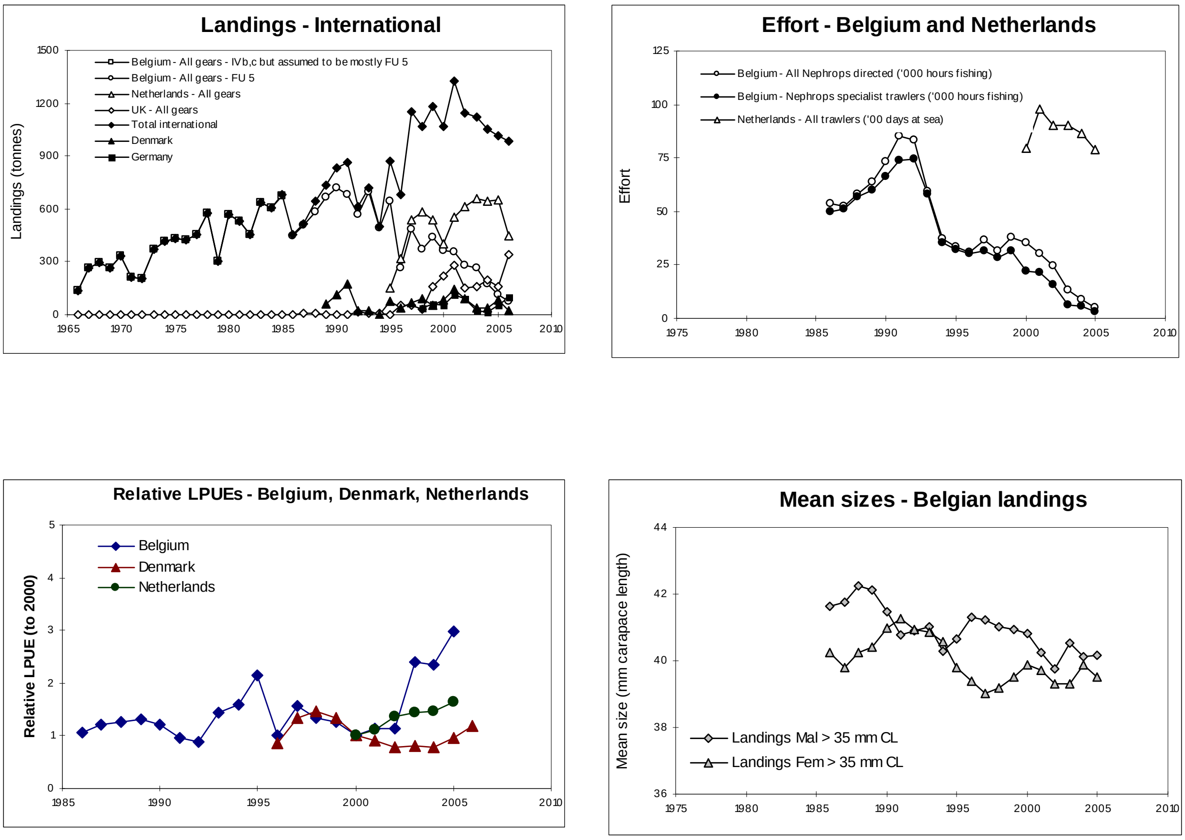

Figure 3.4.5.1 Botney Gut - Silver Pit (FU 5): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of Nephrops.

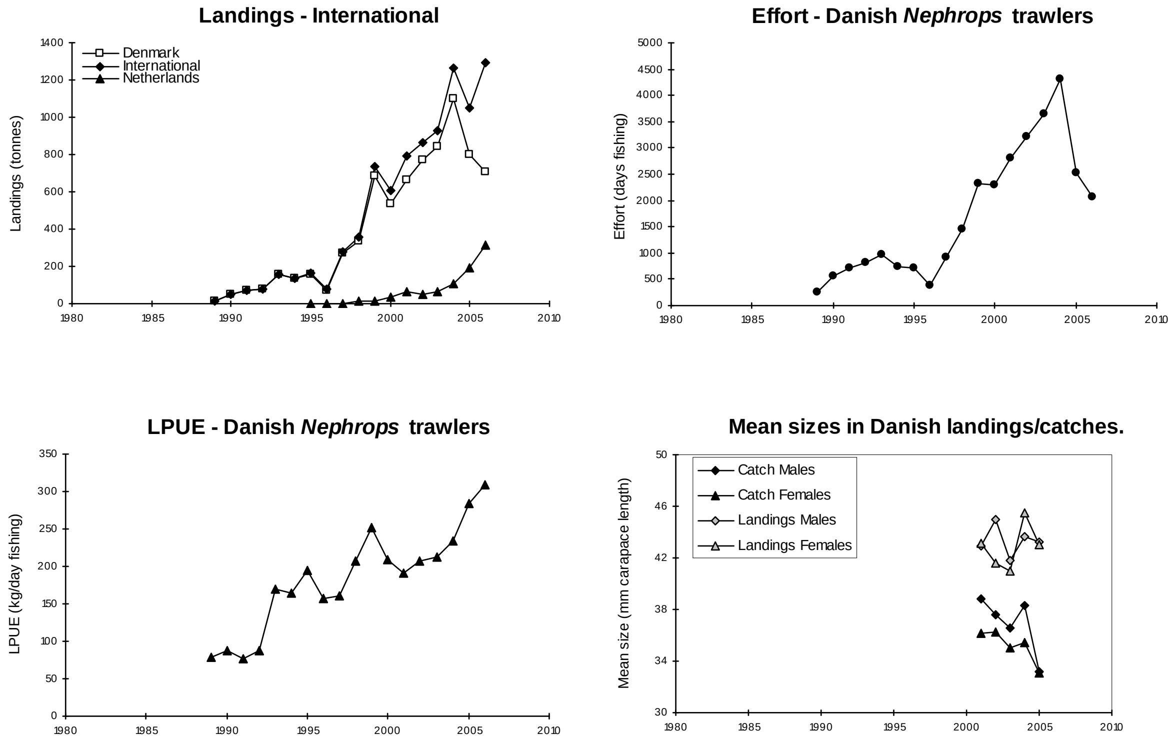

Figure 3.4.5.2 *Nephrops* Off Horn Reef (FU 33): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of *Nephrops.*

4 Sandeel in IV (WGNSSK Sep. 2007)

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

4.1 General

4.1.1 Ecosystem aspects

Sandeels in the North Sea can be divided into a number of reproductively isolated sub-populations (see the Stock Quality Handbook no. Q4). A decline in the sandeel population in recent years, with SSB being below Blim from 2001 to 2006 concurrent with a markedly change in distribution increased the concern about local depletion, of which there have been some evidence (ICES WGNSSK 2006b). This may be of consequence for marine predators that are dependent on sandeels as a food source. This year's assessment shows an improvement in the overall stock situation from 2006 to 2008 as well as a repopulation of sandeels in several areas in which local stock size has been low in recent years, indicating that the risk of local depletion have decreased. It is however presently not possible to make an assessment that takes account of the sub-population structure of sandeels, although a framework for carrying out such analyses have been outlined (ICES AGSAN 2007a).

The stock annex contains a broader description of ecosystem aspects. However there is new material relevant to this section and this is described below.

In general, fishing on sandeel aggregations at a distance less than 100 km from seabird colonies has been found to affect some surface feeding bird species, especially black-legged kittiwake and sandwich tern. Recent research of effects on seabird predators due to changes in sandeel availability showed that breeding success of black-legged kittiwake Rissa tridactyla in the Firth of Forth area off the Scottish east coast was related to abundance of both 1+ group, the age class targeted by the fishery, and 0 group sandeels. The same relationship was not found for six other sandeel dependent seabird species. Controlling for environmental variation (sea surface temperature, abundance of larval sandeels and size of adult sandeels), Frederiksen et al. (submitted) found that breeding productivity in the seabird colony on the Isle of May was significantly depressed by the fishery during periods of unregulated fishery for one surface-feeding seabird species (black-legged kittiwake), but not for four diving species. The mechanism by which the fishery affects the seabird however remains unclear as the fishery is not always in direct competition with the birds. The strong impact on this surface-feeding species, while no effects are documented found for e.g. diving species, could result from its inherently high sensitivity to reduced prey availability, from changes in the vertical distribution of sandeels at lower densities, or from sandeels showing avoidance behaviour to fishery vessels.

4.1.2 Fisheries

General information about the sandeel fishery can be found in the Stock Quality Handbook (no. Q4).

There has been a substantial decrease in the Danish fishing fleet due to decommissioning in recent years. The Norwegian fleet has also seen a drastic decline in the number of vessels fishing sandeels in recent years (ICES WGNSSK 2006b and section 4.2.5).

The sandeel fishery in 2007 was first opened 1st of April, both in the EU zone and in the Norwegian EEZ. The fishery in 2007 differed markedly from that of recent years fisheries, with much higher catch rates from the start of the fishing season, sandeels that were available to the fishery at least one week earlier than in the two previous years, and a higher mean weight of 1-group sandeels than in the two previous years (see ICES AGSAN 2007b). Further, in addition to the fishery in the Dogger Bank area, a large part of the fishery took place in the Northern part of the North Sea (in the Norwegian EEZ, in Skagerrak, and at the grounds off the Danish west coast) in areas where fishing have been on a low level in recent years because of low local abundance of sandeels. The change in the distribution of the fishery partly explains the increase in mean weight at age seen in 2007 (section 4.2.3).

Regulation of the fishery is no explanation to the small fishery observed from 2003 to 2006 (section 4.2.1). The TAC in force has until 2007 never been restrictive in the sandeel fishery. In 2005 (the only year, except for 2007, when additional regulation was introduced in the EU EEZ) the fishery was first regulated in July after the main fishing season. In the Norwegian EEZ the fishery in 2005 was closed from June 23 onwards. Following an experimental fishery (6 vessels in 3 weeks) that indicated a poor state of the stock in 2006 in the Norwegian EEZ, Norway chose not to open the fishery.

4.1.3 ICES Advice

Based on the 2006 assessment ICES (ICES-ACFM 2006) classified the stock as having reduced reproductive capacity. SSB was estimated at below Blim since 2001. A drastic change in the stock situation of sandeels in IV occurred from 2003 and onwards. The change in 2003 came from a historic low recruitment in 2002. An apparent increase in the stock size from 2005 to 2006 is due to the recruitment in 2005. However, this increase only applies to the southern part of the North Sea, whereas the stock in the Northern part of the North Sea is still at a much lower level. The fishing mortality in 2005 was close to the time-series mean, but below that of the last 4 years. Fishing mortality from the completed 2006 fishery was lower than the time-series mean.

Several traditional sandeel aggregations seem depleted, particularly in the northern area of the North Sea. ICES advised that management of fisheries should try to prevent further local depletion of sandeel aggregations, particularly in areas where predators congregate, and that efforts should be made to keep adequate levels of sandeel biomass available as prey.

In response to a special request from The European Community and Norway for "advice on management measures for the sandeel and Norway pout fisheries in the North Sea and Skagerrak in 2007", ICES noted that an F based strategy that aims for maximum yield is not consistent with the precautionary approach. A spawner escapement strategy that aims at a surviving annual amount of spawners equal to Bpa (or having a high probability of being above Blim) could be considered as an appropriate alternative to the fixed-F strategy.

ICES advise that the fishery in 2007 should remain closed until information is available which assures that the stock can be rebuilt to Bpa by 2008. ICES suggests a management procedure for 2007 as outlined in a response to a special request (ICES 2006):

1) The aim of management in 2007 should be to rebuild SSB in 2008 above Blim with a high (95%) probability.
2) The total kilowatt-days for fisheries for sandeel in 2007 may initially be set at no more than 30% of the total kilowatt-days applied in 2005. This effort may be used for exploratory fishing in April and early May 2007.
3) A TAC for 2007 and the maximum number of kilowatt-days shall be determined, as early as possible based on advice from ICES on the size of the 2006 year class of North Sea sandeel in accordance with the following rules

a) TAC 2007= −597 + 4.073 × N1 (N1 is the real-time estimate of age group 1 in billions, derived from an exploratory fishery in April and early May 2007; the TAC is expressed in 1000 t)

b) If the TAC calculated in point 3a) exceeds 400 000 t the TAC shall be set at 400 000 t

c) The number of kilowatt-days for 2007 shall not exceed the effort in 2005

4) .The fishery shall be closed 1 August 2007.

The relationship between the TAC and the real-time recruitment estimate is conditional on the October 2006 assessment of age group 2 and older at the start of 2007.

The real-time monitoring estimate should be based on a regression between CPUE observations and "bias-corrected" stock numbers at age 1. ICES has applied a bias correction to the assessment output by calculating a bias factor from the terminal estimates of a series of retrospective runs divided by the "true value" as estimated in the most recent assessment. The application of the bias factor gave a 50% lower estimate of SSB in 2007. ICES consider that the bias correction reduces the concern about assessment bias for management of the sandeel fishery in 2007.

Because ICES cannot fully evaluate whether the harvest control rule is consistent with the precautionary approach in the longer term, ICES presents the HCR as a suggestion only.

Closing the fishery on 1 August will enhance the possibilities for the 0-group to contribute to the local aggregations and to repopulate earlier depleted grounds.

Real time management (RTM) of the sandeel fishery in 2007

An ICES Ad Hoc group on North Sea sandeel (ICES AGSAN 2007a) met at ICES 27-28 February 2007, to establish a real time monitoring (RTM) system for the North Sea sandeel stock to be implemented in 2007. The AGSAN build upon the work carried out by previous STECF expert group on the RTM methodology (STECF 2004, 2005a and 2005b), by the WGNSSK in 2006 (WGNSSK 2007) and in a response from ICES to a special request (ICES 2006). The TOR for the AGSAN meeting was to:

1) Compile all pertinent information of relevance for the implementation of a real-time monitoring system for the stock of North Sea sandeel. In compiling this information consider the arrangements between the Community and Norway on the 20 000 tonnes allocated to the "experimental fishing" both in Community and Norwegians waters;

2) Suggest methods, on the basis the information compiled under point 1, for a further improvement of the real time monitoring system for the stock of North Sea sandeel that by early May 2007 can provide an unbiased estimate of the size of the 2006 year class of sandeel;

3) Outline feasible options for future management arrangements, taking into account the biological characteristics of the stock as well as future availability of relevant data.

The AGSAN was scheduled to work by correspondence to provide an estimate of the size of the 2006 year class of North Sea sandeel at age 1 as early as possible in May and no later than 15 May 2007.

The HCR investigated by the group was the same as suggested (not advised) by ACFM 2006.

The AGSAN produced the final report 10th of May. The 2006 year class was estimated to 419·109 individuals at age 0 in 2006 and to 188·109 individuals at age 1 in 2007. Using the HCR the TAC for 2007 was estimated to 170 000 t.

ICES advised 15th of May on a TAC for 2007, based on the final AGSAN report (ICES AGSAN 2007b). ICES concluded that "The data obtained from the experimental fishery are considered adequate to provide an estimate of the size of 1-group sandeel in 2007, according to the agreed methodology (ICES AGSAN 2007a)."

4.1.4 Management

The suggestion from ICES on a management strategy for 2007 (section 4.1.3) was later used in the regulation of the 2007 fishing opportunities in Community waters (Council Regulation (EC) No 41/2006 of 21 December 2006 - OJ L15 of 20 January 2007 p 1) and in the Norwegian EEZ

TAC

In the fishery consultations between EU and Norway for 2007, the agreed record allowed the parties to fish 20 000 tonnes of sandeel in each others zones. These quotas were primarily for an experimental fishery, but fishing against these quotas could continue if the commercial fishery was opened.

Both EU and Norway accepted the TAC of 170 000 t as suggested by ICES (22nd of May, EU DG III – Fisheries: NOTE TO DELEGATIONS 225/07). Because there is no agreement between EU and Norway on how to share the sandeel stock, the TAC was overfished by 36 000 t. EU landed 155 000 t and Norway 51 000 t, which correspond to 91% and 30%, respectively, of the TAC of 170 000 t.

Denmark closed the sandeel fishery for Danish vessels in the EU zone from 16th May. From 8th of June Danish vessels were allowed to fish 10 500 t of sandeels, 2 100 t in Norwegian EEZ and 8 400 t in EU waters and Skagerrak/Kattegat. Of the 8 400 t, 4 600 t were a rest of the 2006 TAC that was transferred to 2007, and 3 800 t a rest of the 2007 TAC. The 10 500 t was fully utilized. EU closed the sandeel fishery in the Norwegian EEZ for EU vessels from 4th May. Norway closed the sandeel fishery for Norwegian vessels from 6th of May and reopened the fishery May 16 following the ICES advice. The fishery was closed again in mid-June when the quota of 51 000 t had been taken.

Closed periods

Since 2005 Danish vessels have not been allowed to fish sandeels before 31st of March. In 2007 sandeel fishery in the EU zone was first opened 1st of April and closed again from 1st of August.

Since 2004 the fishery in the Norwegian EEZ has been opened April 1. In 2005 the fishery was closed June 23, and in 2006 the fishery in the Norwegian EEZ was closed except for a limited experimental fishery. In 2007 the sandeel fishery in the Norwegian EEZ was opened April 1t and closed again May 6 pending advice from ICES. The quota of 51 000 t set by Norway for Norwegian vessels was taken within mid-June.

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 2007, with an increase in the effort of the monitoring fishery to 40 boat days. There is presently no decision on weather a full commercial sandeel fishery will be reopened in the Firth of Forth area.

In the Norwegian EEZ all fishing grounds were open during the monitoring fishery in 2007. . When the fishery was reopened May 16, a number of fishing grounds were closed (Fig. 4.1.4.1). The rational for closing these areas was the poor state of several local stocks in the northern North Sea over the last 6-12 years (Fig. 4.2.1.4).

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 2006 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, with a steep drop from 2002 to 2003, after which total landings have been low and historic low in 2005 (Figure 4.2.1.1 and Table 4.2.1.2). Average total landings were 270 000 t in the period 2003-2007 whereas they were 801 000 t in the previous 20 year period.. In spite of a substantial decrease in the fleet size (section 4.2.5) landings were on a much higher level in 2007 compared to the previous 3 years up to when the fishery in the EU zone was closed in mid May.

There are large differences in regional patterns in landings. This is shown in Figure 4.2.1.2 in which landings are given for the three regions: i) north-western North Sea, ii) north-eastern North Sea and iii) the southern North Sea. The landings from the southern North Sea were on a much higher level then those in the north-eastern North Sea until 1985 when a steep increase was seen in landings from the north-eastern North Sea. From 1985 to 1998 landings in the two areas were approximately at the same level. However, from 1999 landings in the north-eastern North Sea decreased dramatically until 2006, when only a limited experimental fishery in the Norwegian EEZ was allowed. The same decline in landings was observed in the southern North Sea, but the decline in this area first occurred from 2003, i.e. 4 years after that in the north-eastern part of the North Sea. Landings in the north-western part of the North Sea have generally been on a much smaller level than those in the other two regions, the exception being 1994 and 1995. The peak in landings in 1995 was due to a large fishery at the Viking Bank. From 2006 to 2007, a large increase was seen in landings in the north-eastern North Sea.

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, Norwegian EEZ in 2006 and in the North Sea in 2007). Figure 4.2.1.3 shows the distribution of catches for 2006 (no fishery in first quarter) and 2007 (only fishery in second quarter) by quarter and ICES statistical rectangle. Yearly landings for the period 1995-2007 distributed by ICES rectangle are shown in Figure 4.2.1.4.

Large variations in the fishing pattern occurred concurrent with the decline in landings and CPUE (section 4.2.5). The distribution of landings in the southern North Sea in 2003 to 2005 (i.e. from the first year when landings were on a low level in both the northern and southern North Sea) seemed more dispersed than the typical long-term pattern in the same area. Hence, grounds usually less exploited became more important for the total fishery during this period. In 2006 there was another large change in the fishing pattern, when the fishery showed a strong concentration at the fishing grounds in the Dogger Bank area. In 2007 yet another change in the distribution of landings was observed, when landings in the north-eastern part of the North Sea were on about the same level as those in the southern North Sea. Although this overall large variation in fishing pattern there is a general high importance for most years of the Dogger Bank area.

As for last year's assessment Danish landing of 13739 t of sandeels in second half year of 2005 was added to first half year landings data on 141057 t (see ICES 2006b).

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 Quality Handbook no. Q4. The mean weights-at-age in the catch for the northern and southern North Sea in the time period 2001 to 2007 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 2007, used in the assessment is given in Table 13.2.3.3 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 2007 is given in Table 4.2.3.4 by half year. There was no biological sampling of the small fishery in second half year of 2006 (representing 21 000 tonnes or 9% of the landings in first half year). As more than 95% of the 21 000 tonnes were taken in July mean weight in the stock from June 2006 was also used for second half year of 2006.

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 are the large changes in mean weight from 1994 to 1996, which partly may be explained by a change in the methodology used for age determination (ICES 1995) that was applied from 1995 and 1996. An increase in mean weight is observed from 2004 to 2006 in first half year in both the northern and southern North Sea. Also from 2006 to 2007 an increase in mean weight was observed. Due to the early stop of the fishery in 2007 (section 4.1.4) and a lack of samples from the small fishery in June mean weight in 2007 used in the assessment may be slightly underestimated.

The large fluctuations of mean weight-at-age have an impact on the quality of the assessment. This year we made a more detailed examination of the variability in the observed mean weight-at-age in the catch, with a view to possible forecasting of this quantity. This is relevant because mean weight at age for 2008 and 2009 is an important input in the short term forecast (section 4.6). Data from the Danish sandeel catch-sampling programme from 1995-2007, corresponding to the period after the introduction of the new age determination procedure, was used as the basis for this analysis. The raw data consisted of a length-class frequency distribution for a given year, month, age of individual fish, and location of the catch (binned into "Northern North Sea" and "Southern North Sea"), using the definitions shown in Figure 4.1.2.1. Each length-class had a total number and weight of fish associated with it, from which the mean weight of an individual in that class could be determined. The overall mean weight-at-age for a given month, year, age and area was then determined using an arithmetic mean weighted by the number of observations for the given length class. The uncertainty in the mean was estimated from the standard deviation, calculated in an analogous manner. Data from the Danish sandeel dredge survey (see ICES 2006b and 2007a) was analysed in a similar fashion.

Inter-annual variation in the mean weight-at-age appears to be a significant factor (Figures 4.2.3.3 and 4.2.3.4). Due to the nature of the dataset used here, it was not possible to test such a hypothesis statistically (e.g. using an ANOVA). However, visual inspection of the plots suggests that the variation between years is significantly greater than the uncertainty in the estimated mean weight-at-age. The most likely explanation arises from the fact that this analysis is based on catch data, rather than survey or population data: the mean weight-at-age is not spatially uniform across the North Sea stock unit and the spatial exploitation pattern of the fishery is known to vary greatly between years. Changes in the distribution of fishing sites between years will also change the mean weight-at-age of fish going into the catch and can thereby create the observed between-year variations.

Further evidence of strong inter-annual effects is provided by normalising the mean weight-at-age in a given month and year by the value averaged over all years (Figures 4.2.3.5 and 4.2.3.6): this transformation allows us to view the mean weight-at-age in terms of an anomaly from the mean value, and thereby easily observe common trends. There appears to be a common pattern between the normalised weights-at-age, especially in the older age-groups (i.e. age 1+), again suggesting that the between-year variability is more important than within year variability.

The month and fishing area from which the catch data are sampled appear to have a strong influence on the observed mean weight-at-age (Figure 4.2.3.7). Generally, the mean weight-at-age is larger in the northern North Sea than in the southern North Sea. The mean weight-at-age increases monotonically throughout the first half of the year, before peaking in early summer (June-July) and decreasing slowly into autumn. There is insufficient data to fully understand these trends, due to the lack of fishing during the winter half of the year, and there does not appear to be an obvious biological explanation. However, it must be remembered that these data only reflect the nature of the fishery, not of the entire population, and are thus likely to be confounded by effects such as temporal changes in both the fishing pattern and catchability (e.g effects such as larger sandeels burrowing into the sand before smaller ones, see e.g. Bergstad et al. 2002, Reeves 1994, or Rindorf et al. 2000). More data, from both catches and dredge surveys, is required in the data-poor autumn and winter months to fully understand these trends.

There does not appear to be a strong cohort effect (Figure 4.2.3.8). While one might expect that some cohorts grow faster or slower than others (e.g. due to competition effects), such an effect does not appear to be strong. Again, due to the nature of the data, it has not been possible to test this hypothesis easily using statistical methods, and thus we are forced to rely on visual examination of the data. If the cohort effect were significant, we would expect that some cohorts are generally above an average weight, and some are generally below it. This does not appear to be the case, and cohorts move above and below the average in a seemingly random manner, suggesting the effect is not significant. However, such an analysis method is inherently weak, and firm conclusions cannot be drawn without the use of proper statistical tests.

Finally, the potential use of observed weights-at-age to predict future weights-at-age was examined. Correlation coefficients were calculated between the mean weight-at-age of a cohort at age t, and that of the cohort again at some point in the future, $t+\delta t$. Generally, it was found that the predictive power of such an approach was extremely poor: the r2 coefficient was almost always below 0.30 for any useful value of δt (e.g. forecasting one year ahead). This result formalises the more qualitative observation made above that there is no cohort effect: if there were, we would expect to see much higher correlation coefficients.

The results of the correlation analysis in relation to the December sandeel dredge survey are worth noting (Table 4.2.3.5). While the r2 values are only based on three data points, they are also appreciably higher than the other values. This is a promising result and may offer a possible route via which mean weight-at-age predictions for the coming spring could be made. The addition of further data points will quickly clarify whether such a method is practicable.

In conclusion, it does not appear to be feasible, with the currently available data, to forecast the mean weight-at-age. The mean weight-at-age appears to exhibit significant area, month and inter-annual effects, but there does not appear to be a strong cohort effect, limiting the ability to make forecasts. As a substantial proportion of inter-annual variability in mean weight at age is likely to be a result of 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. A proposed forecast method would thus need to include information about the expected spatial exploitation pattern in future years, a highly uncertain parameter. Division of the primary North Sea stock unit into smaller units, each assessed individually, may resolve many of these problems.

Because it is not possible to forecast mean weight at age, an average of the time period 1996 to 2007 is used for 2008 and 2009 in the short term forecast (section 4.6).

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

4.2.4 Maturity and natural mortality

Maturity and natural mortality, used also in this year's assessment, are assumed at fixed values and are described in the Stock Quality Handbook no. Q4. 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

Catch data

Catch data used in the assessment is given in Table 4.2.2.1. No catch data was available for second half year of 2007 because no fishery has been recorded.

Recent changes in the fleet composition

The size distribution of the Danish fleet has changed through time, with a clear tendency towards fewer and larger vessels (ICES WGNSSK 2006b). 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). This change was retained in 2006 and 2007 with a small increase to 124 vessels in 2006 and 116 in 2007 (when the fishery was closed in May). The remaining Danish industrial vessels were in 2007 given individual tradable quotas (ITQ) on sandeels. The introduction of ITQ will accelerate the change towards fewer and larger vessels. From the experience with ITQ on herring a halving of number of vessels in the Danish industrial fleet could occur.

The same tendency was seen for the Norwegian vessels fishing sandeels until 2005 (Table 4.2.5.1). In 2006 only 6 Norwegian vessels were allowed to participate in an experimental sandeels fishery in the Norwegian EEZ. In 2007 41 Norwegian vessels with individual quotas participated in the sandeel fishery

From 2002 to 2007 the average GRT per trip in the Norwegian fleet increased from 269 to 460 t. Of the 41 Norwegian vessels that fished sandeel in 2007, 9 participated for the first time. Since 1998 25 of the 41 vessels entered the fishery during this 10 yr period, 9 vessels were rebuilt (either extended or had larger engines installed) whereas only 7 vessels remained unaltered. In addition, there is likely to be a continuous increase in efficiency due to improvement in fishing gear, instruments etc.

Such rapid changes in the structure of the fleet may introduce more uncertainty in the assessment, as the fishing pattern and efficiency of the "new" fleet may differ from the previous fleet.

Trends in overall effort and CPUE

Tables 4.2.5.2 and 4.2.5.3 and Figure 4.2.5.1 show the trends in the international effort over years. Total international standardized effort peaked in 1989, and was at a relative stable level from 1989 to 2001. Total international effort has been decreasing since 2001, with a particular large decrease from 2001 to 2002 and another large decrease from 2004 to 2005. The effort in 2007 is the lowest recorded in the time period used in the assessment. The decrease in effort is likely due to a combination of decreasing catch opportunities and increasing fuel prices. In 2007 the regulation of the fishery was a strong limitation of the effort used.

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 commercial CPUE as an index of sandeel population size was included in last years WG report.

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 have since the 2005 assessment (ICES 2006a) been split into two time periods, i.e. before and after 1999, when a change in gear types has been observed (ICES 2006b). 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 markedly. 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 1999-2007 first half year
Fleet 3: Southern North Sea 1983-1998 first half year
Fleet 4: Southern North Sea 1999-2007 first half year
Fleet 5: Northern North Sea 1983-2006 second half year
Fleet 6: Southern North Sea 1983-2006 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 tuning fleet used for the northern North Sea is a mixture of Danish and Norwegian vessels.

No effort data was available for second half year of 2007 because no fishery has been recorded.

Standardisation of effort data

Due to the change in size distribution of the vessels fishing sandeels in the North Sea (see e.g. ICES WGNSSK 2006b or STECF 2004 and 2005a) and 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 no. 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 4.2.5.2 and 4.2.5.3.

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 4.2.5.2). The exception is 2002 when there was a markedly increase in CPUE in the first half year and a large decrease in the second half year. The CPUE was at 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 4.2.5.3). The exception is in 2007 when CPUE of age-2 sandeels increased in southern North Sea first half-year.

Fisheries independent tuning

There is 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 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.

4.3.1 Reviews of last year's assessment

See the WGNSSK report from April 2007 (ICES WGNSSK 2007).

4.3.2 Exploratory catch-at-age-based analyses

Settings used in the assessment models

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 2006 and first half year of 2007. The settings used in the SXSA are listed in Table 4.3.2.1.

Settings used this year in the assessment models compared to 2006

The settings used for this year's SXSA assessment are the same as those used for the final 2006 SXSA assessment.

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), 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. From 2002 the residuals have in first half year been positive for age-1 sandeels and negative for age-2 sandeels in the Northern North Sea. In this time period both the fishery and the stock in the northern North Sea have been on a low level, except for in 2007 with a drastic change was observed. Also in the southern North Sea the residuals were negative in first half year for age-2 sandeels from 1993 to 1998. There is no clear explanation to these observed trends in the residuals, although some problems with aging the 1998 and 1999 year class (due to the formation of the “winter” ring in the autumn) have been identified at the Norwegian laboratory. There are no clear trends in the residuals of log stock numbers for any of the other age-groups and fleets.

The retrospective analysis (Figure 4.3.2.2) shows that the SXSA has a tendency to underestimating F and overestimating stock size although the retrospective bias seems to have decreased in 2006 compared to 2004 and 2005. This bias in the assessment is also seen in the plot of the historical performance of the assessments (Figure 4.3.2.4). Due to the tendency of the assessment to underestimate F and overestimate N the short term forecast in 2006 was based on a bias-corrected assessment. The bias-correction factors used in 2006 for F and N were estimated for each year and age between 2000-2005 and are variable (Figure 4.6.1 and 4.6.2, WGNSSK 2006). The average value from the last 3 years used and the performance of these adjustments is as follows:

N Age 1, 1st Jan 2006.
bias used in forecast -42%
"actual" bias from final 2007 assessment -15%

N Age 2, 1st Jan 2006.
bias used in forecast -21%
"actual" bias present from 2007 assessment -23%

F Age 1, 1st half year
bias used in forecast +72%
"actual" bias from final 2007 assessment +40%

F Age 2, 1st half year
bias used in forecast +15%
"actual" bias from final 2007 assessment +54%

The bias-correction used in 2006 was thus excessive on the 1-group and not enough on the 2-group.

4.3.3 Exploratory survey-based analyses

No survey based analyses were carried out.

4.3.4 Conclusions drawn from exploratory analyses

The SXSA estimates the 2006 year-class to 401·109 individuals at age 0, which is below average. F1-2 declines from 2004 to 2007 with 2007 being historic low and only about 30% of the long term average. SSB have been below Blim from 2001 to 2006, and is estimated to above Blim but below Bpa in 2007. The increase in SSB to above Blim in 2007 is, in combination with a more uniform spatial distribution pattern, an improvement of the stock situation.

4.3.5 Final assessment

The SXSA update assessment was chosen as the final assessment.

4.4 Historic Stock Trends

The stock summary is given in Figure 4.3.2.3. The final assessment estimate SSB to below Blim from 2001 to 2006 and to above Blim but under Bpa in 2007. Although the 2005 and 2006 year classes are estimated to below average SSB increase to above Blim in 2007 due to a fish-ing mortality well below average since 2006.

The decrease in the sandeel stock concurrent with a decrease in fishing effort, has led to a large decrease in sandeel landings since 2003. Danish landings 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 (only experimental fishery in the Norwegian EEZ) compared to average landings in 1994-2002 in the same area (Figures 4.2.1.2 and 4.2.1.4 and Table 4.2.1.4). A large change in the fishing pattern was observed in 2007, when the fishing season was comparable to those before the considerable change in the stock occurred in 2003. Weekly landings and effort were on a higher level in 2007 compared to the previous 4 years, up to when the fishery was closed (section 4.1.4). Further, landings in the northern North Sea in 2007 were at the same level as in the southern 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, 2006, ICES 2006a, 2006b and 2007).

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.

ICES Study Group on Recruitment Variability in North Sea Planktivorous Fish (ICES-SGRECVAP 2007) analysed the stock-recruitment relationship of sandeels in IV. The residuals in the stock-recruitment relationship are evenly and randomly distributed around the mean value, and do not appear to reflect any obvious trends in the stock dynamics. The productivity (recruits per spawner) is highly variable throughout the time series modelled (1984 to 2005) with the highest productivity in 1997 and 2002, for both years followed by a sharp decrease in the following year. In the most recent years there is again an increasing trend in productivity.

Fisheries independent information on sandeel abundance

In the latest WG reports the need for fishery independent information on sandeel distribution and abundance has been highlighted (ICES 2005, 2006a and 2006b). Catches of sandeels in the international coordinated ICES surveys are not considered representative enough to be used in the assessment. Dedicated sandeel surveys have only been established in recent years to provide large scale abundance estimates of sandeels. The demand for such surveys has increased due to the recent years decline in the North Sea sandeel stock concurrent with large changes in distribution and in the composition and fishing pattern of the fleet.

A detailed description of the methodologies that are presently used for measuring sandeel abundance on scientific surveys is given in the last WG report together with preliminary results from some of the methods (ICES WGNSSK 2007). The methods described are:

- Sampling of sandeel larvae from April to May at sandeel fishing grounds, using a plankton net (a MIK with a diameter of 1 m).
- Sampling of juvenile and adult sandeels in the seabed using dredges, sledges, and seabed samplers such as grabs and box corers.
- Sampling of juvenile and adult sandeels in the water column using a full commercial sandeel trawl equipped with a multiple cod end system.
- Acoustic techniques for measuring the biomass of juvenile and adult sandeels in the water column.

The WG concluded, that all the surveys have the potential to establish a time series of indices that can be used for tuning the historic assessment, and to estimate the size of the incoming year-class all ready in January, before the decisions about how the fishery will be managed have to be made. However, the time series are limited to a few years and therefore still insufficient to be used in the assessment. Further, an analysis of the ability of the indices to measure stock trends, i.e. contrasting the information in the many sources of survey and commercial fishing data, still need to be carried out to achieve a proper evaluation of the methods applied. The WG recommended such an evaluation to be carried out. Further, the WG stated that an international coordinated effort is required to establish a time series of survey information for North Sea sandeels that can be used for stock assessment.

Provisional information about the 2007 year class

Due to no fishing in second half year of 2007 (see section 4.2.1) there are no fishing data from 2007 that can be used to estimate the size of the 2007 year-class.

The Danish Institute for Fisheries Research (DIFRES) has measured sandeel larvae abundance in the North Sea in April 2007. This material is presently being analysed. Further, DIFRES will carry out a survey in December 2007 that may provide information about the size of the 2007 year class. Further the Institute of Marine research (IMR) plan to conduct surveys in 2008 to measure the abundance 1-group and older sandeels in April/May

Recruitment estimates used for short term forecasting

For the short term forecast (section 4.6) the 25th percentile, on 324 109 age-0 sandeels, of the long-term recruitment estimated in the final SXSA assessment was used as the recruitment in 2007 and 2008. This was used because recruitment has been below average since 2002.

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, in 2007 there was no fishery after June (see section 4.2.1). There is therefore no information in the 2007 catch data that can be used for the estimation of the 2007 year-class.

0-group CPUE is a poor predictor of recruitment (ICES WGNSSK 2004) Traditional deterministic forecasts are therefore not considered appropriate. However, because of the low sandeel stock the working group has since 2004 provided an indicative short term prognosis, using a range of scenarios for the recruitment and exploitation pattern. The same approach as used for the standard prognosis in 2006 was taken during this WG meeting to carry out a short term prognosis for 2008 and 2009.

Prognosis for 2008 and 2009

The prediction was made using half year time steps. Stock numbers at 1st of January 2007 were taken from the final SXSA assessment. Values for natural mortalities and proportion mature are the same as those used in the assessment.

In the absence of information about the recruitment a low recruitment was assumed for 2007 and 2008. This was used because recruitment has been below average since 2002. Recruitment in 2007 and 2008 was assumed to be 324 109, which is the 25th percentile of the long-term recruitment (section 4.5).

No fishery was recorded for second half year of 2007. Further, no fishery was assumed for second half year of 2008, due to no or very limited fishery in second half year of 2005, 2006 and 2007. F-at-age for the first half year of 2007 was also used for the first half year of the forecast year. The argument for this is that the exploitation pattern seems to depend on the abundance of the age-classes relative to each other (see e.g. ICES AGSAN 2007a), and it can be assumed that this relative contribution of age-groups to the stock in 2008 will be much like in 2007. Since 2002 recruitment has been below average with the 2005 and 2006 year-classes at about the same level. Therefore, unless the 2007 year class is high exploitation pattern in 2008 is likely to be like that in 2007. Alternative exploitation patterns were also analysed (mean exploitation pattern 2005-2007 scaled to 2007 and mean exploitation pattern 2004-2006 scaled to 2006). However, the results of using these alternative exploitation patterns in the forecast were largely the same as for the forecast that used the 2007 exploitation pattern.

Stock and catch weights for the first half year of 2007 was those used in the assessment. Because of the inability to predict future stock and catch weight (section 4.2.3) average weights of the time period 1995 to 2007 were used for first half year of 2008 and 2009. Stock and catch weight previous to 1995 were not used, due to a change in the procedure used for age determination from 1995 (section 4.2.3 and ICES 1995). Stock and catch weight of second half year of 2007 and 2008 are irrelevant, because SSB is estimated in the start of first half year and no fishery is assumed in second half year.

Data used in the forecast is given in Table 4.6.1.

The forecast predict SSB in 2008 to 681 000 t and above Bpa. In case of low recruitment landings in 2008 on 400 000 t will lead SSB in 2009 to be above Bpa. Landings on 400 000 will lead to F in 2008 being 2.3 times higher than F in 2007.

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 (ICES 2006b). However, the standard forecast from 2006 estimated SSB in 2007 to 498 000 t. SSB is in this years assessment estimated to 455 000 tonnes, e.g. at about the same level as the standard forecast in 2006.

SSB(2008) = 681 000 t; landings (2007) = 204 000 t. Input data in Table 4.6.1.

Shaded scenarios are not considered consistent with the precautionary approach.

The settings applied in the forecast were used to estimate the relationship between recruitment in 2007 and the catch in 2008 that will lead to SSB being 600 000 t in 2009, i.e. the maximum catch in 2008 that will meet the objective of SSB to be above Bpa in 2009. The result of this analysis (Figure 4.6.3) is the relationship:

TAC2008=-138+R0,2007*1.69 (1)

where R0,2007 is recruitment at age-0 in 2007 and TAC2008 is the catch in 2008 that will result in SSB=Bpa in 2009.

The relationship (1) can be translated into a relationship between the stock size of 1-group sandeels in 2008 and the TAC in 2008, that will lead to SSB being 600 000 t in 2009, by projecting age-0 sandeels in second half year of 2007 to age-1 sandeels 1st of January 2008 apply-ing natural mortality of age-0 sandeels for second half year of 2007. This result is the relation-ship (Figure 4.6.3):

TAC2008=-138+R1,2008*3.77 (2)

where R1,2008 is the stock size of age-1 sandeels in 2008.

The TAC for 2007, based on 2007 RTM, was set at a lower level than the stock size in 2007 allowed, because mean weights used for 2007 in the estimation procedure were much lower than the mean weights measured during the 2007 fishery. When estimating the TAC for 2008 it is therefore suggested to adjust the mean weight for age-1 sandeels used in (2) using observed mean weights from the 2008 RTM. This gives the relationship:

(3)

where Wobs is mean weight of age-1 sandeels observed during 2008 RTM and Wm is the mean weight of age-1 sandeels in 2008 used in the short term prediction (Table 4.6.1).

Using this correction of mean weight of age-1 sandeels will reduce the risk of over and underestimating the TAC for 2008 leading to under exploitation or overexploitation of the stock. Relationship (3) is suggested as a harvest control rule for the fishery in 2008.

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

Medium term prognoses can not be made for sandeels.

4.8 Biological reference points

Blim 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 the Stock Quality Handbook no. Q4.

4.9 Quality of the assessment

The tendency in the assessment of underestimating F and overestimation stock size has been important in recent years with a low sandeel stock. When the stock is projected forward in short term prediction these tendencies is even more pronounced (Figure 4.3.2.4). In recent years this bias in the assessment seems to be related to changes in the stock size and distribution pattern of sandeels (section 4.6 and ICES 2006b). The changes in the sandeel stock have subsequently led to a large change in the fishing pattern (section 4.2.1) and fleet structure (section 4.2.5). As a consequence the assumptions about catchabilities of the commercial fleets seem to be violated.

In lack of fisheries independent data for tuning of the assessment the start population and fishing mortalities used in the short term forecast were in last year's assessment adjusted according to the bias estimated from the retrospective analysis. A detailed description of the uncertainties in the assessment and forecast was given in last years WG report, and the method used for bias correction was evaluated by the WG during the 2007 meeting in May (ICES WGNSSK 2007).

In this year's assessment the tendency of underestimating F and overestimating stock size seem to have reduced (Figure 4.3.2.2), although the tendency is still present. This apparent improvement of the quality of this year's assessment concurred with an improvement of the stock situation, with both increasing stock size and a more widespread distribution (section 4.2.1, 4.2.5 and 4.4). This seems to confirm the conclusions in last years WG report that changes in sandeel population size and distribution, and changes in the fishing pattern have introduced bias in the assessment.

In the plot of the historical performance of the assessments (Figure 4.3.2.4) it appears, that last year's adjustment of N's and F's for the short term forecast led to an underestimate of SSB in 2007, although the increase in mean weights observed in 2007 makes up a large portion of the discrepancy between the bias-corrected forecast SSB and the estimate of this years final assessment (20.8%). Further, the harvest rule used in 2007 probably led to an under exploitation of the sandeels stock in 2007.

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. A framework for implementing area based population analysed is presented in ICES (ICES AGSAN 2007a).

The large change in the fleet composition that have all ready taken place, and the likely change that will occur during the next years is expected to increase the uncertainty in the sandeel assessment. It will be most important to develop an approach to include the data from such a changed fleet into the assessment process.

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. This is dependent on the effort used for establishing such time series and coordination of both methodology and effort between European institutes.

4.10 Status of the Stock

Recruitment has been below average since 2002. SSB is estimated to below Bpa from 2001 to 2006. The stock size has increased in the last two years, due to a low fishing mortality. SSB is estimated to above Bpa in 2008. Concurrent with the increase in the stock size some areas with recent low abundance have been repopulated, especially in the northern North Sea. There is an increasing trend in productivity (recruits per spawner) in most recent years.

The probability of SSB being above Bpa in 2009 is not as highly dependent on the size of the incoming year-class (2007 year-class) as was the case in the previous two years. This is mainly due to an increase in the population size of age-2+ sandeel during the last two years.

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 (see the Stock Quality Handbook no. Q4).

The present knowledge on defining subpopulations is too limited to recommend specific management measures for 2008, which can fully take the population structure into account, but work is proceeding on defining local sub-populations so that the scale of "local depletion" can be quantified and be made operational for a North Sea-wide implementation.

Suggestion for management of the sandeel fishery in 2008

1) The aim of management in 2008 should be SSB in 2009 being at least Blim with a high (95%) probability.

2) The total kilowatt-days for the exploratory fishing for sandeel in April and early May 2008 should be set at no more than the total kilowatt-days applied in 2007. This effort may be used for exploratory fishing in April and early May 2008 (the RTM monitoring period). An effort ceiling in the RTM monitoring period corresponding to the effort used in 2007 will give less than 5% probability of SSB in 2009 getting below Blim (WG document no. ** by DIFRES).

3) A TAC for 2008 shall be determined, as early as possible based on advice from ICES and STECF on the size of the 2007 year class of North Sea sandeel in accordance with the follow-ing rules:

   a) where R1,2008 is recruitment at age-1 in 2008, TAC2008 is the catch in 2008 that will result in SSB=Bpa in 2009, Wobs is mean weight of age-1 sandeels observed during 2008 RTM and Wm is the mean weight of age-1 sandeels in 2008 used in the ICES forecast.

   b) If the TAC calculated in point 3a) exceeds 500 000 t the TAC shall be set at 500 000 t

4) The fishery shall be closed 1 August 2007.

The relationship between the TAC and the real-time recruitment estimate is conditional on the assessment of age group 2 and older at the start of 2008 from the final assessment (section 4.4).

The estimate of age group 1 sandeels at the start of 2008 (R1,2008 in 3a above) is to be derived from real-time monitoring in 2008 using a regression between historical CPUE observations and stock numbers at age 1. The regression used in RTM in 2007 have been updated, using

- the methodology described in ICES AGSAN (2007a),
- stock numbers of age-1 sandeels from the final assessment presented here (section 4.4)
- Danish and Norwegian log book data up to and including 2007.

The regression was done on log-transformed data, ($\log(N1) = a + b \cdot \log(CPUE1)$ which gave a more uniform distribution of the residuals. As used in ICES AGSAN (2007a):

- large year classes (1989, 1992, 1995, 1997, 2002) are left out from the analysis, to reduce the tendency of overestimating small year classes,
- years with very high SSB are excluded (1987, 1988, 1993, 1995, 1996, 1998), because the fishery in these years may have been directed more at older fish than at age 1, and
- 1990 is excluded due to poor sampling that year.

The years used in the regression are 1991, 1994, 1999, 2000, 2001, 2003, 2004, 2005 and 2006.

Figure 4.11.1 and Table 4.11.1 show the regression week by week with the year-classes used. The results are close to those of ICES AGSAN (2007a), i.e. using the new assessment results and 2007 logbook data only changed the regression parameters slightly and led to a small improvement of the fit (R-square for week 18 changed from 0.90 to 0.92).

The TAC that is derived according to 3a above is sensitive to decisions on the selection of years included in the regression between CPUE and N1. This selection have been made very carefully in a long process, that probably represents the best possible use of the catch and CPUE data, and are largely on the conservative side.

A proposed time table of when data and model estimates from 2008 RTM will be made available is given in Table 4.11.2. An Ad Hoc Group could work by correspondence, as in 2007, in order to provide an estimate of the 2008 year-class numbers to ICES ACFM by the 8th May 2008 allowing ICES to report by the 15th May.

The final report from the Ad Hoc Group on Sandeel will be submitted to the ICES Share Point on May 8th (at the end of the day).

Risk of local depletion

The increase in stock size and a repopulation of areas with previous low sandeel abundance have reduced the risk of local depletion.

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 and 2007 the Danish fleet increased to 124 and 116 vessels participating in the sandeel fishery. Danish industrial vessels were in 2007 given individual tradable quotas (ITQ) on sandeels. The introduction of ITQ will accelerate the change towards fewer and larger vessels. Also for the Norwegian fleet a drastic decline in number of vessels fishing sandeels has been observed in recent years, with a marked increase again in 2007 when the vessels were given individual quotas.

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Sandeel in IV (WGNSSK Sep. 2007)

Table 4.2.1.1. SANDEEL in IV.

Official landings reported to ICES

SANDEELS IVa

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006
Denmark	23,138	3,388	4,742	1,058	111	399	147	-	N/A
Faroe Islands	11,000	6,582	-	-	-	-	15	-	N/A
Norway	172,887	44,620	11,522	4,121	185	280	64	-	N/A
Sweden	55	495	55	-	-	73	-	-	N/A
UK (E/W/NI)	-	-	-	-	-	-	-	-	N/A
UK (Scotland)	5,742	4,195	4,781	970	543	186	-	-	N/A
Total	212,822	59,280	21,100	6,149	839	938	226	0	

*Preliminary.

SANDEELS IVb

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006
Denmark	603,491	503,572	533,905	638,657	627,097	245,096	273492	129776	N/A
Faroe Islands	-	-			16,167	5,168	3461	-	N/A
Germany	-	-	-	-	-	534	2658	-	N/A
Ireland	-	389	-	-	-	-	-	-	N/A
Norway	170,737	142,969	107,493	183,329	175,799	29,336	48464	17341	N/A
Sweden	8,465	21,920	27,867	47,080	36,842	21,444	34477	8327	N/A
UK (E/W/NI)	-	-	-	-	-	-	-	-	N/A
UK (Scotland)	18,008	7,280	5,978	-	2,442	115	29	-	N/A
Total	800,701	676,130	675,243	869,066	858,347	301,693	362,552	155,444	N/A

*Preliminary.

SANDEELS IVc

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006
Denmark	9,674	10,356	11,993	7,177	4,996	28,646	14,104	22,985	N/A
France	-	-	1	-	-	-	+	-	N/A
Netherlands	+	+	-	-	+	-	-	-	N/A
Norway	-	-	-	-	-	-	139	-	N/A
Sweden	-	-	-	-	-	160	-	-	N/A
UK (E/W/NI)	-	-	+	-	-	+	-	-	N/A
Total	9,674	10,356	11,994	7,177	4,996	28,806	14,243	22,985	N/A

*Preliminary.

Summary table official landings

	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total IV tonnes	1,023,197	745,766	708,337	882,392	864,182	331,437	377,021	178,429	N/A
TAC	1,000,000	1,000,000	1,020,000	1,020,000	1,020,000	918,000	826,200	660,960	300,000

By-catch and other landings

	1998	1999	2000	2001	2002	2003	2004	2005	2006
Area IV tonnes: official-WG	18,797	10,628	9,188	20,781	53,482	5,817	15,521	6,329	N/A

Summary table - landing data provided by Working Group members

	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total IV - tonnes	1,004,400	735,138	699,149	861,611	810,700	325,620	361,500	172,100	287,900

Table 4.2.1.2. SANDEEL in IV.

Landings ('000 t), 1952-2006 (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	250.6	3.2	-	-	-	5.6	27.8	-	287.9
2007	144.6	1.0	2.0	-	-	51.1	6.6	1.0	206.3

2007 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
2000												
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												
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		88		6258
May	34506	57		9536	7512		6507	13333	32	2410		73893
Jun	19216	21		8952	2545		8107	8224	19370	21959		88394
Jul				1668			987	922				3577
Aug				3			2					5
Sep												0
Okt										1		1
Total	57739	78	0	20230	11533	0	16065	22623	19402	24457	0	172128
2006												
Apr	10141			8733	1387		188	111		82		20642
May	96349			25020	3096		3830	201		6455		134951
Jun	59827	34		3184	47		4815	12035	5236	9506		94684
Jul	1122			94			3309	2600	1171	11745		20041
Aug				2			94			283		379
Sep				5			2			2		9
Oct					5		257					262
Nov		30										30
Total	167439	64	0	37038	4530	0	12495	14947	6407	28073	0	270998
%	62%	0%	0%	14%	2%	0%	5%	6%	2%	10%	0%	100%
Average 2000-2006												
	38%	2%	0%	20%	15%	0%	10%	5%	2%	8%	0%	100%
2007												
Apr	23545			6378	19966		7098	646		406		58039
May	65238	308	4	4990	31062		22979	3024	244	1470		129319
Jun	501	69		50	4512		4032	25	559	2966		12714
Total	89284	377	4	11418	55540	0	34109	3695	803	4842	0	200072
%	45%	0%	0%	6%	28%	0%	17%	2%	0%	2%	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
2006	184.4	0.1		37.0	4.5		12.5	14.9	6.4	28.1		17.1	270.8

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
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
	Jul	20,042			20,042
	Aug	379			379
	Sep	9			9
	Oct	266			266
	Nov	30			30
	Total	250,616	5,585	678	256,879
2007	Apr	46,817	11,222		58,039
	May	89,057	35,976		125,033
	Jun	8,775	3,938		12,713
	Total	144,649	51,136	1,000	196,785

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

Year	2007
Season	1
AGE	
0	*
1	8494.
2	778.
3	134.
4+	40.
SOP	91249.

Fishery in the southern North Sea

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

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

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

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

Year	2007
Season	1
AGE	
0	*
1	9301.
2	4871.
3	365.
4+	129.
SOP	114122.

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	11.99	6.99		7.92	11.99
	2	13.79	17.62	15.28		14.42	17.62
	3	26.02	27.45	24.23		25.47	27.45
	4	16.30	16.30			16.30	16.30
	5	31.00	31.00			31.00	
	5+						
	6						
	4++	30.95	30.94	23.00		30.61	30.94
2007	0	1.00		1.74		1.74	
	1	7.50		10.72		8.60	
	2	15.97		16.81		16.68	
	3	21.10		26.95		26.48	
	4	30.93				30.93	
	5						
	5+						
	6						
	4++	30.93		41.93			41.62

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	9.17	-
	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	8.97
	2	10.66	9.69
	3	12.83	13.30
	4	14.09	16.30
	5	15.35	-
	6	16.06	-
	7		-
	8+		-
	4++	15.15	16.30
2007	0	1.40	-
	1	5.91	-
	2	10.60	-
	3	14.90	-
	4	16.08	-
	5	16.73	-
	6	16.37	-
	7		-
	8+		-
	4++	16.18	-

Table 4.2.3.3. SANDEEL in IV.

Mean weight (g) in the catch by half year.

Northern North Sea, first half-year

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

Northern North Sea, second half-year

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

Southern North Sea, first half-year

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

Southern North Sea, second half-year

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

Table 4.2.3.4. SANDEEL in IV.

Mean weight (g) in the stock by half year.

First half-year

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

Second half-year

Year	age-0	age-1	age-2	age-3	age-4+
1983	1.11	11.83	14.73	19.14	24.35
1984	1.19	10.58	16.58	19.54	21.90
1985	1.19	10.69	14.65	22.49	24.95
1986	1.72	10.64	14.75	17.96	30.44
1987	1.43	11.18	14.29	17.26	20.91
1988	1.44	10.81	18.07	17.19	20.61
1989	1.28	10.76	15.80	17.05	19.39
1990	1.36	10.72	15.51	19.37	19.95
1991	1.10	10.67	15.49	18.02	19.39
1992	1.54	10.57	14.85	18.67	20.44
1993	1.44	10.91	14.25	17.61	20.49
1994	6.58	10.95	27.46	45.24	31.15
1995	5.08	10.14	13.66	17.96	21.19
1996	2.90	10.33	16.13	20.52	32.88
1997	1.94	8.04	11.70	15.27	18.86
1998	2.49	3.84	12.03	13.92	17.11
1999	3.15	8.29	10.49	17.14	15.68
2000	1.66	7.56	14.29	15.96	18.87
2001	2.67	9.56	17.42	9.07	17.22
2002	2.49	8.29	12.60	14.06	17.22
2003	3.07	8.10	16.30	17.30	13.80
2004	3.13	9.00	13.46	13.51	12.97
2005	3.13	9.00	13.46	13.51	12.97
2006	3.11	9.31	13.61	17.59	28.91

Table 4.2.3.5. SANDEEL in IV.

Correlation coefficient between mean weight-at-age observed for each age in the December dredge survey and that observed in the catch in the following spring.

Age in December	r^2 in following spring		
	April	May	June
0	0.496	0.747	0.673
1	0.456	0.294	0.204
2	0.585	0.342	0.826

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 in the sandeel fishery by year. In 2006 only experimental fishing was allowed for 6 Norwegian vessels. In 2007 the fishery was stopped in May due to RTM.

	Denmark		Norway
Year	**Kilo watt days (thousands)**	**Number of vessels**	**Number of vessels**
2002	7,867	207	53
2003	7,306	171	35
2004	7,334	200	40
2005	3,390	98	22
2006	3,946	124	6
2007	2,316	116	41

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.

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

- No data   * Added to first half year

Table 4.2.5.3. SANDEEL in IV.

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

	First half year			Second half year		
Year	CPUE (t/day)	Total Int'l catch ('000 t)	Total int'l effort ('000 days)	CPUE (t/day)	Total Int'l catch ('000 t)	Total int'l effort ('000 days)
1982	48.2	427	8.85	35.7	53	1.47
1983	42.8	360	8.41	33.9	59	1.75
1984	50.5	461	9.13	32.9	71	2.16
1985	41.9	417	9.95	33.6	111	3.29
1986	53.7	386	7.20	44.1	76	1.71
1987	57.4	298	5.19	37.1	105	2.83
1988	46.7	462	9.89	30.2	33	1.11
1989	43.8	506	11.54	29.5	19	0.63
1990	31.0	342	11.03	35.6	24	0.67
1991	47.0	327	6.95	46.6	132	2.84
1992	54.9	621	11.31	36.2	73	2.02
1993	38.6	268	6.94	32.0	34	1.07
1994	53.4	226	4.24	48.9	48	0.97
1995	56.8	429	7.56	52.0	68	1.30
1996	41.6	294	7.05	50.1	139	2.77
1997	64.2	421	6.55	41.1	138	3.36
1998	46.6	448	9.61	26.2	43	1.64
1999	40.9	432	10.56	31.9	36	1.13
2000	43.1	360	8.36	33.4	53	1.59
2001	38.7	433	11.20	46.4	185	3.98
2002	62.2	609	9.79	22.4	19	0.86
2003	22.6	211	9.33	20.5	31	1.53
2004	25.2	250	9.91	23.5	31	1.32
2005	27.9	145	5.18	*	*	*
2006	39.0	254	6.50	30.3	17	0.56
2007	45.6	114	2.51			

* 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	8.43	2453	9855	25922	1319	26
1989	1	1	12.43	6124	56661	2219	3385	0
1990	1	1	5.95	0	13101	3907	578	175
1991	1	1	7.26	0	41855	2342	908	318
1992	1	1	4.07	137	9871	4056	486	305
1993	1	1	5.04	1112	15768	2635	1023	646
1994	1	1	7.69	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
2007	1	2	1.52	469.7	8494.4	778	133.8	40.3
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	6.96	0	3581	14659	3707	1012
1994	1	3	4.25	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	6.56	0	52358.7	3647.9	2404.6	683.3
1998	1	3	9.62	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	10.57	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	5.18	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
2007	1	4	2.51	144.8	9300.6	4871	364.9	128.9
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
2006	2	5	0.12	0	229.6	36.9	8.8	1.9
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	1.32	2382.7	1637.4	472.9	405	68
2005	2	6	0	0	0	0	0	0
2006	2	6	0.56	0	1826.5	37.7	20.3	0.3

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 99-07
Fleet:  3: Southern First Half 82-98
Fleet:  4: Southern First Half 99-07
Fleet:  5: Northern Secon Half 76-06
Fleet:  6: Southern Secon Half 82-06
```

The following values was used:

```
 1: First VPA year                 1983
 2: Last VPA year                  2007
 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                  6
```

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	0.173	0.071	0.135	0.005	0.786	0.036
3	0.034	0.015	0.012	0.012	0.118	0.024	0.046	0.000	0.088	0.000	0.066	0.020
4+	0.051	0.000	0.008	0.000	0.222	0.010	0.000	0.000	0.053	0.000	0.014	0.118
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	0.198	0.015
2	0.169	0.041	0.169	0.042	0.161	0.005	0.145	0.000	0.057	0.004	0.352	0.116
3	0.710	0.000	0.167	0.041	0.190	0.003	0.137	0.000	0.118	0.008	0.388	0.053
4+	0.000	0.000	0.199	0.059	0.450	0.015	0.192	0.000	0.545	0.151	1.162	0.208
F (1- 2)	0.263	0.064	0.169	0.050	0.219	0.011	0.098	0.000	0.127	0.017	0.275	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	0.306	0.038	0.205	0.067	0.546	0.015
3	0.183	0.008	0.072	0.030	0.376	0.004	0.258	0.022	0.197	0.005	0.324	0.014
4+	0.030	0.001	0.083	0.035	0.403	0.001	0.086	0.000	0.299	0.000	0.227	0.018
F (1- 2)	0.131	0.028	0.115	0.055	0.143	0.050	0.192	0.164	0.115	0.045	0.384	0.015

Year	2001		2002		2003		2004		2005		2006	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.085	*	0.000	*	0.040	*	0.029	*	0.000	*	0.000
1	0.059	0.023	0.143	0.004	0.121	0.017	0.117	0.042	0.075	0.000	0.016	0.007
2	0.157	0.015	0.140	0.001	0.055	0.016	0.132	0.004	0.050	0.000	0.017	0.009
3	0.148	0.083	0.142	0.000	0.096	0.000	0.072	0.007	0.081	0.000	0.007	0.007
4+	4.496	*	0.232	0.000	*	*	0.208	0.000	0.038	0.000	0.002	0.003
F (1- 2)	0.108	0.019	0.142	0.002	0.088	0.016	0.124	0.023	0.062	0.000	0.016	0.008

Year	2007
Season	1
AGE	
0	*
1	0.079
2	0.034
3	0.047
4+	0.030
F (1- 2)	0.057

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	0.046	0.000
2	0.600	0.105	0.109	0.007	1.040	0.366	0.487	0.044	0.283	0.158	0.305	0.025
3	0.355	0.404	1.053	0.164	0.294	0.601	0.365	0.101	0.290	0.088	0.893	0.354
4+	1.654	0.471	0.824	0.228	0.123	0.261	0.012	0.010	0.056	0.025	1.541	0.472
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	0.025	0.723	0.058	0.633	0.059	0.358	0.026	0.318	0.036	0.126	0.031
3	0.201	0.020	0.714	0.057	0.276	0.043	0.283	0.082	0.428	0.062	0.173	0.026
4+	1.625	1.296	0.848	0.082	0.642	0.000	0.390	0.044	0.853	0.596	0.386	1.151
F (1- 2)	0.312	0.030	0.491	0.054	0.383	0.138	0.338	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	0.390	0.007	0.346	0.111
2	0.189	0.138	0.310	0.154	0.150	0.037	0.364	0.055	0.382	0.007	0.370	0.089
3	0.261	0.097	0.607	0.118	0.172	0.058	0.403	0.059	0.508	0.127	0.416	0.195
4+	0.257	0.055	0.322	0.655	0.228	0.099	0.472	0.027	0.277	0.102	0.546	0.129
F (1- 2)	0.186	0.088	0.211	0.103	0.128	0.056	0.238	0.038	0.386	0.007	0.358	0.100

Year	2001		2002		2003		2004		2005		2006	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.135	*	0.000	*	0.028	*	0.023	*	0.000	*	0.000
1	0.583	0.025	0.560	0.032	0.261	0.131	0.581	0.104	0.465	0.000	0.368	0.052
2	0.884	0.003	0.459	0.052	0.661	0.044	0.271	0.223	0.629	0.000	0.380	0.009
3	0.363	0.000	0.374	0.000	0.760	0.093	0.822	0.232	0.259	0.000	0.439	0.016
4+	10.383	*	0.265	0.000	*	*	0.264	0.129	0.342	0.000	0.244	0.000
F (1- 2)	0.733	0.014	0.510	0.042	0.461	0.087	0.426	0.164	0.547	0.000	0.374	0.031

Year	2007
Season	1
AGE	
0	*
1	0.087
2	0.216
3	0.127
4+	0.096
F (1- 2)	0.151

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	0.772	4.169	0.466
1984	0.000	0.455	0.219	1.356	1.167	0.337
1985	0.015	0.231	1.602	0.968	0.604	0.917
1986	0.017	0.290	0.829	0.536	0.021	0.559
1987	0.005	0.278	0.595	0.487	0.140	0.436
1988	0.027	0.291	1.296	1.387	2.956	0.794
1989	0.015	0.775	0.622	1.046	4.083	0.699
1990	0.029	0.533	1.089	1.073	1.406	0.811
1991	0.047	0.586	0.943	0.553	1.370	0.764
1992	0.032	0.435	0.579	0.532	0.694	0.507
1993	0.067	0.298	0.447	0.664	2.629	0.372
1994	0.001	0.456	0.649	0.688	3.853	0.552
1995	0.017	0.425	0.441	0.578	0.363	0.433
1996	0.026	0.314	0.638	0.880	1.039	0.476
1997	0.012	0.342	0.395	0.658	0.801	0.369
1998	0.144	0.384	0.824	0.803	0.652	0.604
1999	0.107	0.472	0.713	0.896	0.736	0.593
2000	0.020	0.699	1.120	0.999	1.021	0.910
2001	0.222	0.737	1.201	0.633	0.000	0.969
2002	0.000	0.800	0.710	0.571	0.557	0.755
2003	0.068	0.505	0.851	1.040	0.000	0.678
2004	0.052	0.859	0.631	1.202	0.634	0.745
2005	0.000	0.594	0.758	0.374	0.422	0.676
2006	0.000	0.455	0.453	0.511	0.274	0.454
2007	0.000	0.167	0.252	0.174	0.127	0.210

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	*	880841.	*	227326.	*	1206501.	*	624178.	*	199718.	*	718807.
1	105529.	34021.	384252.	96348.	102144.	31221.	533878.	155424.	275624.	82844.	89235.	25425.
2	90721.	31138.	27362.	15145.	69265.	11558.	23748.	7786.	116006.	50230.	59808.	10619.
3	3754.	1679.	22669.	4205.	12208.	5324.	6325.	2763.	5682.	2574.	34916.	7658.
4+	498.	6.	896.	235.	3034.	1424.	3143.	2082.	3732.	2240.	3718.	204.
SSN	94974.		50927.		84507.		33216.		125420.		98441.	
SSB	1245261.		765753.		1181794.		501663.		1657336.		1510835.	
TSN	200503.	947685.	435179.	343259.	186651.	1256028.	567094.	792233.	401043.	337607.	187676.	762714.
TSB	1776070.	1871141.	2341186.	1628297.	1609778.	2094080.	2733274.	2955145.	2952767.	2020848.	1903466.	1637664.

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	325614.	*	636356.	*	805763.	*	319095.	*	622823.	*	872257.
1	314135.	54241.	144041.	32805.	277418.	64504.	344805.	84263.	138732.	39301.	261219.	63837.
2	19656.	7654.	39290.	9490.	24046.	6649.	41703.	16429.	65414.	29689.	30330.	12291.
3	8175.	1925.	5869.	1441.	7028.	2887.	5107.	2205.	13103.	4910.	23344.	8600.
4+	4366.	169.	1571.	300.	1283.	228.	2440.	877.	2351.	218.	3829.	216.
SSN	32197.		46731.		32357.		49250.		80867.		57503.	
SSB	505034.		656457.		463509.		684399.		1095543.		805977.	
TSN	346332.	389603.	190772.	680392.	309775.	880031.	394055.	422869.	219600.	696942.	318722.	957202.
TSB	1887230.	1157451.	1270074.	1398202.	1653630.	1734036.	2091203.	1685142.	1719839.	1839654.	2441207.	7171801.

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	358741.	*	1935600.	*	328464.	*	389939.	*	496073.	*	494502.
1	391624.	98081.	158481.	45129.	846994.	239174.	145826.	43813.	150837.	34826.	199456.	37894.
2	47812.	23889.	74385.	32341.	33568.	16534.	171765.	55559.	26150.	9350.	27702.	6466.
3	8676.	3649.	16730.	5349.	21183.	7929.	12480.	4086.	41408.	12826.	7105.	2105.
4+	6534.	3258.	5210.	2289.	4669.	1583.	7273.	2689.	5226.	1891.	10587.	3005.
SSN	63023.		96324.		59421.		191518.		72785.		45394.	
SSB	1047247.		1095939.		667111.		1735847.		902891.		512194.	
TSN	454647.	487619.	254805.	2020708.	906414.	593684.	337344.	496086.	223622.	554967.	244850.	543972.
TSB	3839527.	3277852.	2165684.	6786092.	5435685.	2904566.	2466436.	1910455.	1746069.	2198920.	1788711.	1290058.

Year	2001		2002		2003		2004		2005		2006	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	860079.	*	77203.	*	280902.	*	153366.	*	366148.	*	401011.
1	217730.	37327.	306135.	47979.	34689.	8336.	117617.	18566.	65330.	12878.	164521.	39500.
2	27344.	5280.	29122.	10256.	37900.	11574.	5884.	2590.	13125.	4201.	10544.	4675.
3	4770.	1863.	4243.	1648.	7964.	2024.	8919.	2149.	1684.	794.	3439.	1445.
4+	3516.	0.	1403.	557.	1805.	0.	1509.	616.	1825.	824.	1325.	690.
SSN	35629.		34769.		47669.		16312.		16635.		15308.	
SSB	350539.		354277.		426317.		192214.		169965.		179172.	
TSN	253360.	904549.	340904.	137643.	82358.	302835.	133929.	177287.	81965.	384846.	179829.	447320.
TSB	1310730.	2762130.	2233948.	751965.	608783.	1153556.	853225.	719010.	549532.	1339911.	1209074.	1723866.

Year	2007
Season	1
AGE	
0	*
1	180186.
2	30479.
3	3760.
4+	1719.
SSN	35958.
SSB	454648.
TSN	216144.
TSB	1750185.

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 99-07

	Log inverse q		q	
Season	1	2	1	2
Age				
0	*	*	*	*
1	3.283	*	0.0375	*
2	2.974	*	0.0511	*
3	2.974	*	0.0511	*

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 99-07

	Log inverse q		q	
Season	1	2	1	2
Age				
0	*	*	*	*
1	3.030	*	0.0483	*
2	2.880	*	0.0561	*
3	2.880	*	0.0561	*

Fleet 5: Northern North Sea 83-06

	Log inverse q		q	
Season	1	2	1	2
Age				
0	*	4.572	*	0.0103
1	*	4.138	*	0.0160
2	*	4.648	*	0.0096
3	*	4.648	*	0.0096

Fleet 6: Southern North Sea 83-06

	Log inverse q		q	
Season	1	2	1	2
Age				
0	*	6.261	*	0.0019
1	*	3.562	*	0.0284
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	TSB tonnes	SSB tonnes	Landings tonnes	Yield/SSB	Mean F Ages 1-2
1983	880841	1776070	1245261	530640	0.426	0.466
1984	227326	2341186	765753	750040	0.979	0.337
1985	1206501	1609778	1181794	707105	0.598	0.917
1986	624178	2733274	501663	685950	1.367	0.559
1987	199718	2952767	1657336	791050	0.477	0.436
1988	718807	1903466	1510835	1007304	0.667	0.794
1989	325614	1887230	505034	826835	1.637	0.699
1990	636356	1270074	656457	584912	0.891	0.811
1991	805763	1653630	463509	898959	1.939	0.764
1992	319095	2091203	684399	820140	1.198	0.507
1993	622823	1719839	1095543	576932	0.527	0.372
1994	872257	2441207	805977	770747	0.956	0.552
1995	358741	3839527	1047247	915043	0.874	0.433
1996	1935600	2165684	1095939	776126	0.708	0.476
1997	328464	5435685	667111	1114044	1.670	0.369
1998	389939	2466436	1735847	1000375	0.576	0.604
1999	496073	1746069	902891	718668	0.796	0.593
2000	494502	1788711	512194	692498	1.352	0.910
2001	860079	1310730	350539	858619	2.449	0.969
2002	77203	2233948	354277	806921	2.278	0.755
2003	280902	608783	426317	309725	0.727	0.678
2004	153366	853225	192214	359361	1.870	0.745
2005	366148	549532	169965	171790	1.011	0.676
2006	401011	1209074	179172	266751	1.489	0.454
2007		1750185	454648	205371	0.452	0.210
2008			681000*			
Average	565888		763189	685836	1.117	0.603
Units	(Millions)		(Tonnes)	(Tonnes)		

*Forecast

Table 4.6.1. SANDEEL in IV.

Data used for short term forecast.

Input in the assesment year

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2007	1	0	0	0.0000	0.0000	0.0000	0.0	0
2007	1	1	180186	0.1660	0.0072	0.0072	1.0	0
2007	1	2	30479	0.2500	0.0114	0.0114	0.4	1
2007	1	3	3760	0.1740	0.0180	0.0180	0.4	1
2007	1	4	1719	0.1260	0.0223	0.0223	0.4	1
2007	2	0	323984	0.0000	0.0031	0.0031	0.8	0
2007	2	1	0	0.0000	0.0091	0.0091	0.2	0
2007	2	2	0	0.0000	0.0135	0.0135	0.2	1
2007	2	3	0	0.0000	0.0149	0.0149	0.2	1
2007	2	4	0	0.0000	0.0183	0.0183	0.2	1

Input for forecast Year and forward

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2008	1	0	0	0.0000	0.0000	0.0000	0.0	0
2008	1	1	0	0.1660	0.0059	0.0059	1.0	0
2008	1	2	0	0.2500	0.0099	0.0099	0.4	1
2008	1	3	0	0.1740	0.0137	0.0137	0.4	1
2008	1	4	0	0.1260	0.0186	0.0186	0.4	1
2008	2	0	323984	0.0000	0.0031	0.0031	0.8	0
2008	2	1	0	0.0000	0.0091	0.0091	0.2	0
2008	2	2	0	0.0000	0.0135	0.0135	0.2	1
2008	2	3	0	0.0000	0.0149	0.0149	0.2	1
2008	2	4	0	0.0000	0.0183	0.0183	0.2	1

Table 4.11.1. SANDEEL in IV.

Result of the VPA 1-group vs CPUE 1-group regression. VPA estimates in billions, CPUE estimates in millions.

Week no.	Intercept	Slope	Adj Rsq
12	4.65	0.41	0.95
13	3.80	0.79	0.85
14	4.23	0.63	0.88
15	4.33	0.59	0.93
16	4.25	0.59	0.90
17	4.12	0.60	0.89
18	4.05	0.68	0.92
19	3.91	0.76	0.95
20	3.92	0.72	0.93
21	3.90	0.72	0.88
22	3.89	0.72	0.88
23	3.93	0.72	0.88
24	3.99	0.70	0.86
25	4.07	0.65	0.83
26	4.09	0.65	0.81

Table 4.11.2. SANDEEL in IV.

Time table for the real time monitoring of the sandeel fishery 2008.

Month	Week	Day		Collection of samples	Data deadline	Report deadline	Comment
April	14	1	Tuesday				**Start of monitoring fishery**
		2	Wednsday				
		3	Thursday				
		4	Friday				
		5	Saturday				
		6	Sunday				
	15	7	Monday				
		8	Tuesday	From landing week 14			
		9	Wednsday				
		10	Thursday				
		11	Friday				
		12	Saturday				
		13	Sunday				
	16	14	Monday				
		15	Tuesday	From landing week 15	Up to and incl. week 14 (bio) and week 15 (log book)		
		16	Wednsday				
		17	Thursday			1st Report	
		18	Friday				
		19	Saturday				
		20	Sunday				
	17	21	Monday				
		22	Tuesday	From landing week 16	Up to and incl. week 15 (bio) and week 16 (log book)		
		23	Wednsday			2nd Report	
		24	Thursday				
		25	Friday				
		26	Saturday				
		27	Sunday				
	18	28	Monday				
		29	Tuesday	From landing week 17	Up to and incl. week 16 (bio) and week 17 (log book)		
		30	Wednsday			3rd Report	
May		1	Thursday				*Ascension Day*
		2	Friday				
		3	Saturday				
		4	Sunday				**End of monitoring period**
	19	5	Monday				
		6	Tuesday	From landing week 18	Up to and incl. week 17 (bio) and week 18 (log book)		
		7	Wednsday				
		8	Thursday			Final Report	
		9	Friday				
		10	Saturday				
		11	Sunday				*Whitsunday*
	20	12	Monday				*Whit Monday*
		13	Tuesday	From landing week 19			
		14	Wednsday				
		15	Thursday				ACFM/STECF advice
		16	Friday				

Danish sandeel sampling areas.

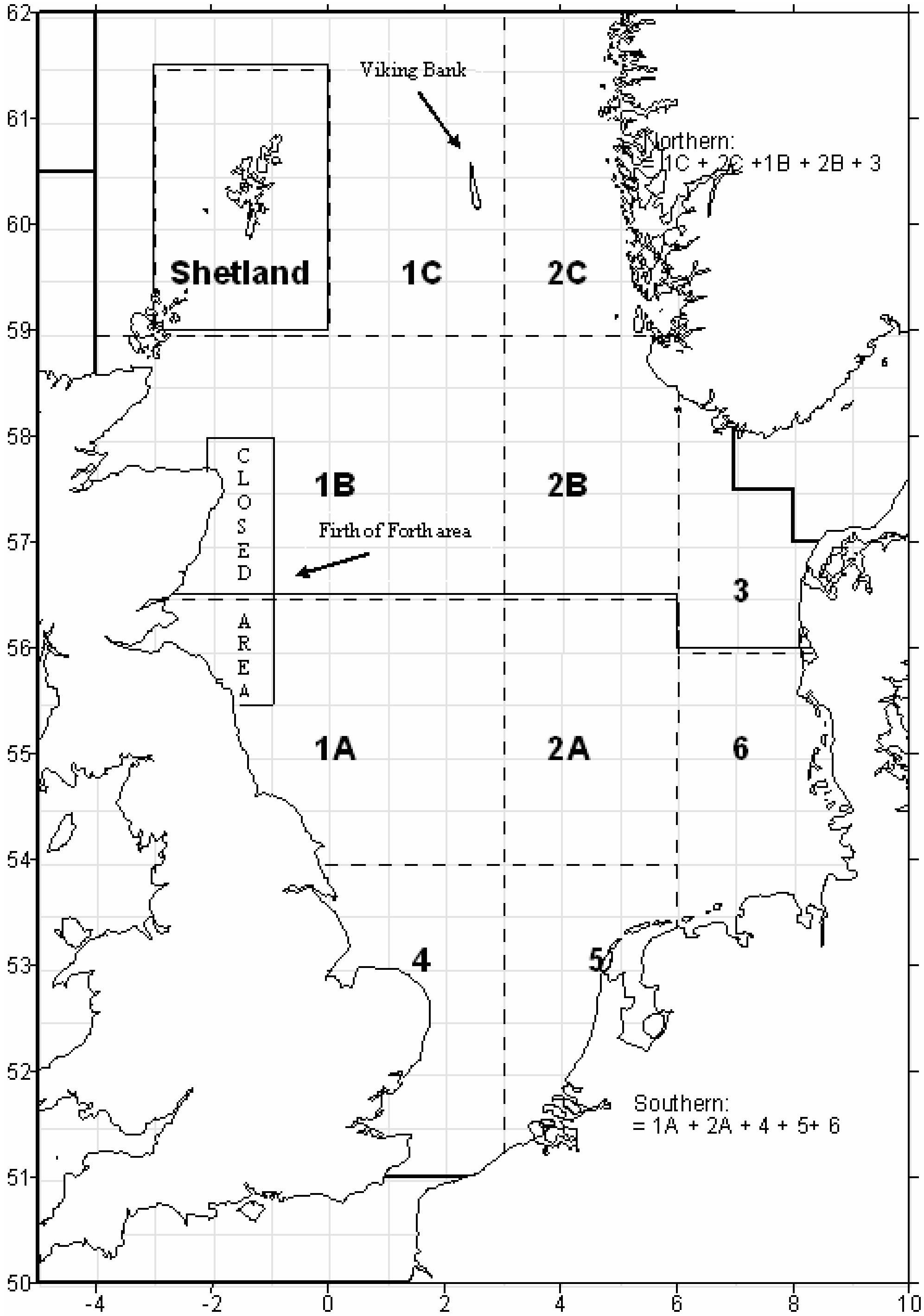


Figure 4.1.2.1. SANDEEL in IV.

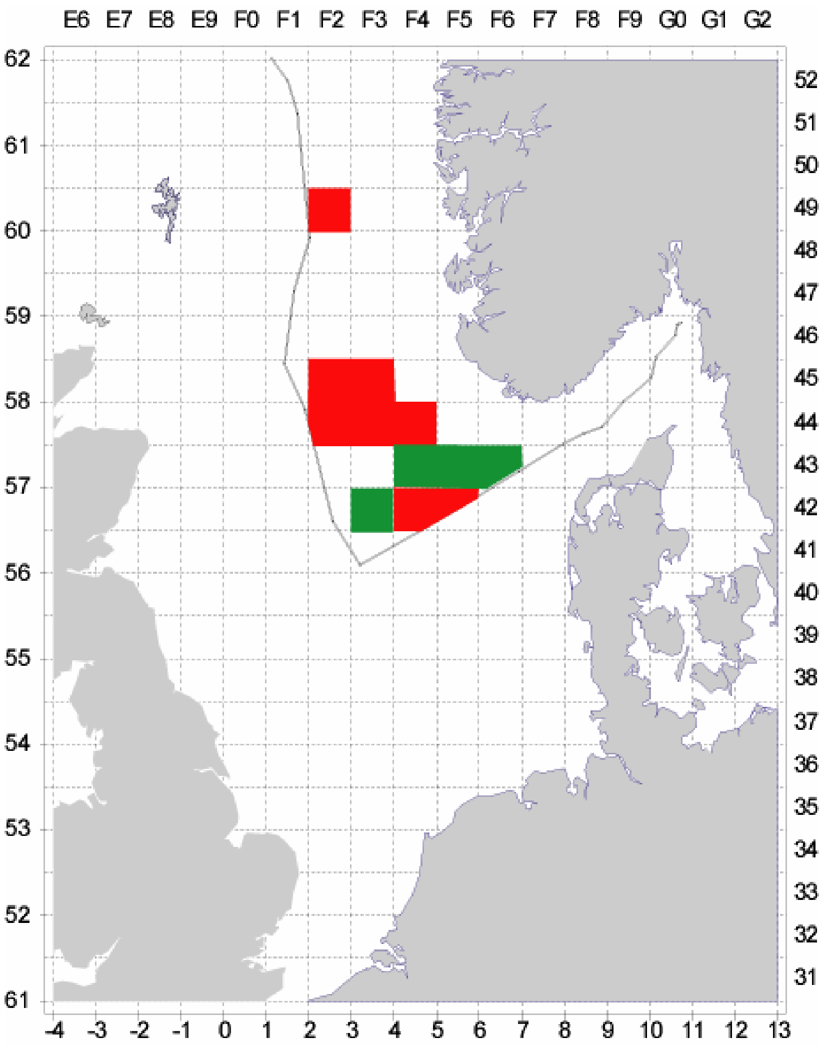


Figure 4.1.4.1. SANDEEL in IV.

Closed (red) and open (green) areas in the Norwegian EEZ during the post-monitoring fishery between mid-May and mid-June 2007. White areas do not have significant sandeel fishing grounds..

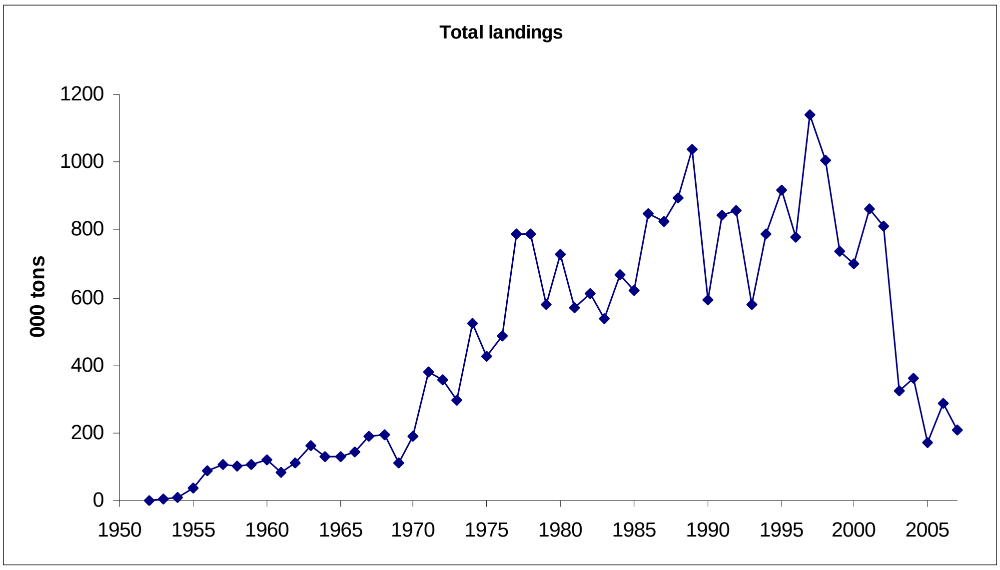


Figure 4.2.1.1. SANDEEL in IV.

Total international landings..

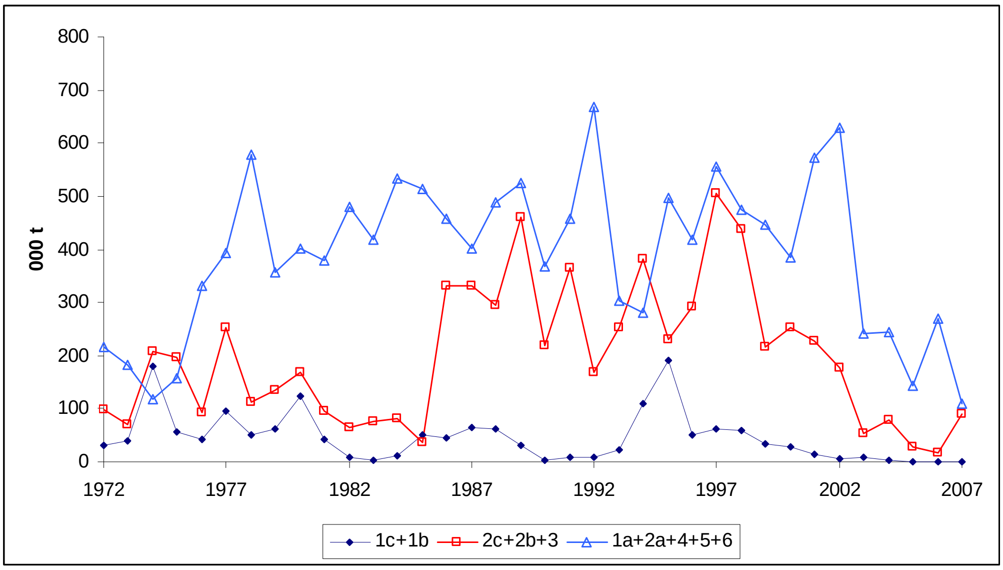
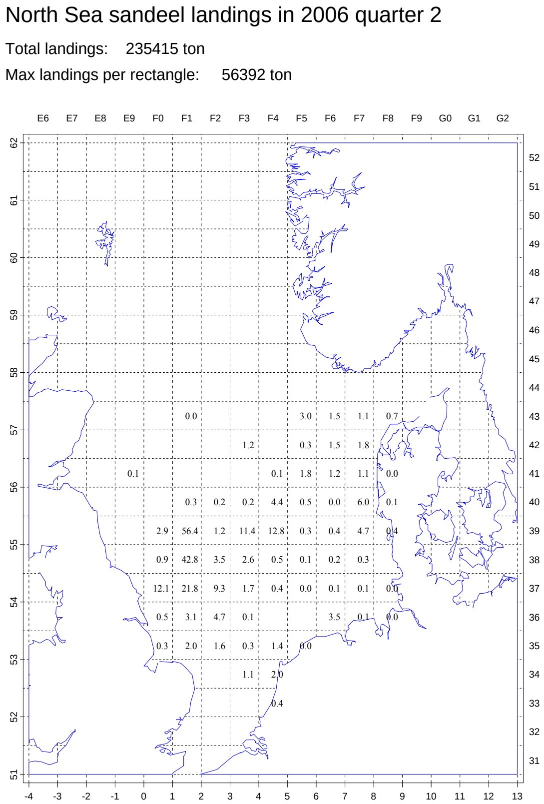


Figure 4.2.1.2. SANDEEL in IV.

Total international landings by three areas (see Figure 4.1.2.1): 1B+1C (north-western North Sea), 2B+2C+3 (north-eastern North Sea) and 1A+2A+4+5+6 (Southern North Sea).

Quarterly catches of sandeels by Denmark and Norway in 2006 and 2007 by ICES rectangle (‘000 tonnes).



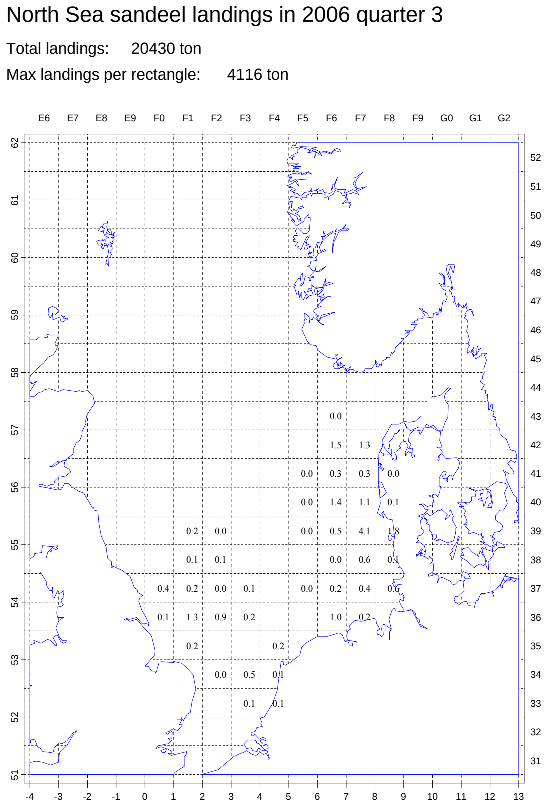
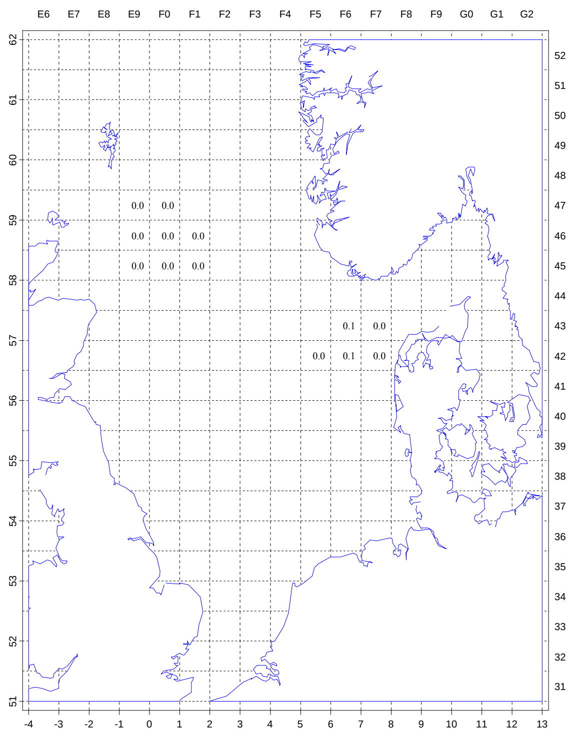


Figure 4.2.1.3. SANDEEL in IV.

North Sea sandeel landings in 2006 quarter 4

Total landings: 296 ton

Max landings per rectangle: 144 ton



North Sea sandeel landings in 2007 quarter 2

Total landings: 195782 ton

Max landings per rectangle: 33518 ton

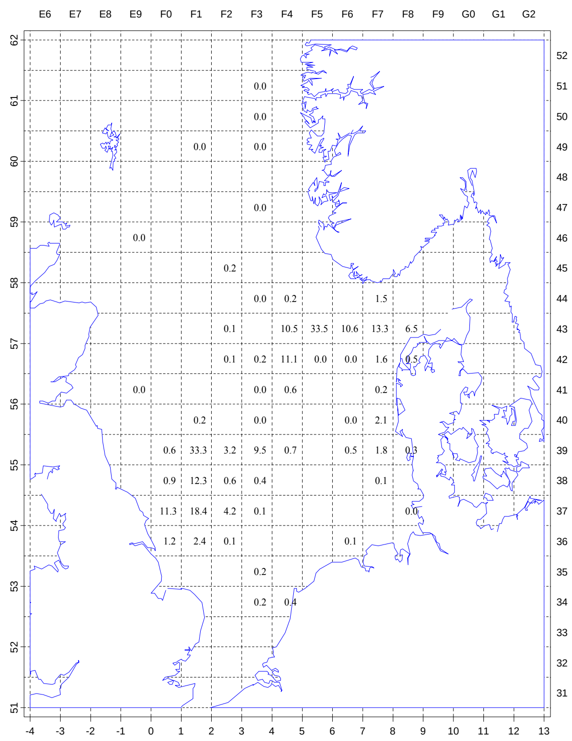


Figure 4.2.1.3. SANDEEL in IV. Continued.

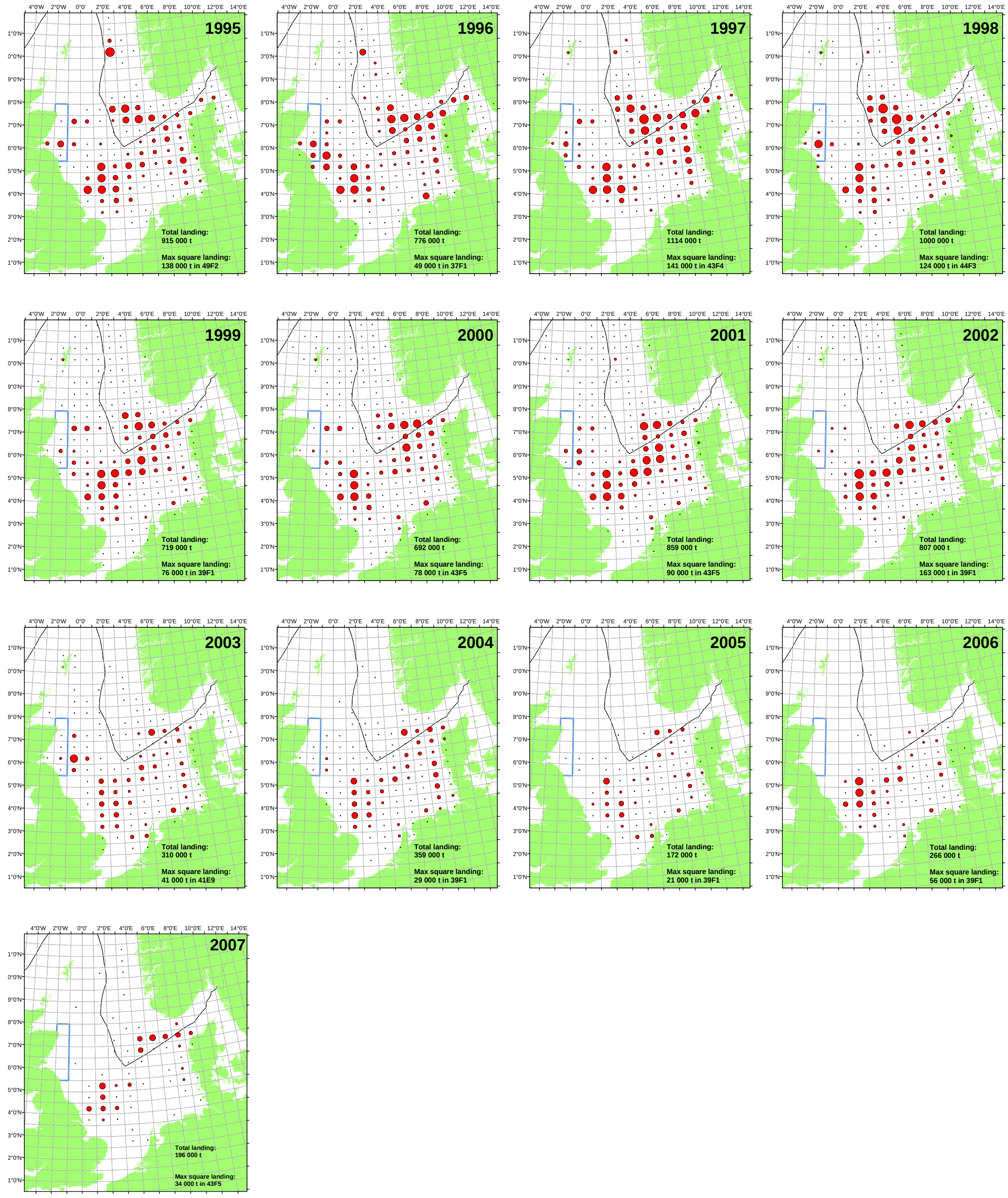
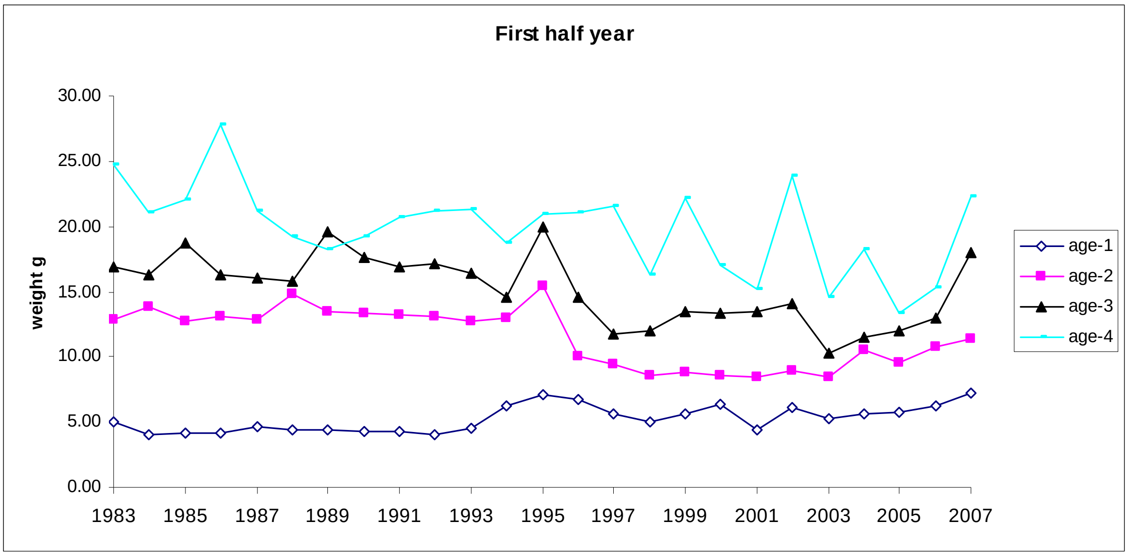


Figure 4.2.1.4. SANDEEL in IV.

Landings of Sandeel by year and ICES rectangles for the period 1995-2007. 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.



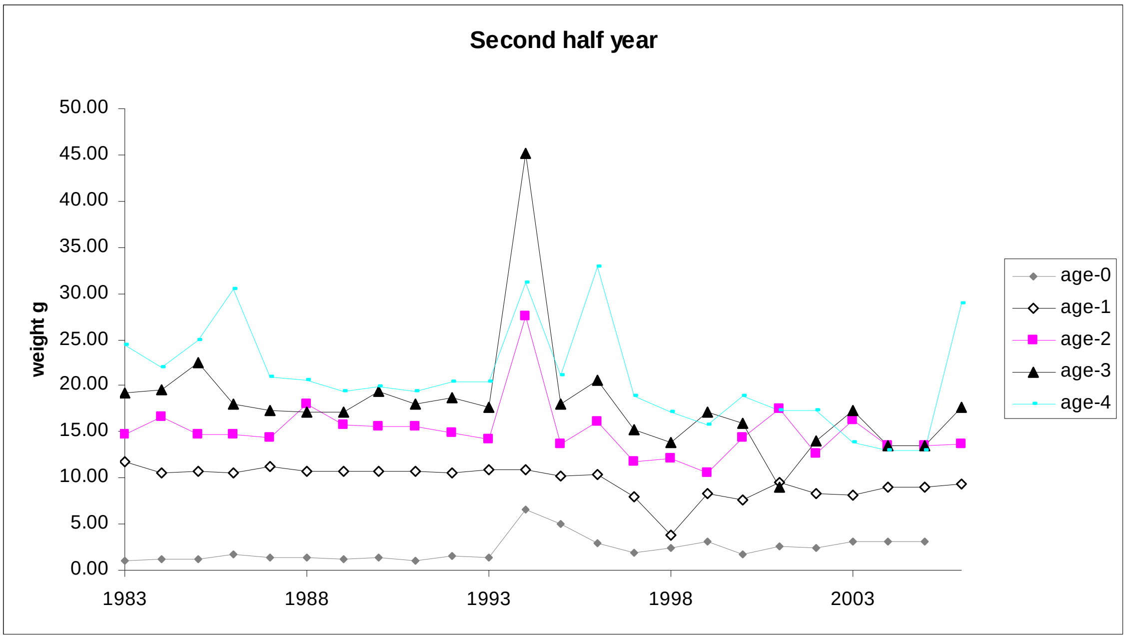


Figure 4.2.3.2 SANDEEL in IV.

Mean weight at age in the stock by half year.

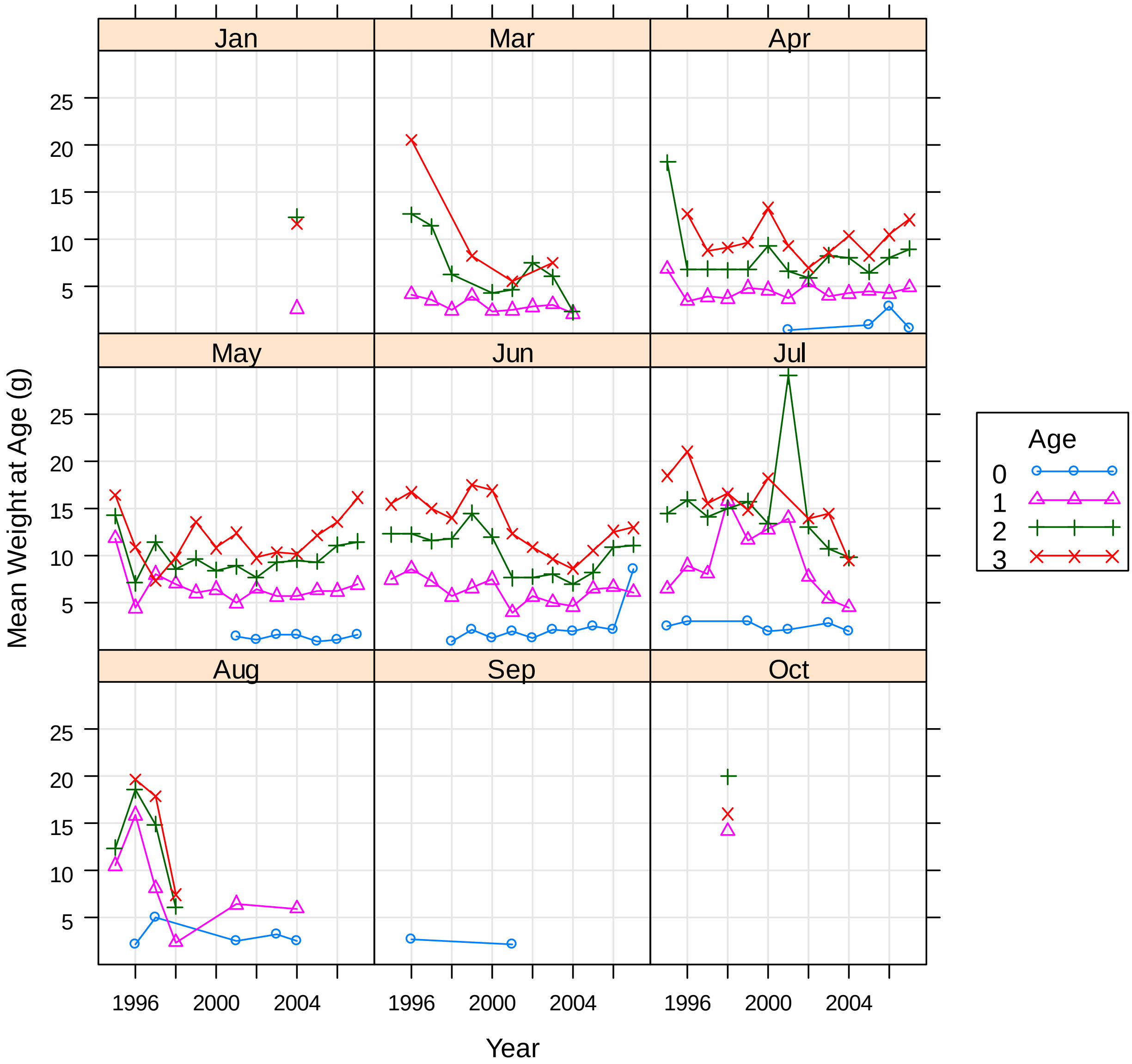


Figure 4.2.3.3 SANDEEL in IV.

Mean weight-at-age in a given month for the period 1995-2007 for sandeel in the southern North Sea. Uncertainties in the mean weight at age are generally of a similar scale to the points used to the plot the data, and have not been plotted for reasons of clarity.

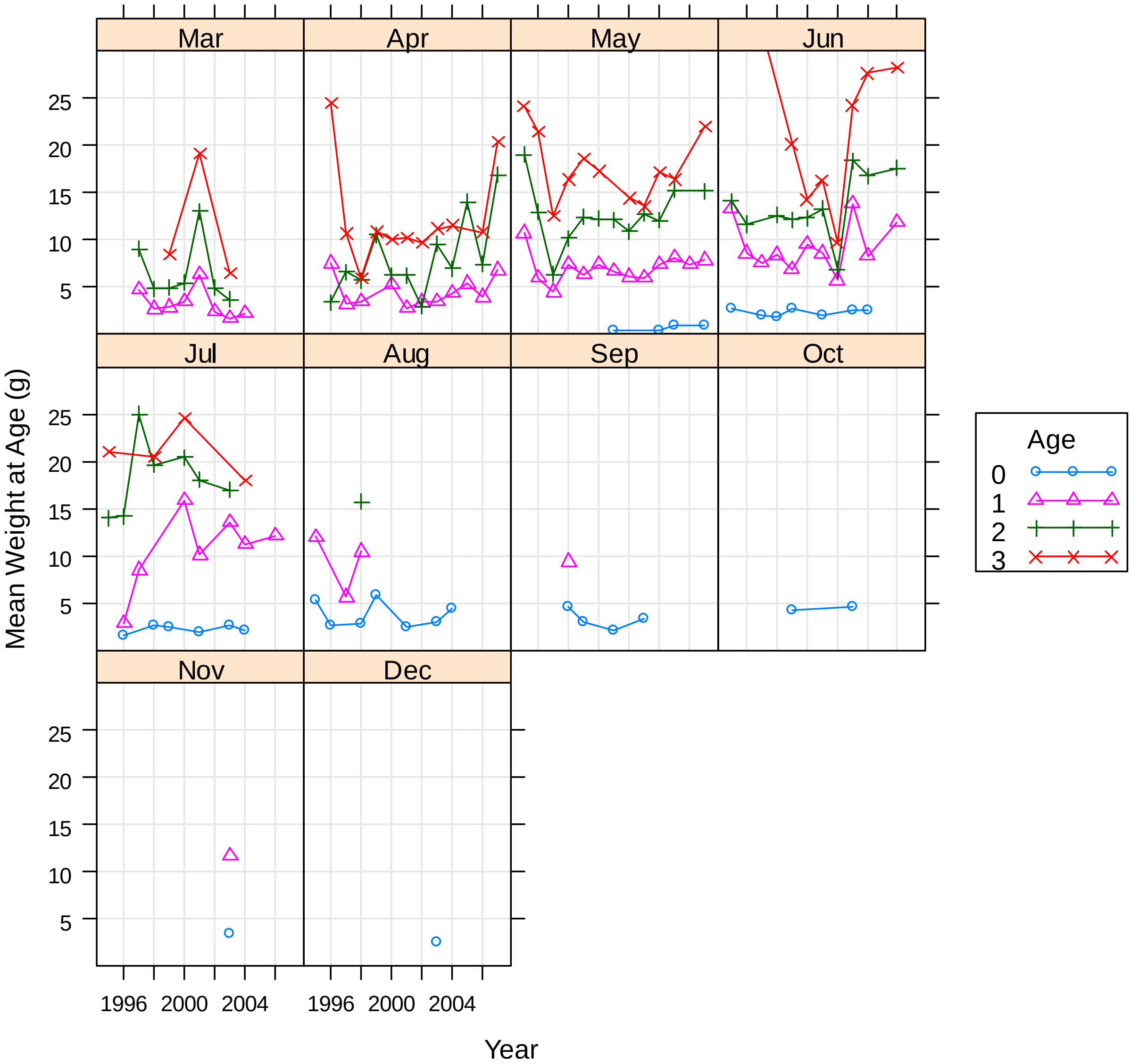


Figure 4.2.3.4 SANDEEL in IV.

Mean weight-at-age in a given month for the period 1995-2007 for sandeel in the northern North Sea. Uncertainties in the mean weight at age are generally small, and of a similar scale to the points used to the plot the data.

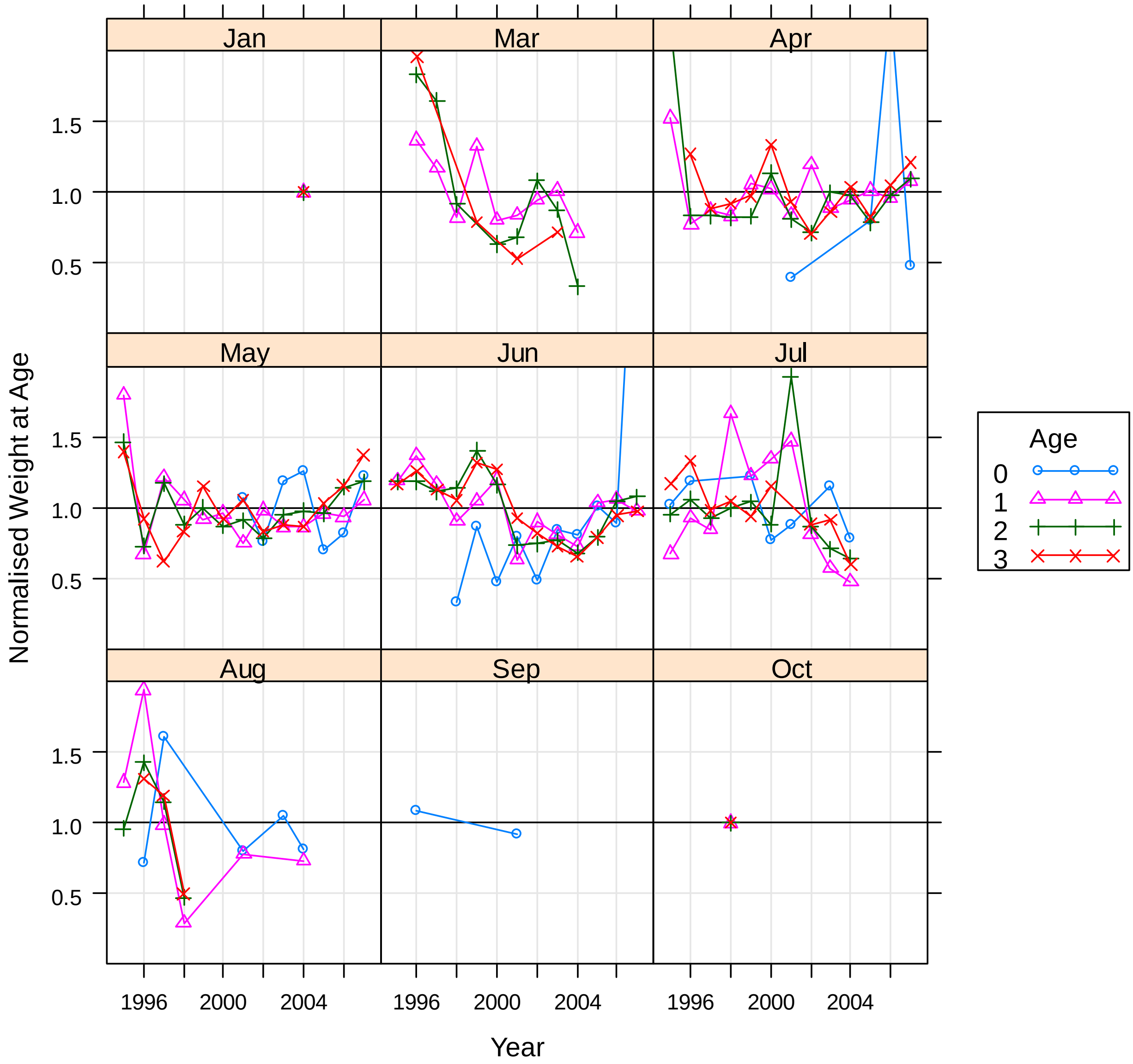


Figure 4.2.3.5 SANDEEL in IV.

Mean weight-at-age for sandeels in the southern North Sea in a given month normalised by the overall mean weight-at-age for that month.

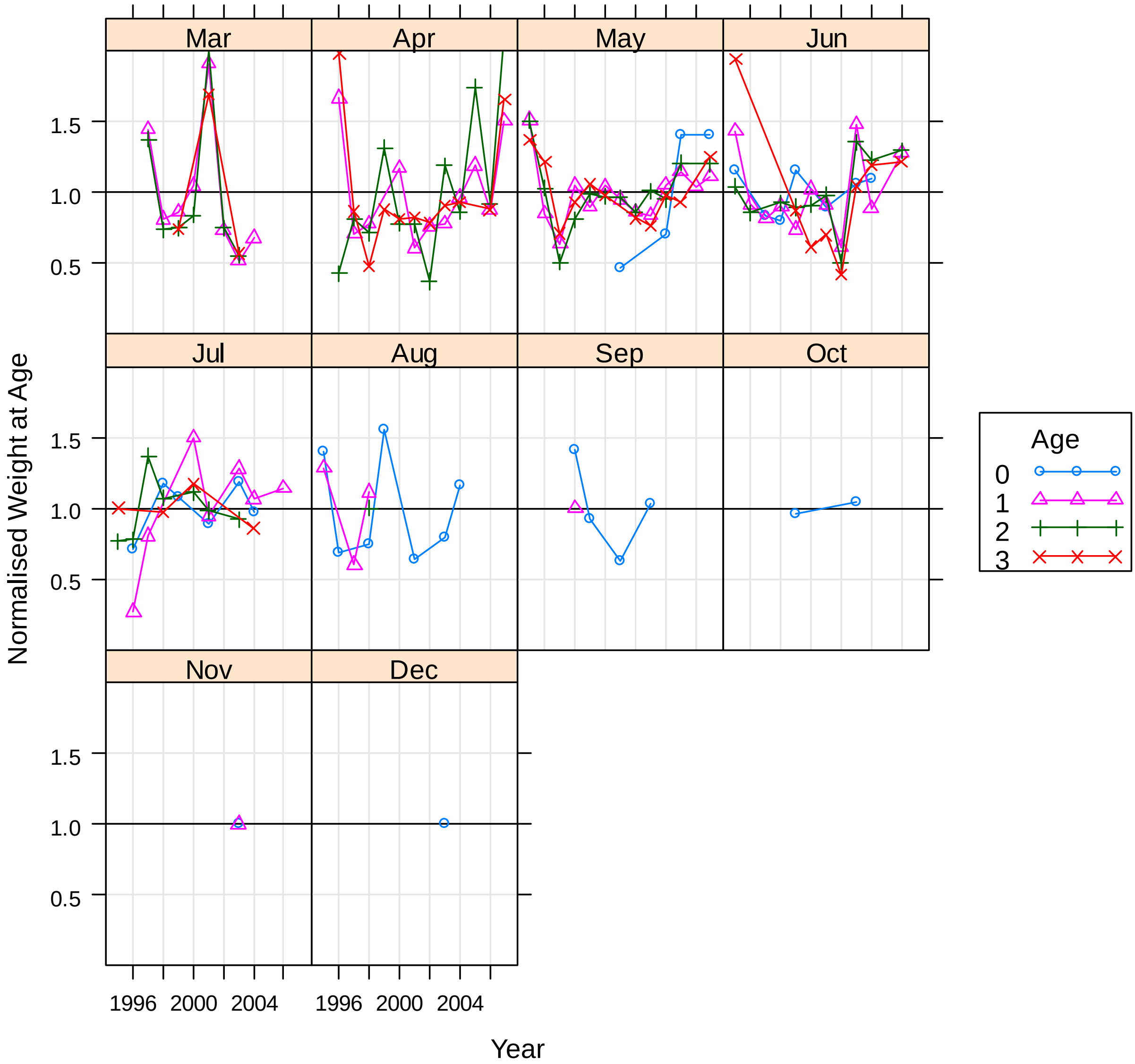


Figure 4.2.3.6 SANDEEL in IV.

Mean weight-at-age of sandeels in the northern North Sea in a given month normalised by the overall mean weight-at-age for that month.

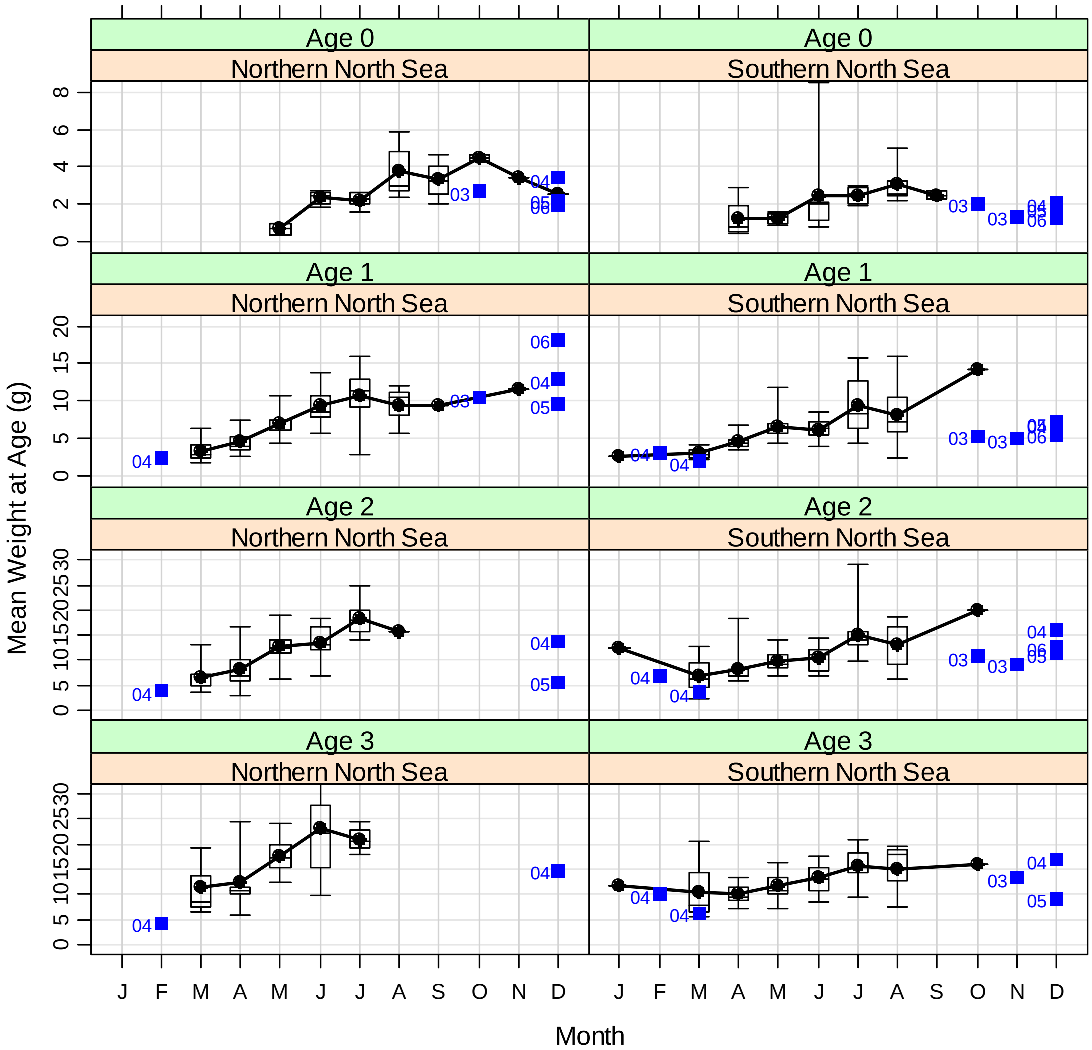


Figure 4.2.3.7 SANDEEL in IV.

Mean weight-at-age in the catch by age and fishing area. Box and whisker plots show the distribution of mean weight-at-age observed in a given month for the period 1995-2007: the box encapsulates the upper and lower quartiles, the horizontal line in the box represents the median, and the whiskers show the full range of observed values. The black line (circles) plots the mean weight-at-age in a given month, averaged over all years. Data from the Danish dredge survey are also shown (blue squares) and are labelled with the corresponding years.

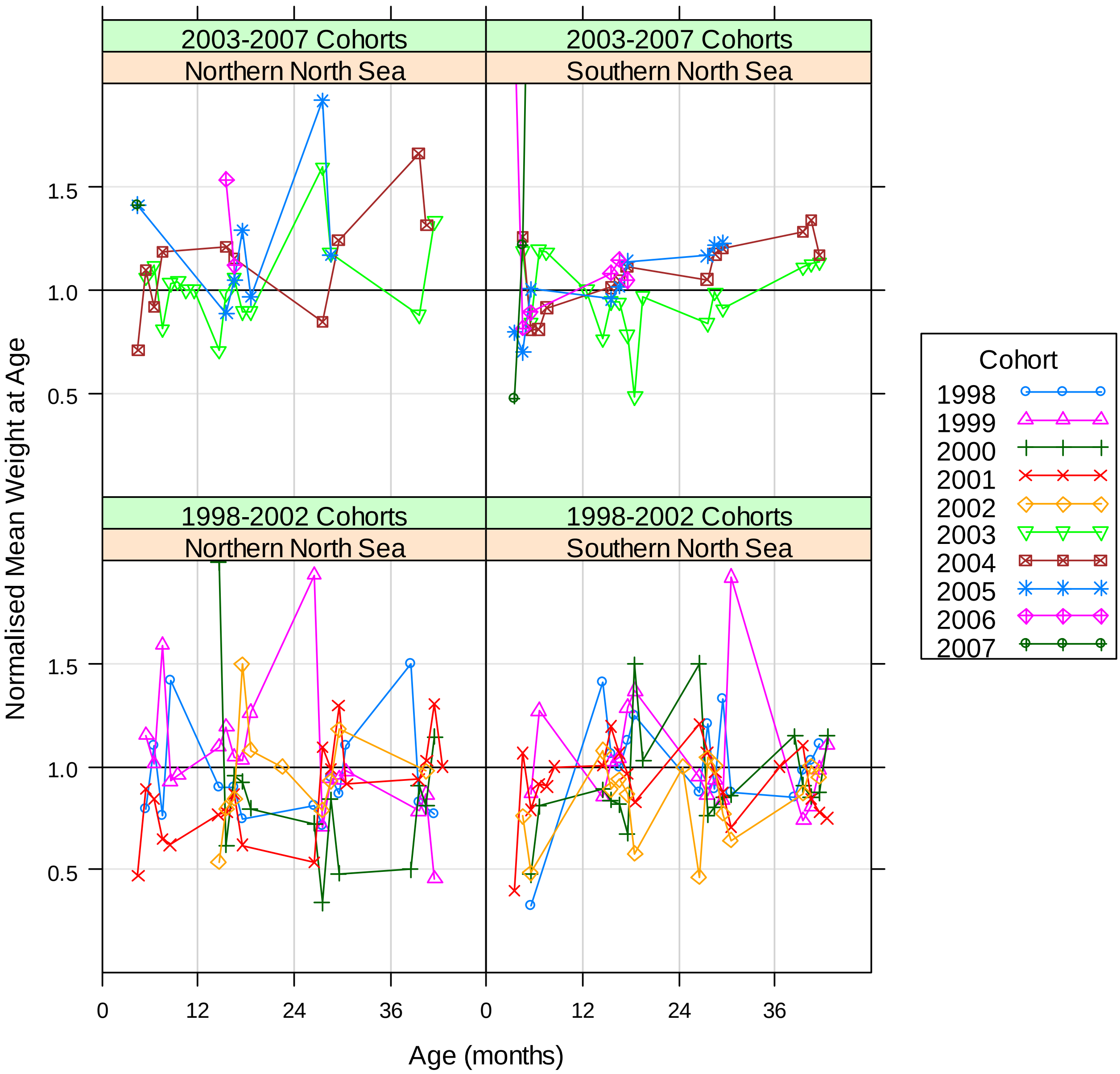


Figure 4.2.3.8 SANDEEL in IV.

Mean weight-at-age normalised by the overall average mean weight-at-age, plotted by cohort and area.

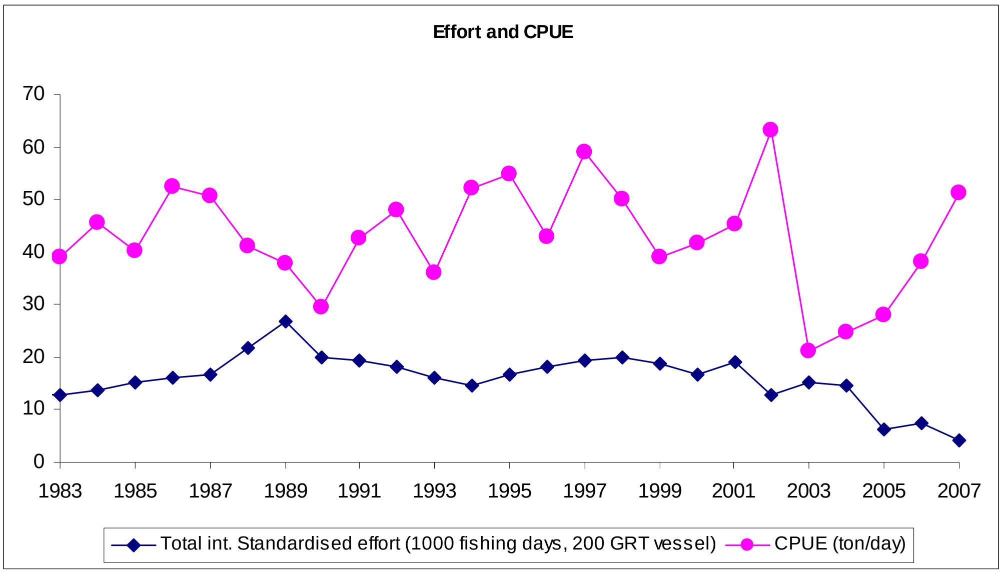
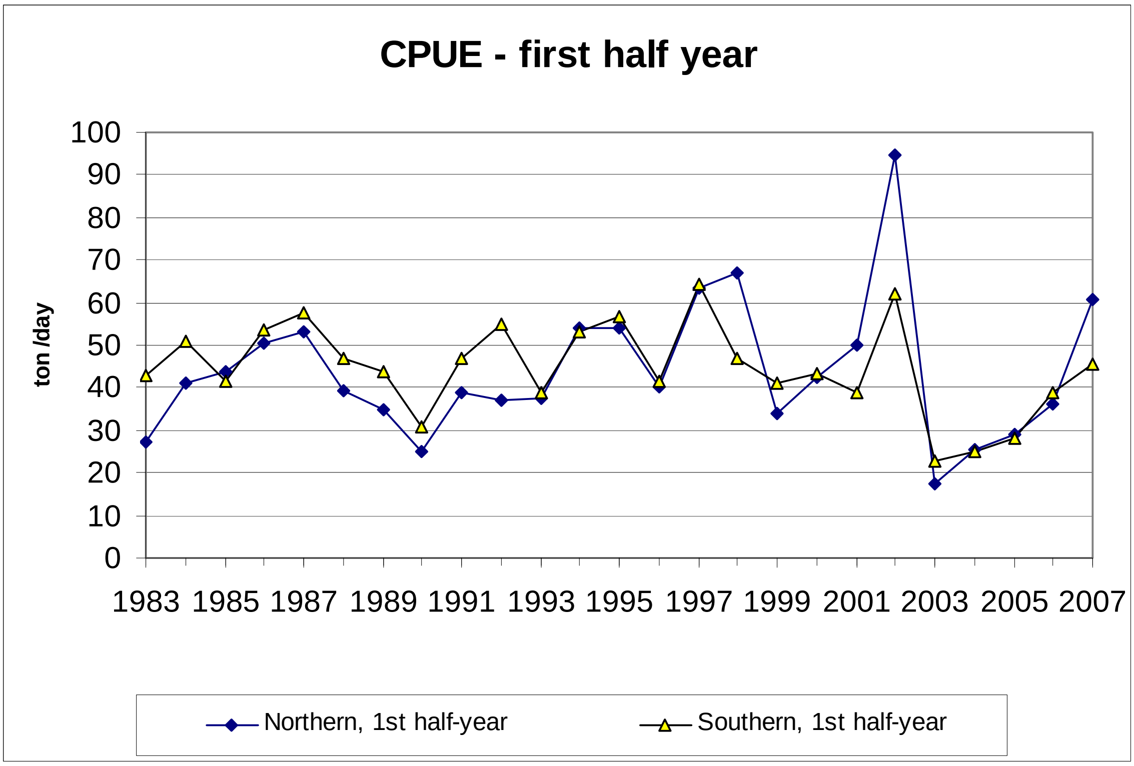


Figure 4.2.5.1. SANDEEL in IV.

Total international effort and CPUE.2007 only represent first half year (see the text for further details about landings in second half year of 2007).



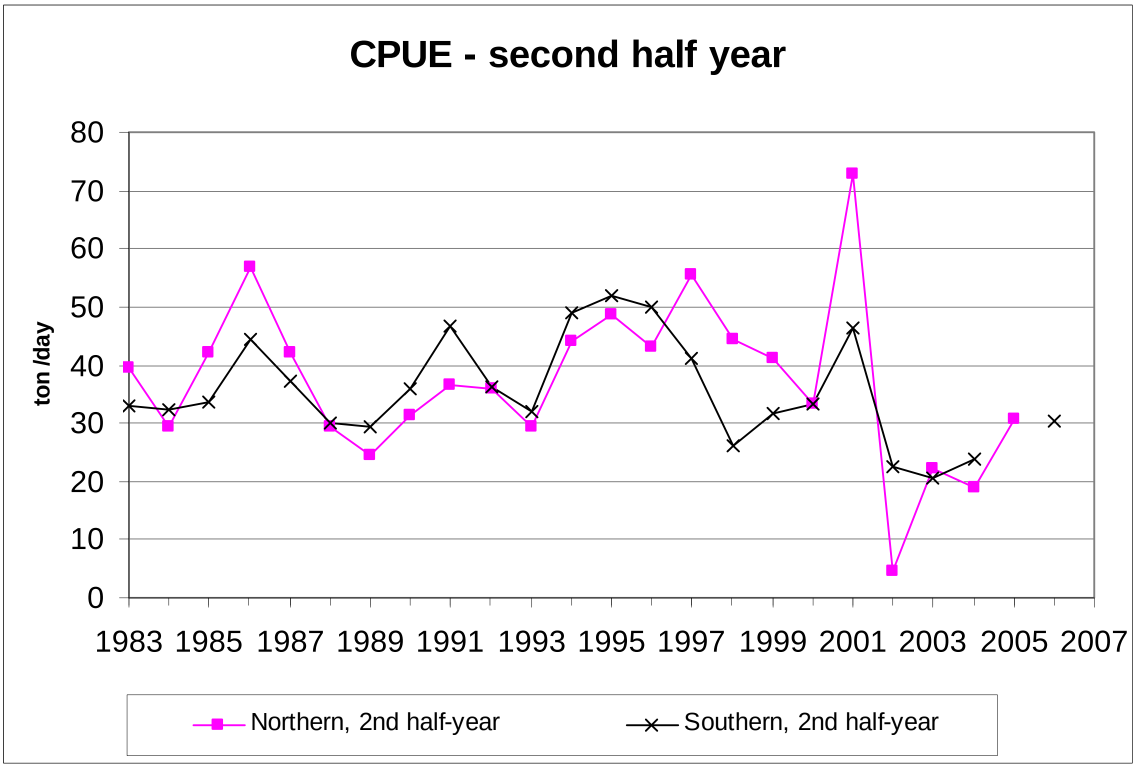


Figure 4.2.5.2. SANDEEL in IV.

CPUE (ton/day) by area, half year and year.

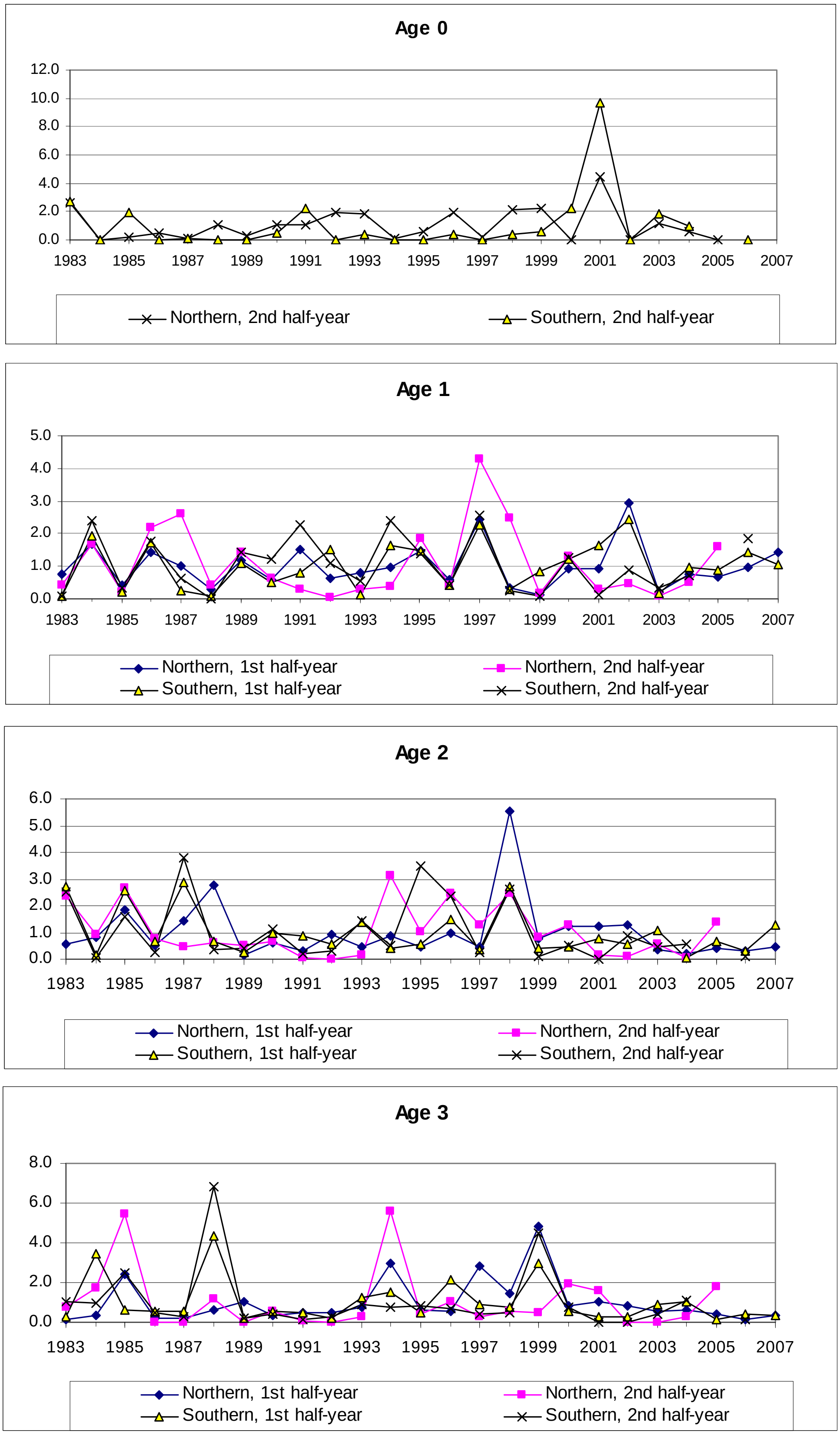


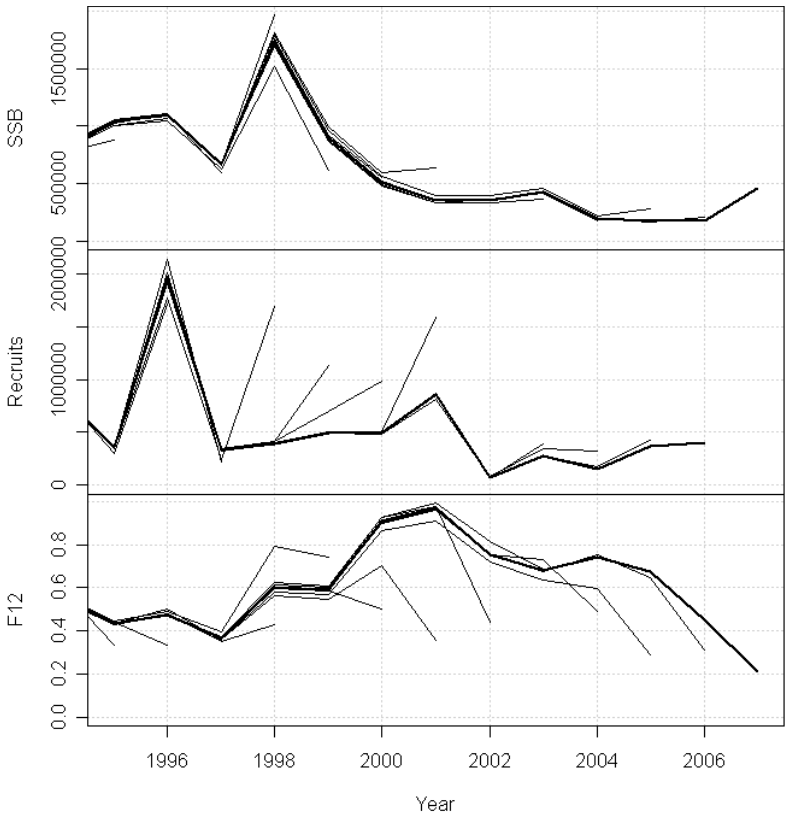
Figure 4.2.5.3 SANDEEL in IV.

CPUE (ton/day) by area age group and year.

Figure 4.3.2.1 SANDEEL in IV.

Log residual stocknr. (nhat/n) by fleet. SXSA.

a) Retrospective analysis of SSB, recruitment, and F_{bar} 1995-2007 for the SXSA analysis.



b) Retrospective analysis of SSB, recruitment, and F_{bar} 2002-2007 for the SXSA analysis.

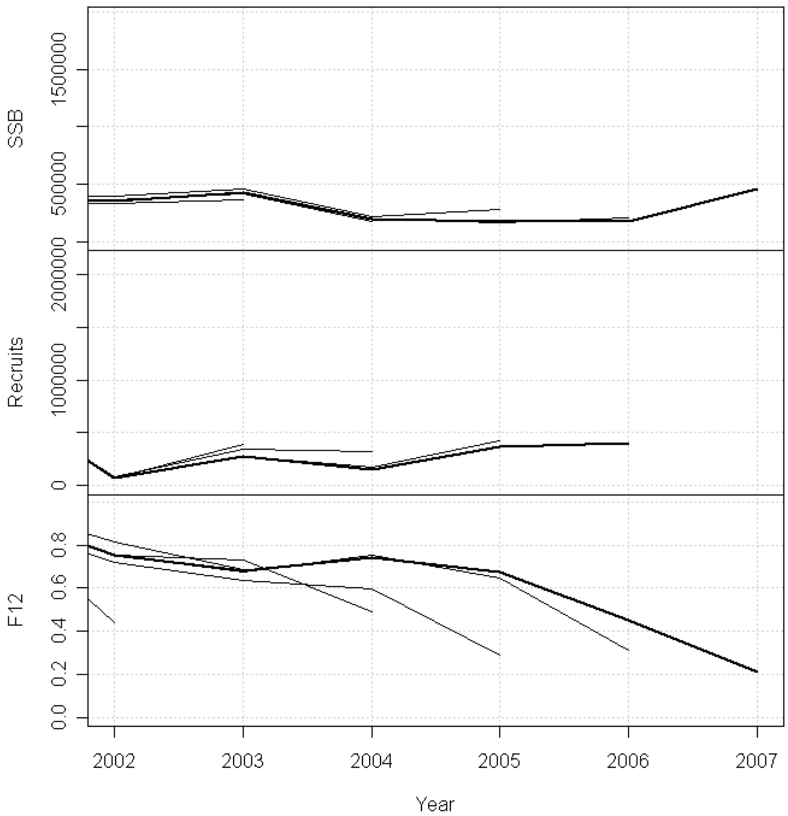


Figure 4.3.2.2. SANDEEL in IV.

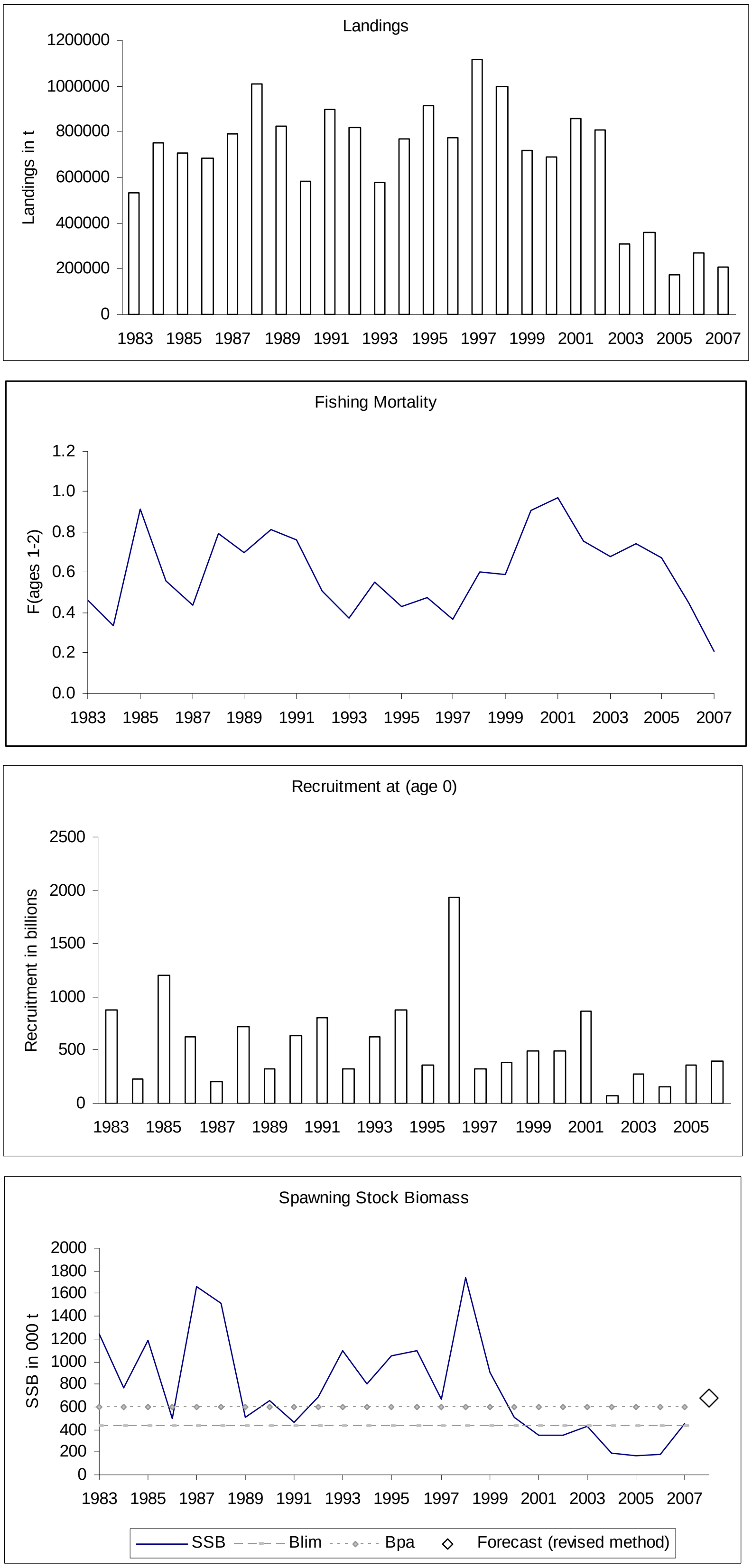


Figure 4.3.2.3. SANDEEL in IV.

SXSA Stock Summary.

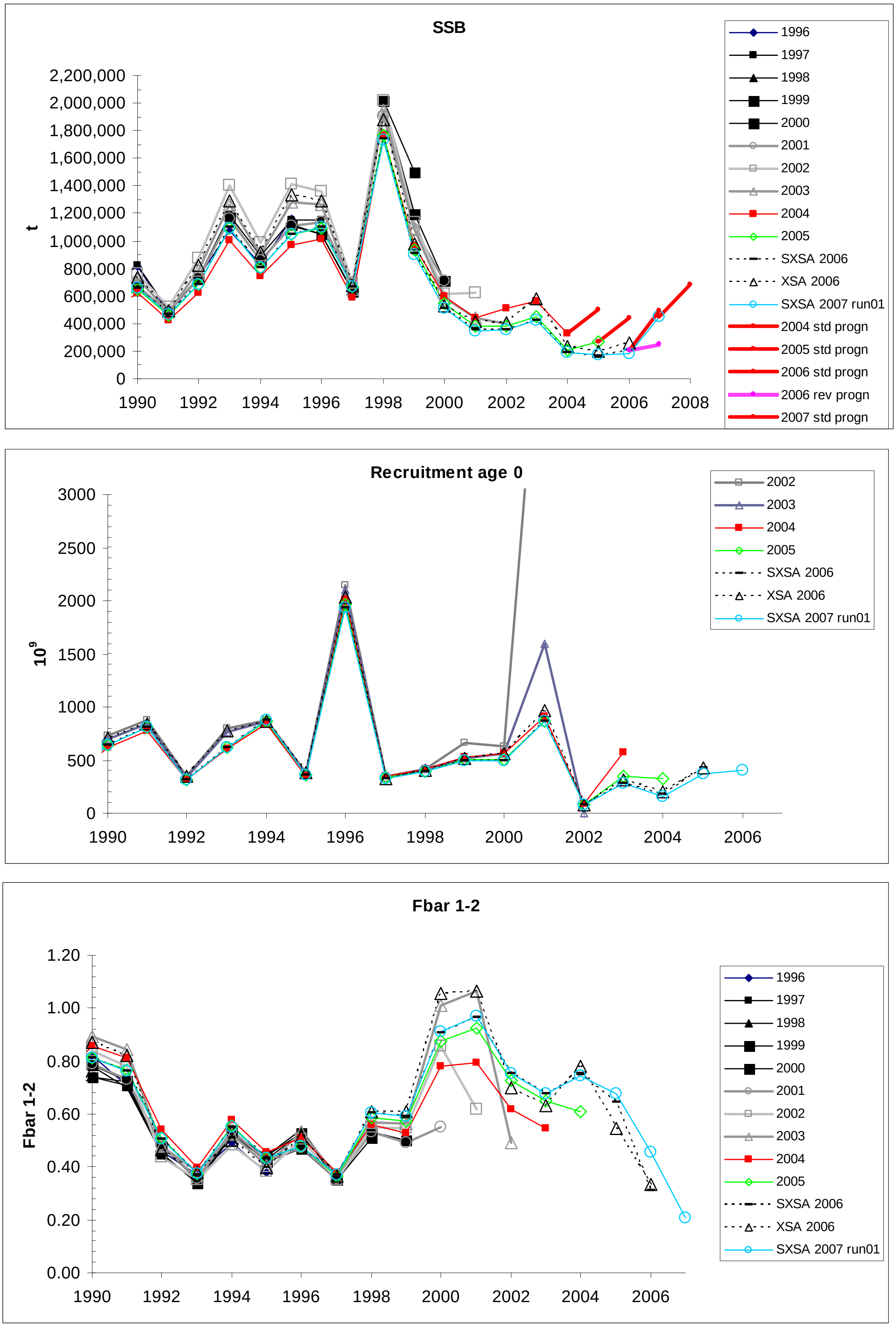


Figure 4.3.2.4. SANDEEL in IV.

Comparison of historical performance of assessments in 2007. $F_{bar1\text{-}2}$ in 2007 based on data for only first half year of 2007.

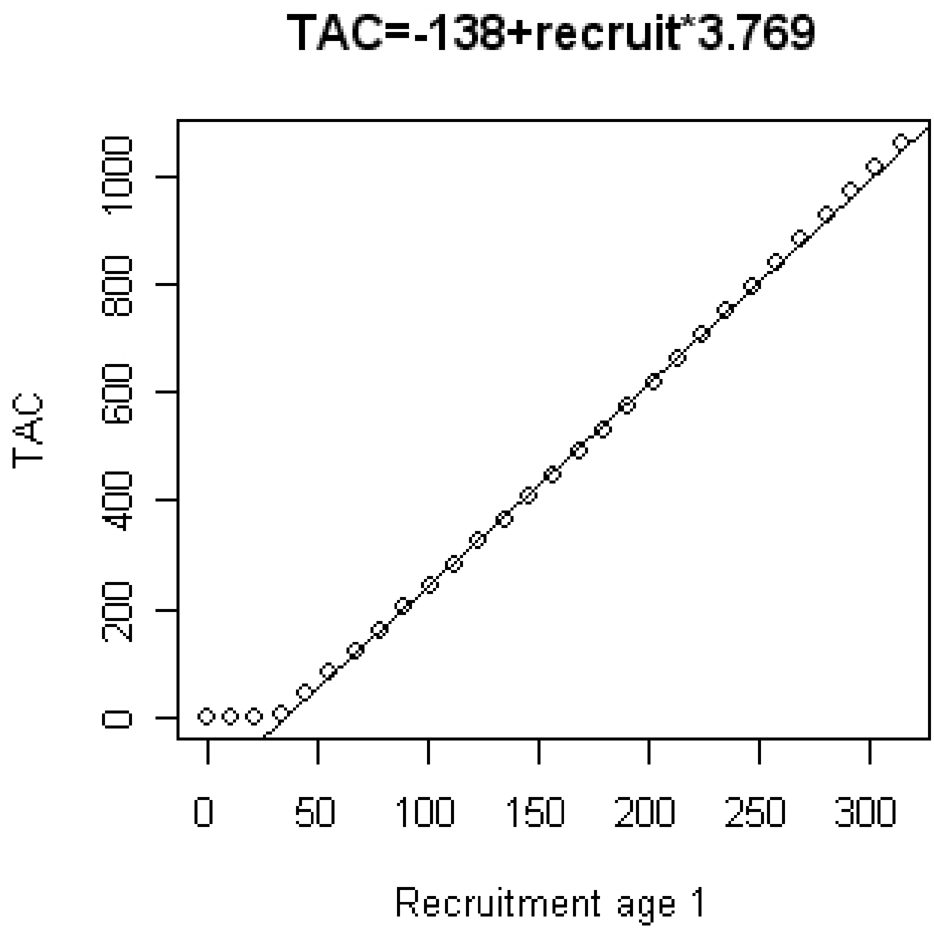


Figure 4.6.3. SANDEEL in IV.

Regression of recruitment in 2007 against TAC in 2008, where TAC in 2008 will lead to SSB in 2009 being B_{pa}.

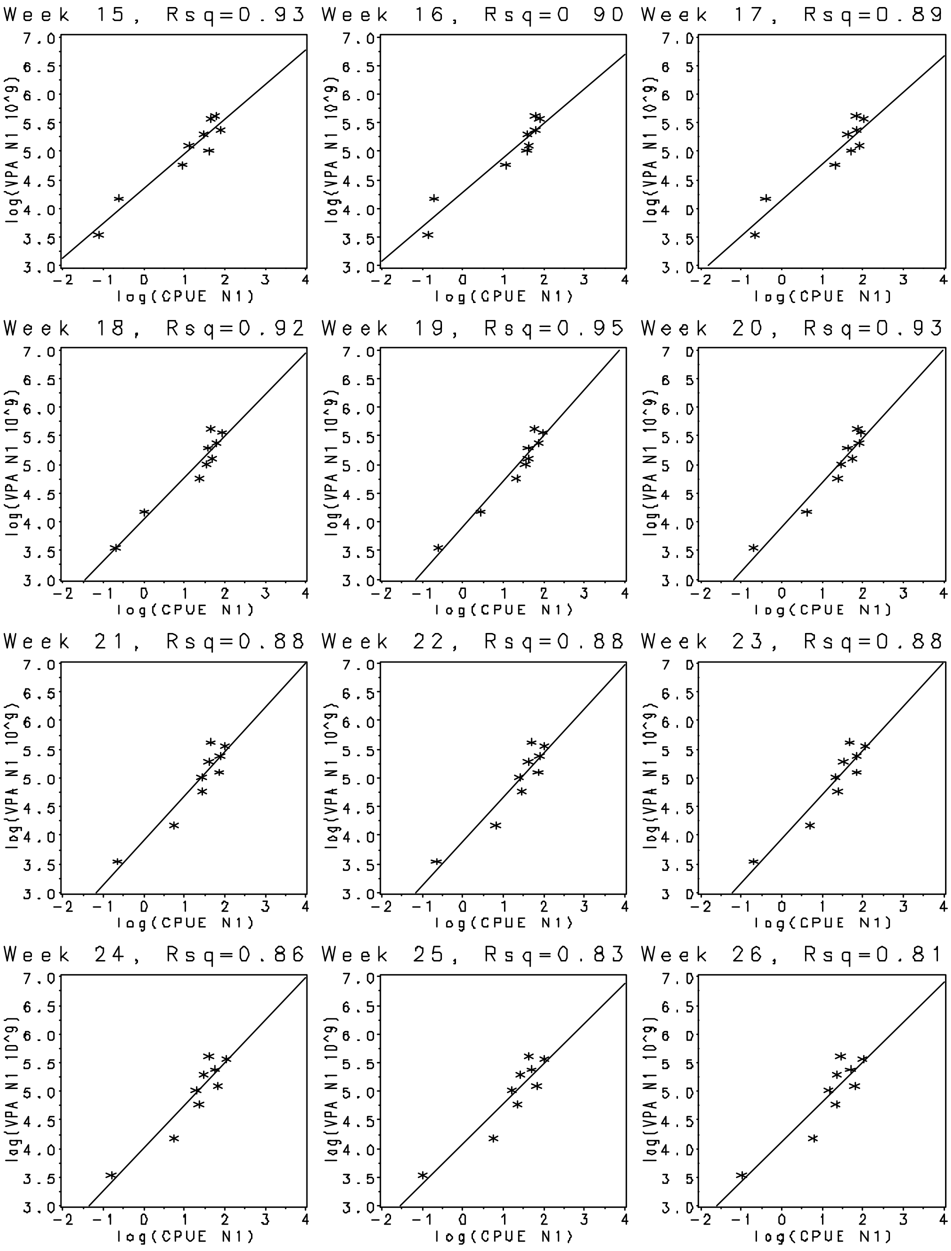


Figure 4.11.1. SANDEEL in IV.

Weekly regression analysis of log(VPA-1-group, billions) on cumulative log(CPUE 1-group, millions)

5 Norway Pout in ICES Subarea IV and Division IIIa

The September 2007 assessment of Norway pout in the North Sea and Skagerrak is an update assessment from the May 2007 assessment which basically is an up-date assessment from the 2004 benchmark assessment using the same tuning fleets and parameter settings. The assessment is a "real time" monitoring (and management) run up to 2nd quarter 2007, but includes new research survey information from 3rd quarter 2007 (backshifted to 2nd quarter).

Furthermore, a short term prognosis (Forecast) up to 1st January 2009 is given for the stock based on the up-date assessment.

Additionally, the report includes a management considerations section with management up to 2007, as well as a combined presentation and evaluation of 3 types of long term management strategies for the stock. ICES ACFM has already in May 2007 evaluated two of the long term management strategies for Norway pout, i.e. the real time escapement management strategy and the long term fixed F or E management strategy, but to give a full picture of all three strategy options they are presented combined here including a full evaluation of the fixed TAC strategy.

5.1 Update assessment

5.1.1 Data available

The new survey data from the 3rd quarter 2007 EGFS and SGFS research surveys have been included in the up-date assessment, where this 3rd quarter information has been back-shifted to 2nd quarter 2007 in the assessment. The survey data time series including the new information is presented in **Table** 5.1.1.

Data for annual nominal landings of Norway pout has been very low in 1st and 2nd quarter 2007 because the directed fishery for Norway pout in the North Sea and Skagerrak has been closed. Because of the closure of the targeted fishery for Norway pout in 2007, there has only been by-catch of Norway pout mainly in the Norwegian targeted blue whiting fishery, resulting in overall low catches of Norway pout during this period. As there at present is no information about this catch, besides it for certain is low, there has been assumed and used low catches of 0.1 million individuals per age (for age group 1-3) per quarter (for all quarters in 2007) in the SXSA, and the weight at age in the catch has been assumed equal to those in 2005 and 2006 for the 1st and 2nd quarter of 2007.

All other data and data standardization methods used in this September 2007 up-date assessment are identical to those used and described in the May 2007 assessment.

5.1.2 Fisheries

As a consequence of the closure of the fishery there has been no directed effort for Norway pout in all of 2007, and Norway pout has only been caught as by-catch in the Norwegian mixed blue whiting and Norway pout fishery.

5.1.3 Final Assessment

The SXSA (Seasonal Extended Survivors Analysis) was used to estimate quarterly stock numbers (and fishing mortalities) for Norway pout in the North Sea and Skagerrak in September 2007. A general description of and reference to documentation for the SXSA model is given in the **Stock Quality Handbook (Q5).**

There has been performed back-shifting of the third quarter survey indices to the second quarter of the year similar to the assessment procedure in the autumn 2006 assessment of the stock. Recruitment season to the fishery in the assessment is accordingly also set to quarter 2.

All other aspects and settings in the assessment are an up-date of the (May 2007 up-date and) 2004 benchmark assessment.

Results of the analysis are presented in **Table** 5.1.2 (assessment model parameters, settings, and options), **Table** 5.1.3 (population numbers at age (recruitment), SSB and TSB), **Table** 5.1.4 (fishing mortalities by year).XSA), and **Table** 5.1.5 (stock summary). The summary of the results of the assessment is shown in **Table** 5.1.5 and **Figure** 5.1.2-2.

5.2 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 2009 using full assessment information for 2006 and 1st half year 2007, i.e. is based on the SXSA assessment estimate of stock numbers at age at the middle of 2007.

The purpose of the forecast is to calculate possible catch of Norway pout in 2008 leaving a SSB at or above Bpa 1st of January 2009 (B_{pa} = 150 000 t). The forecast is based on an escapement management strategy for Norway pout (see section 5.3 and ICES AGNOP Report ICES CM 2007/ACFM:39) where the fishery has been closed in 2007. The forecast is using the 25 percentile of the geometric mean for the stock-recruitment relationship (see below).

Input to the forecast is given in **Table** 5.2.1. The forecast assumes 2007 (the assessment year) closed for directed fishery (F=0) and a 2008 (the forecast year) fishing pattern scaled to long term seasonal exploitation pattern for 1991-2004 (standardized with yearly Fbar to F(1,2)=1) which has been used in the ICES AGNOP Report as well (ICES CM 2007/ACFM:39). Recruitment in the forecast year is assumed to the 25 percentile = 72 558 millions (of the long term geometric mean = 101525 millions).

The weight at age in the catch per quarter is based on estimated mean weight at age in catches during 2003-2006. The constant weight at age in stock by year and quarter of year used in the SXSA assessment has also been used in the forecast for 2007 and 2008.

Ten percent of age 1 is mature and is included in SSB. Therefore, the recruitment in 2007 does influence the SSB in 2008.

The results of the forecasts are presented in **Table** 5.2.2. It can be seen that if the objective is to maintain the spawning stock biomass above B_{pa} by 1st of January 2009 then a catch around 175 000 t can be taken in 2008 according to the escapement strategy. Under a fixed F-management-strategy with F around 0.35 a catch around 95 000 t can be taken. Under a fixed TAC strategy a TAC of 50 000 t can be taken in 2008 according to what is presented in section 5.3 below.

5.3 Management

5.3.1 Management up to 2007

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

Previous to 2005 a precautionary TAC was set to 198 000 t in the EC zone and 50 000 t in the Norwegian zone. On basis of the ICES 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 set a quota on 95.000 t for 2006 (intended for the whole year). The fishery for this TAC was by the EU Commission not opened before the 4th of August 2006 for the second half year 2006. Norway did in the beginning of September 2006 open a directed Norway pout fishery without quota limitations in Norwegian EEZ. However, the area (Egersund Bank) was closed for this fishery from 1st of October 2006. Based on the management advice from ICES in autumn 2006 taking the low recruitment in 2006 into consideration the fishery was closed again by 1st of January 2007. This advice was by ICES confirmed in May 2007, and has resulted in a management where the directed Norway pout fishery has continued to be closed in all of 2007.

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 **Quality Handbook (Q5).**

5.3.2 Long term management strategies

5.3.2.1 Background

On basis of an joint EU and Norwegian Requests in autumn 2006 with respect to Norway pout management strategies and by-catches in the Norway pout fishery as well as on basis of the work by ICES WGNSSK in autumn 2006 and spring 2007 during the ICES AGNOP 2007 (ICES CM 2007/ACFM:39) ACFM has already by May 2007 evaluated detailed output from management plans and harvest control rules evaluations considering two different management strategies for Norway pout, i.e. the real time escapement management strategy and the long term fixed F or E management strategy. This has been based on use of advanced stochastic simulation models and results from here supplied by DIFRES. The fixed TAC long term management strategy were not evaluated in depth by the ICES AGNOP as it was not considered realistic at that time because of substantial loss in yield, but have later in early summer 2007 been evaluated in depth by DIFRES using the same advanced stochastic simulation models.

Based on the above as well as on basis of a Danish Government request to ICES by September 2007 also to evaluate the long term fixed TAC management strategy for Norway pout we here in this report include the combined management strategy presentation and evaluation for the 3 strategies (through the ICES WGNSSK report to the ACFM by September/October 2007).

5.3.2.2 Long Term Harvest Control Rules for Norway pout in the North Sea and Skagerak

In 2006 EC and Norway jointly requested the International Council for Exploration of the Sea (ICES) for advice on management of Norway pout. ICES responded to the request partly in autumn 2006 and finally in spring 2007.

ICES in its response addresses three types of management strategies:

- Fixed TAC strategy,
- Fixed fishing effort strategy and
- Escapement strategy

ICES considered the fixed TAC strategy to be less interesting as such strategies most likely would result in a substantial loss in long-term yield compared to other strategies if the risk of SSB falling below Blim is to remain reasonably low. ICES, therefore, did not fully explore this option.

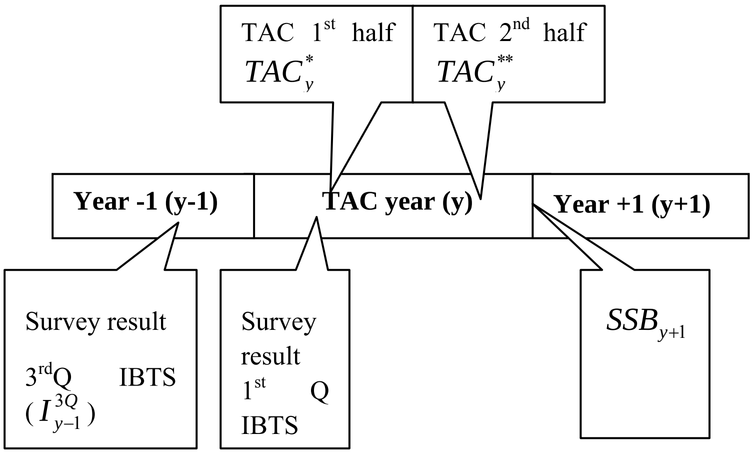
To give a full picture of all three strategy options DIFRES has, following the model and methods used by ICES, performed a full evaluation of the fixed TAC strategy.

This section gives a short description of the evaluation methods used for the three strategies and present the combined results of the evaluations.

Escapement strategy

ICES evaluated an escapement strategy defined as follows: 1) an initial TAC that would be set for the first half of the TAC year, based on a recruitment index, and 2) a TAC for the second half of the year which would be based on a survey assessment conducted in the first half of the TAC year and the setting TAC for the second half of the year based on an SSB escapement rule.

The time line would be as follows:



This escapement strategy that generally will assure an SSB above B_{pa} is formulated as follows:

1. The TAC for the first half of the year, TAC_y^*, is based on the 3rd quarter IBTS survey for the age group 0, I_{y-1}^{3Q}:

$$TAC_y^* = \begin{cases} \min(A \cdot \frac{I_{y-1}^{3Q}}{\bar{I}}, B) \; if \;\; I_{y-1}^{3Q} \geq C \\ 0 \; otherwise \end{cases}$$

Where:

I_{y-1}^{3Q} is the index of age 0 in the 3rd quarter IBTS survey in year y-1

$\bar{I}$ is the geometric average index of age 0 in the 3rd quarter IBTS survey

TAC_y^* is the TAC in year y in the first half of the year

B is the maximum TAC for the first half of the year (50 kt)

A is the slope that converts the relative IBTS index to a TAC for the first half of the year $A(= B/3)$ is determined such that a recruitment three times higher than average will give a TAC at 50 kt)

C is the survey threshold (equivalent to the index for the long-term geometric mean, 70 billions)

2. The TAC for the second half of the year, TAC_y^{**}, is based on a full assessment in April–May which includes the results from the 1st quarter IBTS for the present year:

$$TAC_y^{**} = \max\left(0, SSB_{y+1} - B_{pa}\right)$$
$$\textit{where } TAC_y^{**} \textit{ is restricted by } F_y \leq F_{cap}$$

Where:

SSB_{y+1} is the SSB at the start of the year after the TAC year as projected from a survey assessment based on 1st Q IBTS results

B_{pa} is the PA biomass reference point

F_y is the fishing mortality for the TAC year y

F_{cap} is an upper limit on the fishing mortality in year y

The target of obtaining an SSB that is truly above B_{lim} with a high probability (95%) appears feasible when realistic values of uncertainties in the assessment (CV=0.3 on SSB_{y+1}) and survey (CV=0.42 on I_{y-1}^{3Q}) are used and when a cap on fishing mortality of 0.8 is used. In practice this Harvest Control Rule (HCR) becomes an escapement strategy with an additional maximum effort.

The equilibrium median yield is around 110 kt (**Fig 3.3.1**). There is a 50 % risk for a closure of the fishery in the first half-year and a 20–25% risk of a closure in the second half-year. The distribution of F (**Fig 3.3.2**) shows that the fishery will mostly alternate between a low and a high effort situation. When the fishery has been closed in the second half-year, there is around 20 % probability for another closure in the following year.

The robustness of the HCR to uncertainties in stock size indicates that annual assessment might not be necessary for this stock; an annual survey index could be sufficient.

Caveats to the evaluation of the escapement strategy:

- The sensitivity of the parameters in the HCR used for TAC in the first half-year has not been fully evaluated;
- Non-random distribution of residuals in the surveys may give biased perceptions and need to be included in the evaluation.

Effort control strategy

The effort control scenario with a fixed F indicates that an F of around 0.35 is expected to give a low (5 %) probability of the stock going below B_{lim} (**Fig 3.3.3**). The scenario appears robust to implementation uncertainties (**Fig 3.3.4**). A target F below 0.35 and an implementation noise CV around 25 % (**Fig 3.3.5**) is expected to give a long-term yield below 90 kt and no closures of the fishery would be needed. This management strategy is independent of an assessment because it assumes a direct link between fishing effort and fishing mortality which is also apparent from the historical assessment of this stock (**Fig 3.3.6**).

Caveats to the evaluation of the effort control strategy:

- A regime shift towards a lower recruitment level will not be detected by this approach and there is a risk of over-fishing in such a situation with a fixed effort approach;
- Implementation of a fixed standardized effort (which is not measurable) can be difficult;
- Effort management in by-catch fisheries (e.g. by-catch of Norway pout in blue whiting fishery) is difficult to regulate;
- Effort – F relationships are known to suffer from technological creep and this aspect needs to be tested in the evaluation.

Fixed TAC strategy

The scenario with fixed TAC indicates that a long term TAC on around 50.000 t will be sustainable with a low (5 %) probability of the stock going below B_{lim} (**Figs 3.3.7 and 3.3.8**). The evaluations indicate that if a target TAC below 50 kt is implemented no closures of the fishery would be needed.

Caveats to the evaluation of the fixed TAC strategy:

- A regime shift towards a lower recruitment level will not be detected by this approach and there is a risk of overfishing in such a situation with a fixed TAC approach;
- For a short-lived species with highly variable recruitment such as Norway pout, a catch-stabilizing strategy (fixed TAC) is likely to imply a substantial loss in long-term yield compared to other strategies if the risk of SSB falling below B_{lim} is to remain reasonably low. This strategy is also sensible in relation to potential risks of regime shifts in the stock-recruitment-relationship.

Conclusions from management strategy evaluations

Not any particular of the management strategies presented above is recommended. All strategies that have a low risk of depleting the stock below B_{lim} are considered to be in accordance with the precautionary approach. The choice between different strategies depends on the requirements that fisheries managers and stakeholders have regarding stability in catches or the overall level of the catches.

The evaluation shows that all three types of management strategies (escapement, fixed effort, fixed TAC) are capable of generating stock trends that stay away from B_{lim} with a high probability.

The escapement strategy has a higher long-term yield (110 kt) compared to the fixed effort strategy (90 kt) and the fixed TAC strategy (50 kt) but at the cost of having closures in the fishery with a substantially higher probability. If the continuity of the fishery is an important property, then the fixed effort strategy performs better.

The simulations deal with observation error and implementation error of the management strategies but do not take into account process error in relation to natural mortality, maturity-at-age, or mean weight-at-age in the stock, which could have a significant impact.

The fixed effort strategy does not rely critically on the results of stock assessment models in any particular year. On the other hand, that strategy is very dependent on the possibility of actually implementing an effort scheme, including an account of the bycatch fisheries (e.g. for blue whiting) and ways to deal with effort creep.

The fixed effort strategy and the fixed TAC strategy are likely to imply a substantial loss in long-term yield compared to the escapement strategy if the risk of SSB falling below B_{lim} is to remain reasonably low. These strategies are also sensible in relation to potential risks of regime shifts in the stock-recruitment-relationship.

5.4 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.

5.5 Biological reference points

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

Technical basis:

$B_{lim} = B_{loss}$ = 90 000 t.	$B_{pa} = B_{lim}$ e2-3 : 150 000 t.
F_{lim} None advised.	F_{pa} None advised.

Biomass based reference points have been unchanged since 1997.

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

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

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

Table 5.1.1 NORWAY POUT IV & IIIA (Skagerak). 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	773	647	153	12
2005	691	131	37	6,912	803	67	11	3,073	343	132	18	2,614	439	125	17
2006	3,340	146	27	1,680	2,147	151	18	1,127	1,285	69	9	1,349	1,869	150	15
2007	1,286	778	23	3,329	1,084	332	1	5,003	1,023	395	8	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. Minor GOV sweep changes in 2006 EGFS. [4]Scottish groundfish surveys, arithmetic mean catch no./h. Survey design changed in 1998 and 2000. [5]English groundfish survey: Data for 1996, 2001, 2002, and 2003 have been revised compared to the 2003 assessment. In 2007 numbers for 1997 and 1998 as well as 2002 has been adjusted based on new authomatic calculation and processing process has been introduced.

Table 5.1.2 Norway pout IV & IIIaN (Skagerak). 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 2007

Run: Baseline September 2007 (Summary from NP0907_2)

The following parameters were used:

```
Year range: 1983 - 2007
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:  commercial q134
Fleet  2:  ibtsq1
Fleet  3:  egfsq3
Fleet  4:  sgfsq3
Fleet  5:  ibtsq3
```

The following options were used:

```
1: Inv. catchability:                                       2
  (1: Linear; 2: Log; 3: Cos. filter)
2: Indiv. shats:                                            2
  (1: Direct; 2: Using z)
3: Comb. shats:                                             2
  (1: Linear; 2: Log.)
4: Fit catches:                                             0
  (0: No fit; 1: No SOP corr; 2: SOP corr.)
5: Est. unknown catches:                                    0
  (0: No; 1: No SOP corr; 2: SOP corr; 3: Sep. F)
6: Weighting of rhats:                                      0
  (0: Manual)
7: Weighting of shats:                                      2
  (0: Manual; 1: Linear; 2: Log.)
8: Handling of the plus group:                              1
  (1: Dynamic; 2: Extra age group)
```

Data were input from the following files:

```
Catch in numbers:       canum.qrt
Weight in catch:        weca.qrt
Weight in stock:        west.qrt
Natural mortalities:    natmor.qrt
Maturity ogive:         matprop.qrt
Tuning data (CPUE):     tun2007.xsa
Weighting for rhats:    rweigh.xsa
```

Table 5.1.3 Norway pout IV & IIIaN (Skagerak).

Seasonal extended survivor analysis (SXSA) of Norway pout in the North Sea and Skagerrak.

Stock numbers, SSB and TSB at start of season.

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	220869.	148053.	98877.	*	119189.	79895.	53554.	*	85603.	57382.	38459.
1	108929.	69572.	45141.	25490.	64092.	40703.	25440.	12722.	34072.	20985.	13365.	7812.
2	13109.	7725.	4167.	1505.	13569.	7970.	4389.	1564.	5669.	2683.	1680.	477.
3	115.	65.	36.	10.	698.	350.	15.	3.	447.	143.	85.	41.
4+	6.	3.	0.	0.	1.	0.	0.	0.	2.	1.	1.	0.
SSN	24123.				20677.				9526.			
SSB	369606.				371336.				166602.			
TSN	122159.	298233.	197396.	125882.	78360.	168213.	109739.	67844.	40191.	109416.	72513.	46790.
TSB	1055856.	1309625.	1902065.	1243310.	775118.	899078.	1145210.	679827.	381255.	413220.	641004.	432873.

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	157960.	105884.	70976.	*	46306.	31040.	20800.	*	127751.	85634.	56795.
1	25225.	16584.	10903.	6338.	43015.	26634.	16973.	10045.	13757.	9018.	5967.	3850.
2	2788.	993.	595.	198.	2782.	1536.	981.	518.	4973.	2760.	1790.	995.
3	177.	60.	38.	20.	101.	58.	39.	26.	156.	88.	59.	40.
4+	28.	16.	11.	7.	18.	12.	8.	5.	17.	11.	7.	5.
SSN	5516.				7203.				6521.			
SSB	87647.				96397.				126211.			
TSN	28218.	175613.	117430.	77539.	45917.	74546.	49040.	31394.	18903.	139629.	93458.	61685.
TSB	246562.	286428.	723958.	581125.	367391.	455282.	592969.	379078.	212882.	234161.	572230.	473420.

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	135717.	90974.	60851.	*	127097.	85196.	57092.	*	243243.	163051.	108695.
1	35496.	22372.	14441.	8311.	36816.	23172.	14075.	8640.	37457.	23879.	15486.	9137.
2	2063.	1344.	792.	313.	4146.	2301.	1074.	569.	4825.	2141.	1104.	564.
3	335.	220.	143.	92.	133.	73.	33.	18.	286.	116.	62.	23.
4+	30.	20.	13.	9.	57.	30.	20.	13.	17.	7.	5.	3.
SSN	5978.				8018.				8874.			
SSB	85336.				125512.				144788.			
TSN	37924.	159672.	106362.	69576.	41153.	152673.	100399.	66332.	42585.	269385.	179708.	118422.
TSB	308959.	393390.	767521.	574723.	357455.	431153.	740865.	566169.	380766.	437134.	1090567.	887348.

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	103333.	69266.	45711.	*	72621.	48679.	32552.	*	308548.	206826.	138110.
1	70007.	44015.	28258.	16112.	29860.	18426.	11685.	6894.	20858.	12365.	7983.	4509.
2	5266.	2641.	1530.	707.	8521.	5140.	3058.	1303.	3761.	2037.	1132.	415.
3	225.	55.	20.	13.	256.	159.	59.	24.	509.	296.	174.	59.
4+	3.	0.	0.	0.	7.	4.	3.	2.	16.	11.	7.	5.
SSN	12495.				11769.				6372.			
SSB	174036.				218963.				118608.			
TSN	75501.	150044.	99075.	62542.	38643.	96350.	63485.	40775.	25145.	323256.	216123.	143097.
TSB	615079.	752746.	1050528.	675274.	407080.	459345.	621898.	409991.	250014.	270114.	1086036.	953185.

Year	1995				1996				1997			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	97145.	65118.	43077.	*	234709.	157330.	104868.	*	67184.	45035.	30099.
1	89108.	56463.	36288.	22241.	27490.	17989.	11600.	6922.	68234.	45189.	30210.	17721.
2	2083.	1199.	594.	360.	12167.	7524.	4879.	2450.	4107.	2487.	1560.	741.
3	168.	108.	46.	29.	193.	118.	48.	2.	1370.	854.	475.	232.
4+	43.	29.	19.	13.	25.	17.	11.	8.	6.	4.	3.	2.
SSN	11204.				15135.				12307.			
SSB	117303.				296063.				193267.			
TSN	91401.	154943.	102066.	65719.	39876.	260357.	173868.	114250.	73718.	115717.	77282.	48795.
TSB	678682.	894732.	1196017.	786798.	469250.	532497.	1131983.	891448.	623145.	805290.	1030939.	632773.

Table 5.1.3 (Cont´d.). Norway pout IV & IIIaN (Skagerak).

Year	1998				1999				2000			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	93322.	62555.	41855.	*	229241.	153665.	102971.	*	80663.	54070.	36184.
1	19895.	13122.	8624.	5444.	27779.	18455.	12111.	7055.	68101.	45115.	30012.	18998.
2	10305.	6343.	3998.	2408.	3215.	2050.	1194.	524.	4257.	2702.	1642.	883.
3	327.	181.	106.	70.	1438.	904.	530.	327.	220.	145.	58.	22.
4+	129.	80.	34.	22.	51.	34.	22.	15.	210.	141.	95.	63.
SSN	12750.				7481.				11498.			
SSB	260922.				150539.				161917.			
TSN	30656.	113047.	75317.	49800.	32483.	250684.	167522.	110892.	72789.	128766.	85876.	56150.
TSB	386262.	425978.	644101.	481525.	325547.	393616.	1000563.	821048.	590954.	783760.	1040643.	692416.

Year	2001				2002				2003			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	71390.	47854.	32052.	*	49587.	33239.	22003.	*	21662.	14521.	9728.
1	24008.	15913.	10558.	6978.	21183.	13802.	8965.	5500.	14511.	9679.	6435.	4157.
2	8955.	5311.	3359.	2229.	4459.	2868.	1902.	1043.	3300.	2150.	1401.	840.
3	391.	234.	75.	49.	1135.	747.	497.	314.	415.	260.	154.	90.
4+	52.	35.	24.	16.	43.	29.	19.	13.	197.	132.	89.	59.
SSN	11800.				7755.				5364.			
SSB	232407.				160706.				110410.			
TSN	33407.	92883.	61870.	41324.	26820.	67033.	44623.	28873.	18424.	33884.	22600.	14875.
TSB	383658.	432916.	604292.	449275.	294162.	343488.	468677.	320512.	201832.	238697.	288473.	194513.

Year	2004				2005				2006			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	29820.	19989.	13387.	*	117505.	78766.	52798.	*	59774.	40068.	26850.
1	6520.	4360.	2919.	1915.	8927.	5984.	4011.	2689.	35392.	23699.	15840.	10512.
2	2742.	1793.	1189.	755.	1202.	806.	540.	362.	1802.	1165.	744.	445.
3	431.	282.	184.	118.	442.	296.	199.	133.	243.	156.	85.	51.
4+	73.	49.	33.	22.	92.	62.	42.	28.	108.	72.	48.	32.
SSN	3899.				2630.				5692.			
SSB	86248.				55568.				80159.			
TSN	9767.	36303.	24314.	16198.	10664.	124653.	83557.	56010.	37544.	84867.	56785.	37891.
TSB	127324.	143193.	215118.	162929.	111810.	135449.	450483.	401548.	303126.	406939.	593352.	424534.

Year	2007	
Season	1	2
AGE		
0	*	138784.
1	17697.	11863.
2	6157.	4127.
3	257.	172.
4+	55.	37.
SSN	8240.	
SSB	161236.	
TSN	24167.	154983.
TSB	272728.	328962.

Table 5.1.4 Norway pout IV & IIIaN (Skagerak).

Seasonal extended survivor analysis (SXSA) of Norway pout in the North Sea and Skagerrak.

Fishing mortalities by quarter of year.

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.004	0.033	*	0.000	0.000	0.052	*	0.000	0.000	0.022
1	0.048	0.032	0.169	0.225	0.054	0.069	0.285	0.392	0.084	0.051	0.135	0.588
2	0.127	0.213	0.578	0.355	0.130	0.193	0.589	0.768	0.336	0.067	0.773	0.555
3	0.168	0.194	0.779	1.504	0.281	1.608	0.934	0.000	0.680	0.119	0.316	0.000
4+	0.000	1.807	*	*	0.000	0.000	0.000	0.000	0.428	0.000	0.000	0.000
F (1- 2)	0.087	0.122	0.373	0.290	0.092	0.131	0.437	0.580	0.210	0.059	0.454	0.572

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.000	0.100	*	0.000	0.000	0.013	*	0.000	0.011	0.069
1	0.019	0.019	0.140	0.406	0.078	0.050	0.123	0.294	0.022	0.013	0.038	0.219
2	0.590	0.111	0.646	0.267	0.190	0.049	0.233	0.725	0.185	0.033	0.184	0.636
3	0.637	0.060	0.212	0.000	0.156	0.000	0.010	0.264	0.168	0.000	0.000	0.000
4+	0.139	0.000	0.000	0.000	0.068	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.304	0.065	0.393	0.336	0.134	0.049	0.178	0.510	0.104	0.023	0.111	0.428

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.002	0.101	*	0.000	0.000	0.021	*	0.000	0.005	0.040
1	0.061	0.037	0.150	0.287	0.062	0.097	0.087	0.179	0.050	0.033	0.126	0.149
2	0.029	0.127	0.501	0.431	0.185	0.349	0.231	0.279	0.396	0.255	0.265	0.491
3	0.022	0.034	0.040	0.186	0.198	0.368	0.241	0.317	0.480	0.219	0.547	1.624
4+	0.000	0.000	0.000	0.000	0.236	0.000	0.000	0.000	0.513	0.000	0.000	0.000
F (1- 2)	0.045	0.082	0.325	0.359	0.124	0.223	0.159	0.229	0.223	0.144	0.195	0.320

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.016	0.026	*	0.000	0.002	0.045	*	0.000	0.004	0.038
1	0.063	0.043	0.159	0.232	0.082	0.055	0.126	0.202	0.121	0.037	0.168	0.359
2	0.282	0.143	0.359	0.578	0.104	0.118	0.433	0.510	0.209	0.184	0.567	0.477
3	0.891	0.558	0.062	0.209	0.072	0.552	0.472	0.105	0.142	0.126	0.637	0.000
4+	*	*	*	*	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.173	0.093	0.259	0.405	0.093	0.086	0.279	0.356	0.165	0.111	0.367	0.418

Year	1995				1996				1997			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.013	0.049	*	0.000	0.006	0.030	*	0.000	0.003	0.014
1	0.056	0.042	0.088	0.199	0.024	0.038	0.115	0.120	0.012	0.003	0.131	0.140
2	0.149	0.294	0.099	0.219	0.080	0.033	0.281	0.178	0.101	0.066	0.333	0.401
3	0.041	0.425	0.081	0.135	0.091	0.474	1.586	0.171	0.072	0.183	0.305	0.197
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.103	0.168	0.094	0.209	0.052	0.036	0.198	0.149	0.056	0.034	0.232	0.271

Year	1998				1999				2000			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.002	0.010	*	0.000	0.000	0.013	*	0.000	0.002	0.010
1	0.016	0.020	0.059	0.125	0.009	0.021	0.138	0.104	0.012	0.008	0.057	0.340
2	0.084	0.061	0.106	0.114	0.049	0.138	0.407	0.445	0.054	0.097	0.216	0.397
3	0.190	0.129	0.018	0.258	0.063	0.132	0.082	0.089	0.015	0.494	0.529	0.381
4+	0.078	0.444	0.000	0.000	0.013	0.006	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.050	0.040	0.083	0.120	0.029	0.080	0.273	0.274	0.033	0.052	0.136	0.369

Year	2001				2002				2003			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.001	0.014	*	0.000	0.012	0.016	*	0.000	0.001	0.000
1	0.011	0.010	0.014	0.047	0.028	0.031	0.087	0.109	0.005	0.008	0.037	0.016
2	0.121	0.058	0.010	0.268	0.041	0.010	0.197	0.494	0.028	0.028	0.110	0.260
3	0.115	0.678	0.018	0.022	0.018	0.008	0.059	0.107	0.066	0.122	0.132	0.530
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.026
F (1- 2)	0.066	0.034	0.012	0.158	0.035	0.021	0.142	0.302	0.017	0.018	0.073	0.138

Table 5.1.4 (Cont´d.). Norway pout IV & IIIaN (Skagerak).

Year	2004				2005				2006			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.001	0.005	*	0.000	0.000	0.000	*	0.000	0.000	0.017
1	0.002	0.001	0.021	0.065	0.000	0.000	0.000	0.000	0.001	0.003	0.010	0.133
2	0.025	0.011	0.053	0.133	0.000	0.000	0.000	0.000	0.036	0.048	0.112	0.147
3	0.026	0.024	0.046	0.018	0.000	0.000	0.001	0.001	0.043	0.204	0.107	0.017
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.014	0.006	0.037	0.099	0.000	0.000	0.000	0.000	0.018	0.026	0.061	0.140

Year	2007	
Season	1	2
AGE		
0	*	0.000
1	0.000	0.000
2	0.000	0.000
3	0.000	0.001
4+	0.000	0.000
F (1- 2)	0.000	0.000

Table 5.1.5 Norway pout IV & IIIaN (Skagerak). Stock summary table. (SXSA Baseline September 2007. (Recruits in millions. SSB and TSB in t, and Yield in '000 t).

Year	Recruits (age 0 2nd qrt)	SSB (Q1)	TSB (Q3)	Landings ('000 t)	Fbar(1-2)
1983	220869	369606	1902065	457.6	0.872
1984	119189	371336	1145210	393.01	1.240
1985	85603	166602	641004	205.1	1.295
1986	157960	87647	723958	174.3	1.098
1987	46306	96397	592969	149.3	0.871
1988	127751	126211	572230	109.3	0.666
1989	135717	85336	767521	166.4	0.811
1990	127097	125512	740865	163.3	0.735
1991	243243	144788	1090567	186.6	0.882
1992	103333	174036	1050528	296.8	0.930
1993	72621	218963	621898	183.1	0.814
1994	308548	118608	1086036	182	1.061
1995	97145	117303	1196017	236.8	0.574
1996	234709	296063	1131983	163.8	0.435
1997	67184	193267	1030939	169.7	0.593
1998	93322	260922	644101	57.7	0.293
1999	229241	150539	1000563	94.5	0.656
2000	80663	161917	1040643	184.4	0.590
2001	71390	232407	604292	65.6	0.270
2002	49587	160706	468677	80	0.500
2003	21662	110410	288473	27.1	0.246
2004	29820	86248	215118	13.5	0.156
2005	117505	55568	450483	1.9	0.000
2006	59774	80159	593352	46.6	0.245
2007	138784	161236			
Arit mean	**121,561**	**166,071**	**816,646**		**0.660**
Geomean	**100,750**				

Table 5.2.1 **NORWAY POUT IV and IIIaN (Skagerak). Input data to forecast for Norway pout in the North Sea and Skagerak September 2007.**

Escapement strategy HCR: With 2007 (assessment year) closed for directed fishery and 2008 (forecast year) fishing pattern scaled to long term seasonal exploitation pattern for 1991-2004 (standardized with yearly Fbar to F(1,2)=1). Recruitment in forecast year is assumed to the 25% percentile = 72558 millions (of the long term geometric mean = 103822 millions).

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2007	1	0	0	0	0.000	0.000	0.4	0
2007	1	1	17697	0	0.007	0.012	0.4	0.1
2007	1	2	6157	0	0.022	0.028	0.4	1
2007	1	3	312	0.000	0.040	0.041	0.4	1
2007	2	0	138784	0.000	0.000	0.000	0.4	0
2007	2	1	2	0	0.015	0.015	0.4	0
2007	2	2	0	0	0.034	0.026	0.4	0
2007	2	3	0	0	0.050	0.035	0.4	0
2007	3	0	0	0.000	0.004	0.010	0.4	0
2007	3	1	0	0.000	0.025	0.029	0.4	0
2007	3	2	0	0.000	0.043	0.039	0.4	0
2007	3	3	0	0	0.060	0.049	0.4	0
2007	4	0	0	0	0.006	0.009	0.4	0
2007	4	1	0	0	0.023	0.027	0.4	0
2007	4	2	0	0.000	0.042	0.040	0.4	0
2007	4	3	0	0.000	0.058	0.048	0.4	0

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2008	1	0	0	0.000	0.000	0.000	0.4	0
2008	1	1	0	0.052	0.007	0.012	0.4	0.1
2008	1	2	0	0.211	0.022	0.028	0.4	1
2008	1	3	0	0.269	0.040	0.041	0.4	1
2008	2	0	72558	0.000	0.000	0.000	0.4	0
2008	2	1	0	0.043	0.015	0.015	0.4	0
2008	2	2	0	0.176	0.034	0.026	0.4	0
2008	2	3	0	0.615	0.050	0.035	0.4	0
2008	3	0	0	0.009	0.004	0.010	0.4	0
2008	3	1	0	0.163	0.025	0.029	0.4	0
2008	3	2	0	0.407	0.043	0.039	0.4	0
2008	3	3	0	0.597	0.060	0.049	0.4	0
2008	4	0	0	0.038	0.006	0.009	0.4	0
2008	4	1	0	0.277	0.023	0.027	0.4	0
2008	4	2	0	0.668	0.042	0.040	0.4	0
2008	4	3	0	0.507	0.058	0.048	0.4	0

Table 5.2.2 NORWAY POUT in IV & IIIa, September 2007.
Results of the short term forecast for Norwayt pout
in the North Sea and Skagerak with different
levels of fishing mortality.

SSB in the start of the Forecast year (1st Jan. 2008): 161 000 t

F(2008)	Landings(2008) `000 t	SSB(2009) ´000t
0.0	0	230
0.1	31	216
0.2	59	204
0.3	85	192
0.4	110	181
0.5	133	171
0.6	154	162
0.7	175	153
0.8	194	145
0.9	212	137
1.0	229	130
1.1	245	123
1.2	260	117
1.3	274	111
1.4	288	106
1.5	301	101
1.6	313	96
1.7	325	91
1.8	337	87
1.9	347	83
2.0	358	79

Shaded scenarios are not considered consistent with the
precautionary approach.

Figures Norway pout IV & IIIa, September 2007:

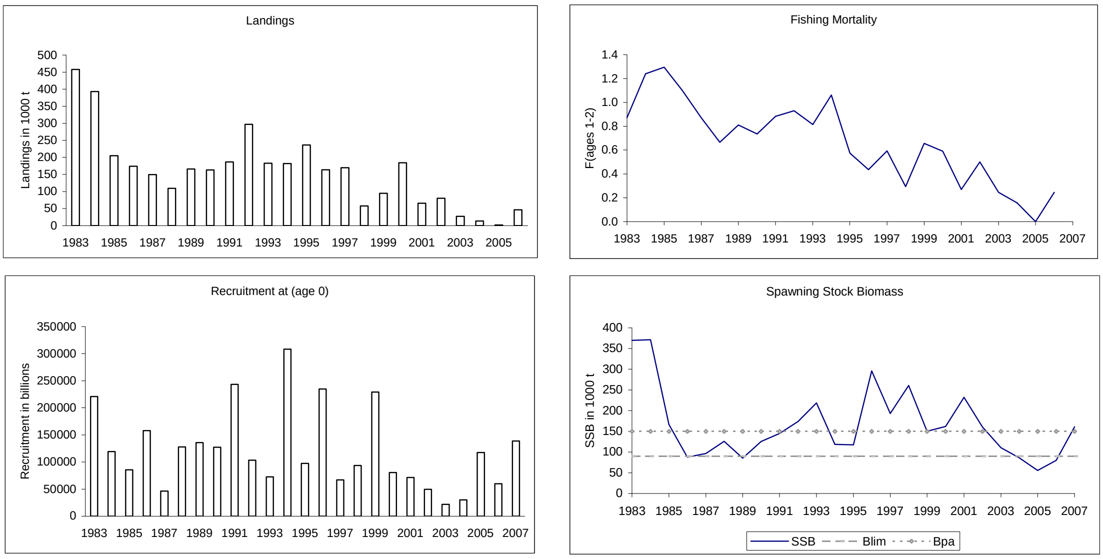


Figure 5.1.1 Norway Pout IV and IIIaN (Skagerak). Stock Summary Plots. SXSA baseline run September 2007.

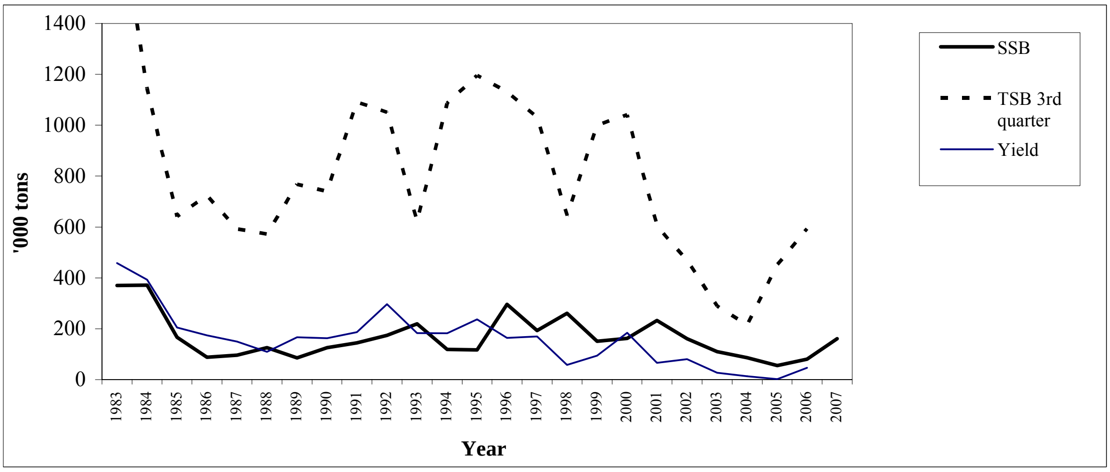
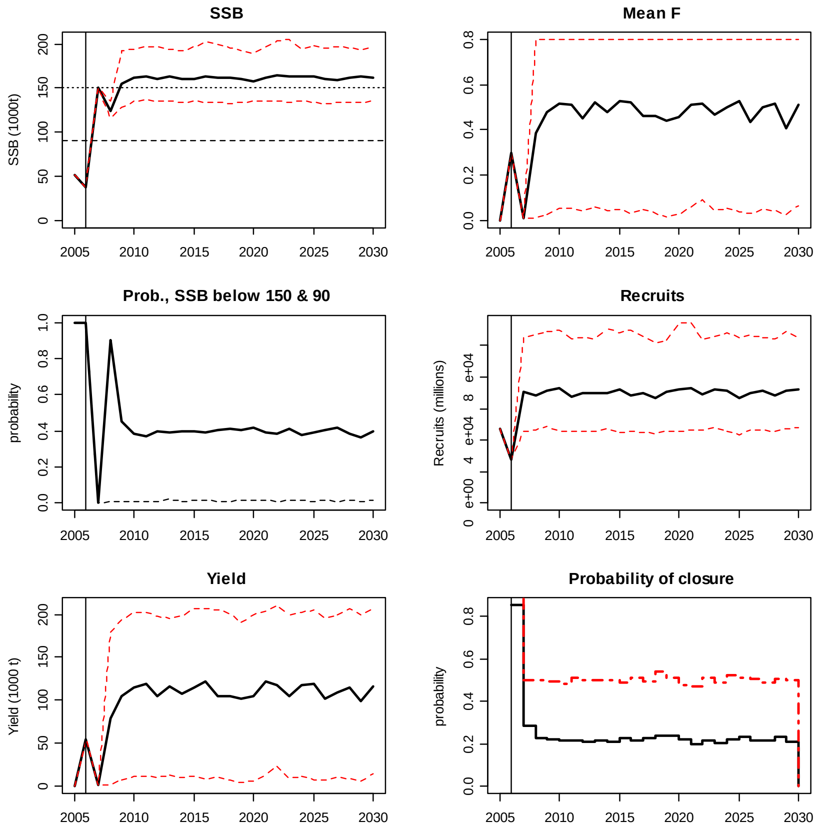
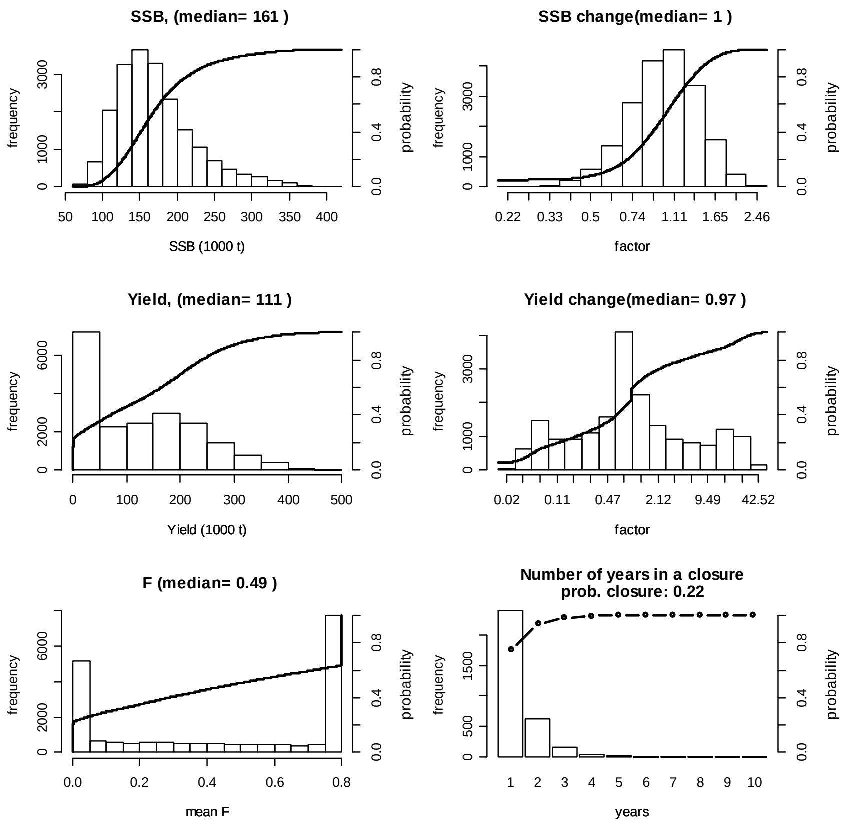


Figure 5.1.2 Norway pout in IV and IIIaN (Skagerak). Trends in yield, SSB and TSB for Norway pout in the North Sea and Skagerrak during the period 1983-2007.



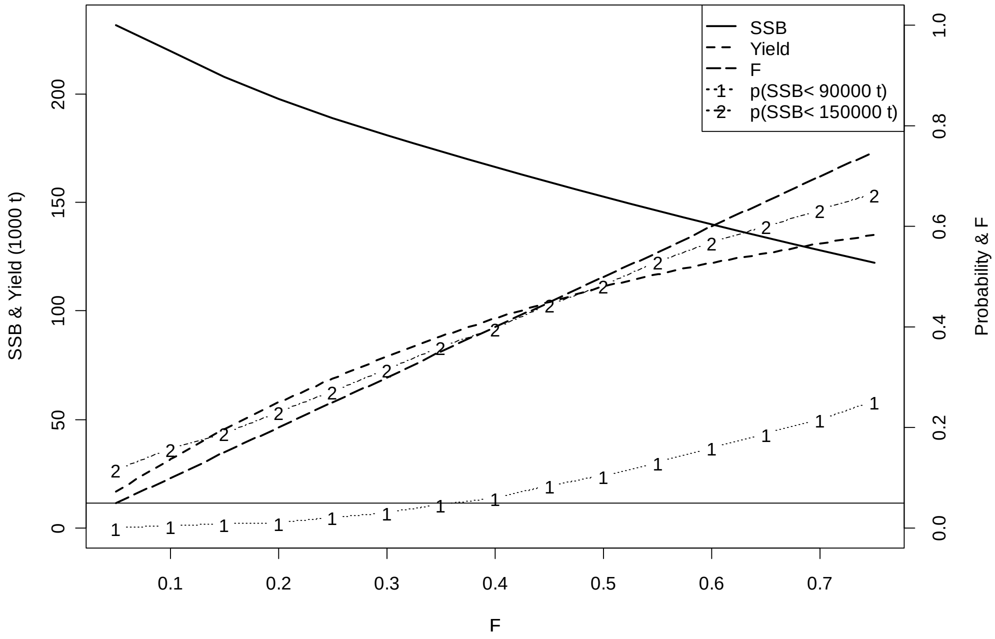
Settings:	
Assessment uncertainty: 0.30 CV, no bias	SSB-R: Hockey stick, Stochastic
Survey uncertanty: 0.42 CV, no bias	Cap F: 0.8
Cap TAC: none	Target SSB: 150 kt

Figure 5.3.1 Escapement strategy, Baseline. Mean trajectory of Norway pout SSB, yield, mean F, and recruit (25, 50, and 75 percentiles), and probability of a fishery closure in the first half-year (dashed, red line) and the second half-year (solid black line), and the probability of the SSB being below B_{pa} (150 kt) and B_{lim} (90 kt).



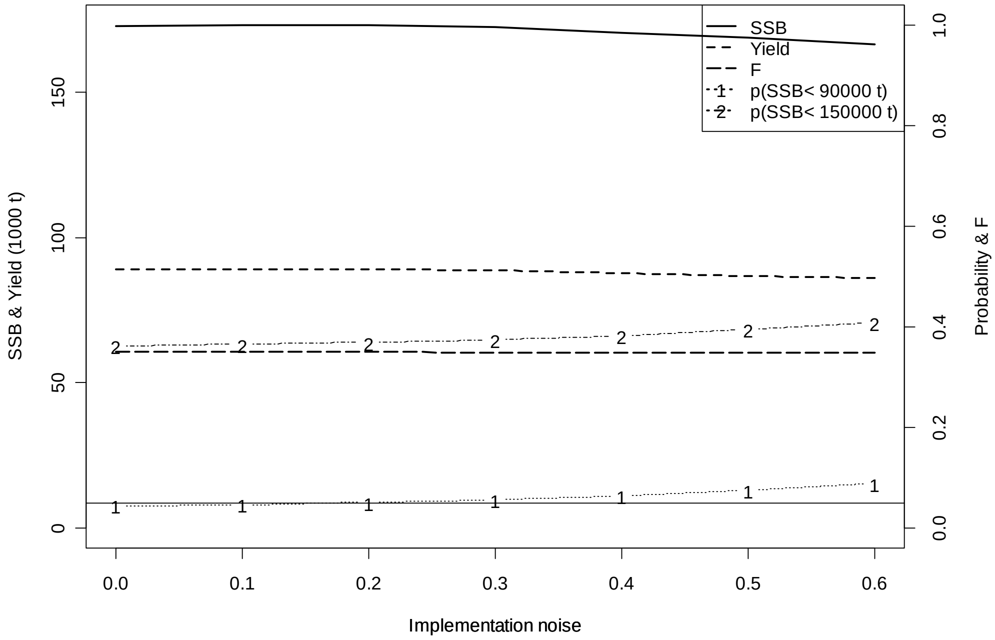
Settings:	
Assessment uncertainty: 0.3, log-normal, no bias	SSB-R: Hockey stick, Stochastic
Survey uncertanty: 0.42, log-normal, no bias	Cap F: 0.8
Cap TAC: none	Target SSB: 150 kt

Figure 5.3.2 Escapement strategy, Baseline. Distribution and cumulative probability of population metrics at long-term equilibrium. The closure of the fishery refers only to the second half year. For the yield change plot a minimum yield of 10 kt has been applied for years with no or very limited yield.



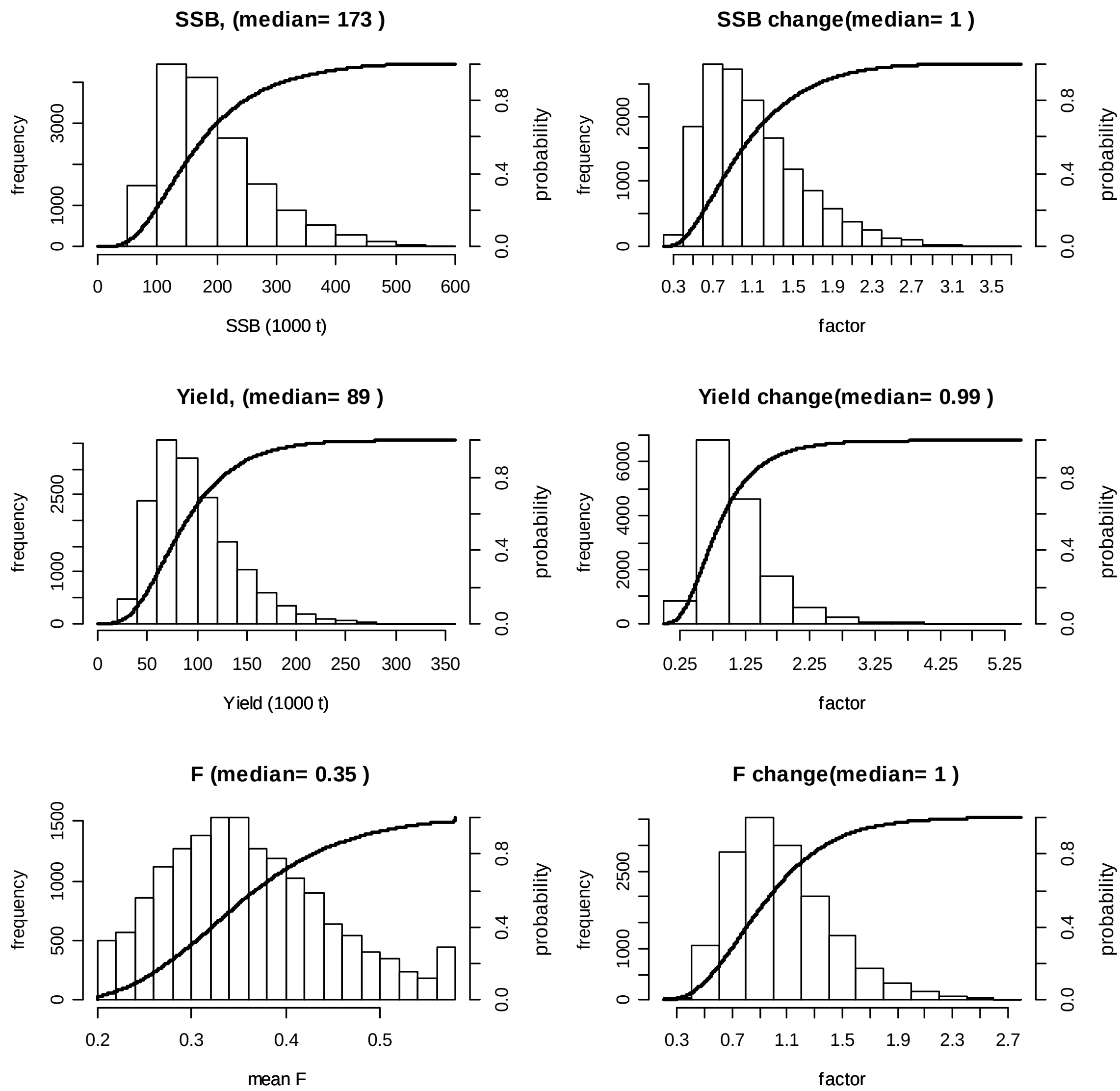
Settings:	
Assessment uncertainty: no	SSB-R: Hockey stick, Stochastic
Survey uncertanty: no	Cap F: none
Implemmentation uncertanty: no	Target SSB: none

Figure 5.3.3 Fixed effort strategy. Long-term equilibrium values.



Settings:	
Assessment uncertainty: no	SSB-R: Hockey stick, Stochastic
Survey uncertanty: no	Cap F: none
Implemmentation uncertanty: CV= 0 to CV=0.6, no bias	Target SSB: none

Figure 5.3.4 Fixed effort strategy. Long-term equilibrium values for levels of implementation noise.



Settings:	
Assessment uncertainty: not relevant	SSB-R: Hockey stick, Stochastic
Survey uncertanty: not relevant	Cap F: 0.8
Implemmentation uncertanty: CV=0.25 no bias	Target SSB: none

Figure 5.3.5 Fixed effort strategy. Long-term equilibrium values for levels of target F=0.35.

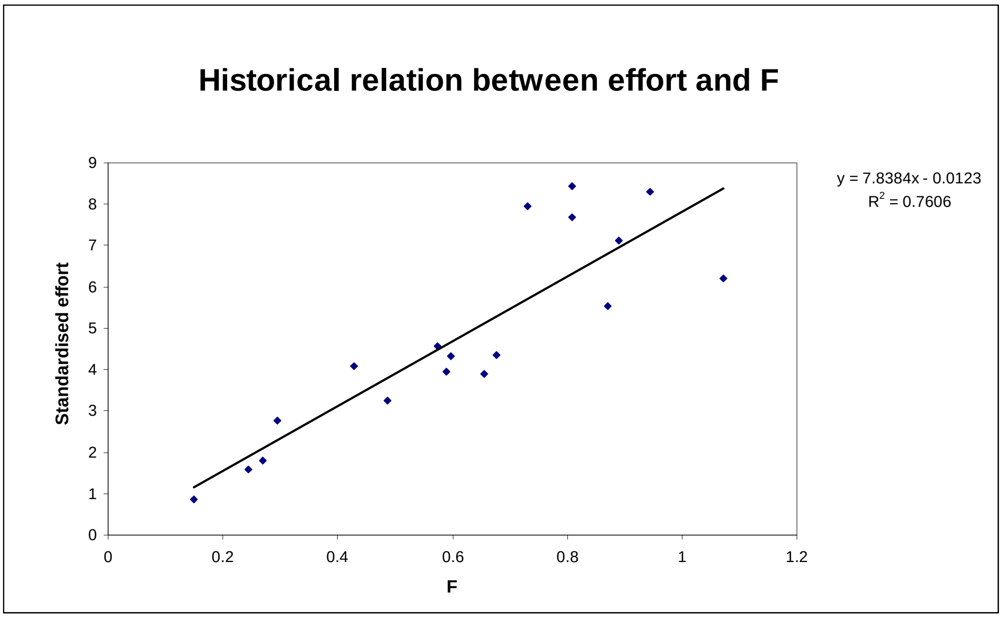
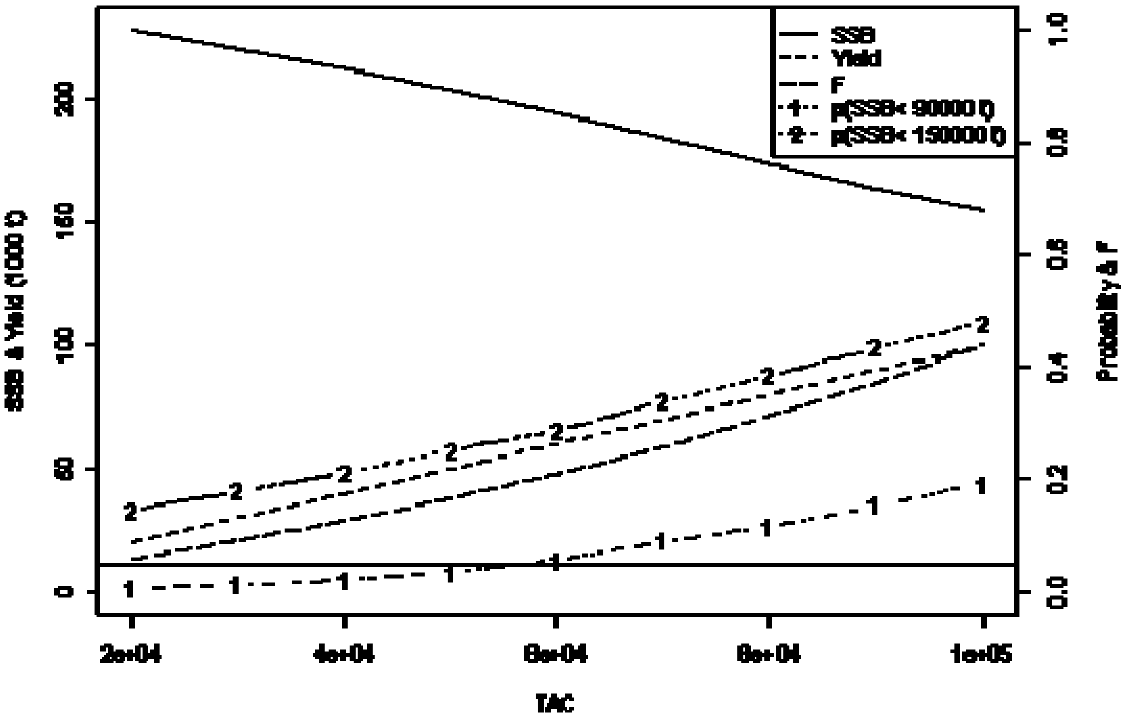
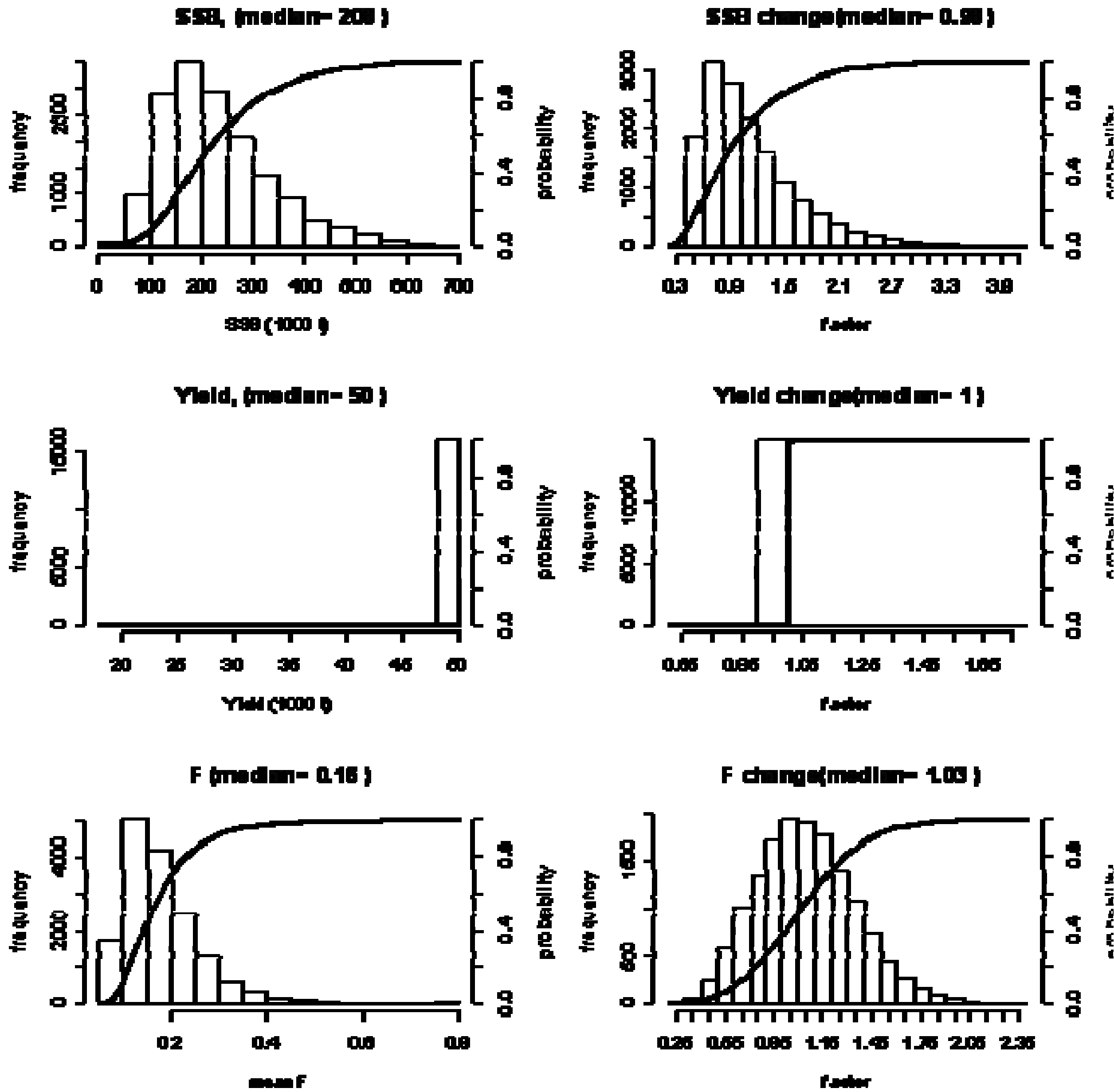


Figure 5.3.6 Historical relationship between yearly standardized effort and fishing mortality (ICES WGNSSK, 2007, September 2006).



Settings:	
Assessment uncertainty: not relevant	SSB-R: Hockey stick, Stochastic
Survey uncertanty: not relevant	Cap F: 0.8
TAC : varyieng 20000 - 100000 t	Target SSB: not relevant

Figure 5.3.7 Fixed TAC strategy, Long term equilibrium values for various levels of fixed TAC.



Settings:	
Assessment uncertainty: not relevant	SSB-R: Hockey stick, Stochastic
Survey uncertanty: not relevant	Cap F: 0.8
TAC : 50000 t	Target SSB: not relevant

Figure 5.3.8 Fixed TAC strategy, Long term equilibrium values

6 Plaice in Division VIId

This assessment of plaice in Division VIId is a benchmark assessment. Following the recommendations from the review group, more investigations have been carried out to attempt solving the recurrent issues raised during the previous years. 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

See section 9.1.1.

6.1.2 Fisheries

Plaice is mainly caught in beam trawl fisheries for sole or in mixed demersal fisheries using otter trawls. There is also a directed fishery during parts of the year by inshore trawlers and netters on the English and French coasts, where the main fleet segments are the English and Belgian beam trawlers. The Belgian beam trawlers fish mainly in the 1st (targeting spawning concentrations in the central Eastern Channel) and 4th quarter and their area of activity covers almost the whole of VIId south of the 6 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 VIId. The inshore trawlers and netters are mainly vessels <10m operating on a daily basis within 12 miles of the coast. There are a large number of these vessels (in excess of 400) operating from small ports along the French and English coast. These vessels target sole, plaice, cod and cuttlefish. The latter two groups are active when plaice is spread over the whole area and IVc.

Due to the minimum mesh size (80 mm) in the mixed beam trawl fishery, a large number of undersized plaice are discarded. The 80-mm mesh size is not matched to the minimum landing size of plaice (27 cm). Management measures directed at sole fisheries will also impact the plaice fisheries.

The first quarter is usually the most important for the fisheries but the share of the landings for this quarter has been decreasing from the early 1990s to a value around 30 – 35% of the total recently. In 2006, the beginning of the year still remains slightly predominant with the first semester corresponding to 57% of the total landings (see text table below). It is noticeable that the quarterly distribution in 2006 is very much similar to the 2005 values.

Quarter	Landings	Cum. landings	Cum. %
I	1135.4	1135.4	33
II	744.6	1780.0	57
III	652.5	2432.5	77
IV	713.1	3145.6	100

Age distributions (exploitation pattern) may be quite different between quarters, as shown for 2006 in Figure 6.1.2.1, with older fish being caught in quarter 1 and recruit at age 1 starting to be caught after summer. This is in line with what is known of the biology of this species, which operates spawning migration in the centre of the Eastern channel during winter.

Belgium beam trawlers are increasingly being equipped with 3D mapping sonar which opens up new areas to fishing (close to wrecks) and a few French vessels have shifted from otter trawl to Danish seine recently (WGFTFB, 2007). These changes are not likely to have modified the fisheries behaviour or affected the data entering into the assessment model.

6.1.3 ICES advice

The assessment is indicative of trends only. In the absence of a reliable assessment, the state of the stock cannot be evaluated in relation to the Precautionary Approach. Analysis of survey indices show that SSB has remained stable since 1998.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary limits

In the absence of short-term forecasts, ICES recommends to maintain landings in 2007 at 4000 t which is the average of landings from the last three years (2003 - 2005).

The assessment is indicative of trends only. In the absence of a reliable assessment, the state of the stock cannot be evaluated in relation to the Precautionary Approach. Analysis of survey indices show that SSB has remained stable since 1998.

6.1.4 Management

No explicit management objectives have been specified for this stock.

The TAC in 2006 and 2007 was set to 5080t and 5050t, respectively, 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.

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 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.

For 2007 Council Regulation (EC) N°41/2007 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 follows: Days at sea limitations for Trawls or Danish seines varies between 95 and unlimited days per year. Beam trawlers have an unlimited number of days permit. Maximum days at sea for Gillnets vary between 130 and 140 days per year. Trammel nets are allowed a maximum of 205 days for trip length less than 24 hours; otherwise the limit is 140 days.

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 2006 landings of 3146 t represent a fourth year of substantial decrease, falling well below the agreed TAC, even considering the landings of 1149t in VIIe as officially reported to ICES. As usual, France contributed the largest share but was below 50% of the total VIId landings in 2006 for the first time since 1997, followed by Belgium and UK.

Routine discard monitoring has recently begun following the introduction of the EU data collection regulations. Discards data for 2006 are available from France and UK (Tables 6.2.1.2a-c and Figure 6.2.1.1a-c) though sampling levels are not high. The percentage discarded per period, métier and country (Table 6.2.1.3) is highly variable and in every case substantial. In a total number of trips sampled of 9 and 4, the trawlers and beam trawlers have discarded 38% and 46% of the catches in number, all ages combined, respectively. The result of no discards from the only trip sampled for gillnetters is doubtful to be representative of the discarding behaviour of this métier. Discards from the Belgian beam trawler fleet could not be processed in time for the working group due to the shift of the working group to an earlier time in the year. The data will be available later in the year when time permits to compile the data. The time series of discards is currently not long enough to be used in analytical assessment. Discards at young ages have influence on the forecast and predictions, but are not thought to influence estimates of F and SSB.

6.2.2 Age compositions

Age compositions of the landings are presented in Table 6.2.2.1. Sampling levels for those countries providing age compositions will be given in the September report.

6.2.3 Weight at age

Weight at age in the catch is presented in Table 6.2.3.1 and weight at age in the stock in Table 6.2.3.2, both are presented Figure 6.2.3.1. The procedure for calculating mean weights is described in the Stock Annex.

6.2.4 Maturity and natural mortality

Information about maturity per age class is given with the table included in this section. 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	0	0.15	0.53	0.96	1	1	1	1	1	1

6.2.5 Catch, effort and research vessel data

Effort and CPUE data are available from four commercial fleets (Figure 6.2.5.1). These are:

- UK Inshore Trawlers
- Belgian Beam Trawlers
- French otter trawlers
- UK Beam Trawlers

The survey series consist of:

- UK Beam Trawlers
- French Ground Fish Survey
- International Young fish survey.

All survey and commercial data available for calibration of the assessment are presented in Tables 6.2.5.1 and Figure 6.2.5.1 and fully described in the Stock Annex. 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.

6.3 Data analyses

A benchmark assessment has been carried out this year. A series of exploratory analysis are then carried out to examine the effect of different F shrinking and the respective performance of individual tuning fleets. In the following sections, the catch at age matrix and the tuning fleets are examined, plus an analysis of a survey-based assessment with SURBA which avoids the use of commercial CPUE.

6.3.1 Reviews of last years assessment

In 2006, RGNSSK stated that :

1) *the status of the assessment ('update') is not relevant in this case and concerns raised last year should have been investigated, particularly for discards, surveys, geographical distribution of the fishery and stock identity.*

2) *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.*

3) *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.*

4) *None of the surveys are well documented in the Stock Annex and maps showing the geographical coverage of each of them (with plaice abundance) should be provided.*

The four issues were addressed by the working group the following way :

1) No inter-sessionary work has been carried out specifically on the issues raised by the RG. However, an InterReg project is on-going in the Eastern Channel with the objective of addressing ecosystem issues. Preliminary results have been included in the stock annex and a summary is provided in Sole VIId section 9.1.1. This project, in the process of extending to the total Eastern channel area and including other partners, will be of high interest to the WG.

2) in-depth exploration has been carried out and described in section 6.3.

3) The consistency and quality of the new tuning fleet has been examined and this new series included in the assessment (section 6.3)

4) Maps of survey positions have been included in the Stock annex, and maps of the UK BTS spatial distribution of indices from 1996 to 2006 are presented in this report in Figure 6.3.4.3.

6.3.2 Exploratory catch-at-age-based analyses

The investigation on the level of shrinking has confirmed the result found last year, i.e. visible but no drastic effect on retrospective performance (Figure 6.3.2.1). The tendency to underestimate F and overestimate SSB from year to year is slightly constrained by a strong shrinkage but never disappears The similarities between results obtained with F shrinkage values of 1.0, 1.5 and 2.0 may be explained by the large reduction of influence on the estimates of survivors at age when shifting from 0.5 to 1.0, as shown in the text table below. With XSA settings as defined section 6.3.5, the difference in scaled weights at age when increasing F shrinkage value to 1.5 or 2.0 is not sufficient to operate visible discrepancies.

Age / F shrinkage	0.5	1	1.5	2
1	0.41	0.15	0.07	0.04
2	0.22	0.06	0.03	0.02
3	0.16	0.04	0.02	0.01
4	0.19	0.05	0.02	0.01
5	0.15	0.04	0.02	0.01
6	0.13	0.03	0.02	0.01
7	0.12	0.03	0.01	0.01
8	0.15	0.04	0.02	0.01
9	0.17	0.04	0.02	0.01

Table : F shrinkage influence (scaled weights) on the final estimates of survivors at age.

The log catch ratio residuals of the separable VPA (Figure 6.3.2.2) show no special pattern nor large values for the recent years of data, which suggests a relative consistency of the catch-at-age matrix.

The log catchability residuals from single fleet runs (with settings as in XSA and F shrinkage = 1.0) are shown figure 6.3.2.3 for all the fleets including the new UK Beam trawler fleet. Together with the two surveys covering the entire geographical area of the stock (UK BTS and French GFS), the UK Inshore Trawl residuals are increasing from the mid 90's, indicating a progressive divergence with the landings at age. There is a jump in the residuals of the UK BTS in 2000, correlated to the decrease of the SSB that same year and the discrepancy between the surveys and the commercial fleets originates from that period. A similar pattern occurs also in the log catchability residuals of this survey for sole VIId. The French Otter trawlers series show a step shift in 1997, although no known reason was found for this. The group recommended to separate this series into two parts, one ending in 1996 and the other beginning in 1997. The log catchability residuals from a XSA run combining all fleets are shown Figure 6.3.2.4.

The rationale to include a new commercial tuning series was because the UK Inshore Trawl effort had strongly decreased in recent years and were therefore considered not representative of the dynamic of the stock due to sample noise. The UK Beam Trawl was thought to be more consistent in terms of its effort series and LPUE and was included in the assessment and the UK Inshore Trawl removed.

6.3.3 Exploratory survey-based analyses

The survey-based analysis was carried out with SURBA software, the results being shown in Figures 6.3.3.1 and 6.3.3.2. 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 3 to 6 like the XSA analysis. The SURBA analysis has been proven to be insensitive to the choice of the initial parameters in the neighborhood of those chosen here (ICES WGNSSK 2005). Figures 6.3.3.1 shows a good performance of the UK beam trawl survey for tracking year classes through time. This is different from the French GFS, which exhibits rather erratic patterns and has a low internal consistency. Moreover, comparing the standardized index per survey (Figure 6.3.3.2) shows year class strength estimated by the FR GFS different from those proposed by UK BTS. This is particularly the case for the modest YC 1998 and 1999 (as assessed by XSA) estimated to be very high only at age 5 and 4 respectively by FR GFS. Considering the relative consistency of FR GFS at younger ages, the group recommended to truncate the age range of this survey to ages 1 to 3 in the assessment. The group welcomed the idea of doing an internal workshop on this survey (re-reading of the otoliths, investigation on different means of deriving the indices), especially knowing that similar discrepancies have been put in evidence for cod indices.

The retrospective analysis (Figure 6.3.3.3) does not show tendencies to under or over estimate as does the XSA but the estimates of mean Z are given with confidence bounds that question on the quality of this information. Some extreme values prevent from drawing a contrasted picture of the recruitment estimates by SURBA.

6.3.4 Conclusions drawn from exploratory analyses

From the exploratory analysis, the group agreed that the new parametrisation of the model should exclude UK inshore trawl,, include the new UK Beam trawl fleet, split the FR otter trawlers fleet in two, truncate FR GFS to ages 1 to 3 and use a level of F shrinkage of 1.0. A summary table of these settings can be found section 6.3.5.

There is a decreasing trend in the contribution of the first quarter to the whole landings, where a fishery on the spawners takes place, yielding an age distribution 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 shown to take place and is substantial, but is constrained to younger ages. The year range of the data series is too short to make use of it in the analysis.

Both landings-at-age and tuning fleets information are highly dependent on the accuracy of the spatial declaration of the fishing activity as an important component of the fisheries operates on the borderline to ICES subdivision IVc.

Comparison of historical dynamics perceived through XSA and SURBA models and from current and previous year's analysis is shown Figure 6.3.4.1 on SSB, F and Recruitment estimates. The values shown in this figure are also respectful of the settings used in 2006 and those modified in 2007 (see section above). The F signals coming from SURBA and XSA are hardly comparable, but the discrepancies are not truthful given the uncertainty surrounding F in SURBA. The recruitment estimates are much more volatile in SURBA than in XSA but the ups and downs are found concurrently. The mean standardized values of SSB obtained from XSA and SURBA diverged in 2000 and 2001, and followed a strict parallel behaviour since then. Looking solely on the recent years trends, the two models agree that the SSB follows a stepped decline (taking into account the overestimation tendency of the two last years) since the end of the 90's. This tendency is confirmed by a survey carried out in 2006 to assess French fisher's perception of the Eastern Channel ecosystem (Prigent *et al.*, 2007). 76% of the interviewees expressed their worry and found the fisheries resources depleted, especially flatfish and gadoids.

Figure 6.3.4.2 compares the single fleet performances to the final assessment. The two main surveys keep diverging from the commercial fleets. A map of UK BTS indices per tow locations from 1996 to 2006 (Figure 6.3.4.3) shows that the catches of plaice by the survey occur mainly inshore, whereas the commercial fisheries spread all over the Channel as plaice is mainly taken as a by-catch. It is important to notice that the three surveys occur in the second half of the year, whereas the period when the most plaice is landed is the first semester. A part of the annual dynamic of the stock seems to be missing in the survey indices.

The group decided to accept the current assessment with the new settings considering the following arguments :

1) XSA and SURBA give the same signal during the last 6 years,
2) XSA reflects commercial activities during all the year, whereas surveys occur after the reproduction migrations,
3) XSA fitted to the new commercial fleet is more accurate in representing the LPUE evolution and
4) The XSA estimates are in line with the fisher's perception of this stock

6.3.5 Final assessment

The settings in the XSA assessment for the last two years are:

Year of assessment:		2006	2006
Assessment model:		XSA	XSA
Assessment software		VPA95	FLR library
Fleets:			
UK Inshore Trawlers	Age range	2-10	**Excluded**
	Year range	1985 onwards	
UK Beam Trawl	Age range	-	**2-10**
	Year range		**1991 onwards**
BE Beam Trawlers	Age range	2-10	2-10
	Year range	1981 onwards	1981 onwards
FR Otter Trawlers	Age range	2-10	**2-10**
	Year range	1989 onwards	**1989 – 1996**
			2-10
			1997 onwards
UK Beam Trawl Survey	Age range	1-6	1-6
	Year range	1988 onwards	1988 onwards
FR Ground Fish Survey	Age range	0-5	**1-3**
	Year range	1988 onwards	1988 onwards
Intern'l Young Fish Survey	Age range	0-1	1
	Year range	19887 onwards	19887 onwards
Catch/Landings			
Age range:		1-10+	1-10+
Landings data:		1980-2005	1980-2006
Discards data		None	None
Model settings			
Fbar:		3-6	3-6
Time series weights:		none	None
Power model for ages:		No	No
Catchability plateau:		Age 7	Age 7
Survivor est. shrunk towards the mean F:		5 years / 5 ages	5 years / 3 ages**
S.e. of mean (F-shrinkage):		0.5	**1.0**
Min. s.e. of population estimates:		0.3	0.3
Prior weighting:		no	no

**Last year's setting at 5 ages was a mistake

The final XSA output is given in Table 6.3.5.1 (diagnostics), table 6.3.5.2 (fishing mortalities) and Table 6.3.5.3 (stock numbers). A summary of the XSA results is given in Table 6.5.3.4 and trends in yield, fishing mortality, recruitment and spawning stock and Total Stock biomass are shown in Figure 6.3.5.4.

6.1 Historic Stock Trends

Fishing mortality has decreased during the last 4 years. It is noticeable that the dynamic of F has a similar trend to the dynamic of the French trawlers effort series.

Two strong year classes dominate the history of this stock. The 1985 year class was followed by the 4 most productive years in the available time series, and the 1996 year class, although estimated at 65% of the 1985 year class, only resulted in stabilization of the yield for a few more years. The ephemeral peek of SSB in 1999 has been followed by years of stepped decline. Current SSB is estimated to be stable at its lowest level for the last 4 years. This confirms the fisher's perception assessed by a survey in France in 2006.

Recruitment is stable over the last 6 years at a lower level than in the first part of the historical series. GM 1980 – 1997 is around 24 millions fish at age 1, whereas GM for the most recent period (1998 – 2006) is 17.5 millions.

6.4 Recruitment estimates

Recruitment estimation was carried out according to the specifications in the stock annex. The model used was RCT3. Input to the RCT3 model is presented in table 6.5.1. Results are presented in table 6.5.2 and 6.5.3. For the estimation of year classes 2005 and 2006, the new information brought in by the RCT3 analysis was not considered to be reliable enough to be taken into account (r-square close to 0 and high standard errors).

The 2005 year class was estimated to be around 15 millions fish at age 1 in 2006. This year class may be stronger as the estimation of both UK BTS and FR GFS are revised downward by the International YFS.

The 2006 and 2007 year classes were estimated using the average recruitment calculated over the period 1998-2004. The truncation was meant to take into account the relative stability of the recruitment in the recent years at a lower level than at the beginning of the series. The geometric mean was about 18 million 1-year-old-fish. Year class strength estimates used for short term prognosis are summarised in the text table below.

Year Class	Age in 2007	XSA (Thousands)	RCT3 (Thousands)	GM (1999-2004) (Thousands)
2005	2	**13296**	17125	-
2006	1	-	24050	**17969**
2007	0	-	-	**17969**

6.5 Short-term forecasts

The short term prognosis was carried out with FLR package. The trend in F seen in the recent years (Figure 6.6.1) favors the use of a three years average scaled to the last year exploitation pattern. Although the 2006 exploitation pattern shows a noisy signal (Figure 6.6.2), it expresses a trend of F decreasing in the younger ages and increasing in the older ages in the recent years (Figure 6.6.2). The exploitation pattern used was then the mean F-at-age over the period 2004-2006 rescaled to the last year. The weights used for prediction were the average over the last three years. Input to the short term predictions are presented in table 6.6.1 and results in tables 6.6.2.

Assuming *status quo F* implies a catch in 2007 of 3777t (the agreed TAC is 5050t for both VIId and VIIe) and a catch of 3984t in 2008. Assuming *status quo F* will result in a SSB in 2008 and 2009 of 7111t and 7592t , respectively.

6.6 Medium-term forecasts

No medium-term forecast is available for this stock.

6.7 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	
$B_{lim} \sim B_{loss}$ (= 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 %

6.8 Quality of the assessment

- The sampling for plaice in VIId are considered to be at a reasonable level
- Discarding of plaice is significant and variable depending on the gear used. The omission of young fish discards has influence on the forecast and the predictions, but unlikely affects the estimates of F and SSB.
- The assessment has a tendency to overestimate SSB and underestimate F, especially from 2000 when surveys and commercial fleets information began to diverge.
- The estimates of 2005 year class is uncertain due to conflicting signals coming from one survey against the two others.
- Trends from surveys and commercial fleets are similar before and after 2000. The rescaling of surveys estimates operated in 2000 is consistent with the shift in log q residuals seen for FR GFS and UK BTS, both for plaice and sole in VIId.
- This assessment has been deeply revised after two years of rejection. Although progress has been made in the comprehension of the dynamics of this stock, much remains to be done before next year's assessment.

6.9 Status of the stock

Fishing mortality estimated in 2006 at 0.45 has decreased from the last 4 years to the Fpa value.

The spawning stock biomass has followed a stepped decline in the last 10 years, following a peak generated by the strong 1996 year class. The current level of SSB is stable at a low level below Blim, and this confirms the fisher's impression assessed by a survey in France in 2006.

The year class 2005 (recruited in 2006) was estimated at 15 million fish, which corresponds to a value among the lowest in the time series.

The projections, at the current level of recruitment and with a value of F at the low 2006 level, indicate a stock slowly recovering.

6.10 Management considerations

Managers should consider that stock identity of plaice in the Channel is unclear and may raise some issues :

- SSB is close to its lowest level and below Blim, a perception shared by fishers.
- The TAC is for Divisions VIId and VIIe combined. Plaice in VIIe is considered at risk of being harvested unsustainably and estimated from trends in the assessment to be at a very low level. Plaice stocks in VIIe, VIId and IV are at the lowest level in history.
- 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

6.11 Comments

Suggested plan for intersession work:

- Estimate the discard volume per year since the at-sea sampling scheme has been put in place and integrate this information 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.
- Work on the FR GFS indices to investigate on errors or new methodologies to derive the indices that would better match the stocks dynamics. This work should also include cod and whiting indices.

Table 6.2.1.1 - Plaice in VIId. Nominal landings (tonnes) as officially reported to ICES , 1976-2006

Year	Belgium	Denmark	France	UK(E+W)	Others	Total reported	Un-allocated	Total as used by WG	Agreed TAC (5)
1976	147	1(1)	1439	376	-	1963	-	1963	
1977	149	81(2)	1714	302	-	2246	-	2246	
1978	161	156(2)	1810	349	-	2476	-	2476	
1979	217	28(2)	2094	278	-	2617	-	2617	
1980	435	112(2)	2905	304	-	3756	-1106	2650	
1981	815	-	3431	489	-	4735	34	4769	
1982	738	-	3504	541	22	4805	60	4865	
1983	1013	-	3119	548	-	4680	363	5043	
1984	947	-	2844	640	-	4431	730	5161	
1985	1148	-	3943	866	-	5957	65	6022	
1986	1158	-	3288	828	488 (2)	5762	1072	6834	
1987	1807	-	4768	1292	-	7867	499	8366	8300
1988	2165	-	5688 (2)	1250	-	9103	1317	10420	9960
1989	2019	+	3265 (1)	1383	-	6667	2091	8758	11700
1990	2149	-	4170 (1)	1479	-	7798	1249	9047	10700
1991	2265	-	3606 (1)	1566	-	7437	376	7813	10700
1992	1560	1	3099	1553	19	6232	105	6337	9600
1993	877	+(2)	2792	1075	27	4771	560	5331	8500
1994	1418	+	3199	993	23	5633	488	6121	9100
1995	1157	-	2598 (2)	796	18	4569	561	5130	8000
1996	1112	-	2630 (2)	856	+	4598	795	5393	7530
1997	1161	-	3077	1078	+	5316	991	6307	7090
1998	854	-	3276 (23)	700	+	4830	932	5762	5700
1999	1306	-	3388 (23)	743	+	5437	889	6326	7400
2000	1298	-	3183	752	+	5233	781	6014	6500
2001	1346	-	2962	655	+	4963	303	5266	6000
2002	1204		3454	841		5499	278	5777	6700
2003	995	-	2783 (3)	756		4536	-	4536	6000
2004	987		2439 (4)	580		4007	-	4007	6060
2005	830		1756	411	20	3018	428	3446	5150
2006	998		1484	544	16	3042	104	3146	5080

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.

Tables 6.2.1.2a Plaice in VIId. Discards

(numbers raised to sampled trips)

	Discards					Landings				
	Fr trawl		Fr Gillnet	UK		Fr trawl		Fr Gillnet	UK	
	Q2	Q3	Q2	Q1	Q2	Q2	Q3	Q2	Q1	Q2
	5 trips	4 trips	1 trips	2 trips	2 trips	5 trips	4 trips	1 trips	2 trips	2 trips
Lg	20 hauls	14 hauls	12 hauls	46 hauls	26 hauls	20 hauls	14 hauls	12 hauls	46 hauls	26 hauls
8	1									
9										
10										
11										
12										
13										
14										
15	1									
16	1									
17										
18	10				10					
19	6			6	5					
20	2			38	24					
21	6	4		82	10					
22	17			177	26					1
23	5			256	23					
24	25			201	42	1				
25	7	5		270	73	4			7	
26				286	62	1			36	9
27	2			251	116	7	1		77	95
28				234	134	14	1	1	116	162
29				139	77	9			113	182
30				131	25	12			117	187
31				18	26	8	1	4	94	147
32				3		15			102	99
33				6		9			83	94
34					10	8		1	68	73
35				4		18		3	45	43
36						6	1	4	50	38
37						10		5	44	35
38						5		4	41	21
39						5		1	35	18
40									33	8
41						6		5	14	4
42								10	15	4
43						4		3	9	7
44									11	1
45						1			6	4
46									9	
47								4	5	
48								1	1	4
49									2	1
50						1			4	1
51										
52						2		2	1	
53									1	
54										
55								1		
56										
57										
58										
59										
60										
61										

Table 6.2.1.3 - Plaice VIId. Landings (L), discards (D) and percentage discards (%D) per period, métier and country

Period	Métier	Country	Numbers Trips sampled	Hauls sampled	Landed	Discarded	%D
Quarter 1	Beam Trawl	UK	2	46	2102	1139	35%
Quarter 2	Gillnet	France	1	12	49	0	0%
Quarter 2	Trawl	France	5	20	146	83	36%
Quarter 2	Beam Trawl	UK	2	26	663	1241	65%
Quarter 3	Trawl	France	4	14	4	9	69%
2005	Gillnet	France	1	12	49	0	0%
2005	Trawl	France	9	34	150	92	38%
2005	Beam Trawl	UK	4	60	2765	2380	46%

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
2006	504	2964	3019	1561	851	191	80	86	59	65

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	0.870	0.863	0.897	0.992	1.174
1982	0.245	0.271	0.353	0.431	0.640	0.795	1.153	1.067	1.504	1.355
1983	0.266	0.296	0.349	0.420	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	0.570	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	0.360	0.477	0.577	0.783	0.735	1.142	1.268	1.515
1988	0.292	0.268	0.321	0.432	0.560	0.657	0.770	0.908	1.218	1.328
1989	0.201	0.268	0.321	0.370	0.473	0.648	0.837	0.907	1.204	1.519
1990	0.201	0.256	0.326	0.378	0.483	0.610	0.781	0.963	1.159	1.310
1991	0.225	0.277	0.311	0.390	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	0.850	1.195
1993	0.220	0.272	0.336	0.432	0.507	0.591	0.741	0.820	0.934	1.156
1994	0.243	0.270	0.288	0.356	0.466	0.576	0.686	0.928	0.969	1.287
1995	0.218	0.271	0.313	0.390	0.485	0.688	0.612	0.806	1.150	1.298
1996	0.221	0.300	0.290	0.396	0.475	0.643	0.764	0.934	1.057	1.312
1997	0.199	0.252	0.298	0.332	0.442	0.577	0.801	0.894	1.055	1.395
1998	0.159	0.244	0.267	0.381	0.502	0.762	0.839	0.981	0.986	1.379
1999	0.197	0.245	0.235	0.306	0.461	0.751	0.768	0.868	0.885	1.508
2000	0.207	0.245	0.261	0.283	0.375	0.576	0.687	0.875	0.926	1.067
2001	0.215	0.252	0.303	0.370	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	0.850	0.583	1.205
2004	0.217	0.243	0.295	0.421	0.493	0.610	0.636	0.933	1.093	1.348
2005	0.210	0.263	0.293	0.360	0.527	0.536	0.753	0.778	0.820	1.014
2006	0.209	0.261	0.314	0.369	0.456	0.601	0.700	0.726	0.850	1.065

Table 6.2.3.2 - Plaice in VIId. Weights in the stock

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
1980	0.171	0.332	0.482	0.622	0.751	0.870	0.977	1.074	1.161	1.339
1981	0.110	0.216	0.317	0.414	0.506	0.594	0.677	0.756	0.830	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	0.470	0.560	0.648	0.735	0.821	1.169
1984	0.082	0.164	0.248	0.333	0.420	0.507	0.596	0.686	0.777	1.086
1985	0.084	0.171	0.259	0.348	0.440	0.533	0.628	0.725	0.824	1.206
1986	0.101	0.205	0.311	0.420	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	0.340	0.427	0.514	0.603	0.692	0.783	0.952
1989	0.079	0.162	0.250	0.342	0.439	0.541	0.648	0.759	0.874	1.211
1990	0.085	0.230	0.322	0.346	0.465	0.549	0.748	0.899	0.979	1.766
1991	0.143	0.219	0.275	0.335	0.375	0.472	0.633	1.057	1.022	1.502
1992	0.088	0.241	0.336	0.421	0.477	0.521	0.634	0.713	0.741	1.229
1993	0.108	0.258	0.296	0.379	0.493	0.539	0.573	0.699	0.787	1.056
1994	0.165	0.198	0.276	0.331	0.383	0.493	0.603	0.903	0.781	1.150
1995	0.124	0.257	0.286	0.354	0.442	0.707	0.531	0.703	1.092	1.194
1996	0.178	0.229	0.263	0.347	0.354	0.474	0.536	0.907	0.958	1.126
1997	0.059	0.202	0.256	0.266	0.417	0.530	0.665	0.686	0.972	1.364
1998	0.072	0.203	0.273	0.361	0.530	0.670	0.629	0.656	0.915	1.107
1999	0.072	0.172	0.213	0.351	0.429	0.644	0.760	0.782	0.593	1.166
2000	0.068	0.184	0.204	0.246	0.355	0.554	0.693	0.817	0.890	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	0.330	0.496	0.492	0.548	0.748	0.522	0.982
2004	0.172	0.183	0.268	0.408	0.471	0.521	0.616	0.892	1.102	1.287
2005	0.096	0.201	0.269	0.308	0.470	0.492	0.707	0.629	0.814	0.890
2006	0.106	0.209	0.275	0.336	0.397	0.525	0.636	0.704	0.842	1.090

Table 6.2.5.1. Plaice in VIId. Tuning fleets

FLT01: UK INSHORE TRAWL METIER <40 trawl
1985 2006
1 1 0 1
2 10

2520	618.3	419.7	221.1	18.8	0.0	0.0	0.0	19.0	0.0
1804	237.9	300.2	132.9	51.6	6.5	4.7	2.9	0.0	0.0
2556	456.0	430.2	153.2	48.0	25.1	5.0	6.3	4.3	0.0
2500	382.4	856.1	141.7	57.8	30.1	14.1	2.8	4.0	5.2
2131	47.4	221.7	465.4	97.1	41.3	19.0	5.5	1.2	6.2
1094	34.3	92.1	52.6	56.9	18.0	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	298.0	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	176.0	240.2	99.7	37.8	21.0	17.0	8.9	17.9	3.5
1531	124.1	70.7	54.6	23.5	8.5	5.0	5.5	3.9	6.8
1659	274.4	63.8	16.9	19.1	10.0	2.5	3.1	2.5	2.5
2024	317.1	223.8	20.4	7.7	10.2	8.0	4.9	2.8	4.0
813	104.3	77.7	27.6	3.7	1.7	3.9	1.4	1.2	0.3
861	53.4	222.2	27.0	8.7	1.2	0.4	1.4	0.5	0.4
652	75.0	46.0	81.3	13.8	4.5	1.1	0.5	1.0	0.4
491	29.4	21.3	13.8	17.5	3.3	0.9	0.6	0.2	0.2
607	120.2	77.2	17.2	8.5	14.7	2.2	1.5	0.3	0.2
653	216.9	46.4	24.9	5.1	4.1	6.9	5.1	0.3	0.3
661	84.6	127.5	13.5	5.4	2.3	1.9	3.8	1.7	0.5
235	52.2	23.0	19.3	2.4	1.8	0.5	0.4	1.1	0.2
633	190.5	124.6	39.8	28.2	4.1	3.4	1.9	1.2	2.5

FLT02: BELGIAN BEAM TRAWL
1981 2006
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
48.3	478.6	887.5	763.1	443.2	78.6	34.7	41.8	40.9	25.2

Table 6.2.5.1.(cont.) Plaice in VIId. Tuning fleets

FLT03: FRENCH TRAWLERS (EFFORT H*KW*10-4) 1989-90 DERAISED 1991-98 TRUE
1989 2006
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	399.5	255.2	41	17.6	11.9	9.9
10519	1802.9	1396.1	370.2	269.4	230.7	143.5	21.2	12.1	11.6
10217	2124.4	1118.2	268.4	56	73.4	48.7	32.3	14.3	4.6
10609	1034.2	2271.2	476.4	177.6	69.5	48.2	48.3	32	25
12384	1354.7	686.5	578.5	95.4	21.4	19.5	27.5	21.8	28.2
14476	1133.3	1283.9	352.7	317.5	98.8	43.6	33.3	34.6	36.9
10921	1396.2	3536	1155.4	139	170.7	88.3	50.8	22.4	28.2
11707	1446	3541.9	1534.4	205.4	29.8	20.2	17.8	6.9	8.2
10625	1139.1	5654.6	2456	254.4	36.1	24.8	23.5	4.4	16.6
13779	2757.4	1634	3110.4	781.5	130.9	21.2	6.1	12.9	19.9
11376	2113.6	1726.3	663.1	642.5	81.3	21.6	1.4	1.2	16.4
13489	3130.4	1134.9	336.6	230.9	186.2	36.7	9.5	2.9	13.1
12647	1984.9	2715.5	701.5	129.6	82.8	75.1	17.8	16.3	11.2
11582	3107.1	2308.6	284.8	110.4	50.1	22.3	24.4	5.9	6.7
12157	1131.3	1428.8	652.9	63.1	37.1	22.4	15.1	10.6	8.9
11779	1009.0	922.0	333.6	140.1	43.5	14.5	14.7	5.0	10.6

FLT04: UK BEAM TRAWL SURVEY true age 6
1988 2006
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
1	17.2	16.1	9.2	3.3	2.6	0.8

Table 6.2.5.1.(cont.) Plaice in VIId. Tuning fleets

FLT05: French GFS [option 2] true age 5

1988 2006

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	7.4	16.3	8.9	2.7	0.8
1	128.0	12.9	9.9	3.8	1.3	0.5

FLT06: Intl YFS

1987 2006

1 1 0.50 0.75

0 1

1	11.68	**1.44**
1	5.56	**1.3**
1	3.97	**0.6**
1	3.42	**0.7**
1	4.36	**0.6**
1	4.04	**1.8**
1	3.70	**0.8**
1	8.69	**0.8**
1	6.87	**1.7**
1	4.07	**0.7**
1	2.23	**0.8**
1	5.30	**0.8**
1	3.81	**0.8**
1	5.14	**0.48**
1	3.74	**0.83**
1	0.67	**0.92**
1	4.86	**0.2**
1	4.83	**0.78**
1	2.19	**0.17**
1	7.62	**0.3**

FLT07: UK BEAM TRAWL FLEET >=10 METRES WHERE PLAICE CATCH IS >=20%

1991 2006

1 1 0 1

2 10

9794	518.2	495.5	359.4	165.2	140.0	23.1	9.2	4.5	2.8
10270	524.0	396.5	246.9	136.8	97.2	77.7	25.7	5.1	4.2
8993	476.8	279.8	102.7	62.5	46.4	33.2	38.6	13.1	5.8
7398	238.6	325.6	135.1	51.2	28.4	23.1	12.0	24.3	4.7
6293	346.0	197.2	152.2	65.5	23.7	13.9	15.2	10.7	18.9
8124	785.2	182.5	48.4	54.8	28.5	7.2	8.8	7.1	7.2
9258	781.9	552.0	50.4	19.0	25.0	19.8	12.1	7.0	9.9
5954	342.0	254.8	90.6	12.1	5.7	12.9	4.5	3.9	0.9
5181	151.8	632.1	76.8	24.7	3.3	1.2	4.0	1.4	1.1
4640	258.7	158.9	280.7	47.6	15.4	3.8	1.6	.5	1.4
5762	211.3	153.2	99.0	126.0	23.4	6.6	4.0	1.4	1.6
7634	430.3	276.2	61.7	30.5	52.6	7.9	5.2	1.1	0.7
6441	684.2	146.5	8.6	16.0	13.0	21.8	16.1	1.0	1.1
3726	206.2	310.8	33.0	13.1	5.6	4.6	9.3	4.1	1.2
2919	188.3	82.9	69.8	8.8	6.4	1.8	1.6	4.0	0.8
2839	196.9	128.8	41.1	29.1	4.2	3.5	2.0	1.2	2.5

Table 6.3.5.1. Plaice in VIId. XSA diagnostics

```
FLR XSA Diagnostics 2007-05-07 15:43:03

CPUE data from My.idx

Catch data for 27 years. 1980 to 2006. Ages 1 to 10.

          fleet first age last age first year last year alpha beta
1    UK B TRAWL         2        9       1991      2006     0    1
2 BE BEAM TRAWL         2        9       1981      2006     0    1
3    FR TRAWL-1         2        9       1989      1996     0    1
4    FR TRAWL-2         2        9       1997      2006     0    1
5        UK BTS         1        6       1988      2006   0.5 0.75
6        FR GFS         1        3       1988      2006  0.75    1
7      Intl YFS         1        1       1987      2006   0.5 0.75


 Time series weights :

   Tapered time weighting not applied

Catchability analysis :

    Catchability independent of size for all ages

    Catchability independent of age for ages >   7

Terminal population estimation :

    Survivor estimates shrunk towards the mean F
    of the final   5 years or the  3 oldest ages.

    S.E. of the mean to which the estimates are shrunk =   1

    Minimum standard error for population
    estimates derived from each fleet =  0.3

   prior weighting not applied

Regression weights
     year
age   1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
  all    1    1    1    1    1    1    1    1    1    1


 Fishing mortalities
    year
age   1997  1998  1999  2000  2001  2002  2003  2004  2005  2006
  1  0.015 0.033 0.045 0.089 0.142 0.046 0.042 0.058 0.022 0.035
  2  0.184 0.147 0.152 0.549 0.369 0.601 0.331 0.458 0.237 0.248
  3  0.799 0.602 0.659 0.585 0.844 0.958 1.262 0.666 0.696 0.342
  4  1.464 1.031 1.150 0.960 0.577 1.015 1.014 0.582 0.573 0.593
  5  1.340 0.853 0.938 0.942 0.670 0.997 0.566 0.519 0.598 0.384
  6  0.943 0.532 0.643 0.705 0.393 0.637 0.599 0.359 0.474 0.470
  7  1.092 0.376 0.628 0.650 0.386 0.513 0.461 0.391 0.409 0.321
  8  0.707 0.481 0.357 0.362 0.316 0.464 0.271 0.299 0.430 0.596
  9  0.624 0.352 0.387 0.282 0.264 0.630 0.748 0.191 0.220 0.508
  10 0.624 0.352 0.387 0.282 0.264 0.630 0.748 0.191 0.220 0.508


 XSA population number ( thousands )
      age
year      1     2     3     4    5    6   7   8   9  10
  1997 37886 26625 13731  4697 1538 1295 734 413 258 689
  1998 14958 33758 20053  5586  984  365 456 223 184 664
  1999 17868 13093 26360  9936 1802  379 194 283 125 363
  2000 17102 15462 10175 12338 2846  638 180  94 179 418
  2001 21342 14159  8080  5132 4276 1003 285  85  59 353
  2002 21062 16759  8856  3145 2607 1981 613 175  56 206
```

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

2003	16372	18200	8312	3075	1032	870	948	332	100	123
2004	17982	14200	11832	2129	1009	530	432	541	229	289
2005	16000	15351	8127	5501	1076	543	335	265	363	255
2006	15224	14169	10961	3666	2807	535	306	201	156	171

Estimated population abundance at 1st Jan 2007

year \ age	1	2	3	4	5	6	7	8	9	10
2007	303	13296	10001	7046	1833	1731	303	201	100	85

Fleet: UK B TRAWL

Log catchability residuals.

age \ year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	0.098	-0.124	-0.368	-0.117	0.151	0.339	-0.119	-0.759	-0.483	0.178
3	0.337	0.240	-0.336	-0.183	0.181	-0.463	0.198	-0.598	0.201	-0.150
4	0.370	0.527	-0.107	-0.038	0.127	-0.629	-0.743	-0.057	-0.612	0.501
5	0.071	0.299	-0.014	0.163	0.300	-0.230	-0.519	-0.277	0.005	0.316
6	0.122	0.248	-0.088	-0.119	0.150	-0.159	-0.202	-0.149	-0.547	0.610
7	-0.180	0.209	0.013	-0.003	-0.015	-0.744	0.330	0.509	-0.757	0.587
8	-0.208	0.367	0.083	-0.337	0.228	-0.158	0.252	0.221	-0.055	0.249
9	-0.395	-0.243	0.307	0.232	0.180	-0.209	0.138	0.209	-0.269	0.344

age \ year	2001	2002	2003	2004	2005	2006
2	-0.235	0.131	0.560	0.215	0.187	0.345
3	-0.061	0.203	-0.075	0.625	-0.064	-0.053
4	-0.045	-0.123	0.312	0.175	0.214	0.128
5	0.550	-0.516	-0.249	0.099	-0.083	0.085
6	0.220	0.179	-0.243	-0.151	0.254	-0.126
7	0.346	-0.463	0.264	0.008	-0.423	0.319
8	1.021	0.348	0.921	0.446	-0.296	0.303
9	0.315	0.007	-0.441	0.434	0.208	0.010

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	2	3	4	5	6	7	8
Mean_Logq	-12.4037	-12.1287	-12.2429	-12.3733	-12.4015	-12.5385	-12.5385
S.E_Logq	0.3419	0.3133	0.3852	0.3017	0.2738	0.4163	0.3853

	9
Mean_Logq	-12.5385
S.E_Logq	0.2800

Fleet: BE BEAM TRAWL

Log catchability residuals.

age \ year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	0.050	-0.129	0.521	-1.208	0.526	0.604	0.434	0.176	-1.909	0.397
3	0.373	-0.292	0.008	0.015	-0.060	0.056	-0.418	-0.128	-0.343	0.477
4	0.386	0.039	0.339	-0.040	-0.010	-0.272	-0.371	-0.505	-0.144	0.028
5	-0.527	0.040	-0.279	0.073	-1.240	-0.367	-0.496	-0.763	0.279	-0.194
6	-0.640	-0.193	-0.191	0.261	0.373	0.012	-1.040	-0.705	0.204	-0.138
7	-0.169	-0.335	-0.479	0.366	0.146	-0.034	0.353	-0.247	0.047	-0.559
8	0.099	0.429	0.901	-0.152	0.593	-0.838	-0.305	-0.394	-0.172	-0.045
9	0.092	0.155	0.144	-0.249	-0.840	-0.476	0.262	-0.094	-0.228	-0.914

age \ year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	1.057	1.333	0.543	0.999	-1.600	-0.130	NA	-0.839	-1.443	-1.325
3	0.804	0.544	-0.135	0.130	0.113	-0.074	-1.461	-0.263	-0.040	-0.933
4	0.114	-0.293	-0.477	0.620	0.105	0.187	0.508	0.273	0.384	-1.152
5	0.534	-0.310	-0.221	0.114	0.269	0.384	1.212	0.441	0.825	-0.377

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

6	0.568	0.259	-0.220	-0.021	-0.178	0.073	0.859	0.444	0.846	-0.383
7	-0.093	-0.201	-0.348	0.035	0.650	-0.299	0.827	0.235	0.594	-0.359
8	-0.081	0.054	-0.602	-0.016	0.275	0.159	-0.107	0.212	-0.540	-0.551
9	0.939	1.103	-1.076	0.023	-0.574	0.061	0.029	0.355	0.332	-0.672

age \ year	2001	2002	2003	2004	2005	2006
2	0.544	0.435	0.243	0.325	-0.032	0.428
3	0.888	0.565	0.647	0.177	-0.141	-0.508
4	0.197	0.325	0.277	-0.134	-0.391	0.005
5	0.115	0.527	-0.093	0.002	0.292	-0.241
6	-0.046	-0.488	0.588	-0.290	0.031	0.016
7	-0.235	-0.103	0.200	0.326	-0.069	-0.250
8	-0.106	-0.751	-0.494	-0.222	0.057	0.480
9	0.035	-0.191	0.606	-0.769	-0.861	0.676

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	2	3	4	5	6	7	8	9
Mean_Logq	-7.5245	-5.6706	-5.1253	-5.2504	-5.5408	-5.6020	-5.6020	-5.6020
S.E_Logq	0.8792	0.5167	0.3852	0.5126	0.4593	0.3584	0.4203	0.5766

Fleet: FR TRAWL-1

Log catchability residuals.

age \ year	1989	1990	1991	1992	1993	1994	1995	1996
2	-0.140	-0.302	0.508	0.266	0.177	0.168	0.017	-0.694
3	-0.136	0.070	0.218	0.353	-0.200	0.277	-0.370	-0.212
4	0.268	0.302	0.614	-0.141	-0.322	-0.187	-0.264	-0.269
5	0.797	0.423	0.070	0.155	-1.049	0.249	-0.798	0.152
6	0.387	0.611	0.092	0.546	-0.300	-0.128	-1.172	-0.037
7	0.275	0.519	-0.138	0.355	-0.176	-0.072	-0.797	0.035
8	0.666	0.640	-0.091	-0.294	-0.667	0.251	-0.301	0.152
9	1.075	1.460	0.046	0.153	-0.177	-0.298	-0.229	0.353

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	2	3	4	5	6	7	8
Mean_Logq	-11.5818	-11.0071	-11.1939	-11.5761	-11.8586	-12.0944	-12.0944
S.E_Logq	0.3743	0.2657	0.3467	0.6172	0.5744	0.4075	0.4710

	9
Mean_Logq	-12.0944
S.E_Logq	0.6437

Fleet: FR TRAWL-2

Log catchability residuals.

age \ year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2	-0.640	-0.930	-0.122	0.520	0.452	0.610	0.014	0.857	-0.382	-0.379
3	0.464	-0.068	0.249	-0.334	0.255	-0.378	0.744	0.070	-0.069	-0.934
4	0.694	0.566	0.605	0.288	-0.353	-0.525	0.296	-0.334	-0.506	-0.731
5	0.083	0.656	0.397	0.804	0.276	-0.284	-0.054	-0.126	-0.763	-0.989
6	0.549	-0.176	0.123	0.658	-0.219	-0.131	-0.071	-0.098	-0.420	-0.216
7	0.826	-0.552	0.720	0.384	0.018	-0.330	-0.008	-0.381	-0.162	-0.516
8	0.688	0.086	0.164	-0.334	-1.542	-0.452	-0.487	-0.557	-0.311	0.042
9	0.303	-0.730	-0.676	-0.274	-1.353	-0.426	0.842	-1.170	-1.078	-0.819

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

	2	3	4	5	6	7	8	9
Mean_Logq	-11.4677	-10.7031	-10.7131	-11.1507	-11.3971	-11.7049	-11.7049	-11.7049
S.E_Logq	0.5926	0.4757	0.5418	0.5749	0.3467	0.4944	0.5886	0.6818

Fleet: UK BTS

Log catchability residuals.

age \ year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.491	-1.438	-0.740	-0.071	0.002	-0.891	-0.194	-0.235	-0.323	0.367
2	0.270	-0.527	-0.869	-0.174	-0.052	-0.271	-0.102	-0.977	-0.303	-0.515
3	0.492	0.060	-0.694	0.148	-0.194	-0.438	0.021	-0.416	-1.574	-0.670
4	-0.148	0.341	-0.287	-0.044	0.251	-0.561	0.288	-0.267	-1.286	-1.295
5	0.564	-0.197	-0.057	0.113	0.587	-0.187	0.044	-0.483	-0.684	-1.118
6	0.056	0.215	0.065	-0.148	0.823	-0.066	-0.486	-0.503	-0.303	-1.098

age \ year	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.242	0.063	0.289	0.405	0.504	-0.452	1.229	0.113	0.637
2	-0.071	0.218	0.698	0.194	0.371	0.481	0.390	0.906	0.332
3	-0.661	-0.078	0.728	0.755	0.473	0.475	0.541	0.980	0.055
4	-0.093	-0.662	0.563	0.539	0.592	0.426	0.685	0.838	0.119
5	-0.972	-0.321	0.477	1.037	-0.066	0.476	-0.107	1.048	-0.153
6	-0.491	-0.462	0.560	0.661	0.744	0.067	-0.973	0.865	0.472

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	1	2	3	4	5	6
Mean_Logq	-7.3382	-6.8947	-6.8621	-6.6997	-6.5295	-6.6231
S.E_Logq	0.6095	0.5036	0.6380	0.6173	0.5972	0.5881

Fleet: FR GFS

Log catchability residuals.

age \ year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	-0.491	-0.790	-0.789	-1.389	0.967	1.533	-0.204	-0.349	-0.792	0.798	0.829
2	0.350	-0.372	-1.617	-0.910	-0.582	0.436	-0.311	-0.208	-0.971	-0.079	0.176
3	-0.014	-0.828	-0.467	-1.000	0.028	0.729	-1.108	-0.451	-2.087	0.246	-0.228

age \ year	1999	2000	2001	2002	2003	2004	2005	2006
1	0.196	0.472	0.043	0.116	-0.888	0.211	-0.045	0.573
2	-0.063	1.142	-0.148	0.600	0.421	0.703	0.921	0.512
3	0.216	0.482	-0.050	0.969	1.424	0.533	1.532	0.073

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	1	2	3
Mean_Logq	-7.5279	-7.4740	-7.6537
S.E_Logq	0.7548	0.7001	0.8888

Fleet: Intl YFS

Log catchability residuals.

age \ year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.242	0.312	0.053	0.09	-0.214	0.621	0.558	0.302	0.707	-0.425	-0.52	0.42

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

```
   year
age 1999  2000 2001  2002  2003  2004   2005   2006
  1 0.25 -0.19 0.17 0.226 -1.05 0.227 -1.203 -0.577


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

                 1
Mean_Logq -10.1735
S.E_Logq    0.5252


 Terminal year survivor and F summaries:

 Age 1 Year class = 2005

source
         survivors N scaledWts
UK BTS       25141 1     0.294
FR GFS       23579 1     0.191
Intl YFS      7470 1     0.396
fshk          7492 1     0.119

 Age 2 Year class = 2004

source
              survivors N scaledWts
UK B TRAWL        14128 1     0.305
BE BEAM TRAWL     15348 1     0.047
FR TRAWL-2         6844 1     0.098
UK BTS            12771 2     0.237
FR GFS            12940 2     0.135

Intl YFS           3004 1     0.128
fshk               5724 1     0.049

 Age 3 Year class = 2003

source
              survivors N scaledWts
UK B TRAWL         7352 2     0.382
BE BEAM TRAWL      4695 2     0.110
FR TRAWL-2         3336 2     0.145
UK BTS            14410 3     0.172
FR GFS            10965 3     0.095
Intl YFS           8838 1     0.062
fshk               2003 1     0.034

 Age 4 Year class = 2002

source
              survivors N scaledWts
UK B TRAWL         1979 3     0.355
BE BEAM TRAWL      1813 3     0.226
FR TRAWL-2         1374 3     0.154
UK BTS             2414 4     0.146
FR GFS             3098 3     0.045
Intl YFS            641 1     0.027
fshk               1315 1     0.047

 Age 5 Year class = 2001

source
              survivors N scaledWts
UK B TRAWL         2189 4     0.433
BE BEAM TRAWL      1362 4     0.203
FR TRAWL-2          982 4     0.146
UK BTS             2320 5     0.142
```

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

```
FR GFS             2489 3     0.026
Intl YFS           2170 1     0.016
fshk                843 1     0.035

 Age 6 Year class = 2000

source
              survivors N scaledWts
UK B TRAWL          280 5     0.426
BE BEAM TRAWL       325 5     0.191
FR TRAWL-2          233 5     0.224
UK BTS              581 6     0.117
FR GFS              660 3     0.006
Intl YFS            359 1     0.003
fshk                284 1     0.034

 Age 7 Year class = 1999

source
              survivors N scaledWts
UK B TRAWL          254 6     0.389
BE BEAM TRAWL       180 6     0.279
FR TRAWL-2          136 6     0.222
UK BTS              325 6     0.074
FR GFS              302 3     0.004
Intl YFS            166 1     0.002
fshk                140 1     0.030

 Age 8 Year class = 1998

source
              survivors N scaledWts
UK B TRAWL           92 7     0.385
BE BEAM TRAWL       114 7     0.311
FR TRAWL-2           92 7     0.206
UK BTS               78 6     0.054
FR GFS              154 3     0.003
Intl YFS            129 1     0.002
fshk                191 1     0.040

 Age 9 Year class = 1997

source
              survivors N scaledWts
UK B TRAWL           77 8     0.499
BE BEAM TRAWL       120 8     0.271
FR TRAWL-2           60 8     0.156
UK BTS               98 6     0.029
FR GFS              124 3     0.003
Intl YFS            129 1     0.002
fshk                 95 1     0.039
```

Table 6.3.5.2 Plaice in VIId. Fishing mortality (F) at age

age	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.002	0.001	0.011	0.005	0.015	0.005	0.012	0.001	0.001
2	0.169	0.119	0.133	0.153	0.116	0.314	0.212	0.180	0.204
3	0.276	0.741	0.500	0.450	0.580	0.600	0.696	0.515	0.658
4	0.385	0.869	0.891	0.948	0.804	0.867	0.770	0.795	0.664
5	0.625	0.327	0.666	0.594	0.807	0.224	0.608	0.580	0.567
6	0.404	0.373	0.361	0.372	0.720	0.594	0.473	0.318	0.468
7	0.359	0.469	0.359	0.242	0.733	0.444	0.465	0.746	0.549
8	0.217	0.591	1.632	0.933	0.404	0.696	0.301	0.505	0.434
9	0.328	0.417	0.589	0.347	0.645	1.412	0.240	0.894	0.683
10	0.328	0.417	0.589	0.347	0.645	1.412	0.240	0.894	0.683

age	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.054	0.095	0.077	0.064	0.060	0.078	0.115	0.039	0.015
2	0.174	0.219	0.503	0.442	0.409	0.413	0.378	0.290	0.184
3	0.448	0.700	0.820	0.797	0.476	0.717	0.609	0.548	0.799
4	0.727	0.729	0.867	0.589	0.480	0.796	0.666	0.671	1.464
5	0.840	0.599	0.660	0.510	0.326	0.615	0.508	0.720	1.340
6	0.585	0.573	0.549	0.584	0.343	0.400	0.290	0.490	0.943
7	0.433	0.452	0.364	0.409	0.330	0.358	0.445	0.345	1.092
8	0.400	0.549	0.373	0.415	0.261	0.423	0.421	0.500	0.707
9	0.482	0.779	0.597	0.661	0.342	0.380	0.309	0.552	0.624
10	0.482	0.779	0.597	0.661	0.342	0.380	0.309	0.552	0.624

age	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.033	0.045	0.089	0.142	0.046	0.042	0.058	0.022	0.035
2	0.147	0.152	0.549	0.369	0.601	0.331	0.458	0.237	0.248
3	0.602	0.659	0.585	0.844	0.958	1.262	0.666	0.696	0.342
4	1.031	1.150	0.960	0.577	1.015	1.014	0.582	0.573	0.593
5	0.853	0.938	0.942	0.670	0.997	0.566	0.519	0.598	0.384
6	0.532	0.643	0.705	0.393	0.637	0.599	0.359	0.474	0.470
7	0.376	0.628	0.650	0.386	0.513	0.461	0.391	0.409	0.321
8	0.481	0.357	0.362	0.316	0.464	0.271	0.299	0.430	0.596
9	0.352	0.387	0.282	0.264	0.630	0.748	0.191	0.220	0.508
10	0.352	0.387	0.282	0.264	0.630	0.748	0.191	0.220	0.508

Table 6.3.5.3 Plaice in VIId. Stock number at age

age	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	25461	12969	25136	19902	25019	29791	60704	31528	26550
2	17864	22988	11719	22492	17920	22305	26821	54281	28504
3	6323	13649	18474	9279	17469	14435	14747	19622	41031
4	1777	4341	5886	10144	5353	8853	7169	6653	10613
5	1108	1094	1647	2185	3558	2167	3366	3002	2717
6	237	537	714	765	1092	1437	1568	1659	1521
7	157	143	335	450	477	481	718	884	1092
8	237	99	81	211	320	207	279	408	379
9	15	173	50	14	75	193	94	187	223
10	386	614	207	361	220	69	167	136	367

age	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	16414	18927	21762	28076	13255	17319	25127	30602	37886
2	24008	14066	15573	18224	23821	11290	14489	20270	26625
3	21025	18263	10229	8517	10599	14319	6760	8982	13731
4	19231	12150	8206	4076	3474	5959	6328	3326	4697
5	4942	8409	5302	3121	2047	1945	2433	2941	1538
6	1395	1930	4181	2480	1695	1337	952	1324	1295
7	861	703	985	2185	1251	1089	811	644	734
8	570	505	405	619	1313	814	688	470	413
9	223	346	264	252	370	915	482	409	258
10	539	446	291	255	549	1034	1017	855	689

age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	14958	17868	17102	21342	21062	16372	17982	16000	15224	17969**
2	33758	13093	15462	14159	16759	18200	14200	15351	14169	13296
3	20053	26360	10175	8080	8856	8312	11832	8127	10961	10001
4	5586	9936	12338	5132	3145	3075	2129	5501	3666	7046
5	984	1802	2846	4276	2607	1032	1009	1076	2807	1833
6	365	379	638	1003	1981	870	530	543	535	1731
7	456	194	180	285	613	948	432	335	306	303
8	223	283	94	85	175	332	541	265	201	201
9	184	125	179	59	56	100	229	363	156	100
10	664	363	418	353	206	123	289	255	171	178

** GM 1998-04

Table 6.3.5.4 Plaice in VIId.Summary table

	recruitment (age 1)	ssb	catch	landings	fbar3-6	Y/ssb
1980	25461	5546	2650	2650	0.42	0.48
1981	12969	6590	4769	4769	0.58	0.72
1982	25136	7494	4865	4865	0.60	0.65
1983	19902	8081	5043	5043	0.59	0.62
1984	25019	7297	5161	5161	0.73	0.71
1985	29791	7925	6022	6022	0.57	0.76
1986	60704	10057	6834	6834	0.64	0.68
1987	31528	13242	8366	8366	0.55	0.63
1988	26550	13093	10420	10420	0.59	0.80
1989	16414	14446	8758	8758	0.65	0.61
1990	18927	14714	9047	9047	0.65	0.61
1991	21762	10361	7813	7813	0.72	0.75
1992	28076	8930	6337	6337	0.62	0.71
1993	13255	8276	5331	5331	0.41	0.64
1994	17319	9023	6121	6121	0.63	0.68
1995	25127	8138	5130	5130	0.52	0.63
1996	30602	6852	5393	5393	0.61	0.79
1997	37886	7159	6307	6307	1.14	0.88
1998	14958	7967	5762	5762	0.75	0.72
1999	17868	8544	6326	6326	0.85	0.74
2000	17102	6638	6015	6015	0.80	0.91
2001	21342	6519	5266	5266	0.62	0.81
2002	21062	6127	5777	5777	0.90	0.94
2003	16372	4473	4536	4536	0.86	1.01
2004	17982	5029	4007	4007	0.53	0.80
2005	16000	4947	3446	3446	0.59	0.70
2006	15224	5274	3146	3146	0.45	0.60

Table 6.5.1 Plaice in VIId.RCT3 input

Plaice in VIId. Input to RCT3

5 21 2

YC	VPA Age 1	VPA Age 2	VPA Age 3	'yfs0'	'yfs1'	'bts1'	'gfs0'	'gfs1'
1986	31248	28504	21025	-11	144	-11	-11	-11
1987	26474	24008	18262	1168	132	2647	-11	80
1988	16281	14066	10228	556	58	231	19	35
1989	18816	15573	8517	397	71	516	16	39
1990	21713	18223	10598	342	62	1175	1	25
1991	27938	23820	14318	436	178	1653	1	344
1992	13217	11289	6759	404	84	322	9	287
1993	17322	14489	8981	370	79	833	66	65
1994	25178	20270	13730	869	168	1132	53	79
1995	30531	26625	20052	687	66	1320	21	66
1996	37964	33757	26359	407	82	3310	305	409
1997	14958	13093	10174	223	80	1140	102	164
1998	17868	15462	8080	530	76	1130	100	103
1999	17102	14159	8855	381	48	1319	10	125
2000	21342	16759	8312	514	83	1791	193	97
2001	21062	18199	11831	374	92	2066	60	112
2002	16372	14199	-11	67	20	618	5	32
2003	17982	-11	-11	486	78	3618	111	104
2004	-11	-11	-11	483	17	1084	24	74
2005	-11	-11	-11	219	30	1721	16	129
2006	-11	-11	-11	762	-11	-11	1280	-11

Table 6.5.2 Plaice in VIId.RCT3 results (Age 1)

```
Analysis by RCT3 ver3.1 of data from file :

recpl7d1.in

7D PLAICE - VPA AGE 1 / indices all * per 100

Data for    5 surveys over   21 years :  1986 - 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    .30
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

yfs0      1.09   3.35    .61   .181     17   6.18   10.08     .673     .096
yfs1      1.21   4.62    .53   .236     18   2.89    8.12     .720     .084
bts1       .60   5.70    .37   .380     17   6.99    9.89     .404     .266
gfs0      1.42   5.10   2.24   .017     16   3.22    9.68    2.466     .007
gfs1      1.42   3.45   1.14   .060     17   4.32    9.60    1.254     .028

                                        VPA Mean =    9.95     .289     .520

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      1.09   3.35    .61   .181     17   5.39    9.22     .695     .089
yfs1      1.21   4.62    .53   .236     18   3.43    8.78     .642     .104
bts1       .60   5.70    .37   .380     17   7.45   10.17     .407     .259
gfs0      1.42   5.10   2.24   .017     16   2.83    9.14    2.475     .007
gfs1      1.42   3.45   1.14   .060     17   4.87   10.39    1.257     .027

                                        VPA Mean =    9.95     .289     .514

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

yfs0      1.09   3.35    .61   .181     17   6.64   10.58     .691     .147
yfs1
bts1
gfs0      1.42   5.10   2.24   .017     16   7.16   15.29    2.898     .008
gfs1

                                        VPA Mean =    9.95     .289     .845

Year     Weighted       Log     Int     Ext     Var     VPA      Log
Class     Average       WAP     Std     Std    Ratio             VPA
         Prediction            Error   Error

2004       17735       9.78     .21     .23     1.19
2005       18533       9.83     .21     .20      .91
2006       24050      10.09     .27     .37     1.97
```

Table 6.5.3 Plaice in VIId.RCT3 results (Age 2)

Analysis by RCT3 ver3.1 of data from file :

recpl7d2.in

7D PLAICE - VPA AGE 1 / indices all * per 100

Data for 5 surveys over 21 years : 1986 - 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 .30
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2004

	I-----------Regression----------I				I-----------Prediction---------I				
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
yfs0	1.14	2.91	.67	.174	16	6.18	9.94	.734	.076
yfs1	1.29	4.12	.59	.225	17	2.89	7.86	.802	.063
bts1	.57	5.81	.29	.523	16	6.99	9.78	.321	.396
gfs0	1.22	5.73	1.93	.024	15	3.22	9.67	2.142	.009
gfs1	1.34	3.70	1.10	.071	16	4.32	9.48	1.219	.027
					VPA Mean =		9.80	.309	.429

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
yfs0	1.14	2.91	.67	.174	16	5.39	9.05	.757	.071
yfs1	1.29	4.12	.59	.225	17	3.43	8.56	.716	.080
bts1	.57	5.81	.29	.523	16	7.45	10.04	.326	.385
gfs0	1.22	5.73	1.93	.024	15	2.83	9.20	2.148	.009
gfs1	1.34	3.70	1.10	.071	16	4.87	10.22	1.222	.027
					VPA Mean =		9.80	.309	.428

Yearclass = 2006

	I-----------Regression----------I				I-----------Prediction---------I				
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
yfs0	1.14	2.91	.67	.174	16	6.64	10.46	.754	.142
yfs1									
bts1									
gfs0	1.22	5.73	1.93	.024	15	7.16	14.48	2.553	.012
gfs1									
					VPA Mean =		9.80	.309	.846

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2004	15856	9.67	.20	.21	1.12		
2005	**17125**	**9.75**	**.20**	**.20**	**.94**		
2006	21055	9.95	.28	.39	1.92		

Table 6.6.1. Plaice in VIId. Input to catch forecast

Age	Stock.n	Mat	M	F
1	17969	0.00	0.1	0.03
2	13296	0.15	0.1	0.27
3	10001	0.53	0.1	0.49
4	7046	0.96	0.1	0.50
5	1833	1.00	0.1	0.43
6	1731	1.00	0.1	0.37
7	303	1.00	0.1	0.32
8	201	1.00	0.1	0.38
9	100	1.00	0.1	0.26
10	178	1.00	0.1	0.26

Table 6.6.2 Plaice in VIId. Management option table

2007 fmult	f3-6	landings	catch	ssb
1	0.447	3777	3777	6538

2008 fmult	f3-6	landings	catch	ssb 2008	ssb 2009
0	0	0	0	7111	11200
0.1	0.045	472	472	7111	10766
0.2	0.089	926	926	7111	10350
0.3	0.134	1363	1363	7111	9951
0.4	0.179	1782	1782	7111	9569
0.5	0.224	2186	2186	7111	9204
0.6	0.268	2574	2574	7111	8853
0.7	0.313	2947	2947	7111	8517
0.8	0.358	3306	3306	7111	8196
0.9	0.403	3651	3651	7111	7887
1	0.447	3984	3984	7111	7592
1.1	0.492	4303	4303	7111	7308
1.2	0.537	4611	4611	7111	7037
1.3	0.581	4908	4908	7111	6776
1.4	0.626	5193	5193	7111	6527
1.5	0.671	5468	5468	7111	6287
1.6	0.716	5732	5732	7111	6058
1.7	0.760	5987	5987	7111	5838
1.8	0.805	6232	6232	7111	5627
1.9	0.850	6469	6469	7111	5424
2	0.895	6697	6697	7111	5230

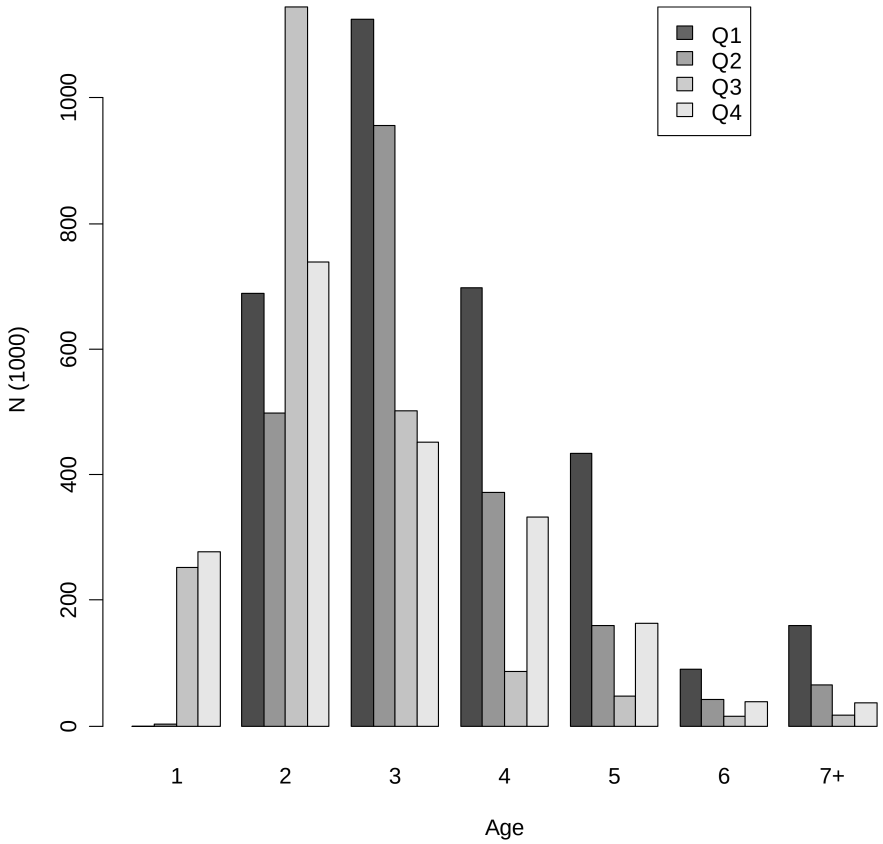


Figure 6.1.2.1. Plaice in VIId. Age distribution in the landings per quarter

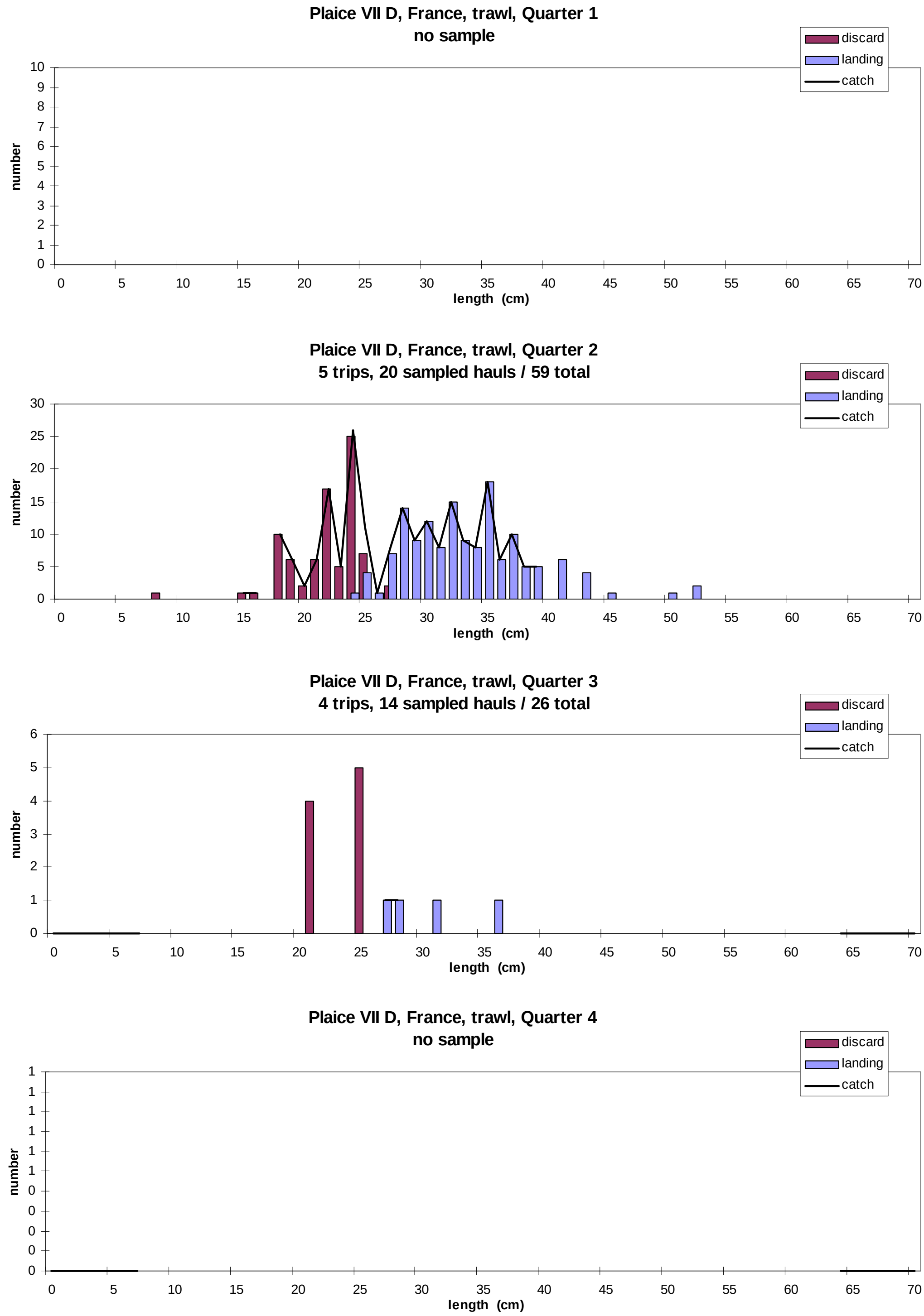
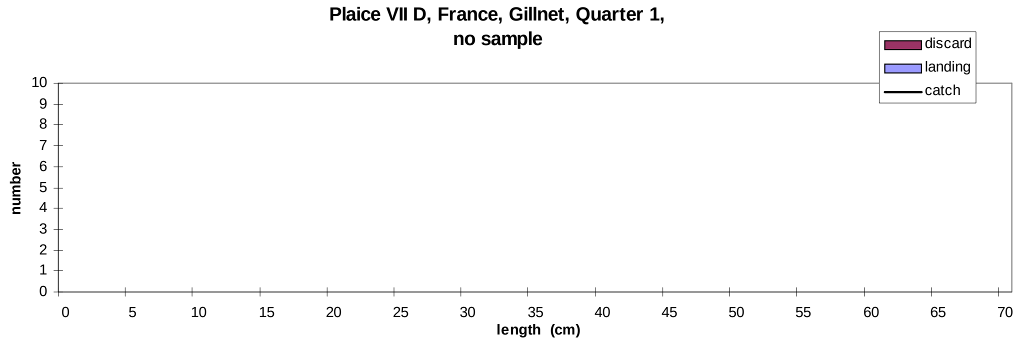
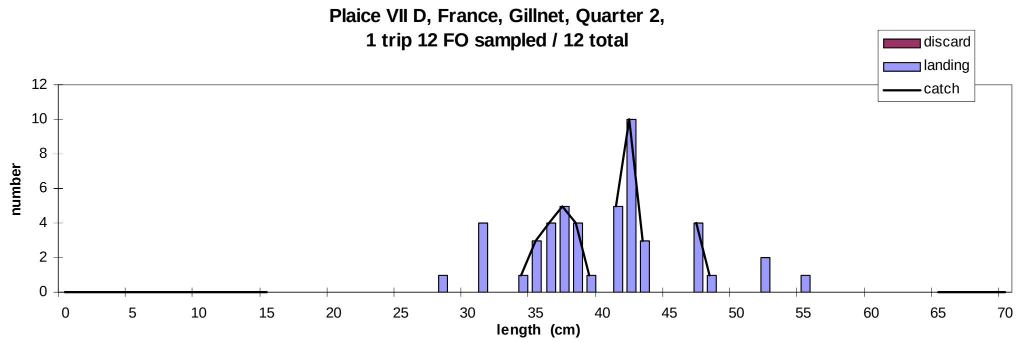
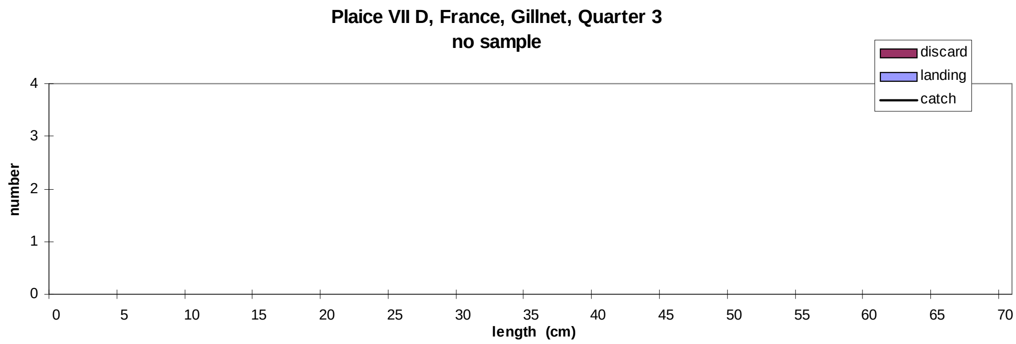


Figure 6.2.1.1a - Plaice VIId - Length structure of discards and landings collected by observations on board







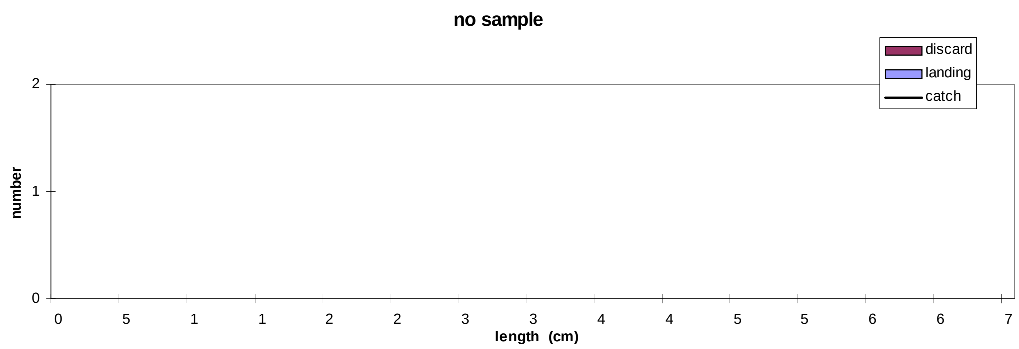
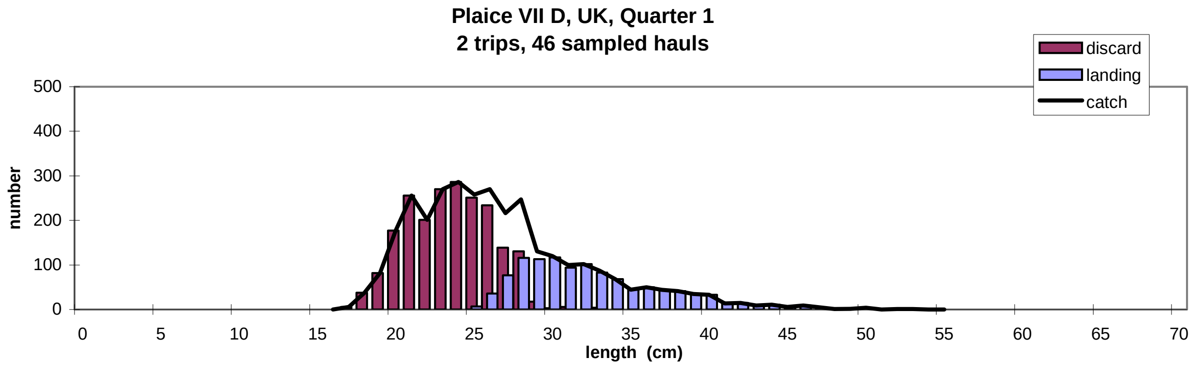
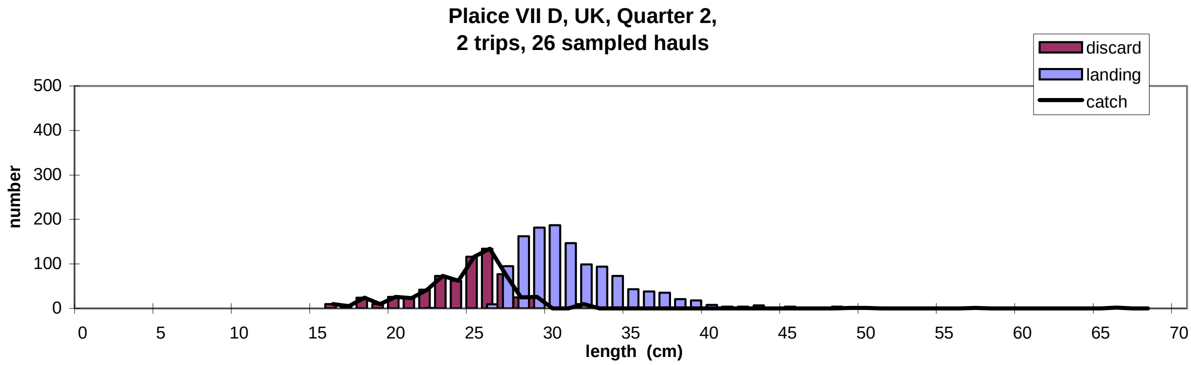
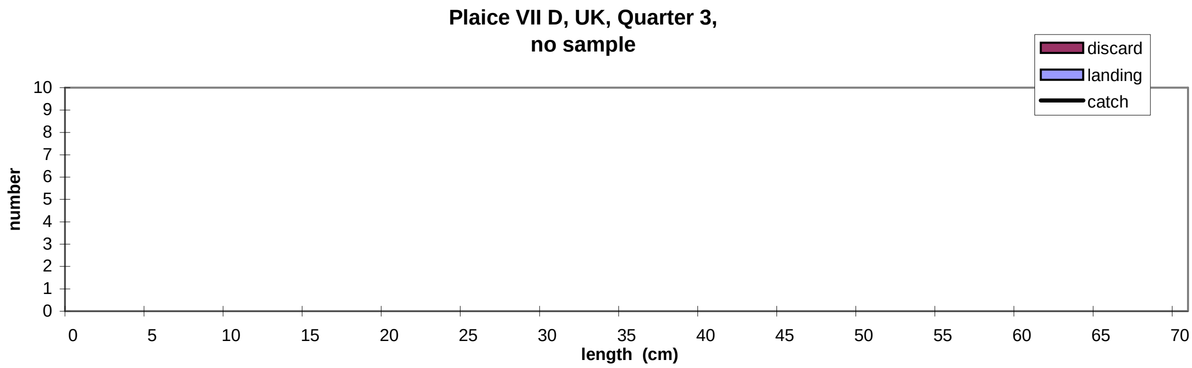


Figure 6.2.1.1b- Plaice VIId - Length structure of discards and landings collected by observations on board







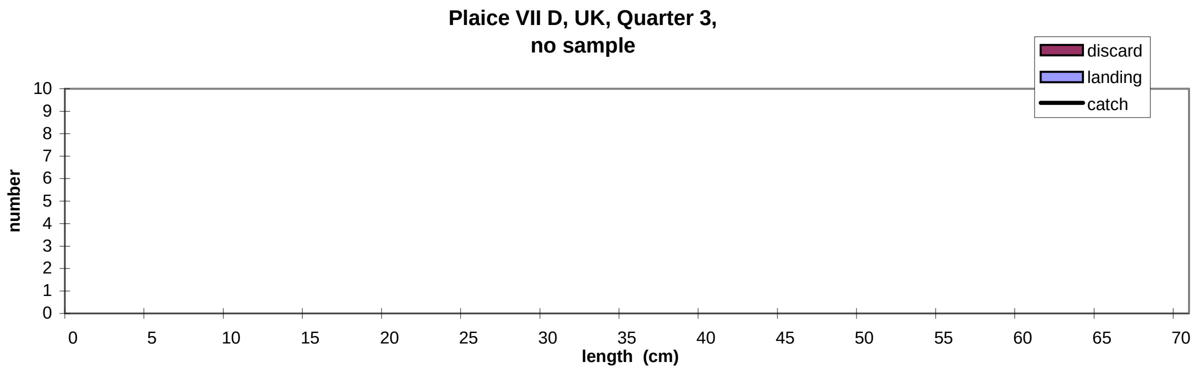


Figure 6.2.1.1 c- Plaice VIId - Length structure of discards and landings collected by observations on board

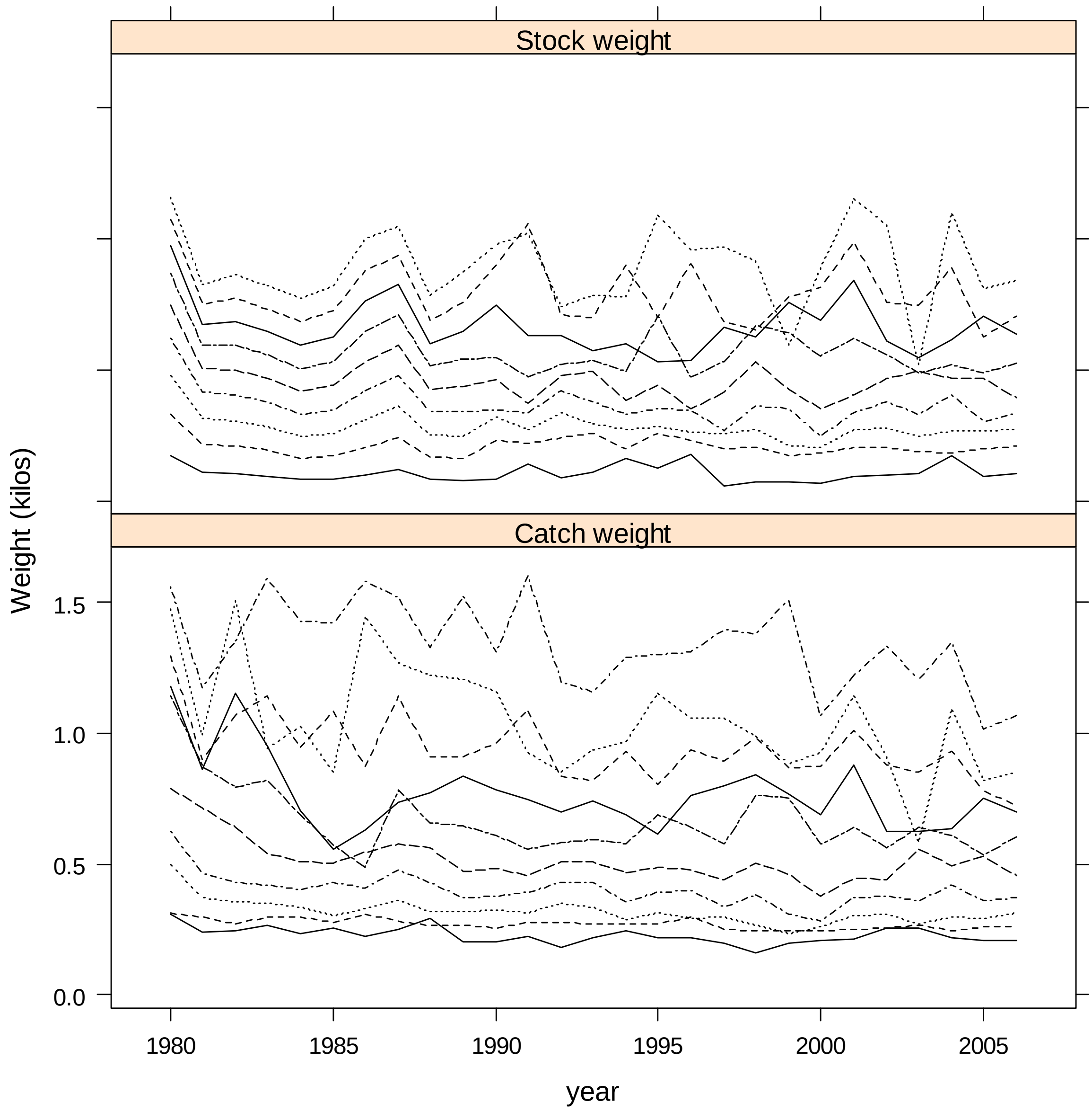


Figure 6.2.3.1. Plaice in VIId. Stock and Catch weight

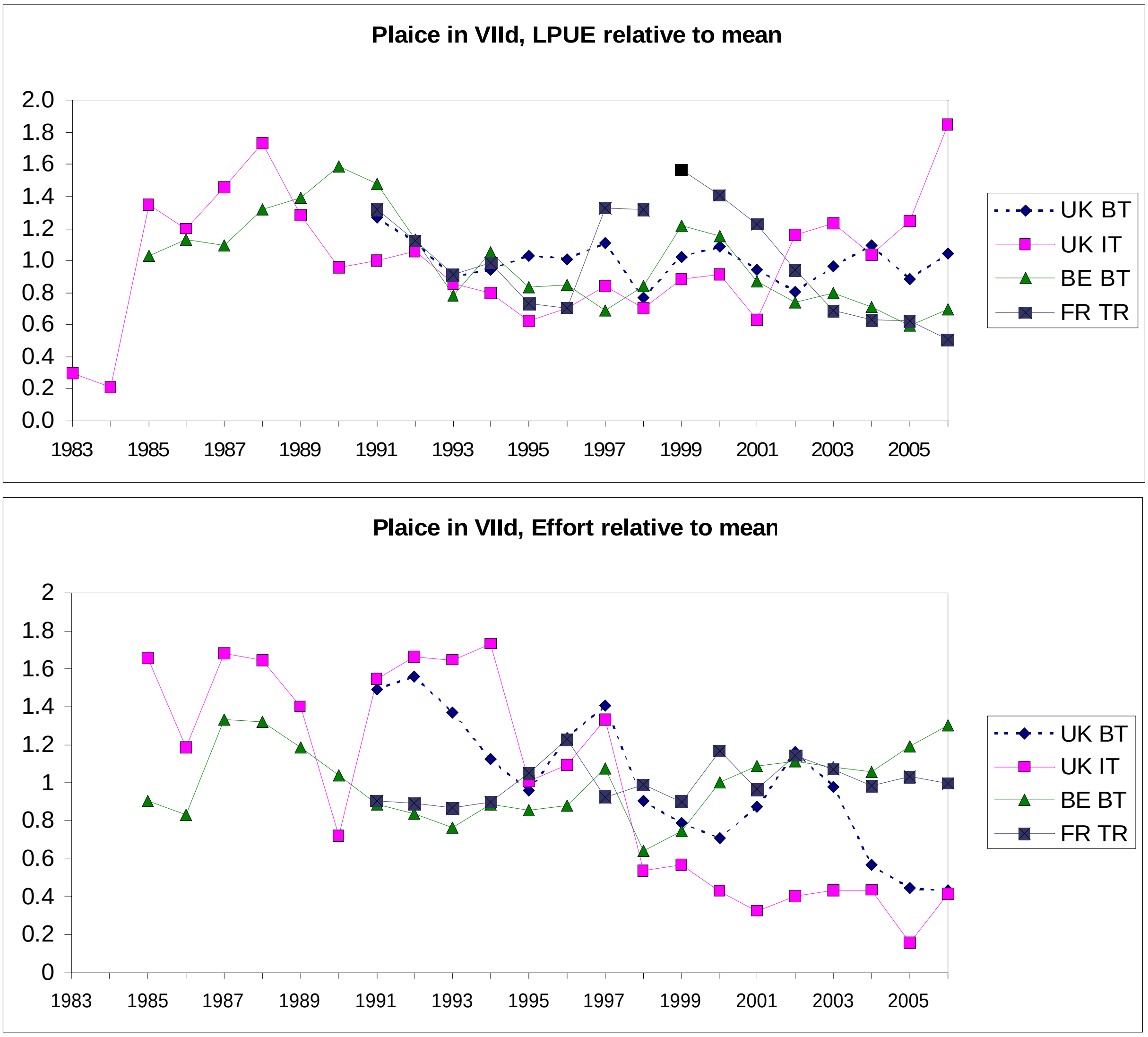


Figure 6.2.5.1 - Plaice in VIId. LPUE and effort

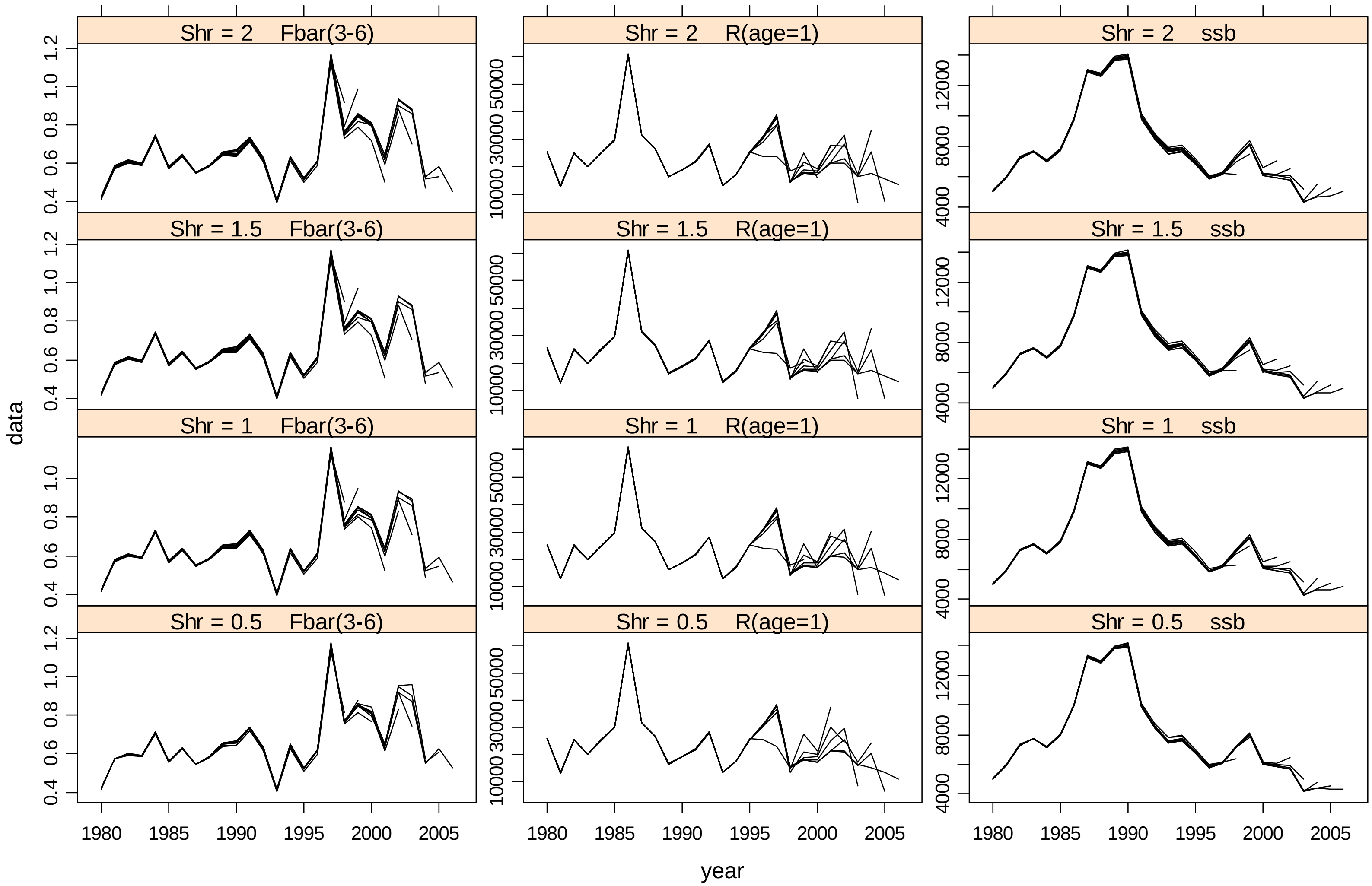
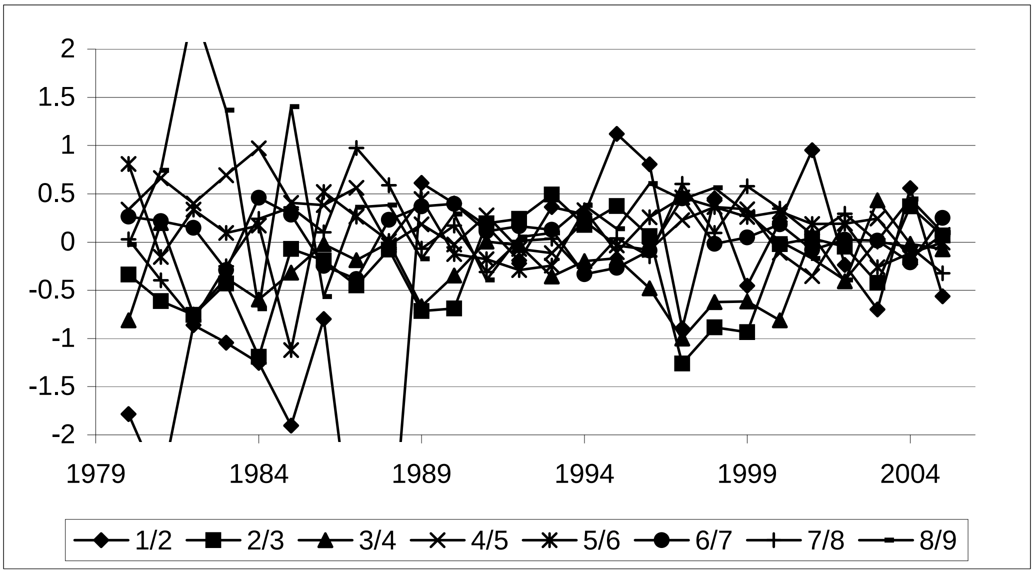


Figure 6.3.2.1. Plaice in VIId. Retrospective analysis for different values of F shrinkage



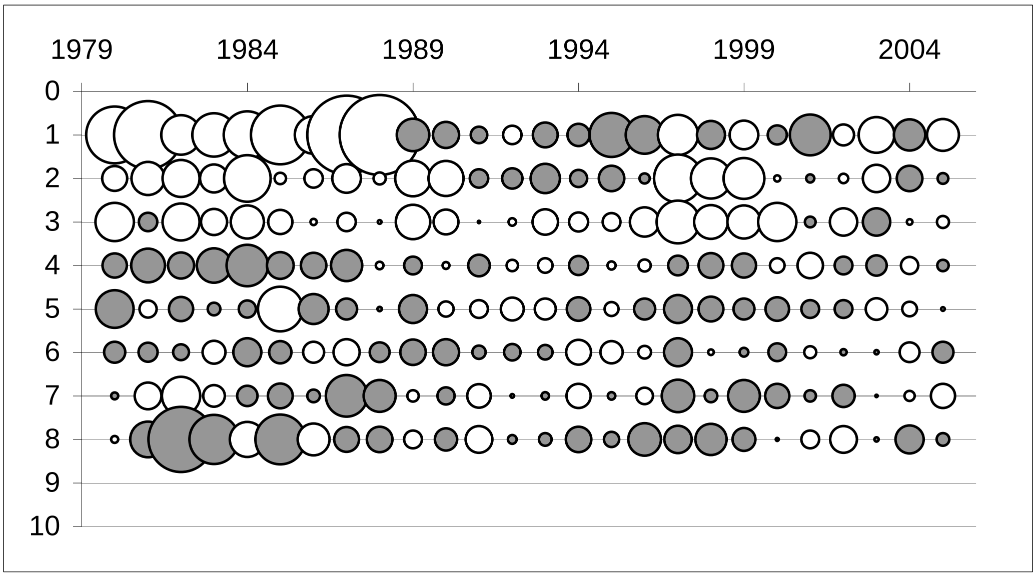


Figure 6.3.2.2 - Plaice in VIId. Separable VPA

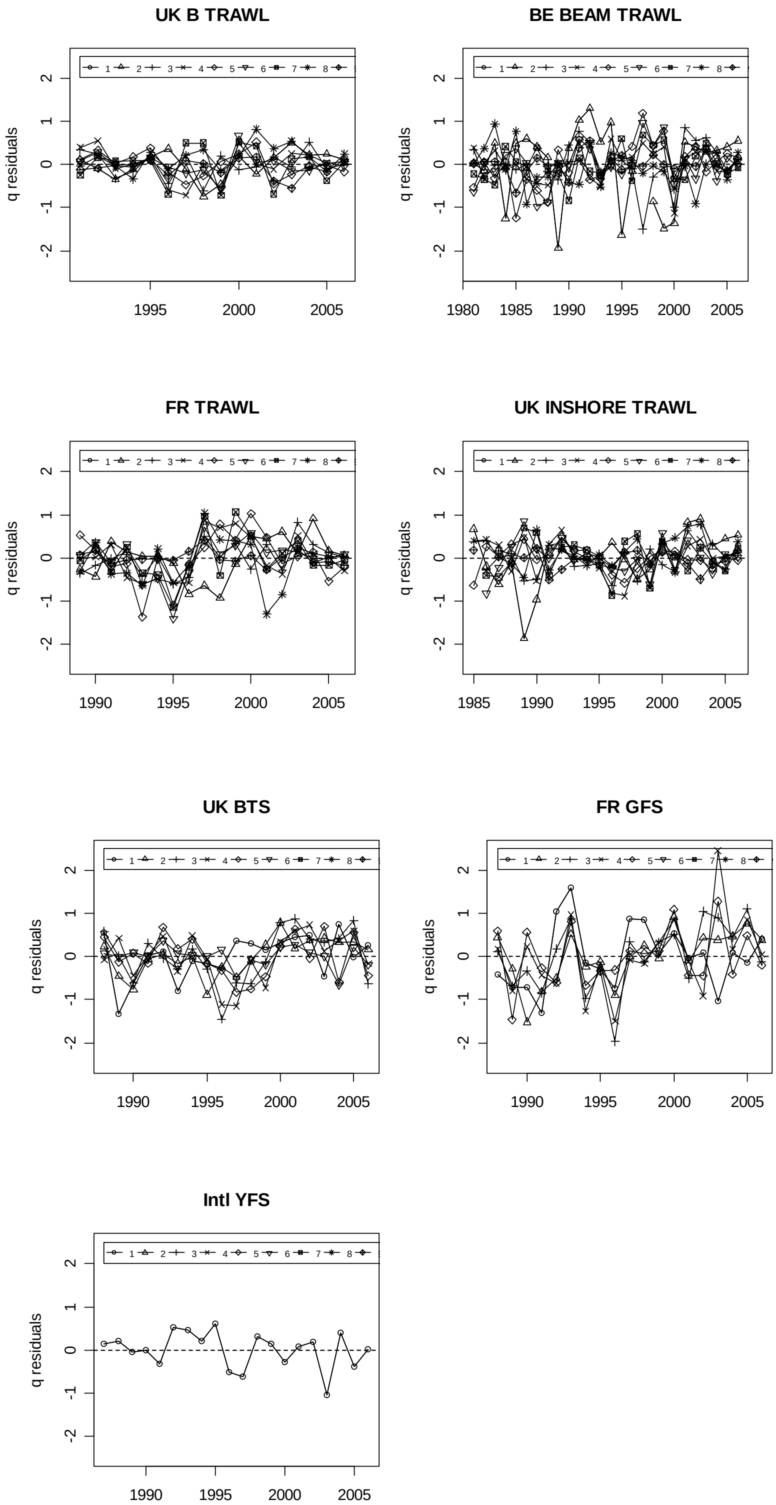


Figure 6.3.2.3. Plaice in VIId. Log q residuals for the single fleet runs (XSA settings and F shrinkage = 1.0)

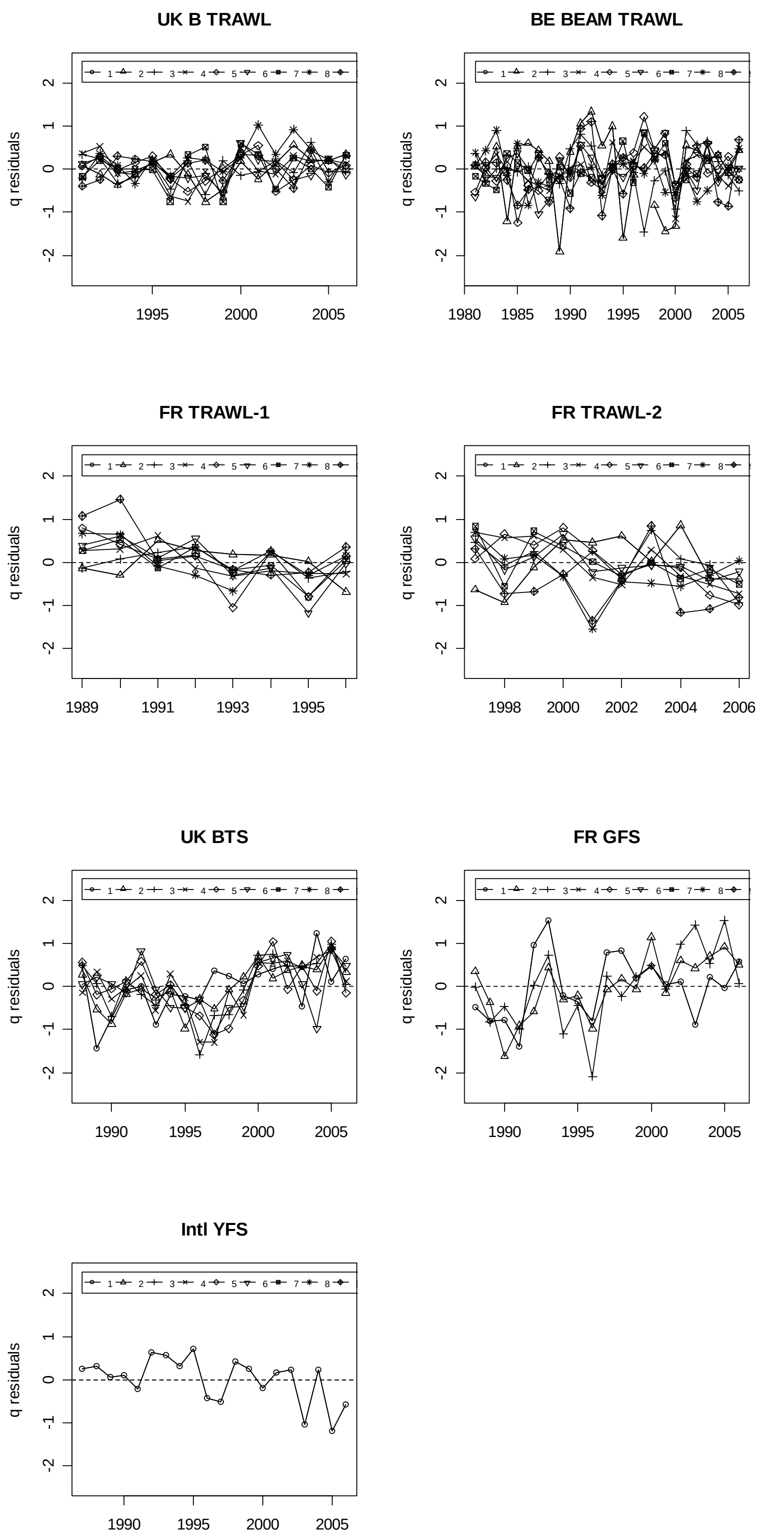


Figure 6.3.2.4. Plaice in VIId. Log q residuals. All fleets combined. Settings as proposed section 6.3.5

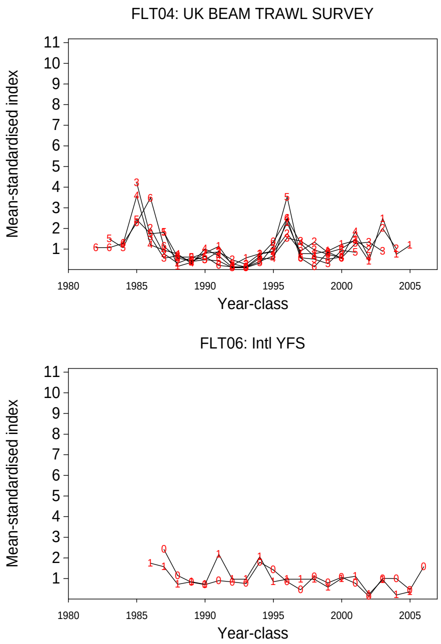


Figure 6.3.3.1. Plaice in VIId. Within survey consistency. Mean standardised indices by year class for each of the surveys.

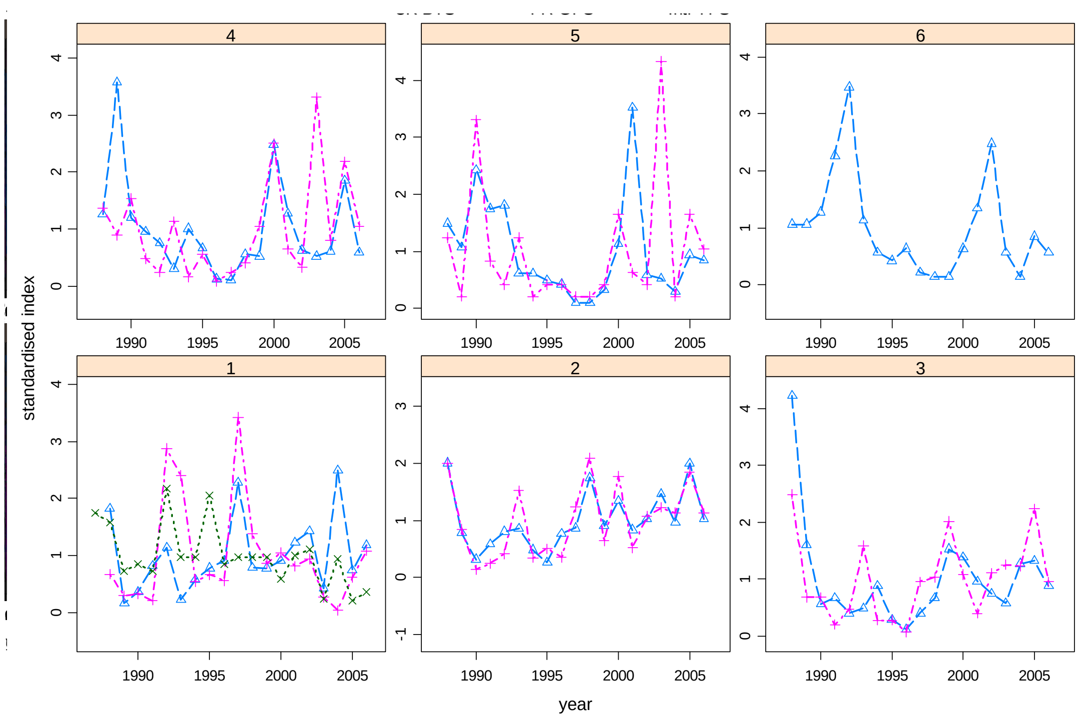


Figure 6.3.3.2. Plaice in VIId. Between survey consistency. Mean standardised indices by surveys for each age groups (△ UK BTS, + FR GFS, X Intl YFS).

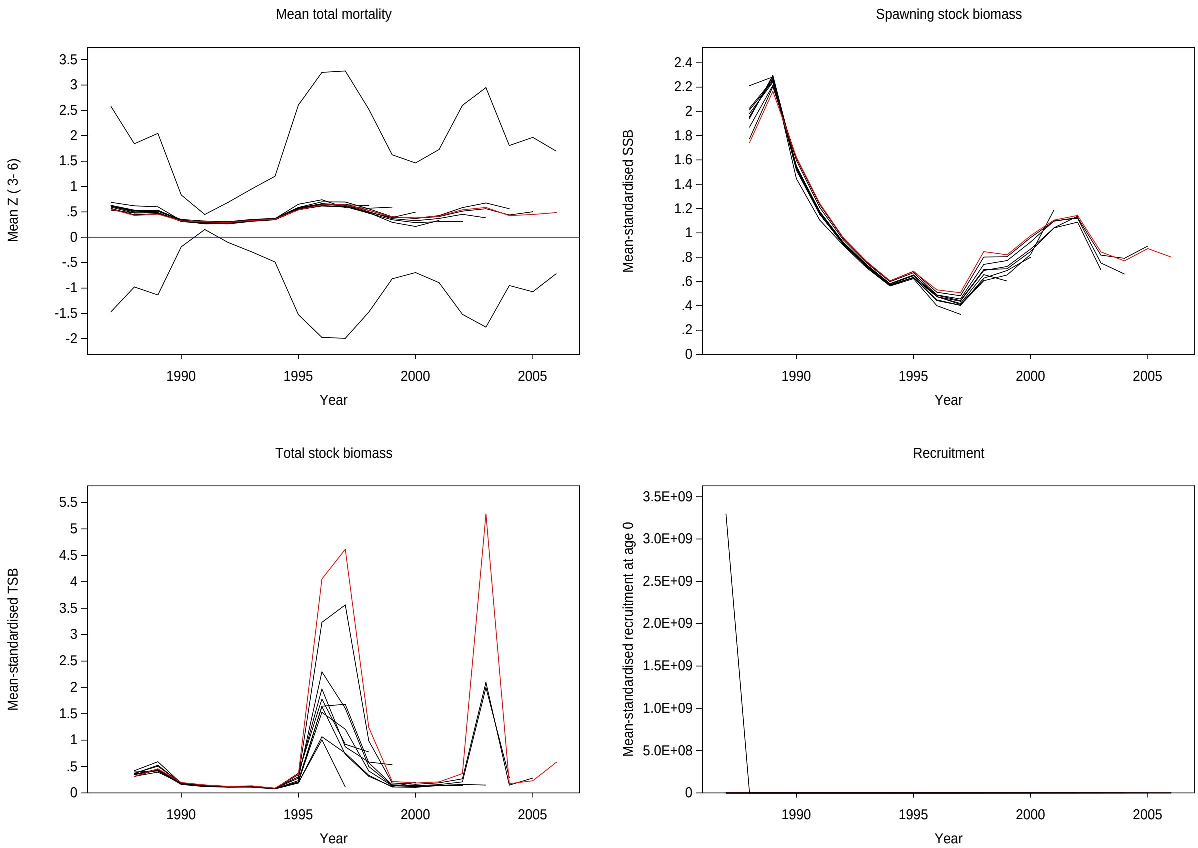


Figure 6.3.3.3. Plaice in VIId. Summary plots of the retrospective analysis from SURBA

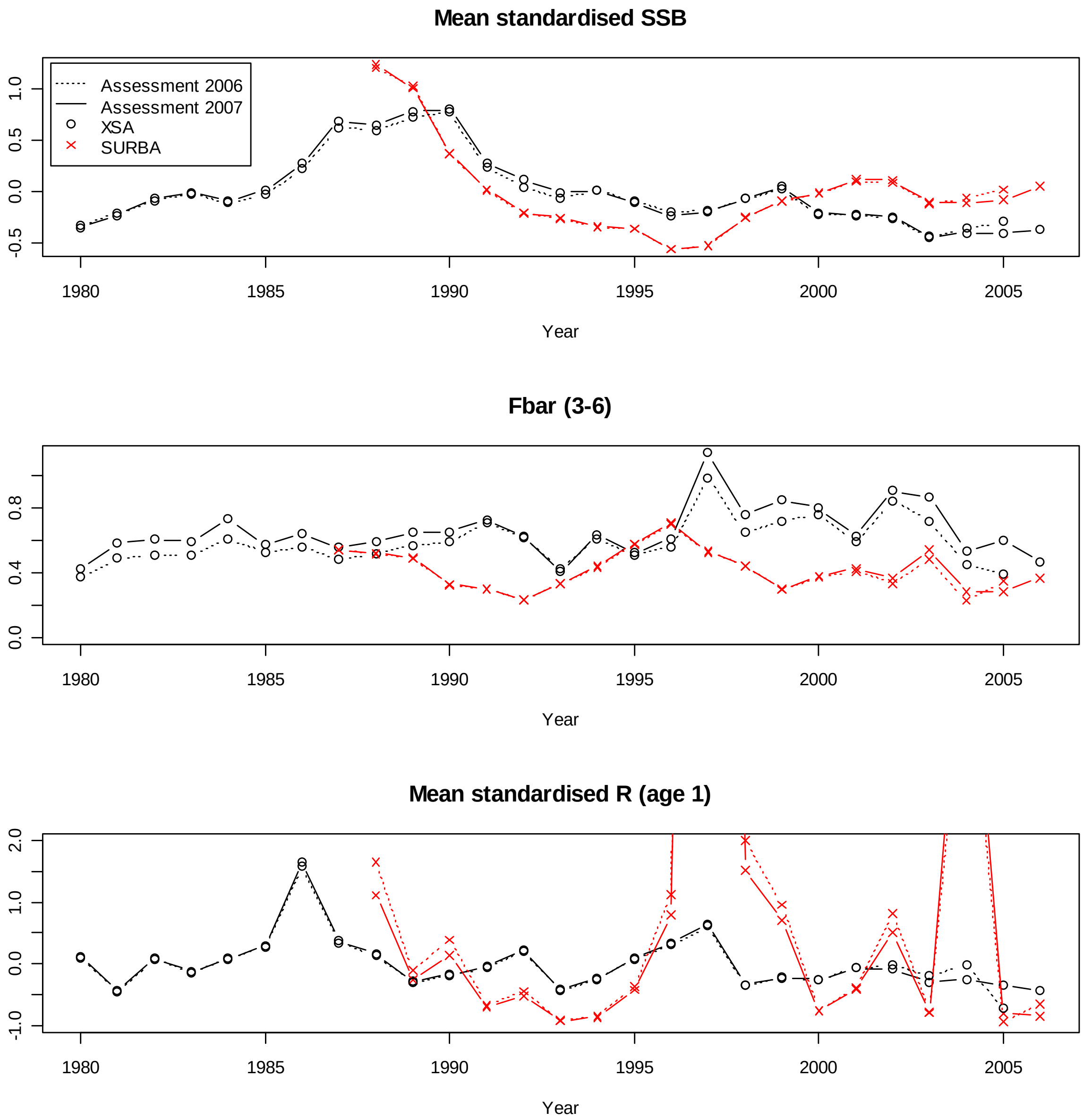


Figure 6.3.4.1. Plaice in VIId. Comparison between 2006 and 2007 assessment and between SURBA and XSA results.

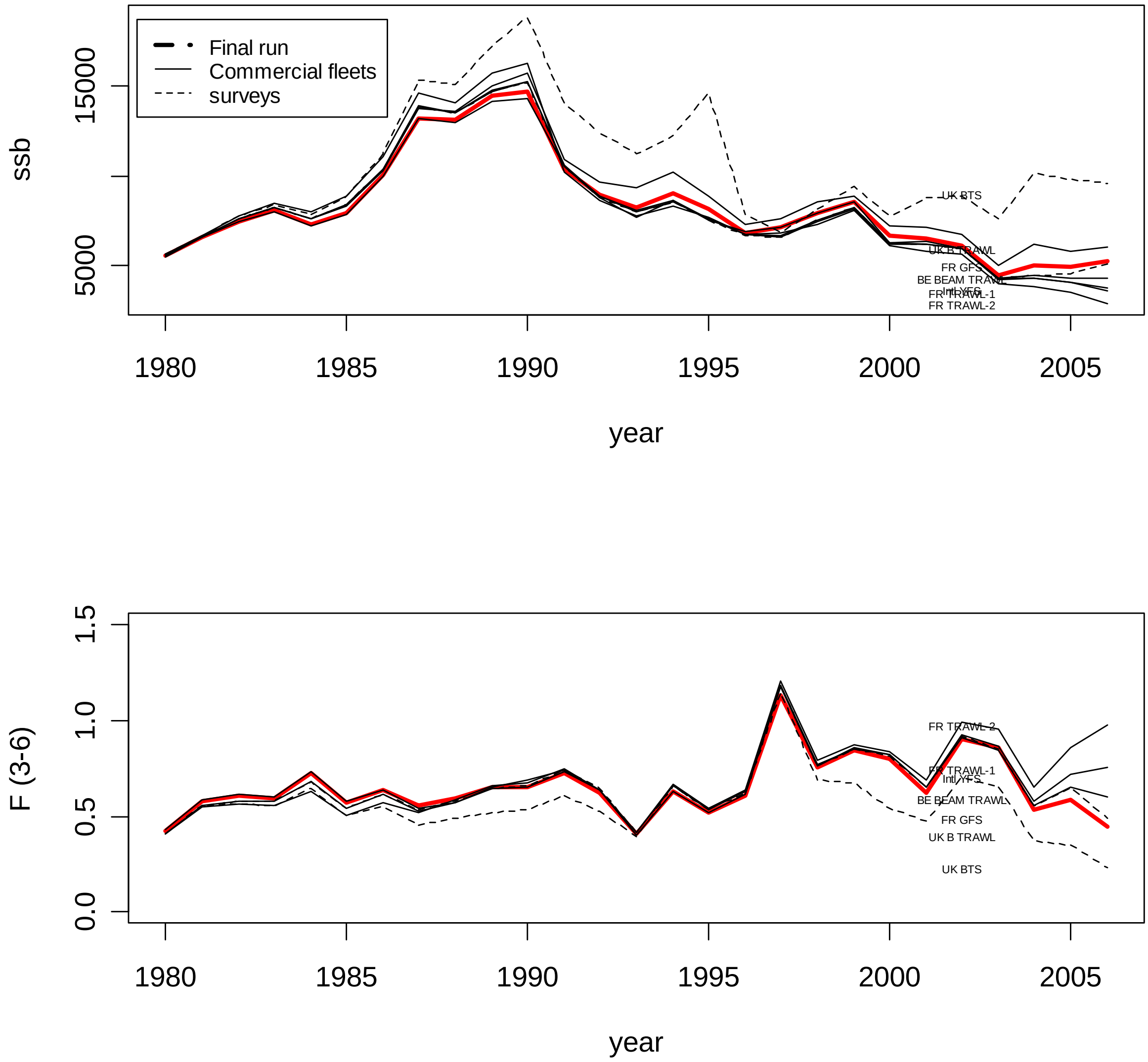


Figure 6.3.4.2. Plaice in VIId. Individual fleet historical performance.

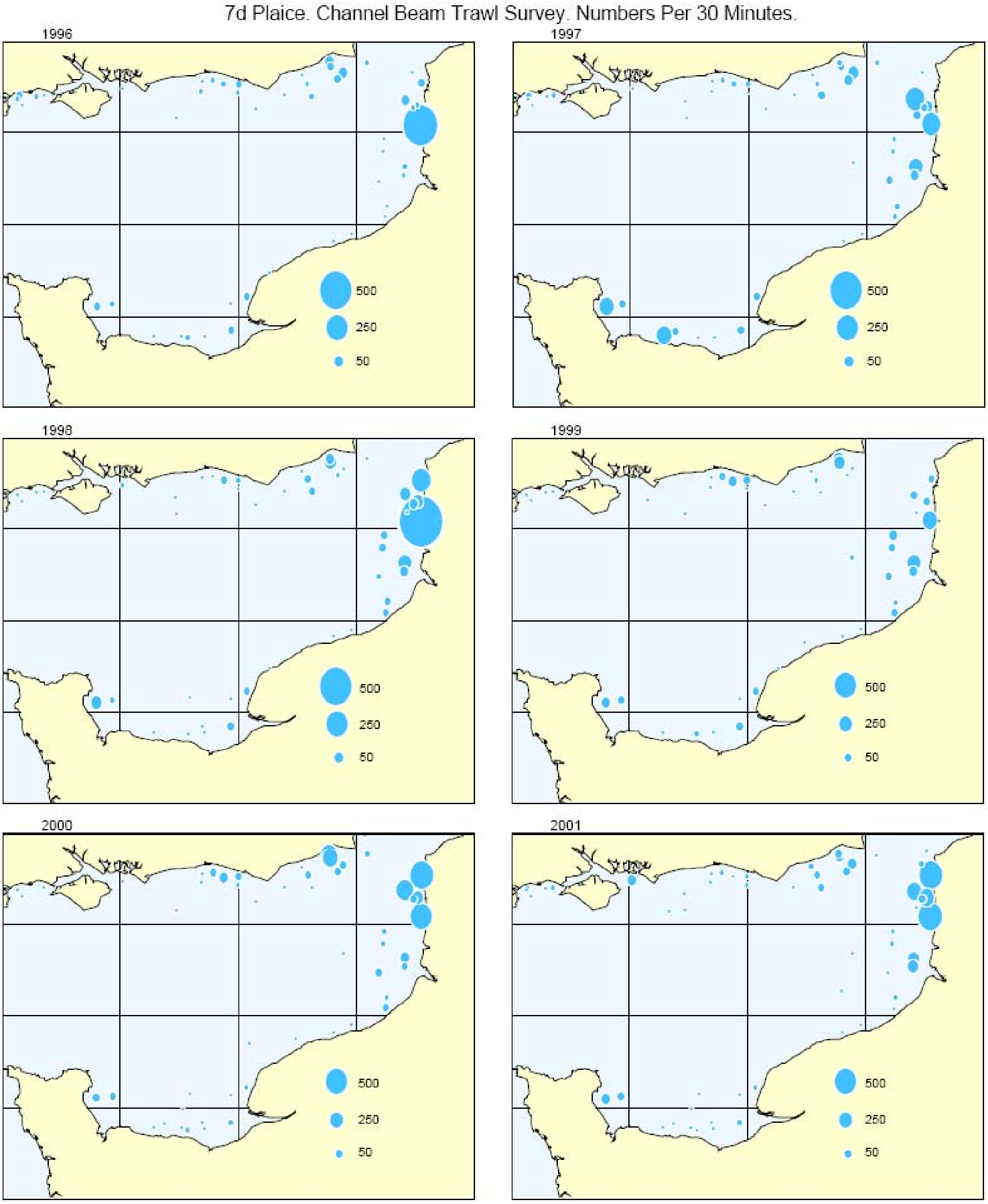


Figure 6.3.4.3. Plaice in VIId. Locations of tows and relative indices of the UK BTS survey from 1996 to 2006.

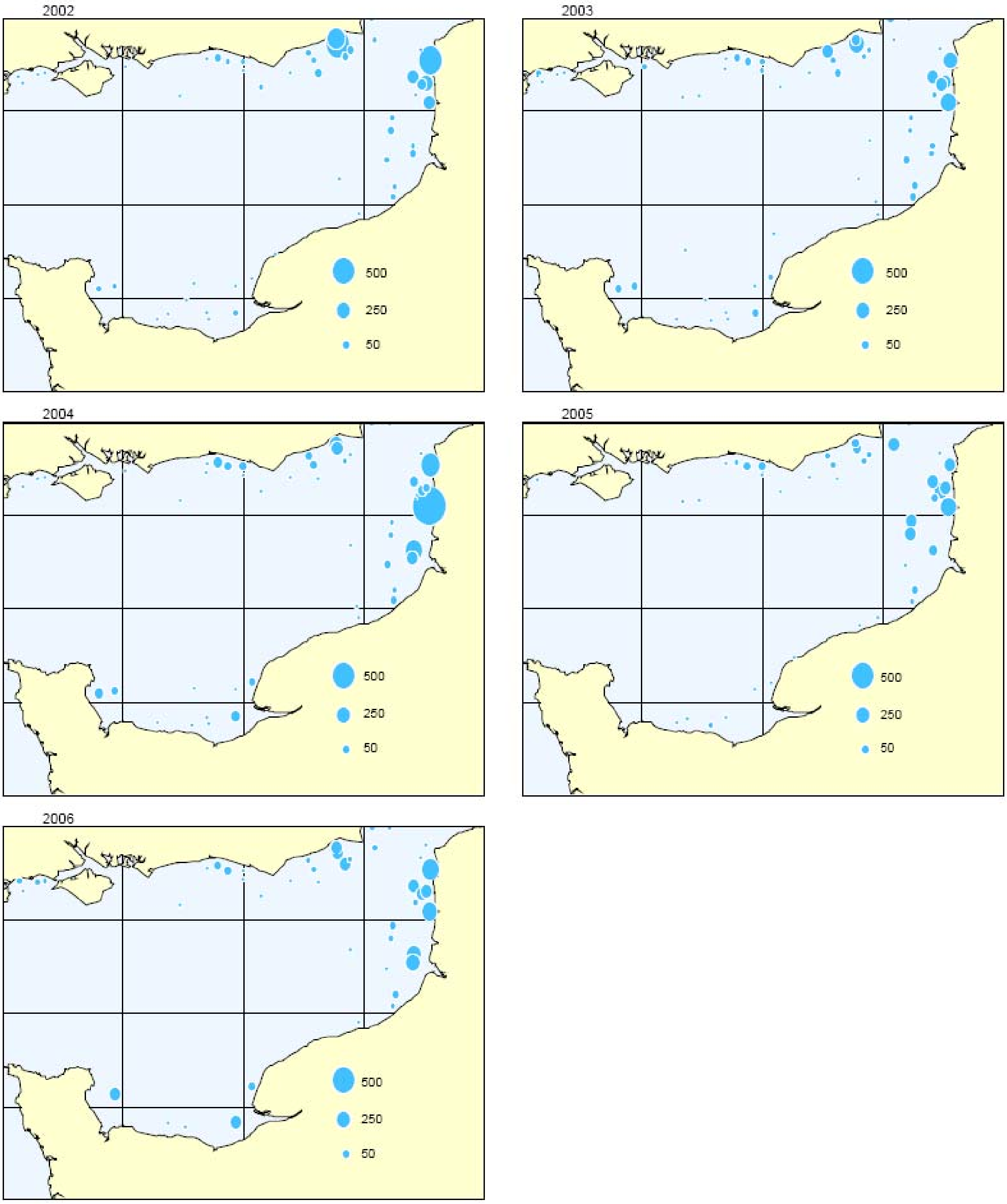


Figure 6.3.4.3. Plaice in VIId. Locations of tows and relative indices of the UK BTS survey from 1996 to 2006.

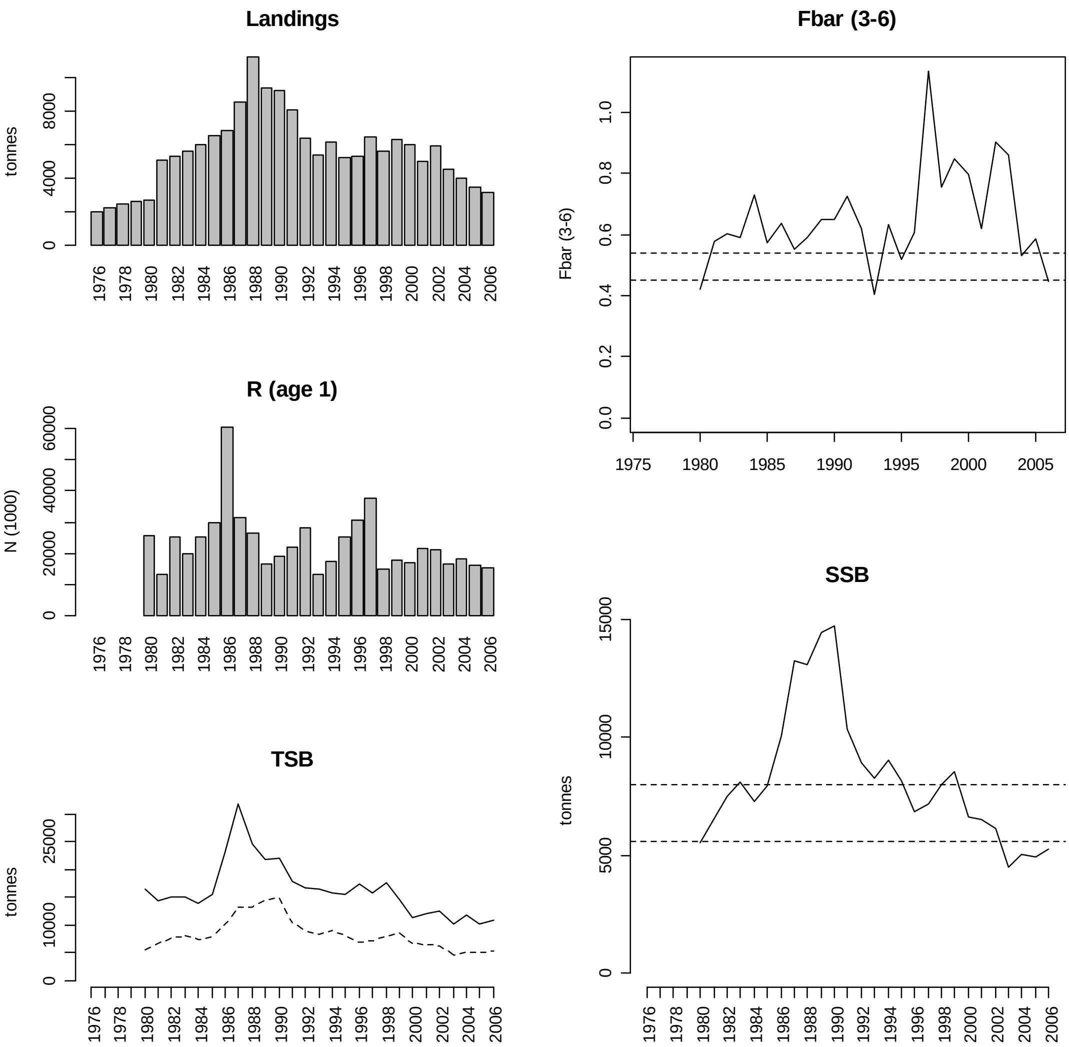


Figure 6.3.5.4. Plaice in VIId. Summary of assessment results

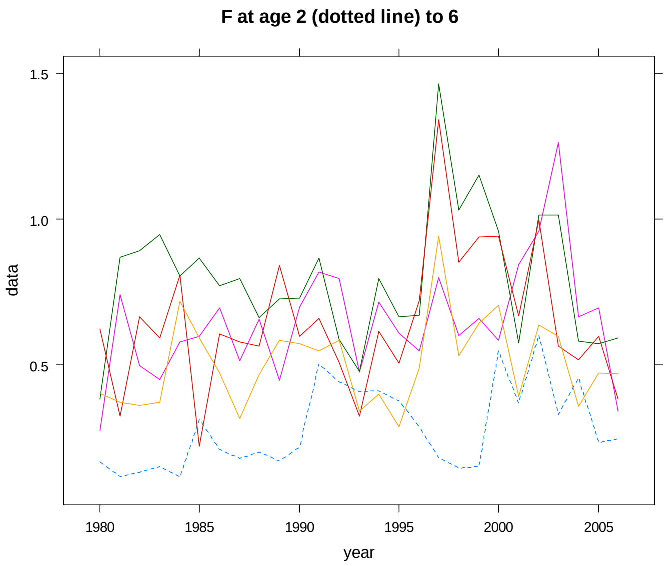


Figure 6.6.1 Plaice in VIId. Trends in F (Age 2 to 6)

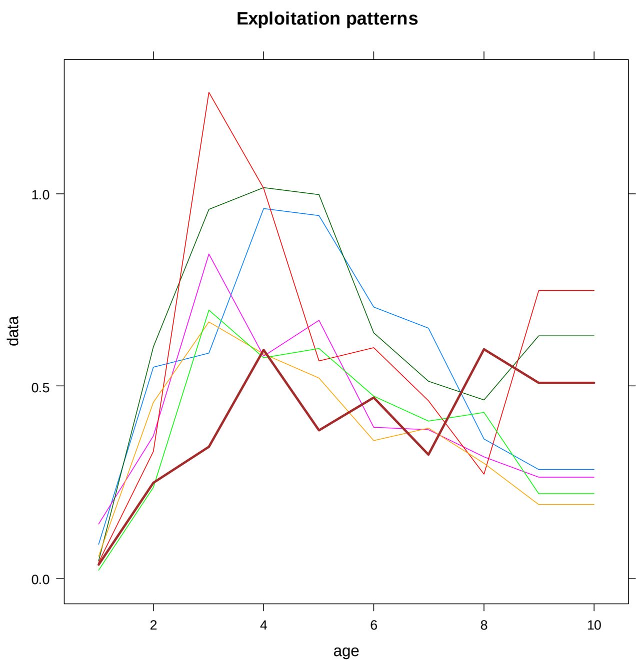


Figure 6.6.2 Plaice in VIId. Exploitation patterns over the lasr 6 years

7 Plaice in Division IIIa

This year plaice in IIIa was a benchmark assessment due to the rejection of the final assessment by this group last year. The assessment performed last year addressed a number of issues repeatedly acknowledged during previous WGs, in particular by (i) improving the definition, standardisation and reliability of tuning fleets and (ii) investigating the effects of including the Western Baltic area 22 in the assessment, as the stock identity is still uncertain. But these analyses were not sufficient to resolve the issues of the high retrospective pattern in F and SSB and the high variation in F between recent years. The WG thus rejected the analytical assessment in 2006, as was the case also in 2005 and 2006.

This year, the WG performed a set of standard trial runs, which showed the same issues as during previous years. There seems though to be an increase of biomass in the Kattegat, while the status of Skagerrak is more unclear.

The WG focused on additional key issues to be dealt with for future improvement of the assessment. They include mostly a further in-depth checking of the catch-at-age matrix, and possibilities for improving the sampling coverage in one hand, and problems with the relatively little geographical overlap between surveys coverage and commercial catches on the other hand.

Furthermore, the WG addressed a number of the comments from the 2006 Review Group. Additional information on stock identity were gathered, through collection of older tagging studies and distributional maps. Although there is no major evidence of error in the IIIa stock definition, some uncertainty remains on the provenance of plaice from the main fishing ground at the border with the North Sea.

Secondly, discards data from both Denmark and Sweden were made available to the WG. They represented 17 to 30% of total landings over the period 2002-2006, and sensitivity analyses including them in the assessment were performed.

7.1 General

7.1.1 Ecosystem and stock identity 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 use of commercial CPUE from this area as an index of stock abundance.

In 2006 the WG collected and reviewed some existing information about the structure of the stock. Spawning takes place in several places in the central part of Kattegat in late February and early March. In Skagerrak spawning has been observed although the extent seems insignificant (Poulsen 1939, Nielsen et al. 2003). This is also supported by anecdotal information from the industry about absence of mature females in Western Skagerrak during first quarter, suggesting no spawning. Egg and larvae distribution supports such a perception, as the main part of drifting eggs have been observed 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). Studies on larvae distribution in SD 20 indicated that larvae plaice in this area may partially recruit from the North Sea and adult return there for spawning. Additional tagging data in Danish waters from the period 1903-1964 has been collected and analysed since 2006 WG (Boje et al., WD#). They have shown a high degree of residence for plaice tagged in The North Sea and in the Belt Sea, suggesting limited mixing with the populations in area IIIa. Within IIIa, there are more consistent patterns on north-western migration of adult plaice, from South Kattegat to North Kattegat and from North Kattegat to Skagerrak. However, Skagerrak plaice were observed both migrating to the North Sea and to the Northern Kattegat.

The populations in Kattegat may however spread into the Belt Sea. Meristic studies of anal fin rays in the Southern Kattegat (Jensen and Nielsen 2005) have shown 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 Eastern Skagerrak and Kattegat intermingle, while plaice in western Skagerrak might be recruited partly from the North Sea. Kattegat plaice seem also connected to plaice in the Northern Belt Sea. 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 favorable conditions that led the Kattegat/Belt Sea stock to expand into this area.

In 2006, The WG did not consider the biological information conclusive to make any decision on stock identity. Additional tagging data made available in 2007 confirmed the limited mixing with Belt Sea. Therefore, the basis for advice on catches in 2007 is still based on a stock unit in IIIa.

7.1.2 The fishery in 2006

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 80% of the total catch (Tables 7.1.1 to 7.1.3). Most landings come from Skagerrak, along the Danish Northwestern coast close to the North Sea border. 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 2006 and 2007

There was no basis for an analytical forecast in 2005. ICES advised that 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.

In 2006, ICES advice was:

State of the stock:

The assessment is indicative of trends only. All survey indices indicate that abundance and recruitment of plaice in Skagerrak and Kattegat has been substantially higher in the last 6-7 years, compared with measurements in the 1990s.

Single-stock exploitation boundaries

There is no analytical assessment, but indications from the surveys are that biomass has increased. The advice is to maintain the current TAC of 9600 t for 2007.

Short-term implications

The assessment is very uncertain and is characterized by large annual revisions in population estimates, hence no short-term forecasts were performed (see Uncertainties in assessment and forecast).

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.

7.1.4 Management applicable in 2006 and 2007

There are no explicit management objectives for this stock.

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 2006, the TAC was fully taken in Skagerrak, which has only happened once (in 2001) during the last decade (Table 7.1.4). It was taken up at 80% in the Kattegat in 2006.

TAC in 2007 is 10 625 t, a 10% increase compared to 2006. It was split between Skagerrak and Kattegat, with 8 500 t and 2 125 t, respectively.

In February 2003 effort 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 has not been applied although logbook information shows a large decrease in vessels with mesh size greater than 100 mm

For 2007 Council Regulation (EC) N°41/2007 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 95 and unlimited days per year. Beam trawlers can fish between 132 and 155 days per year in the Skagerrak, and they are not allowed in the Kattegat. Gillnets and Trammel nets are allowed to fish between 140 and 162 days per year.

The effort management scheme for fisheries in Kattegat that was proposed to be put in force by 1. January 2007 has been postponed, as no common agreement could be reached between the EU Commission and the industry in 2006.

Finally, a right-based "New Regulation" has been put in place for Danish demersal fisheries in since 1st January 2007. The regulation builds upon "Vessel Quota Part" (FKA in Danish), where promilles (‰) of the national quota are attached to individual vessels. The quota parts can be traded, but the vessel capacity must be transferred together with the part. To limit issues of mixed-fisheries catches within individual quotas, fishing vessels can pool there yearly quotas together. The explicit objective of the regulation is to concentrate the fishing into fewer and more efficient vessels, and increase profitability (http://www.fd.dk/Default.asp?ID=17008). The vessels recognised as engaging in coastal fisheries can though decide to pursue fishing under one specific competitive quota. Although little data are available yet, it is expected that this new regulation will affect significantly the Danish fishing patterns, raising major issues about the future use of Danish commercial time series for tuning.

7.2 Data available

The following text table indicates Danish / Swedish sampling levels for IIIaN and IIIaS:

Sampling in 2006

lllaN	**Skagerrak**				
Quarter	**1**	**2**	**3**	**4**	**Total**
Nos age samples	4 / 3	3 / 1	2 / 0	1 / 0	10 / 4
Nos length meas	789 / 780	833 / 1305	712 / 101	238 / 1152	2572 / 3338
Nos aged	772 / 44	809 / 15	682 / 0	232 / 0	2495 / 59
lllaS	**Kattegat**				
Quarter	**1**	**2**	**3**	**4**	**Total**
Nos age samples	5 / 18	3 / 8	3 / 10	3 / 17	14 / 53
Nos length meas	438 / 1348	556 / 780	474 / 792	464 / 1035	1932 / 3955
Nos aged	354 / 341	551 / 391	469 / 341	462 / 425	1836 / 1498

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 2006 more than 80%. According to official and national statistics, total landings in 2006 were estimated at 9 405 t, 35% higher than 2005 and the second largest landings in the decade (after 2001) (Figure 7.2.1). 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 and 2006. Danish landings for 2007 first quarter are though the lowest in the last five years. It is not clear whether this is due to the changes in the fishery after the introduction of the new regulation or to weather conditions, but there is no reporting of reduced LPUE from the industry.

Previously, misreporting had been considered to potentially occur in the area between the North Sea and the Skagerrak, as ICES rectangle 43F8 at the border distribute in both areas, and thus fishery in the rectangle can be reported in either of the areas. In recent years a substantial part of the landings from that rectangle has been reported as being caught in Skagerrak. But information from the fishery suggests that the fishery 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. However, this particular rectangle represents a very large part of the landings for this stock (Figure 7.2.2), and small relative errors in catch allocation to one or another stock following administrative boundaries may potentially lead to dramatic variations in the catch-at-age matrix.

Discards time series from Denmark and Sweden over 2002-2006 were made available to the WG this year (second semester 2004 data missing for Sweden). Total amount was estimated between 1 600 to 2 600 tonnes by year, corresponding to 15-25 % of the catch in weight (Table 7.2.3)

7.2.2 Age compositions

Age compositions of the landings are presented in Table 7.2.1 and Figures 7.2.3 and 7.2.4. Age-disaggregated Swedish and Danish samples were available for 2006 and used in the total landings for age estimation. The age distribution in landings do not show clear patterns, and the year classes are not consistently tracked over ages. The 1999, 2001 and 2003 appeared to be the 2nd, 4rd and 3th strongest year classes as age group 2 respectively, and were relatively well tracked at age 3, but less clearly at age 4,

The 2006 review Group expressed concerns about these noisy patterns from the landings, and the WG has also focused on this issue. The WG collected information from Danish and Swedish otolith readers, which confirmed some uncertainties in age reading for plaice IIIa. This is mainly due to difficulties in interpreting the first ring and the edge, as well as to large variations in growth between males and females in the one hand, and North and South in the other hand. However, it has not been possible to further address this issue in the current assessment neither through data checking nor simulation. This will be a main key issue to be investigated for a forthcoming assessment. The WG recommends that this issue could be referred to PGCCDBS.

Discards age compositions were provided by Denmark and Sweden. Most discarding occurs at age 2 and 3, with a proportion of discarding between 55 and 95%, and 25 to 55% of catches respectively. The large 2001 year class was largely discarded at age 2 in 2003, but apart from that the discards estimates do not appear to have changed substantially during the past three years (Table 7.2.4).

7.2.3 Weight at age

Weight at age in landings is presented in Table 7.2.2 and Figure 7.2.5. The procedure for calculating mean weights is described in the Stock Annex (Q7). Weight at age in discards is presented in Table 7.2.5.

Weight at age in the stock had previously been assumed equal to weight at age in the catch due to unavailable data on stock weights. In 2006, data were made available from IBTS 1st quarter (1991-2005) and KASU 1st quarter (1997-2005) in IIIa, and the 2006 WG provided revised estimates of stock weight at age. Only 1st quarter survey and commercial data are used to calculate mean weights in the stock at the beginning of the year. Age groups 1-4 are used from the surveys as ages 5 and 6 are contradictory and considered too noisy. For older age groups weight at age in 1st quarter are computed from landings sampling in the time period 1995-2006. Before 1995 no information on weights per quarters was available (Table 7.2.6 and Figure 7.2.6). In summary compilation of stock weights at age are as follows:

- For age 1-4 (1997-2006) 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 (1978-1990) an average from 1991-1995 (IBTS) was used as fixed value.
- Age 5-11 (1995-2006) mean weight from the commercial fleet first quarter.
- Age 5-11 (1978-1995) an average from (1996-1998) was used as fixed value.

Although the 2006 review group expressed some concerns about the quality of stock weight estimates, the procedure has not been revised during the 2007 WG.

7.2.4 Maturity and natural mortality

Natural mortality is assumed constant for all years and is set at 0.1 for all ages.

The maturity ogive was also revised during the 2006 WG. Previously, maturity was assumed knife-edge distributed: age group 2 was considered immature whereas age 3 and older plaice were considered fully mature. In 2006, a maturity-at-age was established based on IBTS 1st quarter data since 1994. Given large inter-annual variability especially at age group 2, a fixed 1994-2005 average value per age was applied to the entire time series (Table 7.2.7). The 2007 WG did not investigate the Review Group's proposal of using a smoothed maturity ogive rather than a fixed value, but this will be addressed during a forthcoming benchmark assessment.

7.2.5 Catch and effort data

7.2.5.1 Data

In 2006 the WG made a commendable effort to improve the quality of the commercial tuning fleets used in the assessment, both in terms of data checking, fisheries definition and effort standardisation. The final WG decision was to keep two tuning fleets, the Danish seiners and the Danish gillnetters targeting flatfish with 120 to 220 mm nets, with effort measured as kW*fishing days.

This procedure has not been revised in 2007, and the same fleets have been used (Table 7.2.8). However, it was noted that there had been a significant increase in the number of small gillnet vessels in the Danish national database in 2007. This could be related to the 2007 obligation to fill-in log-books in the Baltic for vessels 8-10m, which could have affected the registration in IIIa as well. No further investigation was done, but it was decided to keep only the vessels larger or equal to 10 m in the tuning fleets.

Furthermore, the Danish national database has been changed to a new system in 2007, with a number of improvements in particular in the kW and HP registration, from a category to an absolute value. It has not been possible this year to produce new time series based on the new database, and to check the full consistency of 2006 data with the previous years. But this will be checked for the coming WG in 2008.

There is no evidence of major issues about the reliability of commercial tuning series with regards to misreporting for the stock.

7.2.5.2 Trends in catch and effort

Effort, yield and LPUE are shown for the two commercial tuning fleets (Figure 7.2.7). Total effort by seiners constitute far the most by the two fleets. Since 2001 effort has decreased in both fleets, however, mostly by the seiners, a decrease of about 56%. There is a clear conflicting signal between the two fleets LPUE trends, especially in 2006, where the seiners show a major increase in LPUE while it has been stable or slightly decreasing for the gillnetters.

This may be due to the differences in age classes that the two fleets are exploiting. Internal consistency is presented on Figure 7.2.8 by means of catch curves and matrix scatterplots. Both fleets present noisy patterns. But LPUE by age are fairly consistent (Figure 7.2.9), likely due to the use of a common ALK. There are clear signals of the strong 2001 and 2003 year classes at age 2 and 3. These year-classes are also recognized clearly in surveys (see Section 7.2.6). But the year class 2004 seems below average.

The difference in signals has raised some concerns. The number of Danish seiners has decreased by almost 50% since 2001, being more specialized and thus less flexible than trawlers to adapt to decrease in cod and plaice abundance. It is thus likely that the remaining vessels are the most efficient, and catchability may have increased. Furthermore, the effect of the changes in kW measurement in the Danish database is still unclear. The gillnetters present a clear relationship between effort and yield with a significant slope (R^2=0.68), while the slope of the regression is not significant for seiners (R^2=0.16) (Figure 7.2.10). No decision was made still to remove the Danish seiners from the analysis, but further investigation should be conducted.

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. As no age data were available yet for KASU Q1 in 2007, the latest information could not be used and the index was not backshifted.

The indices from the four surveys are given in Figure 7.2.11. They are consistent tracking the strong year classes 1998-99, 2001 and 2003 at age 2, 3 and 5, and are noisier at age 1, 4 and 6. 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 7.2.12 and 7.2.13 by means of catch curves and matrix scatterplots. In general, the survey series are consistent with respect to tracking cohorts. The 1st quarter survey series perform better than the 3rd and 4th quarter survey series.

The main issue discussed by the WG in 2007 was the limited survey coverage of main fishing grounds. This issue had been mentioned before but not investigated. Distribution maps (Figures 7.2.2, 7.2.14 and 7.2.15) showed that although IBTS takes place in the Skagerrak, it is limited to the area around Skagen in Northern Denmark, while most of the fisheries take place in the North Western area close to the North Sea border.

7.2.6.1 Establishment of 0-group index

In 2006, the WG established a 0-group index based on an East Kattegat survey conducted with the Danish R/V HAVKATTEN. A standardised 0-group CPUE was found to perform in agreement with both IBTS and KASU surveys, and the WG suggest the use of the standardised CPUE series as an index of 0-group abundance in Div. IIIa. But these data were not used, as no forecast was performed.

However, the 2006 data were not made available to the WG in 2007, and no results are presented.

7.3 Data analysis

7.3.1 Review of 2006 assessment

The issues listed by the RGNSSK in the 2006 dealt all about data issues and have been described in the corresponding chapters above. The WG has considered most of them, although some will require a more in-depth intersessional work to be addressed and resolved properly. The principal shortcoming remains a lack of an examination of the landings at age matrix in detail (spatial distribution, 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. This will have to be addressed with first priority in a forthcoming assessment.

7.3.2 Exploratory catch 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 0.9 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, but show that the cohorts are difficult to track.

In order to explore the single effects of the tuning fleets, **single XSA** runs with low shrinkage (2.0) were performed with FLR for the 2 commercial fleets and the 4 surveys. The consistency between each fleet and the landings at age matrix is explored through log catchability residuals (Figure 7.3.2). The commercial fleets are overall consistent with low residuals. The

Danish seiners had continuously showed an increasing trend in the previous years assessments, but this has no more been observed in the last two years. There is a clear inconsistency between the four surveys and the landings matrix, with positive trends in the residuals observed for three out of four surveys. As it is not assumed that the surveys have increased their catchability, this reflects conflicting signals between the two sources of information collected in different regions.

This conflict is clearly seen on single fleets summary plot (Figure 7.3.3). Fbar in the final year varies from 0.1 to 0.9, while SSB varies from about 20 000 to 75 000 tonnes. The 3rd-4th quarter surveys showed some good consistency with the commercial fleets around higher F and lower SSB, which had not been the case in the previous assessments. But the first quarters surveys give the opposite picture.

In 2006, Ulrich and Hamon (WGNSSK 2006, WD 10) and Hamon and Ulrich (WGNSSK 2006, WD 14) used a combined index for comparing restrospective patterns across runs. For single fleet runs, this index showed the lowest value (thus the smallest pattern) for tuning with the Danish Gillnetters fleet, followed by the Danish seiners. The largest pattern for SSB was obtained with KASU Q4, and with IBTS Q1 for F.

A combined fleet XSA runs with same settings as last year (SPALY run) was then conducted. As for single fleet runs, 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 regressions indicating poor correlations between tuning fleets and catch for several ages (Figure 7.3.4). As in previous assessment a strong retrospective pattern was 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.

As in 2006, an examination of the landings at age matrix and the corresponding F at age, suggested that the high Fbar's in the recent period are primarily caused by the older age groups in which landings are rather variable from year to year. An XSA run with a plus group at age 8 was thus conducted, but this did not change the perception of the assessment.

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, with the same indices than used in XSA but starting at age 2. Various combinations of the available surveys were tested and the results for SSB, R and F are shown in Figure 7.3.5. Although noisy, all runs show a slight decrease in F and an increase of SSB, which is much more pronounced when using Q1 surveys only. There is evidence for large year classes in 1998, 2001 and 2003.

7.3.4 Conclusions drawn from exploratory analyses

The landings at age data seem quite noisy. Although there is no evidence of major error in stock identity nor in misreporting, landings data are probably subject to an unknown proportion of mixing along the border with the North Sea, where most catches occur. Substantial discard are also observed. Finally, low sampling levels as well as age reading issues contribute to blur the signals from the landings at age matrix. This noise in the landings data is meant to be the main factor causing the large inter-annual variations in F.

Most indices suggest that recruitment has been good in recent years: 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 point in the same direction as the overall LPUE from the four surveys, though with less dramatic increases in SSB observed. On the contrary, the signal conveyed by the gillnetters is consistent with the overall signal conveyed by the landings at age matrix, showing lower residuals and retrospective patterns. It is often advocated that effort measures from the gillnetters might not reflect the real fishing effort very precisely, but here the effort measured in Kw*fishing days is significantly correlated with the yield and the internal consistency is good.

All approaches that use survey data show improved recruitment in recent 5-6 years and a corresponding increase in biomass. However, distribution maps have shown limited overlap between surveys and the commercial catches. This may be the main factor causing the large retrospective patterns repeatedly observed during previous years assessments. The good recruitments observed by the surveys are not consistently tracked by the industry, causing overestimation in SSB and underestimation in F.

In conclusion, there is evidence for increased biomass in the Kattegat and in Eastern Skagerrak, where the populations intermingle between both areas. But the status of the stock in the Southwestern Skagerrak, where most catches occur, cannot be determined from surveys.

In the light of this, the WG decided to still use XSA rather than SURBA for the assessment. The proposed assessment uses only commercial data and shrinkage for the tuning because they are both derived from the same area. Because of uncertainties in the validity of this approach, no forecasts are presented. Another assessment is presented, including discards numbers over the last 5 years as a sensitivity analysis.

7.3.5 Proposed assessment

Two XSA runs are presented, run1 without discards and run 2 with discards. The settings are given below

Year of assessment:	2006	2007
Assessment model:		
Fleets:	Danish Gillnetters metier_kwfishdays (age range: 2-10, 1995 onwards)	Danish Gillnetters metier_kwfishdays >10m (age range: 2-10, 1995 onwards)
	Danish Seiners _gear_kwfishdays (age range: 2-10, 1995 onwards)	Danish Seiners _gear_kwfishdays >10m (age range 2-10, 1995 onwards)
	KASU q4 (age range: 1-6, 1994 onwards),	
	KASU_q1_backshifted (age range: 1-6, 1995 onwards) revised	
	IBTS_q1_backshifted (age range: 1-6, 1990	
	IBTS q3 (age range: 1-6, 1997 onwards)	
Age range:	2-10+	2-10+
Catch data:	1978-2005	1978-2006
Fbar:	4-8	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:		

The XSA diagnostic for run 1 is given in Table 7.3.2. 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 7.3.6.

The results of run 2 including discards are also presented on Figure 7.3.6.They are very close from run 1. It affects only the level of recruitment, but not the perception of the large year classes in recent years. The assessment seems thus robust to the inclusion of discards.

Retrospective analyses of the run 1 assessment is presented in Figure 7.3.7. Although still noisy, the quality of the assessment has improved in the last two years. The 2007 assessment is largely consistent with the 2006 one with same settings. Less variability in F has been observed, and the retrospective pattern is has been reduced for all metrics. The assessment has been consistently estimated in the last three years.

7.4 Quality of assessment

The surveys in particular suggest that biomass in Eastern area is increasing in recent years probably due to improved recruitment in the years from 1998. The seiners only partly support this signal, although in their case this could be due to potential increase in catchability due to reduction in fleet size. On the contrary, the gillnetters suggest a more stable biomass, and there is evidence that the current measure of effort is appropriate. The assessment tuned with commercial data support this signal of increase in biomass and since 2005 and good recruitment, though to a lower extend than what surveys indicates. This is also confirmed by qualitative statement from the industry.

While in 2006, the WG decided not to present a final XSA run and to base its advice from the SURBA analysis, in 2007 the WG considers that the SURBA-based analysis is more likely to be appropriate for the Eastern Skagerrak and Kattegat, whereas the XSA tuning using commercial data is more appropriate to reflect trends in the Western Skagerrak.

7.5 Reference points

	ICES considers that:	**ICES proposed that:**
Precautionary Approach reference points	$\mathbf{B}_{lim}$ cannot be accurately defined.	$\mathbf{B}_{pa}$ = 24 000 t.
	$\mathbf{F}_{lim}$ cannot be accurately defined.	$\mathbf{F}_{pa}$ = 0.73.
Target reference points		$\mathbf{F}_{y}$ undefined.

Technical basis

	$\mathbf{B}_{pa}$ = smoothed $\mathbf{B}_{loss}$ (no sign of impairment).
	$\mathbf{F}_{pa}$ = $\mathbf{F}_{med}$.

7.6 Stock status

According to the assessment, the SSB has been decreasing since 1992, has been below Bpa (24 000 t) since 1996, but has increased in the last two years. This is due to a succession of good recruitment in 2003-2005 (YC 2001-2003), after a decade a below average recruitment (GM=43 500). However, the latest year classes (2004-2005) are not estimated high, neither from the commercial data nor from the surveys. The fishing mortality is high and has consistently been estimated over Fpa (0.73).

7.7 Management considerations

Plaice is taken both in a directed fishery and as an important by-catch in a mixed cod-Nephrops- plaice fishery. North Sea cod, which is estimated to be 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.

There is empirical evidence that restrictive by-catch rules on cod in Kattegat create a major incentive to misreport catches in the Western Baltic (ICES_WGBFAS 2007). But the consequences for potential misreporting of plaice have not been investigated. But the TAC for plaice in Western Baltic is not based and analytical assessment, and is not restrictive. Therefore, similar phenomenon may potentially occur if the plaice TAC becomes restrictive in the Kattegat.

In previous years it was postulated that a mismatch between the biological entity of the stock and the defined management area might exist for this stock. An analysis of tagging information has indicated that this is not likely to be the case. Movements of fish between management areas are relatively small and it is unlikely that this will affect the quality of the assessment. However, most catches occur at the border of IIIa and the North Sea, and therefore their provenance needs to be examined.

The reference points for plaice IIIa were defined in the late nineties when the Precautionary Approach was implemented. At that time, there had been no sign of recruitment impairment, and Bpa was set around the Lowest Observed Spawning Stock (1989). Since then, SSB has decreased to lower levels until 2004, without showing any reduced recruitment. On the contrary, the largest recruitments in the recent years have been observed at the lowest levels of SSB. There is thus no sign of impaired recruitment. A revision of the Precautionary Reference Points on the same bases may be considered.

7.8 Issues to be addressed in future assessments

A large number of issues have been investigated in the recent years. Major work has been done towards improving surveys and commercial data quality, collecting additional biological knowledge, analysing stock identity and its consequences on assessment, collecting discards data, producing distribution maps and running alternative assessment models. However, despite this heavy effort, most issues have not been resolved and the assessment is still uncertain.

In 2007, the WG identified measurement error as the key issue that would need to be resolved before reaching any further improvements. Most of the uncertainty comes from the noise of the landings at age matrix, which does not show proper tracking of the cohorts. The two main reasons advocated are (i) mixing of the IIIa stock with North Sea plaice stock on the main fishing ground in Southwestern Skagerrak and (ii) age misspecification due to low sampling levels and uncertainty in age reading. It is still unclear how these issues can be resolved. One approach will be to perform simulation work with various hypotheses about observation error and mixing rates between stocks, and to produce sensitivity analyses. Another approach will be to investigate the possibilities for a dedicated research program toward stock identification in ICES rectangle 43F8. In any cases, this will require major workload to be done intersessionally.

Furthermore, it will be necessary to produce additional analyses of the distribution of effort and landings in time and space, for a better understanding of the coverage of the commercial tuning fleets. The potential increase in catchability for the Danish seiners due to decreasing fleet size should also be investigated in further details.

Finally, the major changes that have occurred in the Danish fisheries in 2007 following the introduction of a transferable effort-based regime will likely affect widely the structure and fishing patterns of the fleets. The extent of these changes is still unknown, and their monitoring is not straightforward as the effort regime put in place is highly flexible. This raises major issues about the reliability of the current commercial time series for tuning.

For 2008 assessment, it is expected that sensitivity analyses about observation error and mixing rates can be performed. A trial run should be performed on the Eastern part of the stock only, to analyse the consistency of commercial catches with surveys in that area. A better description of the distribution of effort in time and space will be provided. In that regard, plaice IIIa should be again considered as a benchmark assessment in 2008.

Table 7.1.1 Plaice in IIIa. Official landings in tonnes as reported to ICES and WG estimates, 1972-2006

Year	Denmark		Sweden		Germany		Belgium		Norway		Netherlands		Total			
	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	Unalloc.	WG est.	TAC
1972		20,599		418		77				3					21,097	
1973		13,892		311		48				6					14,257	
1974		14,830		325		52				5					15,212	
1975		15,046		373		39				6					15,464	
1976		18,738		228		32		717		6					19,721	
1977		24,466		442		32		846		6					25,792	
1978		26,068		405		100		371		9					26,953	
1979		20,766		400		38		763		9					21,976	
1980		15,096		384		40		914		11					16,445	
1981		11,918		366		42		263		13					12,602	
1982		10,506		384		19		127		11					11,047	
1983		10,108		489		36		133		14					10,780	
1984		10,812		699		31		27		22					11,591	
1985		12,625		699		4		136		18					13,482	
1986		13,115		404		2		505		26					14,052	
1987		14,173		548		3		907		27					15,658	19,250
1988		11,602		491		0		716		41					12,850	19,750
1989		7,023		455		0		230		33					7,741	19,000
1990		10,559		981		2		471		69					12,082	13,000
1991		7,546		737		34		315		68					8,700	11,300
1992		10,582		589		117		537		106					11,931	14,000
1993		10,419		462		37		326		79					11,323	14,000
1994		10,330		542		37		325		91					11,325	14,000
1995	9,722	9,722	470	470	48	48	302	302	224	224			10,766	0	10,766	14,000
1996	9,593	9,641	465	465	31	11			428	428			10,517	28	10,545	14,000
1997	9,505	9,504	499	499	39	39			249	249			10,292	-1	10,291	14,000
1998	7,918	7,918	393	393	22	21			181	181			8,514	-1	8,513	14,000
1999	7,983	7,983	373	394	27	27			336	336			8,719	21	8,740	14,000
2000	8,324	8,324	401	414	15	15			163	163			8,789	127	8,916	14,000
2001	11,114	11,114	385	385	1	0			61	61			11,561	-1	11,560	11,750
2002	8,275	8,276	322	338	29	29			58	58			8,684	17	8,701	12,800
2003	6,884	6884	377	396	14	14			341	341	1494	1584	9,110	109	9,219	16,600
2004	7,135	7,135	317	244	77	77			106	106	1455	1511	9,090	-17	9,073	11,173
2005	5,605	5,619	244	244	21	47			116	116	808	915	6,794	147	6,941	9,500
2006	7,690	7,689	349	350	34	34			142	142	1,167	1,190	9,382	23	9,405	9,600
2007																10,625

Table 7.1.2 Plaice in Kattegat. Landings in tonnes Working Group estimates, 1972-2006

Year	Denmark	Sweden	Germany	Belgium	Norway	Total
1972	15,504	348	77			15,929
1973	10,021	231	48			10,300
1974	11,401	255	52			11,708
1975	10,158	296	39			10,493
1976	9,487	177	32			9,696
1977	11,611	300	32			11,943
1978	12,685	312	100			13,097
1979	9,721	333	38			10,092
1980	5,582	313	40			5,935
1981	3,803	256	42			4,101
1982	2,717	238	19			2,974
1983	3,280	334	36			3,650
1984	3,252	388	31			3,671
1985	2,979	403	4			3,386
1986	2,470	202	2			2,674
1987	2,846	307	3			3,156
1988	1,820	210	0			2,030
1989	1,609	135	0			1,744
1990	1,830	202	2			2,034
1991	1,737	265	19			2,021
1992	2,068	208	101			2,377
1993	1,294	175	0			1,469
1994	1,547	227	0			1,774
1995	1,254	133	0			1,387
1996	2,337	205	0			2,542
1997	2,198	255	25			2,478
1998	1,786	185	10			1,981
1999	1,510	161	20			1,691
2000	1,644	184	10			1,838
2001	2,069	260				2,329
2002	1,806	198	26			2,030
2003	2,037	253	6			2,296
2004	1,395	137	77			1,609
2005	1,104	100	47			1,251
2006	1,355	175	20			1,550

* years 1972-1990 landings refers to IIIA

Table 7.1.3. Plaice in Skagerrak. Landings in tonnes. Working Group estimates, 1972-2006

Year	Denmark	Sweden	Germany	Belgium	Norway	Netherlands	Total
1972	5,095	70			3		5,168
1973	3,871	80			6		3,957
1974	3,429	70			5		3,504
1975	4,888	77			6		4,971
1976	9,251	51		717	6		10,025
1977	12,855	142		846	6		13,849
1978	13,383	94		371	9		13,857
1979	11,045	67		763	9		11,884
1980	9,514	71		914	11		10,510
1981	8,115	110		263	13		8,501
1982	7,789	146		127	11		8,073
1983	6,828	155		133	14		7,130
1984	7,560	311		27	22		7,920
1985	9,646	296		136	18		10,096
1986	10,645	202		505	26		11,378
1987	11,327	241		907	27		12,502
1988	9,782	281		716	41		10,820
1989	5,414	320		230	33		5,997
1990	8,729	779		471	69		10,048
1991	5,809	472	15	315	68		6,679
1992	8,514	381	16	537	106		9,554
1993	9,125	287	37	326	79		9,854
1994	8,783	315	37	325	91		9,551
1995	8,468	337	48	302	224		9,379
1996	7,304	260	11		428		8,003
1997	7,306	244	14		249		7,813
1998	6,132	208	11		98		6,449
1999	6,473	233	7		336		7,049
2000	6,680	230	5		67		6,982
2001	9,045	125			61		9,231
2002	6,470	140	3		58		6,671
2003	4,847	143	8		74	1,584	6,656
2004	5,717	179			106	1,511	7,513
2005	4,515	144			116	915	5,690
2006	6,334	175	14		142	1,190	7,855

Table 7.1.4 Plaice IIIa. Initial and final quota and quota uptake by country.
(source - EU Commision database FIDES - on Danish Fiskeridirektoratet http://www.fd.dk)

Nation		Belgium	Germany		Denmark		EU		UK	Netherlands	Sweden		TAC	
		03AN.	03AN.	03AS.	03AN.	03AS.	03AN.	03AS.	03AN.	03AN.	03AN.	03AS.	03AN.	03AS.
1998	Landings	1	7	21	6.115	1.84	6.327	2.046	.	.	204	186	6.327	2.046
	Initial Quota	70	40	30	8.72	2.49	10.98	2.8	.	.	470	280	11.2	2.8
	Final Quota	0	80	70	10.43	2.45	10.98	2.8	.	.	470	280	11.2	2.8
	Quota use	.	8%	30%	59%	75%	58%	73%	.	.	43%	66%	56%	73%
1999	Landings	.	17	7	6.469	1.511	6.707	1.674	.	2	219	156	6.707	1.674
	Initial Quota	.	40	30	8.72	2.49	10.98	2.8	.	1.68	470	280	11.2	2.8
	Final Quota	.	90	80	10.42	2.44	10.98	2.8	.	0	470	280	11.2	2.8
	Quota use	.	19%	9%	62%	62%	61%	60%	.	.	47%	56%	60%	60%
2000	Landings	.	0	9	6.675	1.656	6.902	1.857	.	.	227	192	6.902	1.857
	Initial Quota	.	40	30	8.72	2.49	10.98	2.8	.	.	470	280	11.2	2.8
	Final Quota	.	90	30	10.42	2.49	10.98	2.8	.	.	470	280	11.2	2.8
	Quota use	.	0%	31%	64%	67%	63%	66%	.	.	48%	68%	62%	66%
2001	Landings	.	1	2	9.018	2.085	9.139	2.345	0	.	121	259	9.139	2.345
	Initial Quota	.	40	20	7.31	2.09	9.21	2.35	0	.	390	240	9.4	2.35
	Final Quota	.	22	2	9.028	2.09	9.21	2.35	0	.	160	258	9.4	2.35
	Quota use	.	3%	80%	100%	100%	99%	100%	.	.	75%	100%	97%	100%
2002	Landings	5	24	5	6.476	1.806	6.641	2.015	.	.	137	205	6.641	2.015
	Initial Quota	38	26	16	4.983	1.424	6.272	1.6	.	958	267	160	6.4	1.6
	Final Quota	0	39	21	7.888	1.88	8.279	2.112	.	0	352	210	8.448	2.112
	Quota use	.	61%	22%	82%	96%	80%	95%	.	.	39%	98%	79%	95%
2003	Landings	.	7	6	4.848	2.034	6.344	2.288	.	1.347	142	248	6.344	2.288
	Initial Quota	80	53	33	10.339	2.955	13.014	3.32	.	1.988	554	332	13.28	3.32
	Final Quota	0	53	33	10.419	2.955	13.014	3.32	.	1.988	554	332	13.28	3.32
	Quota use	.	14%	19%	47%	69%	49%	69%	.	68%	26%	75%	48%	69%
2004	Landings	.	76	5	5.726	1.398	7.358	1.54	.	1.383	173	137	7.358	1.54
	Initial Quota	.	38	19	7.397	1.658	9.31	1.863	.	1.422	396	186	9.5	1.863
	Final Quota	.	128	19	7.327	1.658	9.31	1.863	.	1.459	396	186	9.5	1.863
	Quota use	.	59%	28%	78%	84%	79%	83%	.	95%	44%	73%	77%	83%
2005	Landings	1	14	7	4.507	1.1	5.488	1.205	.	828	139	98	5.488	1.205
	Initial Quota	46	30	19	5.917	1.691	7.448	1.9	.	1.138	317	190	7.6	1.9
	Final Quota	0	30	19	5.963	1.691	7.448	1.9	.	1.138	317	190	7.6	1.9
	Quota use	.	47%	36%	76%	65%	74%	63%	.	73%	44%	52%	72%	63%
2006	Landings	.	21	12	6.333	1.355	7.652	1.536	.	1.123	175	169	7.652	1.536
	Initial Quota	.	31	19	5.979	1.709	7.526	1.92	.	1.15	320	192	7.68	1.92
	Final Quota	.	31	19	6.15	1.719	7.526	1.92	.	1.165	180	182	7.68	1.92
	Quota use	.	67%	61%	103%	79%	102%	80%	.	96%	97%	93%	100%	80%

Table 7.2.1. Plaice IIIa 2006 WGNSSK, ANON, COMBSEX, PLUSGROUP. landings.n

2007-05-05 00:43:50 units= thousands

year \ age	2	3	4	5	6	7	8	9	10
1978	489	15692	39531	24919	8011	620	63	63	108
1979	1105	9789	29655	20807	7646	2514	170	75	105
1980	362	4772	16353	12575	6033	2393	949	203	104
1981	190	4048	13098	10970	4306	1427	546	213	216
1982	526	2067	9204	10602	5554	1851	758	301	161
1983	1481	9715	8630	8026	2673	925	531	257	202
1984	2154	12620	11140	4463	2183	985	904	695	457
1985	1400	8641	21798	6232	1715	698	260	197	324
1986	375	4366	14749	19193	4477	633	274	154	239
1987	623	4227	12400	17710	10205	2089	373	242	315
1988	101	3052	12037	13783	6860	2745	946	322	292
1989	1012	3844	7102	6255	2708	1171	549	254	372
1990	3147	8748	8623	9718	3222	981	481	349	428
1991	2309	8611	9583	4663	2893	892	306	156	224
1992	904	3858	11759	17427	4297	1033	296	115	142
1993	1038	3505	10088	13233	6891	1657	376	104	116
1994	1411	6919	8016	9859	8002	2780	448	111	93
1995	446	2277	6606	11530	6622	4929	853	137	116
1996	4527	5353	7971	5283	4751	1812	1355	151	68
1997	529	4733	6379	9465	5104	3072	1369	849	150
1998	563	6710	8219	6856	2971	791	385	234	234
1999	687	2704	8432	8520	7419	1301	380	77	149
2000	1223	3937	8302	11212	3599	888	139	17	36
2001	3981	9172	9399	11001	4744	410	102	19	47
2002	364	5008	8861	7528	4843	1766	448	51	29
2003	3481	4686	9098	9279	4330	969	138	19	16
2004	1724	17816	4271	4056	1994	265	97	11	18
2005	3775	4853	9688	3389	1754	768	169	63	19
2006	1288	13064	9241	7045	1293	673	216	38	28

Table 7.2.2. Plaice IIIa 2006 WGNSSK, ANON, COMBSEX, PLUSGROUP . landings.wt

2007-05-05 00:43:50 units= kg

year \ age	2	3	4	5	6	7	8	9	10
1978	0.236	0.248	0.268	0.322	0.417	0.598	0.752	0.818	0.875
1979	0.222	0.255	0.267	0.297	0.378	0.451	0.655	0.922	1.033
1980	0.261	0.274	0.306	0.345	0.414	0.579	0.640	0.753	0.859
1981	0.230	0.263	0.296	0.357	0.432	0.537	0.671	0.813	0.951
1982	0.270	0.301	0.286	0.318	0.386	0.544	0.704	0.813	0.934
1983	0.285	0.274	0.293	0.356	0.423	0.483	0.531	0.647	1.090
1984	0.282	0.299	0.304	0.372	0.403	0.406	0.383	0.360	0.605
1985	0.278	0.282	0.308	0.354	0.437	0.544	0.680	0.737	0.832
1986	0.250	0.277	0.284	0.310	0.384	0.531	0.707	0.850	0.983
1987	0.322	0.280	0.281	0.292	0.363	0.527	0.711	0.904	1.065
1988	0.252	0.267	0.268	0.290	0.350	0.475	0.567	0.755	1.025
1989	0.274	0.263	0.282	0.320	0.376	0.466	0.635	0.741	0.937
1990	0.292	0.288	0.294	0.337	0.397	0.498	0.684	0.775	1.078
1991	0.263	0.270	0.259	0.274	0.365	0.492	0.584	0.670	1.003
1992	0.309	0.310	0.272	0.280	0.336	0.500	0.646	0.817	0.943
1993	0.267	0.272	0.271	0.295	0.338	0.441	0.566	0.712	1.020
1994	0.275	0.263	0.272	0.289	0.330	0.381	0.516	0.658	0.892
1995	0.263	0.301	0.303	0.289	0.328	0.368	0.499	0.736	0.871
1996	0.266	0.268	0.294	0.384	0.399	0.436	0.430	0.561	0.928
1997	0.300	0.294	0.283	0.299	0.341	0.410	0.465	0.445	0.586
1998	0.260	0.250	0.280	0.327	0.398	0.464	0.515	0.587	0.702
1999	0.271	0.271	0.290	0.290	0.294	0.336	0.370	0.656	0.643
2000	0.257	0.262	0.276	0.302	0.355	0.388	0.517	0.857	0.968
2001	0.257	0.272	0.290	0.322	0.310	0.425	0.589	0.836	0.777
2002	0.246	0.271	0.270	0.287	0.338	0.402	0.595	0.794	1.149
2003	0.243	0.252	0.271	0.290	0.298	0.400	0.464	0.605	0.845
2004	0.240	0.276	0.320	0.347	0.378	0.523	0.786	0.844	0.693
2005	0.244	0.260	0.292	0.327	0.348	0.381	0.513	0.664	1.092
2006	0.246	0.267	0.289	0.342	0.335	0.355	0.456	0.587	0.873

Table 7.2.3. Plaice IIIa, Discards in weight

2007-05-05 09:22:09 units = tonnes

year	Country: Denmark	Sweden
2002	2002	486
2003	2089	584
2004	1628	273
2005	1363	302
2006	1282	347

Table 7.2.4. Plaice IIIa, Discards number

2007-05-05 09:22:09 units = thousands

age	year: 2002	2003	2004	2005	2006
0	4.188	4.037	3.952	3.560	5.959
1	2592.332	2599.916	1664.412	813.521	738.819
2	7174.904	10158.969	4838.959	4732.862	3650.107
3	5885.947	5451.628	5506.262	4579.009	5247.483
4	3000.723	2506.277	2058.430	2017.604	1812.491
5	943.685	954.040	792.553	745.109	722.592
6	225.645	250.545	224.501	213.378	179.148
7	63.519	65.080	39.603	54.600	39.729
8	7.362	6.109	3.615	10.794	3.412
9	2.503	1.663	0.521	0.537	0.257
10	2.003	1.951	0.635	1.000	0.276
11	0.674	0.671	0.275	0.229	0.100

Table 7.2.5. Plaice IIIa, Discards mean weight

2007-05-05 09:22:10 units = kg

age	year: 2002	2003	2004	2005	2006
0	0.033	0.030	0.030	0.030	0.030
1	0.065	0.061	0.076	0.078	0.081
2	0.117	0.116	0.111	0.110	0.115
3	0.136	0.135	0.135	0.132	0.135
4	0.147	0.147	0.151	0.151	0.153
5	0.167	0.157	0.160	0.159	0.164
6	0.258	0.234	0.180	0.177	0.206
7	0.272	0.268	0.284	0.213	0.250
8	0.320	0.300	0.300	0.164	0.271
9	0.316	0.300	0.300	0.300	0.300
10	0.300	0.300	0.300	0.440	0.300
11	0.300	0.300	0.300	0.303	0.300

table 7.2.6. Plaice IIIa 2006 WGNSSK, ANON, COMBSEX, PLUSGROUP . stock.wt

2007-05-05 00:43:50 units= kg

year \ age	2	3	4	5	6	7	8	9	10
1978	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1979	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1980	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1981	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1982	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1983	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1984	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1985	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1986	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1987	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1988	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1989	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1990	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1991	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1992	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1993	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1994	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1995	0.081	0.192	0.306	0.260	0.334	0.385	0.403	0.567	0.695
1996	0.099	0.170	0.287	0.327	0.312	0.317	0.311	0.424	0.443
1997	0.123	0.165	0.243	0.299	0.353	0.495	0.572	0.544	0.689
1998	0.063	0.133	0.223	0.297	0.386	0.451	0.430	0.392	0.501
1999	0.090	0.133	0.208	0.294	0.319	0.346	0.414	0.618	0.849
2000	0.064	0.133	0.196	0.295	0.318	0.316	0.845	0.800	0.926
2001	0.085	0.145	0.234	0.299	0.288	0.382	0.655	0.781	0.699
2002	0.064	0.122	0.162	0.304	0.328	0.372	0.389	0.769	0.932
2003	0.092	0.133	0.179	0.287	0.294	0.348	0.415	0.557	0.782
2004	0.065	0.120	0.169	0.340	0.368	0.473	0.680	0.808	0.969
2005	0.083	0.129	0.214	0.301	0.326	0.349	0.455	0.537	0.730
2006	0.075	0.132	0.215	0.299	0.310	0.407	0.549	0.608	0.792

Table 7.2.7. Plaice IIIa 2006 WGNSSK, ANON, COMBSEX, PLUSGROUP . maturity

2007-05-05 00:43:50 units= NA

year \ age	2	3	4	5	6	7	8	9	10
all	0.54	0.74	0.88	0.92	0.94	1	1	1	1

Table 7.2.8. Plaice IIIa. Tuning fleets used in assessment

106									
DK Gillnetters									
1995	2006								
1	1	0	1						
2	10								
236150	41004	162022	481951	1218991	661753	725503	138092	21132	15727
199512	159746	347956	526608	521810	494928	203666	147976	14233	4957
206792	41993	443102	393385	459126	314599	249657	142019	58770	15012
169842	22639	248607	449714	564524	254092	76487	42318	27666	31297
193717	47487	109450	503992	623875	772756	155731	50526	14452	14581
174610	30628	158975	516760	642735	302086	85045	16696	2099	4583
263858	170611	265684	492485	1059222	629625	66119	19361	2947	5081
199439	25874	322449	386538	366741	362332	224494	70754	11011	8426
170502	138544	168218	436703	518599	301809	105409	18907	2335	2511
152678	45145	756831	293827	284613	156901	30654	13285	1506	3644
119359	113387	162549	537575	255771	138559	66752	18560	8054	1922
163118	34391	525195	530686	466561	95788	47550	23536	6328	1710
DK Seiners									
1995	2006								
1	1	0	1						
2	10								
848990	155505	483163	1237122	2102300	1537781	1039883	145632	22771	19269
829741	671949	1146592	1643737	877448	817287	295731	209090	20906	7374
760695	99282	1097581	1727655	2229125	1100779	739059	319951	250184	29125
726990	113924	1884590	2083633	1781242	779096	207230	96901	56672	58032
822345	197769	601501	2398479	2485717	2164017	319256	89023	19404	39373
920377	291648	1236918	2880342	4216432	1227383	377336	53683	2629	4390
1026524	1545624	3602553	3074242	3346357	1336759	127829	30600	6680	9427
887462	108998	1717074	3300009	2939239	1745286	567066	132372	11880	7024
699429	985829	1658716	3194559	3065635	1240986	234046	40482	4406	3223
641455	582551	5697194	1385089	1168507	587432	82853	14087	2057	3006
514275	1476819	1663149	2875087	892939	442738	170333	32412	8271	2720
449215	369650	3752667	2660569	1929726	346736	173716	52471	10513	2230
KASU_Q4									
1994	2006								
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	17.87	14.8	5.2	3.5	-9	0.11			
1	101.15	38.91	7.15	0.92	0.58	0.63			
1	102.98	129.85	16.63	-9	0.49	0.49			
1	52.93	99.92	29.79	1.71	0.49	0.85			
1	46.14	18.37	25.15	12.39	1.24	0.15			
1	42.11	61.87	15.01	6.14	3.39	0.35			
1	15.03	70.85	80.23	12.3	12.6	11.7			
1	108.73	42.47	8.28	1.38	0.09	0.07			
1	56.28	77.13	60.47	11.28	6.31	2.4			

Table 7.2.8 (ctd)

KASU_Q1						
1996	2006					
1	1	0.25	0.33			
1	6					
1	2.27	23.62	26.53	6.46	2.06	0.81
1	0.05	11.45	19.32	4.39	1.75	0.67
1	-9	-9	18.17	52.83	6	10.33
1	4.68	25.95	22.42	2.94	1.27	0.15
1	33.05	196.25	47.5	9.06	1.87	1.65
1	11.47	127.73	73.92	6.67	1.7	1.33
1	20.89	45.71	78.3	31.99	2.26	0.44
1	9.75	136.93	39.8	35.91	8.52	0.17
1	7.28	81.75	74.97	25.99	13.14	4.26
1	13.49	163.55	100.77	19.07	4.36	1.75
1	16.17	152.56	217.54	37.31	6	0.4
IBTS_Q1_bshift						
1990	2006					
1	1	0.99	1			
1	6					
1	9.55	21.09	11.19	3.71	0.29	0.09
1	9.21	18.69	12.32	2.86	0.38	0.11
1	14.58	13.39	13.41	12.1	4.63	0.54
1	19.29	13.75	3.9	2.33	2.54	0.57
1	10.12	21.41	8.92	2.43	1.74	0.79
1	47.74	30.49	9.76	3.34	0.74	0.35
1	20.89	46.75	9.57	3.34	0.18	0.07
1	15.73	17.19	9.5	3.28	0.77	0.23
1	44.6	19.46	5.92	5.68	0.31	0.19
1	131.44	72.73	14.98	5.36	3.37	0.31
1	55.16	91.76	20.41	3.22	2.09	0.79
1	15.57	66.06	44.18	10.8	1.93	1.62
1	95.55	50.85	46.2	33.62	6.34	1.05
1	40.79	116.25	33.62	27.51	25.39	1.61
1	117.05	85.37	51.22	21.28	31.61	9.21
1	37.98	97.57	22.76	13.04	4.18	13.95
1	52.12	83.73	83.43	27.32	15.66	6.02
IBTS_Q3						
1997	2006					
1	1	0.83	1			
1	6					
1	16.39	17.39	8.42	2.23	0.79	0.45
1	27.92	19.97	5.26	3.66	0.43	-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	33.27	24.38	4.12	0.45
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
1	24.39	59.55	72.11	18.14	13.09	6.99

Table 7.3.1. Plaice IIIa. 2006 WGNSSK, ANON, COMBSEX , PLUSGROUP. SEPARABLE VPA ANALYSIS.

At 6/05/2007 9:41

Separable analysis
from 1978 to 2006 on ages 2 to 9
with Terminal F of .900 on age 6 and Terminal S of 1.000

Initial sum of squared residuals was 382.633 and
final sum of squared residuals is 68.977 after 97 iterations

Matrix of Residuals

Years, Ages	1978/79,	1979/80,	1980/81,	1981/82,	1982/83,	1983/84,	1984/85,	1985/86,
2/ 3,	-1.521,	-.101,	-1.173,	-.754,	-1.586,	-.647,	-.232,	.270,
3/ 4,	-.350,	-.340,	-.935,	-.355,	-1.274,	.187,	-.545,	-.256,
4/ 5,	.581,	.684,	.157,	.357,	-.037,	.657,	.282,	.138,
5/ 6,	.565,	.502,	.296,	.310,	.661,	.770,	.139,	-.127,
6/ 7,	.078,	-.049,	.199,	.039,	.609,	.016,	-.142,	.113,
7/ 8,	.377,	-.068,	.412,	-.012,	.237,	-.794,	.232,	.229,
8/ 9,	-1.422,	-1.559,	.088,	-.361,	-.267,	-1.409,	.082,	-.498,
TOT ,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,

Years,	1986/87,	1987/88,	1988/89,	1989/90,	1990/91,	1991/92,	1992/93,	1993/94,	1994/95,	1995/96,
2/ 3,	-.672,	.013,	-2.501,	-.477,	.108,	.989,	.086,	-.425,	1.022,	-1.135,
3/ 4,	-.441,	-.633,	-.888,	-.304,	-.149,	.042,	-.673,	-.510,	.384,	-1.063,
4/ 5,	.123,	-.042,	.277,	-.144,	.233,	-.539,	-.130,	.037,	-.339,	.103,
5/ 6,	.452,	.463,	.688,	.305,	.281,	-.355,	.413,	.011,	-.093,	.247,
6/ 7,	.167,	.375,	.340,	.219,	-.129,	.160,	-.003,	-.024,	-.450,	.203,
7/ 8,	.095,	.012,	.361,	.251,	-.067,	.403,	.226,	.546,	.414,	.372,
8/ 9,	-.611,	-.953,	-.288,	-.497,	-.459,	-.037,	-.060,	.138,	.097,	.482,
TOT ,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,

Years,	1996/97,	1997/98,	1998/99,	1999/**,	2000/**,	2001/**,	2002/**,	2003/**,	2004/**,	2005/**,	TOT,	WTS,
2/ 3,	1.756,	-1.341,	.193,	-.475,	-.756,	1.442,	-1.057,	-.851,	.393,	.081,	.000,	.289,
3/ 4,	.436,	-.559,	.310,	-1.108,	-.839,	.460,	-.410,	-.393,	.852,	-.498,	.001,	.529,
4/ 5,	.087,	-.448,	.105,	-.706,	-.647,	.223,	-.365,	-.123,	.131,	.134,	.000,	.772,
5/ 6,	-.246,	.185,	-.527,	-.231,	-.133,	.196,	-.496,	-.123,	.184,	.233,	.000,	.783,
6/ 7,	-.280,	.385,	-.081,	.488,	.662,	-.119,	.008,	.514,	-.166,	-.241,	.000,	1.000,
7/ 8,	-.287,	.771,	-.031,	.766,	.822,	-1.052,	1.093,	.216,	-.504,	.242,	.000,	.597,
8/ 9,	-.405,	.099,	.530,	1.259,	.283,	-.600,	1.331,	.003,	-.856,	.127,	.000,	.400,
TOT ,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	-11.452,	
WTS ,	.001,	.001,	.001,	.001,	.001,	1.000,	1.000,	1.000,	1.000,	1.000,		

Fishing Mortalities (F)

,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	
F-values,	.9883,	1.0480,	.9870,	.8076,	.9927,	.8962,	.9586,	.7132,	.6752,	
,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
F-values,	.9242,	1.1188,	.8302,	1.0807,	.7783,	.8246,	.8224,	.8477,	.9052,	.8261,
,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,
F-values,	1.2313,	.9902,	1.4609,	1.3116,	1.1386,	1.5540,	1.8554,	.9972,	1.0040,	.9000,

Table 7.3.1 (ctd)

Selection-at-age (S)

	2	3	4	5	6	7	8	9
S-values	.0426	.2217	.4259	.7465	1.0000	.9557	1.1265	1.0000

Traditional vpa Terminal populations from weighted Separable populations

Fishing mortality residuals

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE									
2	-.0336	-.0187	-.0308	-.0264	-.0307	-.0215	-.0081	.0003	-.0181
3	.0169	-.0243	-.0850	-.0287	-.1194	.0715	-.0400	.0012	-.0363
4	.3488	.3601	.1346	.2234	.0987	.2856	.0900	.1404	.1058
5	.3401	.3339	.1327	.1934	.3986	.4007	.0650	-.0227	.2782
6	.0380	.0231	.0864	-.0634	.1442	.0036	-.0996	-.0149	.0729
7	-.1285	-.0303	.1460	-.0692	-.2047	-.3595	-.0142	-.0246	-.1130
8	-.6379	-.6971	.0394	-.2189	-.2088	-.5772	.0964	-.2441	-.2438
9	-.0088	.5319	.6882	-.0356	-.0631	-.0839	.5368	.0671	-.0016

Fishing mortality residuals

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
2	-.0202	-.0444	-.0191	.0004	.0161	-.0139	-.0034	.0074	-.0261	.0916
3	-.0612	-.1373	-.0389	-.0697	-.0176	-.0851	-.0859	.0810	-.1181	-.0014
4	.0778	.1856	.0039	.0281	-.0778	-.0599	.0008	-.0660	.0080	.0524
5	.3219	.4922	.1541	.2327	-.1088	.2461	-.0695	-.0287	.1082	-.0620
6	.2630	.2565	.0951	.0079	.1425	.1227	.0870	-.1878	.0467	-.0454
7	-.0311	.0621	.0279	-.0926	.1812	.1194	.3286	.2693	.1413	-.1314
8	-.4297	-.1468	-.3078	-.3548	-.1031	-.1109	-.0235	-.0059	.0560	-.1788
9	.1472	.4809	.1055	-.1352	-.1021	-.1601	-.1448	-.1946	-.1377	-.3484

Traditional vpa Terminal populations from weighted Separable populations

Fishing mortality residuals

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
AGE										
2	-.0402	-.0270	-.0417	-.0243	.0917	-.0464	-.0161	.0032	.0023	.0000
3	-.1033	-.0299	-.2395	-.1500	.0558	-.1100	-.0773	.2347	-.0657	-.0061
4	-.2203	.0155	-.2802	-.2045	.0222	-.1757	-.0385	.0844	-.0013	.0577
5	.1315	-.1920	-.1081	-.0716	.1159	-.2853	-.1119	.0586	.1193	-.1152
6	.3076	.0459	.5156	.1886	.0318	-.0030	.2695	-.0496	-.1161	-.0241
7	.6476	.0462	.6694	.4826	-.5055	.8885	-.0541	-.2520	.1535	.0717
8	.0935	.1681	.5938	.2133	-.3731	1.0637	-.2331	-.4088	.1169	-.0040
9	.2461	.0416	-.5966	-.7669	-.0262	.1318	-.4996	-.3423	.3623	.0635

Table 7.3.2. Plaice IIIa. Run 1 with no discards.

```
FLR XSA Diagnostics 2007-05-06 21:07:01

CPUE data from xsa.indices

Catch data for 29 years. 1978 to 2006. Ages 2 to 10.

           fleet first age last age first year last year alpha beta
1 DK Gillnetters         2        9       1995      2006     0    1
2     DK Seiners         2        9       1995      2006     0    1


 Time series weights :

   Tapered time weighting applied
   Power =   3 over  20 years

Catchability analysis :

    Catchability independent of size for all ages

    Catchability independent of age for ages >   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 =   0.5

    Minimum standard error for population
    estimates derived from each fleet =  0.3

   prior weighting not applied

Regression weights
     year
age    1997 1998  1999  2000  2001  2002 2003  2004 2005 2006
  all 0.751 0.82 0.877 0.921 0.954 0.976 0.99 0.997    1    1


 Fishing mortalities
    year
age   1997  1998  1999  2000  2001  2002  2003  2004  2005  2006
  2  0.012 0.015 0.020 0.031 0.141 0.020 0.066 0.044 0.046 0.052
  3  0.169 0.189 0.084 0.140 0.308 0.236 0.343 0.484 0.150 0.198
  4  0.302 0.435 0.340 0.352 0.505 0.486 0.766 0.531 0.469 0.418
  5  1.049 0.543 0.980 0.905 0.962 0.870 1.292 0.839 0.952 0.656
  6  1.553 1.031 1.977 1.501 1.167 1.544 2.132 0.985 0.987 1.112
  7  1.894 1.017 2.059 1.733 0.578 2.405 1.686 0.699 1.253 1.253
  8  1.498 1.522 2.773 1.647 0.895 2.882 2.046 0.666 1.248 1.500
  9  1.451 1.068 1.570 1.353 1.002 1.606 1.559 0.900 1.140 0.961
  10 1.451 1.068 1.570 1.353 1.002 1.606 1.559 0.900 1.140 0.961
```

Table 7.3.2. (ctd)

XSA population number (thousands)

year \ age	2	3	4	5	6	7	8	9	10
1997	45894	32037	25728	15317	6805	3802	1853	1166	204
1998	39661	41023	24487	17212	4856	1302	518	375	371
1999	35752	35352	30737	14338	9053	1568	426	102	195
2000	41478	31696	29415	19791	4869	1134	181	24	50
2001	31825	36368	24935	18719	7243	982	181	32	77
2002	19141	25010	24182	13621	6473	2041	499	67	38
2003	57569	16973	17866	13452	5164	1250	167	25	21
2004	42197	48780	10901	7512	3345	554	210	19	32
2005	88350	36541	27190	5801	2939	1130	249	97	29
2006	26717	76352	28448	15387	2025	991	292	65	47

Estimated population abundance at 1st Jan 2007

year \ age	2	3	4	5	6	7	8	9	10
2007	9170	22949	56659	16950	7222	602	256	59	22

Fleet: DK Gillnetters

Log catchability residuals.

age \ year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	-0.567	0.965	-0.596	-0.869	-0.154	-0.632	0.991	-0.165	0.590	-0.121	0.309
3	-0.678	0.188	0.449	-0.170	-1.023	-0.410	-0.367	0.447	0.391	1.014	-0.144
4	-0.150	-0.056	-0.446	-0.005	-0.293	-0.115	-0.341	-0.281	0.424	0.529	0.437
5	0.071	-0.177	-0.288	-0.217	0.122	-0.098	0.068	-0.433	0.253	0.162	0.608
6	-0.388	-0.373	-0.254	-0.136	0.574	0.189	-0.015	-0.030	0.374	-0.158	0.094
7	-0.155	-0.676	0.012	-0.232	0.547	0.258	-0.724	0.732	0.382	-0.319	0.220
8	-0.068	-0.923	-0.317	-0.046	0.604	0.092	-0.467	0.785	0.462	-0.539	0.109
9	-0.396	-0.859	-0.753	-0.324	0.388	-0.074	-0.557	0.521	0.085	-0.241	0.171

age \ year	2006
2	0.002
3	0.002
4	0.043
5	-0.205
6	-0.164
7	-0.299
8	-0.029
9	-0.046

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	2	3	4	5	6	7	8	9
Mean_Logq	-11.6769	-9.9305	-8.8716	-8.0309	-7.4361	-7.2307	-6.8888	-6.8888
S.E_Logq	0.6214	0.5616	0.3256	0.2834	0.2912	0.4612	0.4930	0.4305

Table 7.3.2. (ctd)

Fleet: DK Seiners

Log catchability residuals.

age \ year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	-1.012	0.478	-1.536	-1.206	-0.671	-0.539	1.338	-0.719	0.643	0.503	0.916
3	-1.351	-0.532	-0.433	-0.085	-1.251	-0.507	0.395	0.140	0.781	1.111	0.234
4	-0.729	-0.585	-0.511	-0.168	-0.421	-0.302	-0.111	0.128	0.760	0.401	0.411
5	-0.662	-1.081	-0.009	-0.521	0.060	0.122	-0.139	0.157	0.620	0.141	0.399
6	-0.594	-1.066	-0.074	-0.240	0.388	0.159	-0.390	0.279	0.607	-0.043	0.026
7	-0.592	-1.246	0.277	-0.207	0.302	0.568	-0.941	0.648	0.251	-0.278	0.179
8	-0.499	-1.207	-0.012	0.123	0.519	0.393	-0.573	0.713	0.607	-1.121	0.001
9	-0.806	-1.105	0.188	-0.266	0.032	-0.716	-0.302	-0.101	0.104	-0.569	-0.468

age \ year	2006
2	0.865
3	0.469
4	0.400
5	0.203
6	0.340
7	0.466
8	0.555
9	0.243

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

	2	3	4	5	6	7	8	9
Mean_Logq	-11.1784	-9.4439	-8.6294	-8.0325	-7.6663	-7.7130	-7.6839	-7.6839
S.E_Logq	0.9674	0.7587	0.4752	0.4771	0.4684	0.6107	0.6671	0.4287

Terminal year survivor and F summaries:

Age 2 Year class = 2004

source	survivors	N	scaledWts
DK Gillnetters	23001	1	0.324
DK Seiners	54530	1	0.128
fshk	18718	1	0.548

Age 3 Year class = 2003

source	survivors	N	scaledWts
DK Gillnetters	65271	2	0.411
DK Seiners	106541	2	0.204
fshk	34821	1	0.384

Age 4 Year class = 2002

source	survivors	N	scaledWts
DK Gillnetters	16609	3	0.500
DK Seiners	24695	3	0.257
fshk	11885	1	0.243

Table 7.3.2. (ctd)

Age 5 Year class = 2001

source	survivors	N	scaledWts
DK Gillnetters	7954	4	0.523
DK Seiners	10348	4	0.245
fshk	3974	1	0.232

Age 6 Year class = 2000

source	survivors	N	scaledWts

Table 7.3.2. (ctd)

	survivors	N	scaledWts
DK Gillnetters	663	5	0.472
DK Seiners	859	5	0.206
fshk	418	1	0.323

Age 7 Year class = 1999

source

	survivors	N	scaledWts
DK Gillnetters	253	6	0.357
DK Seiners	347	6	0.181
fshk	229	1	0.461

Age 8 Year class = 1998

source

	survivors	N	scaledWts
DK Gillnetters	59	7	0.237
DK Seiners	86	7	0.125
fshk	55	1	0.638

Age 9 Year class = 1997

source

	survivors	N	scaledWts
DK Gillnetters	22	8	0.304
DK Seiners	27	8	0.214
fshk	21	1	0.482

Table 7.3.3 . Plaice IIIa 2006 WGNSSK, ANON, COMBSEX, PLUSGROUP.

stock.n, run 1 with no discards.

2007-05-06 21:46:14 units= thousands

year \ age	2	3	4	5	6	7	8	9	10
1978	61486	79457	77596	39753	13176	1281	217	121	206
1979	45716	55170	56969	32608	12267	4301	569	136	189
1980	34375	40314	40608	23339	9713	3826	1501	353	180
1981	25536	30760	31939	21188	9156	3050	1186	455	459
1982	48505	22925	23982	16440	8737	4189	1402	554	294
1983	94503	43389	18777	12945	4791	2622	2029	548	428
1984	70743	84101	30019	8781	4078	1792	1493	1331	869
1985	49004	61962	64093	16565	3700	1614	685	491	803
1986	37205	43009	47846	37259	9061	1717	796	372	575
1987	34598	33307	34763	29263	15456	3940	951	460	594
1988	33175	30713	26117	19660	9632	4278	1578	506	455
1989	66053	29922	24887	12182	4678	2190	1260	528	768
1990	73226	58805	23418	15763	5072	1657	868	618	752
1991	50757	63264	44887	12987	5019	1525	566	328	468
1992	45396	43730	49053	31500	7315	1790	531	221	271
1993	35261	40216	35899	33199	11925	2532	637	199	221
1994	35040	30918	33055	22887	17452	4236	715	218	182
1995	38113	30363	21395	22284	11330	8180	1188	220	185
1996	40166	34062	25308	13075	9196	3953	2713	264	118
1997	45894	32037	25728	15317	6805	3802	1853	1166	204
1998	39661	41023	24487	17212	4856	1302	518	375	371
1999	35752	35352	30737	14338	9053	1568	426	102	195
2000	41478	31696	29415	19791	4869	1134	181	24	50
2001	31825	36368	24935	18719	7243	982	181	32	77
2002	19141	25010	24182	13621	6473	2041	499	67	38
2003	57569	16973	17866	13452	5164	1250	167	25	21
2004	42197	48780	10901	7512	3345	554	210	19	32
2005	88350	36541	27190	5801	2939	1130	249	97	29
2006	26717	76352	28448	15387	2025	991	292	65	47
2007		22949	56659	16950	7222	602	256	59	22

Table 7.3.4. Plaice IIIa 2006 WGNSSK, ANON, COMBSEX, PLUSGROUP.

F at age, run 1 with no discards.

2007-05-06 21:46:14 units= f

year \ **age**	2	3	4	5	6	7	8	9	10
1978	0.008	0.233	0.767	1.076	1.019	0.711	0.364	0.791	0.791
1979	0.026	0.206	0.792	1.111	1.065	0.953	0.377	0.864	0.864
1980	0.011	0.133	0.551	0.836	1.058	1.071	1.093	0.927	0.927
1981	0.008	0.149	0.564	0.786	0.682	0.677	0.662	0.677	0.677
1982	0.011	0.100	0.517	1.133	1.104	0.625	0.840	0.848	0.848
1983	0.017	0.268	0.660	1.055	0.883	0.463	0.322	0.680	0.680
1984	0.033	0.172	0.495	0.764	0.827	0.862	1.012	0.796	0.796
1985	0.030	0.159	0.442	0.503	0.668	0.607	0.510	0.548	0.548
1986	0.011	0.113	0.392	0.780	0.733	0.490	0.449	0.571	0.571
1987	0.019	0.143	0.470	1.011	1.185	0.815	0.531	0.806	0.806
1988	0.003	0.110	0.663	1.336	1.381	1.123	0.995	1.106	1.106
1989	0.016	0.145	0.357	0.776	0.938	0.826	0.613	0.705	0.705
1990	0.046	0.170	0.490	1.044	1.102	0.974	0.874	0.901	0.901
1991	0.049	0.154	0.254	0.474	0.931	0.954	0.840	0.694	0.694
1992	0.021	0.097	0.290	0.871	0.961	0.933	0.881	0.791	0.791
1993	0.031	0.096	0.350	0.543	0.935	1.165	0.970	0.796	0.796
1994	0.043	0.268	0.294	0.603	0.658	1.171	1.076	0.764	0.764
1995	0.012	0.082	0.392	0.785	0.953	1.004	1.405	1.060	1.060
1996	0.126	0.181	0.402	0.553	0.783	0.658	0.745	0.921	0.921
1997	0.012	0.169	0.302	1.049	1.553	1.894	1.498	1.451	1.451
1998	0.015	0.189	0.435	0.543	1.031	1.017	1.522	1.068	1.068
1999	0.020	0.084	0.340	0.980	1.977	2.059	2.773	1.570	1.570
2000	0.031	0.140	0.352	0.905	1.501	1.733	1.647	1.353	1.353
2001	0.141	0.308	0.505	0.962	1.167	0.578	0.895	1.002	1.002
2002	0.020	0.236	0.486	0.870	1.544	2.405	2.882	1.606	1.606
2003	0.066	0.343	0.766	1.292	2.132	1.686	2.046	1.559	1.559
2004	0.044	0.484	0.531	0.839	0.985	0.699	0.666	0.900	0.900
2005	0.046	0.150	0.469	0.952	0.987	1.253	1.248	1.140	1.140
2006	0.052	0.198	0.418	0.656	1.112	1.253	1.500	0.961	0.961

Table 7.3.5. Plaice IIIa 2006 WGNSSK, ANON, COMBSEX, PLUSGROUP.

STOCK SUMMARY. Run 1 with no discards.

2007-05-06 21:46:14

	R(age 2)	ssb	catch	landings	discards	fbar4-8	Y/ssb
1978	61486	45470	26953	26953	0	0.79	0.59
1979	45716	36359	21976	21976	0	0.87	0.60
1980	34375	27385	16445	16445	0	1.00	0.60
1981	25536	22918	12602	12602	0	0.70	0.55
1982	48505	20426	11047	11047	0	0.91	0.54
1983	94503	21471	10780	10780	0	0.68	0.50
1984	70743	26353	11591	11591	0	0.85	0.44
1985	49004	31356	13482	13482	0	0.57	0.43
1986	37205	32154	14052	14052	0	0.60	0.44
1987	34598	28842	15658	15658	0	0.87	0.54
1988	33175	22411	12850	12850	0	1.19	0.57
1989	66053	19298	7741	7741	0	0.77	0.40
1990	73226	23487	12082	12082	0	0.98	0.51
1991	50757	26391	8700	8700	0	0.78	0.33
1992	45396	30435	11931	11931	0	0.89	0.39
1993	35261	28824	11323	11323	0	0.88	0.39
1994	35040	26734	11325	11325	0	0.85	0.42
1995	38113	24510	10766	10766	0	1.04	0.44
1996	40166	21707	10545	10545	0	0.73	0.49
1997	45894	22664	10291	10291	0	1.49	0.45
1998	39661	17812	8430	8430	0	1.04	0.47
1999	35752	18365	8740	8740	0	1.87	0.48
2000	41478	17050	8820	8820	0	1.43	0.52
2001	31825	18200	11560	11560	0	0.92	0.64
2002	19141	13211	8701	8701	0	1.86	0.66
2003	57569	12880	8952	8952	0	1.74	0.70
2004	42197	11423	9122	9122	0	0.82	0.80
2005	88350	15678	6916	6916	0	1.12	0.44
2006	26717	19432	9405	9405	0	1.10	0.48

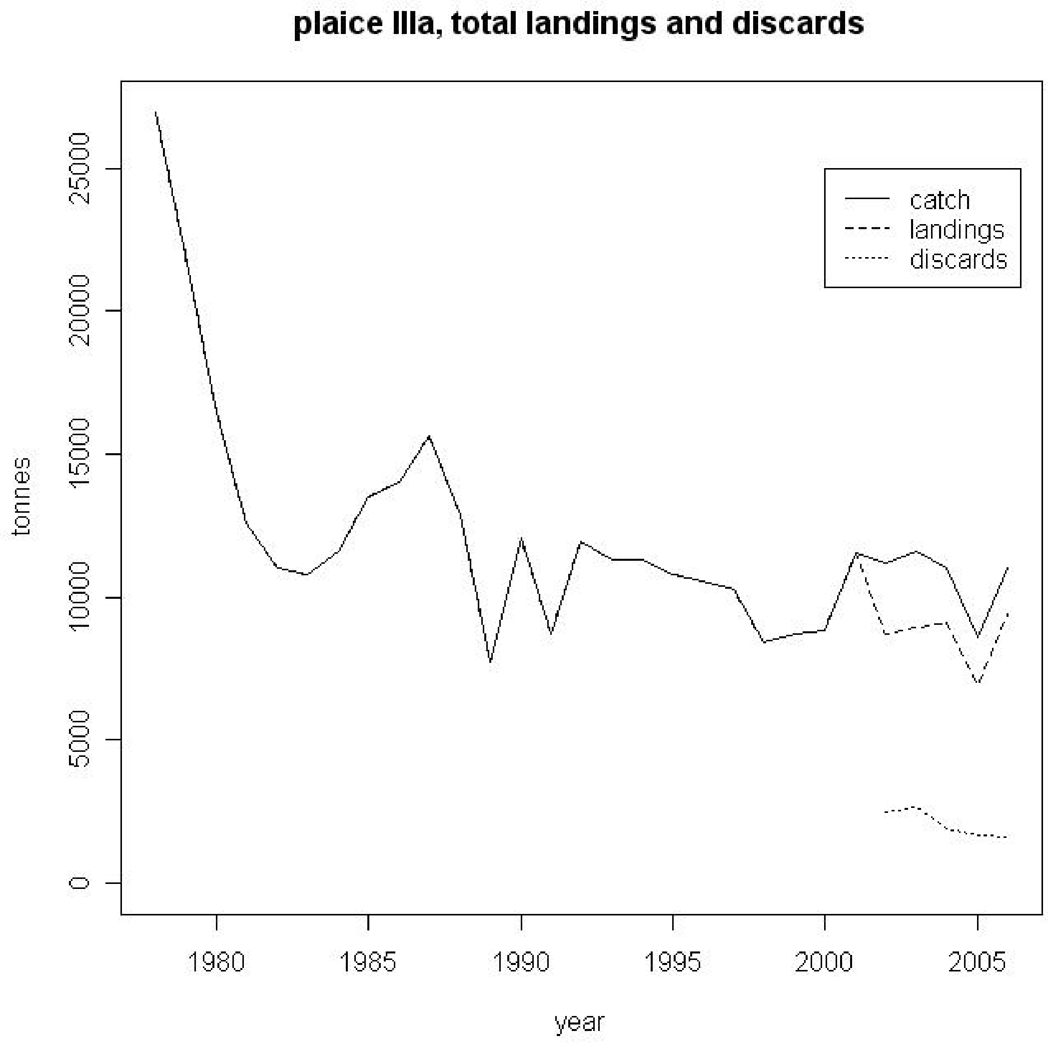


Figure 7.2.1. Plaice IIIa. Total landings and discards, 1978-2006

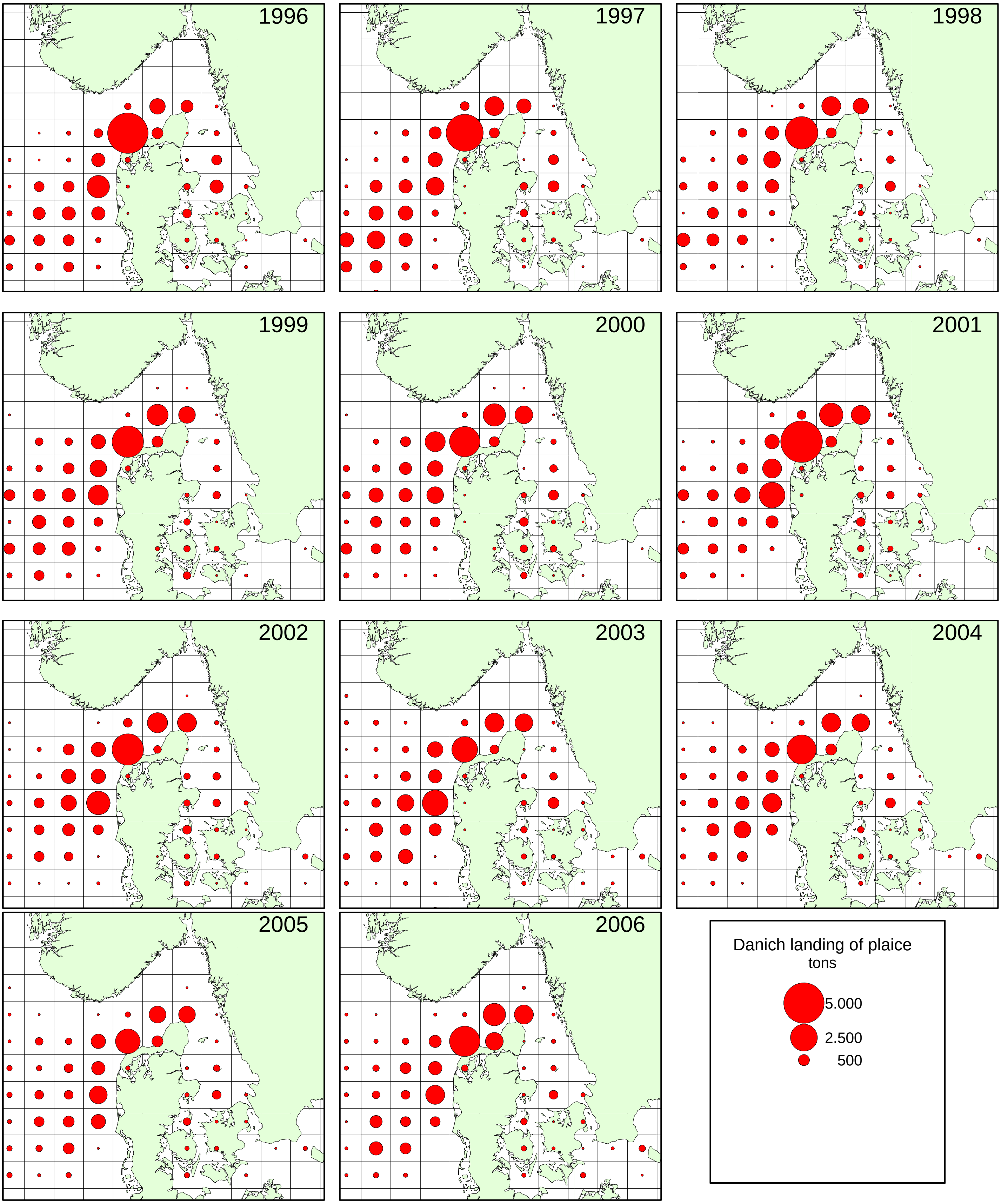


Figure 7.2.2. Annual distribution of Danish plaice landings.

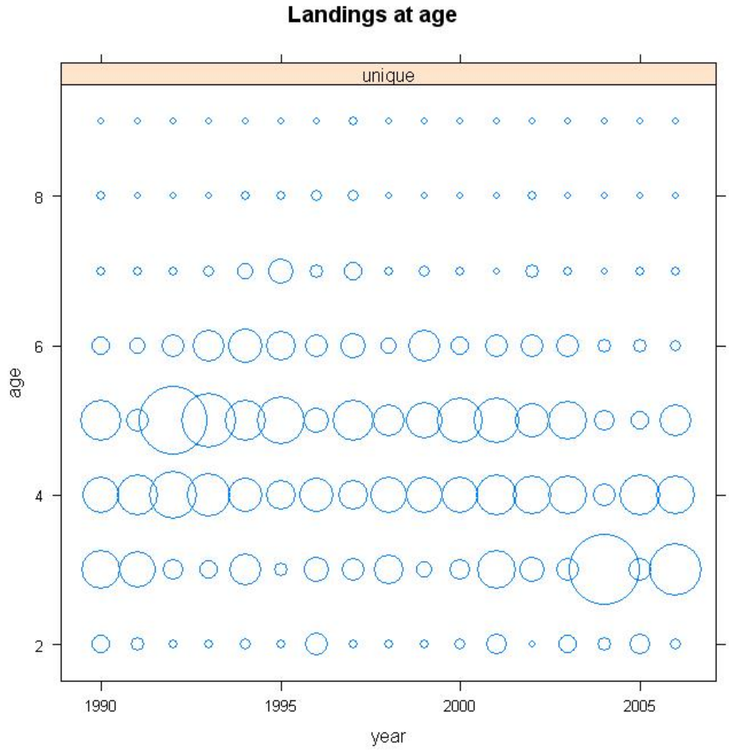


Figure 7.2.3. Plaice IIIa. Relative landings at age.

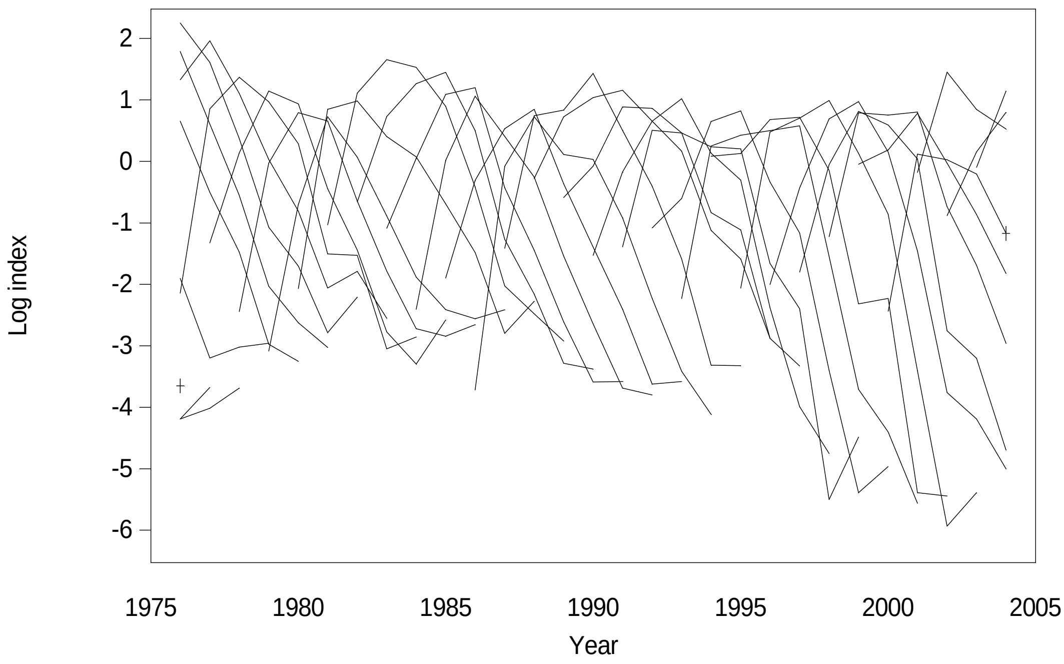


Figure 7.2.4. Plaice IIIa. Log cohort abundance in the landings at age

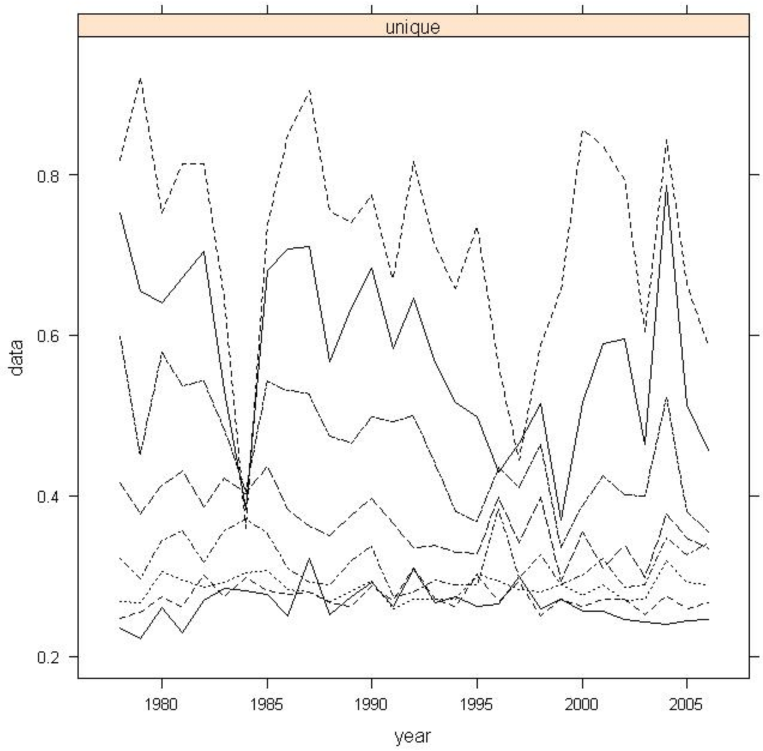


Figure 7.2.5. Landings weight at age

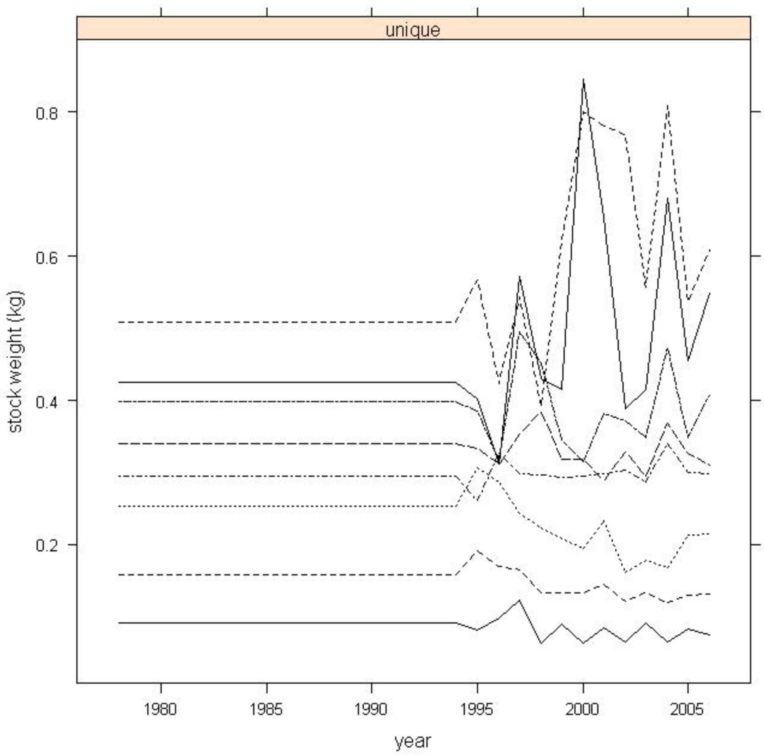
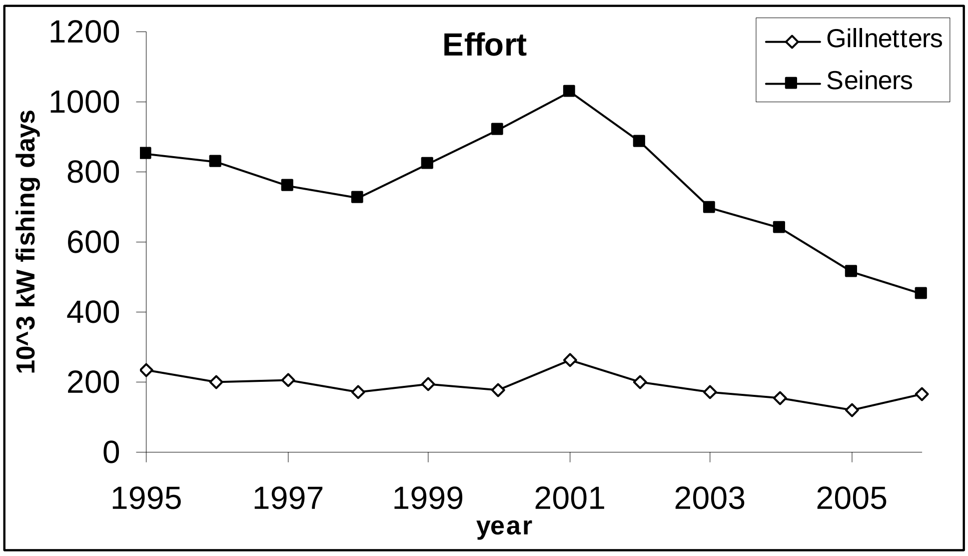


Figure 7.2.6. Stock weight at age



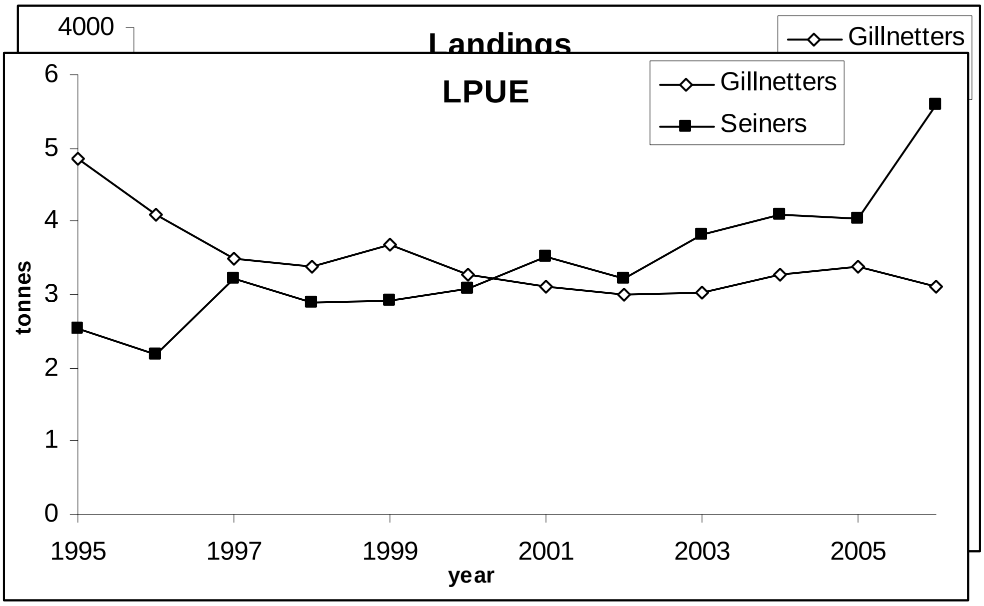


Figure 7.2.7. Plaice IIIa. Effort, landing and LPUE for the Danish commercial tuning fleets.

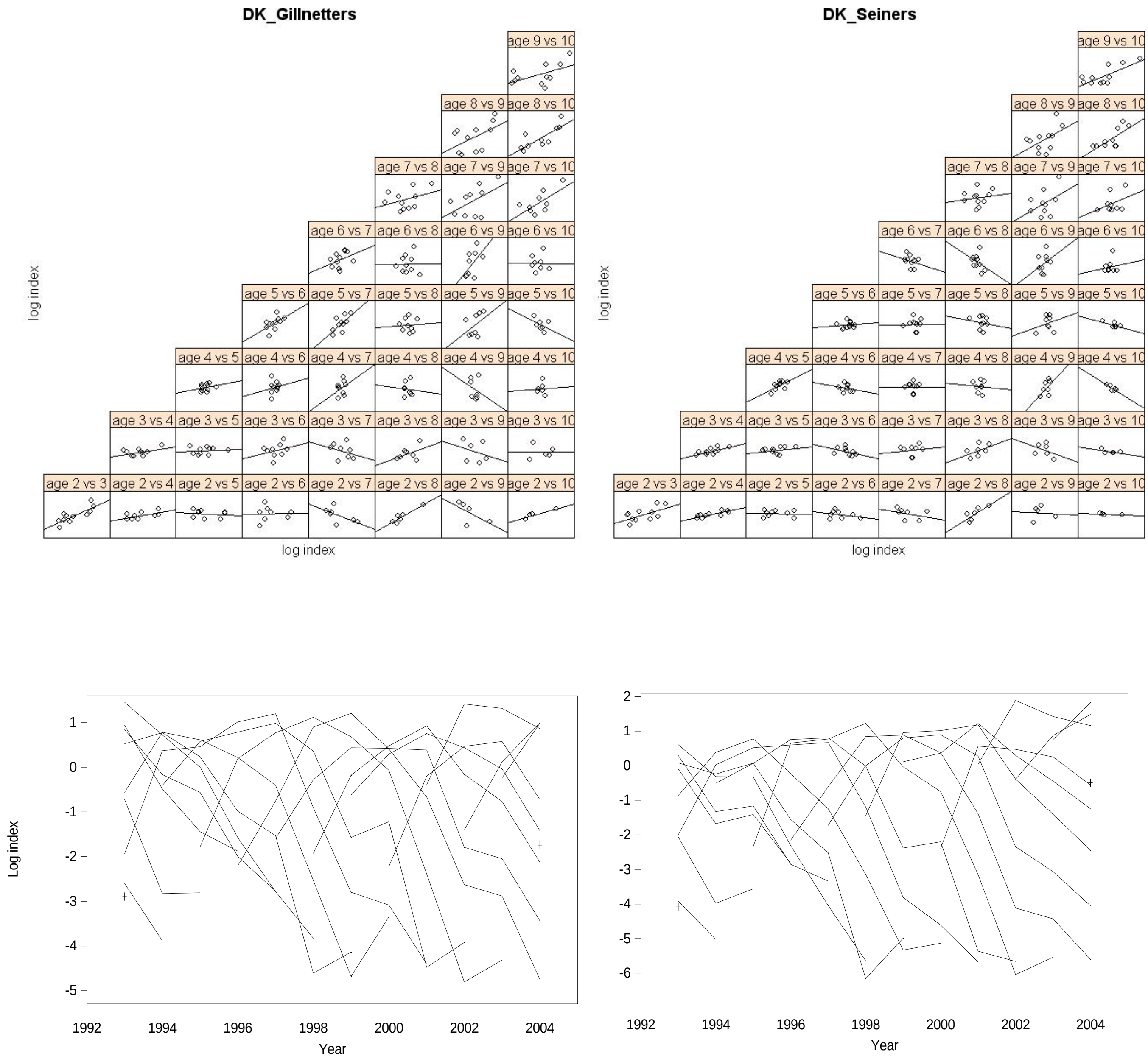


Figure 7.2.8. Plaice IIIa. Internal consistency for the commercial tuning fleets: matrix scatterplots and Log cohort abundance. Left : DK_Gillnetters. Right: DK_Seiners.

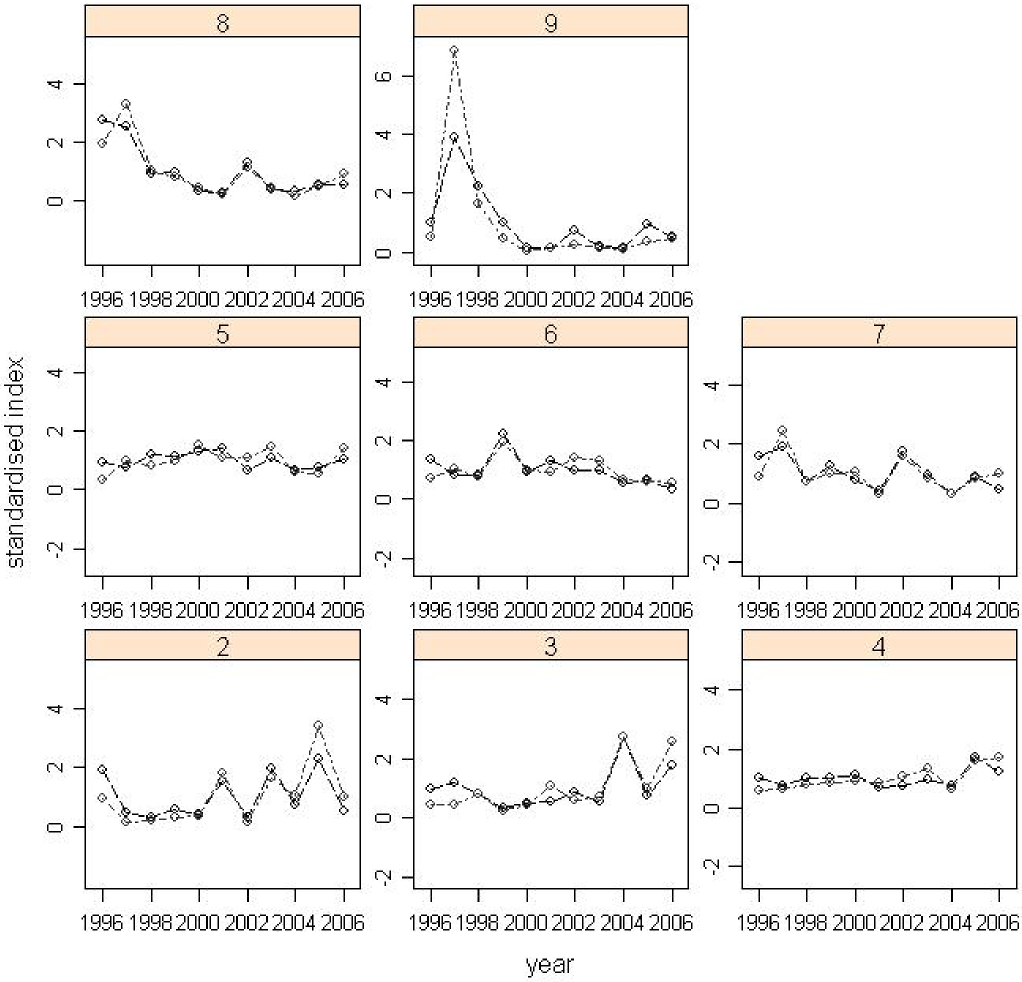


Figure 7.2.9. Plaice IIIa. Standardised LPUE indices. Black : DK_Gillnetters. Grey : DK_Seiners.

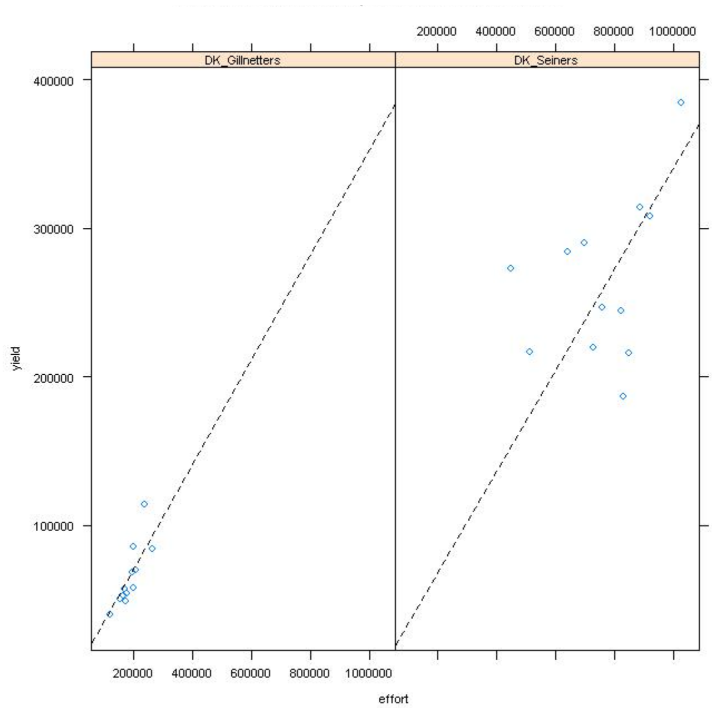


Figure 7.2.10. Plaice IIIa. Yield vs. effort for the commercial tuning fleets.

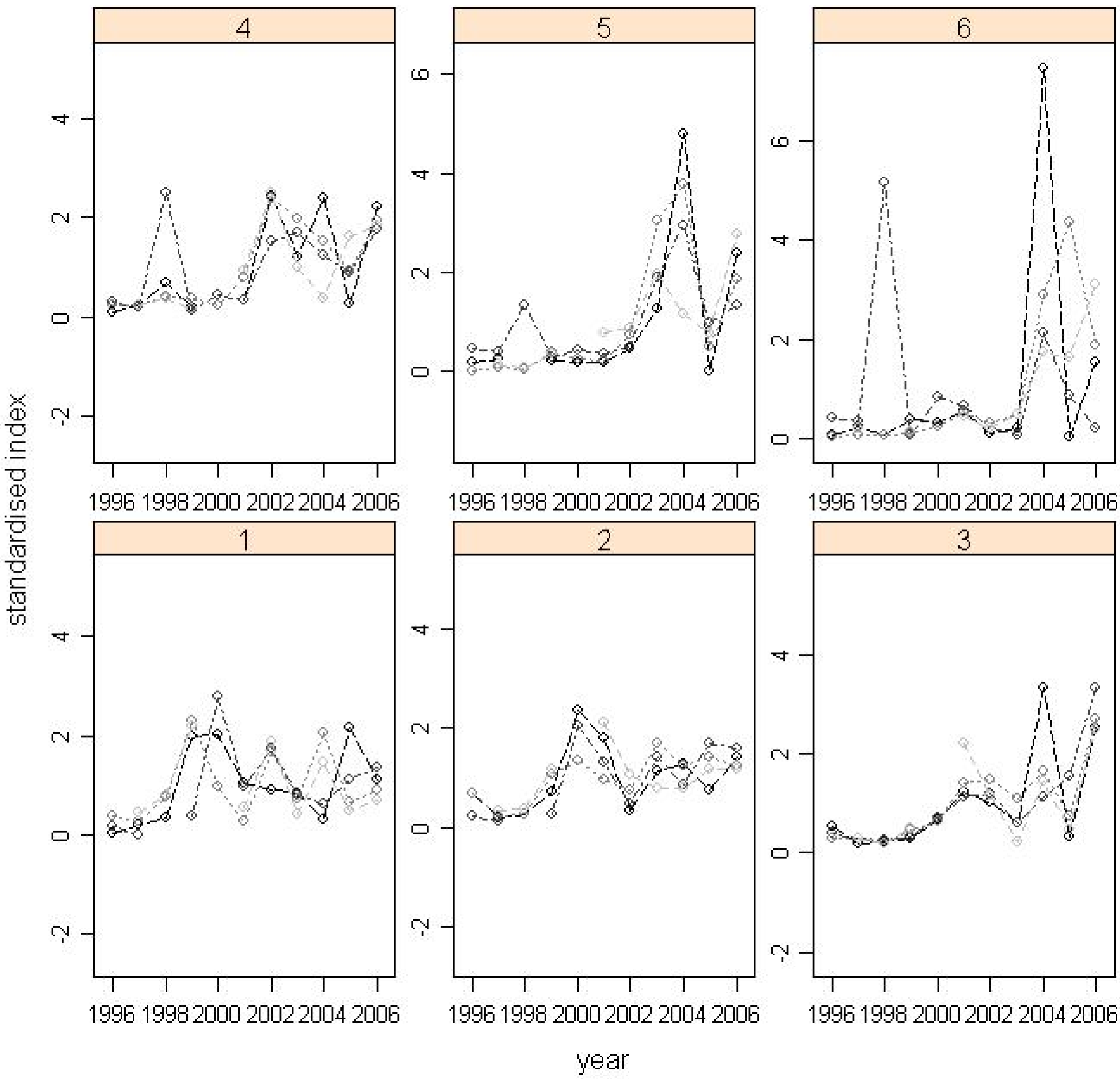


Figure 7.2.11. Plaice IIIa. Standardised survey indices used for tuning. Black : KASU Q4. Dark grey : KASU Q1. Medium Grey: IBTS Q1 Backshifted. Pale Grey : IBTS Q3.

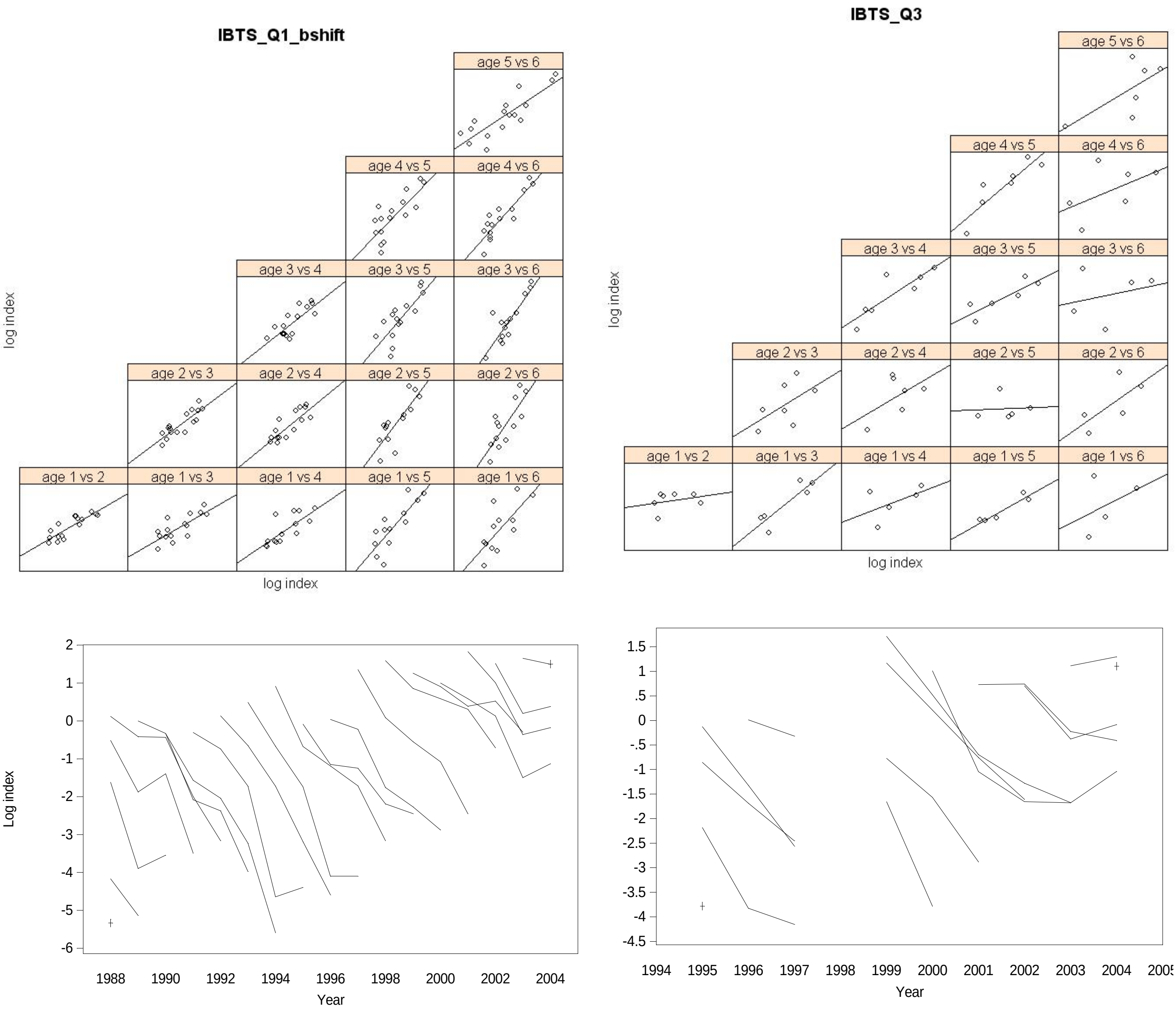


Figure 7.2.12. Plaice IIIa. Internal consistency for the IBTS survey: matrix scatterplots and Log cohort abundance. Left : IBTS Q1 backshifted. Right: IBTS Q3.

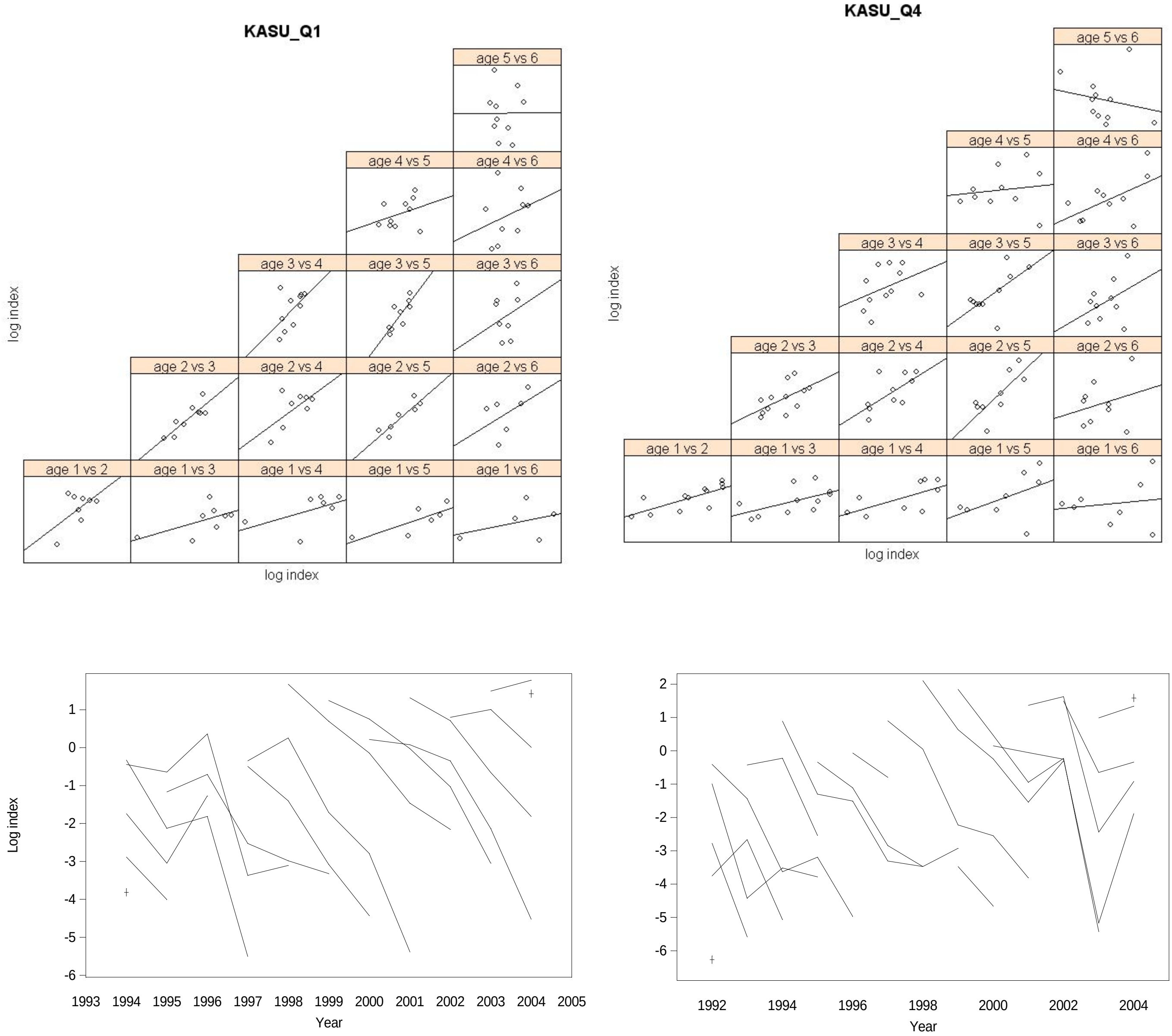


Figure 7.2.13. Internal consistency for the KASU survey: matrix scatterplots and Log cohort abundance. Left : KASU Q1. Right: KASU Q4.

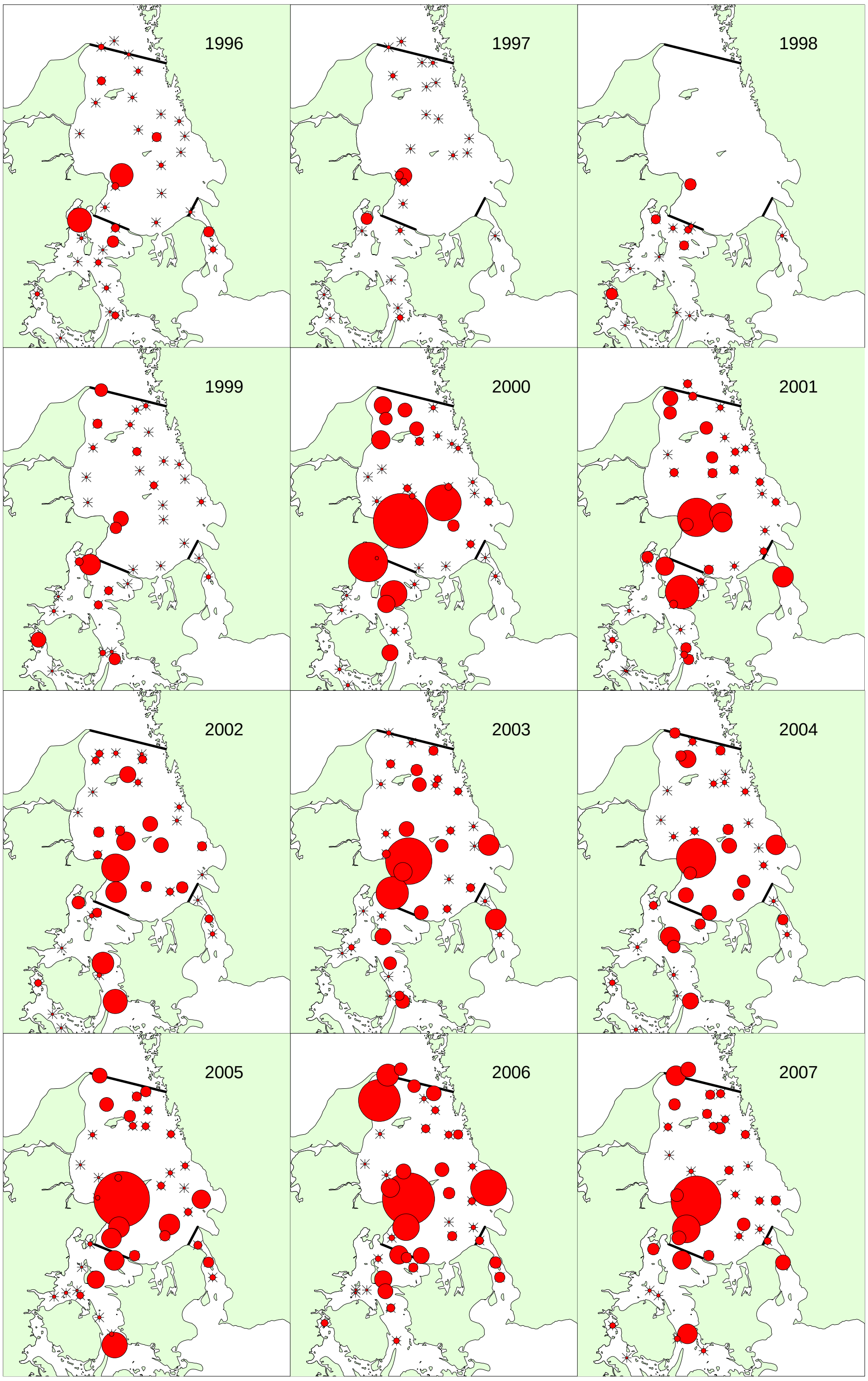


Figure 7.2.14. Plaice IIIa. Distribution and abundance of KASU Q1 catches.

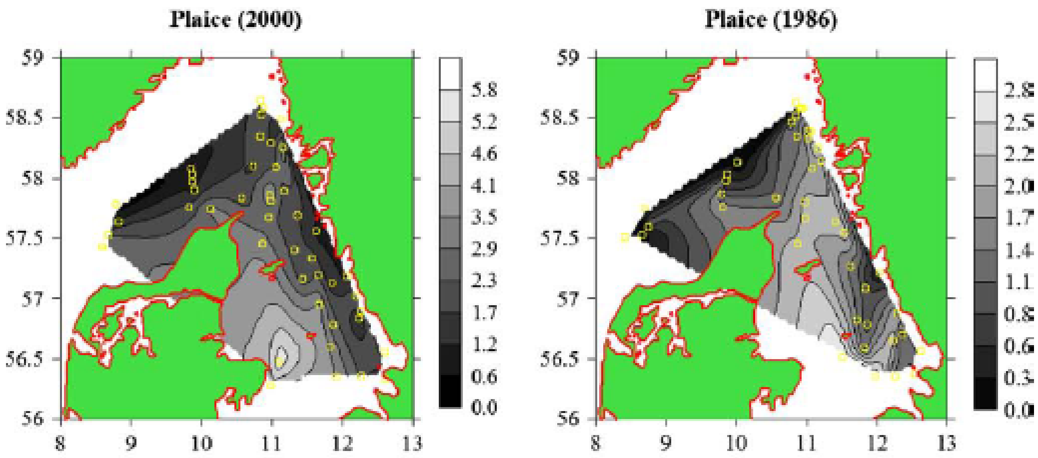


Figure 7.2.15. Plaice IIIa. Distribution and abundance from IBTS Q1 (Figure from Casini et al., 2005).

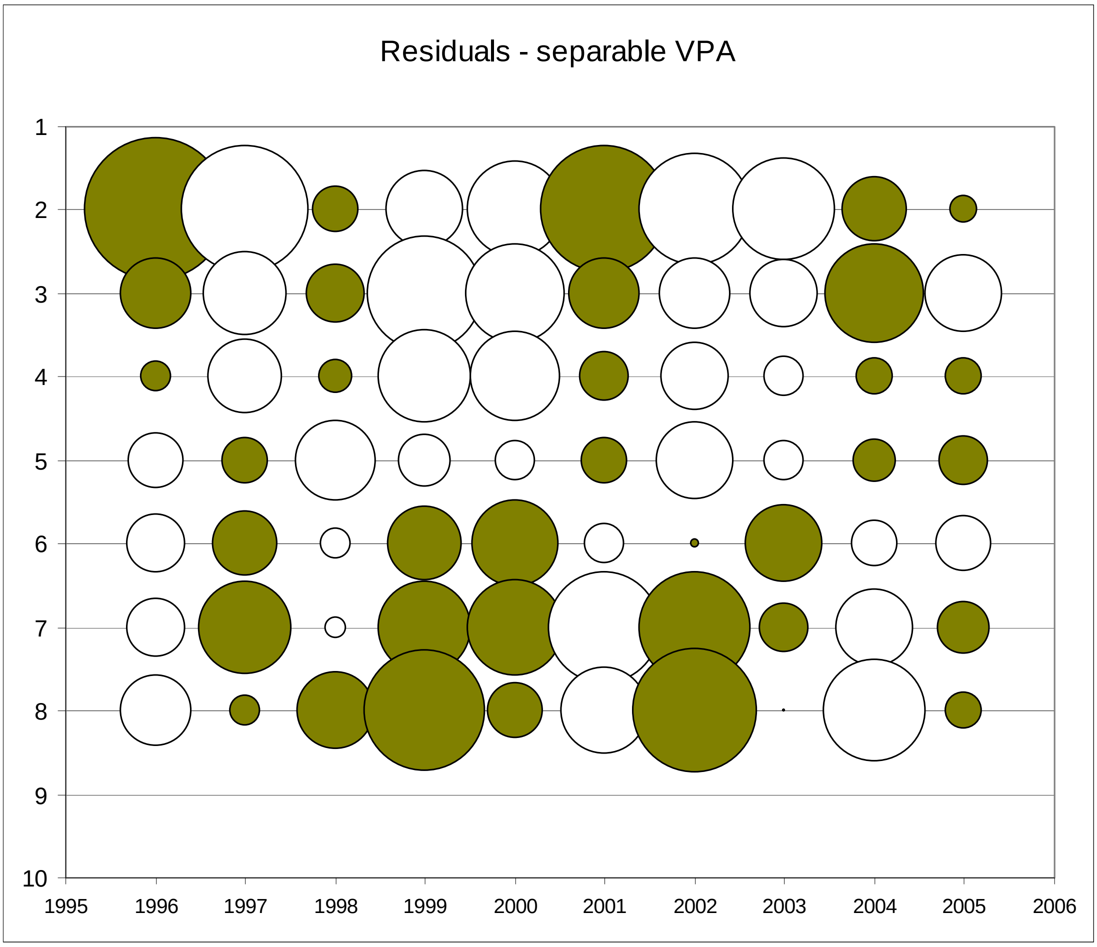


Figure 7.3.1. Plaice IIIa. Residuals of separableVPA. Max bubble size = 1.7

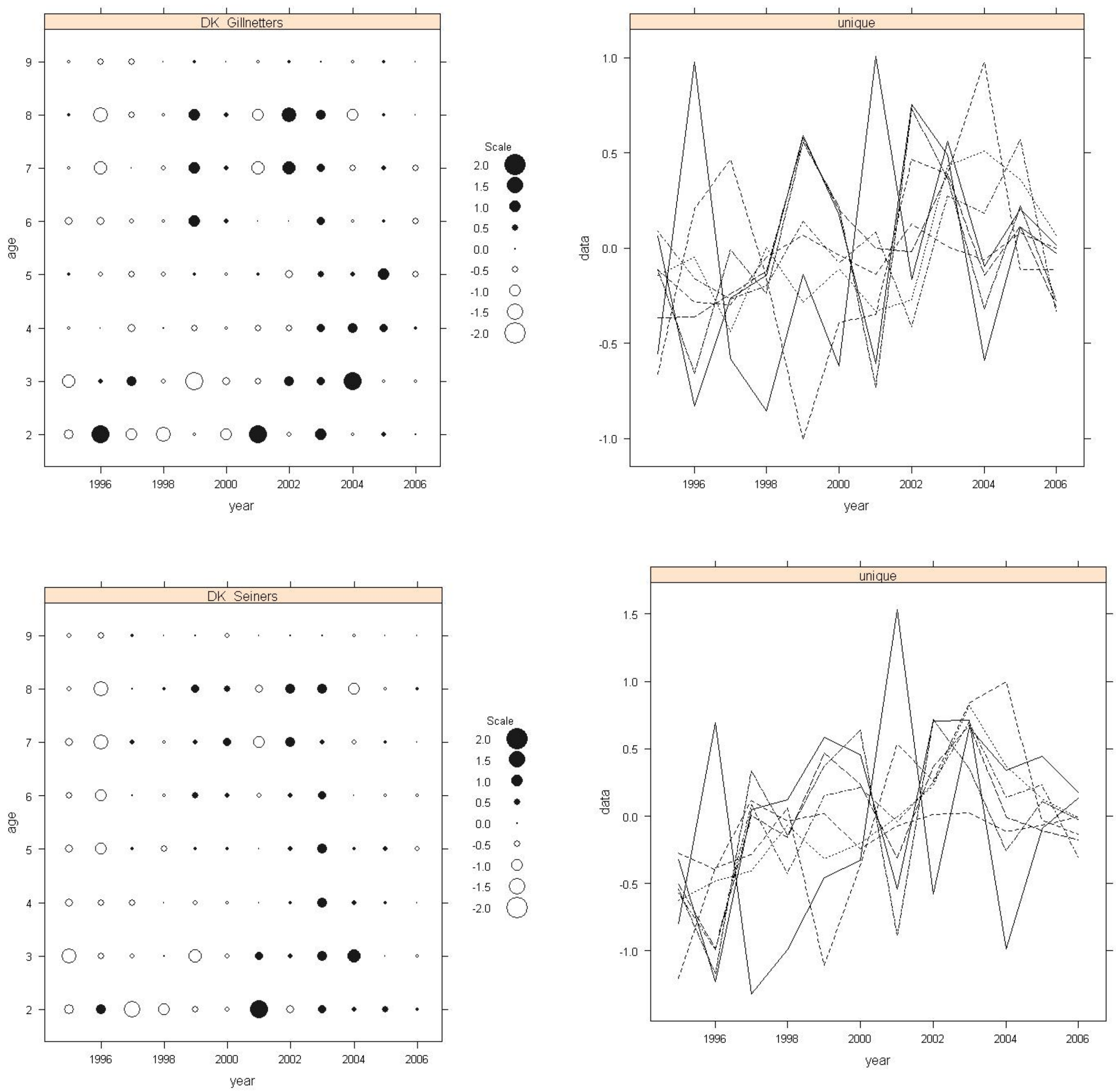


Figure 7.3.2. Plaice IIIa. Log catchability residuals for single fleet XSA with low shrinkage. Top : Danish Gillnetters. Bottom : Danish Seiners.

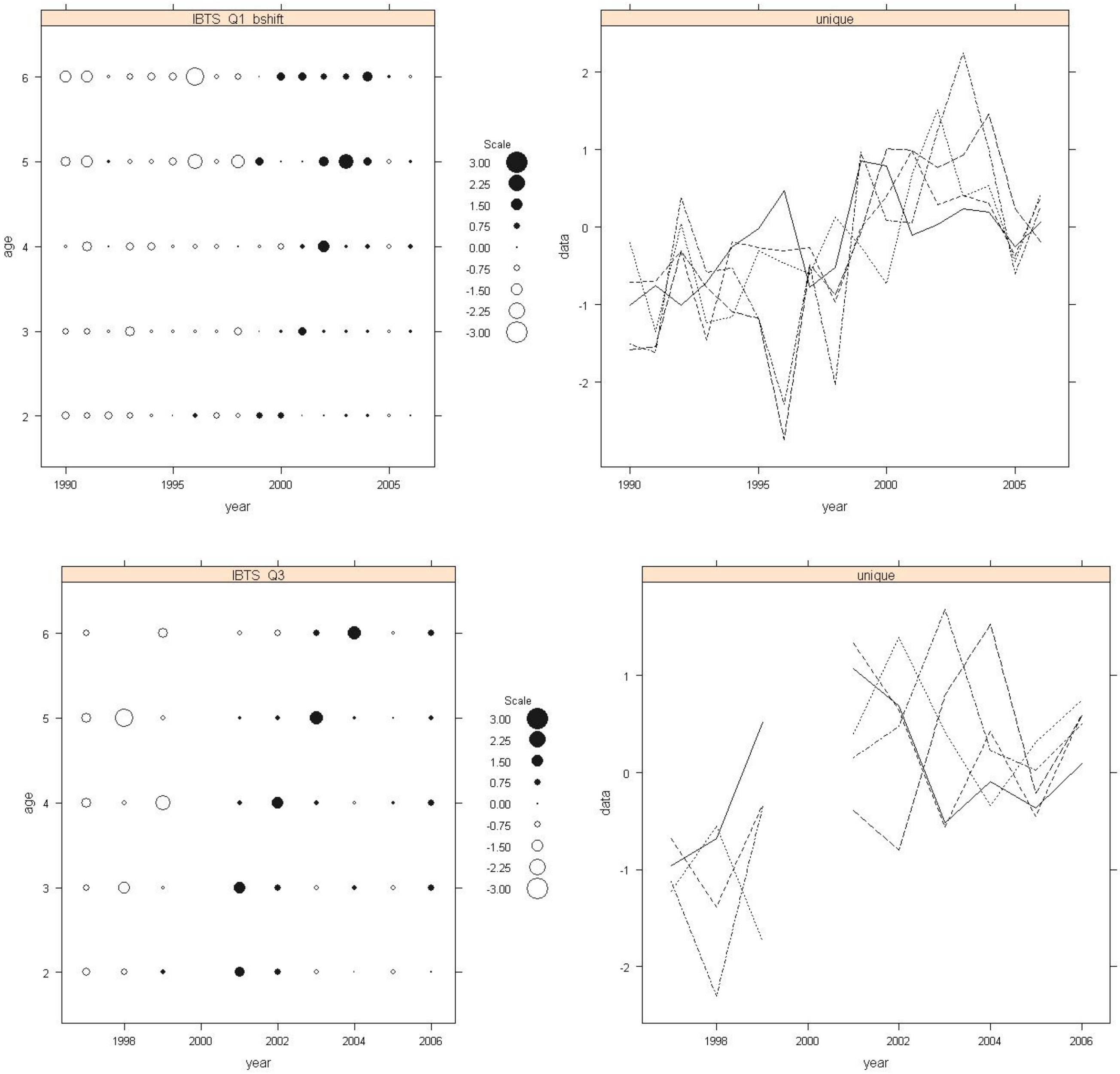


Figure 7.3.2 (ctd). Plaice IIIa. Log catchability residuals for single fleet XSA with low shrinkage. Top : IBTS Q1. Bottom : IBTS Q3.

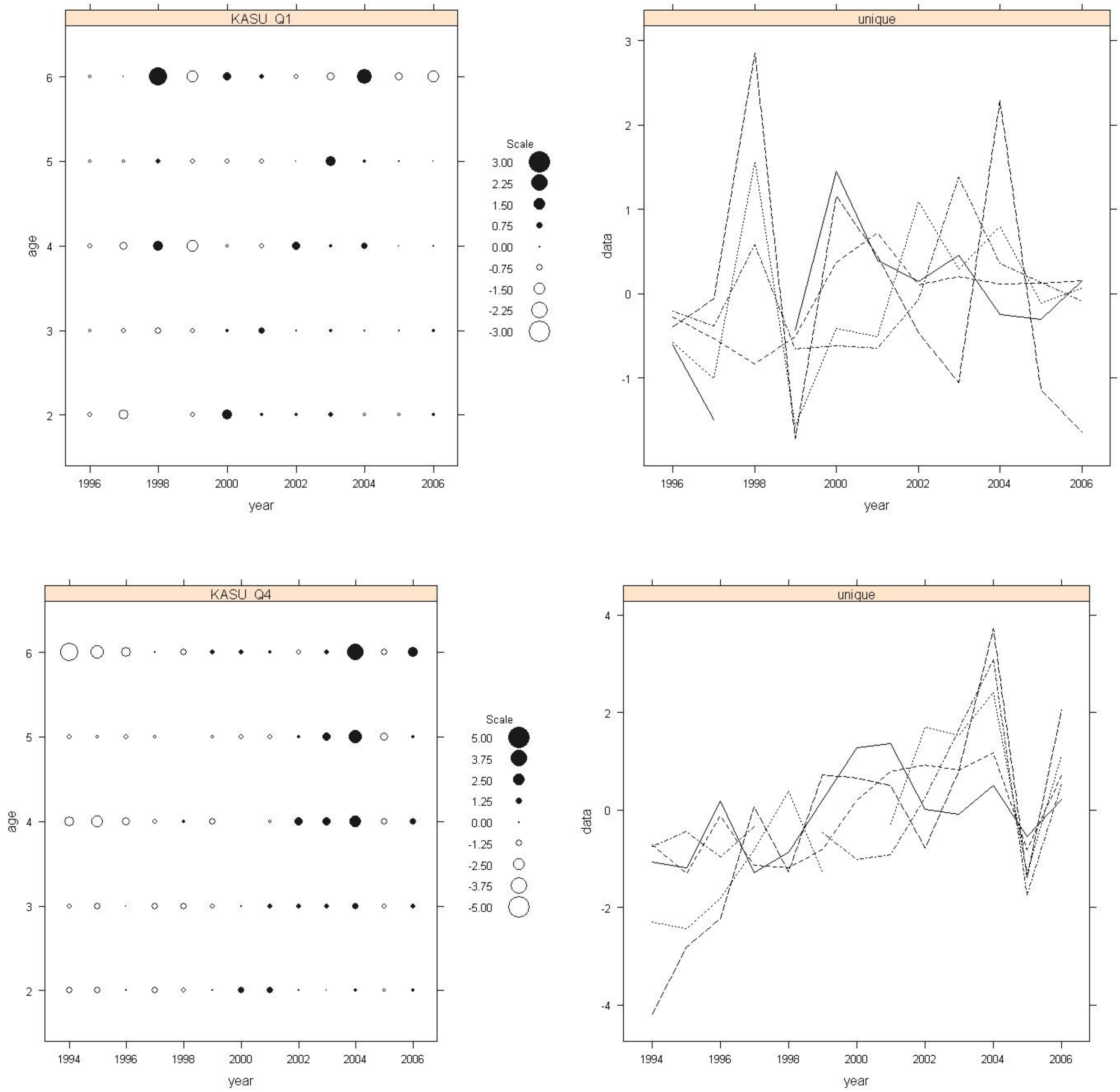


Figure 7.3.2 (ctd). Plaice IIIa. Log catchability residuals for single fleet XSA with low shrinkage. Top : KASU Q1. Bottom : KASU Q4.

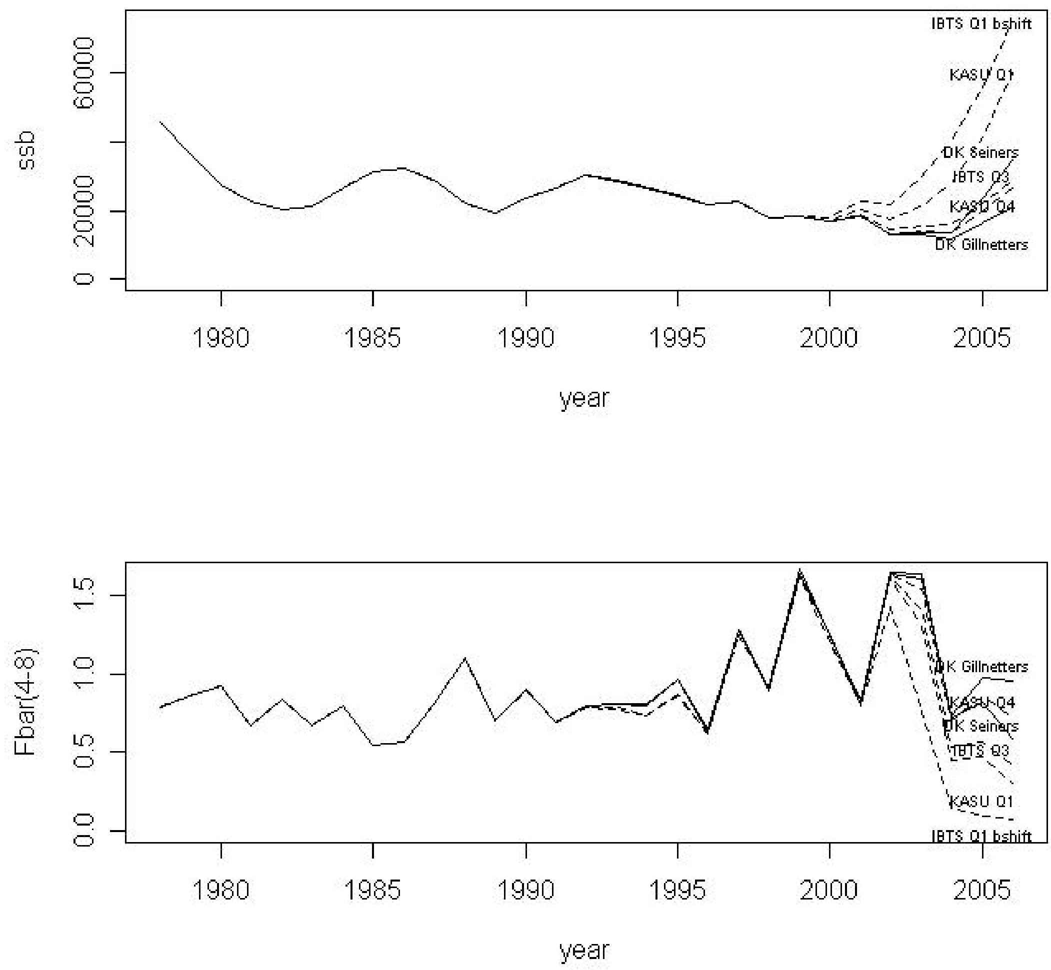
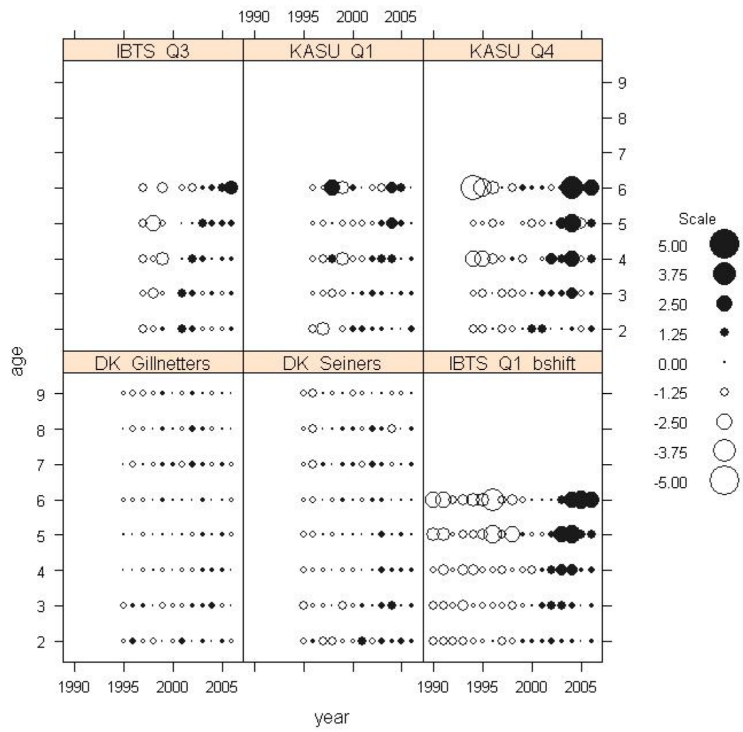


Figure 7.3.3. Plaice IIIa. Summary results for single fleet XSA runs with low shrinkage. Top : SSB. Bottom : Fbar(4-8).



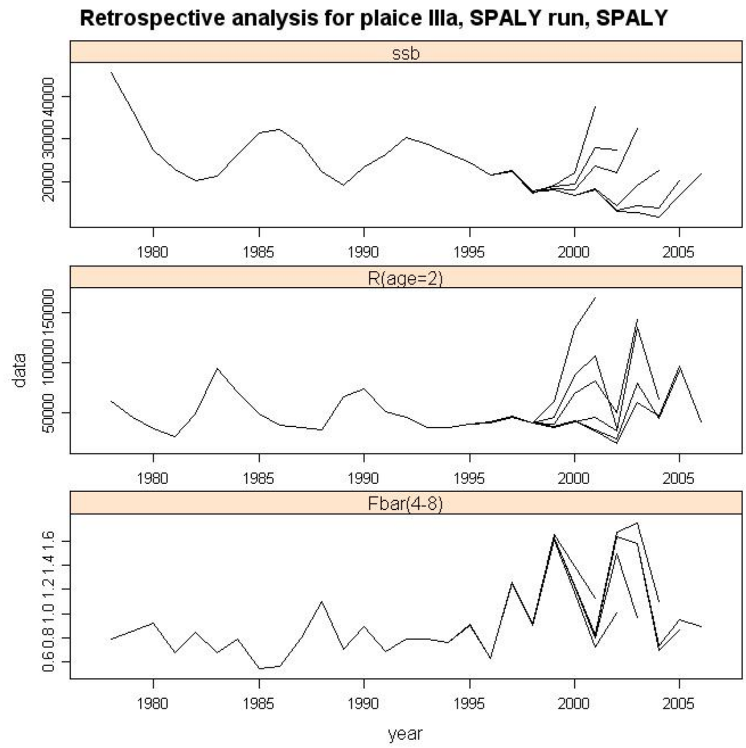
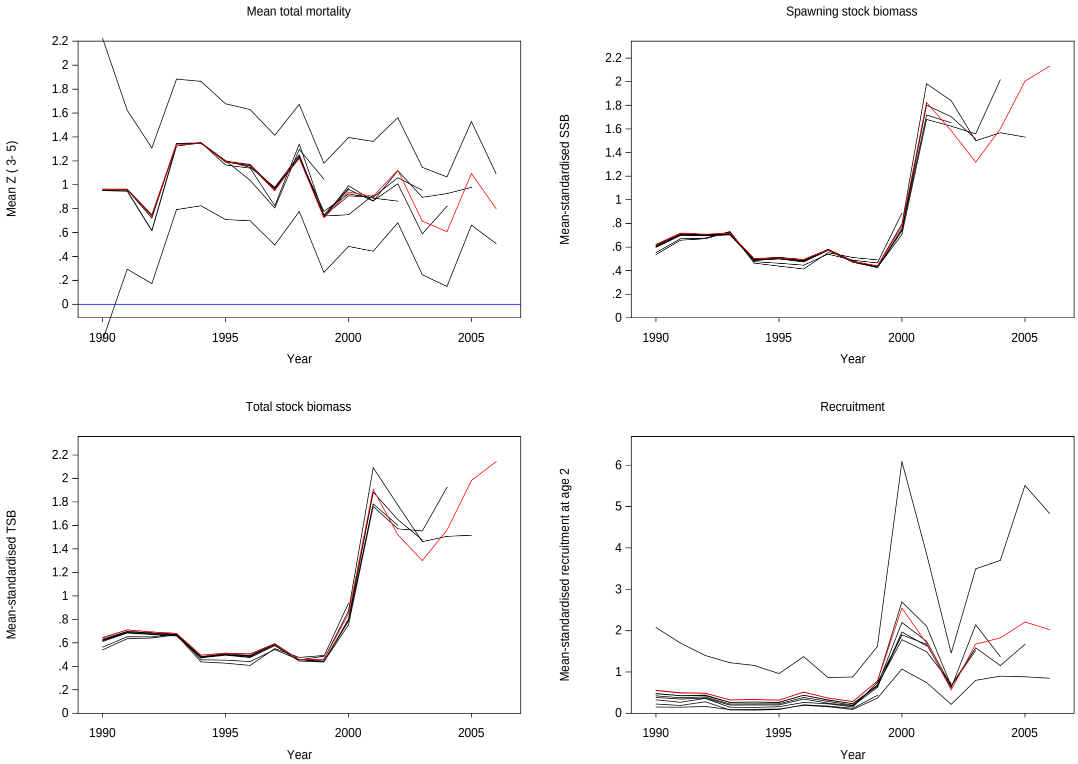


Figure 7.3.4. Plaice IIIa. SPALY run. Log q residuals and retrospective pattern.



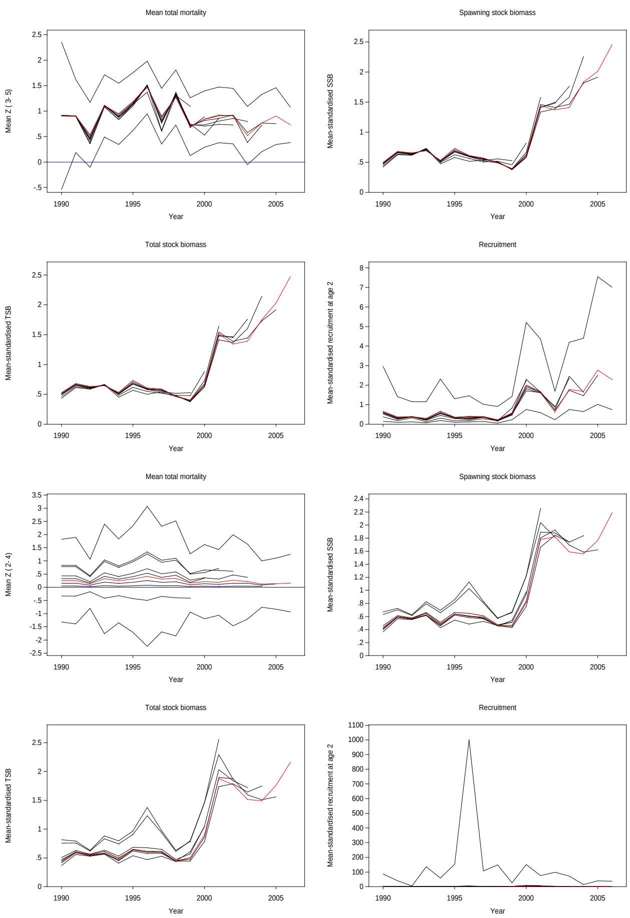


Figure 7.3.5. Plaice IIIa. SURBA runs. Top : with all surveys. Bottom left: all Q1 surveys. Bottom right: all IBTS surveys (Bottom right figure only displays the upper confidence interval for recruitment estimate).

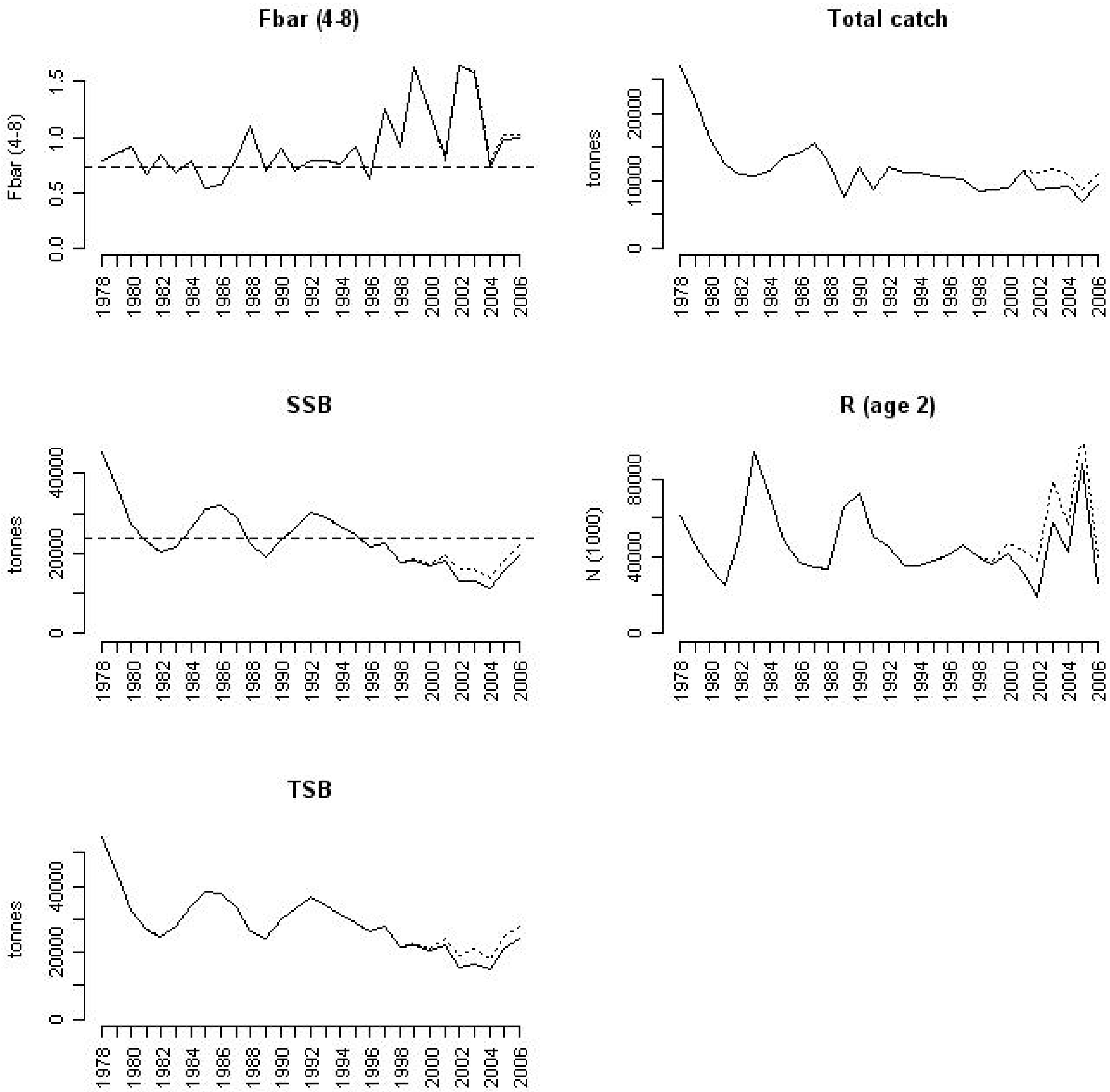


Figure 7.3.6. Plaice IIIa. Final run, summary plots. Solid line : run 1 without discards. Dotted line : run 2 with discards. Dashed lines : Fpa and Bpa reference points.

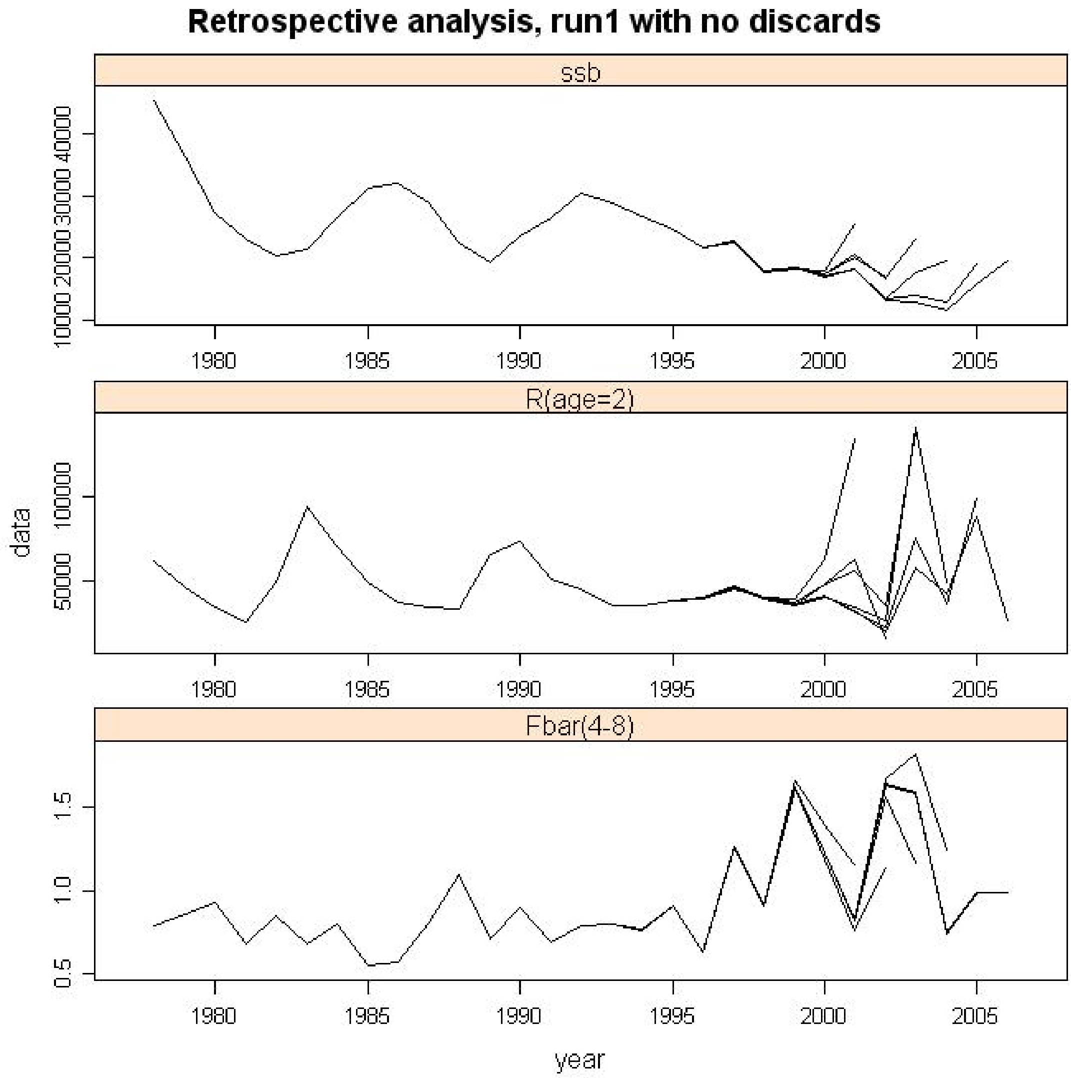


Figure 7.3.7. Plaice IIIa. Final run with no discards. Retrospective diagram.

8 Plaice in Subarea 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 Appendix is not yet available for North Sea plaice. Therefore information that should be given in the Stock Appendix 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. Also, the decrease in fleet size may partially have been compensated by slight increases the technical efficiency vessels. In the Dutch beam trawl fleet of indications of a technical efficiency of around 1.65% by year was found over the period 1990-2004 (Rijnsdorp et al, 2006).

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 CM 2002/ACFM:01), the fishing pattern of flag vessels can be very different from that of other fleet segments.

8.1.3 ICES Advice

The information in this section is taken from the ACFM summary sheet 2006.

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

The management agreement, previously agreed between the EU and Norway was not renewed for 2005 and is no longer in force. A new management plan for North Sea plaice is under development. 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.

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

The current total fishing mortality (including discards) was estimated at 0.52, which is well above the rate expected to lead to high long-term yields ($\mathbf{F}_{0.1}$ = 0.17).

Exploitation boundaries in relation to precautionary limits

The exploitation boundaries in relation to precautionary limits implied human consumption landings of less than 32 000 t in 2007, which was expected to rebuild SSB to the $\mathbf{B}_{pa}$ (=230 000 t) in 2008.

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 2007 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 most recent 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 2005 was estimated at around 193 kt and was estimated at a similar level (194 kt) in 2006. SSB was below the $\mathbf{B}_{pa}$ of 230 kt. Fishing mortality in 2005 was estimated as below $\mathbf{F}_{pa}$. Recruitment since 2003 has been below the time-series average.

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. 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.

Estimates of discards are based on a few observations of two dominant fleets since 1999, and by using a reconstruction model for the years prior to 1999. The most recent information shows that nearly 80% of the catch by number is discarded. The inclusion of discard estimates appears to contribute to a reduction in the retrospective bias that was previously observed in this assessment. However, the apparent reduction in bias has probably been accompanied by decreased precision. The estimate of discard mortality in 1999 is much lower compared with adjacent years. This cannot be explained from changes in the fishery and may be more reflecting the noise in the discard data.

Different trends are observed in different areas of the North Sea. Commercial CPUE series and a survey in the central part of the North Sea appear to indicate an increase in the plaice stock, whereas a survey in the southern North Sea indicates that the stock has remained at a low level, and a survey in the coastal region indicates a decrease in the plaice stock. This discrepancy adds to noise in the assessment.

8.1.4 Management

The management plan previously agreed between the EU and Norway was not renewed for 2005 and is no longer in force. A new management plan for North Sea plaice is under development.

The TAC in 2006 was agreed at 57 441 tonnes. For 2007 the TAC was agreed at 50 261 tonnes.

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. 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 an 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.

For 2007, Council Regulation (EC) No 41/2007 allocates different days at sea depending on gear, mesh size, and catch composition. The days at sea limitations for the major fleets operating in sub-area IV could be summarized as follows: Beam Trawls can fish between 123 and 143 days per year. Trawls or Danish seines can fish between 103 and 280 days per year. Gillnets are allowed to fish between 140 and 162 days per year. 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 2006 (Table 8.2.1) were estimated by the WG at 58 000 t, which is 2 300 t more than the 2005 landings. The TAC of 57 450 t was thus taken in 2006. 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)

The discards time series used in the assessment was derived from Dutch, Danish and UK discards observations for 2000-2006. The discard time series for 1957-1999 was derived from a discard reconstruction using a reconstructed population and selection and distribution ogives (ICES CM 2005/ACFM:07 Section 9.2.3).

This year was the first year that discards observations were made available from the Danish discard sampling program. These data were provided as age structured estimates for the entire Danish catch from 2000 to 2006, similar to the Dutch data. The UK discards samples are provided as length structured estimates from observer trips. After raising to the fleet total and estimation of discards-at age using age length keys from the Dutch BTS surveys, discard observations at age are thus available from the Dutch, Danish and the UK discard sampling programmes. The sampling effort in the Dutch and UK programmes is given in Table 8.2.2. Discards data from other countries were not available. Because the Danish discard observations are only available from 2000 onwards, the discards reconstruction was used for 1957-1999. This is a change with respect to the procedure of WGNSSK 2006, which used the reconstruction from 1957 -1998.

The Dutch sampling programme mainly focuses on 2000 hp 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, which are derived from low sampling level 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 trips for the UK fleets). Discards at age from the Danish sampling program was raised by landings. Discards at age for the other fleets were calculated as a weighted average of the Dutch, Danish 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), Last year, UK discards estimates without UK age-length key, were age-structured using a combined Dutch-UK ALK. This resulted in age estimation that was in some cases based on a very small number of samples, sensitive to errors in e.g. age-reading. To avoid these problems, this year a simpler approach was adopted, where the UK samples were age-structured using annual age-length keys from the BTS surveys. This key represents the age-length conversion in the third quarter of the year, but is well sampled, and therefore less prone to errors in individual age readings. The inclusion of the Danish discard observations and the change in the age structuring of the UK data resulted in lower discard estimates compared to the estimates presented in WGNSSK 2006, and a more consistent age distribution of the discard observations.

Figure 8.2.1 presents a timeseries of landings and discards from these different sources.

A self sampling program for discards was started by the Dutch beam trawl fishery in 2004 (Dekker and van Keeken, Working document WD1). This sampling program has a high number of samples, taken on board by the fishermen, estimating the percentage of discards by volume. The program indicates a strong spatial pattern in the discarding of the fleet (Fig 8.2.2). The percentage discards estimated in the self sampling program is lower than that in the Dutch sampling program in the same years. Currently, no evaluation can be undertaken to analyse the reasons for the difference.

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 CM 2005/ACFM:07 Appendix 1).

8.2.2 Age compositions

Market sampling programmes supplied age distributions for the official landings in 2006. 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 substantial sample 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 different raising procedure compared to WGNSSK 2006 (see section 8.2.1.), the discard numbers at age are different from those presented in WGNSSK 2006: generally, the number discards of age 4 decreased, while the discards at age 2 increased with discards at younger ages. Catch numbers-at-age are presented as the sum of landings numbers at age and discards numbers at age in Table 8.2.5. Figure 8.2.3 presents the landings-at-age, and discards-at-age. Figure 8.2.4 presents the resulting catch-at-age.

8.2.3 Weight at age

The stock weights of age groups 1-4 are calculated using modelled mean lengths from survey and back-calculation data (see ICES CM 2005/ACFM:07 Appendix 1) and converted to mean weight using a fixed length-weight relationship. Stock weights of the older ages are based on the market samples in the first quarter. Stock weights at age are presented in Table 8.2.6. 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 gear selection and discarding ogives are applied. Landing weights at age are derived from market sampling programmes. Catch weights at age are calculated as the weighted average of the discard and landing weights at age. Discard, landing, and catch weights at age are presented in Table 8.2.7, 8.2.8 and 8.2.9 respectively. Figure 8.2.5 presents the stock, discards, landings and catch weights at age.

8.2.4 Maturity and natural mortality

Natural mortality is assumed to be 0.1 for all age groups and constant over time. A fixed maturity ogive (Table 8.2.10) 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 showed that incorporating the historic fluctuations had little effect on SSB estimates in the period 1999-2003.

8.2.5 Catch, effort and research vessel data

Three different survey indices can been used as tuning fleets are (Table 8.2.11 and Figure 8.2.6.):

- Beam Trawl Survey RV Isis (BTS-Isis)

- Beam Trawl Survey RV Tridens (BTS-Tridens)
- Sole Net Survey in September-October (SNS)

Additional Survey indices that can be used for recruitment estimates are (Table 8.2.12):

- Demersal Fish Survey (DFS)

The Beam Trawl Survey RV Isis (BTS-Isis) was initiated in 1985 and was set up to obtain indices of the younger age groups of plaice and sole, covering the south-eastern part of the North Sea (RV Isis). Since 1996 the BTS-Tridens covers the central part of the North Sea, extending the survey area of the surveys. Both vessels use an 8-m beam trawl with 40 mm stretched mesh codend, but the Tridens beam trawl is rigged with a modified net. Owing to the spatial distribution of both BTS surveys, considerable numbers of older plaice and sole are caught. Previously age groups 1 to 4 were used for tuning the North Sea plaice assessment, but the age range has been extended to 1 to 9 in the revision done by ACFM in October 2001.

The Sole Net Survey (SNS & SNSQ2) was carried out with RV Tridens until 1995 and then continued with the RV Isis. Until 1990 this survey was carried out in both spring and autumn, but after that only in autumn. The gear used is a 6 m beam trawl with 40 mm stretched mesh cod-ends. The stations fished are on transects along or perpendicular to the coast. This survey is directed to juvenile plaice and sole. Ages 1 to 3 are used for tuning the North Sea plaice assessment; the 0-group index is used in the RCT3. In an attempt to solve the problem of not having the survey indices in time for the WG, the SNS was moved to spring in 2003. However, because of the gap in the spring series these data could not be used in the plaice assessment or in RCT3. In 2004, the SNS was moved back to autumn as before, based on the recommendation of the WGNSSK in 2004.

As in the previous three 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. Also, the research vessel survey time series have been revised in May 2006 by WGBEAM (ICES 2006), because of small corrections in data bases and new solutions for missing lengths in the age-length-keys. The internal consistency of the survey indices used for tuning appears relatively high for the entire age-range of each individual survey (Figures 8.2.7-8.2.9).

The Demersal Fish Survey (DFS) is the more coastal of the surveys. This survey is not used in the assessment, but rather used to estimate the recruitment of juvenile fish in the RCT3 analysis.

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 8.2.10):

- The Dutch beam trawl fleet
- The UK beam trawl fleet excluding all flag vessels

Effort has decreased in the Dutch beam trawl fleet since the early/mid 1990s. Up until 2002, the age-classes available in both the Dutch and the UK fleets generally show equal trends in LPUE through time.

The 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 and Poos 2007 Working paper WD3). Currently, 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). However, combining the LPUEs with the market categories and the market sampling could result in an age structured LPUE timeseries, corrected for the changes of fishing effort distribution resulting from the targeted fishing at the level of the ICES rectangle. Under the assumption that discarding is negligible for the older ages, the LPUE represents CPUE, and this timeseries could be used to tune age structured assessment methods. Currently the age-aggregated LPUE series, corrected for directed fishing under a TAC-constraint (see Quirijns and Poos 2007, Working paper WD3), by area and fleet component, that can be used as indication of stock development (Figure 8.2.11) are:

- The Dutch beam trawl fleet (only large cutters with engine powers above 221 kW)
- The UK beam trawl flag vessels landing in the Netherlands (only large cutters with engine powers above 221 kW)

The same series aggregated for the Dutch beam trawl fleet is given in Figure 8.2.12. 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 8.2.13.

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 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 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. On average the LPUE in 2005 has decreased to about 58% of the level it had in 1990.

8.3 Data analyses

The assessment of North Sea plaice by XSA was carried out using the FLR version of XSA (1.4.2). All analyses were done in FLR

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:

- "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". This year, the bias corrected LPUEs are presented again. The bias corrected LPUEs give an estimate of the abundance of the marketable fraction of the stock; the older ages in the assessment. Also, the area disaggregated LPUE time series seem to corroborate the spatial differences in abundance found in the tuning indices.

- "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 WG recognizes the importance of this recommendation and will address this question when time allows.
- "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." And "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". This was noted in last years working group and is repeated again. It appears that a change in the spatial distribution of the abundance of North Sea plaice results in differences in the information on the recent stock trends provided by the different surveys. The working group has not been able to model these differences, and therefore uses all the available survey tuning indices to average across the signals.
- "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". With the inclusion of the discard estimates from the discards reconstruction model in 1999, rather than the observations, and the use of a new procedure to age-structure the UK discard observations, the catch-at-age matrix has become more consistent. However, no runs with only landings were made, partly because the changing discarding behaviour observed over the last 15 years would probably create bias in the estimates from such a run. This was observed by WGNSSK prior to 2002 when no discards were incorporated.
- "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 discarded fraction of the catch of North Sea plaice is estimated to be considerable, mainly in the ages 2 and 3. By choosing a different age range to reduce the rapid oscillations, one would deny both the uncertainty and the magnitude of the fishing mortality estimates in the stock. Therefore, Fbar was calculated in this report as ranging from 2 to 6. However, Fbar on the human consumption part (landings) of the catches is also presented, in order to be able to compare the effects of discarding on the estimated of total fishing mortality. Estimates of Fbar hc (2-6) show a relatively stable decrease over time, while estimates of Fbar (2-6) show large inter-annual variation and a smaller decrease over time.
- "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 effects of the age at which the plus group was set were studied by the WG two years ago and were found not to affect the XSA outcomes. This year, a similar study is presented.

8.3.2 Exploratory catch-at-age-based analyses

The following exploratory analysis have been carried out using XSA:

1) explore sensitivity to different structural model assumption in XSA

2) explore sensitivity to different combinations of tuning series

Structural model assumptions

An initial run of XSA with the same settings as last year indicated that the residual variance of the final age of the BTS-Isis tuning index was very low, and much lower than the ages 1-8 (Fig 8.3.1). This could not be explained. Therefore the age was removed from the analysis.

The effect of setting the plus-group at different ages was studied by running XSA with either a plus group at age 10 or at 15. The setting of the plus group has an effect on both the SSB and F estimates coming from the XSA assessment (Fig 8.3.2). In the beginning of the resulting time series, the SSB is higher with the plus group set at age 15 compared to age 10. In the more recent part of the assessment, the SSB estimates are lower when using a plus group at age 15 compared to age 10. For the estimates of fishing mortality the opposite effect can be found.

Different combinations of tuning series

A series of XSA runs was carried out with all possible permutations of the available survey tuning fleets. The settings of the XSA model were the same as in WGNSSK 2006, except for the inclusion of the ages 1-8 rather then ages 1-9. The results (Figure 8.3.3) indicate that the selection of tuning fleets does strongly affect the perception of SSB and F in the most recent part of the assessment; The variance in the SSB estimates for the terminal year as a result of the permutations is high. The inclusion of only the BTS –Tridens would lead to a much higher perception of the final year SSB, combined with a much lower F estimate. Inclusion of only the BTS index, or a combination of the indices result in estimates between these two extremes.

8.3.3 Conclusions drawn from exploratory analyses

The tuning series from the BTS-Isis survey was used in the final assessment in the age range 1-8. Like in previous years, the plus group was set to 10, which has a minor effect on the assessment of F and SSB in the terminal year. The different survey tuning series available give different perceptions of the development of the stock in the most recent part of the assessment. Because the working group has not been able to model these differences, all the available survey tuning indices are used to average across the signals.

8.3.4 Final assessment

The settings for the final assessment, compared to the settings in earlier years is given below:

Year	2005	2006	2007
Catch at age	Landings + (reconstructed) discards based on NL + UK fleets	Landings + (reconstructed) discards based on NL + UK fleets	Landings + (reconstructed) discards based on NL, DK + UK fleets
Fleets	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	BTS-Isis 1985-2006 1-8 BTS-Tridens 1996-2006 1-9 SNS 1982-2006 1-3
Plus group	10	10	10
First tuning year	1982	1982	1982
Last data year	2004	2005	2006
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 / 5 ages	5 years / 5 years
s.e. of the mean for shrinkage	0.5	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 8.3.2. The log catchability residuals for the tuning fleets in the final run are dominated by negative values for the SNS tuning index in the most recent period, and positive values for the BTS-Tridens in the younger ages (Figure 8.3.4). Fishing mortality and stock numbers are shown in Tables 8.3.2 and 8.3.3. respectively. The SSB in 2006 was estimated at 197 kt. Mean F(2-6) was estimated at 0.55. Recruitment of the 2005 year class, in 2006 at the age of 1, was estimated at 636 817 million in the XSA. Retrospective analysis of the XSA presented in Figure 8.3.6 indicate 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), SSB, TSB 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 2002-2003, resulting from strong year classes. Fishing mortality increased until the late 1990s and reached its highest observed level during 1997-1998. Since, the estimates of fishing mortality have been fluctuating strongly. However, overall F has been lower since 2004, fluctuating around 0.50. 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) is estimated to decline since 1997, with little inter-annual variability. Current fishing mortality is estimated at 0.55 ($F_{hc,2\text{-}6}$ = 0.26). 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 year classes since 2002 appear weak. The 2005 year class now appears quite weak as well.

The North Sea Fishers' Survey has not yet been completed, so no comparison can be made between the stock trends observed from the assessment and the fishermens' perceptions from the Fishers' survey

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 2006 (age 1 in 2007) the values predicted by the two surveys (SNS and DFS) in RCT3 differ considerably (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 2005 (age 2 in 2007), 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 survivors estimate.

The recruitment estimates from the different sources are summarized in the text table below.

Year class	At age in 2007	XSA survivors	RCT3	GM 1957-2004	Accepted estimate
2005	2	**403208**	473 371	670 657	XSA survivors
2006	1		1 142 598	**910 585**	GM 1957-2004
2007	0			**910 585**	GM 1957-2004

8.6 Short-term forecasts

Short-term prognoses have been carried out in FLR using FLSTF (1.4.3). Weight-at-age in the stock and weight-at-age in the catch are taken to be the average over the last 3 years. The exploitation pattern was taken to be the mean value of the last three years, scaled to F in 2006. The proportion of landings 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 2007 year-class are taken from the long-term geometric mean (1957-2004). 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 2007 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 2007 and 2008, SSB is expected to be at 181 kt in 2008 and 181 kt in 2009. The yield at Fsq is expected to be around 56 kt in 2007 (total catch 100 kt), which is higher than the predicted value for 2007 from last years status quo forecast (51 kt, total catch 106 kt). At status quo F, the landings in 2008 are predicted to be around 51 kt (total catch 107 kt). In order to bring SSB above Bpa in 2009, fishing in 2008 would have to be at 0.46 * Fsq, corresponding with a yield of around 26 kt (total catch 56 kt).

8.7 Medium-term forecasts

No medium term projections were done for this stock because of time constraints.

8.8 Biological reference points

The current reference points were established by the WGNSSK in 2004, when the discard estimates were included in the assessment for the first time. The stock-recruitment relationship for North Sea plaice did not show a clear breakpoint where recruitment is impaired at lower spawning stocks. Therefore, ICES considered that $\mathbf{B_{lim}}$ can be set at 160 000 t and that $\mathbf{B_{pa}}$ can then be set at 230 000 t using the default multiplier of 1.4 (although the WG acknowledges that, since the noisy discards estimates have been included, the uncertainty of the estimates of stock status is much greater than that, see Dickey-Collas et al. (WGNSSK 2006, Working paper 16). $\mathbf{F_{lim}}$ was set at $\mathbf{F_{loss}}$ (0.74). $\mathbf{F_{pa}}$ was proposed to be set at 0.6 which is the 5^{th} percentile of $\mathbf{F_{loss}}$ and gave a 50% probability that SSB is around $\mathbf{B_{pa}}$ in the medium term. Equilibrium analysis suggests that F of 0.6 is consistent with an SSB of around 230 000 t.

	ICES considered that:	**ICES proposed that:**
Precautionary Approach Reference point	$\mathbf{B_{lim}}$ is 160 000 t	$\mathbf{B_{pa}}$ be set at 230 000 t
	$\mathbf{F_{lim}}$ is 0.74	$\mathbf{F_{pa}}$ be set at 0.60
Target reference points		$\mathbf{F_y}$ undefined

8.9 Quality of the assessment

The assessment presented by the WG incorporates discards. WGNSSK noted in 2002 (ICES 2003) that not considering discard catches in stock assessments could introduce bias and affect estimates of F and stock biomass, particularly when discard patterns vary over time. The discards estimates since 2000 have been derived under EC project 98/097 and under the EC data regulation (EC 2001). Because of the different sampling strategies by the different countries, data from the UK, Denmark and the Netherlands were used in this assessment. These countries contribute to approximately 85% 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. However, by changing the procedure used to age-structure the UK discards estimates, the WG has increased the consistency of the discards-at-age data. The WG also has concerns about the reconstruction of discards before 1999.

Differences are found in the trends in tuning series over the last five years. The more northern BTS-Tridens index indicates higher stock abundances than the two other tuning indices, BTS-Isis and SNS. Because of the historic correspondence between the VPA estimates and the BTS-Isis tuning index in the XSA assessment, it has a higher weight in estimating the stock numbers for ages 1-4 in recent years. The spatial difference of the stock trends is corroborated by the area disaggregated LPUE estimates from the Dutch beam trawl fleet. However, the historic development of the stock abundance as estimated by XSA shows good correspondence with the development of the average commercial LPUE of the Dutch beam trawl fleet. 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, as shown by last years WG.

A retrospective analysis of the assessment shows no clear recurring bias (Figure 8.3.5.). 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 overestimation of F is found (and minor underestimations for 2003 and 2004).

8.10 Status of the Stock

SSB in 2007 is estimated around 189 thousand tonnes which is between Bpa (230 000 t) and Blim (160 000 t). Fishing mortality is estimated to have increase from 0.43 in 2005 to 0.55 in 2006 (both below Fpa = 0.60), and at the same level as 2004 (0.50). At the same time, Fishing mortality of the human consumption part of the catch is estimated to 0.26 Projected landings for 2008 at Fsq are slightly lower than projected landings for 2007 at Fsq which are about equal to estimated landings of 2006. Projected discards for 2008 are quite higher than projected discards for 2007, but this is mainly based on the uncertain assumption of year classes 2006 and 2007 coming in (the geometric mean was chosen for these year classes in the projections, whereas recruitment of the 2005 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. 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 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.

The Commission of the European Community is currently drafting 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. Earlier drafts of the plan defined 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. Also, fishing mortality in the earlier drafts were to 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.

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. Also, the different survey tuning series in different areas of the North Sea indicate different trends in the most recent development of the stock.

8.12 North Sea plaice

8.12.1 Recruitment estimates

Input to the RCT3 analysis is presented in Table 8.12.1. Estimates from the RCT3 analysis of age 1 are presented in Table 8.12.2, and of age 2 in Table 8.12.3. For year class 2006 (age 1 in 2007), three recruitment survey estimates are available: SNS0, DFS0 in 2006 and BTS-ISIS1 in 2007. The surveys with the highest coefficients of determination (SNS0 and BTS-ISIS1) indicate higher than average recruitment for the 2006 year class. The RCT3 estimate for this year class is 1 263 476. For year class 2005 (age 2 in 2007), the data coming from SNS 0-group and DFS 0-group are noisy (high s.e. of the predicted value, Table 8.12.3.). With the inclusion of the BTS-ISIS2 survey for 2007, a survey with a high coefficient of determination and a low standard error in the prediction is included. The RCT3 estimate for this year class at age 2 is 478 647. This is lower than the geometric average, but higher than the XSA survivors estimate. Based on these results we propose to use RCT age 1 and age 2 estimates in the intermediate year of the short term forecast.

The recruitment estimates from the different sources are summarized in the text table below. Accepted estimates are in bold.

Year class	At age in 2007	XSA Survivors	RCT3	GM 1957-2004	Accepted estimate
2005	2	403208	**478 647**	670 657	RCT3
2006	1		**1 263 476**	910 585	RCT3
2007	0			**910 585**	GM 1957-2004

8.12.2 Short-term forecasts

Short-term prognoses have been carried out in FLR using FLSTF (1.4.3). Weight-at-age in the stock and weight-at-age in the catch are taken to be the average over the last 3 years. The exploitation pattern was taken to be the mean value of the last three years, scaled to F in 2006. The proportion of landings at age was taken to be the mean of the last three years. Population numbers at age 1 and 2 in the intermediate year are taken from the RCT3 analysis. Population numbers at age 3 and older are XSA survivor estimates. The recruitment of the 2007 year-class (at age 0) are taken from the long-term geometric mean (1957-2004). Input to the short term forecast is presented in table 8.12.4. The management options are given in Table 8.12.5. F in 2007 is set at the status quo level. The detailed table for a forecast based on Fsq is given in Table 8.12.6. At status quo fishing mortality in 2007 and 2008, SSB is expected to be at 198 kt in 2008 and 196 kt in 2009. The yield at Fsq is expected to be around 57 kt in 2007 (total catch 111 kt), which is higher than the predicted value for 2007 from last years status quo forecast (51 kt, total catch 106 kt). At status quo F, the landings in 2008 are predicted to be around 55 kt (total catch 126 kt). In order to bring SSB above Bpa in 2009, fishing in 2008 would have to be at 0.66 * Fsq, corresponding with a yield of around 39 kt (total catch 91 kt).

Table 8.2.1. North Sea Plaice. Nominal landings

YEAR	Belgium	Denmark	France	Germany	Nether-lands	Norway	Sweden	UK	Others	Total	Un-allocated	WG estimate	TAC
1980	7005	27057	711	4319	39782	15	7	23032		101928	38023	139951	
1981	6346	22026	586	3449	40049	18	3	21519		93996	45701	139697	105000
1982	6755	24532	1046	3626	41208	17	6	20740		97930	56616	154546	140000
1983	9716	18749	1185	2397	51328	15	22	17400		100812	43218	144030	164000
1984	11393	22154	604	2485	61478	16	13	16853		114996	41153	156149	182000
1985	9965	28236	1010	2197	90950	23	18	15912		148311	11527	159838	200000
1986	7232	26332	751	1809	74447	21	16	17294		127902	37445	165347	180000
1987	8554	21597	1580	1794	76612	12	7	20638		130794	22876	153670	150000
1988	11527	20259	1773	2566	77724	21	2	24497	43	138412	16063	154475	175000
1989	10939	23481	2037	5341	84173	321	12	26104		152408	17410	169818	185000
1990	13940	26474	1339	8747	78204	1756	169	25632		156261	-21	156240	180000
1991	14328	24356	508	7926	67945	560	103	27839		143565	4438	148003	175000
1992	12006	20891	537	6818	51064	836	53	31277		123482	1708	125190	175000
1993	10814	16452	603	6895	48552	827	7	31128		115278	1835	117113	175000
1994	7951	17056	407	5697	50289	524	6	27749		109679	713	110392	165000
1995	7093	13358	442	6329	44263	527	3	24395		96410	1946	98356	115000
1996	5765	11776	379	4780	35419	917	5	20992		80033	1640	81673	81000
1997	5223	13940	254	4159	34143	1620	10	22134		81483	1565	83048	91000
1998	5592	10087	489	2773	30541	965	2	19915	1	70365	1169	71534	87000
1999	6160	13468	624	3144	37513	643	4	17061		78617	2045	80662	102000
2000	7260	13408	547	4310	35030	883	3	20710		82151	-1001	81150	97000
2001	6369	13797	429	4739	33290	1926	3	19147		79700	2147	81847	78000
2002	4859	12552	548	3927	29081	1996	2	16740		69705	512	70217	77000
2003	4570	13742	343	3800	27353	1967	2	13892		65669	820	66489	73250
2004	4314	12123	231*	3649	23662	1744	1	15284		61008	428	61436	61000
2005	3396	11385	112	3379	22271	1660	0	12705		54908	792	55700	59000
2006	3487	11907	132	3599	22764	1614	0	12429		55933	2010	57943	57441
2007													50261

Table 8.2.2. North Sea plaice. Sampling effort for the NL and UK discards sampling programmes used for estimating discards at age.

Year	NL hours	UK hours	sum hours
2000	771	904	1675
2001	235	926	1161
2002	342	532	874
2003	494	871	1365
2004	479	1475	1954
2005	514	595	1109
2006	514	611	1125

Table 8.2.3. North Sea plaice. Landing numbers-at-age

2007-05-01 19:32:12 units= thousands

year	age 1	2	3	4	5	6	7	8	9	10
1957	0	4315	59818	44718	31771	8885	11029	9028	4973	10859
1958	0	7129	22205	62047	34112	19594	8178	8000	6110	13148
1959	0	16556	30427	25489	41099	22936	13873	6408	6596	16180
1960	0	5959	61876	51022	21321	27329	14186	9013	5087	15153
1961	0	2264	33392	67906	32699	12759	14680	9748	5996	14660
1962	0	2147	35876	66779	50060	20628	9060	9035	5257	12801
1963	0	4340	21471	76926	54364	31799	12848	6833	7047	16592
1964	0	14708	40486	64735	57408	37091	15819	6595	3980	16886
1965	0	9858	42202	53188	43674	30151	18361	8554	4213	17587
1966	0	4144	65009	51488	36667	27370	16500	10784	6467	14928
1967	0	5982	30304	112917	41383	22053	16175	8004	6728	11175
1968	0	9474	40698	38140	123619	17139	10341	10102	3925	13365
1969	3	15017	45187	36084	35585	102014	10410	6086	8192	16092
1970	76	17294	51174	56153	40686	35074	78886	6311	4185	14840
1971	19	29591	48282	33475	26059	22903	16913	29730	6414	16910
1972	2233	36528	62199	52906	23043	16998	14380	10903	18585	15651
1973	1268	31733	59099	73065	42255	13817	8885	9848	6084	23978
1974	2223	23120	55548	42125	41075	19666	8005	6321	5568	21980
1975	981	28124	61623	31262	25419	21188	11873	5923	4106	19695
1976	2820	33643	77649	96398	13779	9904	9120	6391	2947	12552
1977	3220	56969	43289	66013	83705	9142	5912	5022	4061	9191
1978	1143	60578	62343	54341	50102	35510	5940	3352	2419	7468
1979	1318	58031	118863	48962	47886	39932	24228	4161	2807	9288
1980	979	64904	133741	77523	24974	17982	13761	8458	1864	5377
1981	253	100927	122296	57604	35745	12414	9564	8092	4874	5903
1982	3334	47776	209007	69544	28655	16726	7589	5470	4482	8653
1983	1214	119695	115034	99076	29359	12906	8216	4193	3013	8287
1984	108	63252	274209	53549	37468	13661	6465	5544	2720	6565
1985	121	73552	144316	185203	32520	15544	6871	3650	2698	5798
1986	1674	67125	163717	93801	84479	24049	9299	4490	2733	6950
1987	0	85123	115951	111239	64758	34728	11452	4341	2154	5478
1988	0	15146	250675	74335	47380	25091	16774	5381	3162	6233
1989	1261	46757	105929	231414	52909	19247	10567	7561	2120	5580
1990	1550	32533	97766	110997	159814	26757	8129	4216	3451	3808
1991	1461	43266	83603	116155	72961	77557	14910	5233	3141	5591
1992	3410	43954	85120	72494	72703	33406	29547	6970	3200	6928
1993	3461	53949	98375	72286	51405	29001	13472	11272	3645	5883
1994	1394	45148	101617	80236	38542	20388	15323	6399	5368	5433
1995	7751	36575	81398	78370	36499	17953	9772	4366	2336	3753
1996	1104	42496	64382	46359	32130	14460	10605	4528	2624	4892
1997	892	42855	86948	43669	22541	13518	6362	3632	2179	4181
1998	196	30401	68920	56329	16713	6432	4986	2506	1761	3119
1999	549	8689	155971	39857	24112	6829	2783	2246	1521	3093
2000	2634	15819	39550	164330	14993	9343	2130	1030	940	2097
2001	4509	35886	52480	48238	89949	6836	4418	1127	637	2309
2002	1233	15596	58262	48361	36551	37877	4644	1788	742	1586
2003	694	42594	47802	48894	27126	15999	17069	1608	650	859
2004	543	10317	102332	35165	20527	11293	4787	4555	412	540
2005	2937	16685	26069	82278	17039	9533	5332	2614	2223	613
2006	355	18987	67465	25254	42525	6555	4967	2053	1235	1319

Table 8.2.4. North Sea Plaice. Discards numbers-at-age

2007-05-04 17:57:53 units= thousands

year \ age	1	2	3	4	5	6	7	8	9	10
1957	32356	45596	9220	909	961	25	0	0	0	0
1958	66199	73552	23655	2572	2137	65	0	0	0	0
1959	116086	127771	46402	11407	4737	106	0	0	0	0
1960	73939	167893	44948	997	1067	519	0	0	0	0
1961	75578	144609	89014	538	1612	130	0	0	0	0
1962	51265	181321	87599	21716	799	186	0	0	0	0
1963	90913	136183	129778	9964	2112	188	0	0	0	0
1964	66035	153274	64156	33825	3011	323	0	0	0	0
1965	43708	426021	59262	3404	923	267	0	0	0	0
1966	38496	163125	349358	14399	1402	125	0	0	0	0
1967	20199	133545	87532	152496	623	260	0	0	0	0
1968	73971	72192	46339	26530	22436	58	0	0	0	0
1969	85192	67378	16747	19334	773	2024	0	0	0	0
1970	123569	152480	27747	1287	5061	161	0	0	0	0
1971	69337	96968	42354	2675	426	81	0	0	0	0
1972	70002	55470	33899	5714	567	73	0	0	0	0
1973	132352	49815	4008	673	1289	67	0	0	0	0
1974	211139	308411	3652	285	611	109	0	0	0	0
1975	244969	280130	190536	4807	253	123	0	0	0	0
1976	183879	140921	71054	18013	174	41	0	0	0	0
1977	256628	103696	79317	33552	9317	129	0	0	0	0
1978	226872	154113	27257	10775	1244	570	0	0	0	0
1979	293166	215084	57578	18382	589	310	0	0	0	0
1980	226371	122561	932	687	193	86	0	0	0	0
1981	134142	193241	1850	373	431	55	0	0	0	0
1982	411307	204572	4624	1109	216	98	0	0	0	0
1983	261400	436331	30716	2235	804	72	0	0	0	0
1984	310675	313490	52651	24529	1492	69	0	0	0	0
1985	405385	229208	35566	2221	200	78	0	0	0	0
1986	1117345	490965	48510	26470	1451	146	0	0	0	0
1987	361519	1374202	180969	1427	1348	248	0	0	0	0
1988	348597	608109	459385	61167	882	177	0	0	0	0
1989	213291	485845	193176	85758	7224	115	0	0	0	0
1990	145314	279298	168674	28102	5011	177	0	0	0	0
1991	183126	301575	141567	40739	5528	939	0	0	0	0
1992	138755	219619	94581	34348	4307	880	0	0	0	0
1993	96371	154083	48088	11966	1635	216	0	0	0	0
1994	62122	95703	35703	1038	822	144	0	0	0	0
1995	118863	82676	15753	860	663	120	0	0	0	0
1996	111250	331065	27606	3930	451	116	0	0	0	0
1997	128653	510918	193828	588	271	108	0	0	0	0
1998	104538	646250	191631	53354	297	33	0	0	0	0
1999	127321	208401	231769	54869	278	58	0	0	0	0
2000	94893	185636	60890	47892	1244	243	121	8	0	0
2001	26538	306266	154624	52810	40168	310	89	46	0	0
2002	475243	266382	116991	23287	6175	2515	618	436	0	0
2003	76240	608274	74907	47355	11728	4113	4905	201	0	0
2004	170602	153693	85317	4619	2245	429	70	119	0	0
2005	72998	237776	28646	13241	3046	2137	45	4	0	0
2006	181523	189822	95472	10209	6194	1288	1548	296	0	0

Table 8.2.5. North Sea plaice. Catch numbers-at-age

2007-05-04 17:58:41 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	127870	217090	387740	94726	24390	6887	2783	2246	1521	3093
2000	97527	201455	100440	212222	16237	9586	2251	1038	940	2097
2001	31047	342152	207104	101048	130117	7146	4507	1173	637	2309
2002	476476	281978	175253	71648	42726	40392	5262	2224	742	1586
2003	76934	650868	122709	96249	38854	20112	21974	1809	650	859
2004	171145	164010	187649	39784	22772	11722	4857	4674	412	540
2005	75935	254461	54715	95519	20085	11670	5377	2618	2223	613
2006	**181878**	**208809**	**162937**	**35463**	**48719**	**7843**	**6515**	**2349**	**1235**	**1319**

Table 8.2.6. North Sea plaice. Stock weight-at-age

2007-05-04 10:16:18 units= kg

year \ age	1	2	3	4	5	6	7	8	9	10
1957	0.039	0.099	0.160	0.248	0.325	0.485	0.719	0.682	0.844	1.143
1958	0.042	0.091	0.183	0.279	0.303	0.442	0.577	0.778	0.793	1.112
1959	0.046	0.103	0.177	0.271	0.329	0.470	0.650	0.686	0.908	1.042
1960	0.039	0.108	0.185	0.279	0.364	0.469	0.633	0.726	0.845	1.090
1961	0.038	0.095	0.188	0.313	0.337	0.483	0.579	0.691	0.779	1.067
1962	0.036	0.093	0.176	0.308	0.424	0.573	0.684	0.806	0.873	1.303
1963	0.042	0.100	0.180	0.280	0.378	0.540	0.663	0.788	0.882	1.252
1964	0.025	0.110	0.187	0.304	0.373	0.477	0.645	0.673	0.845	1.232
1965	0.032	0.066	0.202	0.302	0.333	0.430	0.516	0.601	0.722	0.909
1966	0.032	0.097	0.129	0.313	0.403	0.455	0.503	0.565	0.581	0.984
1967	0.030	0.101	0.182	0.210	0.442	0.528	0.585	0.650	0.703	0.985
1968	0.056	0.091	0.178	0.294	0.344	0.532	0.592	0.362	0.667	0.887
1969	0.048	0.153	0.192	0.273	0.344	0.390	0.565	0.621	0.679	0.857
1970	0.044	0.110	0.243	0.281	0.369	0.410	0.468	0.636	0.732	0.896
1971	0.052	0.106	0.259	0.354	0.413	0.489	0.512	0.583	0.696	0.877
1972	0.057	0.154	0.225	0.418	0.473	0.534	0.579	0.606	0.655	0.929
1973	0.037	0.129	0.243	0.320	0.468	0.521	0.566	0.583	0.617	0.804
1974	0.050	0.102	0.224	0.427	0.437	0.524	0.570	0.629	0.652	0.852
1975	0.065	0.138	0.193	0.399	0.483	0.544	0.610	0.668	0.704	0.943
1976	0.083	0.165	0.233	0.316	0.484	0.550	0.593	0.658	0.694	0.931
1977	0.066	0.179	0.274	0.319	0.405	0.551	0.627	0.690	0.667	0.938
1978	0.066	0.148	0.329	0.383	0.411	0.467	0.547	0.630	0.704	0.943
1979	0.063	0.174	0.266	0.375	0.414	0.459	0.543	0.667	0.764	1.004
1980	0.050	0.159	0.299	0.440	0.444	0.524	0.582	0.651	0.778	1.058
1981	0.042	0.136	0.246	0.433	0.473	0.536	0.570	0.624	0.707	1.033
1982	0.049	0.125	0.258	0.361	0.490	0.589	0.631	0.679	0.726	0.981
1983	0.046	0.124	0.250	0.392	0.494	0.559	0.624	0.712	0.754	0.917
1984	0.049	0.126	0.223	0.425	0.464	0.571	0.649	0.692	0.787	1.029
1985	0.050	0.144	0.238	0.326	0.452	0.536	0.635	0.656	0.764	1.011
1986	0.044	0.124	0.252	0.317	0.440	0.533	0.692	0.779	0.888	1.092
1987	0.037	0.103	0.204	0.383	0.401	0.503	0.573	0.711	0.747	0.984
1988	0.037	0.096	0.176	0.269	0.426	0.467	0.547	0.644	0.706	0.973
1989	0.040	0.099	0.193	0.245	0.362	0.484	0.553	0.616	0.759	0.884
1990	0.045	0.109	0.184	0.270	0.343	0.422	0.555	0.647	0.701	0.972
1991	0.050	0.131	0.191	0.269	0.342	0.401	0.463	0.633	0.652	0.826
1992	0.047	0.123	0.204	0.275	0.318	0.403	0.500	0.573	0.683	0.834
1993	0.052	0.117	0.214	0.327	0.330	0.391	0.490	0.587	0.633	0.811
1994	0.054	0.143	0.220	0.297	0.360	0.404	0.462	0.533	0.653	0.798
1995	0.051	0.140	0.260	0.342	0.399	0.448	0.509	0.584	0.678	0.804
1996	0.044	0.116	0.234	0.375	0.390	0.462	0.488	0.554	0.660	0.815
1997	0.032	0.116	0.186	0.375	0.439	0.492	0.521	0.543	0.627	0.852
1998	0.039	0.080	0.208	0.339	0.474	0.577	0.581	0.648	0.656	0.812
1999	0.045	0.090	0.153	0.320	0.437	0.524	0.586	0.644	0.664	0.780
2000	0.052	0.105	0.169	0.224	0.408	0.467	0.649	0.695	0.656	0.787
2001	0.062	0.121	0.207	0.237	0.331	0.452	0.560	0.641	0.798	0.830
2002	0.049	0.117	0.218	0.306	0.319	0.403	0.446	0.612	0.685	0.858
2003	0.061	0.112	0.228	0.270	0.344	0.391	0.464	0.600	0.714	0.883
2004	0.048	0.116	0.206	0.313	0.384	0.430	0.489	0.495	0.780	0.876
2005	0.054	0.105	0.219	0.241	0.378	0.422	0.434	0.527	0.621	1.009
2006	0.053	0.129	0.195	0.321	0.354	0.424	0.439	0.506	0.583	0.728

Table 8.2.7. North Sea plaice. Landings weight-at-age

2007-05-01 19:36:43 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
2006	0.257	0.272	0.289	0.338	0.399	0.409	0.475	0.489	0.533	0.755

table 8.2.8. North Sea plaice. Discards weight-at-age

2007-05-01 19:37:37 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
2006	0.062	0.127	0.163	0.193	0.196	0.198	0.210	0.211	0	0

Table 8.2.9. North Sea plaice. Catch weight-at-age

2007-05-04 17:59:35 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	0.056	0.102	0.197	0.258	0.446	0.537	0.621	0.672	0.742	0.802
2000	0.065	0.121	0.200	0.275	0.405	0.479	0.639	0.684	0.729	0.862
2001	0.094	0.136	0.197	0.238	0.309	0.467	0.575	0.683	0.787	0.793
2002	0.058	0.126	0.208	0.270	0.319	0.422	0.442	0.545	0.745	0.881
2003	0.070	0.123	0.215	0.252	0.313	0.364	0.420	0.570	0.750	0.837
2004	0.057	0.125	0.228	0.309	0.374	0.425	0.501	0.538	0.789	0.861
2005	0.071	0.118	0.222	0.306	0.359	0.386	0.461	0.544	0.603	0.888
2006	0.062	0.140	0.215	0.296	0.373	0.374	0.412	0.454	0.533	0.755

Table 8.2.10. North Sea plaice. Natural mortality at age and maturity ate age vector used in assessments

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	age									
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 indices.

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BTS-Isis

year	effort	age 1	2	3	4	5	6	7	8	9
1985	1	116	179.9	38.81	11.84	1.371	1.048	0.362	0.167	0.098
1986	1	667	131.8	51.00	8.89	3.285	0.428	0.338	0.129	0.038
1987	1	226	764.3	33.06	4.77	2.039	1.017	0.352	0.087	0.072
1988	1	680	147.0	182.31	9.99	2.810	0.814	0.458	0.036	0.112
1989	1	468	319.3	38.66	47.30	5.850	0.833	0.311	0.661	0.132
1990	1	115	102.6	55.67	22.78	5.572	0.801	0.205	0.374	0.259
1991	1	185	122.1	28.55	11.86	4.264	5.710	0.257	0.219	0.099
1992	1	177	125.9	27.31	5.62	3.184	2.662	1.136	0.259	0.053
1993	1	125	179.1	38.40	6.12	0.931	0.812	0.629	0.465	0.167
1994	1	145	64.2	35.24	10.88	2.857	0.638	0.861	0.957	0.401
1995	1	252	43.5	14.22	8.11	1.195	0.868	0.356	1.131	0.218
1996	1	218	212.3	23.02	4.83	3.404	0.917	0.047	0.173	0.131
1997	1	NA	NA	19.91	2.79	0.219	0.390	0.171	0.121	0.000
1998	1	343	431.9	47.40	8.91	1.440	0.755	0.145	0.078	0.105
1999	1	306	130.0	182.52	3.65	2.107	0.137	0.140	0.029	0.032
2000	1	278	74.4	31.38	24.00	0.613	0.175	0.540	0.029	0.013
2001	1	223	78.4	19.39	9.97	9.474	0.294	0.143	0.041	0.043
2002	1	541	47.7	16.05	5.38	2.734	1.422	0.091	0.138	0.000
2003	1	126	170.1	10.78	5.94	1.525	1.214	0.684	0.112	0.104
2004	1	226	41.8	66.60	6.62	2.650	1.603	1.021	3.054	0.000
2005	1	158	69.6	7.23	13.74	1.167	1.254	0.313	0.164	0.530
2006	1	135	39.0	19.50	3.21	6.343	0.934	0.815	0.043	0.289

BTS-Tridens

Year	effort	age 1	2	3	4	5	6	7	8	9
1996	1	1.593	5.59	4.40	3.31	2.37	1.84	0.830	0.529	0.177
1997	1	NA	NA	10.41	3.95	2.84	1.93	0.471	1.102	0.424
1998	1	0.557	30.14	9.93	5.57	2.67	1.35	0.911	0.789	0.308
1999	1	2.387	8.29	36.93	6.47	2.65	2.13	0.600	0.771	0.326
2000	1	4.639	9.45	12.74	17.23	2.94	1.89	1.076	0.954	0.247
2001	1	0.672	6.93	9.05	7.23	7.67	1.21	0.691	0.480	0.603
2002	1	18.480	13.54	11.27	6.87	4.23	4.43	0.741	0.723	0.340
2003	1	4.108	34.84	11.91	8.57	4.75	2.72	3.973	0.699	0.703
2004	1	5.689	10.63	29.05	7.92	4.19	2.23	1.131	2.460	0.396
2005	1	7.340	23.70	11.30	16.20	2.57	5.42	1.552	0.536	3.335
2006	1	7.024	17.45	25.06	9.91	11.39	1.93	3.874	0.835	0.716

SNS

year	effort	age 1	2	3
1970	1	9311	9732	3273
1971	1	13538	28164	1415
1972	1	13207	10785	4472
1973	1	65639	5046	1578
1974	1	15366	16509	1129
1975	1	11628	8168	9556
1976	1	8537	2403	868
1977	1	18537	3424	1737
1978	1	14012	12678	345
1979	1	21495	9829	1575
1980	1	59174	12882	491
1981	1	24756	18785	834
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

Table 8.2.11 North Sea plaice. Survey tuning indices. (Cont'd)

1991	1	57221	11247	1518
1992	1	46798	13842	2268
1993	1	22098	9686	1006
1994	1	19188	4977	856
1995	1	24767	2796	381
1996	1	23015	10268	1185
1997	1	NA	NA	1391
1998	1	33666	30242	5014
1999	1	32951	10272	13783
2000	1	22855	2493	891
2001	1	11511	2898	370
2002	1	30813	1103	265
2003	1	NA	NA	NA
2004	1	18202	1350	1081
2005	1	10118	1819	142
2006	1	12164	1571	384

Table 8.2.12. North Sea plaice. DFS index catches (numbers per hour)

DFS

	Effort	age 0	age 1
1981	1	605.96	169.78
1982	1	433.67	299.36
1983	1	431.72	163.53
1984	1	261.80	124.19
1985	1	716.29	103.27
1986	1	200.11	288.27
1987	1	516.84	195.87
1988	1	318.36	116.45
1989	1	435.70	125.72
1990	1	465.47	130.13
1991	1	498.49	152.35
1992	1	351.59	137.08
1993	1	262.26	75.16
1994	1	445.66	30.60
1995	1	184.51	37.74
1996	1	572.80	116.89
1997	1	149.19	209.92
1998	1	NA	NA
1999	1	NA	NA
2000	1	183.83	11.31
2001	1	499.05	5.00
2002	1	213.17	19.20
2003	1	361.14	11.08
2004	1	199.77	14.78
2005	1	132.18	8.74
2006	1	231.86	9.37

Table 8.2.13 North Sea plaice. Commercial tuning fleets (not used in the final assessment)

2007-05-03 09:08:54[1]

NL Beam Trawl

year	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	64.6	138.9	263	1118	89.6	60.1	11.4	5.20	3.31
2001	61.4	264.3	367	321	664.6	44.7	28.6	6.35	3.19
2002	56.7	177.0	575	383	250.8	292.2	18.5	9.96	2.75
2003	51.6	372.8	387	406	186.4	103.8	129.1	6.03	5.02
2004	48.1	102.5	925	228	150.5	73.8	30.6	44.51	1.95
2005	49.1	154.2	222	727	96.2	59.2	34.1	14.81	23.54
2006	44.1	245.7	593	190	452.9	45.9	50.7	16.30	28.55

English Beam trawl excl Flag-vessels

year	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. XSA diagnostics from final run

```
FLR XSA Diagnostics 2007-05-10 13:47:10

CPUE data from xsa.indices

Catch data for 50 years. 1957 to 2006. Ages 1 to 10.

        fleet first age last age first year last year alpha beta
1    BTS-Isis         1        8       1985      2006  0.66 0.75
2 BTS-Tridens         1        9       1996      2006  0.66 0.75
3         SNS         1        3       1982      2006  0.66 0.75


 Time series weights :

   Tapered time weighting not applied

Catchability analysis :

    Catchability independent of size for all ages

    Catchability independent of age for ages >=   6

Terminal population estimation :

    Survivor estimates shrunk towards the mean F
    of the final   5 years or the  5 oldest ages.

    S.E. of the mean to which the estimates are shrunk =   2

    Minimum standard error for population
    estimates derived from each fleet =  0.3

   prior weighting not applied

Regression weights
     year
age   1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
  all    1    1    1    1    1    1    1    1    1    1


 Fishing mortalities
    year
age   1997  1998  1999  2000  2001  2002  2003  2004  2005  2006
  1  0.067 0.155 0.172 0.110 0.051 0.304 0.187 0.229 0.174 0.357
  2  0.795 0.510 0.484 0.397 0.600 0.751 0.769 0.662 0.551 0.861
  3  0.926 0.999 0.547 0.383 0.807 0.626 0.773 0.460 0.425 0.733
  4  0.753 1.075 1.169 0.581 0.732 0.644 0.750 0.542 0.398 0.476
  5  0.768 0.648 0.642 0.545 0.763 0.702 0.780 0.346 0.512 0.322
  6  0.726 0.449 0.525 0.497 0.435 0.498 0.754 0.500 0.267 0.341
  7  0.605 0.565 0.314 0.287 0.407 0.586 0.491 0.357 0.399 0.209
  8  0.570 0.449 0.475 0.165 0.212 0.320 0.360 0.162 0.295 0.270
  9  0.562 0.530 0.479 0.330 0.130 0.180 0.130 0.116 0.097 0.197
  10 0.562 0.530 0.479 0.330 0.130 0.180 0.130 0.116 0.097 0.197


 XSA population number ( thousands )
      age
year        1       2      3      4      5      6     7     8     9    10
  1997 2103864 1061332 488677  87955  44742  27745 14732  8788  5328 10171
  1998  767540 1780428 433568 175091  37486  18785 12144  7278  4497  7927
  1999  848634  594873 967348 144464  54095  17738 10847  6245  4202  8507
  2000  983831  646242 331761 506463  40611  25747  9499  7168  3514  7815
  2001  652831  797436 393114 204648 256395  21301 14178  6454  5498 19900
  2002 1910944  561173 396085 158701  89053 108224 12476  8542  4724 10078
  2003  474487 1275856 239545 191687  75445  39936 59503  6284  5613  7407
  2004  878142  356152 535317 100025  81891  31306 17005 32939  3965  5190
  2005  500063  631778 166248 305878  52662  52436 17177 10767 25358  6984
  2006  636817  380244 329606  98381 185909  28545 36346 10427  7252  7729
```

Table 8.3.1. North Sea plaice. XSA diagnostics from final run (Cont'd)

Estimated population abundance at 1st Jan 2007

year \ age	1	2	3	4	5	6	7	8	9	10
2007	18363	403209	145435	143253	55287	121877	18369	26690	7201	5387

Fleet: BTS-Isis

Log catchability residuals.

age \ year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	-1.262	-0.439	-0.679	0.531	0.541	-0.759	-0.103	-0.005	0.029	0.325	-0.120	-0.386
2	0.267	-0.370	0.488	-0.353	0.507	-0.327	0.027	0.225	0.667	0.026	-0.252	0.383
3	-0.054	0.338	-0.347	0.456	-0.334	0.081	-0.258	-0.087	0.373	0.361	-0.141	0.478
4	-0.265	-0.216	-0.611	-0.148	0.459	0.427	-0.087	-0.502	-0.218	0.510	0.330	0.197
5	-0.516	-0.147	-0.262	0.266	0.657	-0.326	0.045	0.052	-0.895	0.345	-0.274	0.903
6	0.311	-0.685	-0.299	-0.103	0.054	-0.368	0.773	0.501	-0.221	-0.257	0.116	0.500
7	0.065	-0.126	-0.019	-0.340	-0.311	-0.699	-0.738	-0.096	-0.406	0.815	-0.111	-1.984
8	-0.145	-0.215	-0.787	-1.293	0.764	0.511	0.084	0.091	-0.405	0.428	1.946	-0.130

age \ year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	NA	0.626	0.425	0.136	0.284	0.276	0.130	0.129	0.297	0.025
2	NA	0.421	0.298	-0.404	-0.419	-0.457	0.004	-0.199	-0.340	-0.193
3	-0.425	0.613	0.841	0.035	-0.318	-0.642	-0.433	0.363	-0.714	-0.188
4	-0.183	0.517	-0.116	0.098	0.233	-0.193	-0.207	0.405	-0.084	-0.348
5	-1.456	0.520	0.530	-0.487	0.562	0.334	-0.030	0.135	-0.126	0.172
6	-0.180	0.675	-0.921	-1.068	-0.404	-0.408	0.611	0.953	0.027	0.393
7	-0.457	-0.457	-0.556	0.907	-0.737	-0.935	-0.547	1.012	-0.151	-0.078
8	-0.311	-0.646	-1.465	-1.821	-1.337	-0.327	-0.200	1.308	-0.403	-1.728

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	1	2	3	4	5	6	7	8
Mean_Logq	-8.1608	-8.3151	-8.9601	-9.5757	-10.1596	-10.4101	-10.4101	-10.4101
S.E_Logq	0.4768	0.3638	0.4252	0.3359	0.5425	0.5467	0.6460	0.9376

Fleet: BTS-Tridens

Log catchability residuals.

age \ year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	-1.240	NA	-1.730	-0.362	0.110	-1.453	0.965	0.772	0.512	1.291	1.134
2	-1.200	NA	-0.187	-0.400	-0.413	-0.791	0.337	0.473	0.487	0.637	1.058
3	-0.458	-0.355	-0.231	-0.039	-0.149	-0.361	-0.277	0.385	0.252	0.452	0.781
4	-0.347	0.000	-0.117	0.290	-0.399	-0.254	-0.113	-0.006	0.418	-0.085	0.613
5	-0.267	0.300	0.333	-0.045	0.273	-0.456	-0.035	0.301	-0.214	-0.141	-0.049
6	-0.082	0.141	-0.022	0.546	0.034	-0.268	-0.550	0.140	0.007	0.213	-0.160
7	-0.391	-0.722	0.103	-0.379	0.318	-0.440	-0.116	-0.066	-0.164	0.172	0.203
8	-0.290	0.620	0.389	0.537	0.394	-0.155	0.050	0.352	-0.186	-0.498	-0.040
9	-0.152	0.159	-0.013	0.076	-0.128	0.176	-0.210	0.308	0.072	0.334	0.118

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	1	2	3	4	5	6	7	8	9
Mean_Logq	-12.2270	-10.3694	-9.6786	-9.4102	-9.3534	-9.1316	-9.1316	-9.1316	-9.1316
S.E_Logq	1.1317	0.7095	0.4057	0.3183	0.2676	0.2812	0.3223	0.3705	0.1793

Table 8.3.1. North Sea plaice. XSA diagnostics from final run (Cont'd)

Fleet: SNS

Log catchability residuals.

age \ year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	0.287	0.002	0.364	-0.516	-0.243	-0.429	-0.230	0.087	-0.125	0.881	0.826	0.459	0.462
2	0.387	0.077	0.247	0.576	-0.352	0.218	0.198	0.495	-0.070	0.516	0.890	0.624	0.342
3	0.047	-1.435	0.084	0.055	-0.153	-0.341	1.127	0.786	0.512	0.107	0.724	0.030	-0.057

age \ year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	-0.280	-0.475	NA	0.467	0.357	-0.201	-0.518	-0.429	NA	-0.231	-0.294	-0.222
2	-0.124	0.227	NA	0.635	0.633	-0.927	-0.843	-1.351	NA	-0.758	-1.111	-0.531
3	-0.461	0.811	0.213	1.666	1.557	-0.228	-0.978	-1.447	NA	-0.459	-1.344	-0.816

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	1	2	3
Mean_Logq	-3.4137	-4.2808	-5.3516
S.E_Logq	0.4272	0.6371	0.8546

Terminal year survivor and F summaries:

Age 1 Year class = 2005

source	survivors	N	scaledWts
BTS-Isis	413332	1	0.399
BTS-Tridens	1253465	1	0.067
SNS	322871	1	0.499
fshk	829625	1	0.034

Age 2 Year class = 2004

source	survivors	N	scaledWts
BTS-Isis	140862	2	0.524
BTS-Tridens	443711	2	0.117
SNS	99817	2	0.330
fshk	208449	1	0.029

Age 3 Year class = 2003

source	survivors	N	scaledWts
BTS-Isis	118463	3	0.476
BTS-Tridens	302347	3	0.290
SNS	77238	3	0.213
fshk	180194	1	0.022

Age 4 Year class = 2002

source	survivors	N	scaledWts
BTS-Isis	38194	4	0.500
BTS-Tridens	97397	4	0.434
SNS	19117	2	0.053
fshk	39647	1	0.013

Table 8.3.1. North Sea plaice. XSA diagnostics from final run (Cont'd)

Age 5 Year class = 2001

source	survivors	N	scaledWts
BTS-Isis	132126	5	0.379
BTS-Tridens	120659	5	0.573
SNS	78363	2	0.038
fshk	53604	1	0.010

Age 6 Year class = 2000

source	survivors	N	scaledWts
BTS-Isis	21798	6	0.300
BTS-Tridens	17488	6	0.673
SNS	8375	2	0.017
fshk	11724	1	0.011

Age 7 Year class = 1999

source	survivors	N	scaledWts
BTS-Isis	24248	7	0.274
BTS-Tridens	28557	7	0.698
SNS	13571	3	0.020
fshk	10919	1	0.009

Age 8 Year class = 1998

source	survivors	N	scaledWts
BTS-Isis	6050	8	0.223
BTS-Tridens	7611	8	0.754
SNS	5396	3	0.010
fshk	7195	1	0.013

Age 9 Year class = 1997

source	survivors	N	scaledWts
BTS-Isis	8040	8	0.135
BTS-Tridens	5073	9	0.846
SNS	7612	3	0.008
fshk	3064	1	0.011

Table 8.3.2. North Sea plaice. Fishing mortality estimates in final XSA run

2007-05-10 13:47:10 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	0.435	0.428	0.428
1968	0.197	0.287	0.344	0.361	0.366	0.323	0.410	0.289	0.351	0.351
1969	0.149	0.313	0.327	0.341	0.315	0.428	0.295	0.399	0.356	0.356
1970	0.223	0.435	0.492	0.505	0.462	0.504	0.594	0.261	0.467	0.467
1971	0.196	0.332	0.388	0.388	0.407	0.395	0.428	0.412	0.407	0.407
1972	0.232	0.381	0.401	0.413	0.419	0.443	0.408	0.478	0.434	0.434
1973	0.113	0.394	0.433	0.542	0.545	0.413	0.387	0.480	0.475	0.475
1974	0.221	0.399	0.491	0.515	0.597	0.452	0.394	0.465	0.486	0.486
1975	0.355	0.501	0.531	0.557	0.600	0.618	0.477	0.503	0.553	0.553
1976	0.333	0.407	0.426	0.432	0.383	0.434	0.518	0.452	0.445	0.445
1977	0.323	0.472	0.495	0.500	0.666	0.420	0.441	0.533	0.514	0.514
1978	0.305	0.429	0.465	0.471	0.461	0.520	0.462	0.427	0.470	0.470
1979	0.427	0.639	0.666	0.676	0.684	0.708	0.705	0.606	0.679	0.679
1980	0.239	0.470	0.668	0.623	0.509	0.518	0.493	0.503	0.531	0.531
1981	0.178	0.487	0.579	0.601	0.584	0.451	0.507	0.536	0.538	0.538
1982	0.242	0.518	0.700	0.679	0.604	0.524	0.484	0.540	0.568	0.568
1983	0.237	0.520	0.568	0.758	0.614	0.532	0.464	0.479	0.572	0.572
1984	0.301	0.553	0.585	0.604	0.658	0.556	0.488	0.581	0.580	0.580
1985	0.263	0.474	0.494	0.701	0.484	0.532	0.530	0.499	0.551	0.551
1986	0.284	0.610	0.634	0.640	0.723	0.712	0.620	0.703	0.766	0.766
1987	0.217	0.643	0.682	0.733	0.786	0.648	0.782	0.586	0.778	0.778
1988	0.232	0.619	0.663	0.679	0.718	0.702	0.660	0.958	1.026	1.026
1989	0.211	0.582	0.607	0.624	0.647	0.626	0.635	0.627	1.202	1.202
1990	0.161	0.473	0.573	0.560	0.689	0.598	0.518	0.496	0.580	0.580
1991	0.239	0.606	0.658	0.700	0.631	0.739	0.696	0.659	0.752	0.752
1992	0.214	0.554	0.653	0.670	0.799	0.553	0.606	0.732	0.994	0.994
1993	0.220	0.487	0.606	0.648	0.741	0.719	0.387	0.433	0.978	0.978
1994	0.164	0.484	0.611	0.715	0.637	0.635	0.943	0.285	0.336	0.336
1995	0.121	0.461	0.644	0.771	0.751	0.601	0.628	0.681	0.143	0.143
1996	0.096	0.546	0.691	0.727	0.750	0.663	0.764	0.592	1.043	1.043
1997	0.067	0.795	0.926	0.753	0.768	0.726	0.605	0.570	0.562	0.562
1998	0.155	0.510	0.999	1.075	0.648	0.449	0.565	0.449	0.530	0.530
1999	0.172	0.484	0.547	1.169	0.642	0.525	0.314	0.475	0.479	0.479
2000	0.110	0.397	0.383	0.581	0.545	0.497	0.287	0.165	0.330	0.330
2001	0.051	0.600	0.807	0.732	0.763	0.435	0.407	0.212	0.130	0.130
2002	0.304	0.751	0.626	0.644	0.702	0.498	0.586	0.320	0.180	0.180
2003	0.187	0.769	0.773	0.750	0.780	0.754	0.491	0.360	0.130	0.130
2004	0.229	0.662	0.460	0.542	0.346	0.500	0.357	0.162	0.116	0.116
2005	0.174	0.551	0.425	0.398	0.512	0.267	0.399	0.295	0.097	0.097
2006	**0.357**	**0.861**	**0.733**	**0.476**	**0.322**	**0.341**	**0.209**	**0.270**	**0.197**	**0.197**

Table 8.3.3. North Sea plaice. Stock number estimates in the final XSA runs

2007-05-10 14:36:18 units= thousands

year \ age	1	2	3	4	5	6	7	8	9	10
1957	457973	256778	322069	182986	117504	49780	48438	35192	20763	45210
1958	698110	383613	184865	225749	122171	75186	36568	33338	23255	49887
1959	863386	568706	270362	123650	142799	76063	49331	25309	22555	55137
1960	757298	670799	377298	171551	76786	85609	46907	31440	16805	49877
1961	860576	614899	441591	239779	105744	48183	50972	28949	19875	48420
1962	589153	706789	416673	283132	151855	63044	31337	32158	16921	41052
1963	688365	484323	465009	259569	172009	89026	37245	19737	20503	48075
1964	2231496	536379	304564	276885	152215	101919	50127	21480	11359	47990
1965	694572	1956327	325547	176043	156783	80258	56631	30309	13162	54735
1966	586775	586898	1355537	198051	105458	99441	43686	33776	19288	44345
1967	401292	494317	371936	832382	116531	59210	63824	23833	20304	33590
1968	434274	343890	314555	224453	500702	65484	32351	42364	13951	47348
1969	648863	322584	233482	201829	141577	314122	42894	19435	28723	56232
1970	650569	506075	213509	152350	129907	93519	185265	28910	11797	41652
1971	410259	471044	296422	118119	83213	74029	51103	92596	20155	52937
1972	366601	305245	305832	181998	72492	50101	45121	30152	55505	46555
1973	1311945	263003	188685	185317	108917	43135	29095	27148	16911	66361
1974	1132621	1059994	160404	110700	97540	57132	25823	17874	15197	59725
1975	864640	821882	643760	88827	59824	48605	32885	15751	10161	48494
1976	692511	548403	450449	342637	46064	29711	23708	18461	8618	36556
1977	988409	449016	330165	266133	201200	28408	17424	12776	10625	23935
1978	912046	647175	253458	182120	146098	93568	16885	10142	6784	20852
1979	890147	608359	381367	144108	102848	83353	50343	9628	5988	19696
1980	1125565	525317	290671	177240	66335	46950	37141	22506	4754	13648
1981	866090	802192	297004	134905	85977	36082	25296	20517	12319	14847
1982	2029438	655830	446032	150649	66918	43384	20788	13791	10867	20873
1983	1305975	1441893	353379	200374	69106	33087	23252	11591	7275	19907
1984	1258643	931889	775771	181108	84936	33838	17593	13224	6499	15605
1985	1846215	843242	484840	391027	89604	39793	17557	9769	6692	14309
1986	4752726	1284796	475002	267593	175533	49952	21146	9350	5368	13558
1987	1948611	3236000	631659	227923	127722	77090	22184	10289	4190	10582
1988	1769516	1419289	1539901	289110	99062	52686	36483	9179	5180	10122
1989	1187520	1269528	691367	717930	132704	43727	23637	17056	3187	8304
1990	1036414	870425	642090	341058	347907	62875	21148	11336	8240	9045
1991	914063	798085	490970	327542	176287	158013	31272	11403	6247	11046
1992	776749	651494	394114	230060	147130	84850	68308	14113	5340	11463
1993	531451	567600	338778	185672	106535	59874	44161	33702	6140	9826
1994	442164	385913	315700	167219	87860	45944	26384	27144	19772	19948
1995	1163993	339668	215207	155034	73996	42055	22041	9298	18474	29632
1996	1291068	932786	193909	102315	64915	31604	20861	10648	4260	7872
1997	2103864	1061332	488677	87955	44742	27745	14732	8788	5328	10171
1998	767540	1780428	433568	175091	37486	18785	12144	7278	4497	7927
1999	848634	594873	967348	144464	54095	17738	10847	6245	4202	8507
2000	983831	646242	331761	506463	40611	25747	9499	7168	3514	7815
2001	652831	797436	393114	204648	256395	21301	14178	6454	5498	19900
2002	1910944	561173	396085	158701	89053	108224	12476	8542	4724	10078
2003	474487	1275856	239545	191687	75445	39936	59503	6284	5613	7407
2004	878142	356152	535317	100025	81891	31306	17005	32939	3965	5190
2005	500063	631778	166248	305878	52662	52436	17177	10767	25358	6984
2006	636817	380244	329606	98381	185909	28545	36346	10427	7252	7729
2007		**403208**	**145434**	**143249**	**55286**	**121875**	**18369**	**26690**	**7201**	**11128**

Table 8.4.1. North Sea plaice. Stock summary table.

	recruits	ssb	catch	landings	discards	fbar2-6	fbar hc2-6	fbar dis2-3	Y/ssb
1957	457973	274205	78410	70563	7847	0.27	0.22	0.12	0.26
1958	698110	288540	88133	73354	14779	0.32	0.24	0.19	0.25
1959	863386	296825	109031	79300	29731	0.37	0.24	0.24	0.27
1960	757298	308164	116918	87541	29377	0.37	0.27	0.23	0.28
1961	860576	321353	118234	85984	32250	0.35	0.24	0.27	0.27
1962	589153	372863	124958	87472	37486	0.39	0.25	0.29	0.23
1963	688365	370372	148014	107118	40896	0.42	0.27	0.36	0.29
1964	2231496	363076	147059	110540	36519	0.47	0.30	0.32	0.30
1965	694572	344012	139747	97143	42604	0.39	0.28	0.25	0.28
1966	586775	361547	166589	101834	64755	0.40	0.24	0.34	0.28
1967	401292	416560	162737	108819	53918	0.43	0.25	0.32	0.26
1968	434274	402516	139259	111534	27725	0.34	0.21	0.22	0.28
1969	648863	377426	142708	121651	21057	0.34	0.25	0.17	0.32
1970	650569	333925	159877	130342	29535	0.48	0.35	0.28	0.39
1971	410259	316331	136807	113944	22863	0.38	0.29	0.22	0.36
1972	366601	319043	142308	122843	19465	0.41	0.33	0.19	0.39
1973	1311945	268691	143826	130429	13397	0.47	0.41	0.13	0.49
1974	1132621	278610	157277	112540	44737	0.49	0.41	0.20	0.40
1975	864640	293071	194672	108536	86136	0.56	0.37	0.43	0.37
1976	692511	310839	166515	113670	52845	0.42	0.30	0.27	0.37
1977	988409	316743	176300	119188	57112	0.51	0.34	0.31	0.38
1978	912046	303147	159285	113984	45301	0.47	0.36	0.22	0.38
1979	890147	296644	212501	145347	67154	0.67	0.49	0.36	0.49
1980	1125565	271666	170782	139951	30831	0.56	0.49	0.16	0.52
1981	866090	260767	172144	139747	32397	0.54	0.47	0.16	0.54
1982	2029438	262099	203863	154547	49316	0.61	0.51	0.22	0.59
1983	1305975	311258	217660	144038	73622	0.60	0.49	0.26	0.46
1984	1258643	322648	226102	156147	69955	0.59	0.44	0.28	0.48
1985	1846215	344856	220424	159838	60586	0.54	0.44	0.23	0.46
1986	4752726	369682	296260	165347	130913	0.66	0.50	0.34	0.45
1987	1948611	441943	342796	153670	189126	0.70	0.49	0.51	0.35
1988	1769516	387589	310444	154475	155969	0.68	0.40	0.52	0.40
1989	1187520	407988	276128	169818	106310	0.62	0.38	0.46	0.42
1990	1036414	378102	228218	156240	71978	0.58	0.39	0.39	0.41
1991	914063	345819	229063	148004	81059	0.67	0.43	0.47	0.43
1992	776749	279957	182887	125190	57697	0.65	0.43	0.40	0.45
1993	531451	242015	151999	117113	34886	0.64	0.50	0.28	0.48
1994	442164	217672	134218	110392	23826	0.62	0.51	0.24	0.51
1995	1163993	206144	120215	98356	21859	0.65	0.56	0.21	0.48
1996	1291068	180384	133861	81673	52188	0.68	0.52	0.35	0.45
1997	2103864	197737	179759	83048	96711	0.79	0.51	0.69	0.42
1998	767540	225426	174711	71534	103177	0.74	0.38	0.61	0.32
1999	848634	199740	151598	80662	70936	0.67	0.38	0.40	0.40
2000	983831	223603	124973	81148	43825	0.48	0.32	0.30	0.36
2001	652831	264905	163583	81963	81620	0.67	0.31	0.57	0.31
2002	1910944	219413	155224	70217	85007	0.64	0.35	0.56	0.32
2003	474487	233295	166938	66502	100436	0.77	0.38	0.60	0.29
2004	878142	184265	104729	61436	43293	0.50	0.31	0.41	0.33
2005	500063	203056	94306	55700	38606	0.43	0.25	0.37	0.27
2006	636817	197265	112694	57943	54751	0.55	0.26	0.61	0.29

Table 8.5.1. North Sea plaice. Input table for RCT3 analysis.

Year class	XSA age 1	XSA age 2	SNS0	SNS1	SNS2	SNS3	SNS4	BTS1	BTS2	BTS3	BTS4	DFS0
1967	434274	322584	-11	-11	-11	3273	101	-11	-11	-11	-11	-11
1968	648863	506075	-11	-11	9732	1415	89	-11	-11	-11	-11	-11
1969	650569	471044	-11	9311	28164	4472	488	-11	-11	-11	-11	-11
1970	410259	305245	1200	13538	10785	1578	160	-11	-11	-11	-11	-11
1971	366601	263003	4456	13207	5046	1129	65	-11	-11	-11	-11	-11
1972	1311945	1059994	7757	65639	16509	9556	236	-11	-11	-11	-11	-11
1973	1132621	821882	7183	15366	8168	868	590	-11	-11	-11	-11	-11
1974	864640	548403	2568	11628	2403	1737	135	-11	-11	-11	-11	-11
1975	692511	449016	1314	8537	3424	345	161	-11	-11	-11	-11	-11
1976	988409	647175	11166	18537	12678	1575	180	-11	-11	-11	-11	-11
1977	912046	608359	4373	14012	9829	491	38	-11	-11	-11	-11	-11
1978	890147	525317	3267	21495	12882	834	88	-11	-11	-11	-11	-11
1979	1125565	802192	29058	59174	18785	1261	71	-11	-11	-11	-11	-11
1980	866090	655830	4210	24756	8642	249	42	-11	-11	-11	-11	-11
1981	2029438	1441893	35506	69993	13909	2467	328	-11	-11	-11	11.8	606.0
1982	1305975	931889	24402	33974	10413	1598	145	-11	-11	38.8	8.9	433.7
1983	1258643	843242	32942	44965	13848	1152	200	-11	179.9	51.0	4.8	431.7
1984	1846215	1284796	7918	28101	7580	1227	1350	115.6	131.8	33.1	10.0	261.8
1985	4752726	3236000	47256	93552	32991	13153	7126	667.4	764.3	182.3	47.3	716.3
1986	1948611	1419289	8820	33402	14421	4373	816	225.8	147.0	38.7	22.8	200.1
1987	1769516	1269528	21335	36609	17810	3160	1077	680.2	319.3	55.7	11.9	516.8
1988	1187520	870425	15670	34276	7496	1518	613	467.9	102.6	28.6	5.6	318.4
1989	1036414	798085	24585	25037	11247	2268	98	115.3	122.1	27.3	6.1	435.7
1990	914063	651494	9368	57221	13842	1006	76	185.5	125.9	38.4	10.9	465.5
1991	776749	567600	17257	46798	9686	856	97	177.0	179.1	35.2	8.1	498.5
1992	531451	385913	6473	22098	4977	381	45	124.8	64.2	14.2	4.8	351.6
1993	442164	339668	9234	19188	2796	1185	45	145.2	43.6	23.0	2.8	262.3
1994	1163993	932786	26781	24767	10268	1391	50	252.2	212.3	19.9	8.9	445.7
1995	1291068	1061332	12541	23015	-11	5014	1058	218.3	-11	47.4	3.7	184.5
1996	2103864	1780428	84042	-11	30242	13783	983	-11	431.9	182.5	24.0	572.8
1997	767540	594873	14328	33666	10272	891	176	342.5	130.0	31.4	10.0	149.2
1998	848634	646242	25522	32951	2493	370	65	305.9	74.4	19.4	5.4	-11
1999	983831	797436	39262	22855	2898	265	-11	277.6	78.4	16.0	5.9	-11
2000	652831	561173	24214	11511	1103	-11	51	222.7	47.7	10.8	6.6	183.8
2001	1910944	1275856	99628	30813	-11	1081	366	541.3	170.1	66.6	13.7	499.1
2002	474487	356152	31350	-11	1350	142	50	126.1	41.8	7.2	3.2	213.2
2003	-11	-11	-11	18202	1819	385	-11	226.2	69.6	19.5	-11	361.1
2004	-11	-11	13537	10118	1571	-11	-11	158.5	39.0	-11	-11	199.8
2005	-11	-11	27391	12164	-11	-11	-11	135.1	-11	-11	-11	132.2
2006	-11	-11	51124	-11	-11	-11	-11	-11	-11	-11	-11	231.9

Table 8.5.2. North Sea plaice. RCT3 results for age 1.

Analysis by RCT3 ver3.1 of data from file :

ple_iv_1.txt, North Sea Plaice Age 1: data for 10 surveys over 1967 - 2006

Regression type = C, No tapered time weighting, No survey weighting

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2004

	I-----------Regression---------I				I-----------Prediction---------I				
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
SNS0	.95	4.89	.88	.281	33	9.51	13.89	.920	.072
SNS1	1.32	.41	.61	.427	32	9.22	12.58	.669	.136
SNS2	1.11	3.76	.77	.332	33	7.36	11.93	.859	.082
SNS3									
SNS4									
BTS1	1.68	4.63	.80	.369	18	5.07	13.16	.885	.078
BTS2	.90	9.51	.35	.758	19	3.69	12.84	.400	.379
BTS3									
BTS4									
DFS0	2.47	-.53	.99	.273	20	5.30	12.58	1.114	.049
					VPA Mean =		13.79	.546	.204

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	.95	4.89	.88	.281	33	10.22	14.56	.926	.133
SNS1	1.32	.41	.61	.427	32	9.41	12.82	.661	.261
SNS2									
SNS3									
SNS4									
BTS1	1.68	4.63	.80	.369	18	4.91	12.90	.897	.142
BTS2									
BTS3									
BTS4									
DFS0	2.47	-.53	.99	.273	20	4.89	11.57	1.189	.081
					VPA Mean =		13.79	.546	.383

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
SNS0	.95	4.89	.88	.281	33	10.84	15.15	.942	.212
SNS1									
SNS2									
SNS3									
SNS4									
BTS1									
BTS2									
BTS3									
BTS4									
DFS0	2.47	-.53	.99	.273	20	5.45	12.95	1.095	.157
					VPA Mean =		13.79	.546	.631

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2004	448319	13.01	.25	.23	.89		
2005	618302	13.33	.34	.40	1.37		
2006	1142598	13.95	.43	.49	1.26		

Table 8.5.3. North Sea plaice. RCT3 results for age 2.

```
Analysis by RCT3 ver3.1 of data from file :

 ple_iv_2.txt, North Sea Plaice Age 2: data for 10 surveys over 1967 - 2006

 Regression type = C, no tapered time weighting, no survey weighting

 Final estimates shrunk towards mean
 Minimum S.E. for any survey taken as    .20
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

Yearclass =   2004
         I-----------Regression----------I  I-----------Prediction---------I
 Survey/ Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error          Pts  Value   Value    Error   Weights

 SNS0      .85   5.45    .76   .344     33   9.51   13.57     .793     .091
 SNS1     1.27    .62    .58   .451     32   9.22   12.31     .629     .144
 SNS2     1.15   3.06    .82   .306     33   7.36   11.54     .909     .069
 SNS3
 SNS4
 BTS1     1.59   4.85    .75   .371     18   5.07   12.91     .835     .082
 BTS2      .87   9.38    .34   .755     19   3.69   12.59     .388     .379
 BTS3
 BTS4
 DFS0     2.55  -1.28   1.05   .238     20   5.30   12.24    1.176     .041

                                    VPA Mean =   13.48     .543     .194

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

 SNS0      .85   5.45    .76   .344     33  10.22   14.17     .799     .164
 SNS1     1.27    .62    .58   .451     32   9.41   12.54     .621     .271
 SNS2
 SNS3
 SNS4
 BTS1     1.59   4.85    .75   .371     18   4.91   12.66     .846     .146
 BTS2
 BTS3
 BTS4
 DFS0     2.55  -1.28   1.05   .238     20   4.89   11.19    1.256     .066

                                    VPA Mean =   13.48     .543     .354

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

 SNS0      .85   5.45    .76   .344     33  10.84   14.70     .812     .268
 SNS1
 SNS2
 SNS3
 SNS4
 BTS1
 BTS2
 BTS3
 BTS4
 DFS0     2.55  -1.28   1.05   .238     20   5.45   12.62    1.157     .132

                                    VPA Mean =   13.48     .543     .600

 Year     Weighted       Log     Int     Ext     Var      VPA       Log
 Class     Average       WAP     Std     Std    Ratio               VPA
          Prediction            Error   Error

 2004      344318      12.75     .24     .23      .92
 2005      473371      13.07     .32     .38     1.42
 2006      885487      13.69     .42     .48     1.28
```

Table 8.6.1. North Sea plaice. Input to the short term forecast.

age	year	f	stock.n	catch.wt	landings.wt	discards.wt	mat	M
1	2007	0.28	910585	0.064	0.245	0.061	0.0	0.1
2	2007	0.77	403208	0.128	0.259	0.117	0.5	0.1
3	2007	0.60	145434	0.222	0.282	0.167	0.5	0.1
4	2007	0.52	143249	0.304	0.330	0.187	1.0	0.1
5	2007	0.44	55286	0.369	0.393	0.201	1.0	0.1
6	2007	0.41	121875	0.395	0.423	0.204	1.0	0.1
7	2007	0.36	18369	0.458	0.481	0.209	1.0	0.1
8	2007	0.27	26690	0.512	0.528	0.144	1.0	0.1
9	2007	0.15	7201	0.642	0.642	0.000	1.0	0.1
10	2007	0.15	11128	0.835	0.835	0.000	1.0	0.1
1	2008	0.28	910585	0.064	0.245	0.061	0.0	0.1
2	2008	0.77		0.128	0.259	0.117	0.5	0.1
3	2008	0.60		0.222	0.282	0.167	0.5	0.1
4	2008	0.52		0.304	0.330	0.187	1.0	0.1
5	2008	0.44		0.369	0.393	0.201	1.0	0.1
6	2008	0.41		0.395	0.423	0.204	1.0	0.1
7	2008	0.36		0.458	0.481	0.209	1.0	0.1
8	2008	0.27		0.512	0.528	0.144	1.0	0.1
9	2008	0.15		0.642	0.642	0.000	1.0	0.1
10	2008	0.15		0.835	0.835	0.000	1.0	0.1
1	2009	0.28	910585	0.064	0.245	0.061	0.0	0.1
2	2009	0.77		0.128	0.259	0.117	0.5	0.1
3	2009	0.60		0.222	0.282	0.167	0.5	0.1
4	2009	0.52		0.304	0.330	0.187	1.0	0.1
5	2009	0.44		0.369	0.393	0.201	1.0	0.1
6	2009	0.41		0.395	0.423	0.204	1.0	0.1
7	2009	0.36		0.458	0.481	0.209	1.0	0.1
8	2009	0.27		0.512	0.528	0.144	1.0	0.1
9	2009	0.15		0.642	0.642	0.000	1.0	0.1
10	2009	0.15		0.835	0.835	0.000	1.0	0.1

Table 8.6.2. North Sea plaice. Results from the short term forecast.

year	fmult	f2-6	landings	discards	catch	ssb2007
2007	1	0.55	56225	44161	100446	189133

year	fmult	f2-6	landings	discards	catch	ssb2008	ssb2009
2008	0.0	0.00	0	0	0	181037	284677
2008	0.1	0.05	6217	7280	13504	181037	271664
2008	0.2	0.11	12142	14117	26273	181037	259346
2008	0.3	0.16	17791	20542	38354	181037	247682
2008	0.4	0.22	23179	26580	49786	181037	236634
2008	0.5	0.27	28318	32259	60610	181037	226164
2008	0.6	0.33	33222	37601	70862	181037	216240
2008	0.7	0.38	37902	42629	80576	181037	206830
2008	0.8	0.44	42370	47363	89785	181037	197903
2008	0.9	0.49	46637	51823	98517	181037	189433
2008	1.0	0.55	50712	56026	106801	181037	181392
2008	1.1	0.60	54606	59990	114663	181037	173756
2008	1.2	0.66	58327	63728	122128	181037	166503
2008	1.3	0.71	61884	67257	129219	181037	159610
2008	1.4	0.77	65285	70589	135956	181037	153058
2008	1.5	0.82	68537	73737	142362	181037	146827
2008	1.6	0.87	71649	76713	148454	181037	140899
2008	1.7	0.93	74627	79527	154250	181037	135258
2008	1.8	0.98	77477	82189	159766	181037	129888
2008	1.9	1.04	80205	84709	165020	181037	124774
2008	2.0	1.09	82818	87096	170024	181037	119902

Table 8.6.3. North Sea plaice. Detailed STF table

age	f	stock n	catch wt	land wt	disc wt	mat	M	stock wt	catch n	catch tot	land n	land tot	disc n	disc tot	SSB	TSB
Year 2007																
1	0.28	910585	0.06	0.25	0.06	0.0	0.1	0.05	212802	13533	3107	762	209695	12721	0	47047
2	0.77	403208	0.13	0.26	0.12	0.5	0.1	0.12	206737	26412	15120	3921	191617	22483	23520	47041

3	0.60	145434	0.22	0.28	0.17	0.5	0.1	0.21	62601	13879	29962	8455	32639	5440	15028	30056
4	0.52	143249	0.30	0.33	0.19	1.0	0.1	0.29	55791	16956	45700	15078	10091	1887	41781	41781
5	0.44	55286	0.37	0.39	0.20	1.0	0.1	0.37	18673	6884	16324	6409	2349	471	20566	20566
6	0.41	121875	0.39	0.42	0.20	1.0	0.1	0.43	39103	15441	34098	14419	5004	1019	51837	51837
7	0.36	18369	0.46	0.48	0.21	1.0	0.1	0.45	5260	2409	4804	2311	457	95	8339	8339
8	0.27	26690	0.51	0.53	0.14	1.0	0.1	0.51	5999	3071	5693	3008	306	44	13594	13594
9	0.15	7201	0.64	0.64	0.00	1.0	0.1	0.66	964	619	964	619	0	0	4762	4762
10	0.15	11128	0.83	0.83	0.00	1.0	0.1	0.87	1490	1244	1490	1244	0	0	9705	9705

Year 2008

1	0.28	910585	0.06	0.25	0.06	0.0	0.1	0.05	212802	13533	3107	762	209695	12721	0	47047
2	0.77	622065	0.13	0.26	0.12	0.5	0.1	0.12	318951	40748	23326	6049	295625	34687	36287	72574
3	0.60	169503	0.22	0.28	0.17	0.5	0.1	0.21	72962	16176	34921	9854	38041	6340	17515	35031
4	0.52	72364	0.30	0.33	0.19	1.0	0.1	0.29	28183	8565	23086	7617	5097	953	21106	21106
5	0.44	76799	0.37	0.39	0.20	1.0	0.1	0.37	25939	9563	22676	8902	3263	655	28569	28569
6	0.41	32334	0.39	0.42	0.20	1.0	0.1	0.43	10374	4097	9046	3826	1328	270	13753	13753
7	0.36	73223	0.46	0.48	0.21	1.0	0.1	0.45	20970	9602	19149	9212	1820	380	33243	33243
8	0.27	11634	0.51	0.53	0.14	1.0	0.1	0.51	2615	1339	2482	1311	133	19	5925	5925
9	0.15	18458	0.64	0.64	0.00	1.0	0.1	0.66	2472	1586	2472	1586	0	0	12207	12207
10	0.15	14254	0.83	0.83	0.00	1.0	0.1	0.87	1909	1593	1909	1593	0	0	12431	12431

Year 2009

1	0.28	910585	0.06	0.25	0.06	0.0	0.1	0.05	212802	13533	3107	762	209695	12721	0	47047
2	0.77	622065	0.13	0.26	0.12	0.5	0.1	0.12	318951	40748	23326	6049	295625	34687	36287	72574
3	0.60	261507	0.22	0.28	0.17	0.5	0.1	0.21	112565	24956	53875	15203	58690	9782	27022	54045
4	0.52	84340	0.30	0.33	0.19	1.0	0.1	0.29	32848	9983	26907	8877	5941	1111	24599	24599
5	0.44	38796	0.37	0.39	0.20	1.0	0.1	0.37	13103	4831	11455	4497	1648	331	14432	14432
6	0.41	44916	0.39	0.42	0.20	1.0	0.1	0.43	14411	5691	12567	5314	1844	376	19104	19104
7	0.36	19426	0.46	0.48	0.21	1.0	0.1	0.45	5563	2547	5080	2444	483	101	8820	8820
8	0.27	46375	0.51	0.53	0.14	1.0	0.1	0.51	10424	5336	9893	5227	532	76	23621	23621
9	0.15	8046	0.64	0.64	0.00	1.0	0.1	0.66	1077	691	1077	691	0	0	5321	5321
10	0.15	25439	0.83	0.83	0.00	1.0	0.1	0.87	3406	2843	3406	2843	0	0	22186	22186

Table 8.12.1 North Sea plaice. RCT3 input table

year class	XSA age 1	XSA age 2	SNS0	SNS1	BTS1 ISIS	BTS2 ISIS	DFS0
1967	434274	322584	-11	-11	-11	-11	-11
1968	648863	506075	-11	-11	-11	-11	-11
1969	650569	471044	-11	9311	-11	-11	-11
1970	410259	305245	1200	13538	-11	-11	-11
1971	366601	263003	4456	13207	-11	-11	-11
1972	1311945	1059994	7757	65639	-11	-11	-11
1973	1132621	821882	7183	15366	-11	-11	-11
1974	864640	548403	2568	11628	-11	-11	-11
1975	692511	449016	1314	8537	-11	-11	-11
1976	988409	647175	11166	18537	-11	-11	-11
1977	912046	608359	4373	14012	-11	-11	-11
1978	890147	525317	3267	21495	-11	-11	-11
1979	1125565	802192	29058	59174	-11	-11	-11
1980	866090	655830	4210	24756	-11	-11	-11
1981	2029438	1441893	35506	69993	-11	-11	605.96
1982	1305975	931889	24402	33974	-11	-11	433.67
1983	1258643	843242	32942	44965	-11	179.90	431.72
1984	1846215	1284796	7918	28101	115.58	131.77	261.80
1985	4752726	3236000	47256	93552	667.44	764.29	716.29
1986	1948611	1419289	8820	33402	225.82	146.99	200.11
1987	1769516	1269528	21335	36609	680.17	319.27	516.84
1988	1187520	870425	15670	34276	467.88	102.64	318.36
1989	1036414	798085	24585	25037	115.31	122.05	435.70
1990	914063	651494	9368	57221	185.45	125.93	465.47
1991	776749	567600	17257	46798	176.97	179.10	498.49
1992	531451	385913	6473	22098	124.76	64.22	351.59
1993	442164	339668	9234	19188	145.21	43.55	262.26
1994	1163993	932786	26781	24767	252.16	212.32	445.66
1995	1291068	1061332	12541	23015	218.28	-11	184.51
1996	2103864	1780428	84042	-11	-11	431.90	572.80
1997	767540	594873	14328	33666	342.51	130.00	149.19
1998	848634	646242	25522	32951	305.90	74.40	-11
1999	983831	797436	39262	22855	277.61	78.44	-11
2000	652831	561173	24214	11511	222.71	47.74	183.83
2001	1910944	1275856	99628	30813	541.25	170.08	499.05
2002	474487	356152	31350	-11	126.11	41.75	213.17
2003	-11	-11	-11	18202	226.20	69.60	361.14
2004	-11	-11	13537	10118	158.45	38.99	199.77
2005	-11	-11	27391	12164	135.11	70.44	132.18
2006	-11	-11	51124	-11	333.85	-11	240.06

Table 8.12.2 North Sea Plaice age 1 analysis by RCT3 3.1 of data from file: ple_iv_1.txt

Data for 10 surveys over 40 years : 1967 - 2006
Regression type = C, no tapered time weighting, no survey weighting
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

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	.95	4.89	.88	.281	33	10.84	15.15	.942	.170
BTS1	1.68	4.63	.80	.369	18	5.81	14.41	.879	.195
DFS0	2.47	-.53	.99	.273	20	5.49	13.04	1.092	.127
					VPA Mean =		13.79	.546	.508

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio
2006	1263476	14.05	.39	.36	.87

Table 8.12.3 North Sea Plaice age 2 analysis by RCT3 3.1 of data from file: ple_iv_2.txt

Data for 10 surveys over 40 years : 1967 - 2006

Regression type = C, no tapered time weighting, no survey weighting

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 = 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	.85	5.45	.76	.344	33	10.22	14.17	.799	.093
SNS1	1.27	.62	.58	.451	32	9.41	12.54	.621	.154
BTS1	1.59	4.85	.75	.371	18	4.91	12.66	.846	.083
BTS2	.87	9.38	.34	.755	19	4.27	13.09	.371	.431
DFS0	2.55	-1.28	1.05	.238	20	4.89	11.19	1.256	.038
					VPA Mean =		13.48	.543	.201

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio
2005	478647	13.08	.24	.26	1.13

Table 8.12.4 North Sea plaice. Short term forecast input table.

age	year	f	f_dis	f_land	stock n	catch wt	landings wt	discards wt	mat	M
1	2007	0.28	0.28	0.00	1263476	0.06	0.25	0.06	0.0	0.1
2	2007	0.77	0.71	0.06	478647	0.13	0.26	0.12	0.5	0.1
3	2007	0.60	0.31	0.29	145434	0.22	0.28	0.17	0.5	0.1
4	2007	0.52	0.09	0.43	143249	0.30	0.33	0.19	1.0	0.1
5	2007	0.44	0.06	0.38	55286	0.37	0.39	0.20	1.0	0.1
6	2007	0.41	0.05	0.36	121875	0.39	0.42	0.20	1.0	0.1
7	2007	0.36	0.03	0.33	18369	0.46	0.48	0.21	1.0	0.1
8	2007	0.27	0.01	0.26	26690	0.51	0.53	0.14	1.0	0.1
9	2007	0.15	0.00	0.15	7201	0.64	0.64	0.00	1.0	0.1
10	2007	0.15	0.00	0.15	11128	0.83	0.83	0.00	1.0	0.1
1	2008	0.28	0.28	0.00	910585	0.06	0.25	0.06	0.0	0.1
2	2008	0.77	0.71	0.06	863142	0.13	0.26	0.12	0.5	0.1
3	2008	0.60	0.31	0.29	201216	0.22	0.28	0.17	0.5	0.1
4	2008	0.52	0.09	0.43	72364	0.30	0.33	0.19	1.0	0.1
5	2008	0.44	0.06	0.38	76799	0.37	0.39	0.20	1.0	0.1
6	2008	0.41	0.05	0.36	32334	0.39	0.42	0.20	1.0	0.1
7	2008	0.36	0.03	0.33	73223	0.46	0.48	0.21	1.0	0.1
8	2008	0.27	0.01	0.26	11634	0.51	0.53	0.14	1.0	0.1
9	2008	0.15	0.00	0.15	18458	0.64	0.64	0.00	1.0	0.1
10	2008	0.15	0.00	0.15	14254	0.83	0.83	0.00	1.0	0.1
1	2009	0.28	0.28	0.00	910585	0.06	0.25	0.06	0.0	0.1
2	2009	0.77	0.71	0.06	622065	0.13	0.26	0.12	0.5	0.1
3	2009	0.60	0.31	0.29	362852	0.22	0.28	0.17	0.5	0.1
4	2009	0.52	0.09	0.43	100120	0.30	0.33	0.19	1.0	0.1
5	2009	0.44	0.06	0.38	38796	0.37	0.39	0.20	1.0	0.1
6	2009	0.41	0.05	0.36	44916	0.39	0.42	0.20	1.0	0.1
7	2009	0.36	0.03	0.33	19426	0.46	0.48	0.21	1.0	0.1
8	2009	0.27	0.01	0.26	46375	0.51	0.53	0.14	1.0	0.1
9	2009	0.15	0.00	0.15	8046	0.64	0.64	0.00	1.0	0.1
10	2009	0.15	0.00	0.15	25439	0.83	0.83	0.00	1.0	0.1

Table 8.12.5 North Sea plaice. Short term forecast options table.

year	fmult	ssb	f2-6	f_dis2-3	f_hc2-6	recruit	catch	landings	discards
2007	1	193534	0.55	0.51	0.3	1263476	110633	57254	53298

year	fmult	f2-6	f_dis2-3	f_hc2-6	landings	discards	catch	ssb2008	ssb2009
2008	0.2	0.11	0.10	0.06	13221	17964	31200	198377	286109
2008	0.3	0.16	0.15	0.09	19357	26109	45487	198377	272587
2008	0.4	0.22	0.20	0.12	25200	33745	58972	198377	259811
2008	0.5	0.27	0.26	0.15	30764	40907	71705	198377	247735
2008	0.6	0.33	0.31	0.18	36065	47627	83733	198377	236317
2008	0.7	0.38	0.36	0.21	41116	53936	95098	198377	225517
2008	0.8	0.44	0.41	0.24	45931	59860	105843	198377	215298
2008	0.9	0.49	0.46	0.27	50522	65425	116005	198377	205625
2008	1.0	0.55	0.51	0.30	54900	70655	125619	198377	196467
2008	1.1	0.60	0.56	0.33	59077	75573	134719	198377	187791
2008	1.2	0.66	0.61	0.36	63063	80199	143336	198377	179570
2008	1.3	0.71	0.66	0.39	66868	84552	151499	198377	171778
2008	1.4	0.77	0.72	0.42	70501	88650	159235	198377	164388
2008	1.5	0.82	0.77	0.45	73970	92511	166570	198377	157378
2008	1.6	0.87	0.82	0.48	77285	96148	173527	198377	150725
2008	1.7	0.93	0.87	0.51	80452	99578	180129	198377	144410
2008	1.8	0.98	0.92	0.54	83480	102813	186396	198377	138412
2008	1.9	1.04	0.97	0.57	86375	105866	192348	198377	132714
2008	2.0	1.09	1.02	0.60	89144	108749	198004	198377	127298

Table 8.12.6 North Sea plaice. Short term forecast detailed input table.

age	year	f	stock n	catch wt	land wt	disc wt	mat	M	stock wt	catch n	catch	land n	land	disc n	disc	SSB	TSB
1	2007	0.28	1263476	0.06	0.25	0.06	0.0	0.1	0.05	295271	18777	4311	1058	290960	17652	0	65280
2	2007	0.77	478647	0.13	0.26	0.12	0.5	0.1	0.12	245417	31353	17949	4655	227468	26690	27921	55842
3	2007	0.60	145434	0.22	0.28	0.17	0.5	0.1	0.21	62601	13879	29962	8455	32639	5440	15028	30056
4	2007	0.52	143249	0.30	0.33	0.19	1.0	0.1	0.29	55791	16956	45700	15078	10091	1887	41781	41781
5	2007	0.44	55286	0.37	0.39	0.20	1.0	0.1	0.37	18673	6884	16324	6409	2349	471	20566	20566
6	2007	0.41	121875	0.39	0.42	0.20	1.0	0.1	0.43	39103	15441	34098	14419	5004	1019	51837	51837
7	2007	0.36	18369	0.46	0.48	0.21	1.0	0.1	0.45	5260	2409	4804	2311	457	95	8339	8339
8	2007	0.27	26690	0.51	0.53	0.14	1.0	0.1	0.51	5999	3071	5693	3008	306	44	13594	13594
9	2007	0.15	7201	0.64	0.64	0.00	1.0	0.1	0.66	964	619	964	619	0	0	4762	4762
10	2007	0.15	11128	0.83	0.83	0.00	1.0	0.1	0.87	1490	1244	1490	1244	0	0	9705	9705
1	2008	0.28	910585	0.06	0.25	0.06	0.0	0.1	0.05	212802	13533	3107	762	209695	12721	0	47047
2	2008	0.77	863142	0.13	0.26	0.12	0.5	0.1	0.12	442558	56539	32366	8394	410192	48129	50350	100700
3	2008	0.60	201216	0.22	0.28	0.17	0.5	0.1	0.21	86613	19203	41454	11698	45159	7526	20792	41585
4	2008	0.52	72364	0.30	0.33	0.19	1.0	0.1	0.29	28183	8565	23086	7617	5097	953	21106	21106
5	2008	0.44	76799	0.37	0.39	0.20	1.0	0.1	0.37	25939	9563	22676	8902	3263	655	28569	28569
6	2008	0.41	32334	0.39	0.42	0.20	1.0	0.1	0.43	10374	4097	9046	3826	1328	270	13753	13753
7	2008	0.36	73223	0.46	0.48	0.21	1.0	0.1	0.45	20970	9602	19149	9212	1820	380	33243	33243
8	2008	0.27	11634	0.51	0.53	0.14	1.0	0.1	0.51	2615	1339	2482	1311	133	19	5925	5925
9	2008	0.15	18458	0.64	0.64	0.00	1.0	0.1	0.66	2472	1586	2472	1586	0	0	12207	12207
10	2008	0.15	14254	0.83	0.83	0.00	1.0	0.1	0.87	1909	1593	1909	1593	0	0	12431	12431
1	2009	0.28	910585	0.06	0.25	0.06	0.0	0.1	0.05	212802	13533	3107	762	209695	12721	0	47047
2	2009	0.77	622065	0.13	0.26	0.12	0.5	0.1	0.12	318951	40748	23326	6049	295625	34687	36287	72574
3	2009	0.60	362852	0.22	0.28	0.17	0.5	0.1	0.21	156188	34628	74754	21095	81434	13572	37495	74989
4	2009	0.52	100120	0.30	0.33	0.19	1.0	0.1	0.29	38993	11851	31941	10538	7053	1319	29202	29202
5	2009	0.44	38796	0.37	0.39	0.20	1.0	0.1	0.37	13103	4831	11455	4497	1648	331	14432	14432
6	2009	0.41	44916	0.39	0.42	0.20	1.0	0.1	0.43	14411	5691	12567	5314	1844	376	19104	19104
7	2009	0.36	19426	0.46	0.48	0.21	1.0	0.1	0.45	5563	2547	5080	2444	483	101	8820	8820
8	2009	0.27	46375	0.51	0.53	0.14	1.0	0.1	0.51	10424	5336	9893	5227	532	76	23621	23621
9	2009	0.15	8046	0.64	0.64	0.00	1.0	0.1	0.66	1077	691	1077	691	0	0	5321	5321
10	2009	0.15	25439	0.83	0.83	0.00	1.0	0.1	0.87	3406	2843	3406	2843	0	0	22186	22186

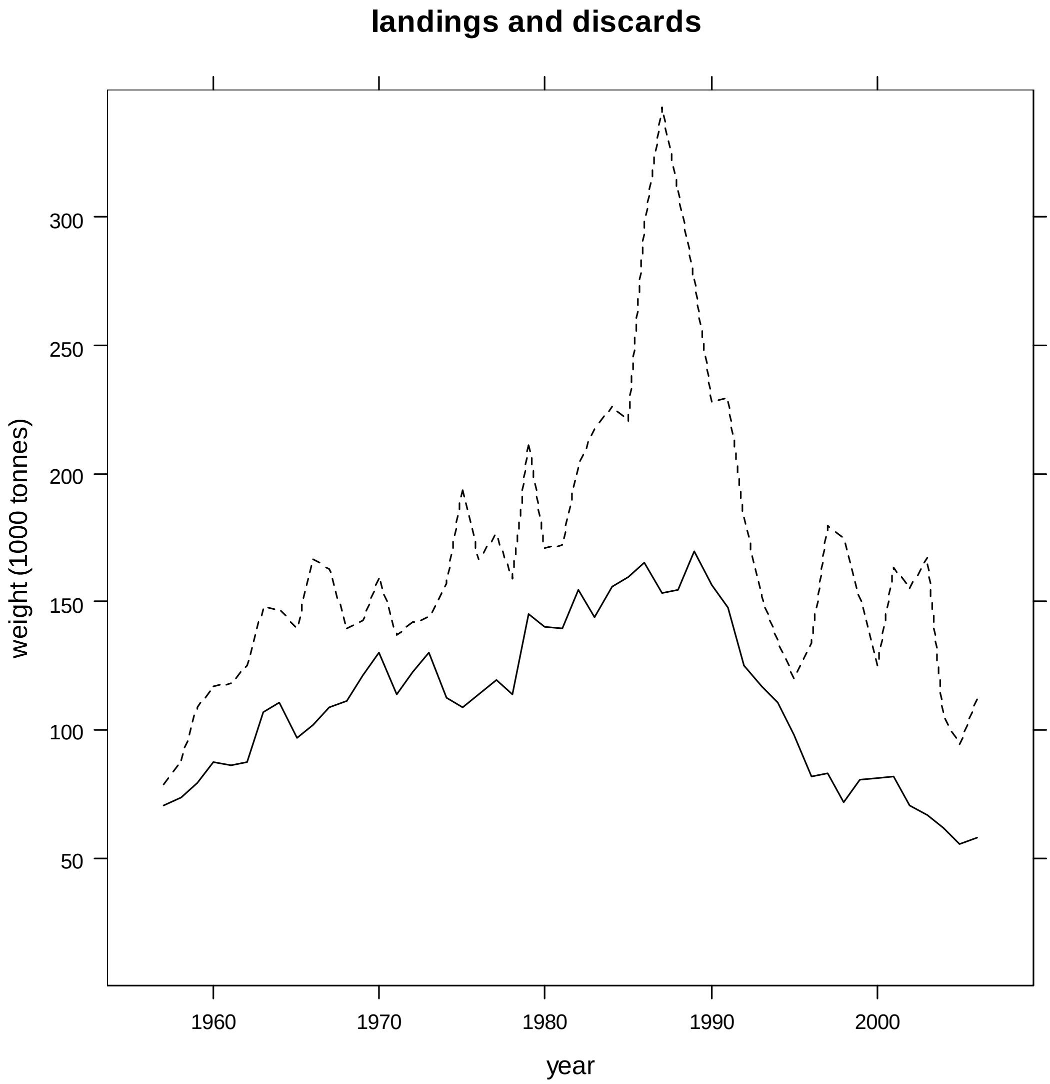


Figure 8.2.1 North Sea plaice. Time series of landings and discards estimates.

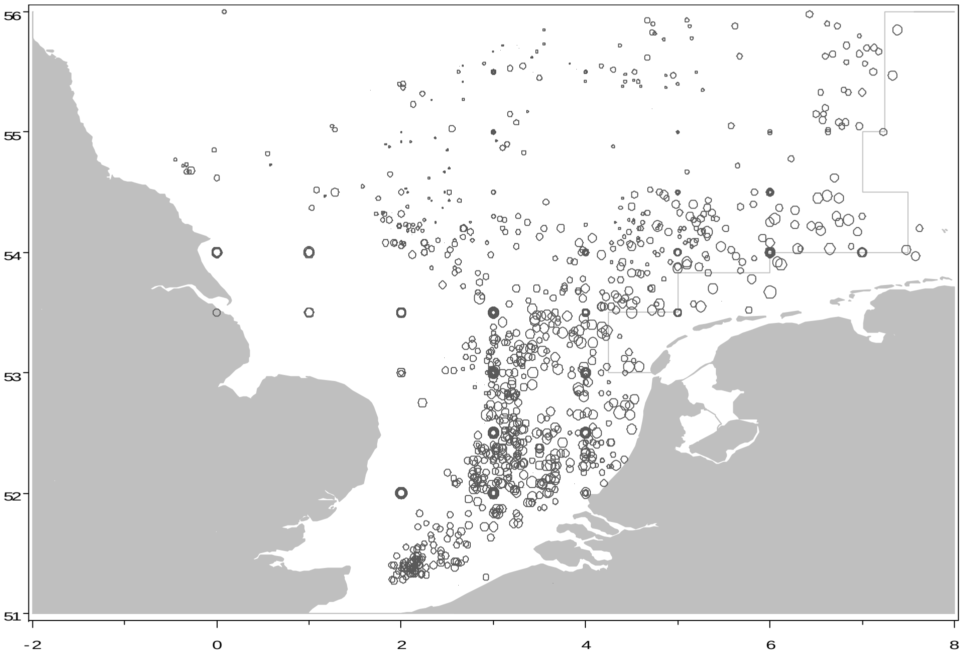
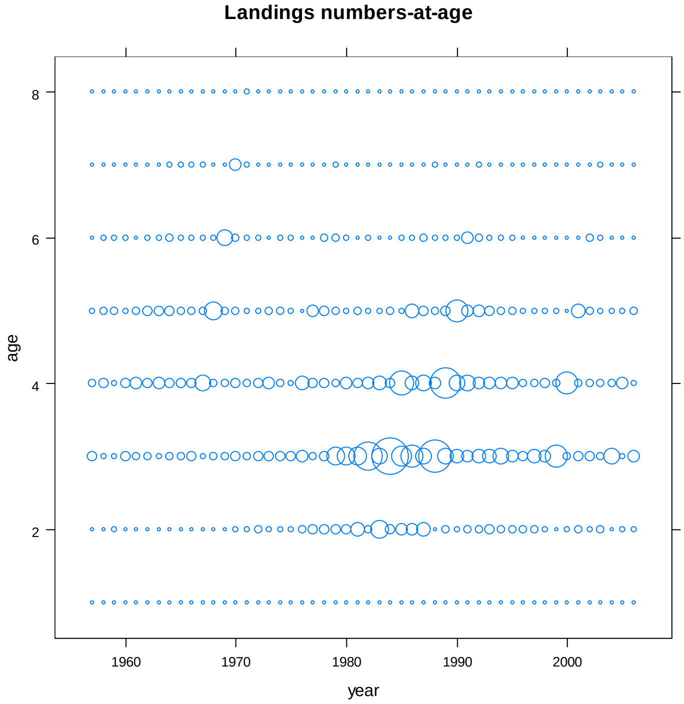


Figure 8.2.2 North Sea plaice. Spatial distribution of plaice discards (in proportion of catch volume) in the Dutch self sampling program in 2004 and 2005. Larger bubbles represent higher proportions of dicards. Source: Dekker and van Keeken 2006, CVO report C039/06, Working paper.



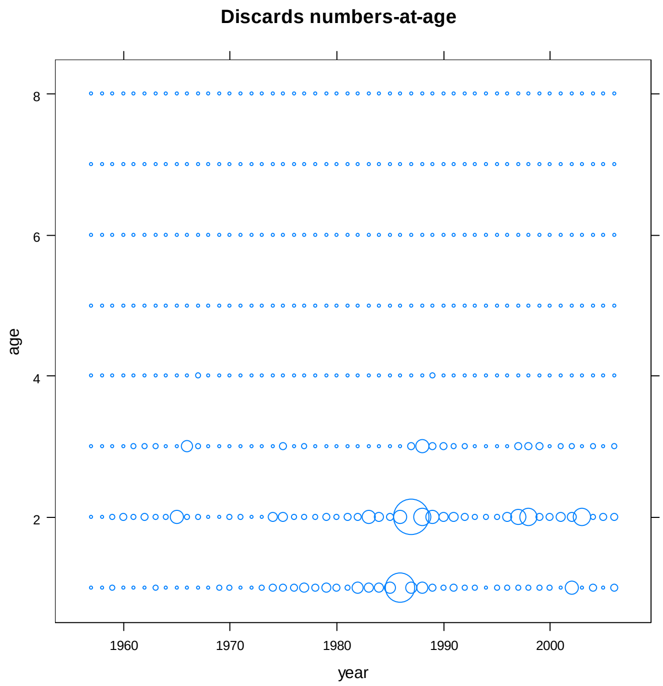


Figure 8.2.3 North Sea plaice. Landing numbers-at-age (left) and discards numbers-at-age (right).

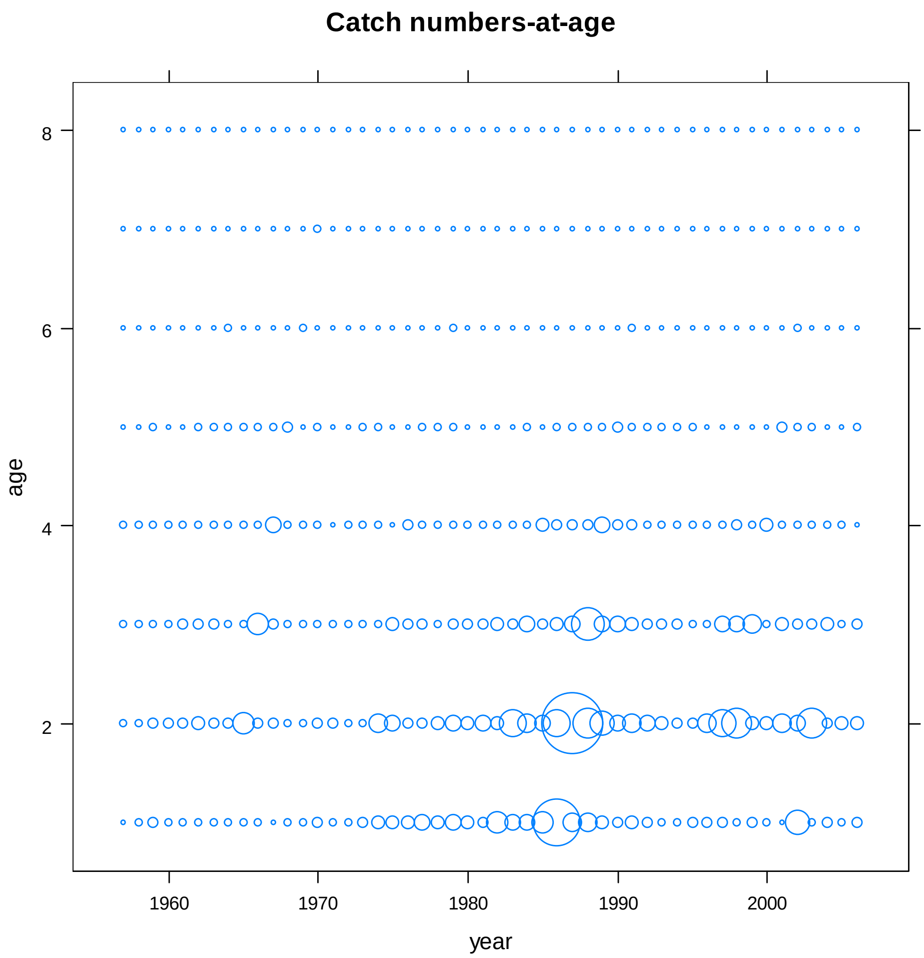


Figure 8.2.4 North Sea plaice. Catch Landing numbers-at-age.

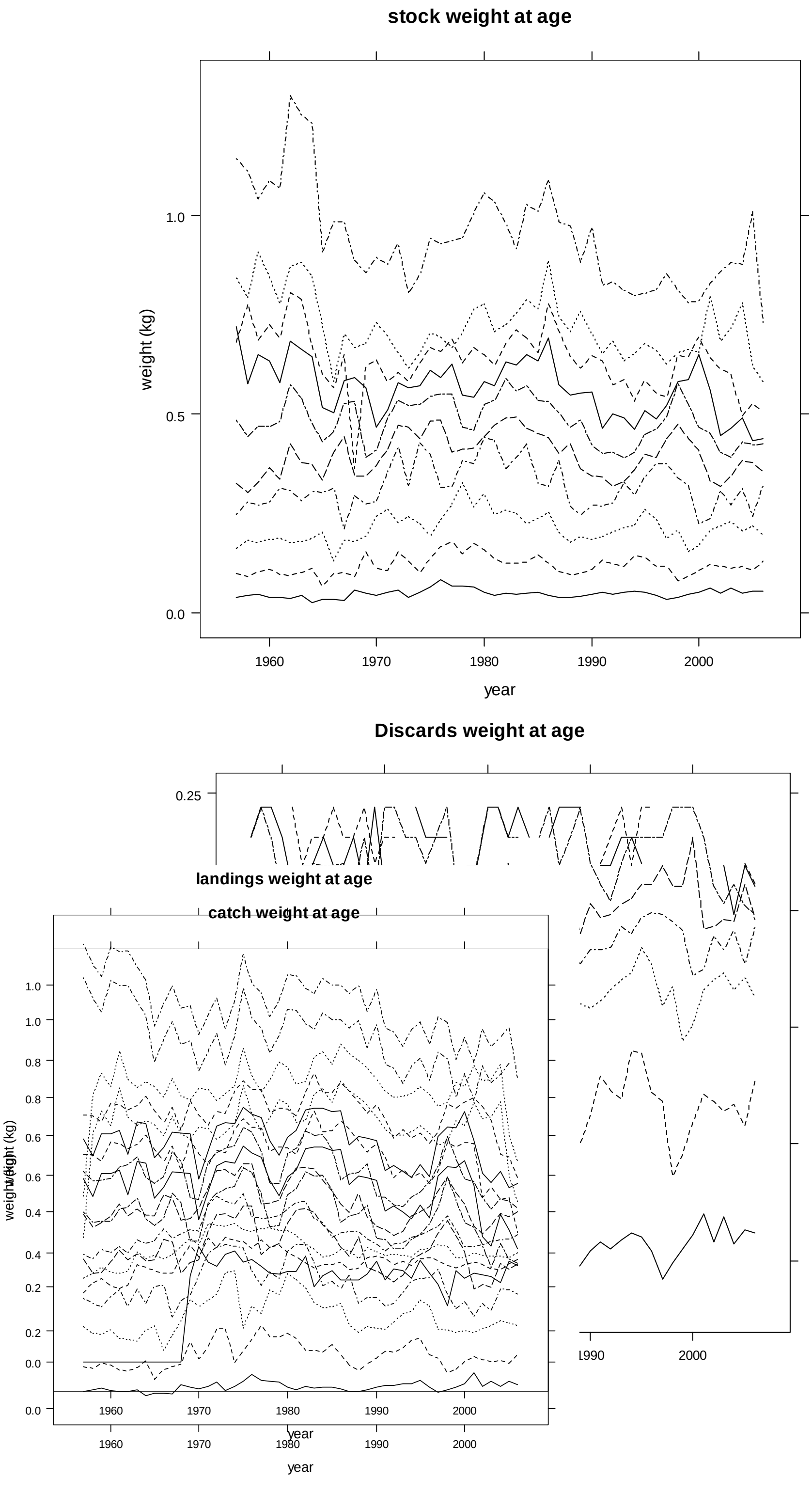


Figure 8.2.5 North Sea plaice. Stock weight-at-age (top left), discards weight-at-age (top right), landings weight-at-age (bottom left) and catch weight-at-age (bottom right)..

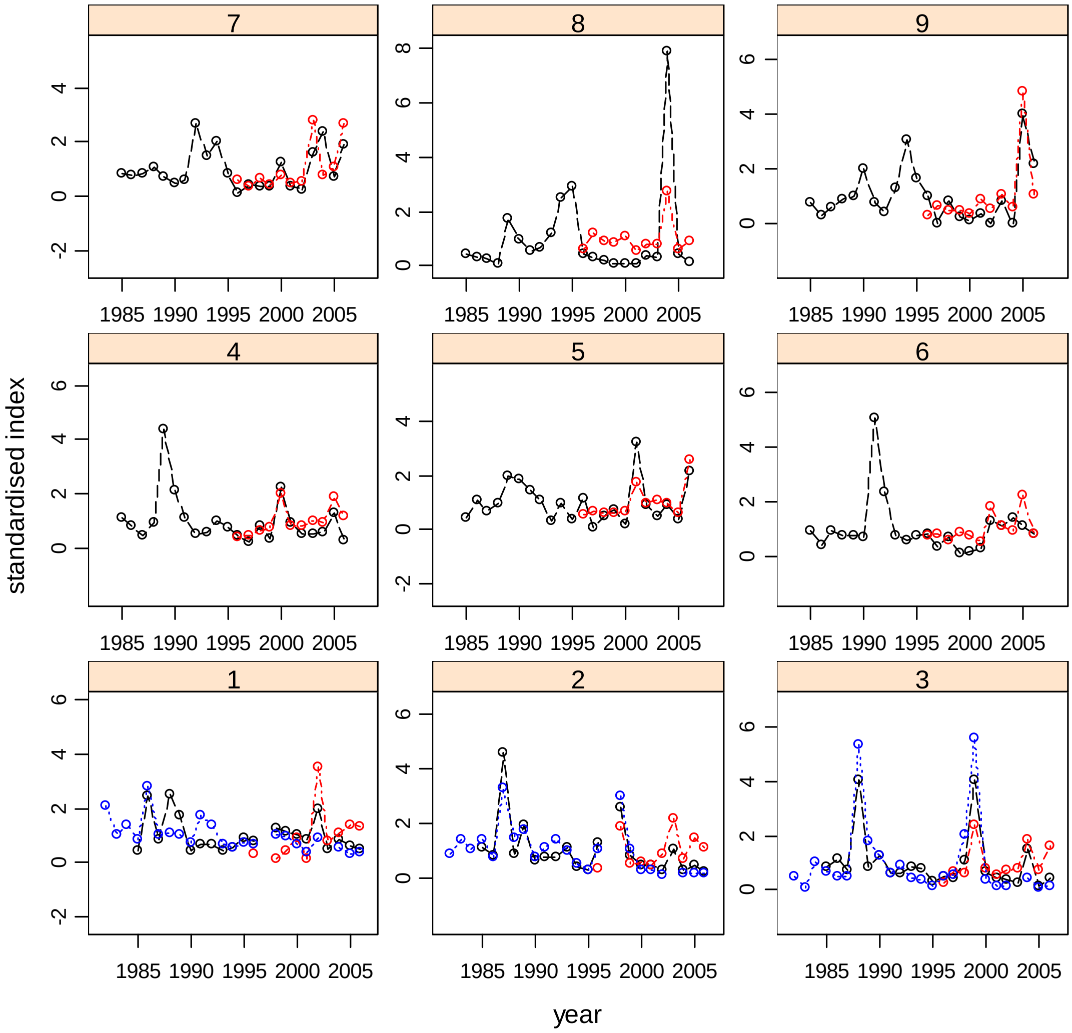


Figure 8.2.6 North Sea plaice. Standardized survey tuning indices used for tuning XSA: BTS-Isis (black), BTS-Tridens (red) and SNS (blue).

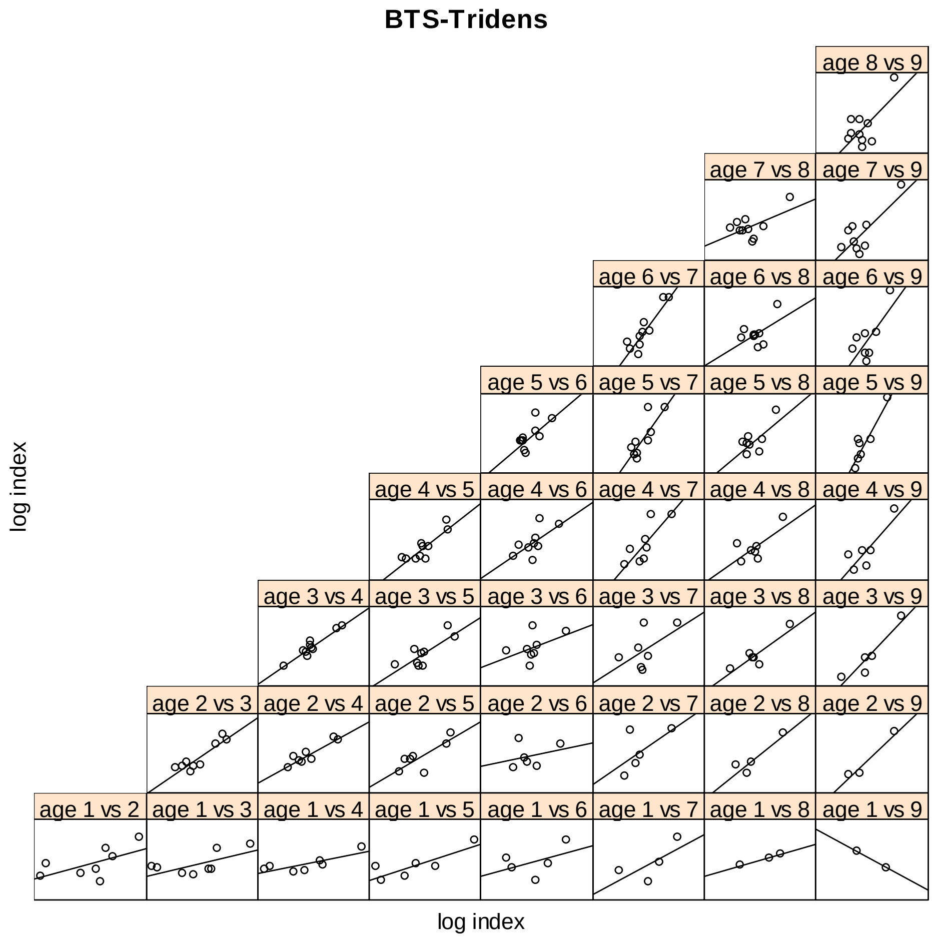


Figure 8.2.7 North Sea plaice. Internal consistency plot for the BTS-Tridens survey.

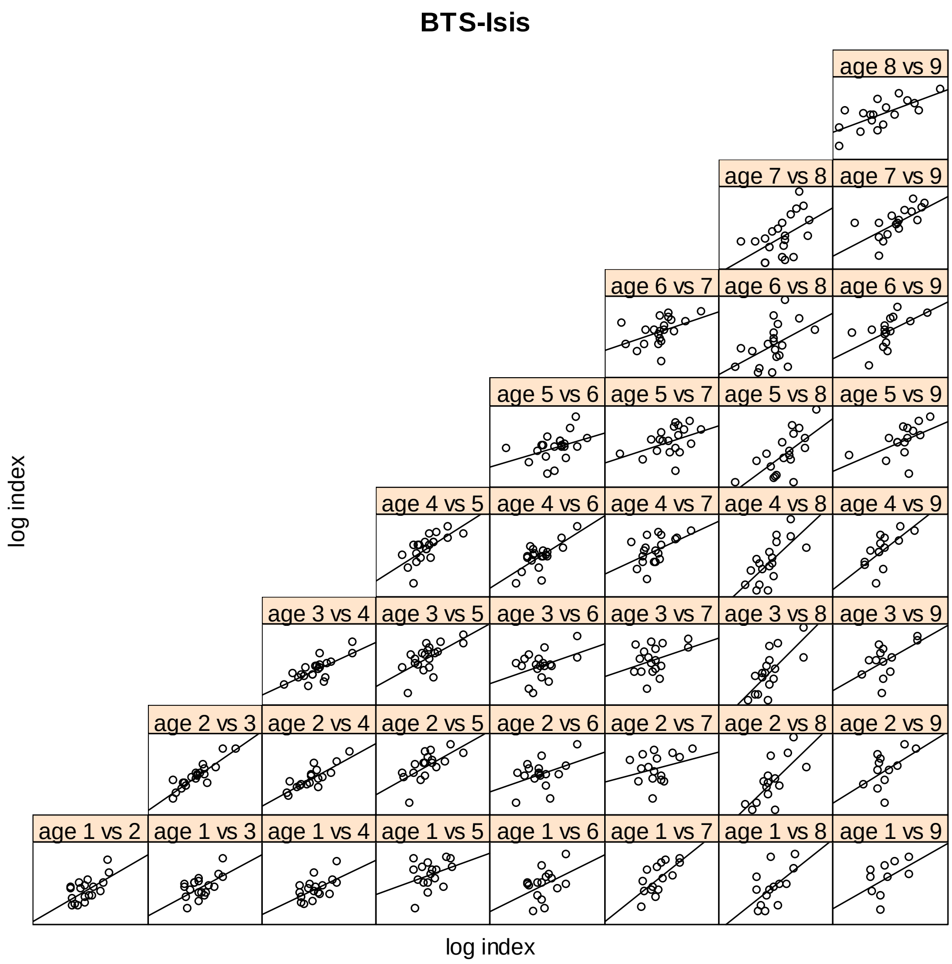


Figure 8.2.8. North Sea plaice. Internal consistency plot for the BTS-Isis survey.

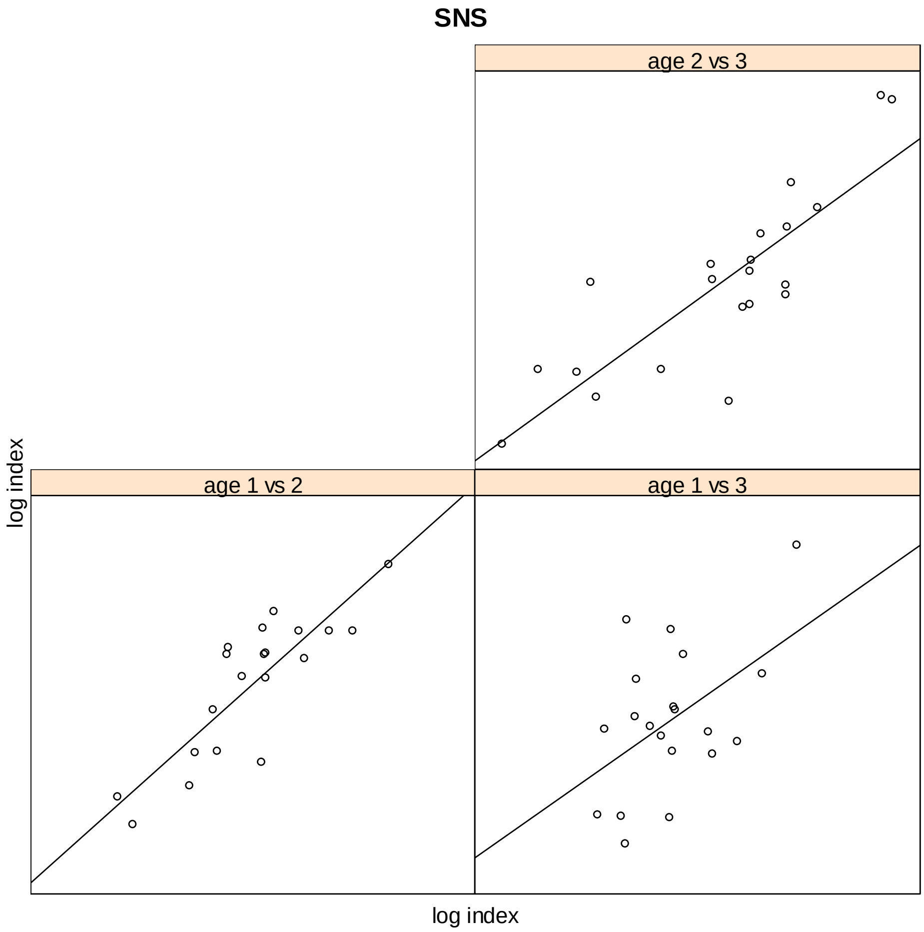


Figure 8.2.9. North Sea plaice. Internal consistency plot for the SNS survey.

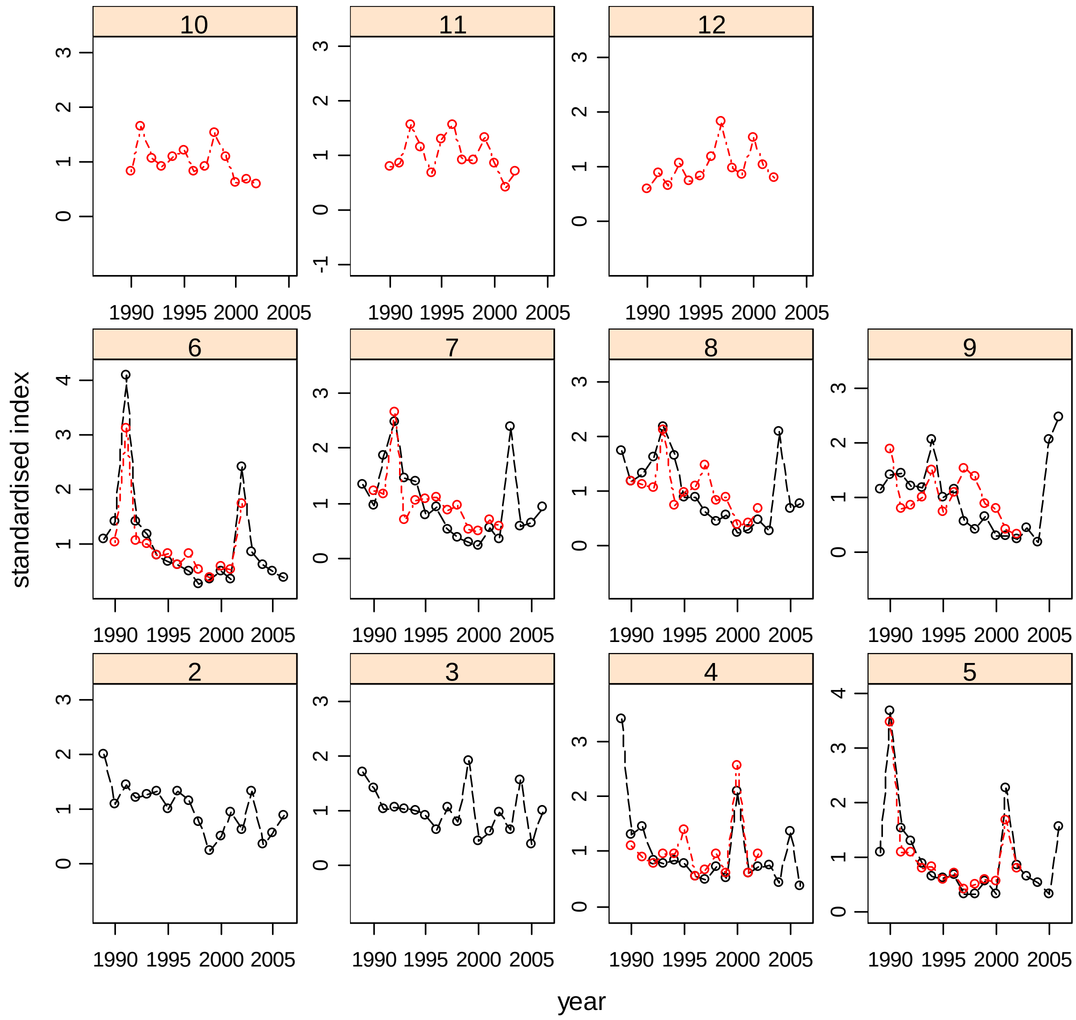


Figure 8.2.10 North Sea plaice. Standardized commercial tuning indices available for tuning: Dutch beam trawl fleet (black) and UK beam trawl fleet excluding all flag vessels (red).

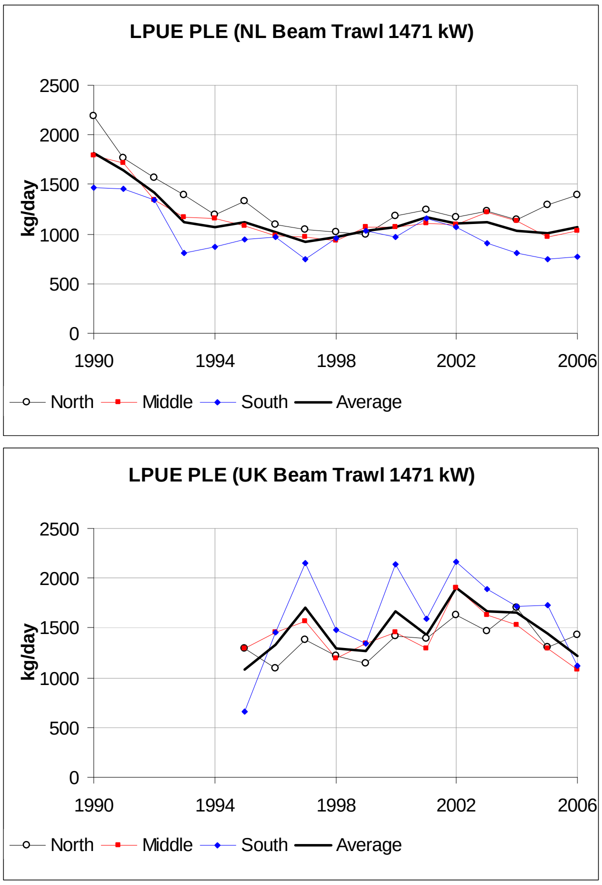


Figure 8.2.11. North Sea plaice. LPUE of the Dutch (left) and UK large trawler fleet (right), in areas north, central and south and the combined North Sea. Source: VIRIS Taken from Quirijns and Poos 2007,Working paper x

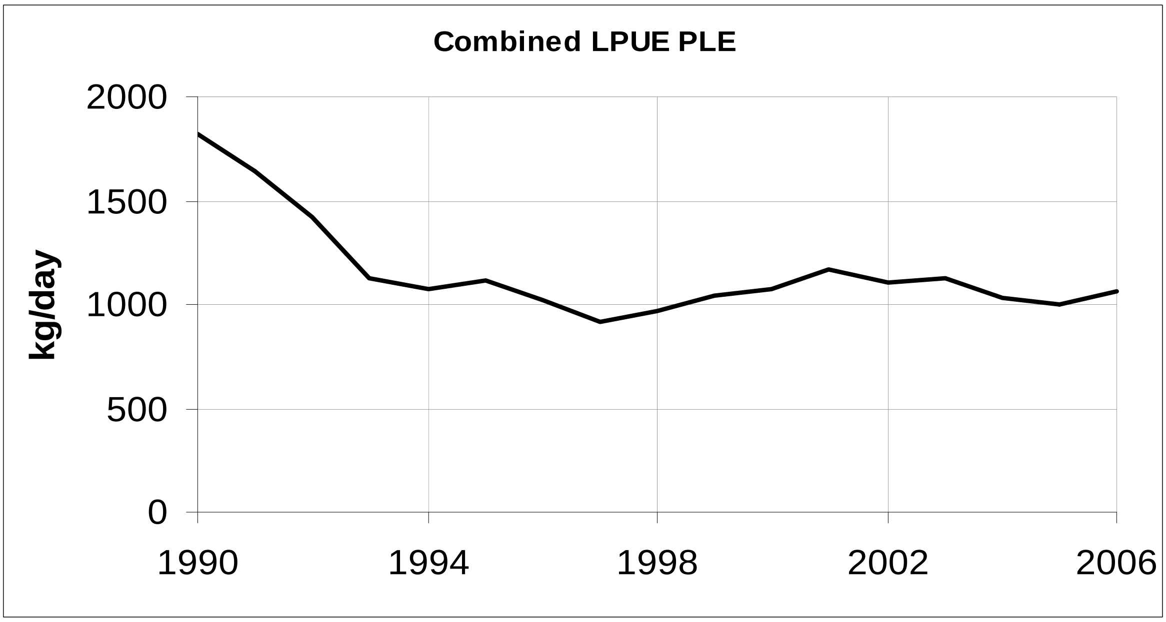


Figure Figure 8.2.12. North Sea plaice. LPUE of the Dutch large trawler fleet in the combined North Sea. Source: VIRIS Taken from Quirijns and Poos 2007,Working paper.

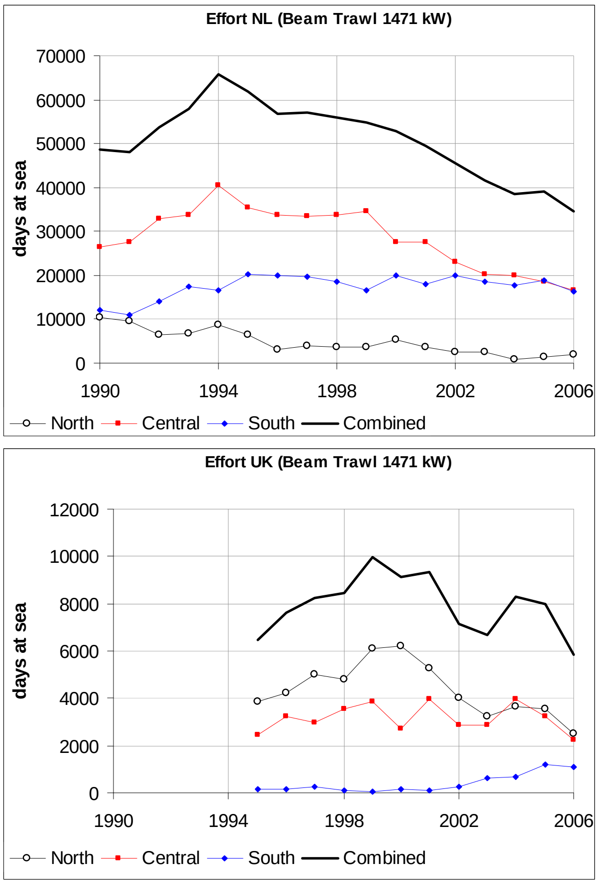


Figure 8.2.13. North Sea plaice. Effort (days at sea per 1471 kW vessel) linked to plaice catches for the Dutch fleet (left) and UK large trawler fleet (right), in areas north, central and south and the combined North Sea. Source: VIRIS. Taken from Quirijns and Poos 2007, Working paper.

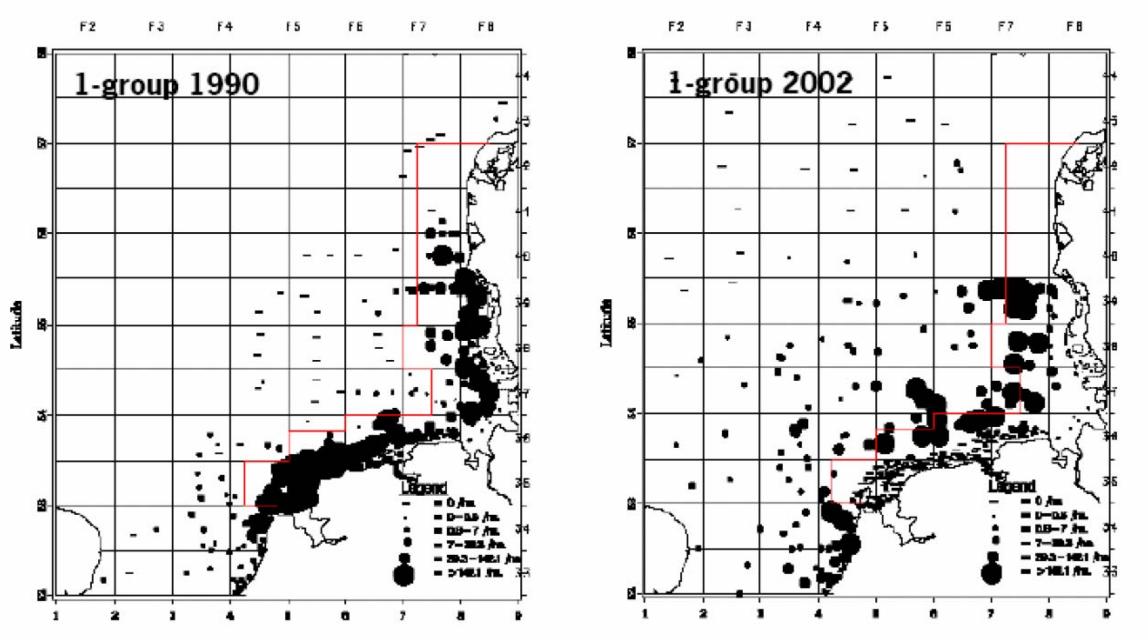


Figure 8.2.14. North Sea plaice. Spatial distribution of plaice age 1 (taken from Grift et al., 2004) in the DFS survey.

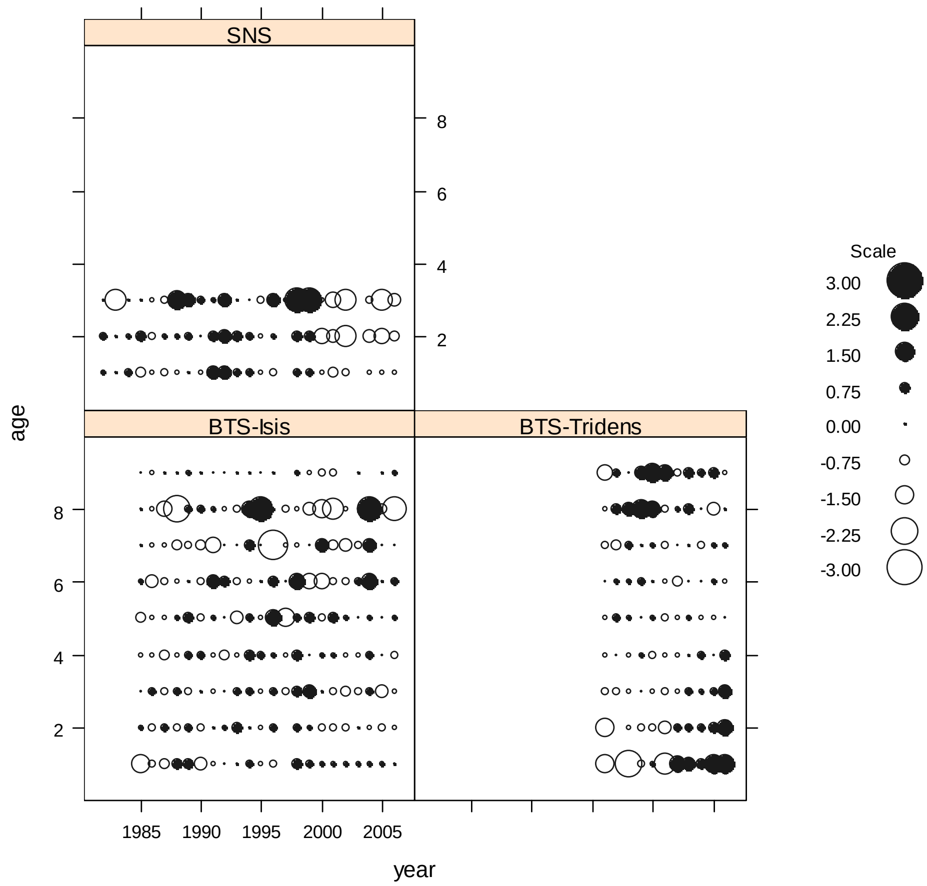
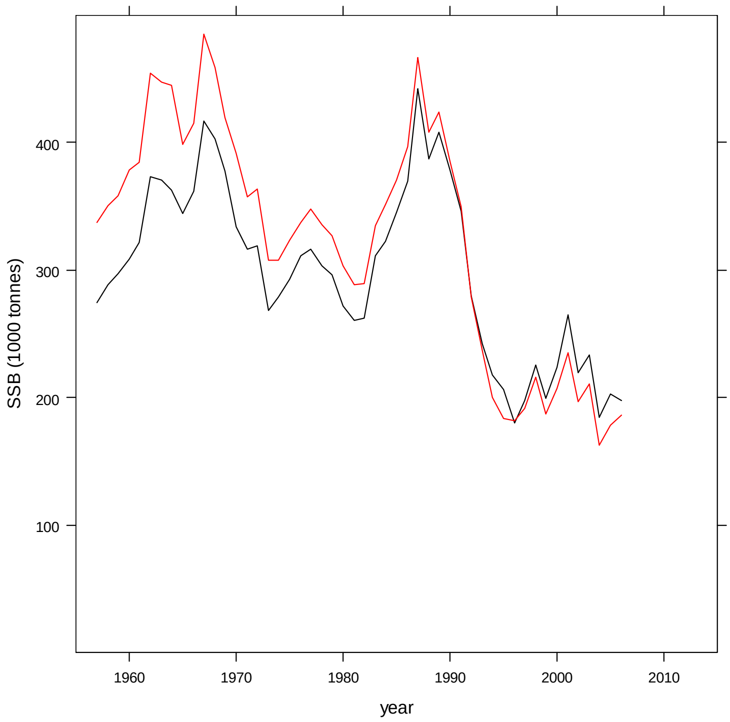


Figure 8.3.1. North Sea plaice. Log catchability residuals from an XSA run with all survey indices. SNS age range 1-3, BTS Isis age range 1-9, BTS Tridens age range 1-9.



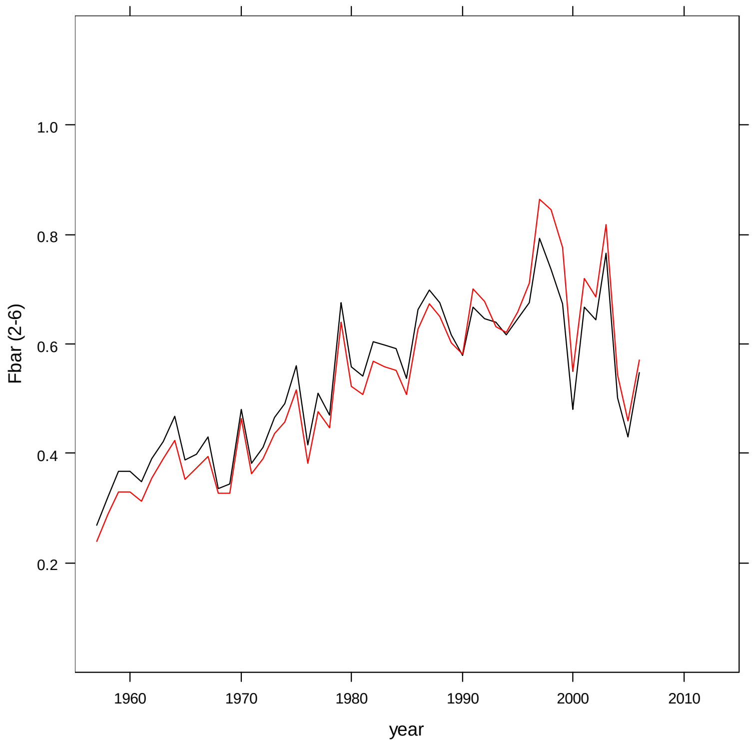
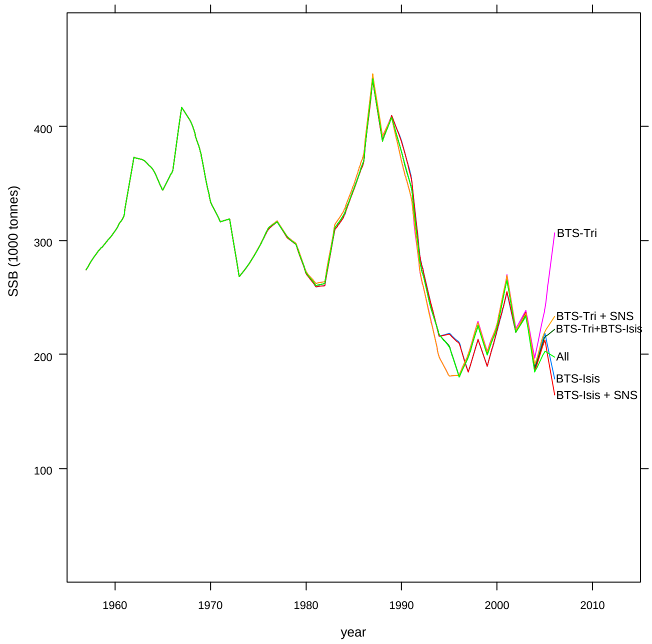


Figure 8.3.2. XSA North Sea plaice. XSA results with respect to SSB (left) and F (right) estimate for different plus group settings used in the assessment. Red line indicates plus group at age 15, black line indicates plus group at age 10.



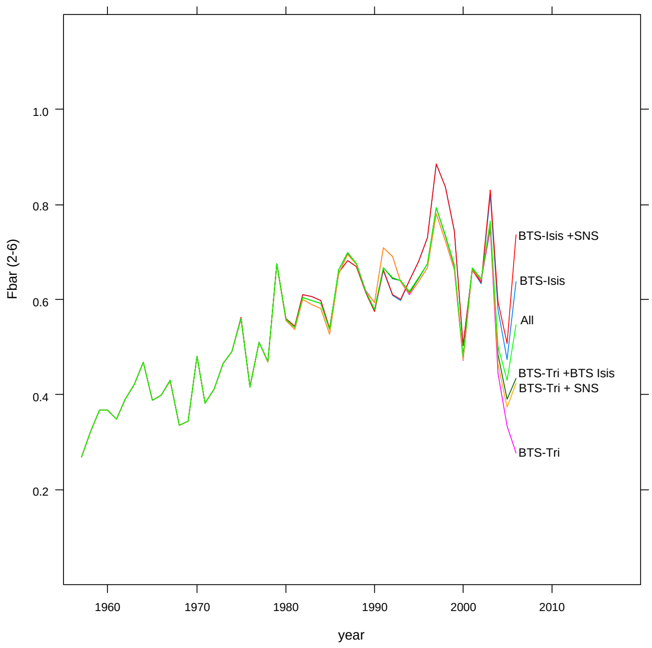


Figure 8.3.3 North Sea plaice XSA results with respect to SSB (left) and F (right) estimates for different permutations of the available survey tuning indices. XSA run with only SNS survey tuning index is omitted because no reliable SSB or F estimates are available owing to the limited age range (only ages 1-3). Labels indicate used tuning indices.

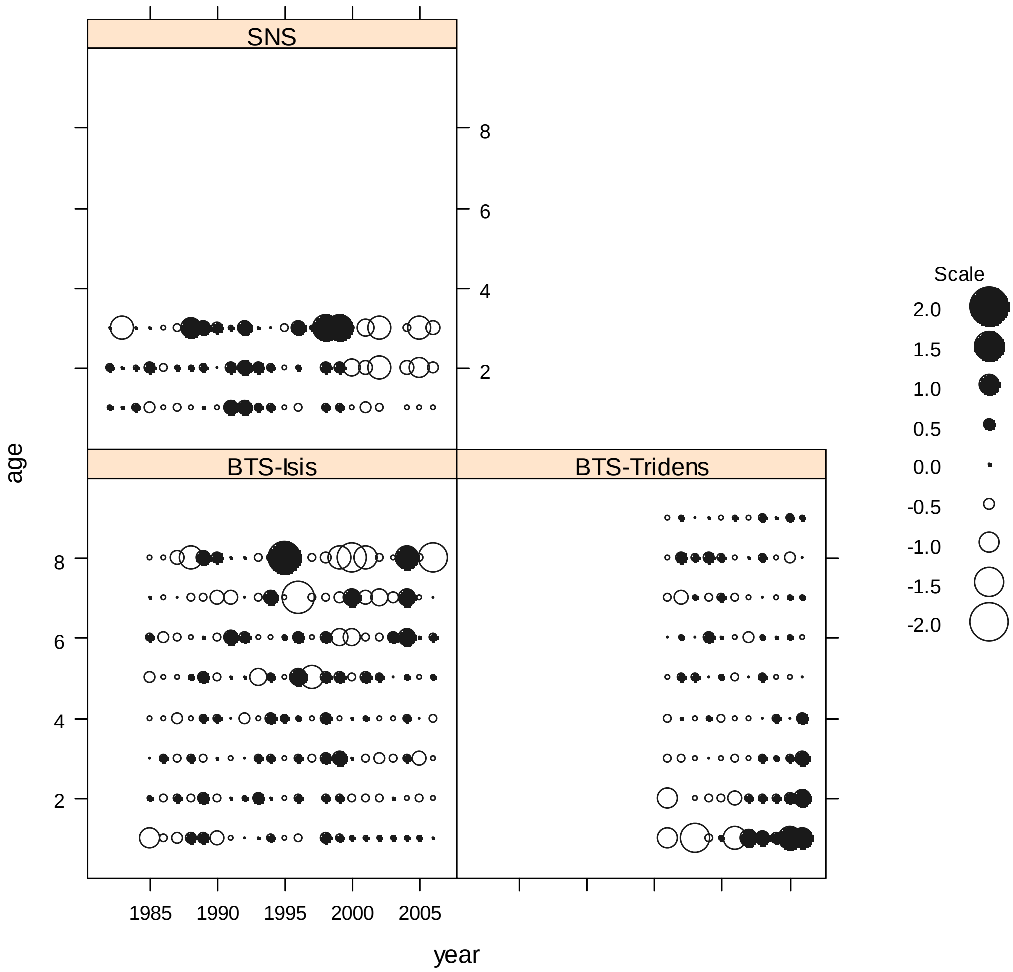


Figure 8.3.4. North Sea plaice. Log catchability residuals for the final XSA run from the three tuning series.

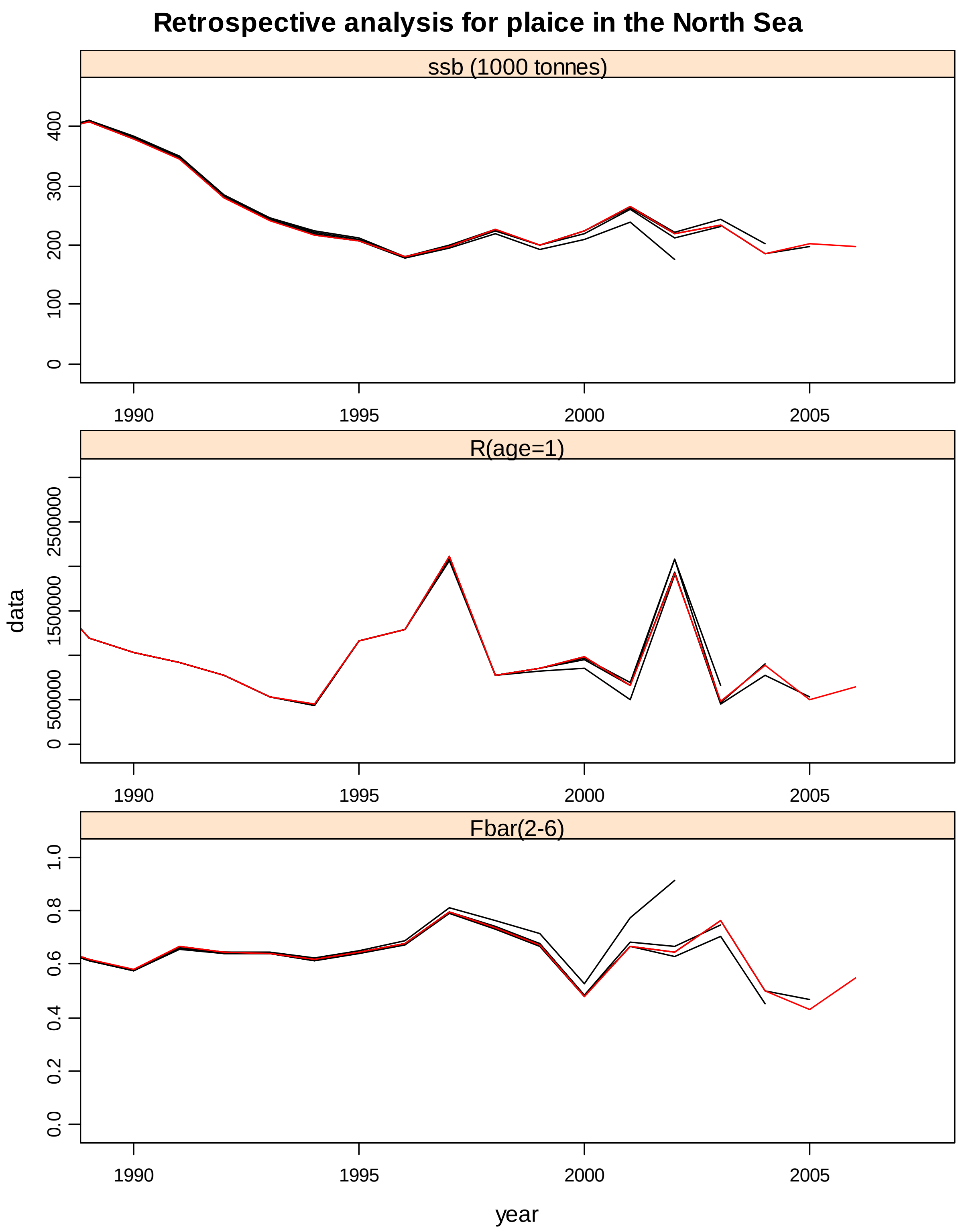


Figure 8.8.12. North Sea plaice. Retrospective pattern of the final XSA run with respect to SSB, recruitment and F.

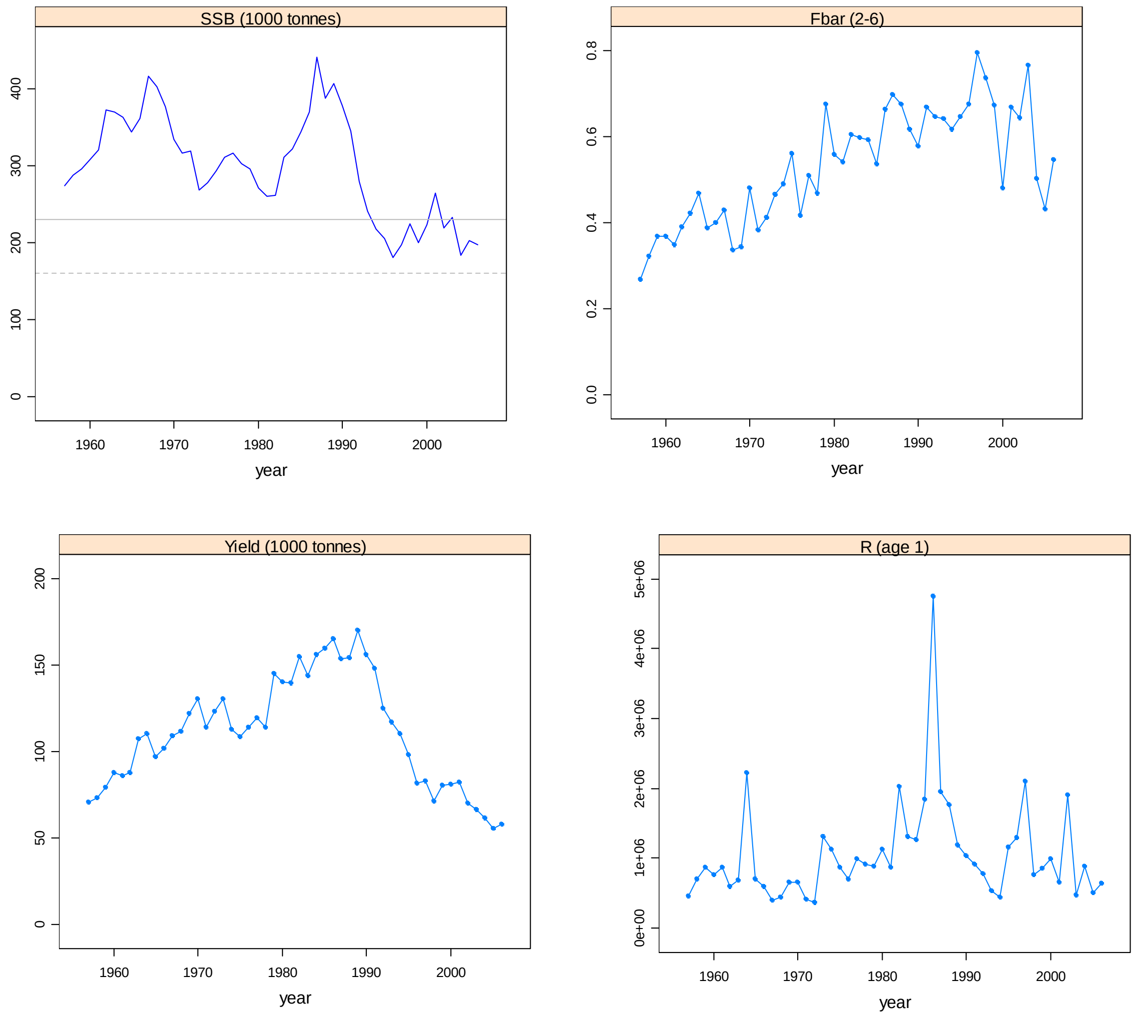


Figure 8.4.1. North Sea plaice. Stock summary figure, time series on SSB, Fishing mortality, ,recruitment at age 1 and Yield. Drawn line in top right panel indicates B_{pa} , dashed line indicates B_{lim}.

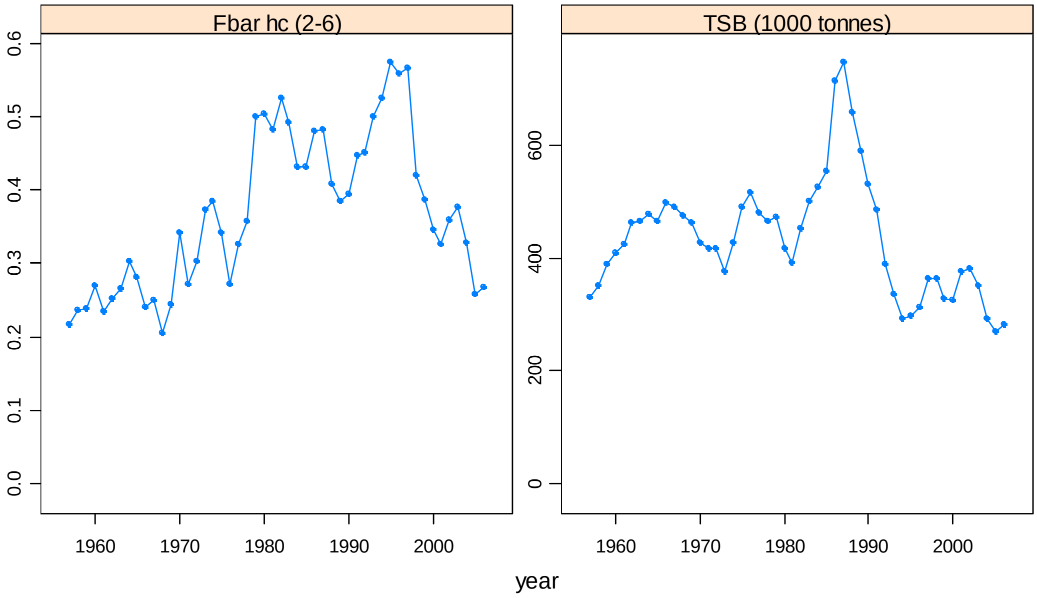


Figure 8.4.2. North Sea plaice. Stock summary figure. Time series on human consumption (left) fishing mortality and total stock biomass (right)

9 Sole in Sub-area VIId

The assessment of sole in subarea 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 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

Vaz et al. (2007) used a multivariate and spatial analyses to identify and locate sh, cephalopod, and macrocrustacean species assemblages in the eastern English Channel from 1988 to 2004 (Figure 9.1.1). Four sub-communities with varying diversity levels were identi ed in relation to depth, salinity, temperature, seabed shear stress, sediment type, and benthic community nature. One Group (class 4 in Fig.9.1.1) was a coastal heterogeneous community represented by pouting, poor cod, and sole and was classified as preferential for many flatfish and gadoids. It displayed the greatest diversity and was characterized by heterogeneous sediment type (from muds to coarse sands) and various associated benthic community types, as well as by coastal hydrology and bathymetry. It was mostly near the coast, close to large river estuaries, and in areas subject to big salinity and temperature variations. Possibly resulting from this potentially heterogeneous environment (both in space and in time), this sub-community type was the most diverse.

Community evolution over time: (From Vaz *et al*., 2007). The community relationship with its environment was remarkably stable over the 17 year of observation. However, community structure changed significantly over time without any detectable trend, as did temperature and salinity. The community is so strongly structured by its environment that it may reflect inter-annual climate variations, although no patterns could be distinguished over the study period. The absence of any trend in the structure of the eastern English Channel fish community suggests that fishing pressure and selectivity have not altered greatly over the study period at least. However, the period considered here (1988–2004) may be insufficient to detect such a trend.

Further information on ecological aspects can be found in the Stock Annex.

9.1.2 Fisheries

A detailed description of the fishery can be found in the Stock Annex.

It is likely that the high oil prices have had some impact on the fishing behavior of the Belgian and UK beam trawl fleets. For the French and UK inshore fleets however this will probably not be the case since they are constrained to the inshore areas.

For the fourth consecutive year, neither France, Belgium nor UK was able to take up their 2006 quota (see section 9.2.1).

9.1.3 ICES advice

In the advice for both 2006 and 2007 ICES considered the stock as having full reproductive capacity. For 2006 ICES classified the stock at risk of being harvested unsustainably and being harvested sustainably in 2007.

Single-stock exploitation boundaries

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 at 0.38, which is above the rate that would lead to high long-term yields and low risk of stock depletion ($F_{0.1}$ = 0.13). F_{max} (= 0.30) is not well defined. Fishing at $F_{0.1}$ is expected to lead to landings in 2007 of 2400t and SSB in 2008 of around19 000t.

Exploitation boundaries in relation to precautionary limits

The exploitation within the precautionary limits would imply landings of less than 6440 t in 2007, which is expected to lead to a 13% decrease in SSB in 2008.

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 below.

Demersal fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2007 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.

9.1.4 Management

No explicit management objectives are set for this stock.

Management of sole in VIId is by TAC and technical measures. The agreed TACs in 2006 and 2007 are 5720t and 6220t respectively. Technical measures in force for this stock are minimum mesh sizes, minimum landing size. The minimum landing size for sole is 24cm. Demersal gears permitted to catch sole are 80mm for beam trawling and 80mm for otter trawlers. Fixed nets are required to use 100mm mesh since 2002 although an exemption to permit 90mm has been in force since that time.

For 2006 Council Regulation (EC) N°51/2006 allocates different days at sea depending on gear, mesh size and catch composition. The days at sea limitations for the major fleets operating in sub-area VIId could be summarised as follow: Days at sea limitations for Trawls or Danish seines varies 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 days at sea limitations varies between 140 and 205 days.

For 2007 Council Regulation (EC) N°41/2007 allocates different days at sea depending on gear, mesh size and catch composition. The days at sea limitations for the major fleets operating in sub-area VIId could be summarised as follows: Days at sea limitations for Trawls or Danish seines varies between 95 and unlimited days per year. Beam trawlers have an unlimited number of days permit. Maximum days at sea for Gillnets vary between 130 and 140 days per year. Trammel nets are allowed a maximum of 205 days for trip length less than 24 hours; otherwise the limit is 140 days.

9.2 Data available

9.2.1 Catch

Due to minor changes in the French landings, the 2005 values were updated. Total landings now amount to 4384t instead of 4434t.

The 2006 landings used by the Working Group were 4554t (Table 9.2.1) which is 20% below the agreed TAC of 5720t and 25% below the predicted landings at a status quo fishing mortality in 2006 (6057t). The contribution of France, Belgium and the UK to the landings in 2006 is 51%, 34% and 15% respectively.

Landing data reported to ICES are shown in Table 9.2.1 together with the total landings estimated by the Working Group. As in last year's assessment, misreporting by UK beam trawlers from Division VIIe into VIId have been taken into account and corrected accordingly (see also section 9.3.1). It should be noted that historically there is also thought to be a considerable under-reporting by small vessels, which take up a substantial part of the landings in the eastern Channel. In the UK buyers and sellers registration is considered to have reduced this significantly since 2005. Substantial progress has been made in recent years by including all return rates of the small vessels.

Recent discard estimates are available for the UK and French static gear (Figure 9.2.1a-b). Numbers are raised to the sampled trips. It should be noted that the number of sampled trips is low. Discard from the Belgian beam trawler fleet could not be processed in time for the working group due to the shift of the working group to an earlier time in the year. The data will be available later in the year when time permits to compile the data.

The available information suggests that discards are not a substantial part of the catch for this high valued species. The Working Group therefore decided not to include discards in the assessment at this stage but future information will be monitor.

Sampling levels for those countries providing age compositions will be provided in the September report.

9.2.2 Age compositions

Quarterly data for 2006 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 catch is presented in Table 9.2.3 and weight at age in the stock in Table 9.2.4. The procedure for calculating mean weights is described in the Stock Annex.

9.2.4 Maturity and natural mortality

As in previous assessments, a knife-edged maturity-ogive was used at age 3.

Natural mortality are assumed at fixed values (0.1) for all ages in time.

9.2.5 Catch, effort and research vessel data

Available estimates of effort and LPUE are presented in Tables 9.2.5a,b and Figures 9.2.2a-c. Effort for the Belgian beam trawl fleet increased to a highest level in 2003 Although effort has decreased in the last 3 years, it is still close to the highest value in the time series. The UK (E&W) beam trawl fleet effort has increased from the late 80's, reaching its peak in 1997. Since then, effort has decreased and fluctuated around 60% of its peak level. At this Working Group information has been provided on effort and LPUE from the recent period of the French fleets in the Eastern Channel. This short data series will be extended historically and for recent years and therefore will provide information on the trends in the main French fisheries.

The Belgian LPUE has been fluctuated around the mean with no strong trend until recently when catch rates have been increasing consistent with the UK beam trawl fleet. The recent time series of the French beam trawl LPUE has been decreasing and GTR has remained stable.

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 RG noted that landings have been corrected for misreporting by area (from VIIe into VIId) and requested some clarification. In 2002 the UK(E&W) beam trawl landings from two rectangles 28E8 and 29E8 (in VIId) were re-allocated to VIIe on a quarterly basis, (based on information provided to the Working Group by the fishing industry) and the age compositions raised accordingly. This was done back to 1986. For VIId sole, UK(E&W) beam trawl and trawl data are processed together (as trawl), so the landings from these two rectangles were removed from the trawl data on a quarterly basis, and the age compositions adjusted to take that into account.

The RG noted that last year there was information from some observed trips where discarding up to 40% in numbers have been measured. However discards were not taken into account in the assessment. Although the Working Group was aware of the discard practices taking place on some discard trips in 2005. This practice could not be evaluated in 2006 as no blinkers were used on the observer trips in that year. The other information available for 2006 (Figure 9.2.1a-b) suggest, as in previous years that discards for sole in ICES subdivision VIId are not substantial and therefore discards are not incorporated in the assessment. Although the observed discarding at age 1 will not affect the assessment substantialy, they will have an impact on forecasts, but the low level of discards are not considered a significant factor in catch forecasts.

The RG noted that the stock structure remains unclear and as for plaice, there is a need to clarify the link between all adjacent areas (from Kattegat to English Channel). The Working Group will address this issue in the future if information becomes available.

The RG found that the estimate of survivors at ages 1-2 given by the two surveys were inconsistent and details on these surveys should be provided in order to better understand this inconsistency. The Working Group has incorporated in the Stock Annex a map of the potential nursery habitat used to raise the Young Fish international indices (France and UK). The Working Group however questioned the use of the word inconsistent for survivor estimates as the difference in survivor estimates between the 2 surveys estimates and the final survivor estimates are 27% at age 1 and 13% at age 2 in this years assessment (Table 9.3.1). A plot of the time series of age 1 index for both surveys are presented in Figure 9.3.1, indicating that both surveys have tracked year class strength rather well in recent years. Historically however they showed more variability. The RG also asked if the age 0 of the YFS was used in RCT3, which is the case.

As the variability in the estimated weights at age may influence the short term forecast, the RG questioned the use of a recent 3 year average for catch- and stockweights in short-term predictions. The Working Group notes that the difference between a 3-year average and a 5-year is minimal. Apart from a 10% difference for age 9 in the stockweights, the difference for all ages are less than 5% and therefore the WG decided to continued the use of a 3-year average as input for the predictions both for catch- and stockweights in order to allow the most recent estimates of weight at age to be used in the forecast.

9.3.2 Exploratory catch at age analysis

Catch at age analysis was carried out according to the specifications in the Stock Annex. The model used was XSA. The results of exploratory XSA runs, which are not included in this report, are available in ICES files.

A preliminary inspection of the quality of international catch-at-age data was carried out using separable VPA with a reference age of 4, terminal F=0.5 and terminal S=0.8. As last year, the log-catch ratios for the fully recruited ages (3-10) did not show any patterns or large residuals (in ICES files).

The tuning data were examined for trends in catchability by carrying out XSA tuning runs (lightly shrunk (se=2.0), mean q model for all ages, full time series and un-tapered), using data for each of the four fleets individually (in ICES files). Apart from the first few year's in the Belgian series (1982-1985, which were excluded from the analyses, as in previous assessments), there were no strong trends for any of the fleets. The Belgian beam trawl fleet had a somewhat noisier log catchability residual pattern, especially for age 2 and age 11. Year effects were noted for the UK(E&W) beam trawl fleet (UK-BT) in 2000. The UK(E&W) beam trawl survey (UK-BTS) showed year effects for 3 consecutive year (1999, 2000 and 2001).

The catchability residuals for the proposed final XSA are shown in Figure 9.3.2 and the XSA tuning diagnostics are given in Table 9.3.1.

In general, estimates between fleets are consistent for ages 2 and above (Figure 9.3.3). For age 1, 97% of the survivors estimates are coming from the surveys (Young fish survey (YFS) and UK(E&W) beam trawl survey giving 80% and 17% respectively of the weighting). At age 2, the strong 2004 year-class is estimated very consistent by surveys and commercial fleets. F shrinkage gets low weights for all ages (< 4%). The weighting of the 2 surveys decreases for the older ages as the commercial fleets are given more weight (Figure 9.3.3).

9.3.3 Exploratory survey-based analyses

Two years ago, 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.

In this update assessment Surba runs were not executed.

9.3.4 Conclusion drawn from exploratory analyses

The XSA analyses was taken as the final assessment, giving mostly consistent survivor estimates between fleets for all ages. The estimates of recruiting age 1 (year class 2005) are for both surveys above average values in the time series, indications of an above average 2005 year class (Figure 9.3.3).

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:

	2006 assessment			2007 assessment		
Fleets	Years	Ages	α-β	Years	Ages	α-β
BEL-BT commercial	86-05	2-10	0-1	86-06	2-10	0-1
UK-BT commercial	86-05	2-10	0-1	86-06	2-10	0-1
UK-BTS survey	88-05	1-6	0.5-0.75	88-06	1-6	0.5-0.75
YFS - survey	87-05	1-1	0.5-0.75	87-06	1-1	0.5-0.75

	2006 assessment	2007 assessment
-First data year	1982	1982
-Last data year	2005	2006
-First age	1	1
-Last age	11+	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 9.3.4.

Retrospective patterns for the final run are shown in Figure 9.3.5. There is good consistency between estimates in successive years.

9.4 Historical Stock Trends

Trends in landings, SSB, F(3-8) and recruitment are presented Table 9.3.4 and Figure 9.3.4.

For most of the time series, fishing mortality has been fluctuating between Fpa (0.4) and Flim (0.57). In the early 90's it dropped below Fpa. Since 1999 it decreased steadily from 0.59 to around 0.4 in 2002 after which it remained stable.

Recruitment has fluctuated around 27 million recruits with occasional strong year classes. The two highest values in the time series have been recorded in the last 5 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

The 2004 year class in 2005 was confirmed by XSA to be around average with 62 million fish at age 1 which is the highest in the time series. 98% of the weight estimate comes from the tuning fleets, giving rather similar results. The XSA survivor estimates for this year class were used for further prediction.

The 2005 year class in 2006 was estimated by XSA to be 38 million one year olds. 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, 1982-2004) was assumed for the 2006 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 hardly 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 and an above average 2005 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 82-04	RCT3	Accepted Estimate
2004	3	43961	15802	-	XSA
2005	2	33624	20529	25639	XSA
2006	1	-	23169	21656	GM 1982-04
2007 & 2008	recruits	-	23169	-	GM 1982-04

9.6 Short term forecasts

The short term prognosis was carried out according to the specifications in the stock annex. As fishing mortality has remained stable in the last six years. Therefore the selection pattern for prediction has been taken as a 3 year unscaled average. Weights at age in the catch and in the stock are averages for the years 2004-2006.

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 2007 of 6160t (the agreed TAC is 6220t) and a catch of 6070t in 2008. Assuming *status quo* F will result in a SSB in 2008 and 2009 of 17490t and 15560t respectively.

Assuming *status quo* F, the proportional contributions of recent year classes to the landings in 2008 and SSB in 2009 are given in Table 9.6.4. The assumed GM recruitment accounts for 10 % of the landings in 2008 and 19 % of the 2009 SSB. The 2004 year class is estimated to contribute 50% of the SSB in 2007 and 30% in 2009.

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 2008 are 4750t and 7500t. There is a less than 5% probability that at current fishing mortality SSB will fall below the B_{pa} of 8000t in 2009.

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 2007, are given in Table 9.7.1 and Figure 9.7.1. F_{max} is estimated to be 0.30 (0.36 = F_{sq}).

9.8 Biological reference points

		Basis
Flim	0.55	Fishing mortality at or above which the stock has shown continued decline.
Fpa	0.40	F is considered to provide approximately 95% probability of avoiding Flim
Blim	-	Not defined
Bpa	8000	Lowest observed biomass at which there is no indication of impaired recruitment.
Fmax	0.30	
F2006	0.36	
Fsq	0.36	

9.9 Quality of the assessment

Sampling for sole landings in division VIId are considered to be at a reasonable level.

Information available on discards for 2006 suggest, as in previous years that discards are not substantial and therefore discards are not incorporated in the assessment. Although the observed discarding at age 1 will not affect the assessment substantially, they will have an impact on forecasts, but the low level of discards are not considered a significant factor in catch forecasts.

The trends and estimates of fishing mortality, SSB and recruitment were consistent with last year's assessment.

Except year class 2002, all year classes from 1998 to 2004 are estimated to be at or above long term 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 and two commercial fleets.

There is no apparent stock/recruitment relationship for this stock and no evidence of reduced recruitment at low levels of SSB (Figure 9.9.1).

The historical performance of this assessment is rather noisy (Figure 9.9.2) but has been more constant in recent years.

9.10 Status of the Stock

Fishing mortality has been stable for the last 6 years just below 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 accordingly.

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 due to the strong 2004 year class.

EU Council Regulation (EC) N°41/2007 allocates different days at sea depending on gear, mesh size and catch composition. The days at sea limitations for the major fleets operating in sub-area VIId could be summarised as follows: Days at sea limitations for Trawls or Danish seines varies between 95 and unlimited days per year. Beam trawlers have an unlimited number of days permit. Maximum days at sea for Gillnets vary between 130 and 140 days per year. Trammel nets are allowed a maximum of 205 days for trip length less than 24 hours; otherwise the limit is 140 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	244	4384	5700
2006	1532	2284	669		4485	69	4554	5720

* Unallocated mainly due misreporting

** 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 - 2007WG - Sol7d.txt

At 4/05/2007 12:02

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1982	1983	1984	1985	1986
AGE					
1	155	0	24	49	49
2	2625	852	1977	3693	1251
3	5256	3452	3157	5211	5296
4	1727	3930	2610	1646	3195
5	570	897	1900	1027	904
6	653	735	742	1860	768
7	549	627	457	144	1056
8	240	333	317	158	155
9	122	108	136	156	190
10	83	89	99	69	212
+gp	202	193	238	128	372
0 TOTALNUM	12182	11216	11657	14141	13448
TONSLAND	3190	3458	3575	3837	3932
SOPCOF %	97	99	99	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
1	9	95	163	1245	383	105	85	31	838	9
2	3117	2162	3484	2851	7166	4046	5028	694	2977	1825
3	3730	7174	3220	5580	4105	8789	6442	6203	4375	7764
4	3271	1602	4399	1151	4160	1888	5444	5902	4765	3035
5	2053	1159	1434	1496	604	1993	1008	3404	2968	3206
6	1042	856	840	301	996	288	563	584	1980	1823
7	1090	388	571	390	257	368	162	567	375	1283
8	784	255	201	260	247	135	188	109	278	271
9	111	256	166	129	258	171	116	147	88	319
10	163	83	224	126	92	95	62	93	106	112
+gp	459	275	282	489	382	231	129	258	241	344
0 TOTALNUM	15829	14305	14984	14018	18650	18109	19227	17992	18991	19991
TONSLAND	4791	3853	3805	3647	4351	4072	4299	4383	4420	4797
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
AGE										
1	24	33	168	138	168	707	379	1030	206	541
2	1489	1376	3268	3586	6042	7011	10957	4254	3468	6805
3	6068	5609	8506	4852	6194	7513	5086	8623	4034	3562
4	5008	2704	3307	4395	1595	3767	3178	2545	5458	2671
5	2082	1636	1311	1076	2491	1414	1805	2272	1543	3247
6	1670	609	869	505	728	655	671	1108	1143	1056
7	916	558	350	319	290	298	588	371	633	764
8	775	441	672	148	128	129	198	448	218	384
9	239	354	351	328	56	97	70	94	283	184
10	169	239	192	150	81	57	88	88	127	196
+gp	267	301	359	248	265	197	245	233	271	292
0 TOTALNUM	18707	13860	19353	15745	18038	21845	23265	21066	17384	19702
TONSLAND	4764	3363	4135	3476	4025	4733	5038	4826	4383	4554
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 9.2.3 - Sole VIId - Catch weights at age (kg)

Run title : Sole in VIId - 2007WG - Sol7d.txt

At 4/05/2007 12:02

Table 2 Catch weights at age (kg)

	YEAR	1982	1983	1984	1985	1986
	AGE					
	1	0.102	0	0.1	0.09	0.135
	2	0.171	0.173	0.178	0.182	0.18
	3	0.225	0.23	0.234	0.23	0.212
	4	0.312	0.302	0.314	0.281	0.306
	5	0.386	0.404	0.38	0.368	0.363
	6	0.428	0.436	0.436	0.394	0.387
	7	0.439	0.435	0.417	0.516	0.437
	8	0.509	0.524	0.538	0.543	0.52
	9	0.502	0.537	0.529	0.594	0.502
	10	0.463	0.583	0.565	0.595	0.523
	+gp	0.6729	0.6283	0.7135	0.8005	0.6015
0	SOPCOFAC	0.9713	0.991	0.9884	0.998	1.0006

Table 2 Catch weights at age (kg)

	YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
	AGE										
	1	0.095	0.102	0.106	0.12	0.114	0.103	0.085	0.099	0.129	0.142
	2	0.175	0.152	0.154	0.178	0.161	0.153	0.147	0.15	0.176	0.165
	3	0.236	0.226	0.192	0.238	0.208	0.203	0.197	0.186	0.179	0.178
	4	0.295	0.278	0.271	0.289	0.266	0.267	0.247	0.235	0.23	0.229
	5	0.353	0.36	0.293	0.349	0.354	0.29	0.335	0.288	0.255	0.269
	6	0.407	0.409	0.358	0.339	0.394	0.403	0.384	0.355	0.333	0.324
	7	0.411	0.459	0.388	0.47	0.421	0.391	0.537	0.381	0.357	0.361
	8	0.482	0.514	0.472	0.465	0.43	0.462	0.553	0.505	0.385	0.405
	9	0.465	0.553	0.515	0.487	0.434	0.459	0.515	0.484	0.49	0.435
	10	0.538	0.563	0.547	0.518	0.478	0.463	0.766	0.496	0.494	0.465
	+gp	0.6176	0.6647	0.7014	0.5621	0.5656	0.5661	0.6666	0.6156	0.6536	0.5854
0	SOPCOFAC	1.0004	1.0001	0.9994	0.9995	1.0001	1.0001	1.0002	1.0001	0.9997	0.9999
	1										

Table 2 Catch weights at age (kg)

	YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
	AGE										
	1	0.139	0.132	0.13	0.145	0.108	0.12	0.114	0.12	0.135	0.139
	2	0.153	0.159	0.151	0.142	0.152	0.162	0.17	0.179	0.172	0.162
	3	0.188	0.172	0.189	0.176	0.211	0.204	0.208	0.205	0.208	0.192
	4	0.233	0.235	0.215	0.223	0.283	0.253	0.257	0.255	0.253	0.248
	5	0.292	0.286	0.26	0.332	0.288	0.316	0.277	0.296	0.303	0.284
	6	0.343	0.343	0.28	0.377	0.334	0.375	0.357	0.304	0.337	0.329
	7	0.39	0.383	0.29	0.424	0.367	0.376	0.381	0.348	0.368	0.354
	8	0.404	0.417	0.341	0.427	0.374	0.393	0.438	0.403	0.433	0.405
	9	0.503	0.484	0.358	0.384	0.493	0.469	0.482	0.492	0.57	0.461
	10	0.474	0.435	0.374	0.459	0.511	0.42	0.494	0.509	0.445	0.451
	+gp	0.6509	0.6162	0.5354	0.68	0.5445	0.5308	0.5274	0.525	0.5369	0.5553
0	SOPCOFAC	1	1.0013	0.9992	1.0009	1.0005	0.9995	1.0002	0.9983	0.9989	0.9998

Table 9.2.4 - Sole VIId - Stock weights at age (kg)

Run title : Sole in VIId - 2007WG - Sol7d.txt

At 4/05/2007 12:02

Table 3 Stock weights at age (kg)

YEAR	1982	1983	1984	1985	1986
AGE					
1	0.059	0.07	0.067	0.065	0.07
2	0.114	0.135	0.131	0.129	0.136
3	0.167	0.197	0.192	0.192	0.198
4	0.217	0.255	0.249	0.254	0.256
5	0.263	0.309	0.304	0.315	0.309
6	0.306	0.359	0.355	0.376	0.358
7	0.347	0.406	0.403	0.436	0.403
8	0.384	0.448	0.448	0.495	0.443
9	0.418	0.487	0.49	0.554	0.48
10	0.45	0.522	0.529	0.611	0.512
+gp	0.53	0.6008	0.6265	0.7798	0.5761

Table 3 Stock weights at age (kg)

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
1	0.072	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
2	0.139	0.145	0.113	0.138	0.138	0.144	0.13	0.116	0.126	0.155
3	0.203	0.223	0.182	0.232	0.225	0.199	0.189	0.161	0.129	0.176
4	0.262	0.268	0.269	0.305	0.279	0.277	0.246	0.215	0.22	0.258
5	0.318	0.365	0.323	0.4	0.38	0.305	0.366	0.273	0.234	0.286
6	0.37	0.425	0.335	0.361	0.384	0.454	0.377	0.316	0.333	0.308
7	0.417	0.477	0.48	0.476	0.41	0.405	0.545	0.368	0.357	0.366
8	0.461	0.498	0.504	0.535	0.449	0.459	0.56	0.53	0.33	0.391
9	0.5	0.572	0.586	0.571	0.474	0.43	0.559	0.461	0.614	0.438
10	0.536	0.636	0.536	0.507	0.451	0.528	0.813	0.47	0.382	0.466
+gp	0.6156	0.7498	0.7135	0.5765	0.6203	0.5269	0.5664	0.6122	0.6292	0.6304

Table 3 Stock weights at age (kg)

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
AGE										
1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
2	0.139	0.14	0.128	0.122	0.127	0.136	0.151	0.137	0.157	0.162
3	0.165	0.158	0.18	0.148	0.157	0.179	0.207	0.185	0.203	0.186
4	0.22	0.233	0.205	0.208	0.216	0.209	0.249	0.236	0.241	0.246
5	0.264	0.299	0.253	0.402	0.226	0.258	0.314	0.265	0.267	0.273
6	0.317	0.374	0.277	0.44	0.223	0.254	0.376	0.267	0.309	0.329
7	0.376	0.363	0.298	0.395	0.231	0.301	0.399	0.273	0.349	0.342
8	0.404	0.357	0.324	0.554	0.253	0.234	0.418	0.331	0.401	0.398
9	0.563	0.45	0.336	0.443	0.256	0.326	0.446	0.504	0.608	0.421
10	0.494	0.372	0.323	0.42	0.301	0.404	0.444	0.409	0.425	0.465
+gp	0.6536	0.5768	0.5118	0.6822	0.4204	0.417	0.5032	0.4501	0.5602	0.5508

Table 9.2.5a **Sole in VIId. Indices of effort**

Year	France Beam trawl[1]	France GTR_Demersal_fish[4]	France OTB_Demersal_fish[4]	France TBB_Demersal_fish[4]	England & Wales Beam trawl[2]	Belgium Beam trawl[3]
1971						
1972						
1973						
1974						
1975						5.02
1976						6.56
1977						6.87
1978						8.22
1979						7.30
1980						12.81
1981						19.00
1982						23.94
1983						23.64
1984						28.00
1985						25.29
1986					2.79	23.54
1987					5.64	27.11
1988					5.09	38.52
1989					5.65	35.67
1990					7.27	30.33
1991	10.69				7.67	24.29
1992	10.52				8.78	21.99
1993	10.22				6.40	20.02
1994	10.61				5.43	25.17
1995	12.38				6.89	24.17
1996	14.09				10.31	25.00
1997	10.92				10.25	30.89
1998	11.71				7.31	18.12
1999	10.63				5.86	21.39
2000	13.78				5.65	30.54
2001	11.38				7.64	32.39
2002		12.92	17.90	4.01	7.90	33.68
2003		14.81	16.19	4.17	6.69	47.50
2004		14.18	17.38	3.55	4.90	41.60
2005		15.36	15.69	2.72	5.90	35.80
2006		13.32	17.44	3.08	5.90	37.85

[1]in Kg/1000 h*KW-04

[2] Beam trawl >= 10m in millions hp hrs >10% sole

[3]Fishing hours - corrected for fishing power using P = 0.000204 BHP^1.23 (x10^3)

[4] Days at sea (x 10^3)

Table 9.2.5b **Sole in VIId. LPUE indices**

Year	France[1] Beam trawl	France GTR_Demersal_fish[4]	France OTB_Demersal_fish[4]	France TBB_Demersal_fish[4]	England & Wales[2] Beam trawl	Belgium[3] Beam trawl
1971						
1972						
1973						
1974						
1975						24.09
1976						27.28
1977						29.99
1978						26.27
1979						37.42
1980						23.26
1981						24.52
1982						23.65
1983						22.37
1984						21.61
1985						22.90
1986					39.48	33.48
1987					32.82	36.56
1988					27.67	15.89
1989					26.59	16.82
1990					26.88	25.94
1991	18.52				22.09	22.56
1992	18.12				25.29	29.11
1993	21.60				23.75	34.77
1994	17.78				31.83	27.89
1995	18.46				28.39	24.70
1996	19.79				25.79	29.80
1997	14.41				25.40	32.57
1998	17.33				25.71	23.51
1999	30.4				27.29	26.41
2000	19.1				27.46	24.49
2001	46.1				26.58	24.58
2002		106.00	35.35	147.32	31.63	27.33
2003		113.05	40.42	134.92	32.81	33.13
2004		105.54	30.21	128.53	38.80	30.86
2005		106.62	28.91	127.26	41.30	31.97
2006		106.83	31.39	90.79	38.90	36.31

[1] in h*KW-04

[2] in Kg/1000 HP*HRS >10% sole

[3] in Kg/hr corrected for fishing power using P = 0.000204 BHP^1.23

[4] in Kilos/days at sea

Table 9.2.6 - Sole VIId - tuning files

Bolded numbers = used in XSA

SOLE	7d,TUNING													
104	1													
BEL	**BT**													
1980	**2006**													
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**
37.8	**1375.8**	**1078.2**	**1035.6**	**908.8**	**446.2**	**380.3**	**151.5**	**81.3**	**77.7**	**36.8**	**26.1**	**28.1**	**20**	**4.2**
UK	**BT**													
1986	**2006**													
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**
5.9	**392.0**	**348.1**	**112.9**	**188.3**	**31.7**	**28.0**	**13.5**	**9.0**	**5.4**	**2.8**	**0.8**	**1.5**	**0.3**	**2.9**

Table 9.2.6 - Sole VIId - tuning files - continued

Bolded numbers = used in XSA

UK	**BTS**					
1988	**2006**					
1	**1**	**0.5**	**0.75**			
1	**6**					
1	**8.20**	**14.20**	**9.90**	**0.80**	**1.30**	**0.60**
1	**2.60**	**15.40**	**3.40**	**1.70**	**0.60**	**0.20**
1	**12.10**	**3.70**	**3.40**	**0.70**	**0.80**	**0.20**
1	**8.90**	**22.80**	**2.20**	**2.30**	**0.30**	**0.50**
1	**1.40**	**12.00**	**10.00**	**0.70**	**1.10**	**0.30**
1	**0.50**	**17.50**	**8.40**	**7.00**	**0.80**	**1.00**
1	**4.80**	**3.20**	**8.30**	**3.30**	**3.30**	**0.20**
1	**3.50**	**10.60**	**1.50**	**2.30**	**1.20**	**1.50**
1	**3.50**	**7.30**	**3.80**	**0.70**	**1.30**	**0.90**
1	**19.00**	**7.30**	**3.20**	**1.30**	**0.20**	**0.50**
1	**2.00**	**21.20**	**2.50**	**1.00**	**0.90**	**0.10**
1	**28.10**	**9.40**	**13.20**	**2.50**	**1.70**	**1.30**
1	**10.49**	**22.03**	**4.15**	**4.24**	**1.03**	**0.58**
1	**9.09**	**21.01**	**8.36**	**1.20**	**1.91**	**0.54**
1	**31.76**	**11.42**	**5.42**	**3.45**	**0.27**	**0.71**
1	**6.47**	**28.48**	**4.13**	**2.46**	**1.58**	**0.30**
1	**7.35**	**8.49**	**7.71**	**1.57**	**1.45**	**0.99**
1	**25**	**5.04**	**2.86**	**3.47**	**1.63**	**1.02**
1	**6.3**	**29.2**	**2.8**	**2**	**1.9**	**0.3**
YFS						
1981	**2006**					
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	**1.45**				
1	1.96	-11.00				

Table 9.3.1 - Sole VIId - XSA diagnostics

Lowestoft VPA Version 3.1

4/05/2007 12:01

Extended Survivors Analysis

Sole in VIId - 2007WG - Sol7d.txt

CPUE data from file Tun7d.txt

Catch data for 25 years. 1982 to 2006. Ages 1 to 11.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
BEL BT	1986	2006	2	10	0	1
UK BT	1986	2006	2	10	0	1
UK BTS	1988	2006	1	6	0.5	0.75
YFS	1987	2006	1	1	0.5	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 5 oldest ages.

S.E. of the mean to which the estimates are shrunk = 2.000

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 64 iterations

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	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.001	0.002	0.007	0.004	0.007	0.015	0.018	0.046	0.004	0.015
2	0.096	0.059	0.234	0.173	0.245	0.384	0.307	0.258	0.192	0.137
3	0.638	0.541	0.534	0.566	0.447	0.481	0.47	0.375	0.368	0.274
4	0.777	0.579	0.631	0.516	0.324	0.475	0.341	0.403	0.383	0.394
5	0.784	0.552	0.545	0.38	0.55	0.469	0.389	0.387	0.404	0.366
6	0.434	0.486	0.566	0.369	0.425	0.24	0.376	0.389	0.305	0.473
7	0.393	0.224	0.507	0.369	0.333	0.274	0.313	0.328	0.358	0.305
8	0.437	0.296	0.407	0.369	0.221	0.216	0.263	0.37	0.29	0.34
9	0.46	0.324	0.362	0.316	0.206	0.232	0.156	0.172	0.375	0.376
10	0.206	1.036	0.261	0.23	0.107	0.298	0.303	0.267	0.328	0.428

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
1997	2.80E+04	1.72E+04	1.35E+04	9.75E+03	4.03E+03	4.98E+03	2.96E+03	2.30E+03	6.82E+02	9.55E+02
1998	1.83E+04	2.53E+04	1.41E+04	6.47E+03	4.06E+03	1.66E+03	2.92E+03	1.81E+03	1.34E+03	3.89E+02
1999	2.64E+04	1.65E+04	2.16E+04	7.43E+03	3.28E+03	2.11E+03	9.26E+02	2.11E+03	1.22E+03	8.80E+02
2000	3.24E+04	2.38E+04	1.18E+04	1.15E+04	3.57E+03	1.72E+03	1.09E+03	5.05E+02	1.27E+03	7.66E+02
2001	2.57E+04	2.92E+04	1.81E+04	6.07E+03	6.19E+03	2.21E+03	1.08E+03	6.79E+02	3.16E+02	8.40E+02
2002	4.89E+04	2.31E+04	2.07E+04	1.05E+04	3.97E+03	3.23E+03	1.31E+03	6.99E+02	4.93E+02	2.32E+02
2003	2.21E+04	4.36E+04	1.43E+04	1.16E+04	5.89E+03	2.25E+03	2.30E+03	9.00E+02	5.10E+02	3.54E+02
2004	24200	19700	29000	8070	7440	3610	1400	1520	626	395
2005	61800	20900	13800	18000	4880	4570	2210	911	951	477
2006	37700	55700	15600	8610	11100	2950	3050	1400	617	591

Estimated population abundance at 1st Jan 2007

0	33600	44000	10700	5250	6980	1660	2040	902	383

Taper weighted geometric mean of the VPA populations:

24600	21400	15700	8710	4800	2730	1650	989	627	401

Standard error of the weighted Log(VPA populations) :

0.42	0.4133	0.3532	0.432	0.4645	0.4664	0.509	0.5065	0.511	0.5656

Log catchability residuals.

Fleet : BEL BT

Age	1986
1	No data for this fleet at this age
2	0.04
3	0.67
4	0.15
5	-0.12
6	-0.12
7	-0.21
8	0.08
9	0.8
10	0.07

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	No data for this fleet at this age									
2	0.58	-0.72	-2.57	1.12	-0.77	-0.03	1.31	-0.29	-0.75	-0.12
3	-0.26	-0.49	-0.05	0.03	0.78	0.04	0.2	-0.08	-0.34	-0.1
4	0.32	-0.76	-0.44	-0.18	0.02	0.36	-0.08	0.53	-0.38	0.24
5	0.54	-0.27	0.98	-0.13	-0.07	0.18	-0.07	0.23	-0.1	-0.17
6	0.91	-0.25	0.25	-0.18	0.61	-0.5	-0.9	0.4	0.06	0.12
7	0.62	0.07	0.33	0.54	0.09	-0.23	0.02	0	0	0.25
8	-0.13	-0.76	-0.04	-0.28	-0.06	-0.14	-0.28	0.31	-1.15	-0.02
9	0.35	-0.8	-0.35	0.36	-0.72	-0.09	0.7	-0.23	0.19	-0.2
10	2.25	1.45	-2.16	-0.15	0.55	-0.76	-0.65	1.38	-0.83	1.09

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	No data for this fleet at this age									
2	-0.73	-0.34	0.37	0.06	0.45	0.89	0.41	0.5	0.74	-0.14
3	0.33	-0.27	-0.02	0.36	-0.02	-0.02	0.14	-0.48	-0.06	-0.35
4	0.32	0.23	0.48	0.29	-0.41	-0.16	-0.13	-0.17	-0.36	0.14
5	0.43	-0.19	0.41	-0.35	0.06	-0.34	-0.17	0.08	-0.56	-0.38
6	0.11	-0.28	-0.1	0.05	0.69	-0.87	0.38	-0.13	-0.75	0.51
7	0.24	-0.24	0	-0.24	0.13	-0.23	-0.42	-0.63	-0.29	0.2
8	-0.22	0.08	-0.25	0.5	-0.67	-0.38	-0.18	-0.57	-0.18	0.08
9	0.07	-0.09	0	-0.33	-0.64	-0.62	-1.54	-0.89	-0.85	0.29
10	-1.04	-0.11	-0.61	-0.35	-1.46	0.3	0.06	0.13	-1.02	0.31

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	-7.0771	-5.7703	-5.6519	-5.5372	-5.7531	-5.7217	-5.7217	-5.7217	-5.7217
S.E(Log q)	0.85	0.3339	0.3461	0.362	0.4965	0.3081	0.4211	0.6198	1.0469

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	0.92	0.182	7.31	0.22	21	0.8	-7.08
3	1.27	-1.033	4.7	0.43	21	0.42	-5.77
4	0.94	0.358	5.87	0.64	21	0.33	-5.65
5	1.14	-0.705	5.11	0.55	21	0.42	-5.54
6	1.09	-0.324	5.56	0.41	21	0.55	-5.75
7	0.97	0.23	5.78	0.74	21	0.31	-5.72
8	1.31	-1.597	5.61	0.58	21	0.46	-5.92
9	1.52	-1.424	5.68	0.29	21	0.85	-5.94
10	-2.78	-5.52	6.76	0.1	21	1.85	-5.8

Fleet : UK BT

Age	1986
1	No data for this fleet at this age
2	-0.32
3	0.52
4	0.54
5	0.3
6	0.42
7	0.65
8	-0.68
9	0.16
10	0.02

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	No data for this fleet at this age									
2	0.42	0.62	-0.02	-0.17	-0.04	-0.36	-0.32	-1.17	-0.14	0.29
3	-0.06	0.36	-0.01	0.1	-0.26	-0.1	-0.5	-0.11	-0.63	-0.49
4	0.42	-0.02	0.25	-0.1	0.05	-0.4	-0.17	-0.29	-0.06	-0.77
5	0.53	0.41	-0.48	0	-1.21	0.46	-0.34	-0.04	-0.13	-0.07
6	-0.25	0.27	0.12	-0.36	-0.26	-0.59	0.04	0.02	0.04	-0.24
7	-0.25	-0.09	0.22	-0.27	-0.9	-0.19	-0.52	0.48	-0.12	-0.09
8	0.37	0.31	-0.21	0.01	-0.61	-0.37	-0.15	-0.14	0.37	-0.16
9	-0.64	0.04	-0.34	-0.14	0.11	0.38	0.04	0.34	0.22	0.17
10	-1.23	0.64	0.26	0.5	0.04	-0.34	-0.51	0.45	0.35	0.19

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
	1	: at this age									
	2	0.17	0.04	0.38	-0.09	0.06	0.43	0.13	0.05	0.12	-0.06
	3	0.16	-0.26	0.11	0.24	-0.13	0.23	0.05	0.37	-0.04	0.45
	4	-0.21	-0.04	0.15	0.19	-0.1	0.18	-0.21	0.19	0.42	-0.05
	5	-0.52	0.14	0.17	0.27	0.21	0.14	-0.22	-0.12	0.17	0.32
	6	0.19	-0.09	0.3	0.24	0.25	-0.03	-0.14	-0.04	0.22	-0.09
	7	-0.1	0.19	0.25	0.46	0.19	0.12	0.08	-0.23	0.36	-0.22
	8	0.13	0.12	0.14	0.25	0.63	0.51	0.23	0.33	0.51	-0.16
	9	-0.08	0.17	-0.04	0.44	0.17	-0.26	-0.23	-0.31	0.39	0.28
	10	0.15	0.37	-0.33	0.11	0.07	-0.14	0.24	-0.11	0.74	-0.17

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9	10
Age	2	3	4	5	6	7	8	9	10
Mean Log q	-6.5583	-5.8501	-5.8284	-5.9513	-5.9459	-6.0517	-6.0517	-6.0517	-6.0517
S.E(Log q)	0.3749	0.3141	0.3022	0.4029	0.2506	0.3612	0.3656	0.2862	0.4433

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	1.06	-0.288	6.34	0.53	21	0.41	-6.56
3	0.97	0.171	5.98	0.58	21	0.31	-5.85
4	0.91	0.62	6.13	0.71	21	0.28	-5.83
5	0.74	1.875	6.61	0.73	21	0.28	-5.95
6	0.83	1.797	6.29	0.85	21	0.2	-5.95
7	0.78	1.851	6.36	0.79	21	0.27	-6.05
8	0.82	1.471	6.15	0.78	21	0.29	-5.98
9	0.82	1.883	6.09	0.86	21	0.22	-6.01
10	1	0.004	5.99	0.65	21	0.45	-5.99

Fleet : UK BTS

Age		1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
	1	99.99	0.3	-0.41	0.17	0.09	-1.73	-2.06	-0.26	-0.24	-0.24
	2	99.99	1.07	0.24	-0.71	0.15	-0.31	0.11	-0.97	-0.18	-0.21
	3	99.99	0.71	0.68	-0.44	-0.31	0.18	0.12	0.18	-0.91	-0.27
	4	99.99	-0.25	-0.02	0.07	0.06	-0.59	0.64	0.03	-0.3	-0.75
	5	99.99	0.44	0.19	-0.14	-0.22	-0.1	0.03	0.41	-0.41	-0.3
	6	99.99	0.14	-0.77	-0.21	0.11	0.4	0.34	-0.79	0.27	0
	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		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
	1	1.07	-0.76	1.52	0.33	0.42	1.03	0.24	0.29	0.55	-0.33
	2	-0.24	0.41	0.14	0.59	0.38	0.09	0.32	-0.13	-0.75	-0.01
	3	-0.06	-0.41	0.82	0.29	0.49	-0.06	0.04	-0.11	-0.36	-0.57
	4	-0.22	-0.2	0.61	0.63	-0.11	0.49	-0.03	-0.08	-0.1	0.09
	5	-1.19	0.16	1	0.31	0.49	-1.08	0.25	-0.08	0.48	-0.22
	6	-0.56	-1.04	1.33	0.61	0.32	0.1	-0.31	0.42	0.16	-0.52
	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									

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	-8.2997	-7.3999	-7.8269	-8.1521	-8.1646	-8.3134
S.E(Log q)	0.87	0.4877	0.4638	0.3816	0.5281	0.5709

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	0.52	1.761	9.23	0.44	19	0.43	-8.3
2	0.9	0.397	7.67	0.47	19	0.45	-7.4
3	0.92	0.289	7.99	0.41	19	0.44	-7.83
4	0.81	1.216	8.34	0.7	19	0.3	-8.15
5	1.06	-0.206	8.14	0.42	19	0.57	-8.16
6	0.99	0.027	8.31	0.41	19	0.58	-8.31

Fleet : YFS

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.51	0	-0.51	-0.31	0.4	-0.42	0.03	0.51	0.76	-0.7
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	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	-0.66	-0.16	-0.11	0.09	-0.09	0.1	0.04	0.43	0.03	0.07
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	-10.1691
S.E(Log q)	0.396

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	1.09	-0.369	10.17	0.48	20	0.44	-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 = 2005

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	24270	0.893	0	0	1	0.166	0.021
YFS	36221	0.406	0	0	1	0.801	0.014
F shrinkage mean	28423	2				0.033	0.018

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
33624	0.36	0.11	3	0.295	0.015

Age 2 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	38197	0.87	0	0	1	0.067	0.157
UK BT	41364	0.384	0	0	1	0.345	0.145
UK BTS	49902	0.436	0.238	0.54	2	0.266	0.122
YFS	45118	0.406	0	0	1	0.307	0.134
F shrinkage mean	20221	2				0.015	0.278

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
43961	0.23	0.08	6	0.349	0.137

Age 3 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	8535	0.319	0.347	1.09	2	0.249	0.334
UK BT	14922	0.247	0.159	0.64	2	0.394	0.205
UK BTS	6275	0.323	0.219	0.68	3	0.225	0.432
YFS	16497	0.406	0	0	1	0.124	0.187
F shrinkage mean	6315	2				0.008	0.43

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
10743	0.15	0.16	9	1.041	0.274

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age 4 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	5667	0.242	0.096	0.4	3	0.284	0.37
UK BT	5098	0.199	0.025	0.12	3	0.405	0.404
UK BTS	5002	0.257	0.115	0.45	4	0.241	0.411
YFS	5462	0.406	0	0	1	0.062	0.382
F shrinkage mean	5389	2				0.007	0.386

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5254	0.13	0.04	12	0.32	0.394

Age 5 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	4801	0.21	0.08	0.38	4	0.336	0.497
UK BT	9848	0.186	0.051	0.28	4	0.388	0.273
UK BTS	6660	0.242	0.131	0.54	5	0.229	0.381
YFS	7723	0.406	0	0	1	0.04	0.336
F shrinkage mean	5568	2				0.007	0.441

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6979	0.12	0.09	15	0.789	0.366

Age 6 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	1572	0.206	0.217	1.06	5	0.296	0.494
UK BT	1750	0.173	0.077	0.44	5	0.469	0.454
UK BTS	1589	0.242	0.162	0.67	6	0.205	0.49
YFS	1512	0.406	0	0	1	0.023	0.51
F shrinkage mean	2413	2				0.008	0.348

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1661	0.11	0.08	18	0.662	0.473

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age 7 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	2025	0.183	0.141	0.77	6	0.381	0.307
UK BT	2005	0.161	0.092	0.57	6	0.452	0.309
UK BTS	2143	0.237	0.065	0.27	6	0.143	0.292
YFS	2237	0.406	0	0	1	0.018	0.281
F shrinkage mean	1915	2				0.006	0.322

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2035	0.11	0.06	20	0.527	0.305

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	794	0.181	0.06	0.33	7	0.398	0.378
UK BT	911	0.162	0.086	0.53	7	0.481	0.337
UK BTS	1418	0.241	0.093	0.39	6	0.101	0.229
YFS	809	0.406	0	0	1	0.013	0.373
F shrinkage mean	1166	2				0.007	0.273

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
902	0.11	0.05	22	0.495	0.34

Age 9 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	310	0.18	0.143	0.8	8	0.34	0.447
UK BT	451	0.152	0.098	0.64	8	0.57	0.328
UK BTS	278	0.242	0.198	0.82	6	0.074	0.489
YFS	327	0.406	0	0	1	0.009	0.429
F shrinkage mean	681	2				0.007	0.229

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
383	0.11	0.08	24	0.723	0.376

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 = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	235	0.185	0.135	0.73	9	0.307	0.584
UK BT	409	0.153	0.078	0.51	9	0.613	0.376
UK BTS	542	0.253	0.12	0.47	6	0.062	0.296
YFS	180	0.406	0	0	1	0.008	0.711
F shrinkage mean	412	2				0.01	0.373

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
349	0.11	0.08	26	0.708	0.428

Table 9.3.2 - Sole VIId - Fishing mortality (F) at age

Run title : Sole in VIId - 2007WG - Sol7d.txt

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Table 8 Fishing mortality (F) at age

YEAR	1982	1983	1984	1985	1986
AGE					
1	0.0129	0.0000	0.0012	0.004	0.002
2	0.1857	0.0820	0.1132	0.2213	0.1198
3	0.3067	0.3518	0.4306	0.4295	0.4984
4	0.4870	0.3518	0.4344	0.3712	0.4519
5	0.2300	0.4466	0.2553	0.27	0.3186
6	0.2230	0.4598	0.7229	0.3778	0.2959
7	0.4651	0.3080	0.5128	0.2581	0.3397
8	0.4087	0.5057	0.2251	0.2957	0.4311
9	0.3446	0.2891	0.3525	0.1477	0.611
10	0.3352	0.4031	0.415	0.2705	0.2731
+gp	0.3352	0.4031	0.415	0.2705	0.2731
0 FBAR 3- 8	0.3534	0.4040	0.4302	0.3337	0.3893

Table 8 Fishing mortality (F) at age

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
1	0.0009	0.0038	0.0102	0.0298	0.0116	0.0033	0.0053	0.0012	0.0462	0.0005
2	0.1513	0.2593	0.1693	0.2216	0.2141	0.1462	0.1897	0.0494	0.1394	0.1207
3	0.5434	0.5369	0.6680	0.3954	0.5021	0.3910	0.3244	0.3351	0.4348	0.5640
4	0.5816	0.4195	0.6571	0.4707	0.5100	0.4028	0.3968	0.4911	0.4124	0.5405
5	0.5203	0.3695	0.7248	0.4296	0.4286	0.4343	0.3462	0.4104	0.4345	0.4773
6	0.6501	0.3777	0.4433	0.2836	0.5022	0.3313	0.1861	0.3077	0.3948	0.4611
7	0.7766	0.4729	0.4129	0.3372	0.3702	0.3098	0.2799	0.2583	0.2953	0.4256
8	0.4034	0.3618	0.4249	0.2974	0.3295	0.3012	0.2294	0.2747	0.1740	0.3208
9	0.5562	0.1976	0.3763	0.4709	0.4778	0.3546	0.4061	0.2521	0.3314	0.2758
10	1.6026	0.9540	0.2374	0.4833	0.6425	0.2867	0.1870	0.5868	0.2595	0.8045
+gp	1.6026	0.9540	0.2374	0.4833	0.6425	0.2867	0.1870	0.5868	0.2595	0.8045
0 FBAR 3- 8	0.5792	0.4231	0.5552	0.3690	0.4404	0.3617	0.2938	0.3462	0.3576	0.4649

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Table 8 Fishing mortality (F) at age

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	FBAR 04-06
AGE											
1	0.0009	0.0019	0.0067	0.0045	0.0069	0.0153	0.0182	0.0458	0.0035	0.0152	0.0215
2	0.0957	0.0588	0.2338	0.1728	0.2452	0.3836	0.3071	0.2578	0.1916	0.1374	0.1956
3	0.6378	0.5414	0.5341	0.5658	0.4465	0.4810	0.4699	0.3749	0.3684	0.2741	0.3391
4	0.7768	0.5788	0.6312	0.5161	0.3235	0.4753	0.3408	0.4030	0.3830	0.3944	0.3935
5	0.7842	0.5517	0.5449	0.3804	0.5501	0.4688	0.3890	0.3869	0.4043	0.3664	0.3859
6	0.4341	0.4860	0.5659	0.3687	0.4248	0.2397	0.3764	0.3895	0.3047	0.4729	0.3890
7	0.3935	0.2241	0.5067	0.3693	0.3326	0.2737	0.3130	0.3275	0.3576	0.3053	0.3302
8	0.4372	0.2964	0.4069	0.3686	0.2208	0.2157	0.2629	0.3702	0.2899	0.3400	0.3334
9	0.4598	0.3241	0.3617	0.3159	0.2063	0.2318	0.1559	0.1717	0.3751	0.3764	0.3077
10	0.2058	1.0360	0.2606	0.2304	0.1069	0.2981	0.3032	0.2671	0.3281	0.4283	0.3412
+gp	0.2058	1.0360	0.2606	0.2304	0.1069	0.2981	0.3032	0.2671	0.3281	0.4283	
0 FBAR 3- 8	0.5773	0.4464	0.5316	0.4282	0.3831	0.3591	0.3587	0.3753	0.3513	0.3589	

Table 9.3.3 - Sole VIId - Stock numbers at age

Run title : Sole in VIId - 2007WG - Sol7d.txt

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Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1982	1983	1984	1985	1986
AGE					
1	12738	21459	21641	12930	25846
2	16282	11379	19416	19559	11653
3	20920	12235	9486	15688	14185
4	4709	13930	7787	5580	9238
5	2916	2618	8866	4564	3483
6	3435	2096	1516	6215	3152
7	1552	2487	1198	666	3854
8	752	882	1653	649	465
9	440	452	481	1195	437
10	306	282	306	306	933
+gp	743	609	734	566	1632
0 TOTAL	64793	68429	73085	67917	74878

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
1	11007	26088	16836	44506	34959	33926	16828	26618	19524	18968
2	23340	9951	23515	15079	39086	31268	30597	15145	24056	16869
3	9354	18154	6947	17963	10932	28550	24444	22903	13044	18935
4	7797	4915	9602	3223	10946	5987	17473	15990	14823	7641
5	5320	3944	2924	4504	1822	5947	3621	10632	8854	8880
6	2292	2861	2466	1282	2652	1074	3485	2318	6382	5188
7	2122	1082	1774	1432	873	1452	698	2618	1542	3891
8	2483	883	610	1062	925	546	964	477	1830	1038
9	274	1501	556	361	714	602	365	693	328	1391
10	215	142	1114	346	204	401	382	220	488	213
+gp	596	466	1400	1335	842	971	793	608	1106	650
0 TOTAL	64798	69987	67746	91093	103955	110723	99651	98222	91975	83664

Run title : Sole in VIId - 2007WG - Sol7d.txt

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Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	GMST 82-04	AMST 82-04
AGE													
1	28016	18250	26426	32428	25741	48889	22149	24187	61817	37729	0*	23169	24781
2	17154	25327	16482	23752	29210	23132	43564	19681	20906	55738	33624	20529	21978
3	13528	14105	21608	11805	18080	20683	14262	28996	13762	15617	43961	15802	16818
4	9747	6469	7427	11461	6066	10468	11569	8066	18034	8615	10743	8447	9170
5	4027	4056	3281	3575	6189	3972	5888	7445	4878	11126	5254	4628	5101
6	4985	1663	2114	1722	2211	3231	2249	3611	4575	2946	6979	2660	2965
7	2960	2922	926	1086	1077	1308	2300	1397	2213	3052	1661	1581	1792
8	2301	1807	2113	505	679	699	900	1522	911	1401	2035	978	1119
9	682	1344	1216	1273	316	493	510	626	951	617	902	616	707
10	955	389	880	766	840	232	354	395	477	591	383	392	464
+gp	1506	486	1641	1264	2744	801	982	1042	1015	878	866		
0 TOTAL	85861	76820	84114	89635	93155	113909	104727	96968	129539	138310	106409		

* Replaced with GM in prediction

Table 9.3.4 - Sole VIId - Summary

Run title : Sole in VIId - 2007WG - Sol7d.txt

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Table 16 Summary (without SOP correction)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 8
1982	12738	10484	7876	3190	0.405	0.3534
1983	21459	12700	9662	3458	0.3579	0.404
1984	21641	13068	9075	3575	0.394	0.4302
1985	12930	13469	10106	3837	0.3797	0.3337
1986	25846	14159	10765	3932	0.3653	0.3893
1987	11007	13166	9130	4791	0.5248	0.5792
1988	26088	13023	10276	3853	0.375	0.4231
1989	16836	12198	8699	3805	0.4374	0.5552
1990	44506	14122	9816	3647	0.3715	0.369
1991	34959	16092	8951	4351	0.4861	0.4404
1992	33926	17661	11462	4072	0.3553	0.3617
1993	16828	18261	13442	4299	0.3198	0.2938
1994	26618	15859	12772	4383	0.3432	0.3462
1995	19524	15386	11378	4420	0.3885	0.3576
1996	18968	15953	12390	4797	0.3872	0.4649
1997	28016	14688	10903	4764	0.437	0.5773
1998	18250	12765	8307	3363	0.4049	0.4464
1999	26426	12751	9320	4135	0.4436	0.5316
2000	32428	13301	8782	3476	0.3958	0.4282
2001	25741	12945	7948	4025	0.5064	0.3831
2002	48889	14472	8881	4733	0.5329	0.3591
2003	22149	18386	10700	5038	0.4708	0.3587
2004	24187	15942	12036	4826	0.401	0.3753
2005	61817	18716	12343	4383	0.3551	0.3513
2006	37729	22566	11650	4554	0.3909	0.3589
2007	23169[1]	23162[2]	16893[2]			0.3618[3]
Arith. Mean	26780	14885	10267	4148	0.4092	0.4109
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

1 Geometric mean 1982-2004

2 From forecast

3 $F_{(04\text{-}06)}$ NOT rescaled to F_{2006}

Table 9.5.1 - Sole VIId – RCT3 input

Yearclass	XSA (Age 1)	XSA (Age 2)	yfs0	yfs1	bts1	bts2
1981	12738	11379	1.881	0.2005	-11	-11
1982	21459	19416	2.6555	0.695	-11	-11
1983	21641	19559	11.887	-11	-11	-11
1984	12930	11653	-11	-11	-11	-11
1985	25846	23340	-11	-11	-11	-11
1986	11007	9951	-11	0.6595	-11	14.2
1987	26088	23515	7.995	0.935	8.2	15.4
1988	16836	15079	1.1875	0.356	2.6	3.7
1989	44506	39086	12.588	1.152	12.1	22.8
1990	34959	31268	3.3285	1.8695	8.9	12
1991	33926	30597	1.3865	0.796	1.4	17.5
1992	16828	15145	1.281	0.615	0.5	3.2
1993	26618	24056	6.534	1.591	4.8	10.6
1994	19524	16869	8.1035	1.4635	3.5	7.4
1995	18968	17154	5.3135	0.339	3.5	7.3
1996	28016	25327	0.9865	0.5205	19	21.23
1997	18250	16482	1.942	0.559	2	9.44
1998	26426	23752	9.3725	0.854	28.14	22.03
1999	32428	29210	2.7455	1.282	10.49	21.01
2000	25741	23132	1.8475	0.8365	9.09	-11
2001	48889	43564	4.5135	1.93	31.76	28.48
2002	22149	19681	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	29.2
2005	-11	-11	4.51	1.45	6.3	-11
2006	-11	-11	1.96	-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 26 years : 1981 - 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/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
yfs0	1.84	7.28	1.14	.088	19	2.10	11.15	1.267	.031
yfs1	2.22	8.70	.42	.481	19	1.19	11.33	.509	.195
bts1	.57	9.03	.39	.435	16	3.26	10.88	.453	.246
bts2	1.01	7.53	.44	.458	16	3.41	10.96	.519	.188
						VPA Mean =	10.05	.385	.340

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
yfs0	1.84	7.28	1.14	.088	19	1.71	10.43	1.244	.037
yfs1	2.22	8.70	.42	.481	19	.90	10.69	.467	.263
bts1	.57	9.03	.39	.435	16	1.99	10.16	.426	.315
bts2									
						VPA Mean =	10.05	.385	.385

Yearclass = 2006

	I-----------Regression----------I					**I-----------Prediction---------I**			
Survey/ Series	**Slope**	**Inter- cept**	**Std Error**	**Rsquare**	**No. Pts**	**Index Value**	**Predicted Value**	**Std Error**	**WAP Weights**
yfs0	**1.84**	**7.28**	**1.14**	**.088**	**19**	**1.09**	**9.28**	**1.258**	**.086**
yfs1									
bts1									
bts2									
						VPA Mean =	**10.05**	**.385**	**.914**

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2004	44734	10.71	.22	.25	1.23		
2005	28709	10.26	.24	.15	.40		
2006	**21656**	**9.98**	**.37**	**.21**	**.34**		

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   26 years :  1981 - 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

 yfs0      1.90   7.08   1.19   .082    19   2.10   11.07    1.313     .029
 yfs1      2.23   8.58    .42   .470    19   1.19   11.23     .518     .188
 bts1       .57   8.92    .39   .434    16   3.26   10.77     .452     .246
 bts2       .99   7.46    .43   .465    16   3.41   10.84     .508     .195

                                        VPA Mean =    9.94     .383     .342

 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      1.90   7.08   1.19   .082    19   1.71   10.33(30638)    1.289     .035
 yfs1      2.23   8.58    .42   .470    19    .90   10.58(39340)     .475     .255
 bts1       .57   8.92    .39   .434    16   1.99   10.05(23156)     .425     .318
 bts2

                                        VPA Mean =    9.94(20744)     .383     .392

 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

 yfs0      1.90   7.08   1.19   .082    19   1.09    9.15    1.304     .080
 yfs1
 bts1
 bts2

                                        VPA Mean =    9.94     .383     .920


 Year     Weighted       Log     Int     Ext      Var     VPA       Log
 Class     Average       WAP     Std     Std     Ratio              VPA
          Prediction            Error   Error

 2004       39886      10.59     .22     .25     1.23
 2005       25639      10.15     .24     .15      .40
 2006       19477       9.88     .37     .21      .34
```

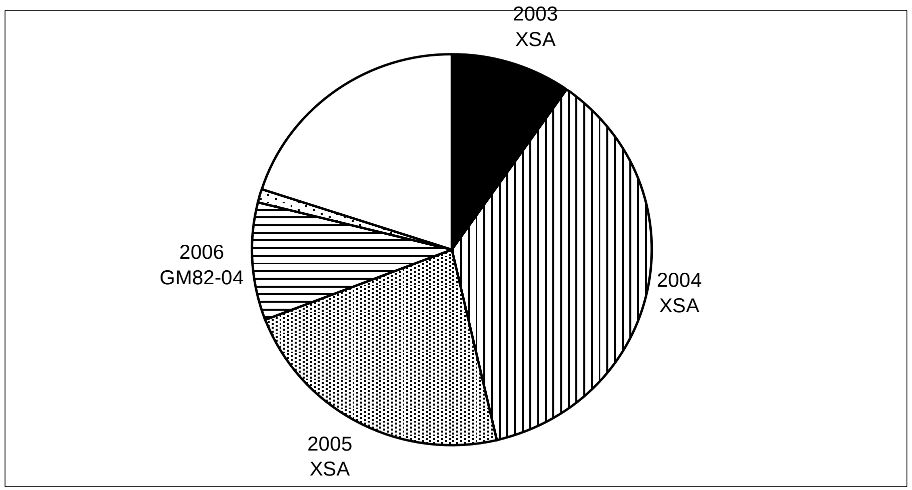
Table 9.6.4 Sole VIId
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class	2003	2004	2005	2006	2007
Stock No. (thousands) of 1 year-olds	24133	61695	37658	23100	23100
Source	XSA	XSA	XSA	GM82-04	GM82-04
Status Quo F:					
% in 2007 landings	13.7	39.5	15.8	1.0	-
% in 2008 landings	9.7	36.6	22.8	9.8	1.0
% in 2007 SSB	15.3	49.8	0.0	0.0	-
% in 2008 SSB	10.1	39.1	27.4	0.0	0.0
% in 2009 SSB	7.8	29.8	25.0	18.8	0.0

GM : geometric mean recruitment

Sole VIId : Year-class % contribution to

a) 2008 landings



b) 2009 SSB

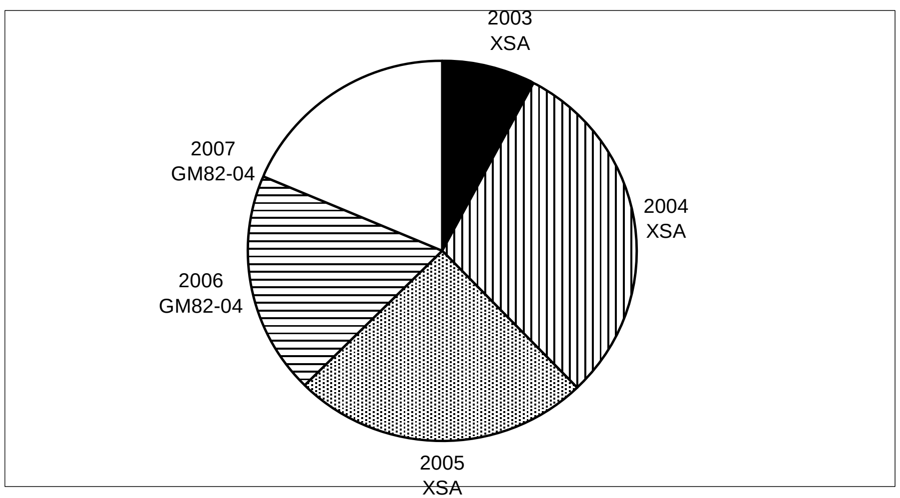


Table 9.6.1 - Sole in VIId
Input for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	23169	0.38	WS1	0.050	0.00
N2	33624	0.36	WS2	0.152	0.09
N3	43961	0.23	WS3	0.191	0.05
N4	10743	0.16	WS4	0.241	0.02
N5	5254	0.13	WS5	0.268	0.02
N6	6979	0.12	WS6	0.302	0.10
N7	1661	0.11	WS7	0.321	0.13
N8	2035	0.11	WS8	0.377	0.11
N9	902	0.11	WS9	0.511	0.18
N10	383	0.11	WS10	0.433	0.07
N11	866	0.11	WS11	0.520	0.12
H.cons selectivity			Weight in the HC catch		
sH1	0.0220	0.19	WH1	0.131	0.08
sH2	0.1960	0.28	WH2	0.171	0.05
sH3	0.3390	0.16	WH3	0.202	0.04
sH4	0.3940	0.01	WH4	0.252	0.01
sH5	0.3860	0.07	WH5	0.294	0.03
sH6	0.3890	0.21	WH6	0.323	0.05
sH7	0.3300	0.10	WH7	0.357	0.03
sH8	0.3330	0.09	WH8	0.414	0.04
sH9	0.3080	0.40	WH9	0.508	0.11
sH10	0.3410	0.25	WH10	0.468	0.08
sH11	0.3410	0.25	WH11	0.539	0.03
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		
HF07	1	0.03	K07	1	0.1
HF08	1	0.03	K08	1	0.1
HF09	1	0.03	K09	1	0.1
Recruitment in 2007 and 2008					
R08	23169	0.38			
R09	23169	0.38			

Table 9.6.2 Sole in VIId - Management option table

MFDP version 1a
Run: Sole7d_Fin
Sole in VIId
Time and date: 14:39 04/05/2007
Fbar age range: 3-8

2007 Biomass	SSB	FMult	FBar	Landings
23162	16893	1.0000	0.3618	6157

2008 Biomass	SSB	FMult	FBar	Landings	2009 Biomass	SSB
21763	17485	0.0000	0.0000	0	26099	21754
.	17485	0.1000	0.0362	704	25371	21033
.	17485	0.2000	0.0724	1384	24667	20336
.	17485	0.3000	0.1086	2042	23988	19664
.	17485	0.4000	0.1447	2677	23332	19014
.	17485	0.5000	0.1809	3291	22698	18387
.	17485	0.6000	0.2171	3885	22086	17782
.	17485	0.7000	0.2533	4458	21494	17197
.	17485	0.8000	0.2895	5013	20923	16632
.	17485	0.9000	0.3257	5549	20371	16087
.	17485	1.0000	0.3618	6067	19837	15560
.	17485	1.1000	0.3980	6567	19322	15051
.	17485	1.2000	0.4342	7052	18824	14560
.	17485	1.3000	0.4704	7520	18343	14085
.	17485	1.4000	0.5066	7972	17878	13627
.	17485	1.5000	0.5428	8410	17428	13184
.	17485	1.6000	0.5789	8833	16994	12756
.	17485	1.7000	0.6151	9243	16574	12343
.	17485	1.8000	0.6513	9639	16168	11944
.	17485	1.9000	0.6875	10022	15776	11558
.	17485	2.0000	0.7237	10392	15397	11186

Input units are thousands and kg - output in tonnes

Fmult corresponding to Fpa = 1.10

.	17485	1.1	0.398	6567	19322	15051

Bpa = 8 000 t

Table 9.6.3 Sole in VIId. Detailed results

MFDP version 1a
Run: Sole7d_Fin
Time and date: 14:39 04/05/2007
Fbar age range: 3-8

Year: 2007 F multiplier: 1 Fbar: 0.3618

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0215	469	62	23169	1158	0	0	0	0
2	0.1956	5694	974	33624	5111	0	0	0	0
3	0.3391	12066	2433	43961	8411	43961	8411	43961	8411
4	0.3935	3336	841	10743	2589	10743	2589	10743	2589
5	0.3859	1606	473	5254	1410	5254	1410	5254	1410
6	0.3890	2147	694	6979	2105	6979	2105	6979	2105
7	0.3301	446	159	1661	534	1661	534	1661	534
8	0.3334	551	228	2035	767	2035	767	2035	767
9	0.3077	228	116	902	461	902	461	902	461
10	0.3412	106	49	383	166	383	166	383	166
11	0.3412	239	129	866	451	866	451	866	451
Total		26887	6157	129577	23162	72784	16893	72784	16893

Year: 2008 F multiplier: 1 Fbar: 0.3618

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0215	469	62	23169	1158	0	0	0	0
2	0.1956	3475	594	20518	3119	0	0	0	0
3	0.3391	6867	1385	25019	4787	25019	4787	25019	4787
4	0.3935	8800	2218	28337	6829	28337	6829	28337	6829
5	0.3859	2005	590	6559	1760	6559	1760	6559	1760
6	0.3890	994	322	3232	975	3232	975	3232	975
7	0.3301	1148	410	4280	1375	4280	1375	4280	1375
8	0.3334	292	121	1080	407	1080	407	1080	407
9	0.3077	333	169	1319	674	1319	674	1319	674
10	0.3412	166	78	600	260	600	260	600	260
11	0.3412	222	119	803	418	803	418	803	418
Total		24771	6067	114917	21763	71230	17485	71230	17485

Year: 2009 F multiplier: 1 Fbar: 0.3618

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0215	469	62	23169	1158	0	0	0	0
2	0.1956	3475	594	20518	3119	0	0	0	0
3	0.3391	4190	845	15267	2921	15267	2921	15267	2921
4	0.3935	5009	1262	16127	3887	16127	3887	16127	3887
5	0.3859	5287	1556	17300	4642	17300	4642	17300	4642
6	0.3890	1241	401	4035	1217	4035	1217	4035	1217
7	0.3301	532	190	1982	637	1982	637	1982	637
8	0.3334	753	312	2784	1048	2784	1048	2784	1048
9	0.3077	177	90	700	358	700	358	700	358
10	0.3412	242	113	878	380	878	380	878	380
11	0.3412	249	134	903	470	903	470	903	470
Total		21624	5559	103663	19837	59975	15560	59975	15560

Input units are thousands and kg - output in tonnes

Table 9.7.1 - Sole in VIId Yield per recruit summary table

MFYPR version 2a
Run: Sole7d_Fin_yield
Time and date: 14:43 04/05/2007
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	10.5083	3.6662	8.6035	3.4787	8.6035	3.4787
0.1000	0.0362	0.2272	0.0848	8.2390	2.5748	6.3361	2.3876	6.3361	2.3876
0.2000	0.0724	0.3619	0.1259	6.8945	1.9530	4.9935	1.7661	4.9935	1.7661
0.3000	0.1086	0.4509	0.1475	6.0068	1.5592	4.1078	1.3726	4.1078	1.3726
0.4000	0.1447	0.5140	0.1591	5.3779	1.2919	3.4808	1.1055	3.4808	1.1055
0.5000	0.1809	0.5611	0.1654	4.9097	1.1011	3.0146	0.9150	3.0146	0.9150
0.6000	0.2171	0.5975	0.1686	4.5480	0.9597	2.6547	0.7740	2.6547	0.7740
0.7000	0.2533	0.6265	0.1701	4.2602	0.8518	2.3689	0.6663	2.3689	0.6663
0.8000	0.2895	0.6502	0.1706	4.0260	0.7673	2.1366	0.5821	2.1366	0.5821
0.9000	0.3257	0.6698	0.1704	3.8316	0.6998	1.9441	0.5149	1.9441	0.5149
1.0000	0.3618	0.6864	0.1699	3.6678	0.6449	1.7822	0.4603	1.7822	0.4603
1.1000	0.3980	0.7007	0.1692	3.5277	0.5995	1.6440	0.4151	1.6440	0.4151
1.2000	0.4342	0.7130	0.1683	3.4065	0.5614	1.5247	0.3774	1.5247	0.3774
1.3000	0.4704	0.7238	0.1675	3.3006	0.5291	1.4207	0.3454	1.4207	0.3454
1.4000	0.5066	0.7333	0.1666	3.2072	0.5015	1.3292	0.3180	1.3292	0.3180
1.5000	0.5428	0.7418	0.1657	3.1242	0.4775	1.2481	0.2943	1.2481	0.2943
1.6000	0.5789	0.7494	0.1649	3.0498	0.4565	1.1756	0.2736	1.1756	0.2736
1.7000	0.6151	0.7563	0.1641	2.9827	0.4380	1.1104	0.2554	1.1104	0.2554
1.8000	0.6513	0.7626	0.1633	2.9219	0.4216	1.0514	0.2393	1.0514	0.2393
1.9000	0.6875	0.7683	0.1625	2.8665	0.4069	0.9979	0.2249	0.9979	0.2249
2.0000	0.7237	0.7736	0.1618	2.8157	0.3937	0.9490	0.2120	0.9490	0.2120

Reference point	F multiplier	Absolute F
Fbar(3-8)	1.0000	0.3618
FMax	0.8160	0.2953
F0.1	0.3381	0.1223
F35%SPR	0.3536	0.128

Weights in kilograms

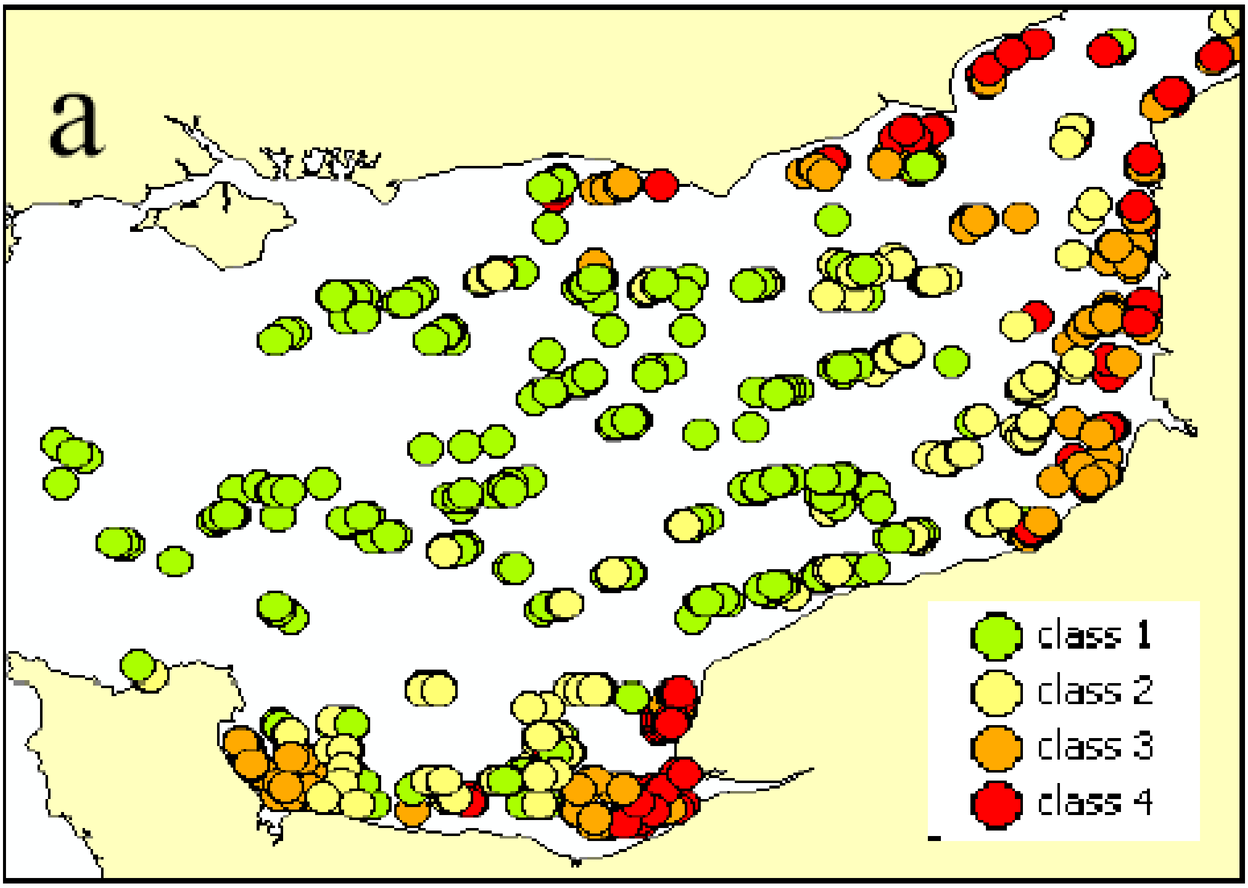
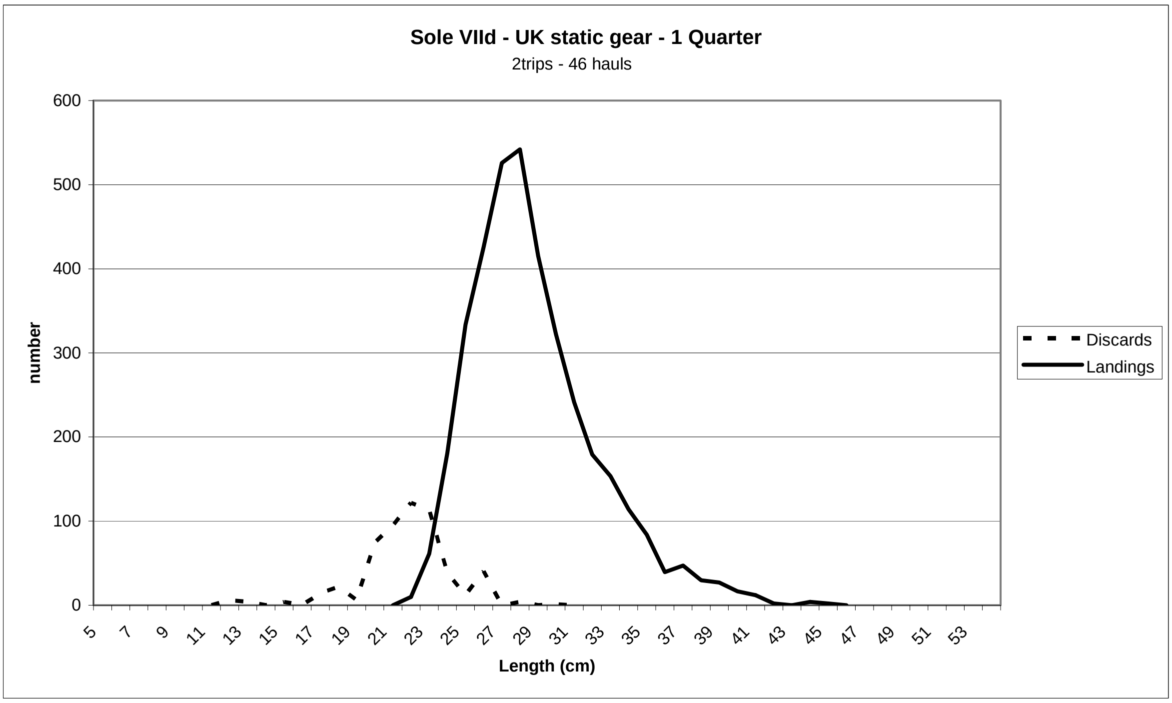


Figure 9.1.1 - Spatial distribution of Fish Subcommunities in the Eastern Channel from 1988 to 2003. Observed assemblage type at each station, These illustrate the gradation from open sea community to coastal and estuarine communities. (In Vaz et al., 2004)

Figure 9.2.1a - Sole VIId - UK Length distributions of discarded and retained fish from discard sampling studies



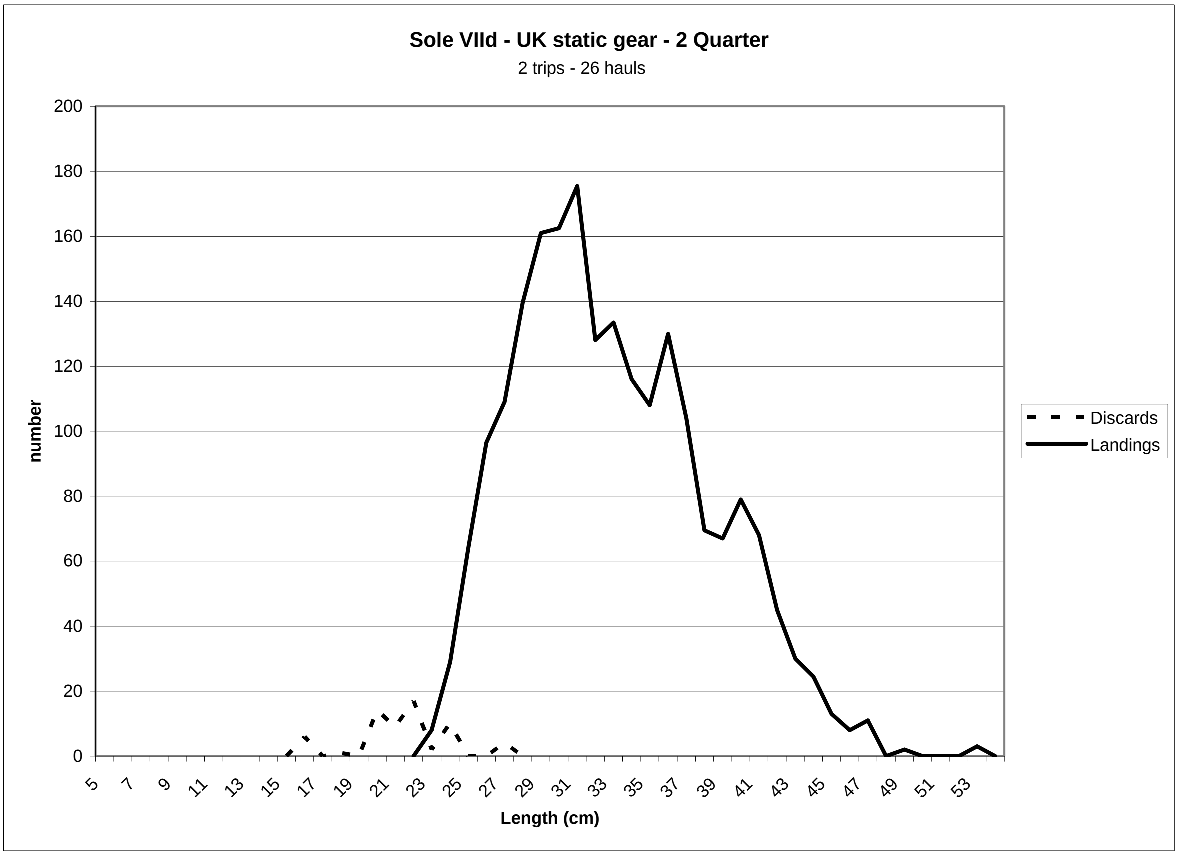
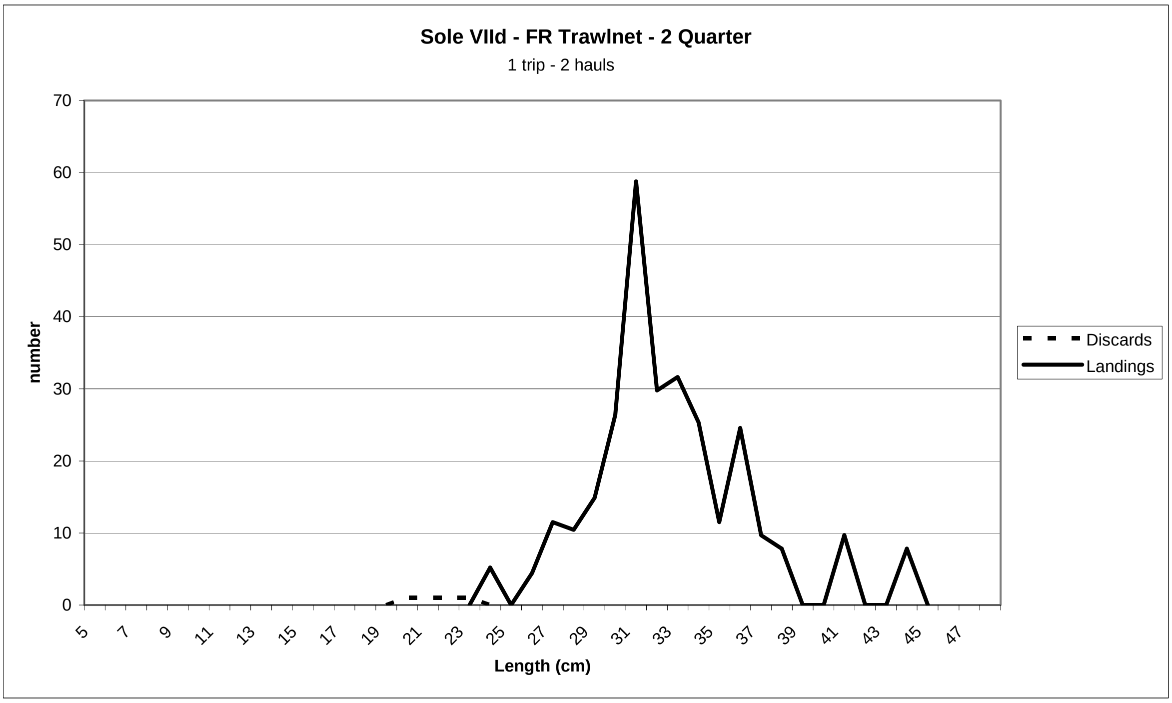


Figure 9.2.1b - Sole VIId - French Length distributions of discarded and retained fish from discard sampling studies



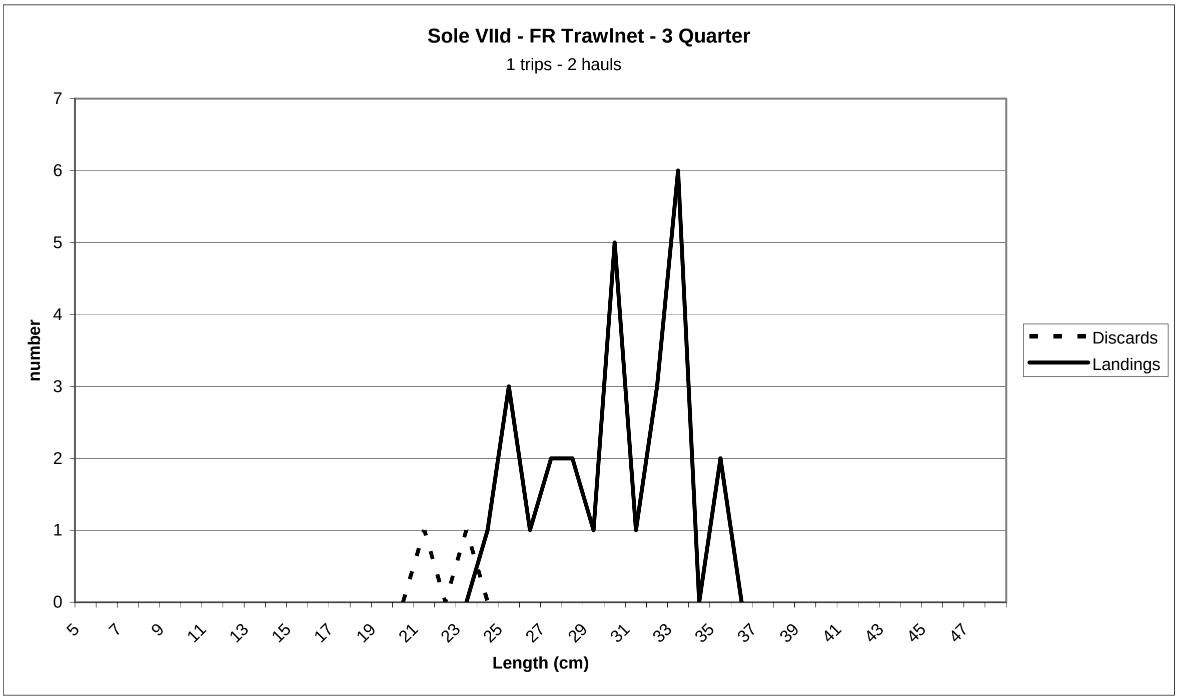


Figure 9.2.2a **Sole VIId - Effort series**

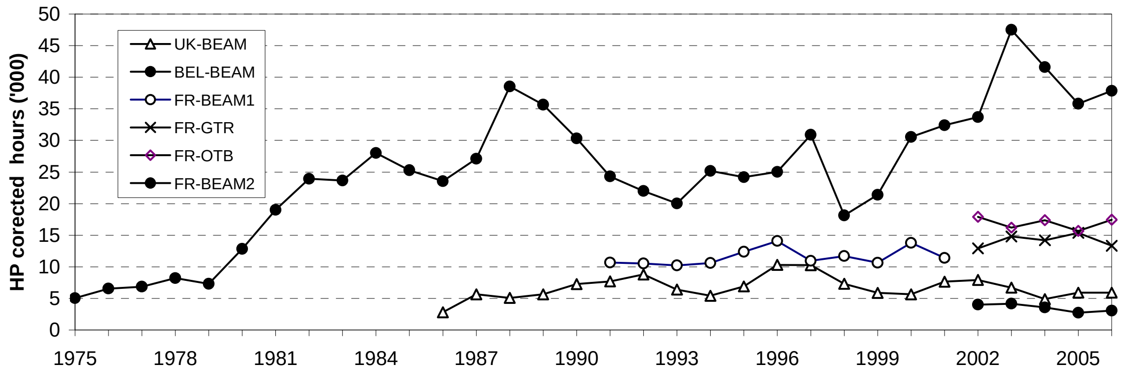


Figure 9.2.2b **Sole VIId - Relative Effort series**

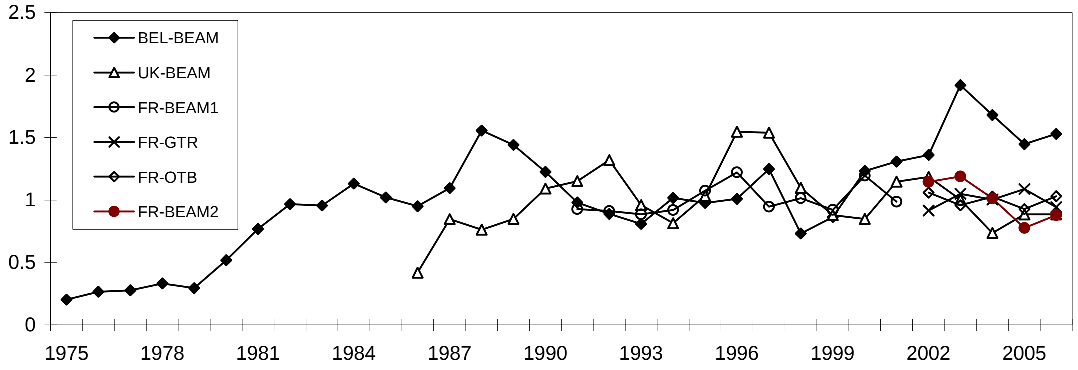


Figure 9.2.2c **Sole VIId - Relative LPUE series**

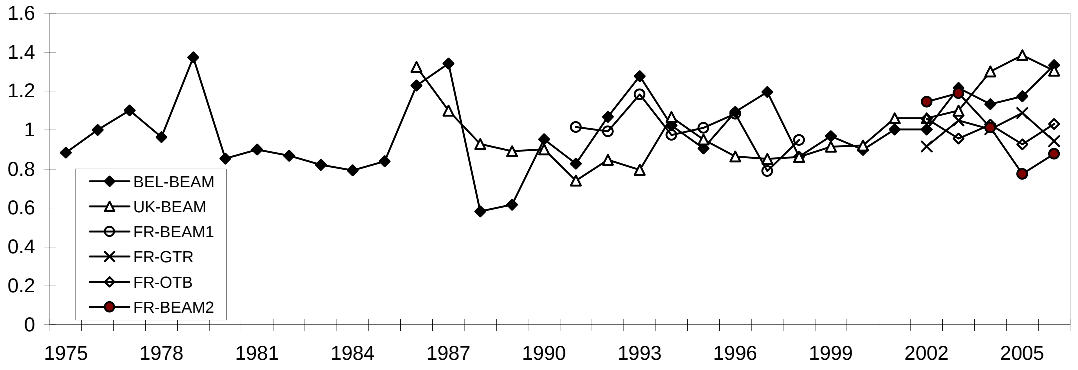


Figure 9.3.1 - Sole VIId -Standardised Survey indices from UK-BTS and YFS at age 1

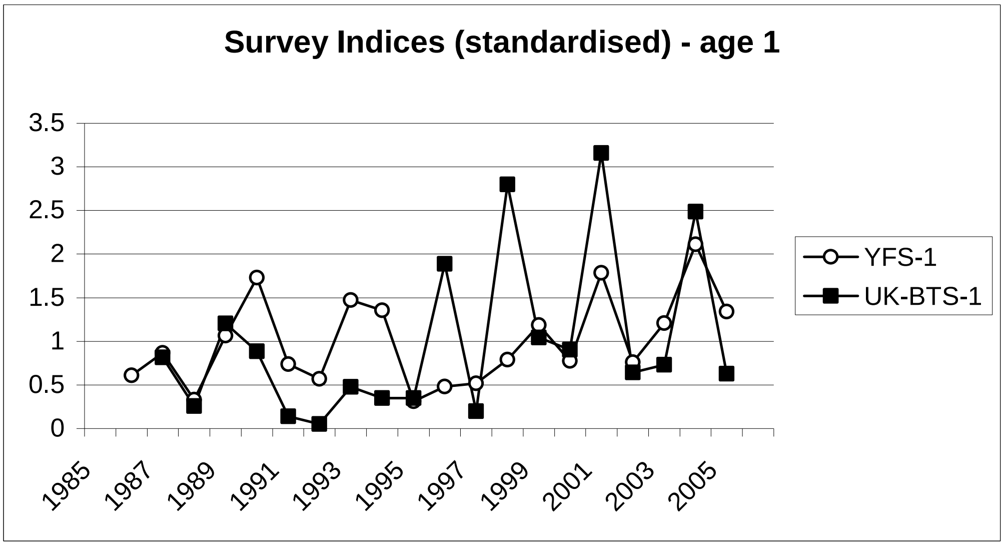


Figure 9.3.2 - VIId SOLE LOG CATCHABILITY RESIDUAL PLOTS - Final XSA

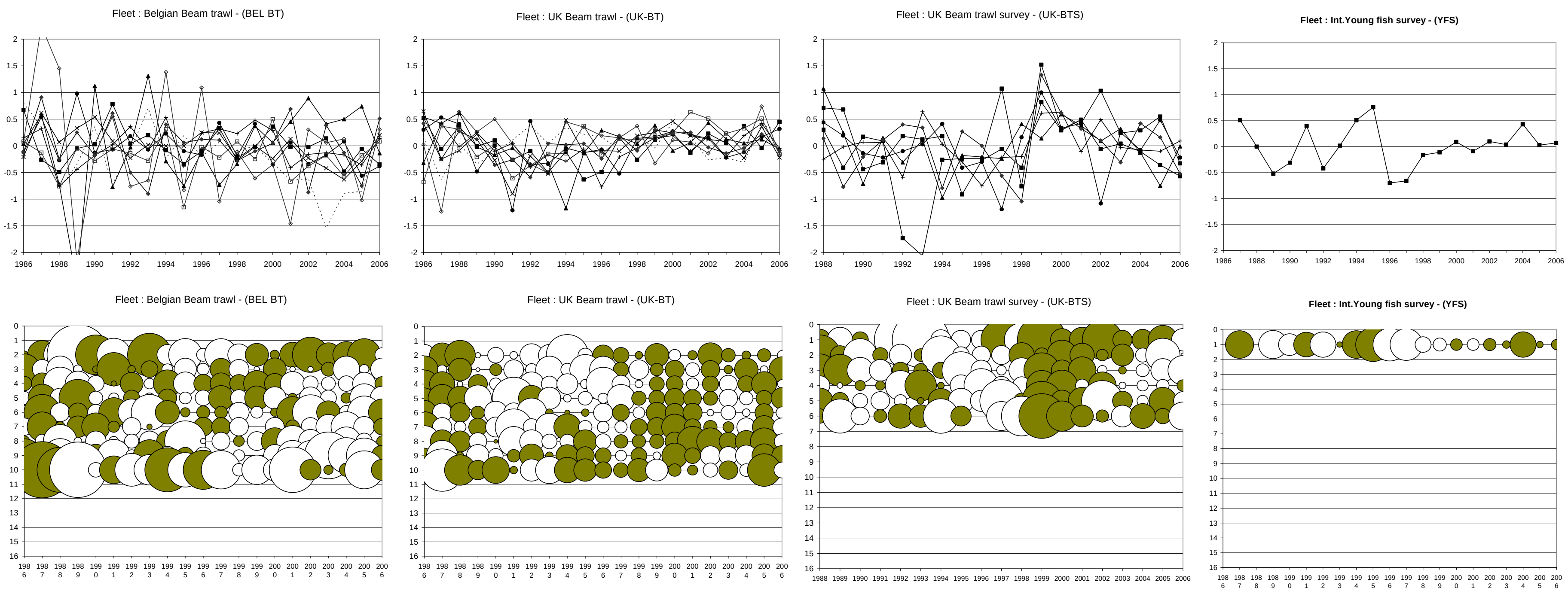
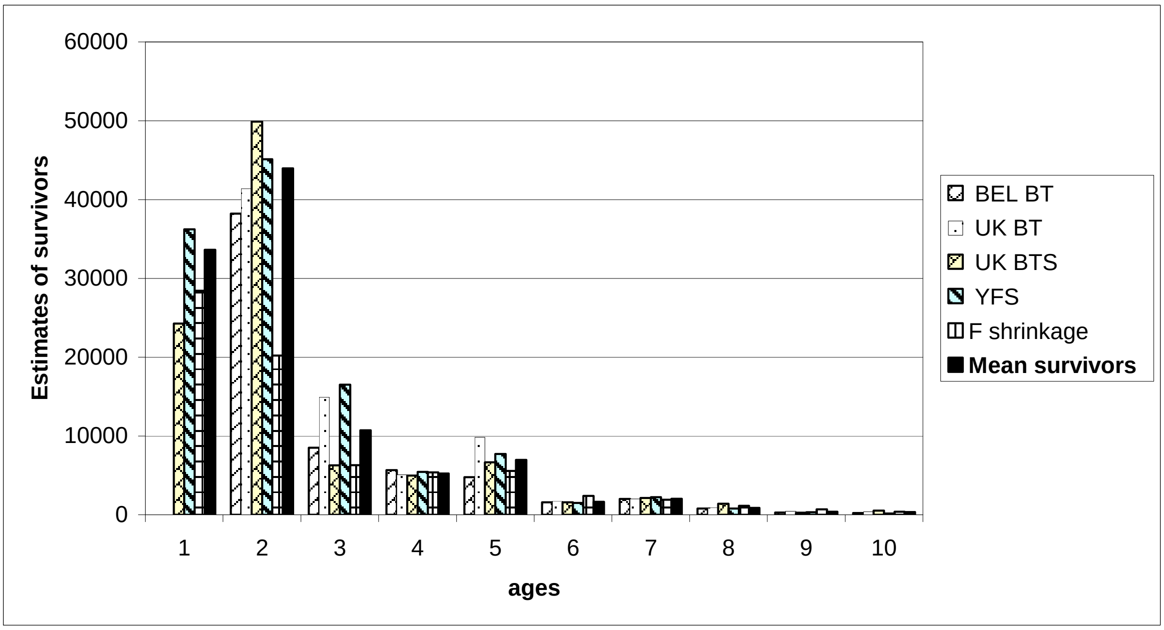


Figure 9.3.3 Sole in VIId. Estimates of survivors from different fleets and shrinkage, as well as their different weighting in the final XSA-run



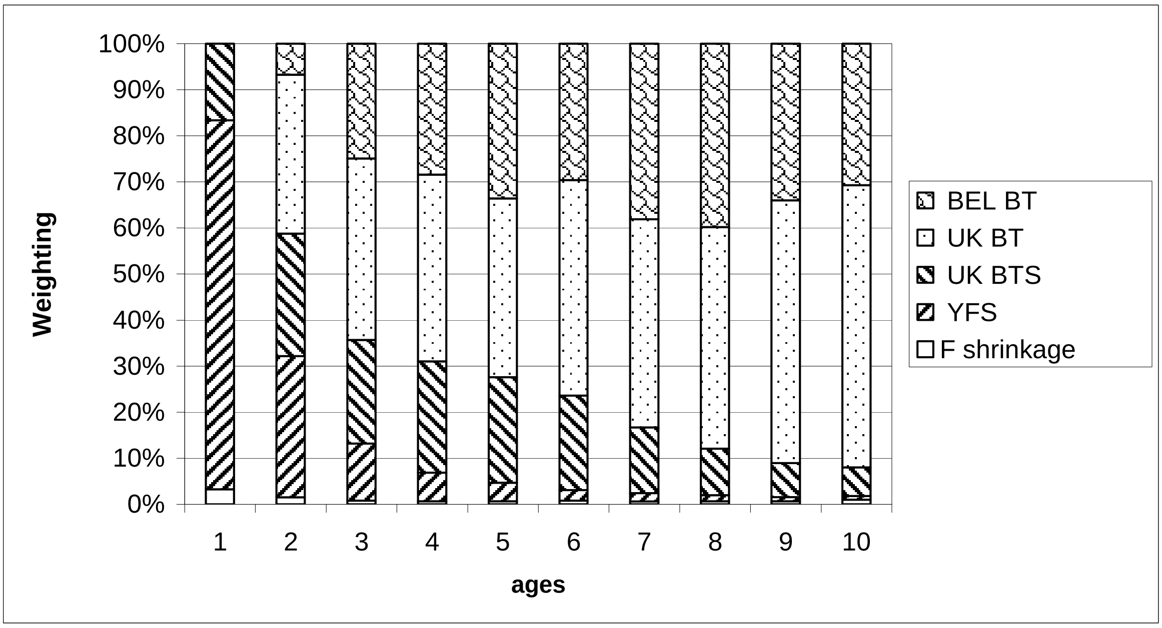


Figure 9.3.4 Sole in VIId. Summary plots

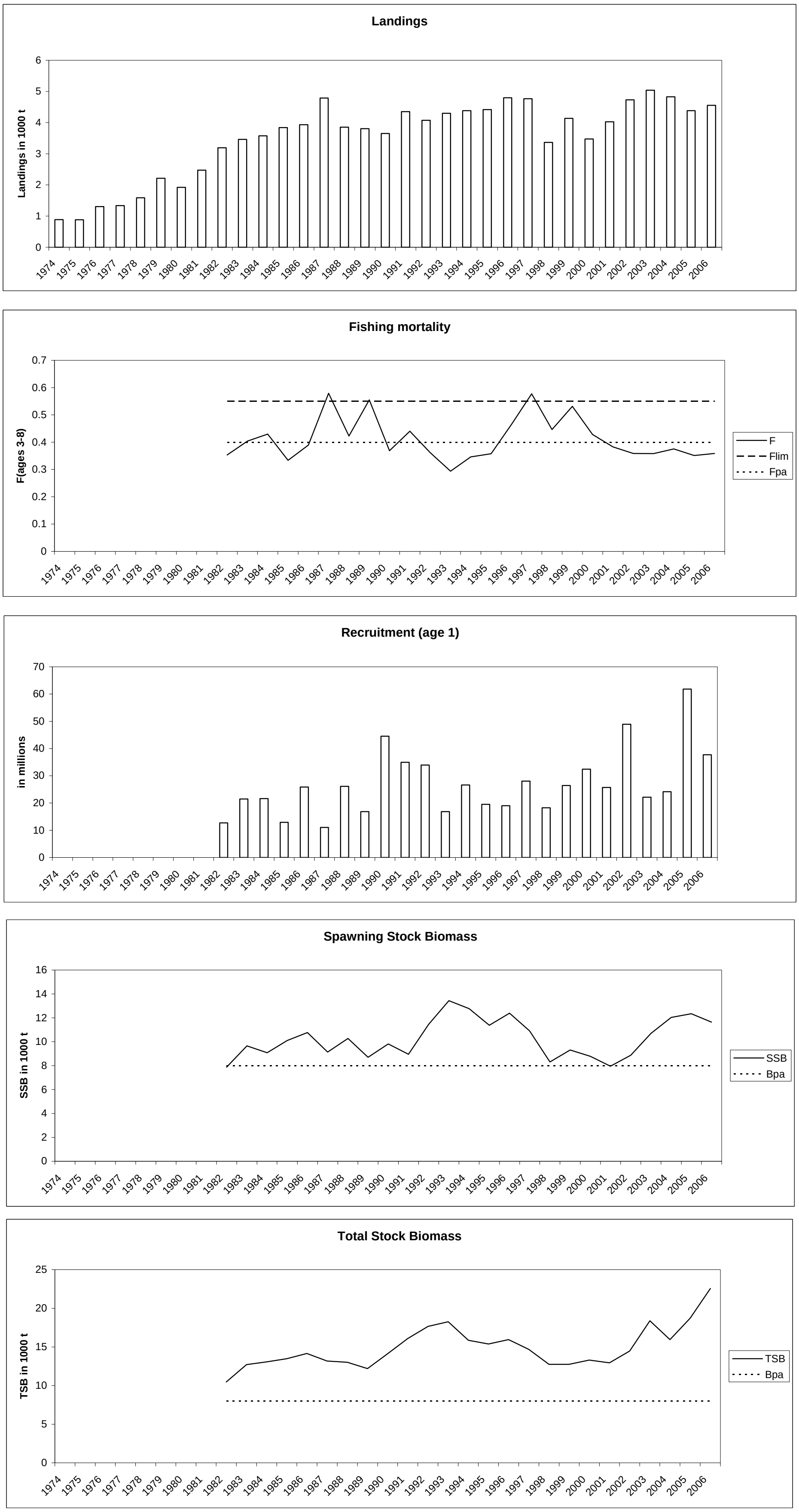


Figure 9.3.5 - Sole VIId retrospective XSA analysys (shinkage SE=2.0)

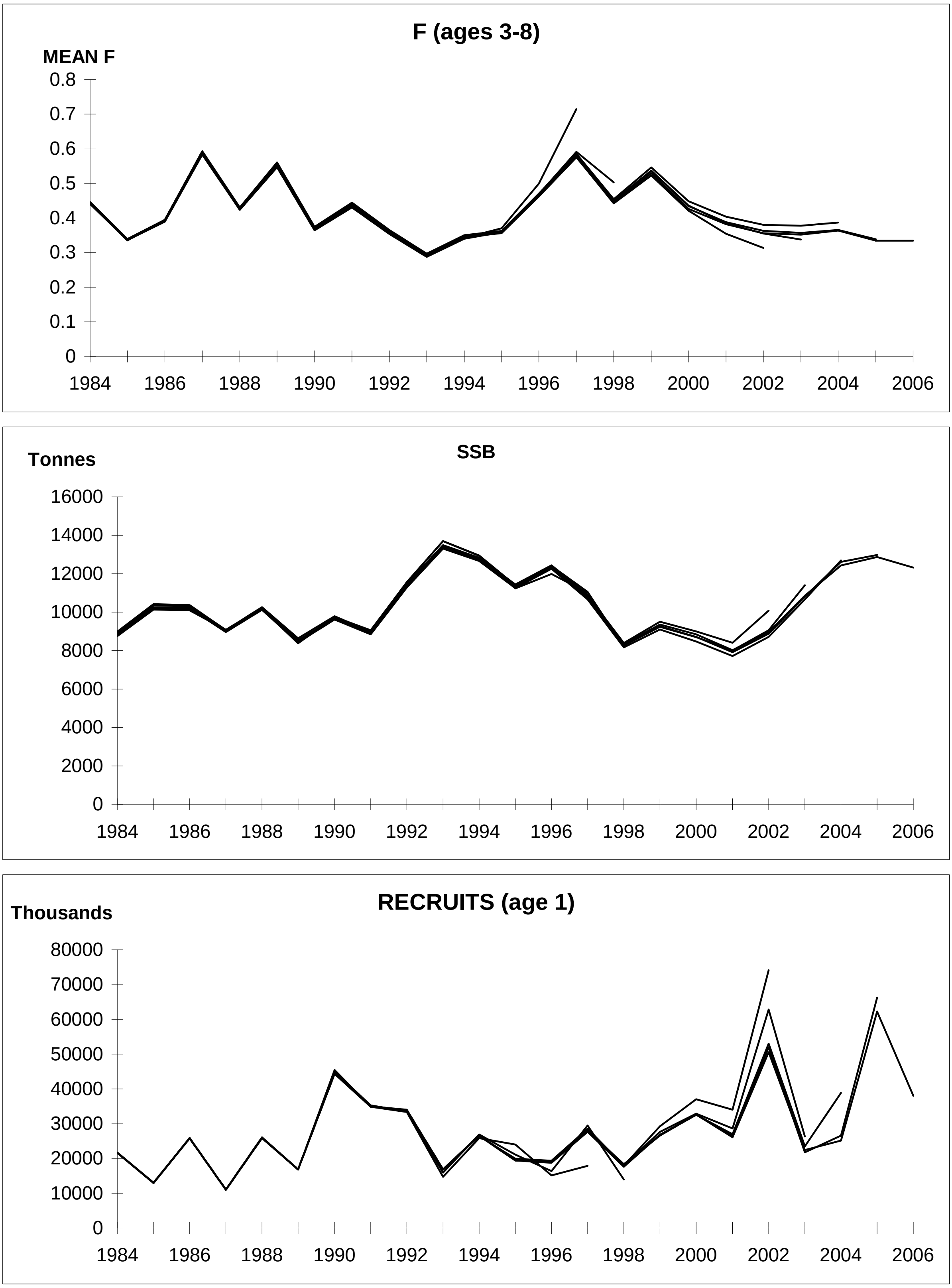
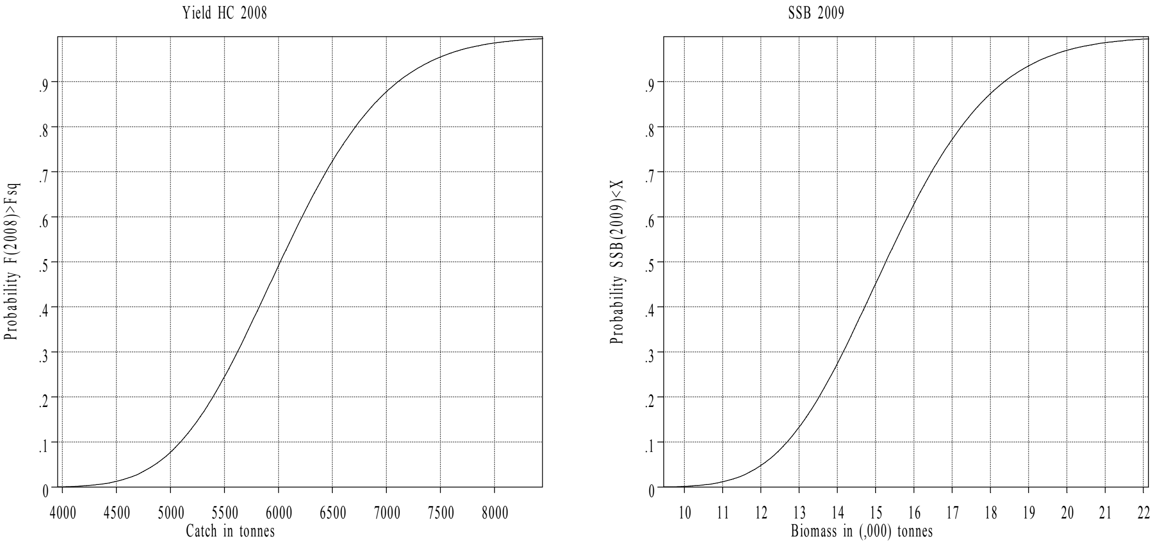
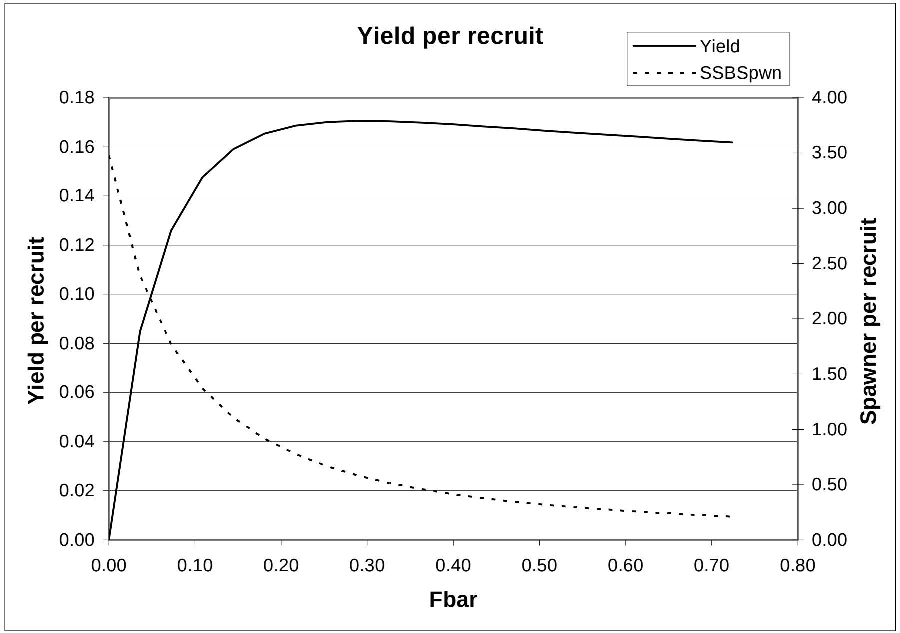


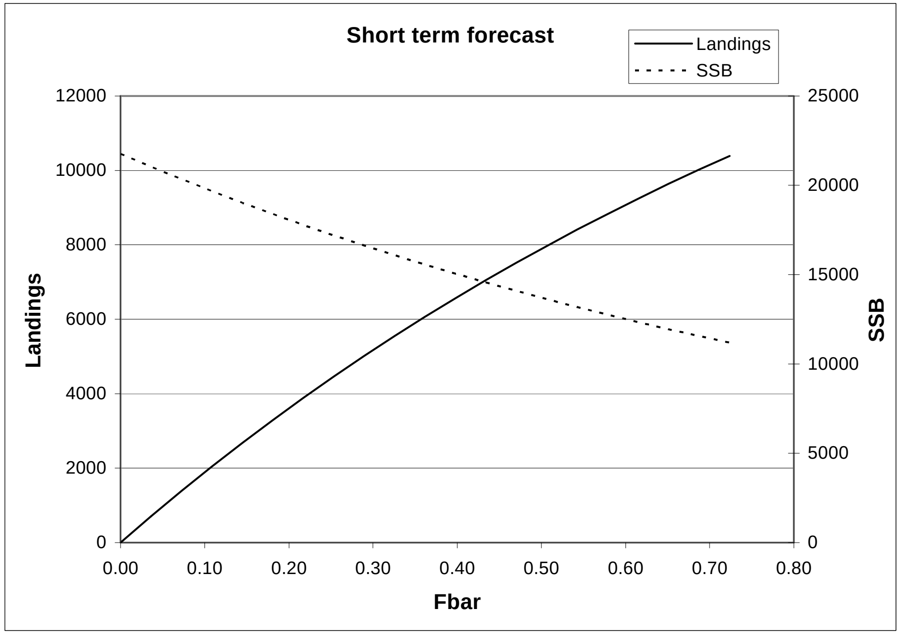
Figure 9.6.1 - Sole VIId - Probability profiles for short term forecast.



Data from file:C:\WGNSSK_2007\Sole_VIId\2007WG\Prediction\Sensetivity_insens\Pie

Figure 9.7.1 - Sole in VIId Yield per recruit and short term forecast plots





MFYPR version 2a
Run: Sole7d_Fin_yield
Time and date: 14:43 04/05/2007

Reference point	F multiplier	Absolute F
Fbar(3-8)	1.0000	0.3618
FMax	0.8160	0.2953
F0.1	0.3381	0.1223
F35%SPR	0.3536	0.1280

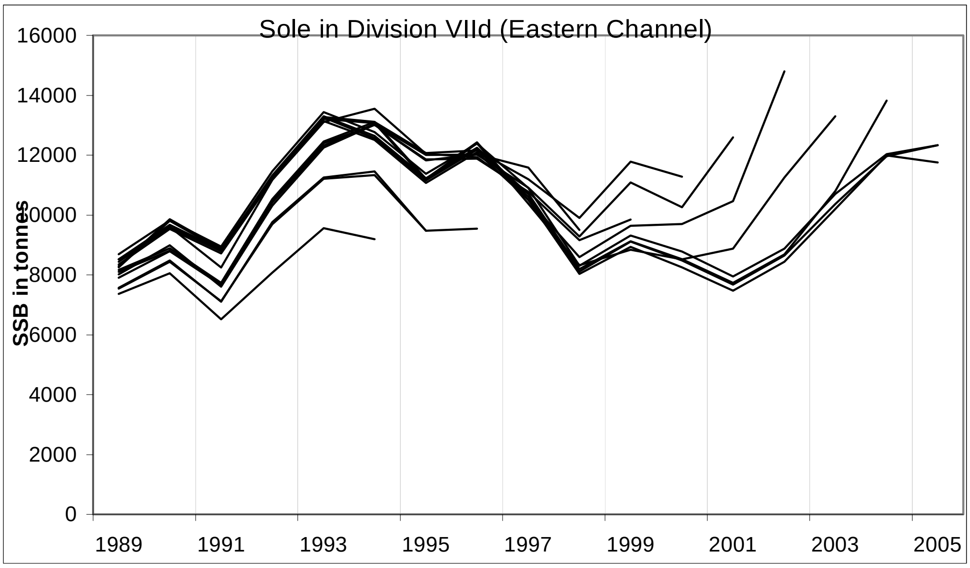
Weights in kilograms

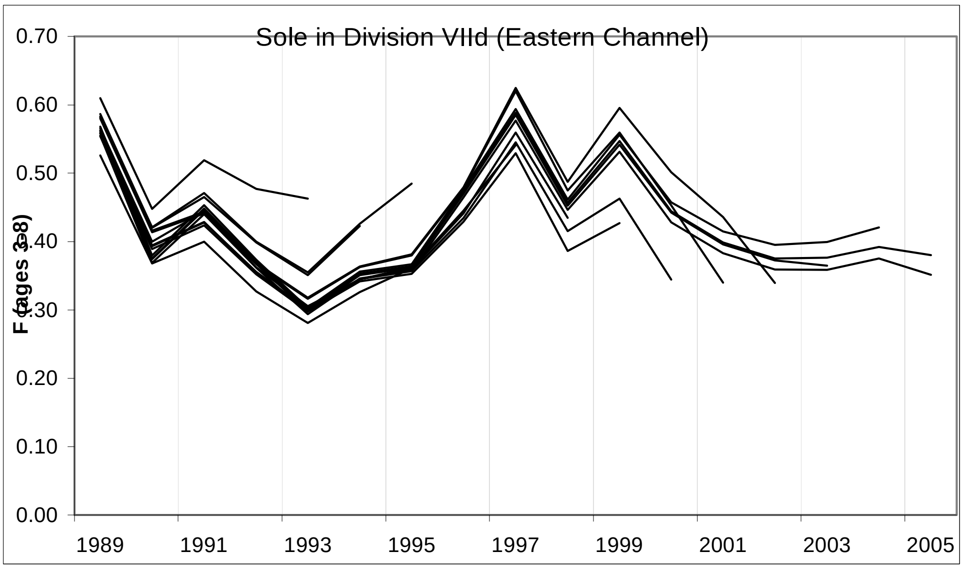
MFDP version 1a
Run: Sole7d_Fin
Sole in VIId
Time and date: 14:39 04/05/2007
Fbar age range: 3-8

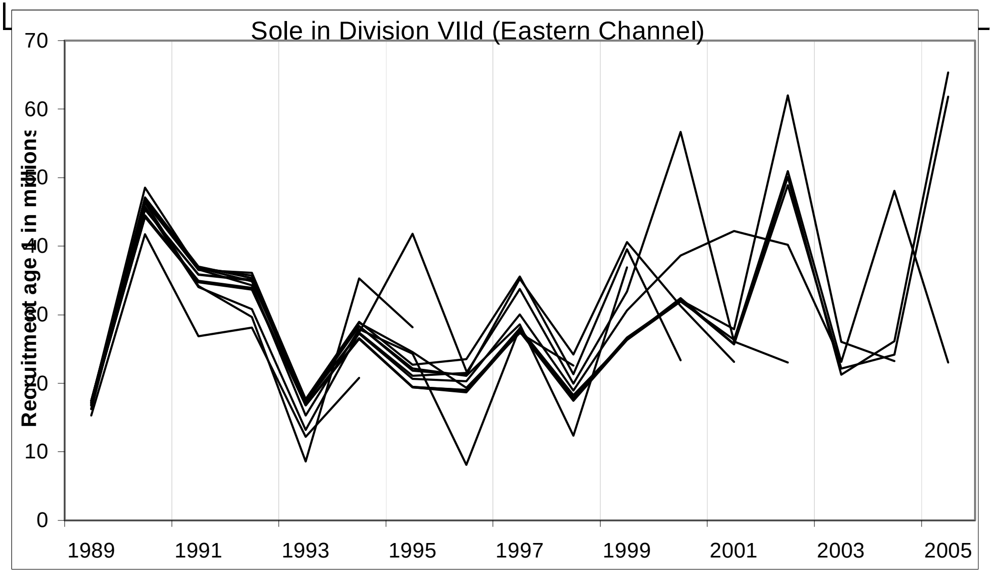
Input units are thousands and kg - output in tonnes

Figure 9.9.1 - Sole VIId Stock/recruitment plot

Figure 9.9.2 Sole in VIId. Historical Performance of assessment of successive WG assessment and forecast







10 Sole in Subarea IV

The assessment of sole in sub-area IV is presented as an update assessment with a sensitivity analysis requested by the review group. 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 trawl fleet 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, 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) and this was analyzed by the working group last year. It was concluded that fitting an efficiency factor to the time series of commercial lpue data resulted in improved fit of the model to the time series of fleet data but did not significantly change the estimates of biomass and mortality. The group noted that changes in the trend in efficiency change had occurred in recent years with a stabilization or decrease since 1996/7 and that efficiency changes could not be estimated for the most recent years. The WG therefore opted for an update assessment until a full benchmark analysis is carried out.

10.1.3 ICES Advice

In 2006, based on the estimate of SSB and fishing mortality, ICES classified the stock as being:

Below full reproductive capacity, and as being harvested unsustainably. SSB in 2006 was estimated at 30 000 t which is below Bpa (35 000 t), while F in 2004 (0.45) is above Fpa (0.4). The 2004 year class is estimated to be relatively weak and recruitment of the subsequent 2005 year class was estimated above the long term average.

Mixed fishery advice:

Demersal fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2007 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

There are no specific management objectives for this stock. The TAC in 2007 was set at 15 000 tonnes, which is 2 700 tonnes lower then the agreed TAC of 2006 (Table 10.2.1). A long term management plan (EC) is under consideration.

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 41/2007).

For 2006 Council Regulation (EC) N°51/2006 allocates different days at sea depending on gear, mesh size and catch composition. 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.

For 2007 Council Regulation N°41/2005, annex IIa allocates different days at sea depending on gear, mesh size and catch composition. (see section 2.1.2 for a complete list). The days at sea limitations for the major fleets operating in ICES sub-area IV could be summarised as follow: Beam trawlers can fish between 132-143 days per year. Trawls or Danish seines can fish between 103 and 280 days per year. Gillnets are allowed to fish between 140 and 162 days per year and Trammel nets between 140 and 205 days.

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 initited, 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 and illustrated in Figure 10.2.1a. In 2006 less than 75% of the TAC was taken, which is an exceptional low percentage.

The percentage of discards observed in the Dutch discards sampling programme sampling beam trawl vessels fishing for sole with 80 mm mesh size are much lower for sole (for 2002-2006, between 13-17% in weight, see Table 10.2.2) than for plaice. The fraction of sole discarded per age group is shown in Figure 10.2.1. The average fraction discarded decreased from 62% for age group 1 to 4% and less for age groups older then 3. No significant trends in discards percentages were observed. Inclusion of a stable time series of discards in the assessment will have minor effect on the relative trends in stock indications (Kraak et al 2002; Van Keeken et al 2003). Currently gaps in the discards sampling programs of North Sea sole result in an incomplete time series of sole for the reconstruction of discards and adding them into the assessment may result in sensitivities and noise similar to that recorded for the North Sea plaice assessment. With fishing mortality at ages 1 and 2 estimated to be very low (0.02 and 0.23) and exclusion of the percentage of discards currently recorded from the catch data is not considered to bias the assessment significantly, however this will be examined further at the next bench mark analysis of this stock.

10.2.2 Age compositions

The age composition (10+group) of the landings is presented in Table 10.2.3 and the percentage contribution of year classes plotted in Figure 10.2.1b. Age compositions and mean length at age in the landings were available on a quarterly basis from Belgium, Denmark, France, The Netherlands (by sex) and UK(E,W&N.I) (sexes combined). Age compositions on an annual basis were available from Scotland (sexes combined). Overall, the samples are thought to be representative for around 95 % of the total landings in 2006. 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). The Fishbase raising program data files for 2003 to 2005 were checked for errors and mistakes were discovered in the raising of the 2004 data. This resulted in the substantial drop in fishing mortality estimated for 2004 in previous years assessments.

10.2.3 Weight at age

Weights at age in the landings (Table 10.2.4, Figure 10.2.1d, 10+group) are measured weights from the various national market sampling programs. Weights at age in the stock (Table 10.2.5, Figure 10.2.1c) 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 10.2.1c,d). Estimates of weights for older ages fluctuate more because of smaller samples sizes as a result of decreasing numbers of older fish in the stock and landings.

10.2.4 Maturity and natural mortality

As in previous North Sea sole assessments, a knife-edged maturity-ogive was used, assuming full maturation at age 3. The maturity-ogive is based on market samples of females from observations in the sixties and seventies. See Mollet et. al. (2006) for a description of the shift of the age at maturity towards younger ages the sensitivity of the assessment estimates to the variation in maturity will be evaluated at the next benchmark assessment.

Natural mortality in the period 1957-2006 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 50% of the maximum effort (1994) (Table 10.2.6 and 10.2.7).

Trends in commercial LPUE of the Dutch beam trawl fleet by area are shown in Figure 10.2.3 (a). The data are based on various sources (Quirijns, 2007, Working paper 4). 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 and was compared with the time-series used for tuning the assessment after combining the ages. The patterns of both series are similar and differences within years were less than 10%.

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 10.2.4). The research vessel survey time series have been revised by WGBEAM (ICES-WGBEAM, 2006), because of small corrections in databases and new algorithms for estimating 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) (reference) and the Fortran version of XSA (Darby and Flatman 1994), which were found to give the same results.

10.3.1 Reviews of last year's assessment

In the following bullet points the comments made in 2006 by the RGNSSK (Technical Minutes) that are relevant to this stock are summarised, and it is explained how this WG addressed the comments.

- The main concern remains the use of a commercial lpue series as tuning series along with the two surveys. The analysis of the effect of the use of this tuning series is discussed in section 10.3.2
- Another concern is the large decline in F in 2004. See remarks below and 10.2.2.
- Discards could be a matter of concern. Time series of discard fraction of the catch per age group are discussed in section 10.2.1
- Anomaly in the landing at age matrix between 2004 and 2005. The Fishbase input files of 2003 to 2005 were checked and found to be incorrectly specified the historic landing at age information was used to correct mistake. After revision of the data the assessment result showed a reduction in the decline in F estimates for 2004.

10.3.2 Exploratory catch-at-age-based analysis

In previous working groups 3 tuning indices were included in the assessment. It was noted that the inclusion of a commercial lpue series was one of the major concerns of the review group. Therefore, some exploratory analyses were carried out to explore the sensitivity of an assessment with and without the commercial NL BT lpue series.

Five XSA runs were done: Three with single fleets (BTS, SNS, BTNL), a run with the survey fleets and a run with all 3 indices. The XSA run with the (single) SNS fleet was done with a plus group at age 5. Log catchability residual plots are shown in Figure 10.3.1. and 10.3.2. The diagnostics for the XSA run with only the survey indices and the commercial lpue series are available in ICES files. From the residual plots it was concluded that the model fit was better for the commercial data at the age groups 5 and older, while the latter gave a better signal for age 4 and younger.

In Figure 10.3.3 the retrospective analyses of F and SSB (Figure 10.3.4), using survey, commercial or all indices are shown. The retrospective patterns of the assessment fitted to the survey indices in comparison with the lpue series differ. Fitting to the survey indices leads to a higher final year F estimates and an improved retrospective pattern closer to that of the converged fits to the lpue series. If the lpue index is fitted in isolation the perception of last year F estimate is low but there is a strong retrospective pattern. Including all 3 series result in an estimated time series of F bar which lies in between the single fleet runs.

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 limited time allocated to the WG for its 2007 meeting precluded further investigation of the sensitivity until time is made available full benchmark review that includes a comparison of survey and commercial information and further analysis of the commercial fleet efficiency trends discussed earlier.

10.3.5 Final assessment

Catch at age analysis was carried out with XSA using the settings given below.

YEAR	2005	2006	2007
Catch at age	Landings	Landings	Landings
Fleets	BTS-Isis1985-2004 SNS 1982-2002 Nl-BT 1990-2004	BTS-Isis 1985-2005 SNS 1982-2005 Nl-BT 1990-2005	BTS-Isis 1985-2006 SNS 1982-2006 Nl-BT 1990-2006
Plus group	10	10	10
First tuning year	1982	1982	1982
Last data year	2004	2005	2006
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. Figure 10.3.5 shows the log catchability residuals for the tuning fleets in the final run. Figures 10.3.6 show the assessment final estimates of stock numbers at age in comparison to the tuning series estimates.

Fishing mortality and stock numbers per age group are presented in Tables 10.3.2 and 10.3.3 respectively. SSB in 2006 was estimated at 28,000t. Mean F(2-6) was estimated at 0.38. Recruitment of the 2005 year class, in 2006 at the age of 1, was estimated at 147 million.

Retrospective analysis is presented in Figure 10.3.6. There is a marked upwards revision of mean *F* estimates in consecutive years and a concurrent decrease in the estimates of SSB. Recruit estimates were relatively unbiased.

10.4 Historic Stock Trends

Table 10.4.1 and Figure 10.4.1 present the trends in landings, mean F(2-6), 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 2006 landings were estimated to be around 13 000 t.

Recruitment was high in 1959 and 1964 and contributed to an increased SSB from the end of the 1950s to a peak in early 1960s, followed by a period of declining SSB until the 1990s. Recruitment was again high in 1988 and 1992 resulting in another SSB increase between 1990-1995. The year classes 2003 and 2004 year classes were weak and will have contributed to the 6000t decline in SSB from 2005 to 2006 (estimated at 28,000t). Recruitment in 2006 of the 2005 year class at the age of 1 was estimated at 147 million to be higher than the long term geometric mean of 95 million.

The mean fishery mortality on ages 2-6 increased with from 1967 to a mean level of 0.5 in 1987, fluctuating between 0.4 – 0.6 until the late 1990's when a sharp increase to 0.7 has been followed by continued decline o 2006. In 2006 fishing mortality decreased compared to 2005 from 0.49 to 0.38 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. Geometric mean recruitment of 1-year-old-fish in the period 1957-2004 was around 95 million. For the 2006 yearclass (age 1 in 2007) the value predicted by the RCT3 was approximately 40% lower than the geometric mean (Table 10.5.2.). The estimate was based on the estimate of the DSF0 survey (20 000) and showed a large standard error (1.2) giving an uncertainty multiplier of $10^{\pm1}$, and therefore the geometric mean was accepted for the short-term forecasts. For the 2005 yearclass (age 2 in 2007), the data coming from DFS 1-group are also noisy (high s.e. of the predicted value, Table 10.5.3.). Apart from DFS0 data the RCT3 estimate is based on the same data as the XSA; the WG did not wish desirable to use the same data twice and therefore accepted the XSA estimate. The year class strength estimates from the different sources are summarized in the table below and the estimates used for the short-term forecast are bold-underlined. After the surveys that are executed in August and September 2007, the new information on year class strength of cohorts 2005 and 2006 will be used to provide an updated forecast for ACFM to consider revisions

YEAR CLASS	AGE IN 2007	XSA THOUSANDS	RCT3 THOUSANDS	GM(1957-2004) THOUSANDS
2005	2	**<u>126 000</u>**	113 000	
2006	1		69 000	**<u>95 160</u>**
2007	Recruit			**<u>95 160</u>**

10.6 Short-term forecasts

The short-term forecasts were carried out according to the specifications in the Stock Annex (Q10). The software used was FLR and WGFRANSW.

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 2006. Population numbers at ages 2 and older are XSA survivor estimates. Numbers at age 1 and recruitment of the 2007 year-class are taken from the long-term geometric mean (1957-2004: 95 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 2007 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 2008 and 2009, SSB is expected to increase from 23 600 t in 2007 to 33 700 t in 2008. The 2009 SSB is predicted to be 35 900 t. The landings at Fsq are expected to be around 12 400 t in 2007 which is below the 2007 TAC (15 000) and slightly lower than last years status quo forecast (13 400 t). The landings in 2008 are predicted to be around 14 800 t at Fsq. A F lower then 1.1 * Fsq will maintain SSB above Bpa (35 000) in 2009.

The probability-profile plot in Figure 10.6.1 (top panel) shows that the 90% confidence interval for the 2007 yield is from 10 000 to 21 000 t . Figure 10.6.1 (lower panel) also shows that fishing at Fsq in 2007 has a 50% probability that SSB will reach Bpa of 35 000 t in 2008, whereas the probability that SSB will fall below Blim (25 000 t) is less then 15%.

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 (2003-2007), and for almost 20% of year classes for which the geometric mean was taken (2006-2007). Other stock number estimates originate from XSA. The contribution of year classes 2006 and 2007 to SSB forecast in 2009 is approximately 35%. These forecasts are subject to revision by ACFM in October 2007 when new survey information becomes available/

Yield and SSB, per recruit, under the condition of the current exploitation pattern and assuming Fsq as exploitation rate in 2007 are given in Table 10.6.4 and Figure 10.6.3. Fmax is estimated at 0.51.

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 proposed management plan for North Sea plaice and sole that is published by the EC (5403/06 PECHE 14) uses the target reference **F** of 0.2 for sole..

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 also confirmed in this year's assessment results. The low terminal mean *F* (2005) estimate for 2004 of 0.35 was not confirmed by the current assessment and was estimated to be 0.46 due to a revision of the dataset in that year. Terminal mean *F* (2006) estimate for 2005 of 0.45 was estimated to be 0.49 in this years assessment. The (2006) SSB estimate for 2005 was 40 000 t, which is 5 000 t higher then the estimate in the current assessment. The historic performance of the assessment is summarized in Figure 10.10.1.

The XSA assessment showed a decrease in SSB in 2007 compared to 2006, caused by an average year class 2002 (90 000 million) and weak year classes 2003 and 2004 (44 000 million) being caught.

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 0.38 in 2006, Fishing mortality appears to be below Fpa (=0.4). The SSB in 2006 was estimated at 28 000 t which is below Bpa (=35 000 t). The average year class in 2002 is followed by two weak year classes in 2003 and 2004 and a strong year class in 2005. Projected landings for 2008 at Fsq are 15 000 t. and higher than projected landings for 2007 (12 500)

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 to be reflected in the recent estimates in fishing mortality. 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.

10.12 North Sea sole update forecast

This working document presents an updated Short Term Forecasts for North Sea sole, based on new recruitment estimates including the BTS survey in 2007. The documents includes sections on recruitment estimates and Short Term Forecasts. We propose to use RCT3 estimates from age 1 and the XSA estimate from age 2 as input in the Short Term Forecast.

10.12.1 Recruitment estimates

Recruitment estimation was carried using RCT3. Input to the RCT3 model is presented in Table 10.12.1.1 for age-1 and age-2. Results are presented in Table 10.12.1.2 for age-1 and age-2. Average recruitment of 1-year-old-fish in the period 1957-2004 was around 95 million (geometric mean). For year class 2006 (age 1 in 2007) the value predicted by the RCT3 was approximate 30% lower as the geometric mean. The estimate was based on the estimates of the DSF0 (20 million) and BTS1 (70 million) after the surveys executed in August and September 2007. Standard errors (1.2 and 0.4) give uncertainty multiplier of $10^{\pm 1}$ and $2.2^{\pm 1}$ for the DFS and BTS survey respectively. Rsquares of the regression were 0.3 and 0.75 for DFS and BTS survey results respectively. The RCT3 mean of year class 2006 was accepted as input for the short-term forecasts. For year class 2005 (age 2 in 2007) the RCT3 estimate equals 130 000. The data originating from DFS 1-group are also noisy (high s.e. of the predicted value. Apart from DFS0 and BTS1 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 for year class 2005. The year class strength estimates from the different sources are summarized in the table below and the estimates used for the short-term forecast are bold-underlined

Year Class	Age in 2007	XSA thousands	RCT3 thousands	GM(1957-2004) thousands
2005	2	**126 000**	130 000	
2006	1		**68 000**	95 160
2007	Recruit			**95 160**

10.12.2 Short-term forecasts

The short-term forecasts were carried out in FLR (FLSTF).

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 2006. Population numbers at ages 2 and older are XSA survivor estimates. Numbers at age 1 in the intermediate year are taken from the RCT3 analysis. and recruitment of the 2007 year-class are taken from the long-term geometric mean (1957-2004: 95 million).

Input to the short term forecast is presented in Table 10.12.2.1.The management options are given in Table 10.12.2.2. F in 2007 is set at the status quo level. The detailed table for a forecast based on Fsq is given in Table 10.12.2.3. At status quo fishing mortality in 2007 and 2008, SSB is expected to increase from 23 600 t in 2007 to 33 700 t in 2008. The 2009 SSB is predicted to be 32 500 t. The landings at Fsq are expected to be around 12 300 t in 2007 which is below the 2007 TAC (15 000) and slightly lower than last years status quo forecast (13 400 t). The landings in 2008 are predicted to be around 14 000 t at Fsq (table 10.12.2.4). A F lower then 0.8 * Fsq will maintain SSB above Bpa (35 000) in 2009 and resulting landings amount 11 600 t. At F equals 0.9 * Fsq the landings will be 12 900 t, which is 14% less than the 2007 TAC.

Table 10.2.2 Sole in sub-area IV: Overview of landings and discards numbers and weights (kg) per hour and there percentages in the Dutch discards

			Numbers			Weight	
Period	trips	Landings	Discards	%D	Landings	Discards	%D
	n	$n \cdot h^{-1}$	$n \cdot h^{-1}$		$kg \cdot h^{-1}$	$kg \cdot h^{-1}$	
1976-1979	21	116	8	6%	38	1	3%
1980-1983	22	84	23	21%	27	3	9%
1989-1990	6	286	83	22%	72	11	13%
1999-2001	20	92	21	19%	22	2	8%
2002	6	124	37	24%	18	3	13%
2003	9	95	32	25%	20	3	14%
2004	8	174	58	25%	28	5	17%
2005	9	99	29	23%	20	2	11%
2006	9	64	26	29%	16	2	13%

Table 10.2.3 Sole in sub-area IV: Landings numbers at age (thousands)

[1] 2007-05-04 14:34:42 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	516	14950	47970	9524	7457	2165	901	961	389	389
2005	1156	7417	23141	29523	4262	3948	1524	616	785	401
2006	6814	9690	10109	9340	10640	1572	1533	704	363	538

Table 10.2.4 Sole in sub-area IV: Landing weights at age (kg)

[1] 2007-05-04 14:34:43 units= kg

year \ age	1	2	3	4	5	6	7	8	9	10
1957	0.000	0.160	0.184	0.212	0.258	0.290	0.302	0.348	0.454	0.425
1958	0.000	0.146	0.179	0.221	0.255	0.274	0.316	0.325	0.390	0.416
1959	0.000	0.164	0.190	0.230	0.263	0.304	0.331	0.324	0.377	0.430
1960	0.000	0.152	0.184	0.233	0.252	0.275	0.299	0.307	0.379	0.415
1961	0.000	0.148	0.176	0.214	0.259	0.292	0.323	0.308	0.351	0.425
1962	0.000	0.154	0.164	0.207	0.240	0.293	0.318	0.319	0.332	0.409
1963	0.000	0.162	0.170	0.217	0.256	0.306	0.320	0.384	0.373	0.481
1964	0.148	0.169	0.206	0.243	0.265	0.299	0.316	0.334	0.375	0.464
1965	0.000	0.162	0.200	0.236	0.274	0.271	0.331	0.363	0.388	0.460
1966	0.000	0.175	0.188	0.178	0.298	0.328	0.424	0.395	0.444	0.496
1967	0.000	0.196	0.206	0.258	0.283	0.398	0.428	0.347	0.434	0.502
1968	0.157	0.188	0.206	0.266	0.326	0.341	0.353	0.454	0.464	0.506
1969	0.155	0.195	0.200	0.260	0.317	0.381	0.564	0.406	0.477	0.533
1970	0.154	0.212	0.218	0.285	0.350	0.404	0.441	0.463	0.443	0.533
1971	0.147	0.195	0.240	0.326	0.362	0.430	0.425	0.496	0.540	0.554
1972	0.167	0.202	0.249	0.330	0.429	0.420	0.526	0.480	0.552	0.622
1973	0.149	0.212	0.243	0.353	0.412	0.456	0.562	0.578	0.519	0.597
1974	0.162	0.189	0.230	0.333	0.412	0.442	0.513	0.551	0.601	0.644
1975	0.130	0.184	0.227	0.323	0.410	0.461	0.535	0.601	0.636	0.676
1976	0.146	0.194	0.227	0.313	0.397	0.451	0.523	0.574	0.681	0.679
1977	0.150	0.192	0.240	0.313	0.376	0.432	0.438	0.530	0.573	0.631
1978	0.151	0.195	0.230	0.313	0.368	0.424	0.464	0.415	0.569	0.663
1979	0.139	0.211	0.249	0.327	0.396	0.454	0.541	0.551	0.617	0.772
1980	0.144	0.203	0.249	0.338	0.378	0.426	0.509	0.561	0.610	0.698
1981	0.147	0.192	0.232	0.332	0.388	0.435	0.454	0.530	0.556	0.647
1982	0.143	0.191	0.219	0.311	0.376	0.415	0.443	0.498	0.588	0.665
1983	0.135	0.183	0.218	0.302	0.391	0.418	0.469	0.491	0.507	0.645
1984	0.154	0.172	0.222	0.287	0.362	0.387	0.467	0.557	0.577	0.636
1985	0.121	0.185	0.214	0.285	0.353	0.423	0.442	0.538	0.606	0.638
1986	0.134	0.178	0.212	0.297	0.355	0.404	0.482	0.540	0.564	0.606
1987	0.138	0.184	0.204	0.276	0.354	0.376	0.426	0.478	0.391	0.653
1988	0.127	0.175	0.217	0.270	0.354	0.428	0.484	0.520	0.558	0.712
1989	0.116	0.170	0.213	0.283	0.331	0.369	0.449	0.484	0.463	0.601
1990	0.123	0.181	0.225	0.289	0.367	0.409	0.411	0.509	0.471	0.613
1991	0.125	0.183	0.206	0.259	0.310	0.429	0.435	0.459	0.498	0.548
1992	0.144	0.175	0.210	0.254	0.294	0.374	0.403	0.453	0.480	0.547
1993	0.096	0.165	0.194	0.236	0.261	0.297	0.334	0.436	0.490	0.596
1994	0.141	0.178	0.200	0.225	0.254	0.296	0.313	0.427	0.404	0.504
1995	0.150	0.185	0.195	0.245	0.263	0.317	0.342	0.353	0.441	0.587
1996	0.161	0.175	0.200	0.231	0.271	0.282	0.314	0.366	0.386	0.587
1997	0.150	0.178	0.204	0.234	0.264	0.293	0.320	0.303	0.380	0.435
1998	0.127	0.180	0.187	0.250	0.260	0.287	0.333	0.289	0.332	0.500
1999	0.161	0.177	0.210	0.227	0.284	0.321	0.350	0.368	0.368	0.448
2000	0.144	0.168	0.198	0.246	0.287	0.296	0.320	0.364	0.398	0.423
2001	0.139	0.179	0.196	0.262	0.266	0.323	0.379	0.401	0.420	0.478
2002	0.139	0.181	0.209	0.241	0.279	0.309	0.363	0.316	0.566	0.531
2003	0.136	0.182	0.214	0.256	0.273	0.317	0.340	0.344	0.502	0.430
2004	0.127	0.180	0.209	0.252	0.263	0.284	0.378	0.367	0.327	0.425
2005	0.168	0.181	0.202	0.238	0.236	0.276	0.259	0.369	0.311	0.392
2006	0.160	0.195	0.226	0.270	0.299	0.331	0.301	0.368	0.408	0.408

Table 10.2.5 Sole in sub-area IV: Stock weights at age (kg)

[1] 2007-05-04 14:34:43 units= 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	0.601
2005	0.050	0.150	0.189	0.234	0.237	0.258	0.276	0.396	0.369	0.428
2006	0.050	0.148	0.197	0.250	0.270	0.319	0.286	0.341	0.409	0.456

Table 10.2.6 Sole in subarea IV: Effort and CpUE series

year	NL beam Effort HP days ($\cdot 10^6$)	lpue kg· 1000HP days^{-1}
1990	71.1	423.0
1991	68.5	386.0
1992	71.1	339.8
1993	76.9	338.3
1994	81.4	331.2
1995	81.2	298.3
1996	72.1	244.6
1997	72.0	165.2
1998	70.2	250.8
1999	67.3	283.6
2000	64.6	259.3
2001	61.4	263.8
2002	56.7	243.2
2003	51.6	279.9
2004	48.1	309.0
2005	49.1	260.2
2006	44.1	190.4

Table 10.2.7 Sole in subarea IV: Tuning data. BTS and SNS surveys (Year, effort index, lpue at age)

```
 [1] 2007-05-04 14:34:43
[1] BTS-ISIS  units= NA
                              Age
             1     2      3     4     5     6     7     8     9
1985 1    2.65  7.89  3.541 1.669 0.620 0.279 0.000 0.000 0.000
1986 1    7.88  4.49  1.726 0.826 0.590 0.221 0.108 0.000 0.018
1987 1    6.97 12.55  1.834 0.563 0.583 0.222 0.228 0.058 0.000
1988 1   83.11 12.51  2.684 1.032 0.123 0.149 0.132 0.103 0.014
1989 1    9.02 68.08  4.191 4.096 0.677 0.128 0.242 0.000 0.051
1990 1   22.60 22.36 20.090 0.611 0.682 0.511 0.078 0.055 0.013
1991 1    3.71 23.19  5.843 6.011 0.103 0.137 0.064 0.040 0.011
1992 1   74.44 23.20  9.879 2.332 2.903 0.061 0.142 0.065 0.016
1993 1    4.99 27.36  0.987 4.367 2.376 4.295 0.024 0.090 0.057
1994 1    5.88  4.99 15.422 0.133 1.412 0.095 1.006 0.010 0.000
1995 1   27.86  8.46  7.039 6.718 0.476 0.913 0.314 0.966 0.049
1996 1    3.51  6.17  1.909 1.488 2.493 0.308 0.406 0.051 0.299
1997 1 173.94  5.37  3.234 0.800 0.769 0.403 0.105 0.038 0.045
1998 1   14.12 29.21  1.998 1.346 0.079 0.016 0.424 0.000 0.000
1999 1   11.41 19.26 16.626 0.629 2.061 0.334 0.224 0.651 0.003
2000 1   14.46  6.53  4.207 1.587 0.283 0.153 0.064 0.008 0.162
2001 1    8.17 10.71  2.335 1.683 0.737 0.081 0.040 0.030 0.000
2002 1   21.90  4.17  3.431 0.906 0.356 0.359 0.022 0.060 0.000
2003 1   10.76 10.55  2.506 1.752 0.380 0.202 0.337 0.000 0.022
2004 1    3.65  4.40  3.618 0.630 0.650 0.122 0.072 0.075 0.000
2005 1    3.14  3.29  2.375 1.337 0.137 0.139 0.078 0.046 0.000
2006 1   16.82  2.44  0.300 0.763 0.516 0.163 0.095 0.000 0.008
```

[1] SNS units= NA

		1	2	3	4
1970	1	5410	734	238	35
1971	1	893	1844	110	3
1972	1	1455	272	149	0
1973	1	5587	935	84	37
1974	1	2348	361	65	0
1975	1	529	848	166	47
1976	1	1399	74	229	27
1977	1	3743	776	104	43
1978	1	1548	1355	294	28
1979	1	94	408	301	77
1980	1	4313	89	109	61
1981	1	3737	1413	50	20
1982	1	5856	1146	228	7
1983	1	2621	1123	121	40
1984	1	2493	1100	318	74
1985	1	3619	716	167	49
1986	1	3705	458	69	31
1987	1	1948	944	65	21

		1	2	3	4
1988	1	11227	594	282	82
1989	1	2831	5005	208	53
1990	1	2856	1120	914	100
1991	1	1254	2529	514	624
1992	1	11114	144	360	195
1993	1	1291	3420	154	213
1994	1	652	498	934	10
1995	1	1362	224	143	411
1996	1	218	349	30	36
1997	1	10279	154	190	26
1998	1	4095	3126	142	99
1999	1	1649	972	456	10
2000	1	1639	126	166	118
2001	1	970	655	107	35
2002	1	7542	379	195	0
2003	1	NA	NA	NA	NA
2004	1	1367	623	396	69
2005	1	568	163	124	0
2006	1	4167	382	80	105

Table 10.2.7 cont. Sole in subarea IV: Commercial series from NL beam trawl (Year, effort index, lpue at age)

[1] NL Beam Trawl units= NA

		Age							
		2	3	4	5	6	7	8	9
1990	71.1	127.6	1190	101.9	92.6	23.5	8.93	11.52	5.288
1991	68.5	107.1	251	872.3	67.7	31.2	9.97	4.55	5.723
1992	71.1	71.0	477	156.6	419.6	20.5	29.27	6.27	3.080
1993	76.9	510.9	142	313.8	125.2	242.2	11.53	10.56	3.069
1994	81.4	66.2	858	91.1	159.8	38.1	109.74	2.33	6.437
1995	81.2	120.4	140	658.7	35.0	63.2	11.05	57.66	1.810
1996	72.1	219.7	126	154.9	294.2	21.8	44.01	6.55	38.474
1997	72.0	62.6	256	62.6	46.2	135.7	6.90	25.00	1.319
1998	70.2	720.4	129	158.4	26.0	16.3	48.36	3.01	4.801
1999	67.3	175.6	820	61.7	66.3	10.8	4.99	22.69	1.976
2000	64.6	190.5	458	336.6	31.7	24.5	7.04	4.98	9.923
2001	61.4	305.0	222	243.8	213.0	11.7	8.24	2.21	1.515
2002	56.7	158.8	437	140.0	106.4	89.6	7.48	6.77	0.952
2003	51.6	502.8	224	241.1	65.8	54.7	38.02	4.36	1.202
2004	48.1	232.6	774	117.1	105.2	24.7	13.31	11.27	2.807
2005	49.1	103.1	333	428.3	77.3	40.8	18.76	5.89	12.607
2006	44.1	114.7	154	152.1	186.5	21.6	21.43	11.84	6.100

Table 10.3.1. Sole in sub area IV: XSA diagnostics of final catch-at-age-based analysis

FLR XSA Diagnostics 2007-05-04 14:21:10
CPUE data from xsa.indices

Catch data for 50 years. 1957 to 2006. Ages 1 to 10.

	fleet	first age	last age	first year	last year	alpha	beta
1	BTS-ISIS	1	9	1985	2006	0.66	0.75
2	SNS	1	4	1970	2006	0.66	0.75
3	NL Beam Trawl	2	9	1990	2006	0	1

Time series weights :
Tapered time weighting not applied

Catchability analysis :
Catchability independent of size for ages > 1
Catchability independent of age for ages > 7

Terminal population estimation :
Survivor estimates shrunk towards the mean F
of the final 5 years or the 5 oldest ages.

S.E. of the mean to which the estimates are shrunk = 2

Minimum standard error for population
estimates derived from each fleet = 0.3

prior weighting not applied

Regression weights

year age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

year age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.006	0.002	0.004	0.020	0.014	0.006	0.012	0.012	0.028	0.050
2	0.154	0.279	0.175	0.236	0.281	0.220	0.217	0.219	0.221	0.306
3	0.578	0.615	0.608	0.579	0.549	0.608	0.562	0.506	0.541	0.467
4	0.698	0.789	0.709	0.790	0.747	0.616	0.602	0.605	0.594	0.386
5	0.805	0.760	0.783	0.612	0.734	0.708	0.590	0.550	0.530	0.391
6	0.737	0.732	0.573	0.759	0.519	0.619	0.780	0.401	0.561	0.335
7	0.603	0.596	0.524	0.836	0.550	0.438	0.441	0.358	0.484	0.390
8	0.821	0.927	0.470	0.692	0.678	0.868	0.447	0.277	0.394	0.382
9	1.033	0.975	1.216	0.372	0.554	0.428	0.396	0.931	0.341	0.378
10	1.033	0.975	1.216	0.372	0.554	0.428	0.396	0.931	0.341	0.378

XSA population number (NA)

age year	1	2	3	4	5	6	7	8	9	10
1997	271745	44656	56668	15332	9714	25787	2789	4368	544	2731
1998	114195	244373	34655	28778	6906	3931	11164	1381	1740	1416
1999	83475	103096	167233	16954	11834	2923	1710	5566	495	1201
2000	125146	75258	78292	82383	7553	4895	1492	916	3150	2407
2001	66012	111000	53758	39700	33827	3707	2073	585	415	1780
2002	193766	58889	75852	28101	17016	14694	1997	1082	269	1095
2003	89587	174323	42771	37384	13736	7582	7162	1166	411	1443
2004	43976	80065	126981	22056	18521	6893	3145	4169	675	669
2005	43908	39300	58225	69267	10898	9665	4177	1989	2858	1455
2006	146903	38630	28505	30672	34592	5807	4990	2330	1213	1792

Estimated population abundance at 1st Jan 2007

age year	1	2	3	4	5	6	7	8	9	10
2007	0	126441	25737	16177	18869	21179	3759	3057	1439	753

Table 10.3.1. Continued

Fleet: BTS-ISIS

Log catchability residuals.

age \ year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	-0.461	-0.438	0.028	-0.109	-0.125	-0.052	-0.225	0.009	-0.087	0.115	0.457
2	0.207	-0.612	-0.200	0.585	0.362	0.694	0.205	1.148	-0.258	-0.357	0.493
3	-0.030	-0.105	-0.424	-0.533	0.609	0.141	0.366	0.360	-1.001	0.235	1.016
4	0.318	-0.387	-0.213	0.069	0.962	-0.390	-0.173	0.298	0.460	-2.036	0.478
5	-0.095	0.194	0.043	-0.903	0.400	-0.007	-1.261	-0.187	1.251	0.184	0.071
6	0.244	-0.084	0.150	-0.417	-0.028	1.029	-0.799	-0.777	1.089	-0.762	0.665
7	NA	-0.125	0.361	0.060	0.408	-0.157	-0.502	-0.278	-1.024	0.053	1.139
8	NA	NA	0.039	0.080	NA	-0.451	-0.121	0.232	-0.074	-1.094	0.604
9	NA	-0.132	NA	-0.440	-0.165	-1.102	-1.260	-0.159	0.958	NA	1.480

age \ year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	-0.017	0.551	0.035	0.149	-0.010	0.162	-0.122	0.080	0.081	0.021
2	-0.326	0.063	0.146	0.519	-0.204	-0.067	-0.420	-0.579	-0.675	-0.251
3	0.259	0.192	0.228	0.768	0.133	-0.102	-0.020	0.207	-0.553	-0.170
4	0.679	0.483	0.437	0.149	-0.449	0.310	-0.056	0.308	-0.185	-0.584
5	0.417	1.090	-0.876	1.863	0.206	-0.250	-0.309	-0.113	0.097	-0.944
6	0.750	-0.338	-1.687	1.535	0.371	-0.157	0.025	0.225	-0.451	-0.545
7	0.408	0.239	0.243	1.431	0.534	-0.466	-1.106	0.349	-0.430	-0.546
8	0.340	-1.072	NA	1.279	-1.159	0.601	0.813	NA	-0.728	-0.395
9	0.013	1.331	NA	-1.155	0.389	NA	NA	0.446	NA	NA

age \ year	2006
1	-0.041
2	-0.473
3	-1.577
4	-0.478
5	-0.871
6	-0.036
7	-0.592
8	NA
9	-1.661

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	2	3	4	5	6	7	8	9
Mean_Logq	-8.9105	-9.4854	-9.7815	-9.8963	-10.1383	-9.9314	-9.9314	-9.9314
S.E_Logq	0.4836	0.5715	0.6168	0.7473	0.7358	0.6336	0.7176	0.9701

Regression statistics

Ages with q dependent on year class strength

	slope	intercept
Age 1	0.6572665	9.91079

Fleet: SNS

Log catchability residuals.

age \ year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	0.247	0.146	-0.031	0.464	-0.041	-0.115	-0.339	0.036	0.354	-0.134	0.051
2	0.737	0.788	-0.007	0.602	-0.675	0.188	-1.375	0.066	0.395	0.263	0.065
3	0.470	0.131	-0.311	0.228	-0.735	-0.155	0.211	0.239	0.428	0.276	0.252
4	0.100	-2.561	NA	-0.400	NA	0.264	-0.766	-0.181	0.149	0.383	-0.028

age \ year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	-0.015	0.216	-0.170	0.315	0.418	-0.069	0.163	-0.241	0.070	-0.287	-0.053
2	0.363	0.152	0.179	0.201	0.489	-0.214	-0.106	0.219	0.434	0.381	0.671
3	0.744	-0.044	-0.756	0.367	-0.226	-0.467	-0.906	0.072	0.464	-0.091	0.793
4	-0.178	0.003	-0.388	0.087	-0.069	-0.528	-0.361	0.678	-0.244	0.942	0.703

age \ year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	-0.062	-0.025	-0.246	-0.217	-0.737	0.092	0.231	-0.029	-0.323	-0.139	0.174
2	-1.252	0.345	0.019	-0.457	-0.516	-0.807	0.593	0.214	-1.471	-0.180	-0.136
3	-0.094	0.000	0.289	-0.022	-1.036	0.215	0.442	0.030	-0.242	-0.327	-0.029
4	0.958	0.581	-1.483	0.826	0.099	0.198	0.969	-0.851	0.094	-0.422	NA

year

Table 10.3.1. Continued

age	2003	2004	2005	2006
1	NA	0.344	-0.123	0.074
2	NA	0.053	-0.574	0.354
3	NA	0.092	-0.264	-0.041
4	NA	0.745	NA	0.680

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	2	3	4
Mean_Logq	-4.6845	-5.4357	-6.0152
S.E_Logq	0.5702	0.4223	0.7436

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 1	0.734424	5.798799

Fleet: NL Beam Trawl

Log catchability residuals.

age \ year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	-0.440	-1.129	-0.604	-0.215	-0.648	0.235	0.341	-0.359	0.444	-0.154
3	-0.215	-0.316	-0.208	-0.470	-0.200	-0.444	-0.061	0.083	-0.098	0.178
4	-0.177	-0.100	-0.382	-0.175	-0.438	0.099	0.298	-0.105	0.233	-0.215
5	-0.158	0.115	-0.252	0.086	-0.175	-0.703	0.094	0.062	-0.191	0.215
6	-0.261	-0.439	-0.079	0.017	0.044	-0.194	-0.170	0.331	0.093	-0.090
7	-0.230	-0.314	0.191	0.237	-0.072	-0.193	0.221	-0.418	0.139	-0.288
8	0.057	-0.242	-0.040	-0.130	-0.494	-0.120	0.249	0.515	-0.408	0.021
9	0.067	0.112	0.196	0.041	0.145	0.139	0.059	-0.255	-0.150	0.317

age \ year	2000	2001	2002	2003	2004	2005	2006
2	0.271	0.374	0.327	0.393	0.401	0.299	0.464
3	0.341	-0.018	0.340	0.222	0.350	0.303	0.212
4	-0.064	0.325	0.058	0.311	0.117	0.265	-0.050
5	-0.148	0.312	0.294	-0.025	0.128	0.341	0.004
6	0.289	-0.272	0.427	0.666	-0.201	0.033	-0.194
7	0.329	0.033	-0.078	0.273	0.008	0.125	0.037
8	0.409	0.040	0.624	-0.075	-0.478	-0.333	0.202
9	-0.281	-0.051	-0.138	-0.345	0.242	0.041	0.189

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	2	3	4	5	6	7	8	9
Mean_Logq	-6.0868	-5.1629	-5.0237	-4.9915	-5.1891	-5.2527	-5.2527	-5.2527
S.E_Logq	0.4847	0.2784	0.2394	0.2585	0.2878	0.2262	0.3329	0.1932

Terminal year survivor and F summaries:

Age 1 Year class = 2005

source	survivors	N	scaledWts
BTS-ISIS	118847	1	0.422
SNS	139784	1	0.470
fshk	441869	1	0.015
nshk	82637	1	0.093

Age 2 Year class = 2004

source	survivors	N	scaledWts
BTS-ISIS	22005	2	0.419
SNS	25148	2	0.414
NL Beam Trawl	40918	1	0.154
fshk	35316	1	0.013

Table 10.3.1. Continued

Age 3 Year class = 2003

source

	survivors	N	scaledWts
BTS-ISIS	10853	3	0.289
SNS	17953	3	0.353
NL Beam Trawl	20393	2	0.349
fshk	12953	1	0.010

Age 4 Year class = 2002

source

	survivors	N	scaledWts
BTS-ISIS	14759	4	0.269
SNS	20187	3	0.177
NL Beam Trawl	21090	3	0.544
fshk	10003	1	0.010

Age 5 Year class = 2001

source

	survivors	N	scaledWts
BTS-ISIS	12368	5	0.213
SNS	25117	2	0.119
NL Beam Trawl	24701	4	0.657
fshk	11659	1	0.011

Age 6 Year class = 2000

source

	survivors	N	scaledWts
BTS-ISIS	3143	6	0.180
SNS	3992	3	0.069
NL Beam Trawl	3943	5	0.740
fshk	1911	1	0.011

Age 7 Year class = 1999

source

	survivors	N	scaledWts
BTS-ISIS	2209	7	0.174
SNS	2411	3	0.043
NL Beam Trawl	3343	6	0.771
fshk	2526	1	0.012

Age 8 Year class = 1998

source

	survivors	N	scaledWts
BTS-ISIS	1056	7	0.125
SNS	982	3	0.034
NL Beam Trawl	1541	7	0.828
fshk	947	1	0.012

Age 9 Year class = 1997

source

	survivors	N	scaledWts
BTS-ISIS	429	9	0.137
SNS	757	4	0.016
NL Beam Trawl	825	8	0.836
fshk	752	1	0.011

Table 10.3.2. Sole in sub area IV: fishing mortality at age

[1] 2007-05-04 14:34:43 units= f

year	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	0.549	0.320	0.332	0.382	0.368	0.392	0.392
1971	0.011	0.335	0.562	0.672	0.581	0.412	0.376	0.372	0.484	0.484
1972	0.005	0.238	0.662	0.525	0.531	0.362	0.228	0.311	0.393	0.393
1973	0.007	0.207	0.694	0.610	0.569	0.451	0.365	0.536	0.508	0.508
1974	0.001	0.189	0.592	0.645	0.519	0.518	0.561	0.389	0.529	0.529
1975	0.007	0.278	0.554	0.665	0.480	0.524	0.369	0.645	0.521	0.521
1976	0.010	0.107	0.566	0.514	0.561	0.378	0.478	0.421	0.633	0.633
1977	0.013	0.263	0.555	0.617	0.501	0.367	0.184	0.501	0.314	0.314
1978	0.001	0.236	0.573	0.538	0.526	0.529	0.651	0.557	0.541	0.541
1979	0.001	0.225	0.660	0.632	0.486	0.463	0.381	0.647	0.393	0.393
1980	0.004	0.128	0.555	0.592	0.585	0.407	0.587	0.533	0.602	0.602
1981	0.003	0.255	0.521	0.599	0.532	0.581	0.452	0.440	0.550	0.550
1982	0.018	0.231	0.697	0.557	0.628	0.601	0.509	0.527	0.540	0.540
1983	0.003	0.310	0.598	0.725	0.327	0.473	0.464	0.557	0.655	0.655
1984	0.003	0.290	0.719	0.679	0.669	0.707	0.534	0.429	0.583	0.583
1985	0.002	0.320	0.740	0.770	0.594	0.555	0.386	0.425	0.448	0.448
1986	0.002	0.145	0.622	0.686	0.673	0.745	0.742	0.320	0.576	0.576
1987	0.001	0.238	0.520	0.614	0.513	0.557	0.427	0.661	0.367	0.367
1988	0.000	0.238	0.659	0.736	0.618	0.582	0.527	0.408	0.919	0.919
1989	0.001	0.126	0.529	0.683	0.454	0.441	0.390	0.386	0.337	0.337
1990	0.005	0.137	0.407	0.531	0.579	0.616	0.488	0.579	0.589	0.589
1991	0.002	0.090	0.425	0.534	0.762	0.425	0.669	0.652	0.751	0.751
1992	0.003	0.120	0.435	0.467	0.485	0.626	0.662	0.597	0.831	0.831
1993	0.001	0.181	0.423	0.555	0.826	0.566	0.863	0.518	0.825	0.825
1994	0.013	0.140	0.479	0.635	0.673	0.879	0.504	0.638	0.867	0.867
1995	0.054	0.306	0.445	0.761	0.610	0.534	0.785	0.486	0.988	0.988
1996	0.004	0.275	0.695	0.979	0.696	0.840	0.713	0.975	0.479	0.479
1997	0.006	0.154	0.578	0.698	0.805	0.737	0.603	0.821	1.033	1.033
1998	0.002	0.279	0.615	0.789	0.760	0.732	0.596	0.927	0.975	0.975
1999	0.004	0.175	0.608	0.709	0.783	0.573	0.524	0.470	1.216	1.216
2000	0.020	0.236	0.579	0.790	0.612	0.759	0.836	0.692	0.372	0.372
2001	0.014	0.281	0.549	0.747	0.734	0.519	0.550	0.678	0.554	0.554
2002	0.006	0.220	0.608	0.616	0.708	0.619	0.438	0.868	0.428	0.428
2003	0.012	0.217	0.562	0.602	0.590	0.780	0.441	0.447	0.396	0.396
2004	0.012	0.219	0.506	0.605	0.550	0.401	0.358	0.277	0.931	0.931
2005	0.028	0.221	0.541	0.594	0.530	0.561	0.484	0.394	0.341	0.341
2006	0.050	0.306	0.467	0.386	0.391	0.335	0.390	0.382	0.378	0.378

(age columns 1–10)

Table 10.3.3 Sole in sub area IV: stock numbers at age

[1] 2007-05-04 14:34:43 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	128640	116639	64212	71154	41455	12092	10843	18272	9061	26295
1959	488738	116399	103776	50073	50905	28474	7627	6950	12311	26788
1960	61712	442228	101841	82462	35414	37523	20277	5754	4362	32545
1961	99476	55839	388690	78706	58636	23190	25994	13738	3691	31942
1962	22893	90010	49613	304343	53010	41257	16517	19768	8360	29932
1963	20417	20715	79928	38985	219077	33368	27304	10355	13976	32248
1964	538987	8301	7991	27179	10395	59611	8153	6856	2665	9787
1965	121931	487643	7363	5221	19159	5783	37447	4403	4482	9389
1966	39887	110327	396435	5627	3203	12578	2871	21993	2503	8708
1967	75125	36091	88149	231608	4150	1775	7872	1890	13884	7978
1968	99252	67976	29151	55330	128593	1896	1096	5297	988	19804
1969	50659	88821	45195	13158	26310	70153	1276	759	3229	14243
1970	137647	45461	57613	20490	6840	12022	39564	840	454	16919
1971	42054	123313	35294	27405	10706	4492	7805	24423	526	12529
1972	76466	37653	79836	18214	12662	5421	2693	4849	15236	9035
1973	104733	68849	26846	37273	9751	6735	3417	1939	3215	15214
1974	109877	94098	50665	12132	18328	4994	3883	2146	1027	12269
1975	40800	99325	70513	25354	5758	9867	2691	2006	1316	8882
1976	113287	36667	68039	36660	11796	3224	5285	1683	952	5933
1977	140279	101516	29808	34962	19842	6089	1998	2966	1000	8236
1978	47222	125268	70616	15487	17075	10876	3818	1504	1626	4013
1979	11727	42703	89537	36033	8183	9135	5799	1801	780	4925
1980	151673	10602	30859	41854	17327	4555	5201	3585	854	2783
1981	149243	136633	8443	16022	20957	8737	2742	2616	1904	2245
1982	152775	134639	95839	4540	7966	11141	4423	1579	1524	3204
1983	142187	135707	96680	43204	2355	3845	5525	2406	844	2556
1984	70797	128286	90062	48112	18937	1537	2168	3145	1247	2116
1985	80846	63878	86843	39703	22080	8772	686	1150	1853	2825
1986	159694	72995	41992	37473	16628	11034	4555	422	680	4020
1987	72540	144141	57142	20401	17068	7677	4738	1962	277	2365
1988	455066	65547	102789	30734	9994	9250	3979	2797	917	550
1989	108306	411751	46735	48126	13320	4876	4677	2125	1683	1714
1990	177760	97888	328443	24916	21997	7654	2840	2865	1308	1984
1991	70485	160023	77216	197828	13254	11158	3740	1577	1453	2155
1992	354444	63663	132274	45687	104889	5597	6601	1733	743	2182
1993	69288	319782	51106	77473	25926	58457	2708	3080	863	1565
1994	57073	62643	241361	30292	40223	10266	30032	1034	1660	1634
1995	96132	50959	49259	135252	14521	18570	3857	16415	494	1109
1996	49534	82417	33965	28569	57154	7138	9852	1592	9132	2718
1997	271745	44656	56668	15333	9714	25787	2789	4368	544	2731
1998	114195	244373	34655	28778	6906	3931	11164	1381	1740	1416
1999	83475	103096	167233	16954	11834	2923	1710	5567	495	1201
2000	125146	75258	78292	82383	7553	4895	1492	916	3150	2407
2001	66012	111000	53759	39700	33828	3707	2073	585	415	1780
2002	193766	58889	75852	28101	17016	14694	1997	1082	269	1095
2003	89587	174323	42771	37384	13736	7582	7162	1166	411	1443
2004	43976	80065	126981	22056	18521	6893	3145	4169	675	669
2005	43909	39300	58225	69267	10898	9665	4177	1989	2858	1455
2006	146903	38631	28505	30672	34592	5807	4990	2330	1213	1792
2007										

Table 10.4.1. Sole in sub area IV: XSA summary

[1] 2007-05-01 16:56:49

	recruitment	ssb	catch	landings	discards	fbar2-6	Y/ssb
1957	128907	55107	12067	12067	0	0.18	0.22
1958	128640	60918	14287	14287	0	0.21	0.23
1959	488738	65579	13832	13832	0	0.17	0.21
1960	61712	73397	18620	18620	0	0.20	0.25
1961	99476	117094	23566	23566	0	0.19	0.20
1962	22893	116825	26877	26877	0	0.21	0.23
1963	20417	113621	26164	26164	0	0.31	0.23
1964	538987	37123	11342	11342	0	0.29	0.31
1965	121931	30025	17043	17043	0	0.32	0.57
1966	39887	84227	33340	33340	0	0.33	0.40
1967	75125	82934	33439	33439	0	0.41	0.40
1968	99252	72274	33179	33179	0	0.49	0.46
1969	50659	55230	27559	27559	0	0.55	0.50
1970	137647	50637	19685	19685	0	0.40	0.39
1971	42054	43676	23652	23652	0	0.51	0.54
1972	76466	47331	21086	21086	0	0.46	0.45
1973	104733	36644	19309	19309	0	0.51	0.53
1974	109877	35946	17989	17989	0	0.49	0.50
1975	40800	38204	20773	20773	0	0.50	0.54
1976	113287	38770	17326	17326	0	0.43	0.45
1977	140279	34165	18003	18003	0	0.46	0.53
1978	47222	35966	20280	20280	0	0.48	0.56
1979	11727	44638	22598	22598	0	0.49	0.51
1980	151673	33426	15807	15807	0	0.45	0.47
1981	149243	22791	15403	15403	0	0.50	0.68
1982	152775	32757	21579	21579	0	0.54	0.66
1983	142187	39879	24927	24927	0	0.49	0.63
1984	70797	43388	26839	26839	0	0.61	0.62
1985	80846	40984	24248	24248	0	0.60	0.59
1986	159694	34460	18201	18201	0	0.57	0.53
1987	72540	29649	17368	17368	0	0.49	0.59
1988	455066	38751	21590	21590	0	0.57	0.56
1989	108306	34046	21805	21805	0	0.45	0.64
1990	177760	89746	35120	35120	0	0.45	0.39
1991	70485	77580	33513	33513	0	0.45	0.43
1992	354444	76879	29341	29341	0	0.43	0.38
1993	69288	54849	31491	31491	0	0.51	0.57
1994	57073	74478	33002	33002	0	0.56	0.44
1995	96132	59054	30467	30467	0	0.53	0.52
1996	49534	38477	22651	22651	0	0.70	0.59
1997	271745	28141	14901	14901	0	0.59	0.53
1998	114195	20945	20868	20868	0	0.63	1.00
1999	83475	41978	23475	23475	0	0.57	0.56
2000	125146	39316	22641	22641	0	0.60	0.58
2001	66012	30915	19944	19944	0	0.57	0.65
2002	193766	31818	16945	16945	0	0.55	0.53
2003	89587	26585	17920	17920	0	0.55	0.67
2004	43976	40199	18757	18757	0	0.46	0.47
2005	43909	35908	16355	16355	0	0.49	0.46
2006	146903	28010	12594	12594	0	0.38	0.45

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	50659	-11.0	-11.0	-11	734	110.4	-11.0	-11.0	-11.0
1969	137647	-11.0	-11.0	5410	1844	148.6	-11.0	-11.0	-11.0
1970	42054	-11.0	-11.0	893	272	83.8	-11.0	-11.0	-11.0
1971	76466	-11.0	-11.0	1455	935	65.2	-11.0	-11.0	-11.0
1972	104733	-11.0	-11.0	5587	361	165.8	-11.0	-11.0	-11.0
1973	109877	-11.0	-11.0	2348	848	229.1	-11.0	-11.0	31.5
1974	40800	-11.0	2.9	529	74	103.8	-11.0	-11.0	16.3
1975	113287	168.8	7.0	1399	776	294.1	-11.0	-11.0	34.4
1976	140279	82.3	9.7	3743	1355	300.8	-11.0	-11.0	-11.0
1977	47222	33.8	2.1	1548	408	109.3	-11.0	-11.0	41.5
1978	11727	96.9	2.3	94	89	50.0	-11.0	-11.0	1.9
1979	151673	392.1	48.2	4313	1413	227.8	-11.0	-11.0	76.1
1980	149243	404.0	13.4	3737	1146	120.6	-11.0	-11.0	77.1
1981	152775	293.9	14.3	5856	1123	318.3	-11.0	-11.0	147.1
1982	142187	328.5	20.3	2621	1100	167.1	-11.0	-11.0	77.8
1983	70797	104.4	11.9	2493	716	69.2	-11.0	7.9	10.8
1984	80846	186.5	3.4	3619	458	64.8	2.7	4.5	29.8
1985	159694	315.0	10.5	3705	944	281.6	7.9	12.6	24.6
1986	72540	73.2	6.4	1948	594	207.6	7.0	12.5	20.3
1987	455066	523.9	35.0	11227	5005	914.3	83.1	68.1	66.9
1988	108306	50.1	11.6	2831	1120	513.8	9.0	22.4	86.4
1989	177760	77.8	11.3	2856	2529	360.4	22.6	23.2	54.1
1990	70485	21.1	8.3	1254	144	153.8	3.7	23.2	11.3
1991	354444	391.9	17.9	11114	3420	934.1	74.4	27.4	180.7
1992	69288	25.3	10.7	1291	498	142.9	5.0	5.0	-11.0
1993	57073	25.1	6.2	652	224	29.6	5.9	8.5	-11.0
1994	96132	69.1	9.8	1362	349	189.8	27.9	6.2	12.9
1995	49534	19.1	4.0	218	154	141.7	3.5	5.4	0.9
1996	271745	59.6	19.0	10279	3126	455.6	173.9	29.2	45.7
1997	114195	44.1	-11.0	4095	972	166.3	14.1	19.3	13.8
1998	83475	-11.0	-11.0	1649	126	106.7	11.4	6.5	-11.0
1999	125146	-11.0	4.5	1639	655	195.3	14.5	10.7	-11.0
2000	66012	15.5	3.4	970	379	-11.0	8.2	4.2	-11.0
2001	193766	84.6	18.4	7542	-11	393.0	21.9	10.6	-11.0
2002	89587	65.4	5.3	-11	624	124.0	10.8	4.4	-11.0
2003	-11	18.5	9.0	1369	163	79.8	3.7	3.3	-11.0
2004	-11	54.5	8.9	568	382	-11.0	3.1	2.4	-11.0
2005	-11	48.8	7.6	4167	-11	-11.0	16.8	-11.0	-11.0
2006	-11	25.6	-11.0	-11	-11	-11.0	-11.0	-11.0	-11.0

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	45461	-11.0	-11.0	-11	734	110.4	-11.0	-11.0	-11.0
1969	123313	-11.0	-11.0	5410	1844	148.6	-11.0	-11.0	-11.0
1970	37653	-11.0	-11.0	893	272	83.8	-11.0	-11.0	-11.0
1971	68849	-11.0	-11.0	1455	935	65.2	-11.0	-11.0	-11.0
1972	94098	-11.0	-11.0	5587	361	165.8	-11.0	-11.0	-11.0
1973	99325	-11.0	-11.0	2348	848	229.1	-11.0	-11.0	31.5
1974	36667	-11.0	2.9	529	74	103.8	-11.0	-11.0	16.3
1975	101516	168.8	7.0	1399	776	294.1	-11.0	-11.0	34.4
1976	125268	82.3	9.7	3743	1355	300.8	-11.0	-11.0	-11.0
1977	42703	33.8	2.1	1548	408	109.3	-11.0	-11.0	41.5
1978	10602	96.9	2.3	94	89	50.0	-11.0	-11.0	1.9
1979	136633	392.1	48.2	4313	1413	227.8	-11.0	-11.0	76.1
1980	134639	404.0	13.4	3737	1146	120.6	-11.0	-11.0	77.1
1981	135707	293.9	14.3	5856	1123	318.3	-11.0	-11.0	147.1
1982	128286	328.5	20.3	2621	1100	167.1	-11.0	-11.0	77.8
1983	63878	104.4	11.9	2493	716	69.2	-11.0	7.9	10.8
1984	72995	186.5	3.4	3619	458	64.8	2.7	4.5	29.8
1985	144141	315.0	10.5	3705	944	281.6	7.9	12.6	24.6
1986	65547	73.2	6.4	1948	594	207.6	7.0	12.5	20.3
1987	411751	523.9	35.0	11227	5005	914.3	83.1	68.1	66.9
1988	97888	50.1	11.6	2831	1120	513.8	9.0	22.4	86.4
1989	160023	77.8	11.3	2856	2529	360.4	22.6	23.2	54.1
1990	63663	21.1	8.3	1254	144	153.8	3.7	23.2	11.3
1991	319782	391.9	17.9	11114	3420	934.1	74.4	27.4	180.7
1992	62643	25.3	10.7	1291	498	142.9	5.0	5.0	-11.0
1993	50959	25.1	6.2	652	224	29.6	5.9	8.5	-11.0
1994	82417	69.1	9.8	1362	349	189.8	27.9	6.2	12.9
1995	44656	19.1	4.0	218	154	141.7	3.5	5.4	0.9
1996	244373	59.6	19.0	10279	3126	455.6	173.9	29.2	45.7
1997	103096	44.1	-11.0	4095	972	166.3	14.1	19.3	13.8
1998	75258	-11.0	-11.0	1649	126	106.7	11.4	6.5	-11.0
1999	111000	-11.0	4.5	1639	655	195.3	14.5	10.7	-11.0
2000	58889	15.5	3.4	970	379	-11.0	8.2	4.2	-11.0
2001	174323	84.6	18.4	7542	-11	393.0	21.9	10.6	-11.0
2002	80065	65.4	5.3	-11	624	124.0	10.8	4.4	-11.0
2003	-11	18.5	9.0	1369	163	79.8	3.7	3.3	-11.0
2004	-11	54.5	8.9	568	382	-11.0	3.1	2.4	-11.0
2005	-11	48.8	7.6	4167	-11	-11.0	16.8	-11.0	-11.0
2006	-11	25.6	-11.0	-11	-11	-11.0	-11.0	-11.0	-11.0

Table 10.5.3. Sole in sub area IV: Output RCT3 – age 1

Sole North Sea Age 1

Data for 8 surveys over 39 years : 1968 - 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 = 2003

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------				I	-----------Prediction---------I			
DFS0	1.27	5.83	1.13	.301	26	2.97	9.59	1.253	.021
DFS1	1.35	8.44	.60	.614	27	2.30	11.53	.632	.084
SNS1	.73	5.93	.34	.809	33	7.22	11.17	.357	.263
SNS2	.78	6.40	.43	.723	34	5.10	10.40	.457	.160
SNS3	1.12	5.70	.53	.636	34	4.39	10.64	.558	.108
BTS1	.69	9.82	.37	.753	19	1.54	10.87	.412	.198
BTS2	1.12	8.78	.53	.587	20	1.46	10.42	.606	.091
Sol3									
					VPA Mean =		11.49	.678	.073

Yearclass = 2004

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------				I	-----------Prediction---------I			
DFS0	1.27	5.83	1.13	.301	26	4.02	10.91	1.208	.026
DFS1	1.35	8.44	.60	.614	27	2.29	11.52	.632	.095
SNS1	.73	5.93	.34	.809	33	6.34	10.54	.365	.286
SNS2	.78	6.40	.43	.723	34	5.95	11.06	.447	.190
SNS3									
BTS1	.69	9.82	.37	.753	19	1.42	10.79	.414	.222
BTS2	1.12	8.78	.53	.587	20	1.24	10.17	.620	.099
Sol3									
					VPA Mean =		11.49	.678	.083

Yearclass = 2005

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------				I	-----------Prediction---------I			
DFS0	1.27	5.83	1.13	.301	26	3.91	10.77	1.211	.035
DFS1	1.35	8.44	.60	.614	27	2.15	11.34	.633	.129
SNS1	.73	5.93	.34	.809	33	8.34	11.98	.358	.402
SNS2									
SNS3									
BTS1	.69	9.82	.37	.753	19	2.88	11.79	.400	.322
BTS2									
Sol3									
					VPA Mean =		11.49	.678	.112

Yearclass = 2006

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------				I	-----------Prediction---- -----I			
DFS0	1.27	5.83	1.13	.301	26	3.28	9.98	1.235	.231

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2003	53208	10.88	.18	.16	.78		
2004	50977	10.84	.19	.16	.70		
2005	125530	11.74	.23	.15	.41		
2006	68985	11.14	.59	.64	1.150		

Table 10.5.4. Sole in sub area IV: Output RCT3 – age 2

Sole North Sea-Age 2

Data for 8 surveys over 39 years : 1968 - 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

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
DFS0	1.26	5.74	1.13	.302	26	4.02	10.81	1.204	.026
DFS1	1.34	8.33	.59	.616	27	2.29	11.41	.630	.096
SNS1	.72	5.83	.34	.811	33	6.34	10.43	.362	.290
SNS2	.78	6.30	.42	.725	34	5.95	10.96	.445	.193
SNS3									
BTS1	.69	9.69	.38	.744	19	1.42	10.68	.426	.210
BTS2	1.12	8.68	.53	.594	20	1.24	10.07	.613	.101
Sol3									
				VPA Mean =		11.38	.678	.083	

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			
DFS0	1.26	5.74	1.13	.302	26	3.91	10.67	1.206	.036
DFS1	1.34	8.33	.59	.616	27	2.15	11.23	.630	.131
SNS1	.72	5.83	.34	.811	33	8.34	11.87	.356	.412
SNS2									
SNS3									
BTS1	.69	9.69	.38	.744	19	2.88	11.69	.411	.308
BTS2									
Sol3									
				VPA Mean =		11.38	.678	.113	

Yearclass = 2006

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
DFS0	1.26	5.74	1.13	.302	26	3.28	9.88	1.231	.233
BTS2									
Sol3									
				VPA Mean =		11.38	.678	.767	

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2004	45702	10.73	.20	.16	.71		
2005	112734	11.63	.23	.15	.41		
2006	61902	11.03	.59	.64	1.15		

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	95160	0.77	WS1	0.050	0
N2	126441	0.24	WS2	0.145	0.05
N3	25737	0.19	WS3	0.194	0.02
N4	16176	0.18	WS4	0.241	0.03
N5	18869	0.14	WS5	0.251	0.07
N6	21178	0.14	WS6	0.294	0.11
N7	3758	0.14	WS7	0.293	0.07
N8	3057	0.14	WS8	0.395	0.14
N9	1438	0.14	WS9	0.378	0.07
N10	1863	0.14	WS10	0.495	0.19
H.cons selectivity				Natural mortality	
sH1	0.03	0.75	M1	0.1	0.1
sH2	0.21	0.35	M2	0.1	0.1
sH3	0.43	0.07	M3	0.1	0.1
sH4	0.45	0.13	M4	0.1	0.1
sH5	0.42	0.08	M5	0.1	0.1
sH6	0.37	0.16	M6	0.1	0.1
sH7	0.35	0.14	M7	0.1	0.1
sH8	0.30	0.25	M8	0.1	0.1
sH9	0.47	0.57	M9	0.1	0.1
sH10	0.47	0.57	M10	0.1	0.1
Weight in the catch					Proportion mature
WH1	0.152	0.15	MT1	0	0
WH2	0.185	0.03	MT2	0	0.1
WH3	0.212	0.03	MT3	1	0.1
WH4	0.253	0.04	MT4	1	0
WH5	0.265	0.09	MT5	1	0
WH6	0.296	0.08	MT6	1	0
WH7	0.312	0.19	MT7	1	0
WH8	0.367	0.03	MT8	1	0
WH9	0.347	0.12	MT9	1	0
WH10	0.407	0.04	MT10	1	0
relative effort in HC fisheries			Year effect for natural mortality		
HF07	1	0.13	K07	1	0.1
HF08	1	0.13	K08	1	0.1
HF09	1	0.13	K09	1	0.1
Recruitment in 2007 and 2008					
R08	95160	0.77			
R09	95160	0.77			

Table 10.6.2. Sole in sub area IV: Catch forecast table.

2007

SSB	Fmult	Fbar	Landings
23600	1	0.38	12444

2008

SSB	Fmult	Fbar (2-6)	landings	SSB 2009
33724	0.0	0.00	0	51100
33724	0.1	0.04	1736	49300
33724	0.2	0.08	3409	47600
33724	0.3	0.11	5023	45900
33724	0.4	0.15	6578	44300
33724	0.5	0.19	8078	42800
33724	0.6	0.23	9524	41300
33724	0.7	0.26	10919	39900
33724	0.8	0.30	12265	38500
33724	0.9	0.34	13563	37200
33724	1.0	0.38	14815	35900
33724	1.1	0.41	16023	34700
33724	1.2	0.45	17190	33500
33724	1.3	0.49	18315	32400
33724	1.4	0.53	19402	31300
33724	1.5	0.57	20451	30200
33724	1.6	0.60	21463	29200
33724	1.7	0.64	22441	28200
33724	1.8	0.68	23386	27300
33724	1.9	0.72	24298	26400
33724	2.0	0.75	25180	25500

Table 10.6.3. Sole in sub area IV: Detailed forecast table.

year: 2007 Fmult.: 1 Fbar: 0.38

age	F	catch.n	landings	stock.n	biomass	SSB
1	0.03	2305	350	95160	4758	
2	0.21	23076	4280	126441	18334	
3	0.43	8611	1831	25737	4984	4984
4	0.45	5616	1423	16177	3904	3904
5	0.42	6168	1641	18869	4730	4730
6	0.37	6246	1855	21179	6227	6227
7	0.35	1062	332	3759	1100	1100
8	0.30	756	278	3057	1207	1207
9	0.47	516	180	1439	544	544
10	0.47	668	273	1864	923	923

year: 2008 Fmult.: 1 Fbar: 0.38

age	F	catch.n	landings	stock.n	biomass	SSB
1	0.03	2305	350	95160	4758	
2	0.21	15315	2841	83913	12167	
3	0.43	30950	6581	92506	17915	17915
4	0.45	5253	1331	15130	3651	3651
5	0.42	3046	810	9317	2336	2336
6	0.37	3311	984	11229	3301	3301
7	0.35	3742	1171	13244	3876	3876
8	0.30	592	218	2394	946	946
9	0.47	734	256	2049	774	774
10	0.47	669	273	1868	925	925

year: 2009 Fmult.: 1 Fbar: 0.38

age	F	catch.n	landings	stock.n	biomass	SSB
1	0.03	2305	350	95160	4758	
2	0.21	15315	2841	83913	12167	
3	0.43	20540	4367	61392	11890	11890
4	0.45	18879	4785	54380	13124	13124
5	0.42	2849	758	8714	2184	2184
6	0.37	1635	486	5545	1630	1630
7	0.35	1984	621	7021	2055	2055
8	0.30	2087	768	8435	3332	3332
9	0.47	575	201	1604	606	606
10	0.47	794	324	2215	1097	1097

Table 10.6.4. Sole in sub area IV: Yield per recruit summary table

MFYPR version 2a
Run: SOLIV_yld
Time and date: 12:01 5/7/2007
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJ	SSBJan	SpwnNosS	SSBSpwn
0.000	0.000	0.000	0.000	10.508	3.507	8.604	3.326	8.604	3.326
0.100	0.038	0.261	0.083	7.907	2.314	6.004	2.133	6.004	2.133
0.200	0.075	0.399	0.119	6.526	1.712	4.626	1.531	4.626	1.531
0.300	0.113	0.486	0.139	5.661	1.354	3.763	1.173	3.763	1.173
0.400	0.151	0.546	0.149	5.063	1.119	3.167	0.939	3.167	0.939
0.500	0.189	0.590	0.156	4.623	0.954	2.730	0.775	2.730	0.775
0.600	0.226	0.624	0.160	4.285	0.834	2.394	0.654	2.394	0.654
0.700	0.264	0.651	0.162	4.017	0.742	2.129	0.563	2.129	0.563
0.800	0.302	0.673	0.164	3.800	0.671	1.913	0.492	1.913	0.492
0.900	0.339	0.691	0.165	3.619	0.613	1.735	0.435	1.735	0.435
1.000	0.377	0.707	0.166	3.467	0.567	1.585	0.389	1.585	0.389
1.100	0.415	0.720	0.166	3.337	0.528	1.458	0.351	1.458	0.351
1.200	0.452	0.732	0.166	3.225	0.496	1.348	0.319	1.348	0.319
1.300	0.490	0.742	0.166	3.127	0.469	1.252	0.292	1.252	0.292
1.400	0.528	0.750	0.166	3.041	0.445	1.168	0.269	1.168	0.269
1.500	0.566	0.758	0.166	2.965	0.425	1.094	0.249	1.094	0.249
1.600	0.603	0.765	0.166	2.896	0.407	1.028	0.231	1.028	0.231
1.700	0.641	0.772	0.166	2.835	0.391	0.969	0.216	0.969	0.216
1.800	0.679	0.777	0.166	2.779	0.377	0.915	0.202	0.915	0.202
1.900	0.716	0.783	0.166	2.729	0.365	0.867	0.190	0.867	0.190
2.000	0.754	0.788	0.165	2.683	0.353	0.823	0.179	0.823	0.179

ReferencF	multip	Absolute F
Fbar(2-6	1.000	0.377
FMax	1.351	0.509
F0.1	0.316	0.119
F35%SPR	0.303	0.114

Weights in kilograms
Weights in kilograms

Table 10.12.1.1 Sole North Sea. RCT3 input table

YC	N AGE 1	N Age 2	DFS 0	DFS 1	SNS 1	SNS 2	SNS 3	BTS 1	BTS 2
1968	50659	45461	-11.00	-11.00	-11.00	734.00	110.35	-11.00	-11.00
1969	137647	123313	-11.00	-11.00	5410.00	1844.00	148.55	-11.00	-11.00
1970	42054	37653	-11.00	-11.00	893.00	272.00	83.81	-11.00	-11.00
1971	76466	68849	-11.00	-11.00	1455.00	935.00	65.16	-11.00	-11.00
1972	104733	94098	-11.00	-11.00	5587.00	361.00	165.84	-11.00	-11.00
1973	109877	99325	-11.00	-11.00	2348.00	848.00	229.11	-11.00	-11.00
1974	40800	36667	-11.00	2.86	529.00	74.00	103.84	-11.00	-11.00
1975	113287	101516	168.84	6.95	1399.00	776.00	294.07	-11.00	-11.00
1976	140279	125268	82.28	9.69	3743.00	1355.00	300.84	-11.00	-11.00
1977	47222	42703	33.80	2.13	1548.00	408.00	109.33	-11.00	-11.00
1978	11727	10602	96.87	2.27	94.00	89.00	49.97	-11.00	-11.00
1979	151673	136633	392.08	48.21	4313.00	1413.00	227.78	-11.00	-11.00
1980	149243	134639	404.00	13.39	3737.00	1146.00	120.58	-11.00	-11.00
1981	152775	135707	293.93	14.28	5856.00	1123.00	318.32	-11.00	-11.00
1982	142187	128286	328.52	20.32	2621.00	1100.00	167.07	-11.00	-11.00
1983	70797	63878	104.38	11.89	2493.00	716.00	69.24	-11.00	7.89
1984	80846	72995	186.53	3.43	3619.00	458.00	64.82	2.65	4.49
1985	159694	144141	315.03	10.47	3705.00	944.00	281.61	7.88	12.55
1986	72540	65547	73.22	6.43	1948.00	594.00	207.56	6.97	12.51
1987	455066	411751	523.86	35.04	11227.00	5005.00	914.25	83.11	68.08
1988	108306	97888	50.07	11.59	2831.00	1120.00	513.84	9.02	22.36
1989	177760	160023	77.80	11.25	2856.00	2529.00	360.41	22.60	23.19
1990	70485	63663	21.09	8.26	1254.00	144.00	153.78	3.71	23.20
1991	354444	319782	391.93	17.90	11114.00	3420.00	934.10	74.44	27.36
1992	69288	62643	25.30	10.67	1291.00	498.00	142.85	4.99	4.99
1993	57073	50959	25.13	6.18	652.00	224.00	29.60	5.88	8.46
1994	96132	82417	69.11	9.82	1362.00	349.00	189.82	27.86	6.17
1995	49534	44656	19.07	3.99	218.00	154.00	141.71	3.51	5.37
1996	271745	244373	59.62	19.02	10279.00	3126.00	455.61	173.94	29.21
1997	114195	103096	44.08	-11.00	4095.00	972.00	166.28	14.12	19.26
1998	83475	75258	-11.00	-11.00	1649.00	126.00	106.67	11.41	6.53
1999	125146	111000	-11.00	4.53	1639.00	655.00	195.30	14.46	10.71
2000	66012	58889	15.51	3.40	970.00	379.00	-11.00	8.17	4.17
2001	193766	174323	84.62	18.36	7542.00	-11.00	393.00	21.90	10.55
2002	89587	80065	65.38	5.34	-11.00	624.00	124.00	10.76	4.40
2003	-11	-11	18.47	8.95	1369.00	163.00	79.80	3.65	3.30
2004	-11	-11	54.51	8.85	568.00	382.00	-11.00	3.14	2.44
2005	-11	-11	48.76	13.07	4167.00	-11.00	-11.00	16.82	20.71
2006	-11	-11	18.04	-11.00	-11.00	-11.00	-11.00	6.05	-11.00

Table 10.12.1.2. Sole North sea RCT3 analysis

Analysis by RCT3 ver3.1 of data from file : altin_1.txt
Sole North Sea Age 1

Data for 8 surveys over 39 years : 1968 - 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.

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
DFS0	1.27	5.83	1.13	.301	26	2.95	9.56	1.255	.071
BTS1	.69	9.82	.37	.753	19	1.95	11.16	.404	.685
					VPA Mean =		11.49	.678	.244

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio
2006	67809	11.12	.33	.32	.93

Analysis by RCT3 ver3.1 of data from file : altin_2.txt
Sole North Sea-Age 2

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			
DFS0	1.26	5.74	1.13	.302	26	3.91	10.67	1.206	.031
DFS1	1.34	8.33	.59	.616	27	2.64	11.89	.632	.113
SNS1	.72	5.83	.34	.811	33	8.34	11.87	.356	.356
BTS1	.69	9.69	.38	.744	19	2.88	11.69	.411	.267
BTS2	1.12	8.68	.53	.594	20	3.08	12.13	.576	.136
					VPA Mean =		11.38	.678	.098

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio
2005	129855	11.77	.21	.12	.34

Table 10.12.1.3 Sole North Sea STF input

Short term forecast input table

age	year	f	stock.n	catch.wt	mat	M
1	2007	0.03	67809	0.15	0.0	0.1
2	2007	0.21	126441	0.19	0.0	0.1
3	2007	0.43	25737	0.21	1.0	0.1
4	2007	0.45	16177	0.25	1.0	0.1
5	2007	0.42	18869	0.27	1.0	0.1
6	2007	0.37	21179	0.30	1.0	0.1
7	2007	0.35	3759	0.31	1.0	0.1
8	2007	0.30	3057	0.37	1.0	0.1
9	2007	0.47	1439	0.35	1.0	0.1
10	2007	0.47	1864	0.41	1.0	0.1
1	2008	0.03	95160	0.15	0.0	0.1
2	2008	0.21	59795	0.19	0.0	0.1
3	2008	0.43	92506	0.21	1.0	0.1
4	2008	0.45	15130	0.25	1.0	0.1
5	2008	0.42	9317	0.27	1.0	0.1
6	2008	0.37	11229	0.30	1.0	0.1
7	2008	0.35	13244	0.31	1.0	0.1
8	2008	0.30	2394	0.37	1.0	0.1
9	2008	0.47	2049	0.35	1.0	0.1
10	2008	0.47	1868	0.41	1.0	0.1
1	2009	0.03	95160	0.15	0.0	0.1
2	2009	0.21	83913	0.19	0.0	0.1
3	2009	0.43	43746	0.21	1.0	0.1
4	2009	0.45	54380	0.25	1.0	0.1
5	2009	0.42	8714	0.27	1.0	0.1
6	2009	0.37	5545	0.30	1.0	0.1
7	2009	0.35	7021	0.31	1.0	0.1
8	2009	0.30	8435	0.37	1.0	0.1
9	2009	0.47	1604	0.35	1.0	0.1
10	2009	0.47	2215	0.41	1.0	0.1

Table 10.12.2.1 Sole North Sea STF options

Short term forecast option table

year	fmult	f2-6	catch	ssb	
2007	1.0	0.38	12344	23619	
				ssb.2008	ssb.2009
2008	0.0	0.00	0	33724	46869
2008	0.1	0.04	1646	33724	45167
2008	0.2	0.08	3232	33724	43530
2008	0.3	0.11	4760	33724	41956
2008	0.4	0.15	6231	33724	40443
2008	0.5	0.19	7648	33724	38987
2008	0.6	0.23	9014	33724	37587
2008	0.7	0.26	10330	33724	36241
2008	0.8	0.30	11598	33724	34945
2008	0.9	0.34	12820	33724	33699
2008	1.0	0.38	13998	33724	32500
2008	1.1	0.41	15134	33724	31347
2008	1.2	0.45	16229	33724	30238
2008	1.3	0.49	17285	33724	29170
2008	1.4	0.53	18303	33724	28143
2008	1.5	0.57	19286	33724	27154
2008	1.6	0.60	20233	33724	26202
2008	1.7	0.64	21147	33724	25286
2008	1.8	0.68	22029	33724	24405
2008	1.9	0.72	22879	33724	23556
2008	2.0	0.75	23701	33724	22739

Table 10.12.2.2 Sole North Sea: STF detailed

Sole North Sea. Short term forecast detailed input table

age	year	f	stock.n	catch.n	stock.wt	catch.wt	catch	mat	M	SSB	TSB
1	2007	0.03	67809	1643	0.05	0.15	250	0.0	0.1	0	3390
2	2007	0.21	126441	23076	0.15	0.19	4280	0.0	0.1	0	18334
3	2007	0.43	25737	8611	0.19	0.21	1831	1.0	0.1	4984	4984
4	2007	0.45	16177	5616	0.24	0.25	1423	1.0	0.1	3904	3904
5	2007	0.42	18869	6168	0.25	0.27	1641	1.0	0.1	4730	4730
6	2007	0.37	21179	6246	0.29	0.30	1855	1.0	0.1	6227	6227
7	2007	0.35	3759	1062	0.29	0.31	332	1.0	0.1	1100	1100
8	2007	0.30	3057	756	0.39	0.37	278	1.0	0.1	1207	1207
9	2007	0.47	1439	516	0.38	0.35	180	1.0	0.1	544	544
10	2007	0.47	1864	668	0.50	0.41	273	1.0	0.1	923	923
1	2008	0.03	95160	2305	0.05	0.15	350	0.0	0.1	0	4758
2	2008	0.21	59795	10913	0.15	0.19	2024	0.0	0.1	0	8670
3	2008	0.43	92506	30950	0.19	0.21	6581	1.0	0.1	17915	17915
4	2008	0.45	15130	5253	0.24	0.25	1331	1.0	0.1	3651	3651
5	2008	0.42	9317	3046	0.25	0.27	810	1.0	0.1	2336	2336
6	2008	0.37	11229	3311	0.29	0.30	984	1.0	0.1	3301	3301
7	2008	0.35	13244	3742	0.29	0.31	1171	1.0	0.1	3876	3876
8	2008	0.30	2394	592	0.39	0.37	218	1.0	0.1	946	946
9	2008	0.47	2049	734	0.38	0.35	256	1.0	0.1	774	774
10	2008	0.47	1868	669	0.50	0.41	273	1.0	0.1	925	925
1	2009	0.03	95160	2305	0.05	0.15	350	0.0	0.1	0	4758
2	2009	0.21	83913	15315	0.15	0.19	2841	0.0	0.1	0	12167
3	2009	0.43	43746	14636	0.19	0.21	3112	1.0	0.1	8472	8472
4	2009	0.45	54380	18879	0.24	0.25	4785	1.0	0.1	13124	13124
5	2009	0.42	8714	2849	0.25	0.27	758	1.0	0.1	2184	2184
6	2009	0.37	5545	1635	0.29	0.30	486	1.0	0.1	1630	1630
7	2009	0.35	7021	1984	0.29	0.31	621	1.0	0.1	2055	2055
8	2009	0.30	8435	2087	0.39	0.37	768	1.0	0.1	3332	3332
9	2009	0.47	1604	575	0.38	0.35	201	1.0	0.1	606	606
10	2009	0.47	2215	794	0.50	0.41	324	1.0	0.1	1097	1097

Table 10.12.2.3: Sole North Sea: Short term implications, outlook for 2008

Basis: F(2007) = Fsq = mean F(04-06 scaled) = 0.38; R82-04 = GM = 95.2 million; SSB(2007) = 23.62kt; SSB(2008) = 33.72kt; landings (2007) = 12.41kt

The maximum fishing mortality which would be in accordance with precautionary limits (F (precautionary limits)) is 0.4

The fishing mortality which is consistent with taking high long-term yield and achieving low risk of depleting the productive potential of the stock (F(long term yield)) is 0.51

Rationale	**TAC(2008) (1)**	**Basis**	**F(2008)**	**SSB(2009)**	**%SSB change**	**%TAC change**
Zero catch	0.00	F=0	0.00	46.87	39%	-100%
Status quo	14.00	Fsq	0.38	32.50	-4%	-7%
High long term yield	17.82	F(long term yield)	0.51	28.63	-15%	19%
Status quo	7.65	Fsq *0.5	0.19	38.99	16%	-49%
	9.01	Fsq *0.6	0.23	37.59	11%	-40%
	10.33	Fsq *0.7	0.27	36.24	7%	-31%
	11.60	Fsq *0.8	0.30	34.95	4%	-23%
	12.82	Fsq *0.9	0.34	33.70	0%	-15%
	14.00	Fsq *1	0.38	32.50	-4%	-7%
	15.13	Fsq *1.1	0.42	31.35	-7%	1%
	16.23	Fsq *1.2	0.46	30.24	-10%	8%
Precautionary limits	1.74	(Fpa) *0.1	0.04	45.07	34%	-88%
	4.23	(Fpa) *0.25	0.10	42.50	26%	-72%
	8.06	(Fpa) *0.5	0.20	38.56	14%	-46%
	11.54	(Fpa) *0.75	0.30	35.00	4%	-23%
	13.47	(Fpa) *0.9	0.36	33.04	-2%	-10%
	14.69	(Fpa) *1	0.40	31.80	-6%	-2%
	15.87	(Fpa) *1.1	0.44	30.60	-9%	6%
	17.55	(Fpa) *1.25	0.50	28.90	-14%	17%
	20.15	(Fpa) *1.5	0.60	26.28	-22%	34%
	22.51	(Fpa) *1.75	0.70	23.92	-29%	50%
	25.15	(Fpa) *2	0.80	21.27	-37%	68%
	28.29	(Fpa) *2.25	0.90	18.07	-46%	89%

(1) It is assumed that the TAC will be implemented and that the landings in 2008 therefore correspond to the TAC.

All weights in thousand tones and shaded scenarios not consistent with precautionary approach

Table 10.2.1 Sole in Sub-Area IV: Nominal landings and landings as estimated by the Working Group (tonnes).

Year	Belgium	Denmark	France	Germany	Netherlands	UK (E/W/NI)	Other countries	Total reported	Unallocated landings	WG Total	TAC
1982	1900	524	686	266	17686	403	2	21467	112	21579	21000
1983	1740	730	332	619	16101	435		19957	4970	24927	20000
1984	1771	818	400	1034	14330	586	1	18940	7899	26839	20000
1985	2390	692	875	303	14897	774	3	19934	4314	24248	22000
1986	1833	443	296	155	9558	647	2	12934	5266	18200	20000
1987	1644	342	318	210	10635	676	4	13829	3539	17368	14000
1988	1199	616	487	452	9841	740	28	13363	8227	21590	14000
1989	1596	1020	312	864	9620	1033	50	14495	7311	21806	14000
1990	2389	1427	352	2296	18202	1614	263	26543	8577	35120	25000
1991	2977	1307	465	2107	18758	1723	271	27608	5905	33513	27000
1992	2058	1359	548	1880	18601	1281	277	26004	3337	29341	25000
1993	2783	1661	490	1379	22015	1149	298	29775	1716	31491	32000
1994	2935	1804	499	1744	22874	1137	298	31291	1711	33002	32000
1995	2624	1673	640	1564	20927	1040	312	28780	1687	30467	28000
1996	2555	1018	535	670	15344	848	229	21199	1452	22651	23000
1997	1519	689	99	510	10241	479	204	13741	1160	14901	18000
1998	1844	520	510	782	15198	549	339	19742	1126	20868	19100
1999	1919	828		1458	16283	645	501	21634	1841	23475	22000
2000	1806	1069	362	1280	15273	600	539	20929	1603	22532	22000
2001	1874	772	411	958	13345	597	394	18351	1593	19944	19000
2002	1437	644	266	759	12120	451	292	15969	976	16945	16000
2003	1605	703	728	749	12469	521	363	17138	782	17920	15850
2004	1477	808	655	949	12860	535	544	17828	-681	17147	17000
2005	1374	831	676	756	10917	667	357	15579	776	16355	18600
2006	980	585	648	475	8299	910		11933	-777	12600	17670

TAC 2007: 15 000 t

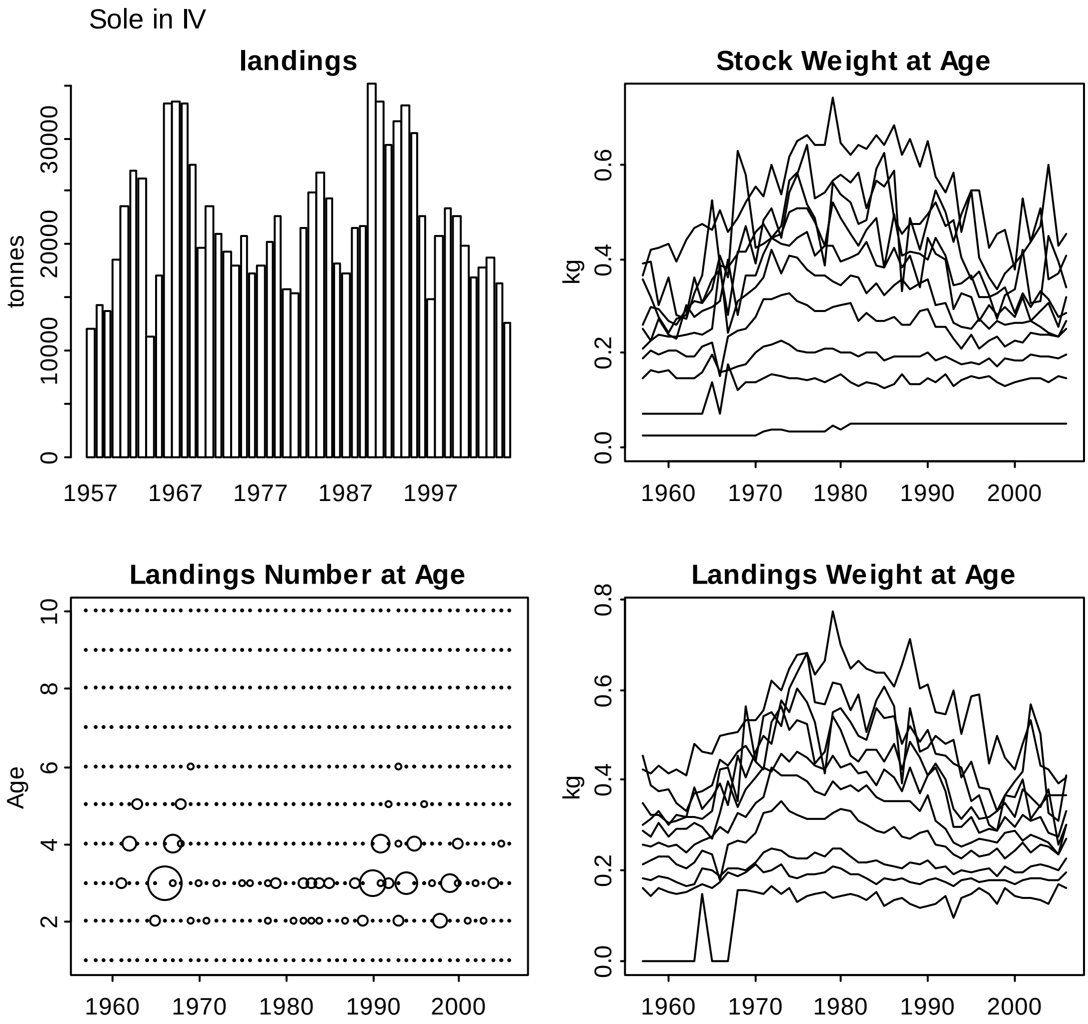


Figure 10.2.1. North Sea sole: Time series of landings (a- top left), standardised landings numbers (b - bottom left), stock weights and landings weights (c - top right, d – bottom right).

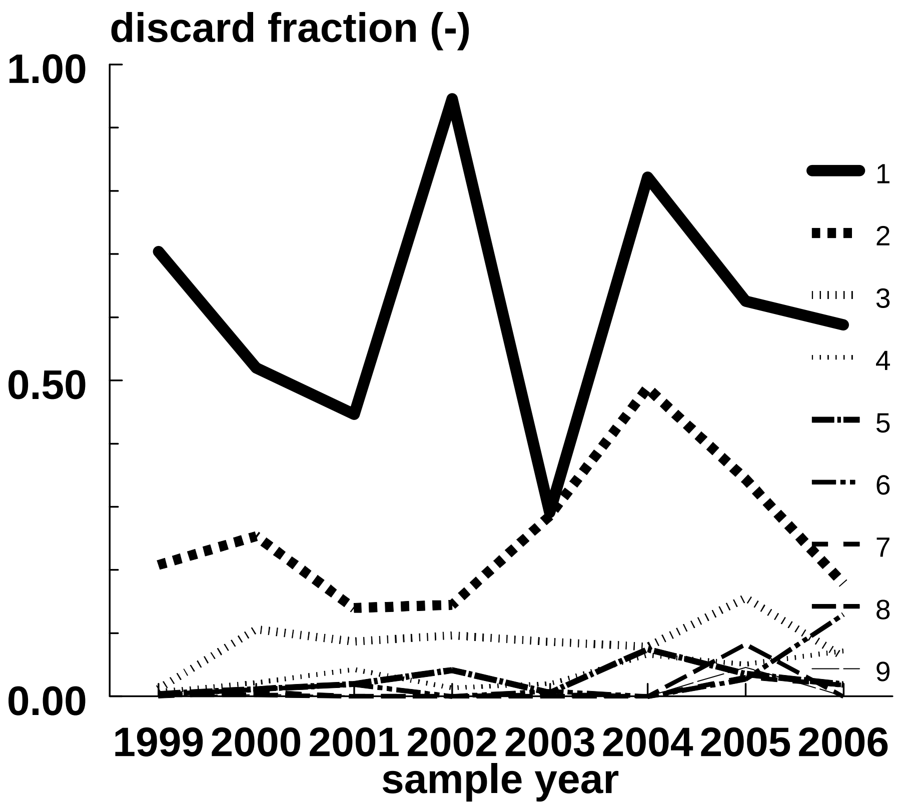
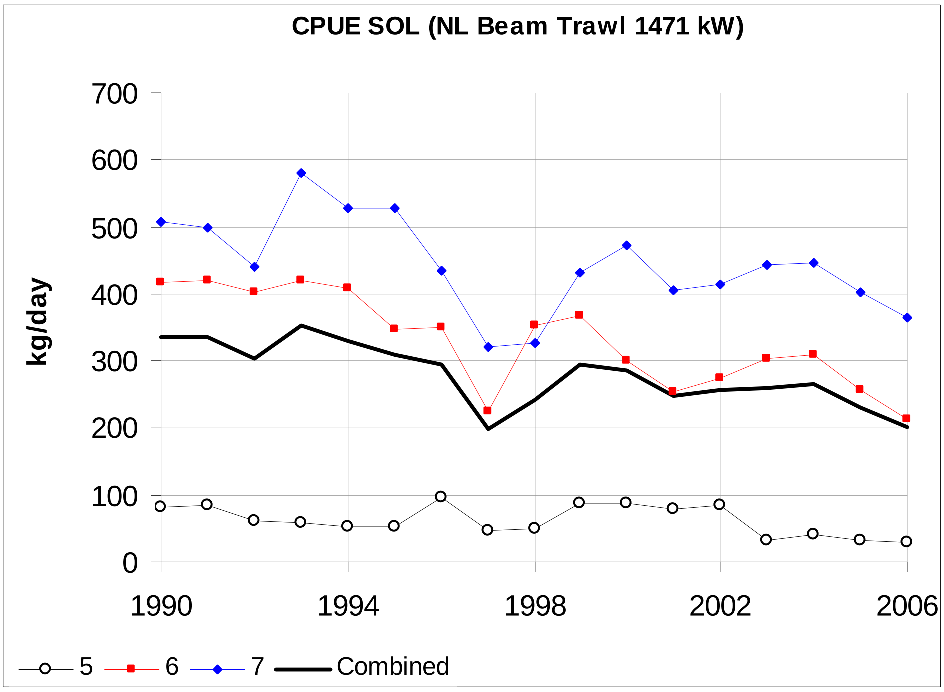


Figure 10.2.2. North Sea sole: Time series of discard fractions of catches of age group 1 to 9.



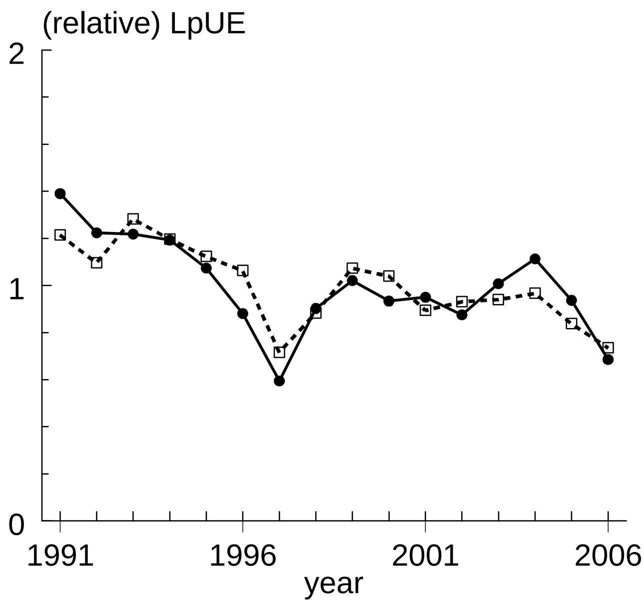


Figure 10.2.3. North Sea sole: lpue serie

Top: lpue trends in the Dutch beam trawl fleet (only large vessels, 2000 HP,) based on landings and effort records in the Dutch logbook database from vessels landings into the Netherlands. Three (North Sea) areas are considered: 5 (north, open circles), 6 (central, squares) and 7 (south, diamond). Black line indicates the overall trend in lpue)

Below: The overall trend in lpue (dashed line, open squares) and the trend in lpue (combined for age groups) of the commercial tuning serie used in the assessment .

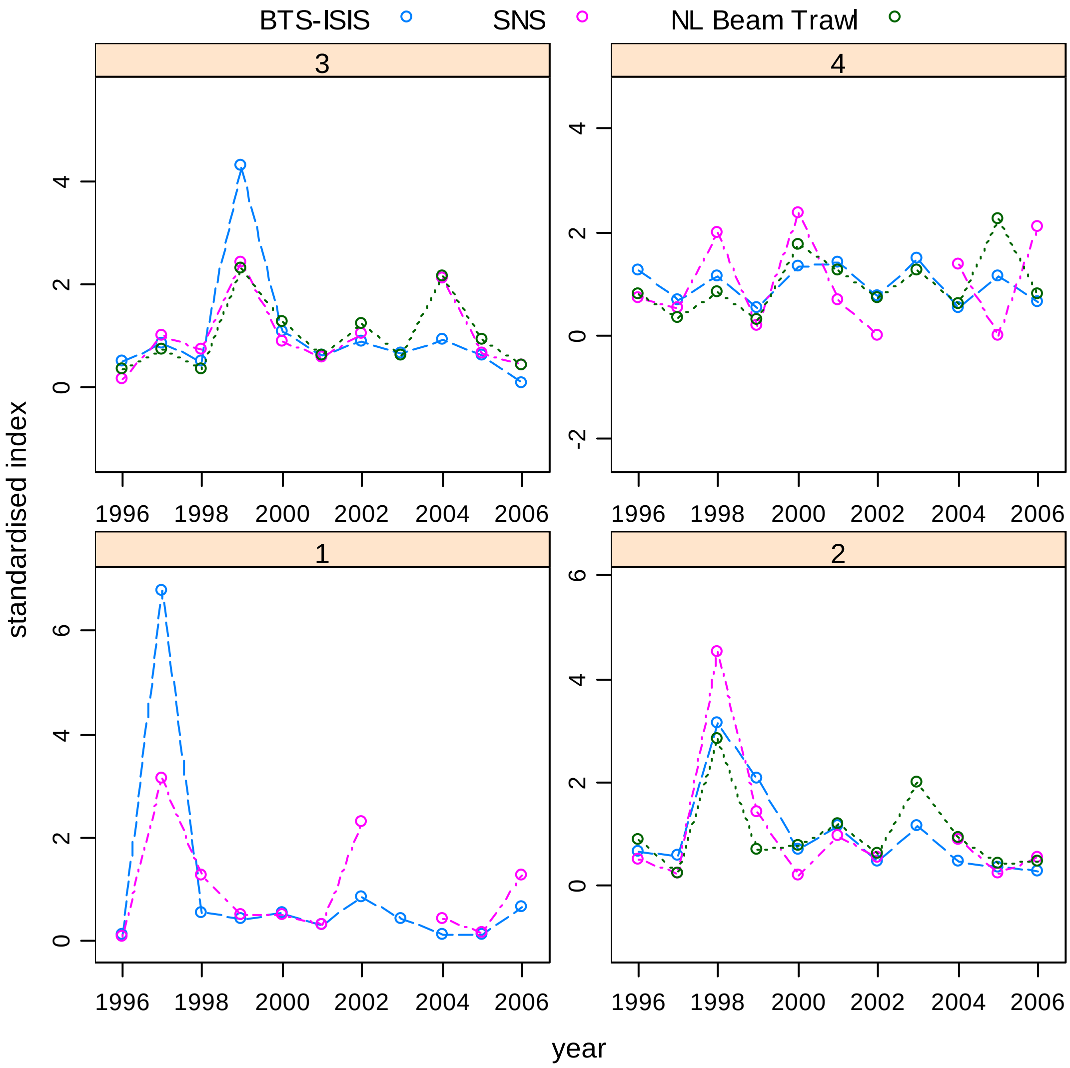


Figure 10.2.4 Sole in sub-area IV. Time series of the standardized indices age 1 to 4 from tuning fleets BTS-ISIS, SNS and NL beam trawl.

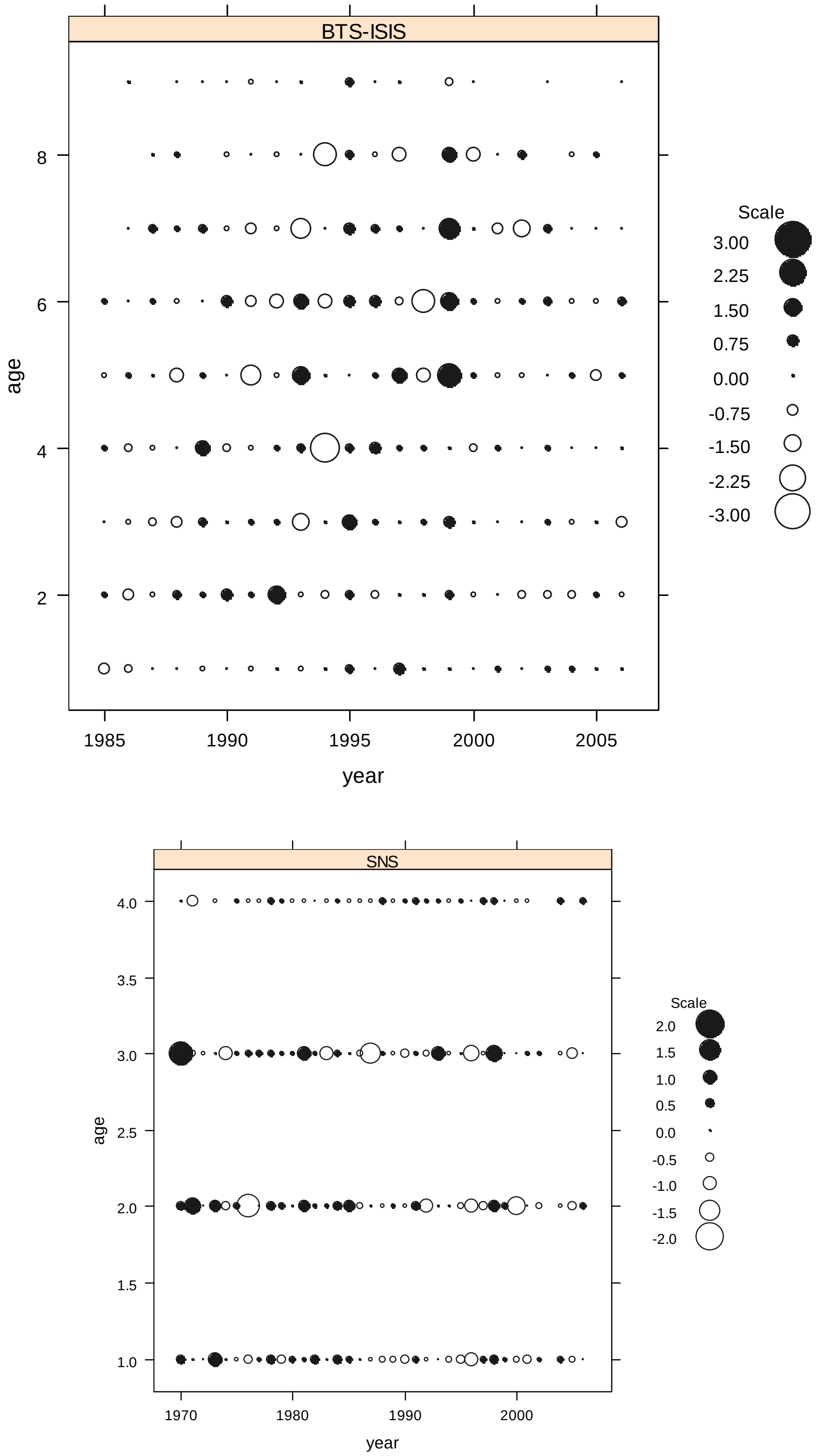
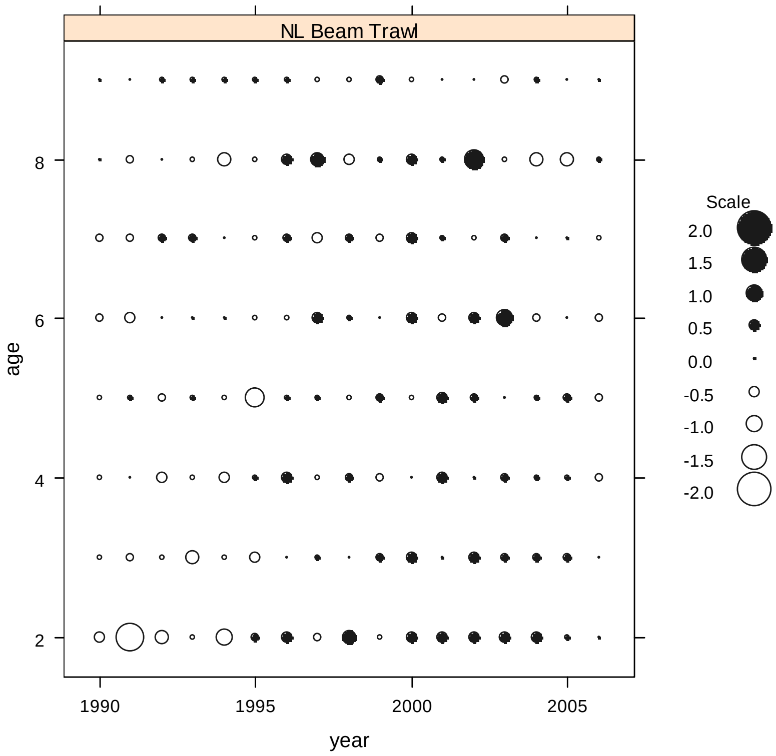


Figure 10.3.1. North Sea sole: Log catchability residuals for the tuning fleets, BTS (top) and SNS (lower) used in individual runs. Open circles indicate positive residuals, Closed and dark- circles indicate negative residuals



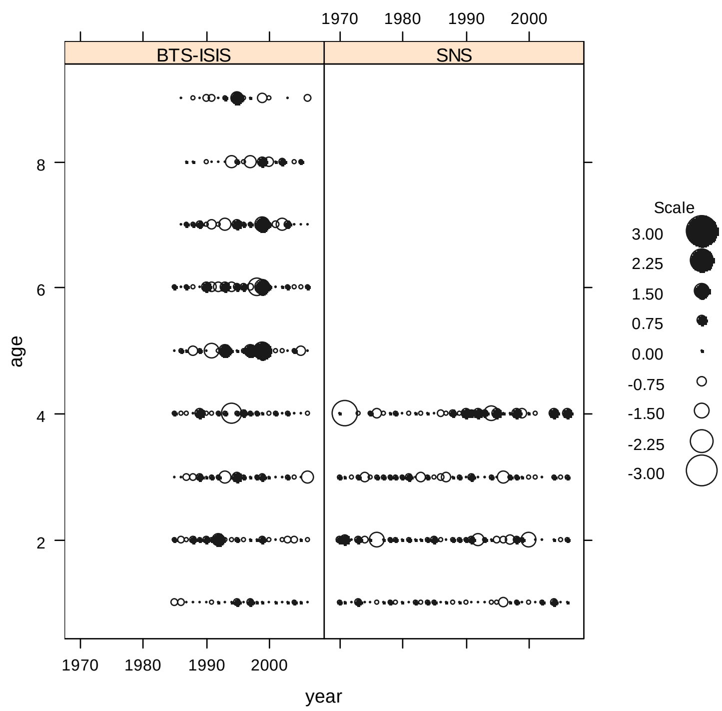


Figure 10.3.2 Sole in sub-area IV. : Top: Log catchability residuals for the NL BT tuning fleets used in a single fleet run. Below: Residuals for BTS ans SNS surveys in a combined survey analysis. Open circles indicate positive residuals, Closed and dark- circles indicate negative residuals

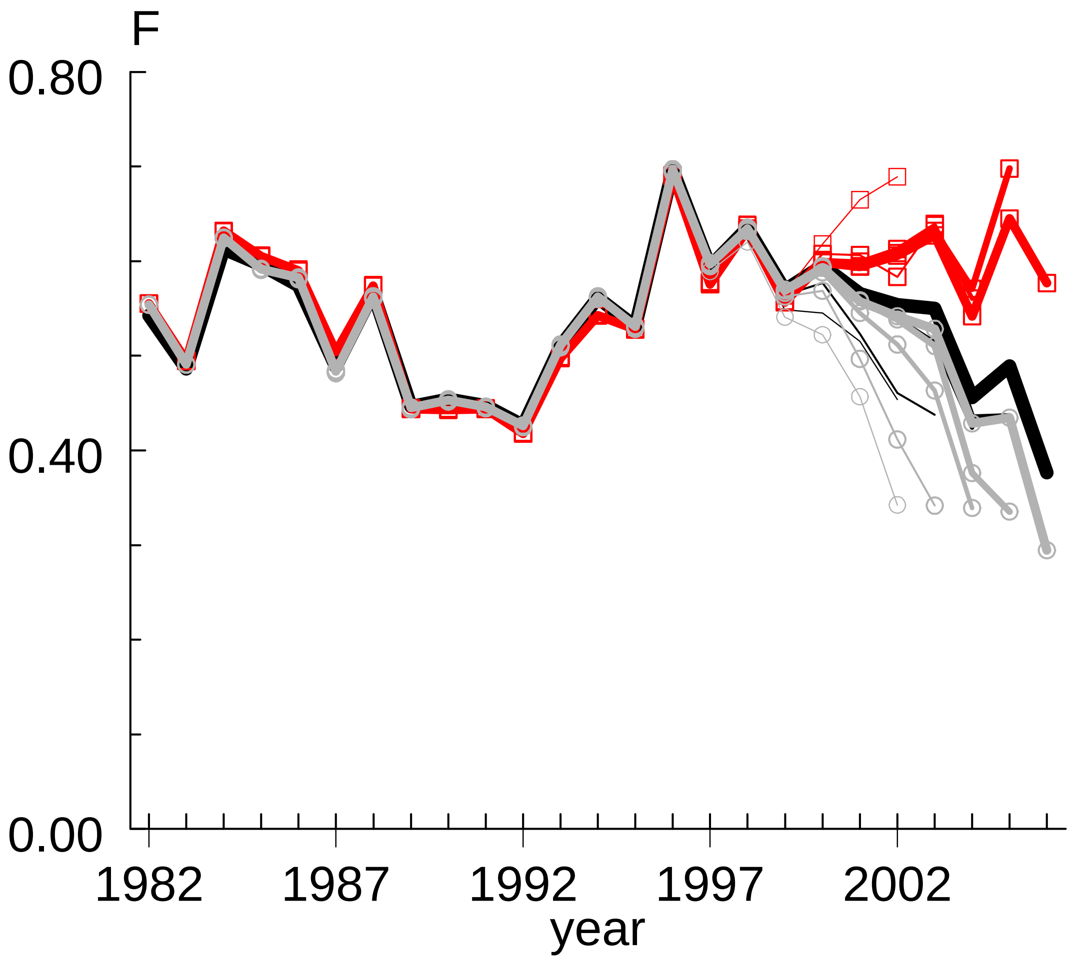


Figure 10.3.3 Sole in sub-area IV. XSA retrospective analysis of assessment estimates of fishing mortality using different combinations of indices. Open squares markers: using survey indices only, open circle markers is the result of using the commercial lpue index only and black without markers is the result of assessments using all three indices

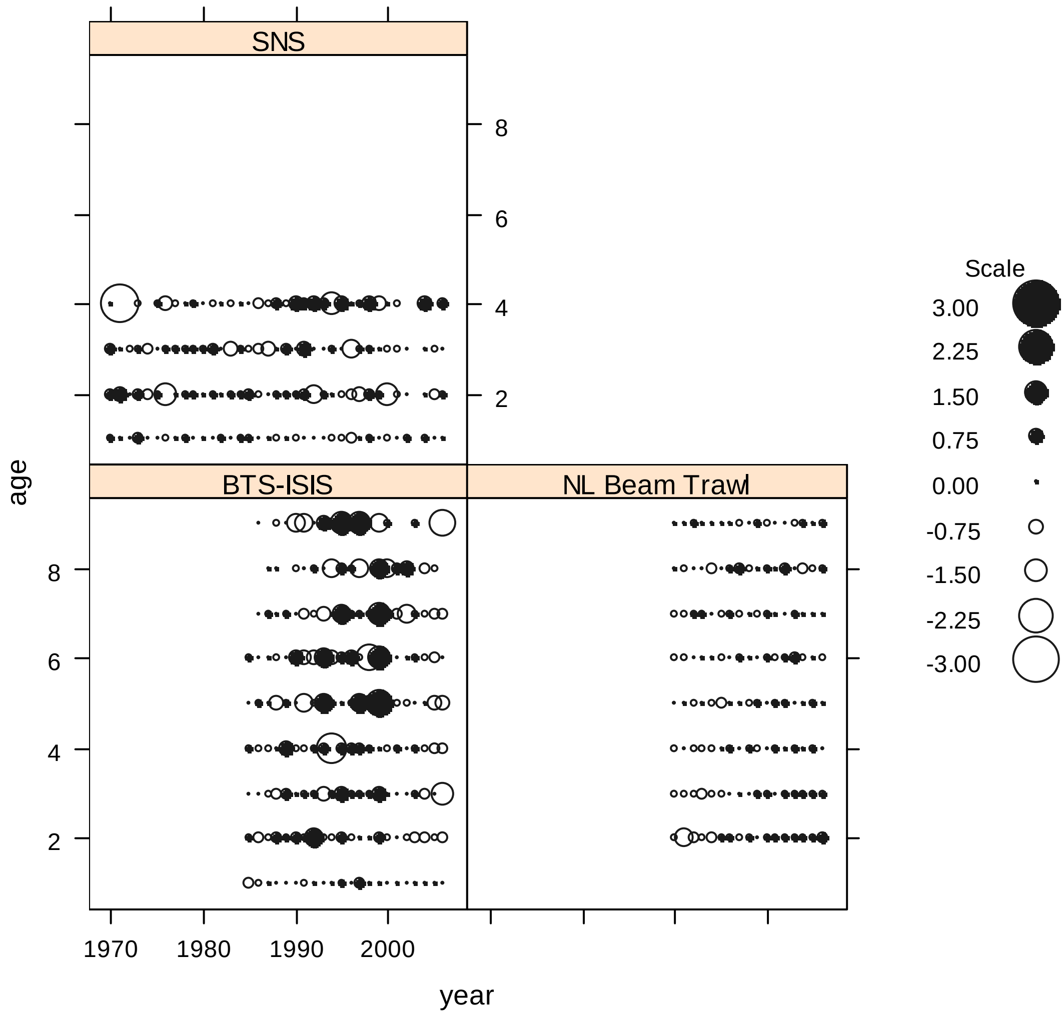


Figure 10.3.4 Sole in sub-area IV. XSA retrospective analysis of assessment estimates of spawning stock biomass using different combinations of indices. Open squares markers: using survey indices only, open circle markers is the result of using the commercial lpue index only and black without markers is the result of assessments using all three indices

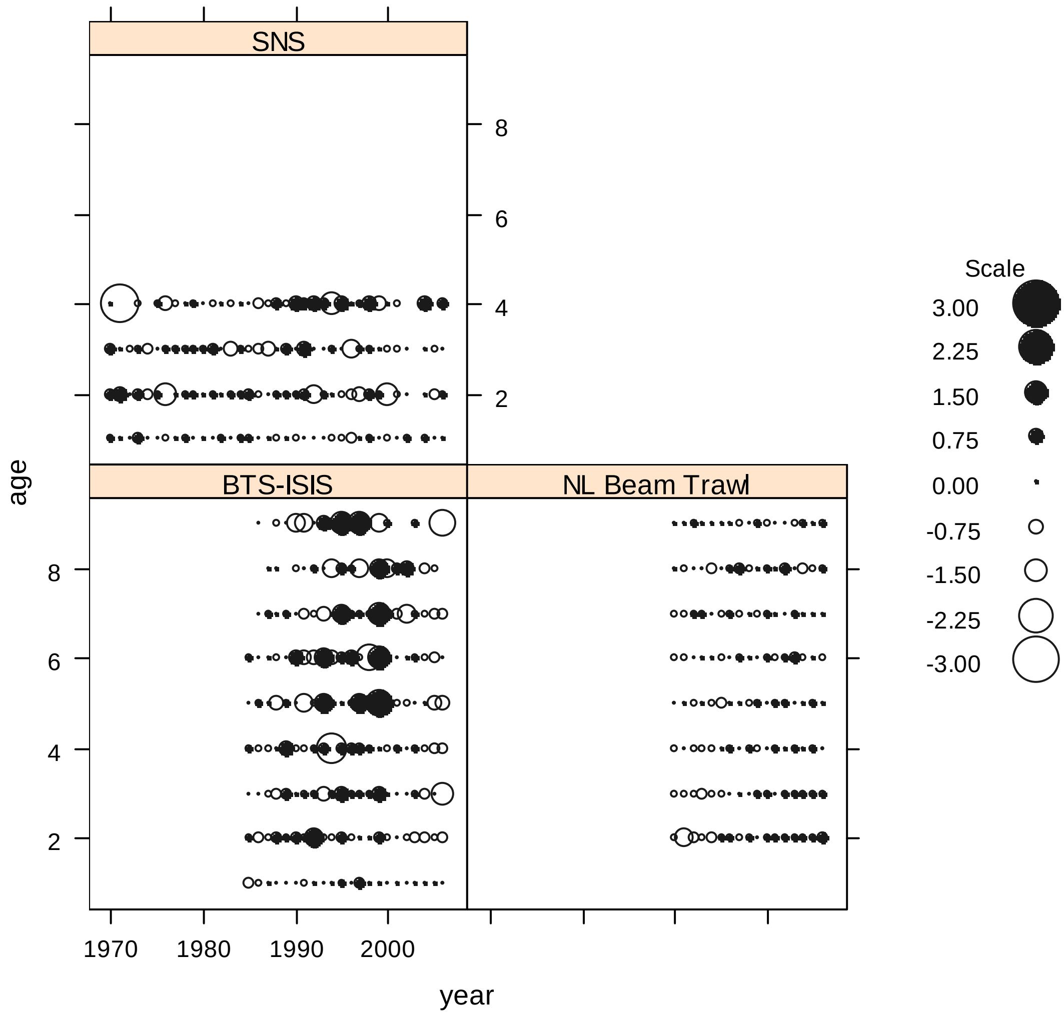


Figure 10.3.5 Sole in sub-area IV. log catchability residuals for the tuning fleets, BTS, SNS and NL beam trawl, in the final run. Open circles indicate positive residuals, Closed and dark- circles indicate negative residuals

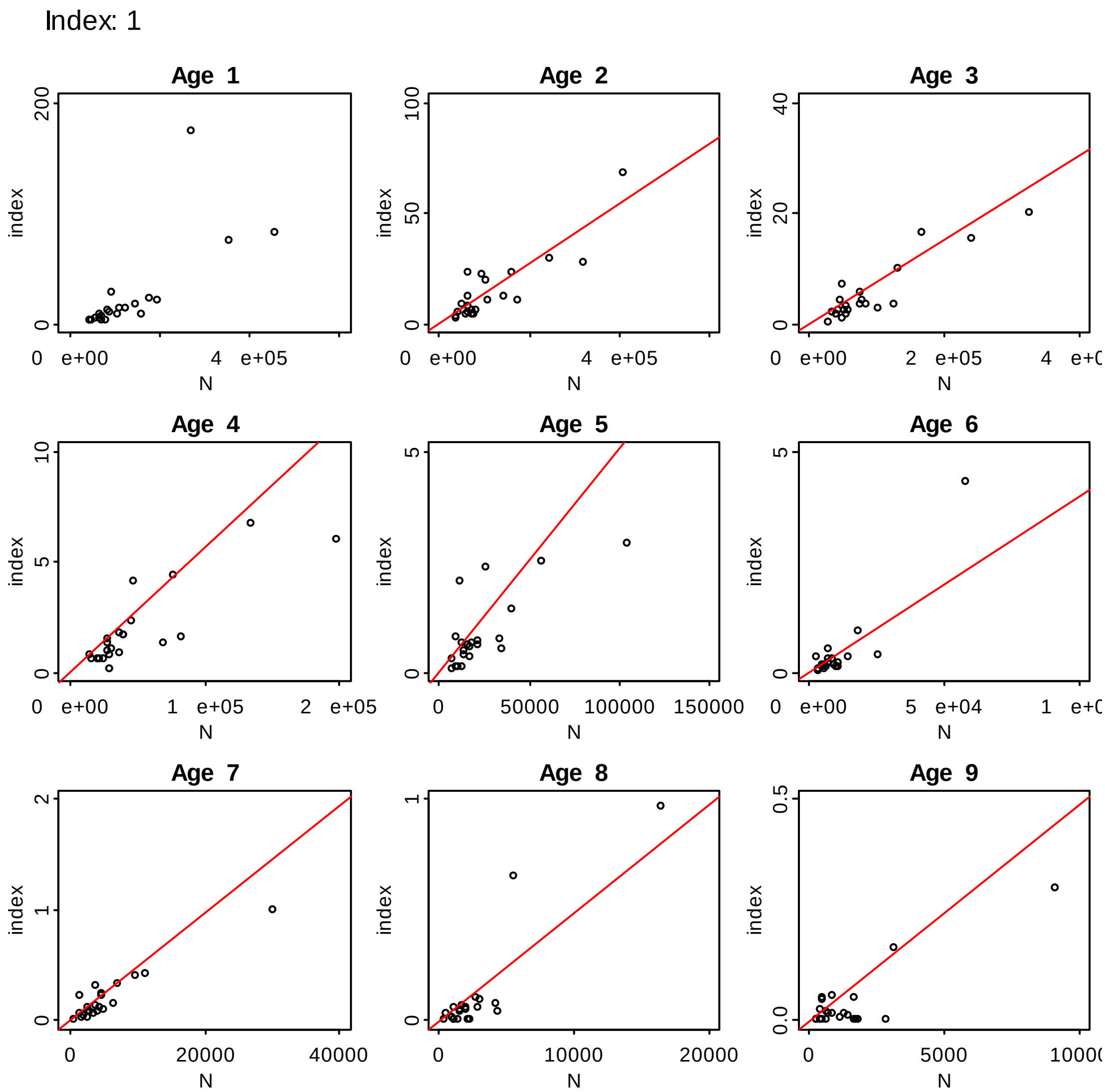


Figure 10.3.6 (a) Sole in sub-area IV. The estimated stock numbers at age in comparison to the tuning series BTS ISIS

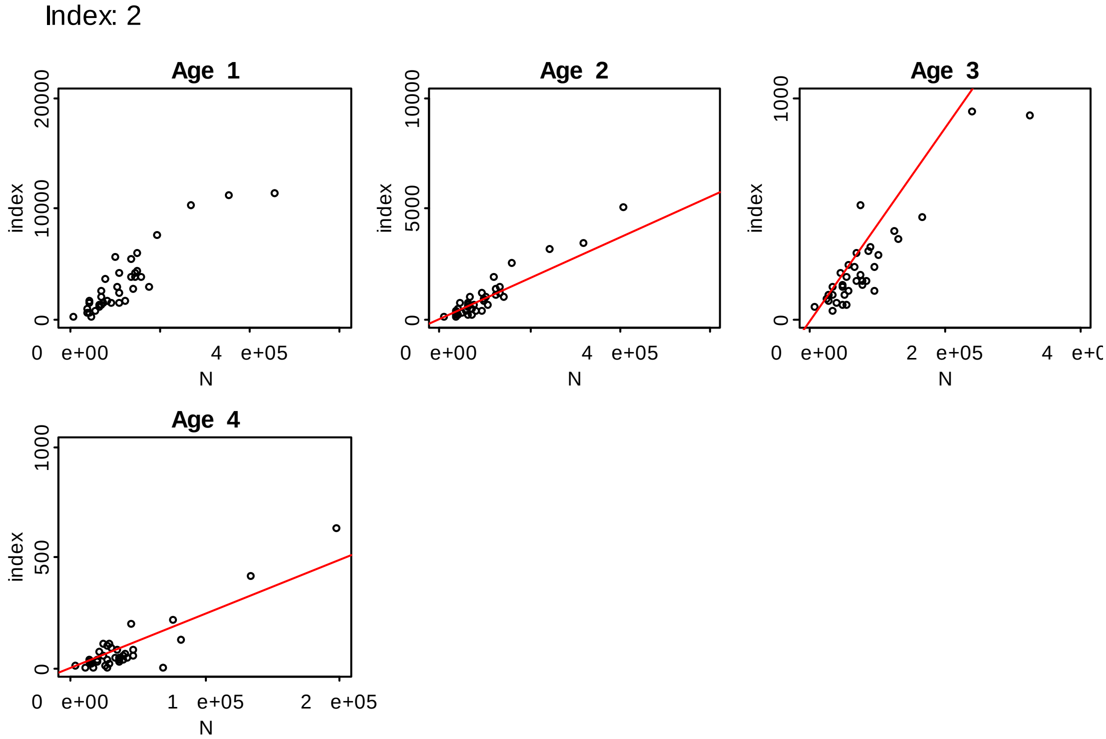


Figure 10.3.5 (b) Sole in sub-area IV. Time series of the estimated stock numbers at age in comparison to the tuning series SNS

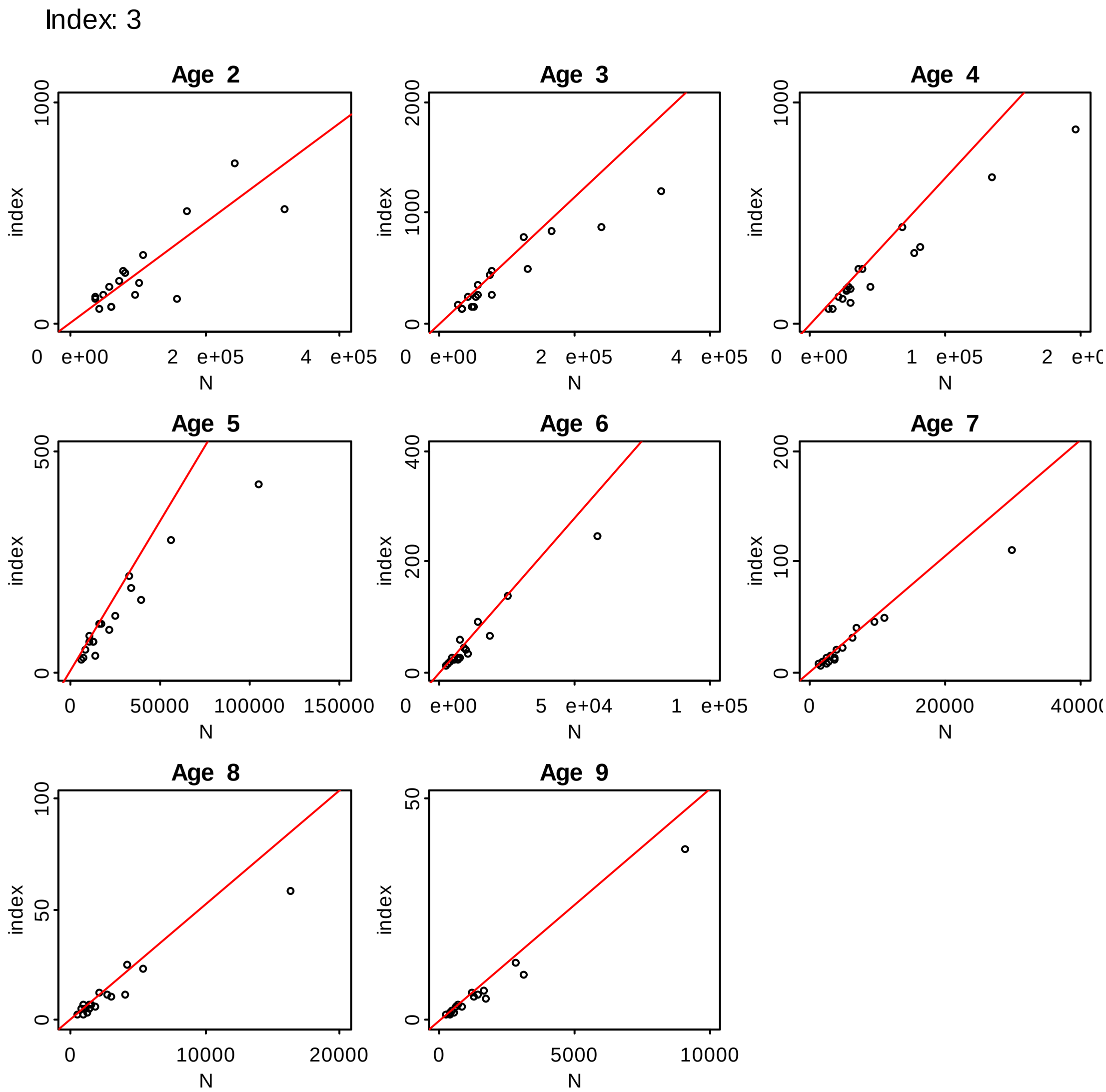


Figure 10.3.5 (c) Sole in sub-area IV. Time series of the estimated stock numbers at age in comparison to the commercial tuning series NL BT

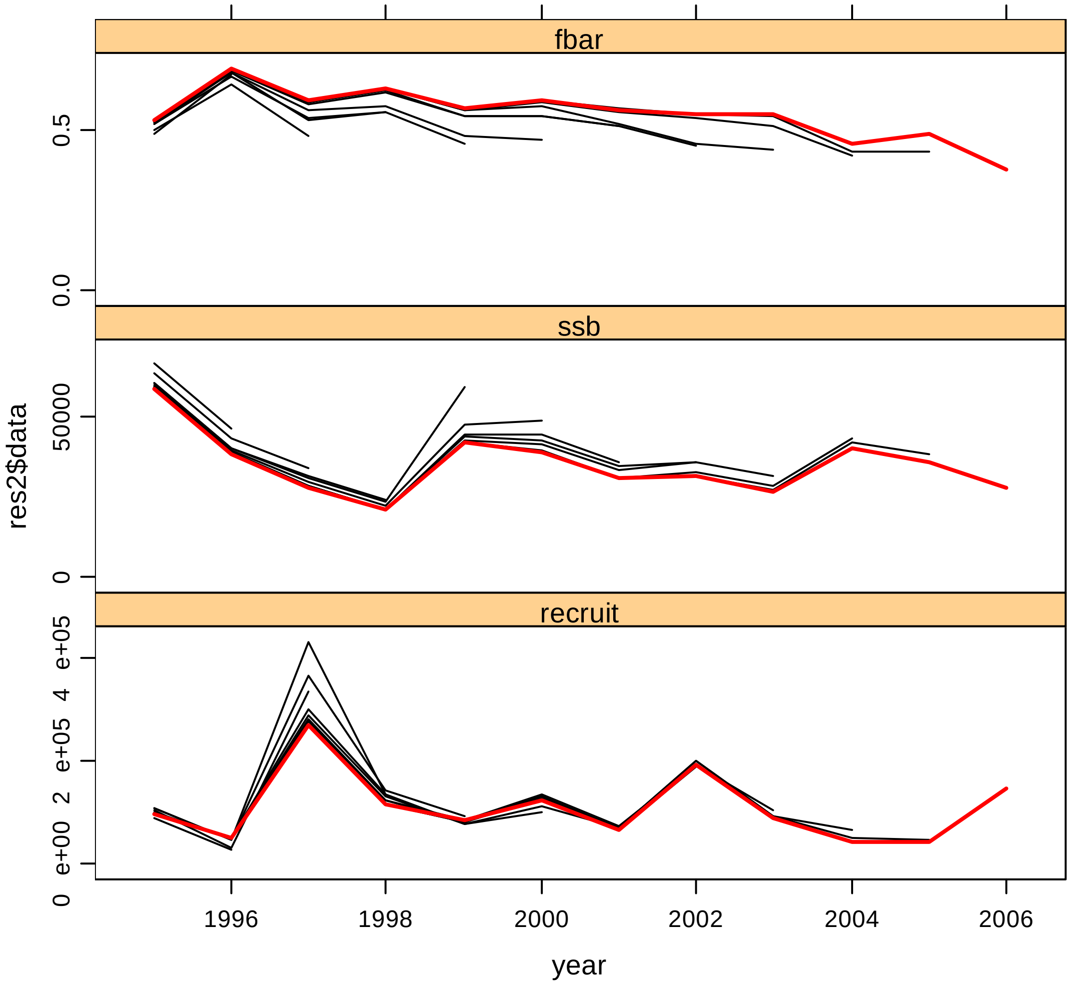


Figure 10.3.6 Sole in sub-area IV. Retrospective analysis of F, SSB and recruitment for 1995-2006

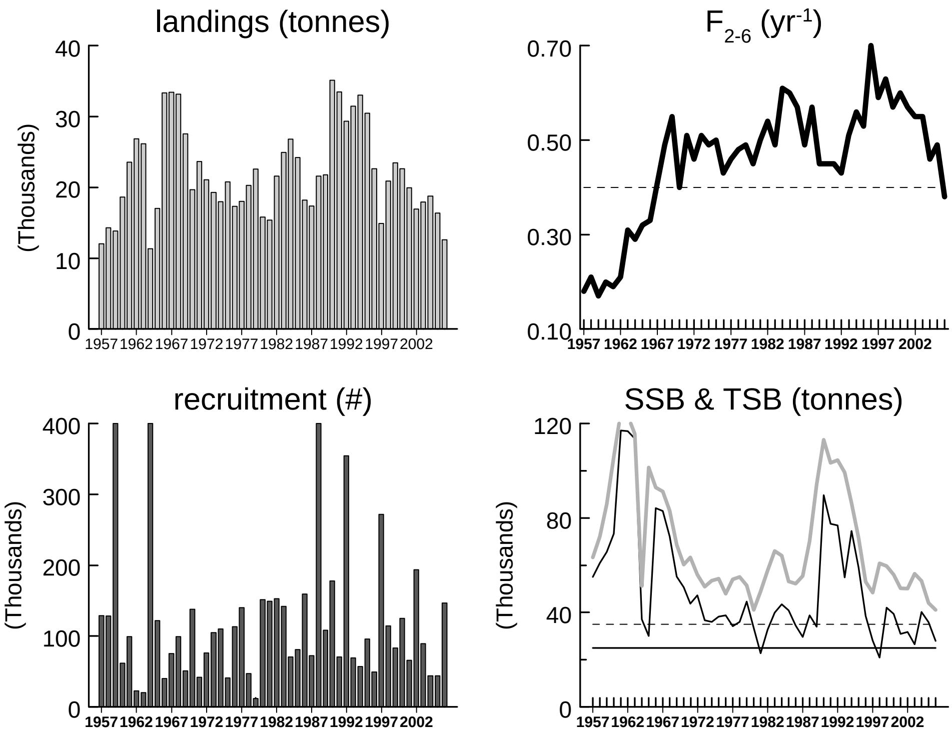
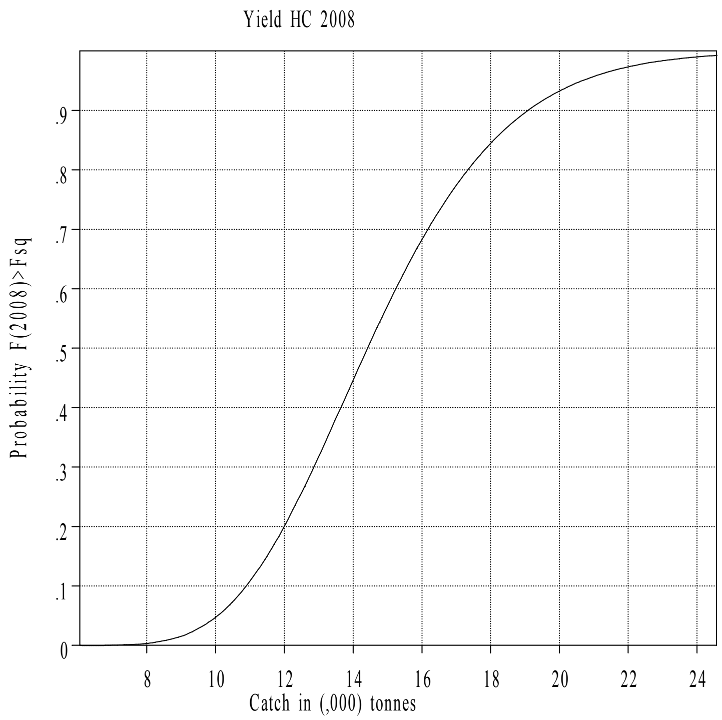


Figure 10.4.1 Sole in sub-area IV. Population and fishery summary plots



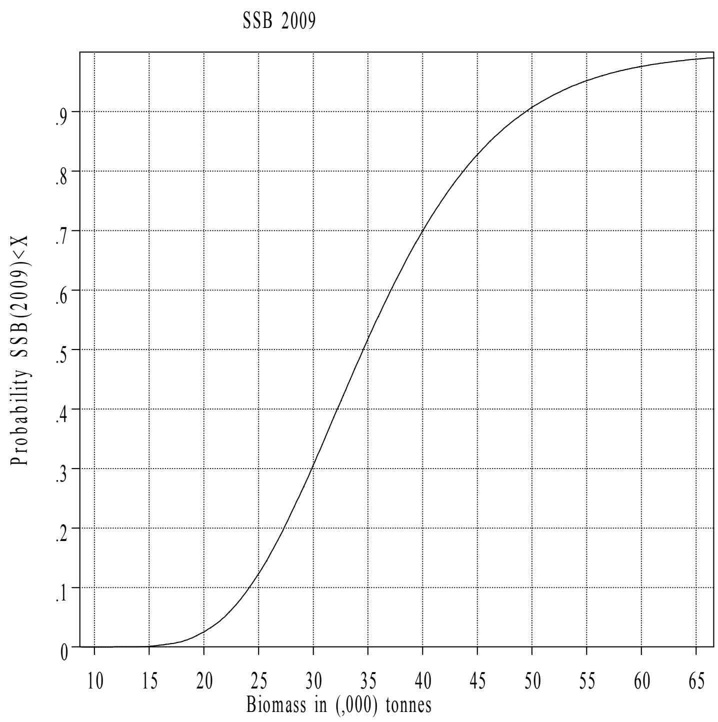


Figure 10.6.1. Sole in sub-area IV: Probability plots for short-term forecasts. Top, probability plot for Fsq and below a probability plot for SSB.

Year-class			2003	2004	2005	2006	2007
Stock No. (thousands) of 1 year-olds			43976	43909	146903	97700	97700
Source			XSA	XSA	XSA	GM57-03	GM57-03
Status Quo F:							
% in	2007	landings	11.4	14.7	34.4	2.8	-
% in	2008	landings	5.5	9.0	44.4	19.2	2.4
% in	2007	SSB	16.5	21.1	0.0	0.0	-
% in	2008	SSB	6.9	10.8	53.1	0.0	0.0
% in	2009	SSB	4.5	6.1	36.5	33.1	0.0

GM : geometric mean recruitment

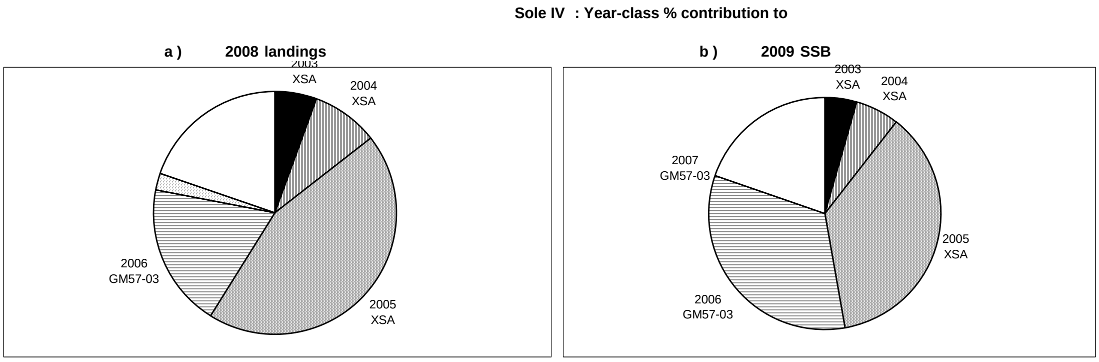
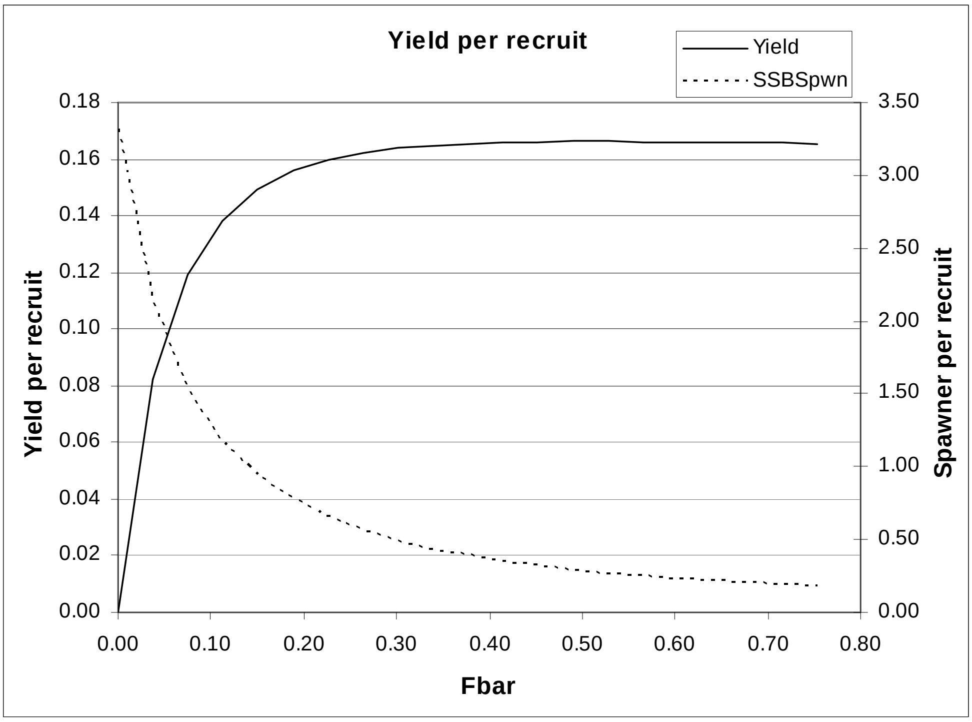


Figure 10.6.2 Sole in sub-area IV. Relative year class contribution to 2007 predicted landings (top) and 2008 SSB (below)



Reference point	F multiplier	Absolute F
Fbar(2-6)	1.00	0.38
FMax	1.35	0.51
F0.1	0.32	0.12
F35%SPR	0.30	0.11

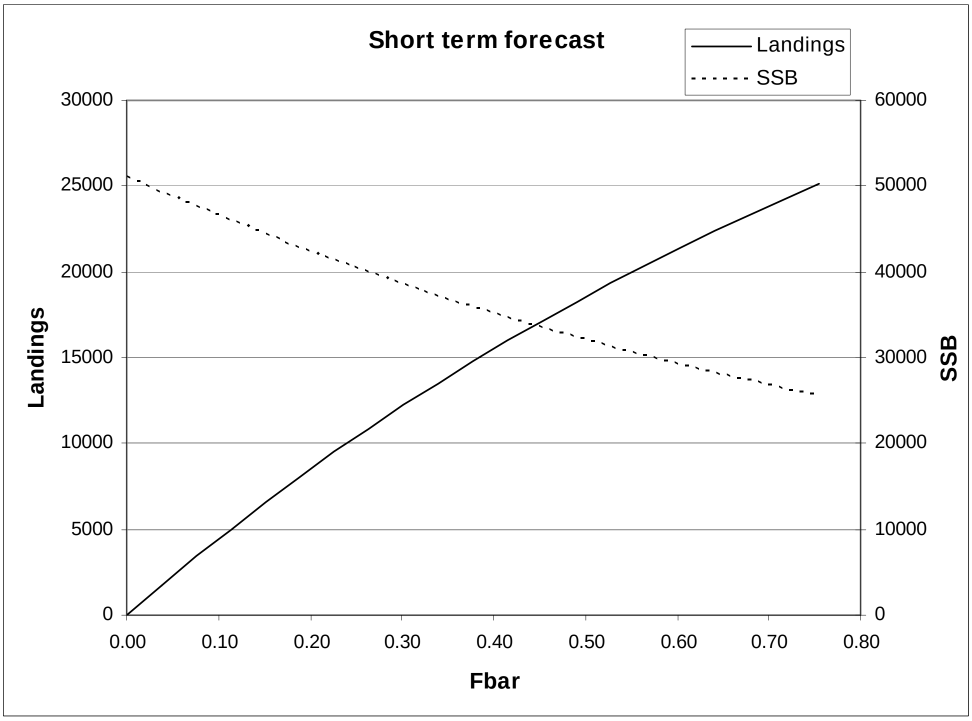


Figure 10.6.4 Sole in sub-area IV. XSA YPR results (top) and short-term forecast (bottom).

11 Saithe in Sub-area IV, VI and Division IIIa

The 2007 assessment of saithe in Sub-areas IV and VI and Division IIIa is classified as an update assessment. However, as some changes were made in this year's settings compared to last year, "modified assessment" is a more appropriate description.

11.1 General

11.1.1 Ecosystem aspects

The geographical distributions of juvenile (< age 3) and adult saithe differ. Typical for all saithe stocks are the inshore nursery grounds. Juvenile saithe in the North Sea are therefore mainly distributed along the west and south coast of Norway, the coast of Shetland and the coast of Scotland. At around age 3 the individuals gradually migrate from the costal areas to the northern part of the North Sea (57°N - 62°N).

The age at first maturity is between 4 and 6 years, and spawning takes place in January-March at about 200 m depth along the Northern Shelf edge and the western edge of the Norwegian 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 mechanisms behind the 0-group's migration from oceanic to costal areas remain unknown, but it seems like they are actively swimming towards the coasts. The west coast of Norway is probably the most important nursery ground for saithe in the North Sea.

When saithe exceeds 60-70 cm in length the diet changes from plankton (krill, copepods) to fish (mainly Norway pout, blue whiting, haddock and herring). Large saithe (>70 cm) has a highly migratory behaviour and the feeding migrations extend from far into the Norwegian Sea to across the Norwegian Deeps to the Norwegian coast.

Tagging experiments by various countries have shown that exchange takes place between all saithe stock components in the northeast Atlantic. In particular, exchange between the saithe stock north of 62°N (Northeast Arctic saithe) and saithe in the North Sea has been observed.

11.1.2 Fisheries

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. Norwegian, French, and German trawlers take the majority of the catches. In the first quarter of the year the fisheries are directed towards mature fish in spawning aggregations, while concentrations of immature fish (age 3-4) often are targeted during the rest of the year. In recent years the French fishery 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. 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 3-4). 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 about 3 years old, discarding of young fish is assumed to be a small problem in this fishery. Problems with by-catches in other fisheries when saithe quotas are exceeded may cause discarding. French and German trawlers are targeting saithe and they have larger quotas, so the problem may be less in these fleets. The Norwegian trawlers move out of the area when the boat quotas are reached, and in addition the fishery is closed if the seasonal quota is reached.

In 2006 the landings were estimated to be around 117 000 t in Sub-area IV and Division IIIa, and around 8 500 t in Sub-Area VI, which both are below the TACs for these areas. 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

In 2006 ICES considered the stock as having full reproductive capacity and as being harvested sustainably.

Exploitation boundaries in relation to existing management plans

At the present SSB level, F should be below 0.3 to be in accordance with the management plan. This corresponds to landings of 136 000 t in 2007.

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

The current fishing mortality is estimated at 0.25, which is above the rate expected to lead to high long-term yields ($F_{0.1}$ = 0.11). Fishing at $F_{0.1}$ is expected to lead to landings of 51 000 t in 2007.

Exploitation boundaries in relation to precautionary limits

The exploitation boundaries in relation to precautionary limits imply human consumption landings of about 170 000 t in 2007, where the SSB is expected to remain above B_{pa} (200 000 t) in 2008.

ICES conclusion on exploitation boundaries

Although ICES has not evaluated the agreed management plan, the target fishing mortality in the management plan is expected to give higher long-term gains in the present situation with a stock that is well above B_{pa} and ICES therefore recommended to limit landings in 2007 to 136 000 t.

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 2006 was 123 250 t. In Division Vb and Sub-Areas VI, XII, and XIV the TAC for 2006 was 12 787 t. For 2007 the TACs were 123 250 t and 12 787 t, respectively.

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." The agreement is due for revision in 2007.

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 and Fig. 11.2.1. 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. These discrepancies have not been investigated because of data coordination difficulties in 2007. Fig. 11.2.1 shows that the proportions of older saithe (age>5) in the catches have increased in recent years.

11.2.3 Weight at age

Weight at age in the catch is presented in Table 11.2.3 and Fig. 11.2.2. These are also used as stock weights. There has been a decreasing trend in mean weights from the mid-1990s for ages 4 and older.

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 Fig. 11.2.3. The LPUE shows an increasing trend in all fleets and ages (Fig. 11.2.3). Three commercial series of effort and catch at age and two series of survey indices were available:

Commercial fleets:

- French fresh fish trawl, age range: 3-9, year range 1990-2006 ("FRATRB")

- German bottom trawl, age range: 3-9, year range 1995-2006 (“GEROTB”)
- Norwegian bottom trawl, age range: 3-9, year range 1980-2006 (“NORTRL”)

Surveys:

- Norwegian acoustic survey, age range 3-6, year range 1995-2006 (“NORACU”)
- IBTS quarter 3, age range: 3-5, year range 1991-2006 (“IBTSq3”)

11.3 Data analyses

Although this year’s assessment is classified as an update assessment, the data analyses are more extensive than last year. The consistency in the input data is analysed using catch curves, separable VPA, correlation plots and standardised tuning indices.

11.3.1 Reviews of last year’s assessment

The Review Group in ACFM had several comments to the assessment:

1. 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). However, surveys only cover ages 3-6 and thus could not be used by themselves to assess the SSB using a SURBA analysis.
2. More information on the Norwegian surveys is required
3. The decrease in weight at older ages should be investigated (sampling problem ?)
4. The RG asked to investigate the SOP discrepancies since 2000 (corrections seem to have been done previously).

The Working Group has the following responses:

1. The Working Group sees no alternative to using commercial LPUE in combination with surveys as long as age based models are used. The commercial tuning series are scrutinized in more detail this year for internal consistency.

2. The NORACU indices are number of fish calculated from echo recordings of saithe along the survey track during IBTS quarter three, covering the area north of 56°30′ N up to 62° N. In the last three years the saithe survey and the international acoustic herring survey have been merged.

3. Data from individual countries all show a consistent decrease in weight at age in the catch during recent years. In addition the other saithe stocks in the Northeast Atlantic show similar patterns in weight at age. All this strongly indicates that the observed pattern is not a consequence of biased sampling.

4. The working group did not look into this, but plans to do it when a new data coordinator has been appointed.

11.3.2 Exploratory catch-at-age-based analyses

Catch curves (log numbers caught at age linked by cohort) for the total catch-at-age matrix are shown in Fig 11.3.1. The plot shows that age 3 is partly recruited to fishery for recent cohorts, but fully recruited for some of the earlier cohorts. Moreover the catch curves are less steep in recent years compared to earlier. The negative slopes in the catch curves, which give an indication of total mortality inferred from the catch data, are shown in Fig. 11.3.2. The trend in the gradients is in agreement with the trend in estimated fishing mortality. A separable VPA was run to check the consistency in the catch data, and the resulting log catch residuals are shown in Fig. 11.3.3. The residuals do not indicate problems with the data in terms of large year effects etc.

Single fleet XSAs were run with each of the available 3 commercial tuning fleets using the same settings as in the final assessment last year. The log catchability residuals from these runs are shown in Fig. 11.3.4. The residuals from the run with NORTRL (Norwegian trawl) are larger than the residuals from the other two series. The survey time series have a too narrow age range for single fleet runs (lack of tuning information for some ages leads to unreliable results).

Fig. 11.3.5 shows the log catchability residuals from an XSA using identical settings as last year ("SPALY" run). Note the large negative residuals in the first year of the two survey series (which is 1991 in IBTSq3 and 1995 in NORACU), and the large residuals in NORTRL series. A trial was made with the NORTRL series divided in two, but this did not improve the residual pattern (results not shown).

11.3.3 Exploratory survey-based analyses

Log-abundance indices by cohort for the tuning series are shown in Fig. 11.3.6. The pattern is similar to the pattern in the total landings data catch curves, with partial recruitment of age 3 for recent cohorts. The curves for the most recent cohorts from the last part of the NORTRL time series have a pattern that differs markedly from earlier cohorts in the same series and from the curves in the other tuning series. This indicates considerable changes in the exploitation pattern or data problems for this fleet.

Within-survey correlations for the available tuning series are shown in Figs. 11.3.7 – 11.3.11. For the IBTSq3 series the relationship between age 3 and 4 is quite poor, but the relationship between age 4 and 5 is considerably better (Fig. 11.3.7). The same seems to be the case for the NORACU time series with poor relationship between age 3 and 4, and considerably better for age 4 to 5 and age 5 to 6 (Fig. 11.3.8). The internal consistencies are stronger in FRATRL and GEROTB compared to the NORTRL series (Figs 11.3.9-11.3.11). The relationships between age 3 and age 4 are also poor for the commercial tuning series.

The two survey time series are quite consistent (Fig. 11.3.12). They are, however, not entirely independent since the age-disaggregation of both indices is based on the same age and length samples. The relative trends in the commercial tuning series are compared in Fig. 11.3.13. For age 3 and 9 the consistency between the series is poor, but better for the age groups in-between.

11.3.4 Conclusions drawn from exploratory analyses

Both the catch curves of the total landings data and the residuals from the separable VPA indicate changes in the relative exploitation of age 3 with time. A likely explanation of this apparent change in exploitation pattern is that the proportion of catches taken by purse seine decreased significantly in the early 1990s, and purse seiners mainly target young saithe.

Therefore, it may now be more appropriate to use a reference-F that does not include age 3. This should be investigated further in the forthcoming evaluation of the EU-Norway management plan.

The explorations of the within and between consistencies in the available tuning series indicate that the abundance indices of age 3 are uncertain, and that age 4 indices seem to give more reliable information about year class strength.

The working group suggests removing the NORTRL tuning series from the assessment based on the recent diverging pattern in log-cpue curves and the large log catchability residuals from the XSA runs. In addition, the working group suggests the removal of the first year in both the survey series (1991 in IBTSq3 and 1995 in NORACU) because of the large negative log-catchability residuals (in the SPALY run).

11.3.5 Final assessment

The settings in final XSA assessment for 2007 are shown below (together with the settings in the final assessments in the two preceding years). The adjustments in the 2007 settings do not lead to large changes in the results compared to the SPALY run.

Year of assessment:	2005	2006	2007
Assessment model:	XSA	no change	no change
Fleets:	FRAtrb (age range: 3-9, 1990 onwards)	no change	no change
	GERotb (age range: 3-9, 1995 onwards)	no change	no change
	NORtrl (age range: 3-9, 1980 onwards)	no change	removed
	NORacu (age range: 3-6, 1995 onwards)	no change	NORacu (age range: 3-6, 1996 onwards)
	IBTSq3 (age range: 3-6, 1991 onwards)	no change	IBTSq3 (age range: 3-5, 1992 onwards)
Age range:	3-10+	no change	no change
Catch data:	1967-2004	1967-2005	1967-2006
Fbar:	3-6	no change	no change
Time series weights:	Tricubic over 20 years	no change	no change
Power model for ages:	No	no change	no change
Catchability plateau:	Age 7	no change	no change
Survivor est. shrunk towards the mean F:	5 years / 3 ages	no change	no change
S.e. of mean (F-shrinkage):	1.0	no change	no change
Min. s.e. of population estimates:	0.3	no change	no change
Prior weighting:	No	no change	no change
Number of iterations before convergence:	39	40	51

Outputs from the final run are given in Table 11.3.1 (diagnostics), Table 11.3.2 (fishing mortality at age), Table 11.3.3 (population numbers at age), and Table 11.3.4 (stock summary).

The log catchability residuals from the final run are shown in Fig. 11.3.14, the relative weights of F-shrinkage and tuning fleets are shown in Fig. 11.3.15, a retrospective analysis is shown in Fig. 11.3.16 and the historical performance of the assessment is shown in Figure 11.3.17. Average Fs taken over different age ranges are shown in Fig. 11.3.18. The perception of the recent trend in fishing mortality does not change much when varying the age range used in the reference F.

11.4 Historic Stock Trends

The historic stock and fishery trends are presented in Fig. 11.4.1 (and Table 11.3.4). The reported landings increased from 1967 to the highest observed landing levels in the mid-1970s. After 1976 the landings decreased rapidly to a stable level between 1979-1981 and increased again from 1981 to 1985. From 1985 the reported landings decreased and levelled off in 1989 to a fairly stable level where they have stayed since. During the last 5 years (2002-2006), TAC levels have been higher than the reported landings. Estimated fishing mortality shows the same trends as landings in the period 1967-1985, while it has decreased continuously since 1985 until present (except for some small jumps), dropping below F_{lim} in 1993 and below F_{pa} in 1997. Estimated SSB increased from 1967 reaching the highest observed level in 1974 after which it decreased to below B_{lim} in 1990. After 1991 SSB increased to above B_{pa} in 1999. SSB is estimated to have been slightly above B_{pa} since 2001. The level and variation in estimated recruitment (measured at age 3) are higher before about 1985 than after, e.g., the six strongest year classes observed all occurred in the earliest period. The 2002 year class, which is the youngest cohort where the strength now probably can be measured fairly precisely, seems above average.

11.5 Recruitment estimates

Reliable abundance information does not exist for the 2004 and 2005 year classes. It was therefore decided to use the geometric mean of recruits (age 3 from the final assessment) from the period 1988-2004, as the estimated recruitment for these year classes. The reason for excluding data before 1988 is that the recruitment dynamics (level and variation) seems quite different before and after 1988.

Year class	Age in 2007	XSA	GM(88-04)
2003	4	115594	
2004	3		124451
2005	Age 3 in 2008		124451

11.6 Short-term forecasts

The short-term prognosis was performed using the same settings as last year. Inputs are presented in Table 11.6.1. The averages over the last three years are used for weight at age in the stock and catch. Fishing mortalities at age are estimated as an arithmetic average over the last three years. Number at age 3 (recruitment) is taken as the geometric mean of age 3 from the period 1988-2004. Population numbers at age 4 and older are the XSA survivor estimates from the final assessment. The management options table are given in Table 11.6.2. Status quo fishing mortality (F_{sq}) in 2007 and 2008 is expected to lead to landings of about 122 000 tonnes in 2008 and a slight decrease in the expected spawning stock biomass in 2009. A fishing mortality in 2008 according to the current EU-Norway management plan is expected to lead to landings of about 150 000 tonnes and SSB above Bpa in 2009. The forecasted contribution of the most recent year classes in landings and SSB are shown in Table 11.6.3 and Fig. 11.6.1.

11.7 Medium-term forecasts

No medium-term forecasts were carried out. Such forecasts/simulations will be carried out during the forthcoming evaluation of the EU-Norway management plan.

11.8 Biological reference points

The biological reference points were estimated in 2006 and are:

$\mathbf{F}_{0.1}$	0.10	$\mathbf{F}_{lim}$	0.60
$\mathbf{F}_{max}$	0.22	$\mathbf{F}_{pa}$	0.40
$\mathbf{F}_{med}$	0.35	$\mathbf{B}_{lim}$	106 000 t
$\mathbf{F}_{high}$	>0.49	$\mathbf{B}_{pa}$	200 000 t

11.9 Quality of the assessment

Compared to last year's assessment, the changes in estimated SSB and F(3-6) for 2003 and before are small. For 2005, SSB is revised upwards by about 4 % and F is changed by less than 1 % (Fig. 11.3.17). The retrospective pattern for F and SSB looks fairly good for the most recent years, but the recruitment of the 1998 and 1999 year classes becomes strongly overestimated if data up to and including 2002 are used. (Fig. 11.3.16). The log catchability residuals from this year's final run (Fig. 11.3.14) improved compared to last year's run (Fig. 11.3.5).

A problem with this assessment is the necessity to use 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 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 may be demonstrated if the degree of the fleet's spatial concentration is monitored. Norway and Germany have now permitted the use of data from their satellite based vessel monitoring systems for research purposes, which makes it possible to perform such monitoring of the German and Norwegian tuning fleets. This needs to be addressed in future Working Group meetings. The underestimation of F and overestimation of SSB in the beginning of 2001 and 2002, as seen in the retrospective plot (Fig. 11.3.16), may be due to hyperstability.

A serious problem with stock forecasts for saithe is the lack of reliable information about year class strength before age 4. As seen in Table 11.6.3 and Fig. 11.6.1, the year classes that are age 2 and 3 in the assessment year (2007) contribute significantly to the projected landings in the forecast year (2008) and to the SSB the year thereafter (2009). 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 is estimated to be well below F_{pa} and the spawning stock biomass is estimated to be well above B_{pa}.

11.11 Management Considerations

The ICES advice applies to the combined areas IIIa, IV, and VI.

The reported landings have been lower than the TAC over the last five years. Information from fishermen indicates that low prices for saithe combined with high fuel prices are causing this.

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 spawning stock of saithe in the North Sea is expected to remain above B_{pa} if the TAC for 2008 is set according to the agreed management plan.

Table 11.2.1 Nominal landings (in tonnes) of Saithe in Subarea IV, VI and Division IIIa and Subarea VI, 1998-2006, as officially reported to ICES.

SAITHE IV and IIIa

Country	1999	2000	2001	2002	2003	2004*	2005*	2006
Belgium	200	122	24	107	45	22	28	16
Denmark	4494	3529	3575	5668	6954	7991	7498	7471
Faroe Islands	1101	-	289	872	495	558	184	62
France	24305[1]*	19200	20472	25441	18001	13628	10768	15739
Germany	10481	9273	9479	10999	8956	9589	12401	14390
Greenland	-	601[2]*	1526[2]*	62	1616	403	-	-
Ireland	-	1	-	-	-	1	-	0
Netherlands	7	11	20	6	11*	3	40	28
Norway	56150	43665	44397	60013	61735	62783	67365	61268
Poland	862	747	727	752	734*	0	1100	-
Russia	-	67	-	-	-	-	35	2
Sweden	1929	1468	1627	1863	1876	2249	2114	1695
UK (E/W/NI)	2874	1227	1186	2521	1215	457	1190	9129**
UK (Scotland)	5420	5484	5219	6596	5829	5924	7703	
Total reported	107823	85395	88541	114900	107467	103608	110575	109800
Unallocated	-509	2281	1030	1291	-5809	-3646	968	7312
W.G. Estimate	107314	87676	89571	116191	101658	99962	111543	117112
TAC	110000	85000	87000	135000	165000	190000	145000	123250

*Preliminary, [1]reportedbyTACarea, IIa(EC), IIIa-d(EC) and IV, [2]Preliminary data reported in IVa
**Scotland+E/W/NI combined

Table 11.2.1 Continued

SAITHE VI

Country	1999	2000	2001	2002	2003	2004*	2005*	2006
Faroe Islands	2	-	-	-	2	34	21	76
France	3467[1]*	3310	5157	3062	3499	3053	3452	5782
Germany	250	305	466	467	54	4	373	532
Ireland	320	410	399	91	170	95	168	243
Norway	126	58	31	12	28	16	20	28
Russia	3	25	1	1	6	6	25	7
Spain	23	3	15	4	6	2	3	-
UK (E/W/NI)	503	276	273	307	263	37	203	2748**
UK (Scotland)	2084	2463	2246	1567	1189	1563	4433	
Total reported	6778	6850	8588	5513	5215	4810	8699	9416
Unallocated	564	-960	-1770	-327	35	-296	-2960	848
W.G.Estimate	7342	5890	6818	5186	5250	4514	5739	8568
TAC	7500	7000	9000	14000	17119	20000	15044	12787

*Preliminary, [1]reported by TAC area, IIa(EC), IIIa-d(EC) and IV
**Scotland+E/W/NI combined

SAITHE IV, IIIa and VI

	1999	2000	2001	2002	2003	2004	2005	2006
WG estimate	114656	93566	96389	121377	106908	104476	117282	125680

Table 11.2.2 Saithe in Sub-Areas IV, VI and Division IIIa. Landed numbers (in thousands) at age.

age \ year	1967	1968	1969	1970	1971	1972	1973	1974
3	17330	23223	30235	37249	69808	48075	54332	66938
4	16220	21231	17681	76661	57792	66095	37698	33740
5	15531	13184	11057	15000	32737	25317	26849	14123
6	2303	6023	7609	12128	4736	21207	16061	20688
7	1594	429	5738	3894	4248	3672	8428	14666
8	292	242	791	1792	2843	2944	2000	5199
9	198	123	626	318	1874	1641	1357	1477
+10	183	145	150	267	774	1607	2381	1955

age \ year	1975	1976	1977	1978	1979	1980	1981	1982
3	56987	207823	27461	35059	16332	17494	26178	31895
4	25864	53060	54967	27269	14216	12341	8339	40587
5	10319	11696	14755	18062	11182	9015	6739	9174
6	7566	6253	5490	3312	8699	6718	3675	5978
7	13657	3976	3777	1138	2805	5658	3335	2145
8	9357	5362	3447	1033	733	1150	3396	1454
9	3501	3586	3812	768	540	509	657	982
+10	2687	3490	4701	3484	2089	2302	2536	1254

age \ year	1983	1984	1985	1986	1987	1988	1989	1990
3	28242	80933	134024	55434	31220	32578	22128	40808
4	20604	32172	55605	91223	97470	26408	30752	19583
5	26013	12957	13281	15186	13990	35323	13187	11322
6	5678	13011	4765	5381	3158	3828	10951	4714
7	4893	1657	3005	2603	1811	1908	1557	2776
8	1494	1252	682	1456	1240	1104	739	745
9	1036	335	399	445	910	776	419	281
+10	1327	646	742	900	700	680	488	364

age \ year	1991	1992	1993	1994	1995	1996	1997	1998
3	46117	18404	37823	19958	26664	11066	15036	10363
4	29871	33614	20828	40194	26034	38861	19299	31017
5	7467	12753	11845	13034	14797	11786	30177	16367
6	3583	3193	3125	4297	3774	7731	3676	16077
7	1716	1524	1568	947	3494	3163	2640	2231
8	953	696	1511	346	674	808	1012	1206
9	367	518	814	427	552	210	291	567
+10	458	422	1026	794	800	491	288	277

age \ year	1999	2000	2001	2002	2003	2004	2005	2006
3	9429	7064	16052	19914	11661	5315	13933	9871
4	13872	17295	17646	42331	20209	14987	12508	28211
5	26684	8940	22421	8871	25759	17696	16861	12355
6	8389	12339	3349	8899	6269	13412	17796	9364
7	10070	3159	3586	2437	7061	3820	11585	11375
8	2346	3226	1772	2976	1512	4104	2838	5958
9	891	641	1614	1865	1979	1118	2248	1545
+10	657	441	245	1623	1039	806	460	1432

Table 11.2.3 Saithe in Sub-Areas IV, VI and Division IIIa. Landings weights at age (kg).

year								
age	1967	1968	1969	1970	1971	1972	1973	1974
3	0.9305	1.2784	0.9663	0.9414	0.8399	0.8082	0.8212	0.8608
4	1.362	1.6521	1.5568	1.4408	1.348	1.1958	1.4061	1.5606
5	2.1035	1.9886	2.2614	2.0587	2.1775	1.961	1.641	2.3834
6	3.1858	3.0093	2.7133	2.718	2.936	2.3687	2.5709	2.7527
7	3.7541	4.0404	3.5588	3.5995	3.7657	3.7941	3.3571	3.4286
8	5.3162	4.4278	4.4063	4.4632	4.6339	4.2276	4.6844	4.4977
9	5.8905	6.1355	5.2203	5.6871	5.1725	4.6304	4.8138	5.7128
+10	7.719	7.4055	6.7675	6.8452	6.163	6.3263	6.4449	7.857

year								
age	1975	1976	1977	1978	1979	1980	1981	1982
3	0.8928	0.7024	0.7598	0.8215	1.1072	0.9546	0.9608	1.0857
4	1.4977	1.3092	1.256	1.3267	1.6228	1.8212	1.8211	1.5746
5	2.4904	2.2604	1.9348	2.1545	2.2381	2.3911	2.7175	2.5293
6	3.3002	3.0706	3.1107	3.3401	3.095	3.03	3.5868	3.2202
7	3.7647	4.0347	4.1618	4.5221	4.0504	4.0895	4.536	4.2069
8	4.2957	4.3833	4.6045	4.9005	5.2742	5.1262	5.4776	5.1251
9	5.5396	5.1117	4.8589	5.4494	6.3077	5.9393	6.9804	5.9049
+10	7.562	7.147	6.5419	7.4	7.9551	8.1476	8.7237	8.8232

year								
age	1983	1984	1985	1986	1987	1988	1989	1990
3	1.0276	0.7948	0.6632	0.6943	0.6739	0.7787	0.8954	0.8441
4	1.7178	1.6139	1.2654	1.0353	0.8763	0.981	1.0362	1.1958
5	2.1493	2.2966	1.9505	1.7944	1.8236	1.3859	1.4196	1.5828
6	3.1377	2.6899	2.7715	2.4316	3.0747	2.7907	1.9984	2.2472
7	3.6906	3.8959	3.4067	3.5717	4.2098	4.0238	3.9139	3.2419
8	4.6317	4.6647	4.9499	4.2094	5.33	5.2544	5.0175	4.8583
9	5.5053	6.183	5.8649	5.6506	6.1284	6.3221	6.4298	6.3149
+10	8.4529	8.4735	8.8543	8.2184	8.6026	8.6489	8.4308	8.4162

year								
age	1991	1992	1993	1994	1995	1996	1997	1998
3	0.7913	0.9641	0.8994	0.9439	1.0022	0.9668	0.9047	0.8917
4	1.1579	1.1893	1.2603	1.1188	1.2937	1.1873	1.1448	0.966
5	1.7523	1.6066	1.7544	1.601	1.8159	1.8068	1.4522	1.3925
6	2.3646	2.2417	2.6363	2.4337	2.5619	2.3678	2.5867	1.744
7	3.1653	3.6677	3.1851	3.6175	3.5549	2.9518	3.5556	2.9486
8	4.2221	4.3296	3.9798	4.7869	4.767	4.7053	4.5251	3.8829
9	6.0661	5.4125	5.0802	6.5479	5.2674	6.0922	6.1575	4.9955
+10	8.1914	7.0455	6.8909	8.3256	7.8907	8.3821	8.8663	7.2273

year								
age	1999	2000	2001	2002	2003	2004	2005	2006
3	0.8808	1.0274	0.8023	0.8057	0.718	0.8766	0.6664	0.8931
4	1.0605	1.1266	1.0717	0.8594	0.9543	1.0154	1.0735	0.9986
5	1.2112	1.5389	1.313	1.3243	1.0829	1.2574	1.3015	1.3483
6	1.7537	1.6843	2.095	1.7524	1.6609	1.5822	1.6007	1.7378
7	2.3374	2.5936	2.5461	2.2885	2.2484	2.4753	1.9977	2.0772
8	3.4934	3.0842	3.4848	3.1089	3.348	3.1027	3.0085	2.5779
9	4.8438	4.7733	4.141	3.9206	3.7733	4.2858	3.7959	3.7839
+10	6.7452	7.4615	6.141	3.7472	4.2936	5.5559	4.8845	5.3492

Table 11.2.4 Saithe in Sub-Areas IV,VI and Division IIIa. Tuning data. Data in bold are used in the final assessment.

FRATRB_IV

1990	2006						
1	1	0	1				
3	9						
21758	**3380**	**2472**	**1406**	**304**	**290**	**33**	**15**
15248	**1381**	**2539**	**731**	**372**	**131**	**68**	**12**
7902	**717**	**1481**	**499**	**74**	**24**	**7**	**6**
13527	**3918**	**2253**	**1162**	**104**	**8**	**9**	**6**
14417	**1771**	**3653**	**1381**	**434**	**39**	**5**	**3**
14632	**3152**	**1683**	**922**	**226**	**70**	**24**	**13**
16241	**895**	**4286**	**1053**	**536**	**108**	**25**	**15**
12903	**1087**	**1915**	**3175**	**190**	**84**	**17**	**14**
13559	**800**	**2538**	**1870**	**1481**	**52**	**23**	**10**
14588	**852**	**1234**	**2667**	**620**	**400**	**24**	**14**
8695	**889**	**1993**	**1039**	**1195**	**215**	**181**	**32**
6366	**724**	**1339**	**2373**	**270**	**145**	**26**	**29**
11022	**3276**	**7577**	**1220**	**1242**	**175**	**151**	**41**
10536	**1517**	**3236**	**2355**	**264**	**325**	**81**	**113**
5234	**447**	**978**	**1021**	**495**	**93**	**36**	**20**
3015	**407**	**661**	**643**	**428**	**210**	**16**	**14**
5710	**1682**	**3142**	**551**	**145**	**199**	**40**	**13**

NORTRL_IV

1980	2006						
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	1202	3080	5177	9204	6954	1728	1434
29978	791	4089	3829	4600	7301	3966	808

Table 11.2.4 (Cont'd). Saithe in Sub-Areas IV, VI and Division IIIa. Tuning data. Data in bold are used in the final assessment.

GER_OTB_IV

1995	2006						
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**
10815	**374**	**1575**	**690**	**668**	**685**	**350**	**147**

NORACU

1995	2006			
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**
1	**18909**	**58132**	**11378**	**7922**

IBTSq3

1991	2006		
1	1	0.5	0.75
3	5		
1	1.946	0.402	0.064
1	**1.077**	**2.76**	**0.516**
1	**7.965**	**2.781**	**1.129**
1	**1.117**	**1.615**	**0.893**
1	**13.959**	**2.501**	**1.559**
1	**3.825**	**6.533**	**1.112**
1	**3.756**	**3.351**	**7.461**
1	**1.027**	**3.921**	**1.333**
1	**2.1**	**2.019**	**2.949**
1	**3.479**	**8.836**	**1.081**
1	**21.496**	**6.173**	**3.937**
1	**10.748**	**18.974**	**1.327**
1	**19.272**	**23.802**	**13.402**
1	**4.979**	**6.896**	**3.158**
1	**8.893**	**6.87**	**4.994**
1	**9.866**	**30.605**	**3.155**

Table 11.3.1 Saithe in Sub-Areas IV, VI and Division IIIa. XSA diagnostics.

FLR XSA Diagnostics 2007-05-03 15:56:41

Catch data for 40 years. 1967 to 2006. Ages 3 to 10.

	fleet	first age	last age	first year	last year	alpha	beta
1	FRATRB_IV	3	9	1990	2006	0	1
2	GER_OTB_IV	3	9	1995	2006	0	1
3	NORACU	3	6	1996	2006	0.5	0.75
4	IBTSq3	3	5	1992	2006	0.5	0.75

Time series weights :
Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :
Catchability independent of size for all ages
Catchability independent of age for ages > 7

Terminal population estimation :
Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1

Minimum standard error for population
estimates derived from each fleet = 0.3

prior weighting not applied

Regression weights

age \ year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
all	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

age \ year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
3	0.107	0.173	0.077	0.085	0.080	0.125	0.100	0.073	0.080	0.074
4	0.309	0.334	0.369	0.198	0.317	0.310	0.180	0.181	0.246	0.231
5	0.425	0.469	0.539	0.433	0.427	0.260	0.315	0.236	0.319	0.410
6	0.335	0.423	0.470	0.517	0.285	0.299	0.297	0.269	0.397	0.294
7	0.540	0.350	0.515	0.322	0.274	0.347	0.411	0.297	0.394	0.479
8	0.513	0.510	0.772	0.306	0.302	0.386	0.377	0.448	0.377	0.362
9	0.439	0.613	0.917	0.492	0.247	0.604	0.482	0.533	0.476	0.362
10	0.439	0.613	0.917	0.492	0.247	0.604	0.482	0.533	0.476	0.362

XSA population number (thousands)

year \ age	3	4	5	6	7	8	9	10
1997	164070	80336	96282	14266	6992	2789	906	890
1998	72125	120724	48311	51524	8354	3336	1367	660
1999	140137	49674	70775	24744	27637	4821	1640	1190
2000	95446	106203	28118	33802	12668	13516	1824	1244
2001	231849	71752	71303	14932	16510	7514	8146	1232
2002	187860	175297	42779	38091	9194	10272	4548	3912
2003	134946	135789	105218	26998	23134	5323	5718	2972
2004	83269	99933	92889	62837	16431	12552	2989	2134
2005	199924	63366	68257	60039	39311	9996	6564	1331
2006	152096	151077	40562	40628	33054	21703	5616	5168

Table 11.3.1(cont d). Saithe in Sub-Areas IV, VI and Division IIIa.. XSA diagnostics.

Estimated population abundance at 1st Jan 2007

year \ age	3	4	5	6	7	8	9	10
2007	24796	115600	98177	22034	24796	16771	12386	3203

Fleet: FRATRB_IV

Log catchability residuals.

age \ year	1990	1991	1992	1993	1994	1995	1996	1997	1998
3	0.536	-0.150	0.155	0.861	0.356	0.083	-0.576	-0.553	-0.057
4	0.251	0.319	0.267	0.233	0.322	-0.205	-0.381	-0.266	-0.429
5	0.061	0.062	0.197	0.183	0.257	-0.421	-0.200	-0.076	0.054
6	-0.227	0.391	-0.275	-0.426	0.384	-0.332	0.252	-0.532	0.227
7	0.745	0.487	-0.574	-1.719	-0.318	-0.126	0.004	-0.100	-0.886
8	-0.340	0.416	-1.139	-1.312	-1.519	-0.180	-0.282	-0.817	-0.716
9	-0.013	-0.273	-0.695	-0.994	-1.462	0.246	-0.143	0.088	-0.576

age \ year	1999	2000	2001	2002	2003	2004	2005	2006
3	-0.776	0.172	-0.612	0.580	0.175	0.123	-0.292	0.758
4	-0.320	-0.161	0.200	0.488	-0.123	-0.313	0.332	0.378
5	-0.015	0.436	0.640	-0.138	-0.311	-0.359	0.077	-0.154
6	0.038	0.920	0.457	0.504	-0.655	-0.186	0.325	-1.056
7	-0.047	0.543	0.174	0.434	0.203	-0.063	0.478	0.000
8	-0.994	0.297	-0.761	0.194	0.261	-0.680	-0.754	-1.247
9	-0.426	0.645	-0.731	-0.203	0.575	0.203	-0.384	-0.992

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	3	4	5	6	7	8
Mean_Logq	-13.7791	-12.6926	-12.5047	-12.9957	-13.4405	-13.4405
S.E_Logq	0.4914	0.3150	0.2784	0.5069	0.5991	0.6054

	9
Mean_Logq	-13.4405
S.E_Logq	0.5716

Fleet: GER_OTB_IV

Log catchability residuals.

age \ year	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	-0.041	-0.052	-0.114	0.491	-0.871	0.583	0.295	0.061	-0.012
4	0.473	-0.134	0.180	-0.038	0.000	0.300	0.354	0.321	-0.575
5	-0.014	0.060	-0.066	-0.241	-0.027	0.257	0.463	0.115	-0.129
6	0.243	0.040	-0.638	-0.003	0.198	0.581	0.214	0.218	-0.489
7	-0.027	0.412	-0.258	-0.068	0.340	0.020	0.625	-0.588	-0.235
8	-0.632	1.050	-0.196	0.055	-0.382	0.243	0.666	-0.334	-0.692
9	-0.241	0.390	-0.175	0.050	-0.003	0.183	0.086	-0.131	-0.500

age \ year	2004	2005	2006
3	0.115	-0.338	-0.137
4	0.169	-0.573	-0.242
5	-0.291	0.041	-0.174
6	-0.385	0.235	-0.180
7	-0.557	0.143	0.294
8	-0.058	0.159	-0.009
9	-0.195	0.080	0.475

Table 11.3.1(cont d). Saithe in Sub-Areas IV, 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

                3        4        5        6        7        8
Mean_Logq -15.0256 -13.4021 -12.8990 -12.9802 -13.1390 -13.1390
S.E_Logq    0.3806   0.3485   0.2119   0.3585   0.3773   0.5052
                9
Mean_Logq -13.1390
S.E_Logq    0.2733


 Fleet:  NORACU

 Log catchability residuals.

   year
age   1996   1997   1998   1999  2000   2001   2002   2003   2004
  3 -0.254 -0.607 -0.141 -0.756 0.347  0.191  0.564  0.683  0.464
  4 -0.900 -0.816 -0.115 -0.033 0.462 -0.123  0.717  0.474 -0.118
  5 -0.397 -0.226 -0.120  0.233 0.447 -0.285  0.127  0.130 -0.070
  6  0.535  0.068  0.154 -0.017 0.846  0.245 -0.538 -0.171 -0.697
   year
age   2005   2006
  3 -0.058 -0.729
  4  0.197 -0.218
  5  0.162 -0.156
  6 -0.110 -0.034


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

               3       4       5       6
Mean_Logq -1.1845 -0.4684 -0.7348 -1.2927
S.E_Logq   0.5204  0.5039  0.2538  0.4361


 Fleet:  IBTSq3

 Log catchability residuals.

   year
age   1992   1993   1994   1995   1996   1997   1998   1999   2000
  3 -1.198  0.361 -1.264  0.411 -0.183 -0.605 -1.038 -1.047 -0.153
  4 -0.341 -0.294 -1.133 -0.453 -0.545 -0.522 -0.757 -0.510  0.100
  5 -0.469 -0.070 -0.331 -0.048 -0.197  0.472 -0.533 -0.077 -0.224
   year
age  2001   2002  2003   2004  2005  2006
  3 0.777  0.323 1.222  0.335 0.043 0.417
  4 0.207  0.433 0.833 -0.098 0.394 1.010
  5 0.135 -0.546 0.901 -0.469 0.349 0.467


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

               3       4       5
Mean_Logq -9.8886 -9.2453 -9.5480
S.E_Logq   0.7674  0.5991  0.4309
```

Table 11.3.1(cont d). Saithe in Sub-Areas IV, VI and Division IIIa. XSA diagnostics.

Terminal year survivor and F summaries:

Age 3 Year class = 2003

source	survivors	N	scaledWts
FRATRB_IV	246775	1	0.231
GER_OTB_IV	100794	1	0.389
NORACU	55760	1	0.206
IBTSq3	175366	1	0.105
fshk	92840	1	0.068

Age 4 Year class = 2002

source	survivors	N	scaledWts
FRATRB_IV	118488	2	0.322
GER_OTB_IV	73877	2	0.349
NORACU	84640	2	0.187
IBTSq3	185891	2	0.108
fshk	90614	1	0.034

Age 5 Year class = 2001

source	survivors	N	scaledWts
FRATRB_IV	23236	3	0.291
GER_OTB_IV	17696	3	0.322
NORACU	21976	3	0.251
IBTSq3	33760	3	0.113
fshk	30370	1	0.023

Age 6 Year class = 2000

source	survivors	N	scaledWts
FRATRB_IV	19868	4	0.270
GER_OTB_IV	24544	4	0.357
NORACU	28042	4	0.265
IBTSq3	35930	3	0.087
fshk	23225	1	0.021

Age 7 Year class = 1999

source	survivors	N	scaledWts
FRATRB_IV	15863	5	0.286
GER_OTB_IV	16380	5	0.397
NORACU	17856	4	0.215
IBTSq3	16874	3	0.072
fshk	24824	1	0.029

Table 11.3.1(cont d). Saithe in Sub-Areas IV, VI and Division IIIa. XSA diagnostics.

Age 8 Year class = 1998

source	survivors	N	scaledWts
FRATRB_IV	11038	6	0.278
GER_OTB_IV	12177	6	0.437
NORACU	12037	4	0.191
IBTSq3	26651	3	0.061
fshk	11646	1	0.033

Age 9 Year class = 1997

source	survivors	N	scaledWts
FRATRB_IV	2304	7	0.245
GER_OTB_IV	3789	7	0.544
NORACU	3307	4	0.136
IBTSq3	2362	3	0.044
fshk	3018	1	0.031

Table 11.3.2 Saithe in Sub-Areas IV, VI and Division IIIa. Fishing mortality (F) at age.

age \ year	1967	1968	1969	1970	1971	1972	1973	1974
3	0.1628	0.2548	0.1178	0.1521	0.2682	0.3711	0.4990	0.6879
4	0.2632	0.3074	0.3145	0.4897	0.3728	0.4397	0.5628	0.6748
5	0.3781	0.3551	0.2599	0.4828	0.3998	0.2767	0.3202	0.4242
6	0.4836	0.2455	0.3574	0.5070	0.2735	0.4925	0.2838	0.4388
7	0.4161	0.1524	0.3913	0.3127	0.3319	0.3538	0.3695	0.4556
8	0.2603	0.1004	0.4639	0.2016	0.3965	0.4054	0.3317	0.4106
9	0.3893	0.1668	0.4070	0.3425	0.3360	0.4201	0.3303	0.4381
+10	0.3893	0.1668	0.4070	0.3425	0.3360	0.4201	0.3303	0.4381
Fbar 3-6	0.3219	0.2907	0.2624	0.4079	0.3286	0.3950	0.4164	0.5564

age \ year	1975	1976	1977	1978	1979	1980	1981	1982
3	0.4269	0.9112	0.2973	0.5432	0.2646	0.3397	0.1833	0.3870
4	0.6292	0.9305	0.6548	0.5446	0.4421	0.3279	0.2686	0.4796
5	0.4462	0.6615	0.7374	0.4639	0.4503	0.5632	0.2995	0.5345
6	0.4243	0.5383	0.7713	0.3552	0.4265	0.5402	0.4726	0.4754
7	0.5872	0.4143	0.7468	0.3485	0.5819	0.5492	0.5697	0.5632
8	0.5974	0.4831	0.7841	0.4633	0.3977	0.5028	0.7688	0.5258
9	0.5407	0.4822	0.7751	0.3916	0.4723	0.5350	0.6090	0.5257
+10	0.5407	0.4822	0.7751	0.3916	0.4723	0.5350	0.6090	0.5257
Fbar 3-6	0.4817	0.7604	0.6152	0.4767	0.3959	0.4428	0.3060	0.4691

age \ year	1983	1984	1985	1986	1987	1988	1989	1990
3	0.3068	0.5729	0.6456	0.2397	0.3663	0.3772	0.3792	0.4703
4	0.4665	0.6923	1.0469	1.4031	0.8713	0.6108	0.7513	0.6901
5	0.6572	0.6099	0.6999	0.9590	0.8549	0.9553	0.7205	0.7003
6	0.7638	0.8389	0.4739	0.6963	0.5254	0.6006	0.9305	0.6177
7	0.9379	0.5252	0.4630	0.5184	0.5338	0.7136	0.5259	0.6453
8	1.0315	0.6649	0.4263	0.4285	0.5030	0.7447	0.6785	0.5181
9	0.9210	0.6827	0.4577	0.5523	0.5249	0.6928	0.7185	0.5998
+10	0.9210	0.6827	0.4577	0.5523	0.5249	0.6928	0.7185	0.5998
Fbar 3-6	0.5486	0.6785	0.7166	0.8245	0.6545	0.6360	0.6954	0.6196

age \ year	1991	1992	1993	1994	1995	1996	1997	1998
3	0.4586	0.2471	0.3226	0.2420	0.1400	0.1175	0.1068	0.1729
4	0.7698	0.7299	0.4901	0.6816	0.5730	0.3113	0.3086	0.3340
5	0.6215	0.9279	0.6211	0.6606	0.5787	0.5582	0.4252	0.4691
6	0.4978	0.5979	0.6118	0.4804	0.4020	0.6934	0.3352	0.4229
7	0.4783	0.4081	0.6750	0.3745	0.9482	0.7062	0.5401	0.3498
8	0.4785	0.3619	0.9422	0.3007	0.5027	0.5913	0.5128	0.5100
9	0.5244	0.5230	0.9764	0.7776	1.1509	0.2851	0.4388	0.6129
+10	0.5244	0.5230	0.9764	0.7776	1.1509	0.2851	0.4388	0.6129
Fbar 3-6	0.5869	0.6257	0.5114	0.5162	0.4234	0.4201	0.2939	0.3497

age \ year	1999	2000	2001	2002	2003	2004	2005	2006
3	0.0773	0.0853	0.0796	0.1246	0.1004	0.0731	0.0801	0.0744
4	0.3691	0.1984	0.3172	0.3104	0.1797	0.1812	0.2461	0.2311
5	0.5390	0.4329	0.4270	0.2603	0.3155	0.2364	0.3188	0.4104
6	0.4695	0.5166	0.2849	0.2987	0.2966	0.2690	0.3969	0.2940
7	0.5153	0.3224	0.2745	0.3467	0.4115	0.2969	0.3941	0.4786
8	0.7718	0.3063	0.3020	0.3859	0.3769	0.4483	0.3766	0.3616
9	0.9175	0.4917	0.2471	0.6036	0.4821	0.5332	0.4755	0.3624
+10	0.9175	0.4917	0.2471	0.6036	0.4821	0.5332	0.4755	0.3624
Fbar 3-6	0.3637	0.3083	0.2772	0.2485	0.2230	0.1900	0.2605	0.2525

Table 11.3.3 Saithe in Sub-Areas IV, VI and Division IIIa. Stock numbers at age.

age \ year	1967	1968	1969	1970	1971	1972	1973	1974
3	127456	114114	300688	291835	327931	171372	152852	148740
4	77470	88671	72416	218825	205230	205322	96808	75983
5	54512	48750	53387	43291	109792	115736	108298	45149
6	6638	30578	27984	33705	21871	60268	71849	64373
7	5177	3351	19585	16026	16622	13622	30155	44292
8	1407	2796	2356	10843	9597	9765	7829	17063
9	680	888	2070	1213	7256	5286	5330	4601
+10	621	1041	490	1008	2974	5132	9288	6037
TOTAL	273961	290189	478976	616746	701273	586503	482409	406238

age \ year	1975	1976	1977	1978	1979	1980	1981	1982
3	181238	384108	118012	92449	77635	67123	172747	109849
4	61209	96821	126435	71772	43968	48785	39126	117747
5	31681	26711	31259	53780	34087	23135	28775	24489
6	24186	16601	11286	12242	27688	17790	10784	17461
7	33984	12956	7934	4273	7027	14798	8487	5504
8	22993	15466	7009	3078	2469	3215	6996	3931
9	9266	10359	7811	2620	1586	1358	1592	2655
+10	7036	9984	9495	11784	6074	6075	6074	3356
TOTAL	371593	573006	319241	251998	200534	182279	274581	284992

age \ year	1983	1984	1985	1986	1987	1988	1989	1990
3	118140	205102	311394	287485	112488	114585	77487	120200
4	61077	71170	94691	133678	185214	63849	64337	43418
5	59678	31363	29159	27214	26905	63445	28380	24849
6	11749	25323	13953	11856	8540	9368	19983	11304
7	8887	4482	8960	7112	4838	4134	4207	6452
8	2566	2848	2170	4617	3468	2323	1658	2036
9	1902	749	1199	1160	2463	1717	903	689
+10	2397	1424	2211	2318	1874	1484	1038	881
TOTAL	266396	342461	463737	475440	345790	260905	197993	209829

age \ year	1991	1992	1993	1994	1995	1996	1997	1998
3	138553	92903	151583	102626	225560	110352	164070	72125
4	61487	71709	59410	89882	65964	160547	80336	120724
5	17829	23312	28295	29795	37221	30451	96282	48311
6	10100	7840	7547	12449	12601	17085	14266	51524
7	4990	5027	3530	3351	6304	6902	6992	8354
8	2771	2532	2737	1472	1887	2000	2789	3336
9	993	1406	1444	873	892	934	906	1367
+10	1227	1133	1787	1600	1267	2173	890	660
TOTAL	237950	205862	256333	242048	351696	330444	366531	306401

age \ year	1999	2000	2001	2002	2003	2004	2005	2006	2007
3	140137	95446	231849	187860	134946	83269	199924	152096	0
4	49674	106203	71752	175297	135789	99933	63366	151077	115600
5	70775	28118	71303	42779	105218	92889	68257	40562	98177
6	24744	33802	14932	38091	26998	62837	60039	40628	22034
7	27637	12668	16510	9194	23134	16431	39311	33054	24796
8	4821	13516	7514	10272	5323	12552	9996	21703	16771
9	1640	1824	8146	4548	5718	2989	6564	5616	12386
+10	1190	1244	1232	3912	2972	2134	1331	5168	3203
TOTAL	320618	292821	423238	471953	440098	373034	448788	449904	292967

Table 11.3.4 Saithe in Sub-Areas IV, VI and Division IIIa. Stock summary.

Year	LANDINGS	Fbar 3-6	RECRUITS (Age3)	SSB	TSB	Yield/SSB
1967	88326	0.322	127456	150838	395635	0.5856
1968	113751	0.291	114114	211723	520415	0.5373
1969	130588	0.262	300688	263959	694141	0.4947
1970	234962	0.408	291835	312007	890606	0.7531
1971	265381	0.329	327931	429569	1018303	0.6178
1972	261877	0.395	171372	474092	903655	0.5524
1973	242499	0.416	152852	534484	847489	0.4537
1974	298351	0.556	148740	554904	833737	0.5377
1975	271584	0.482	181238	472064	743437	0.5753
1976	343967	0.760	384108	351529	752264	0.9785
1977	216395	0.615	118012	263118	509424	0.8224
1978	155141	0.477	92449	268081	463810	0.5787
1979	128360	0.396	77635	241039	419101	0.5325
1980	131908	0.443	67123	235126	396704	0.5610
1981	132278	0.306	172747	241155	495014	0.5485
1982	174351	0.469	109849	210362	511429	0.8288
1983	180044	0.549	118140	214115	466864	0.8409
1984	200834	0.679	205102	176397	465471	1.1385
1985	220869	0.717	311394	160465	489750	1.3764
1986	198596	0.825	287485	151335	486118	1.3123
1987	167514	0.654	112488	152382	383490	1.0993
1988	135172	0.636	114585	147003	318464	0.9195
1989	108877	0.695	77487	113489	255620	0.9594
1990	103800	0.620	120200	100756	260684	1.0302
1991	108048	0.587	138553	97609	279524	1.1069
1992	99742	0.626	92903	99821	274873	0.9992
1993	111491	0.511	151583	105671	322524	1.0551
1994	109622	0.516	102626	113951	313634	0.9620
1995	121810	0.423	225560	135265	457359	0.9005
1996	114997	0.420	110352	157201	446472	0.7315
1997	107327	0.294	164070	195832	468075	0.5481
1998	106123	0.350	72125	194645	387255	0.5452
1999	110716	0.364	140137	204370	402641	0.5417
2000	91322	0.308	95446	192004	410441	0.4756
2001	95042	0.277	231849	214736	497328	0.4426
2002	115395	0.248	187860	207795	510864	0.5553
2003	105569	0.223	134946	243724	489421	0.4331
2004	104237	0.190	83269	290742	494974	0.3585
2005	124532	0.260	199924	298905	526224	0.4166
2006	125681	0.252	152096	297959	585508	0.4218
Mean	156427	0.454	161708	237006	509718	0.7282
Units	Tonnes		Thousands	Tonnes	Tonnes	

Table 11.6.1 Saithe in Sub-Areas IV, VI and Division IIIa. Input data for short term forecast.

2007

age	stock.n	mat	M	F
3	124451	0.00	0.2	0.08
4	115594	0.15	0.2	0.22
5	98165	0.70	0.2	0.32
6	22030	0.90	0.2	0.32
7	24791	1.00	0.2	0.39
8	16769	1.00	0.2	0.40
9	12378	1.00	0.2	0.46
10	6145	1.00	0.2	0.46

Table 11.6.2 Saithe in Sub-Areas IV, VI and Division IIIa. Management option table.

2007

fmult	f3-6	landings	ssb2007
1.00	0.23	126761	323857

2008

fmult	f3-6	landings	ssb2008	ssb2009
0.00	0.00	0	325355	438977
1.00	0.23*	122253	325355	315785
0.43	0.10	57069	325355	381026
0.13	0.03	17968	325355	420657
0.32	0.07	43541	325355	394699
0.64	0.15	82755	325355	355183
0.96	0.23	118111	325355	319895
1.15	0.27	137650	325355	300552
1.28	0.30**	150028	325355	288362
1.41	0.33	161916	325355	276705
1.60	0.38	178874	325355	260166
0.17	0.04	23791	325355	414734
0.85	0.20	106728	325355	331219
1.54	0.36	173334	325355	265557
1.71	0.40***	187865	325355	251444
1.88	0.44	201645	325355	238143
2.13	0.50	221001	325355	219606

*F_{sq}, **$F_{man.plan}$, ***F_{pa}

Table 11.6.3 Saithe in Sub-Areas IV, VI and Division IIIa. Stock numbers of recruits and their source for recent year classes used in predictions, and relative (%) contributions to landings and SSB (by weight) of these year classes.

Year-class	2001	2002	2003	2004	2005
Stock no. (thousands) of 3 years old	83269	199924	152096	124451	124451
Source	XSA	XSA	XSA	GM88-04	GM88-04
Status Quo F:					
% in 2007 landings	7.11	25.29	16.82	5.29	-
% in 2008 landings	6.89	19.50	20.30	14.25	5.48
% in 2007 SSB	10.04	27.63	5.51	0	-
% in 2008 SSB	8.79	26.43	21.29	4.48	0.00
% in 2009 SSB	6.66	23.95	21.08	17.92	4.62

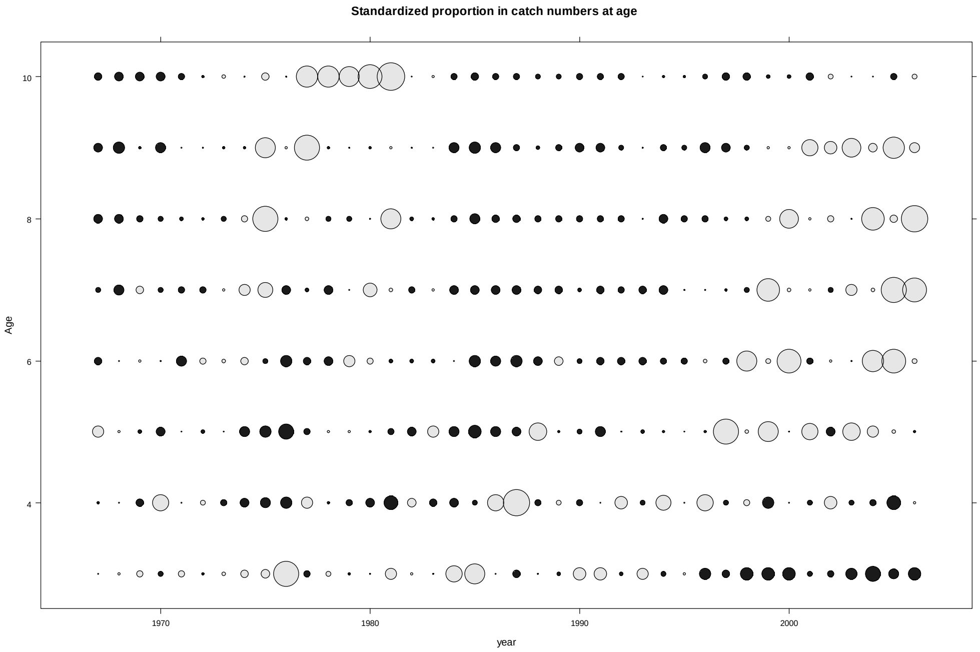


Figure 11.2.1. Saithe in Sub-Area IV, VI and Division IIIa. Standardised proportion of catch at age (scaled to zero mean for each age). Grey circles are positive numbers and black are negative.

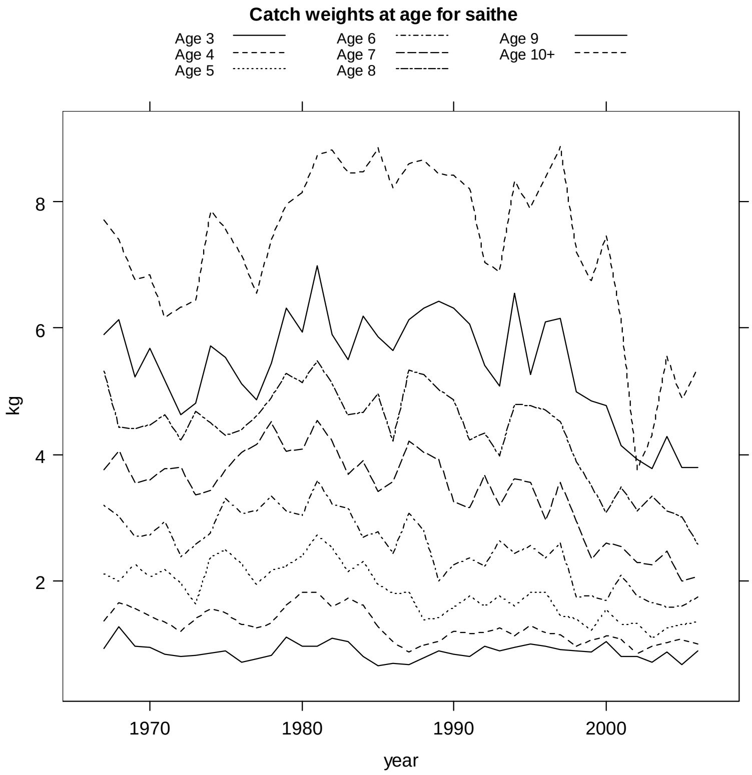
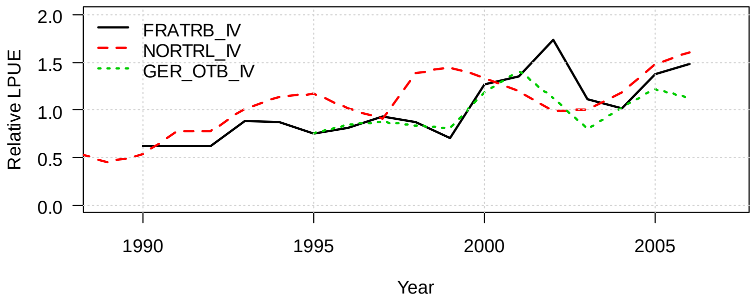


Figure 11.2.2. Saithe in Sub-Area IV, VI and Division IIIa. Trends in mean weights at age in landings.



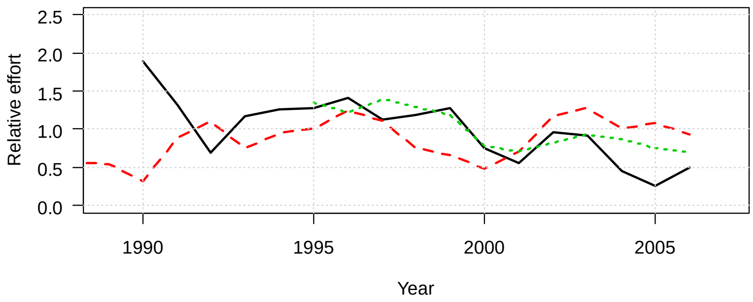


Figure 11.2.3. Saithe in Sub-Area IV, VI and Division IIIa. Relative trends in total landings per unit effort and effort for the commercial tuning fleets.

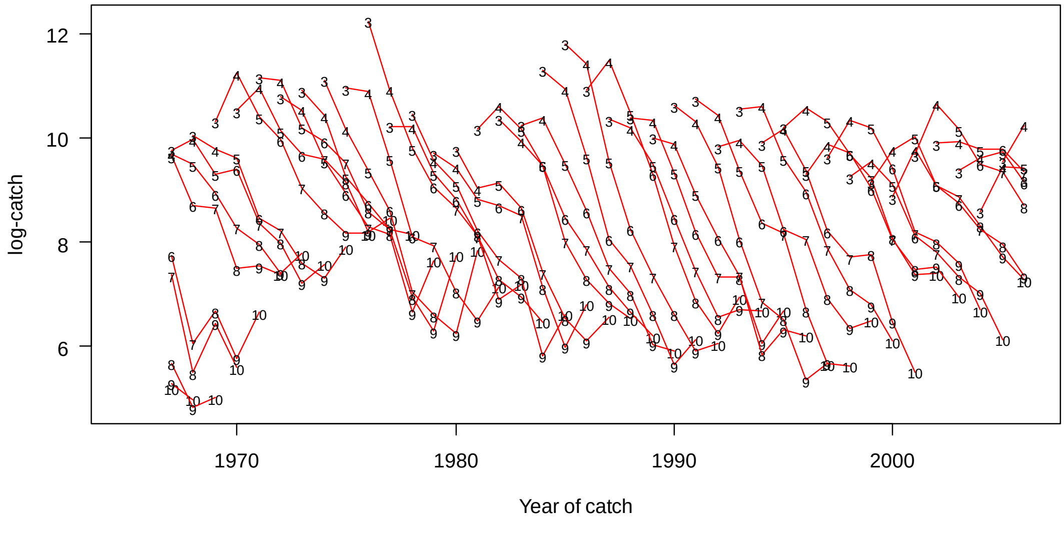


Figure 11.3.1. Saithe in Sub-Area IV, VI and Division IIIa. Log catch by cohort for total catches.

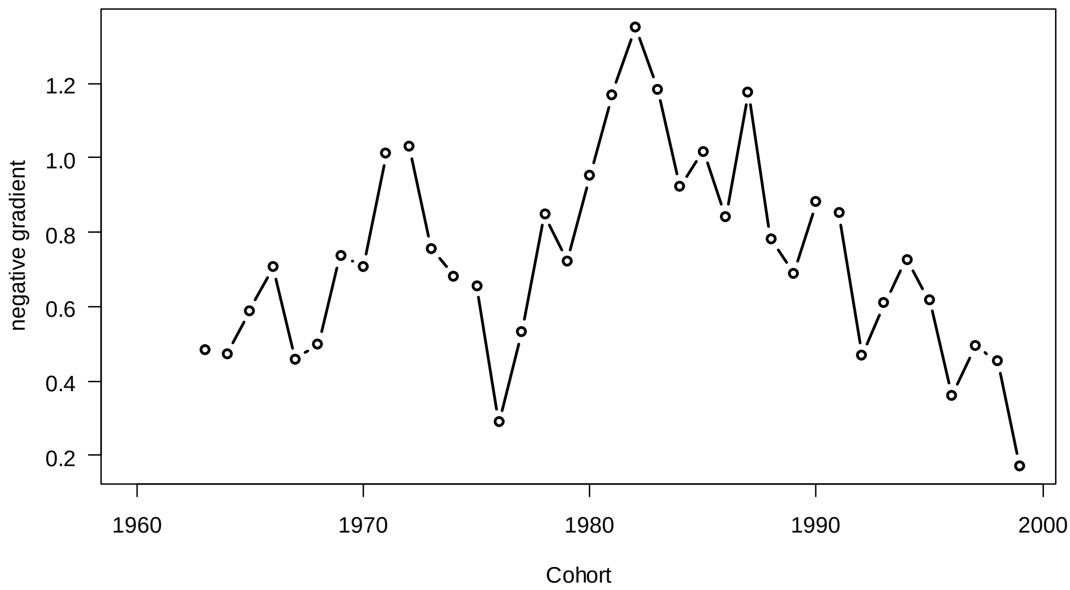


Figure 11.3.2. Saithe in Sub-Area IV, VI and Division IIIa. Negative gradients of log-catches per cohort for the age-range 4-7.

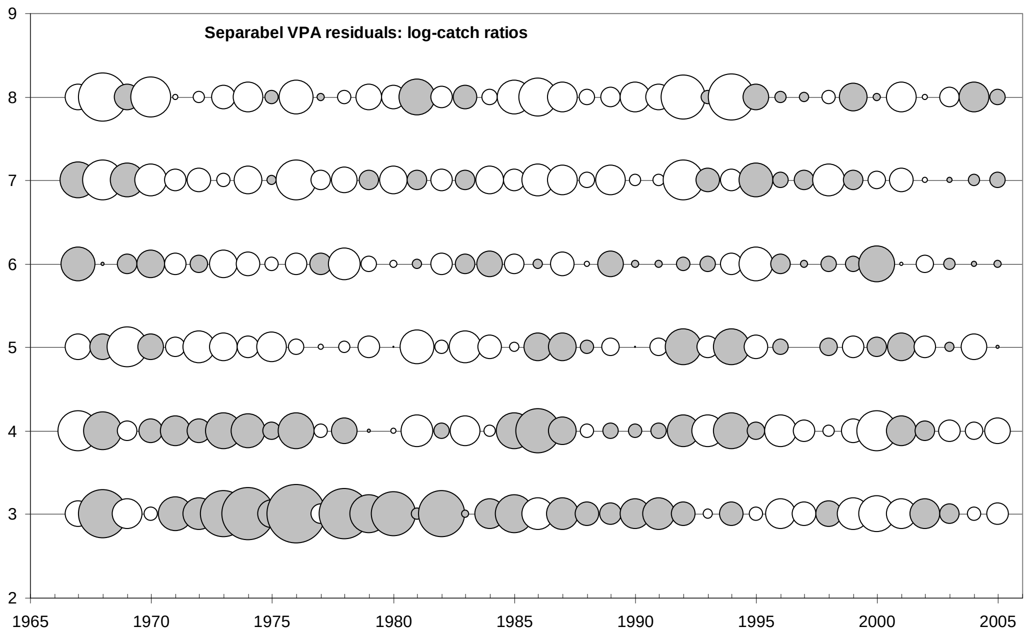


Figure 11.3.3. Saithe in Sub-Area IV, VI and Division IIIa. Log catch residuals from a separable VPA run.

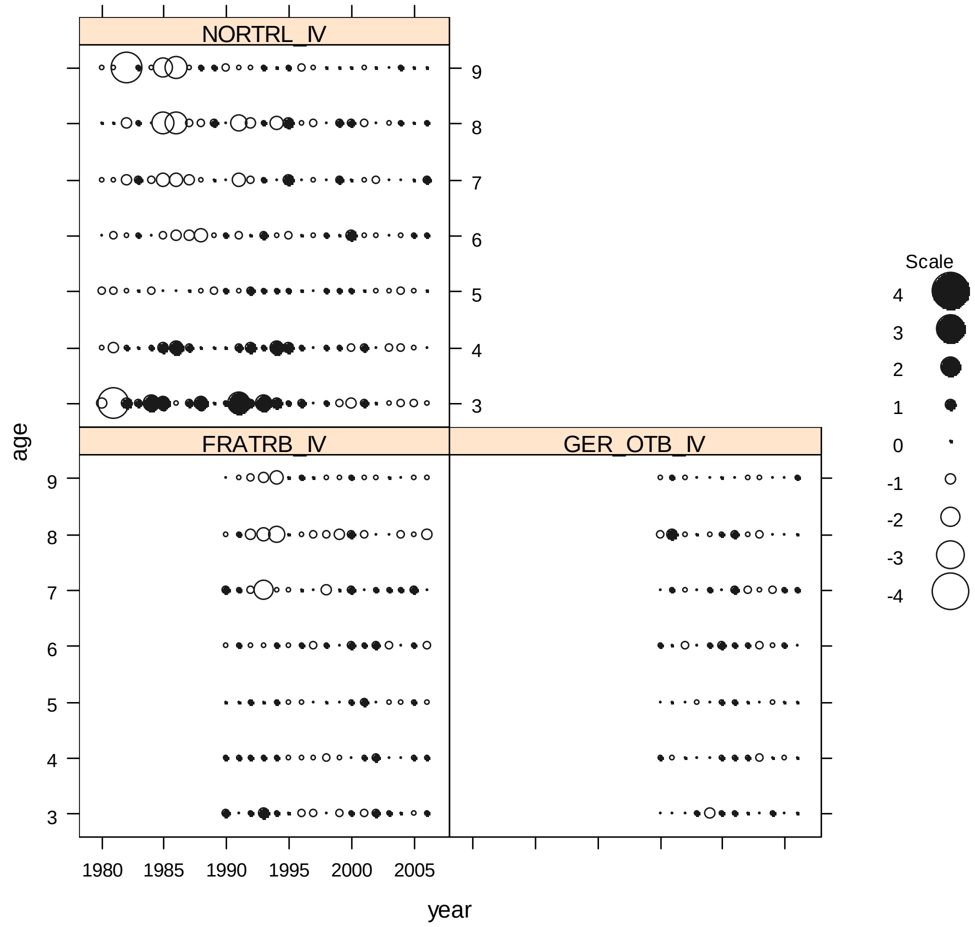


Figure 11.3.4. Saithe in Sub-Area IV, VI and Division IIIa. Log catchability residuals from single-fleel XSAs (with same settings as last year's assessment).

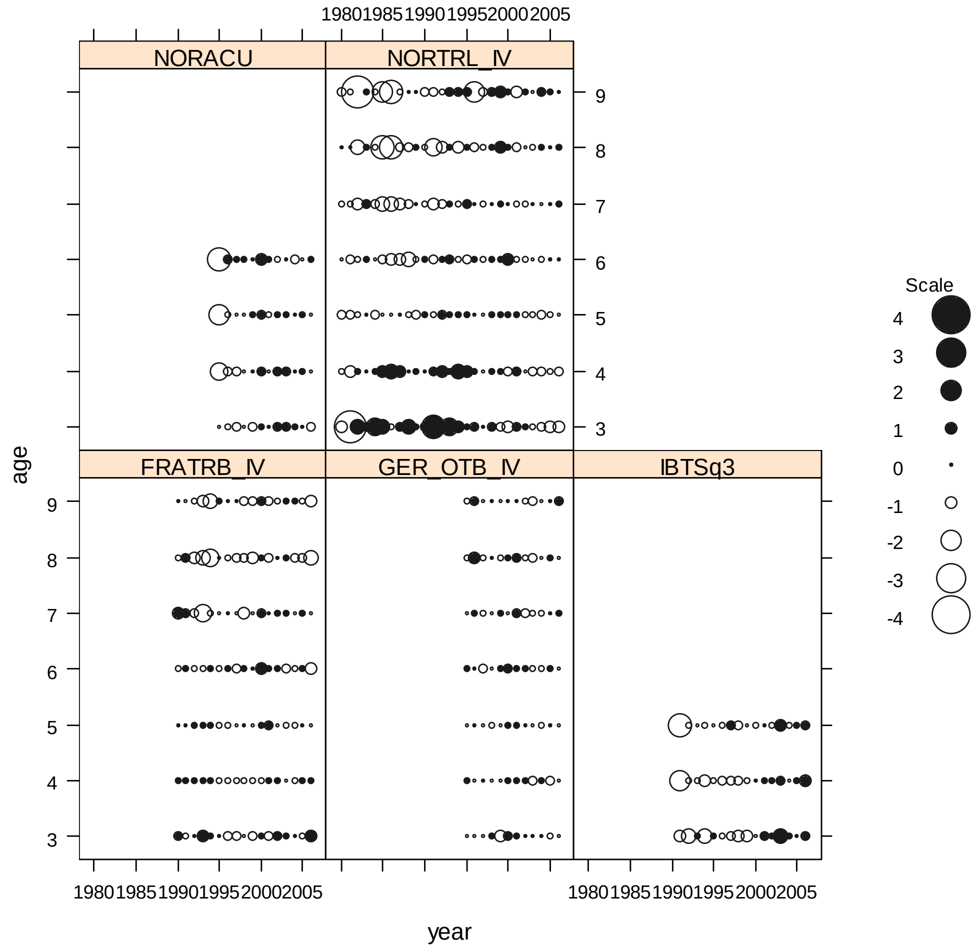


Figure 11.3.5. Saithe in Sub-Area IV, VI and Division IIIa. Log catchability residuals from a XSA run with the same settings as last year (SPALY).

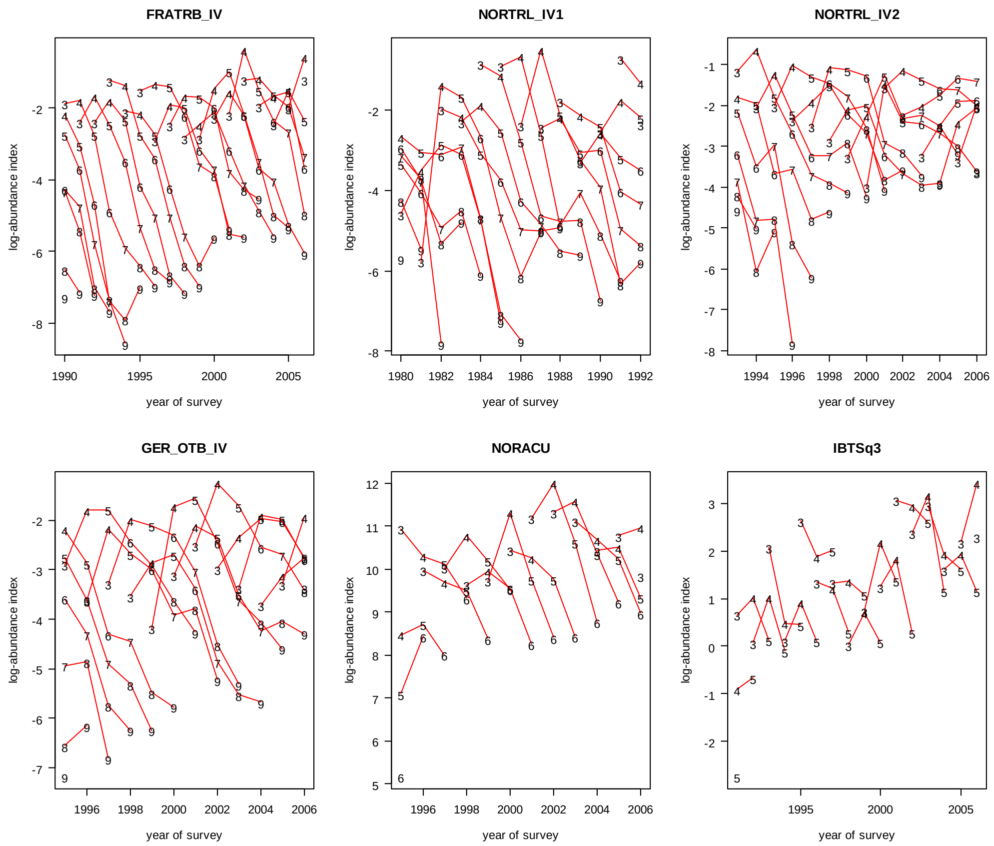


Figure 11.3.6. Saithe in Sub-Area IV, VI and Division IIIa. Log-abundance indices by cohort for each of the available tuning series.

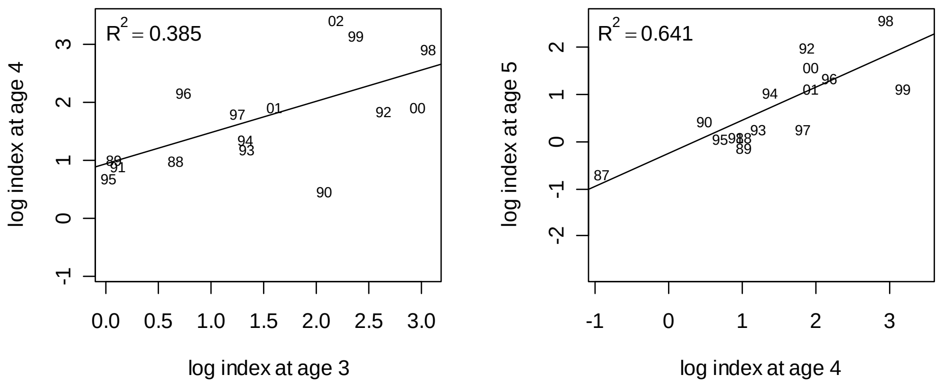


Figure 11.3.7. Saithe in Sub-Area IV, VI and Division IIIa. Within-survey correlations for IBTSq3 for the period 1991-2006. Individual points are given by cohort (year-class).

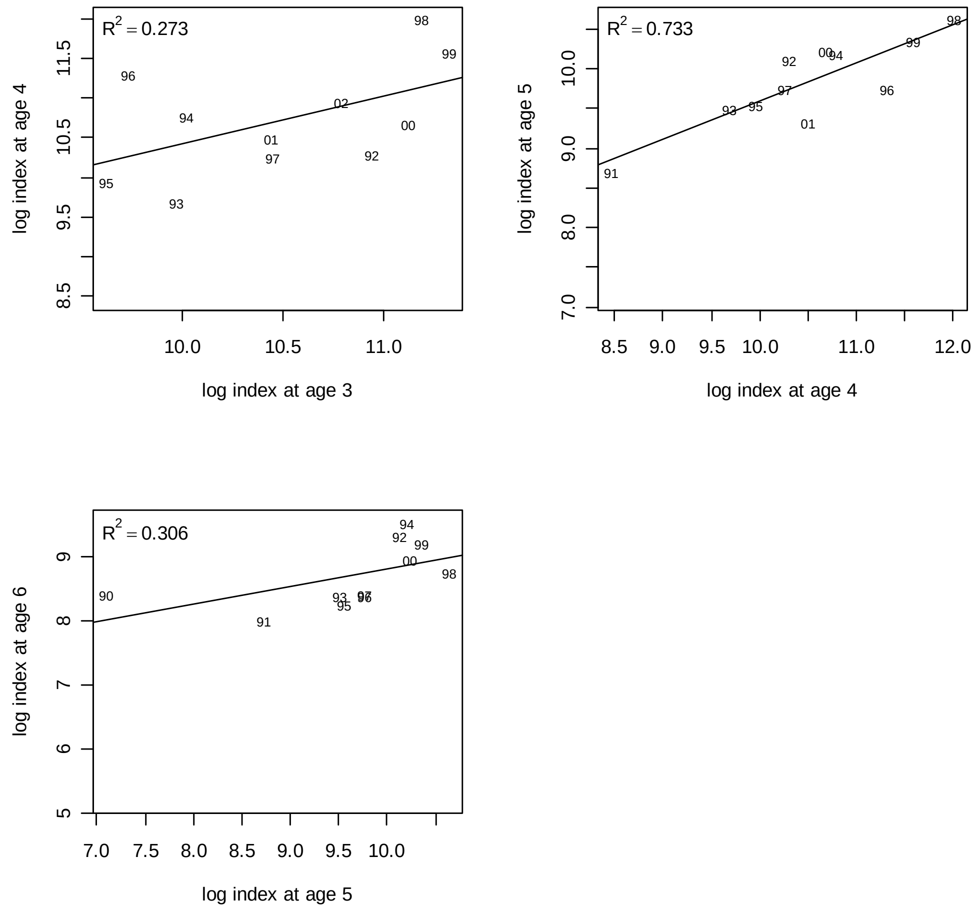


Figure 11.3.8. Saithe in Sub-Area IV, VI and Division IIIa. Within-survey correlations for NORACU for the period 1994-2006. Individual points are given by cohort (year-class).

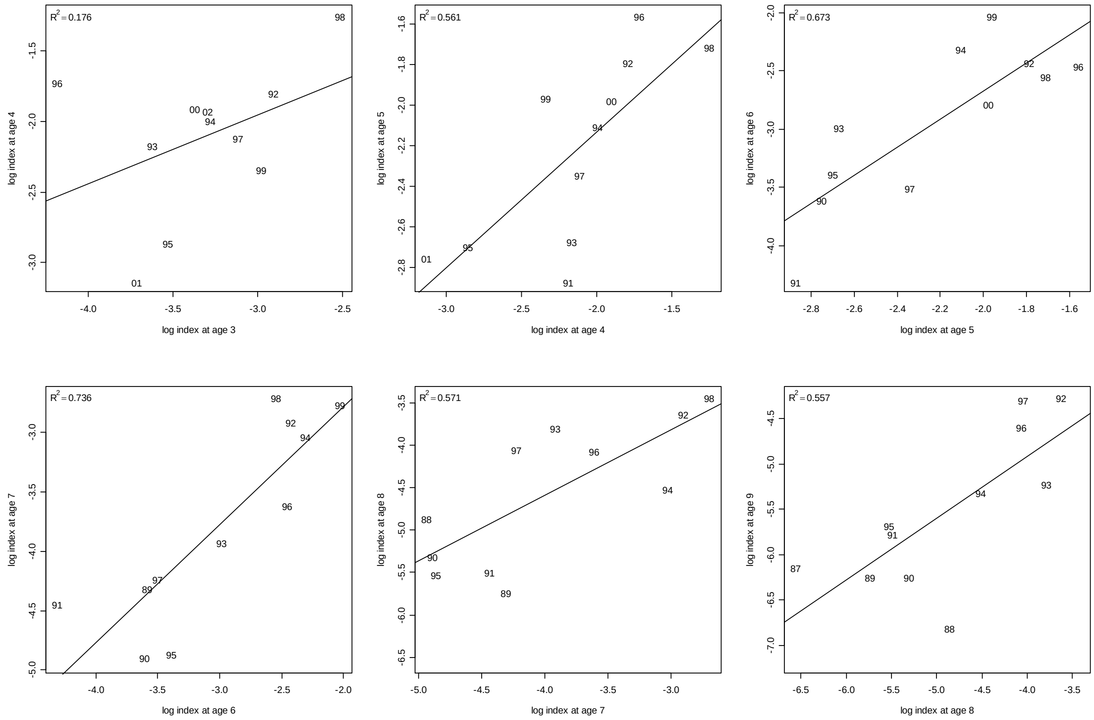


Figure 11.3.9. Saithe in Sub-Area IV, VI and Division IIIa. Within--survey correlations for GEROTB.

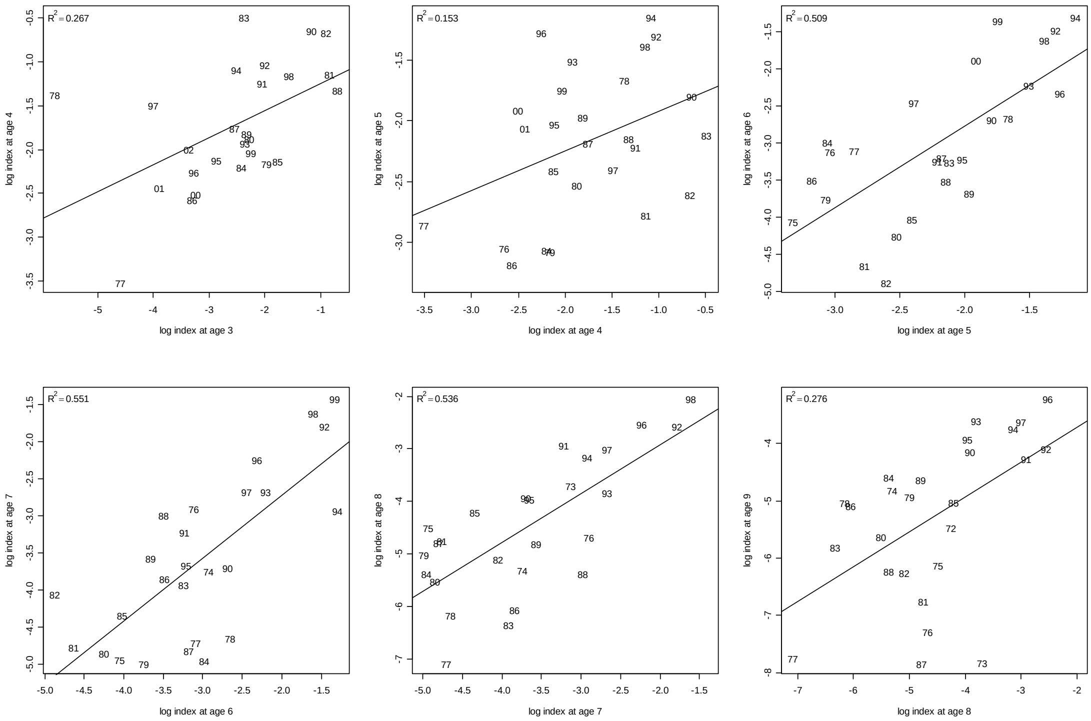


Figure 11.3.10. Saithe in Sub-Area IV, VI and Division IIIa. Within--survey correlations for NORTRL.

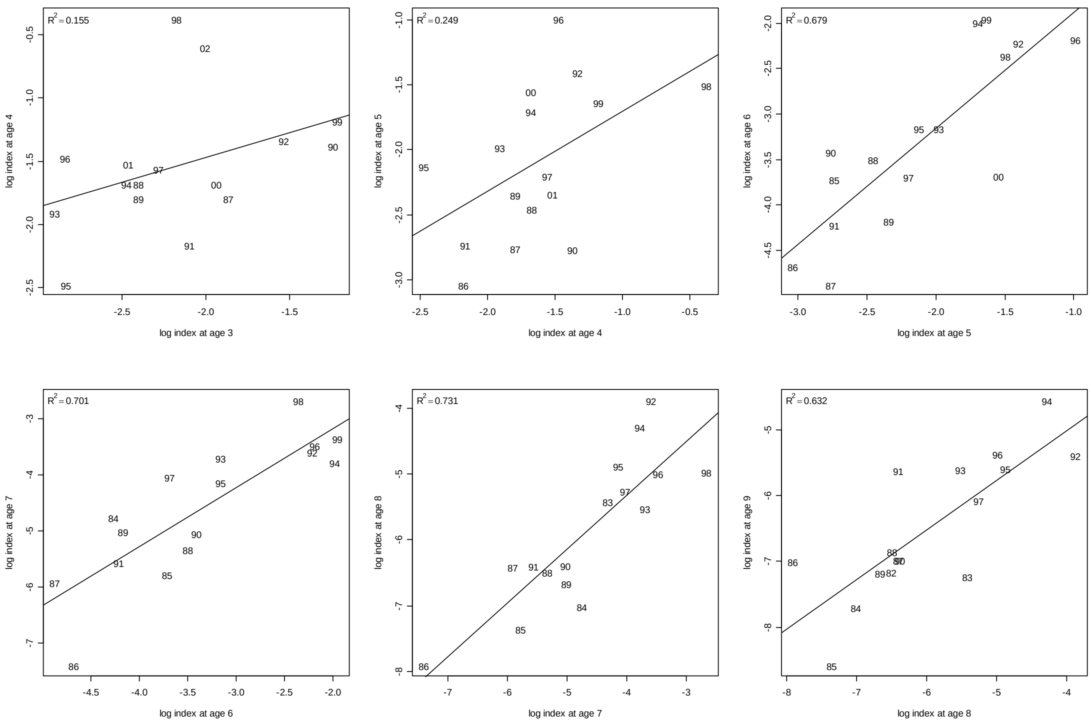


Figure 11.3.11. Saithe in Sub-Area IV, VI and Division IIIa. Within--survey correlations for FRATRL.

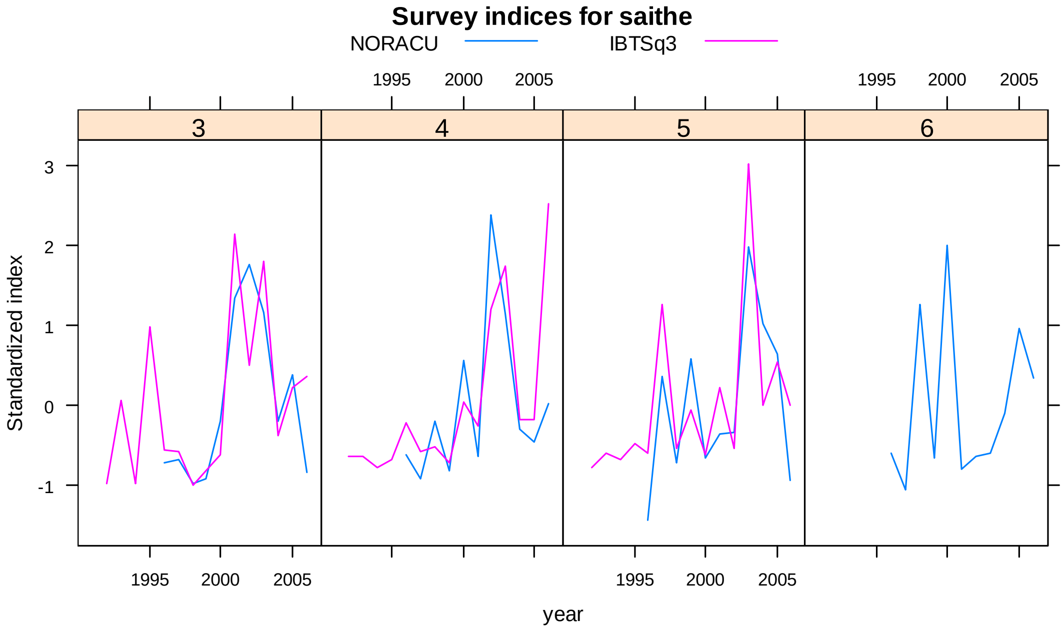


Figure 11.3.12. Saithe in Sub-Area IV, VI and Division IIIa. Standardised indices from the two survey time series.

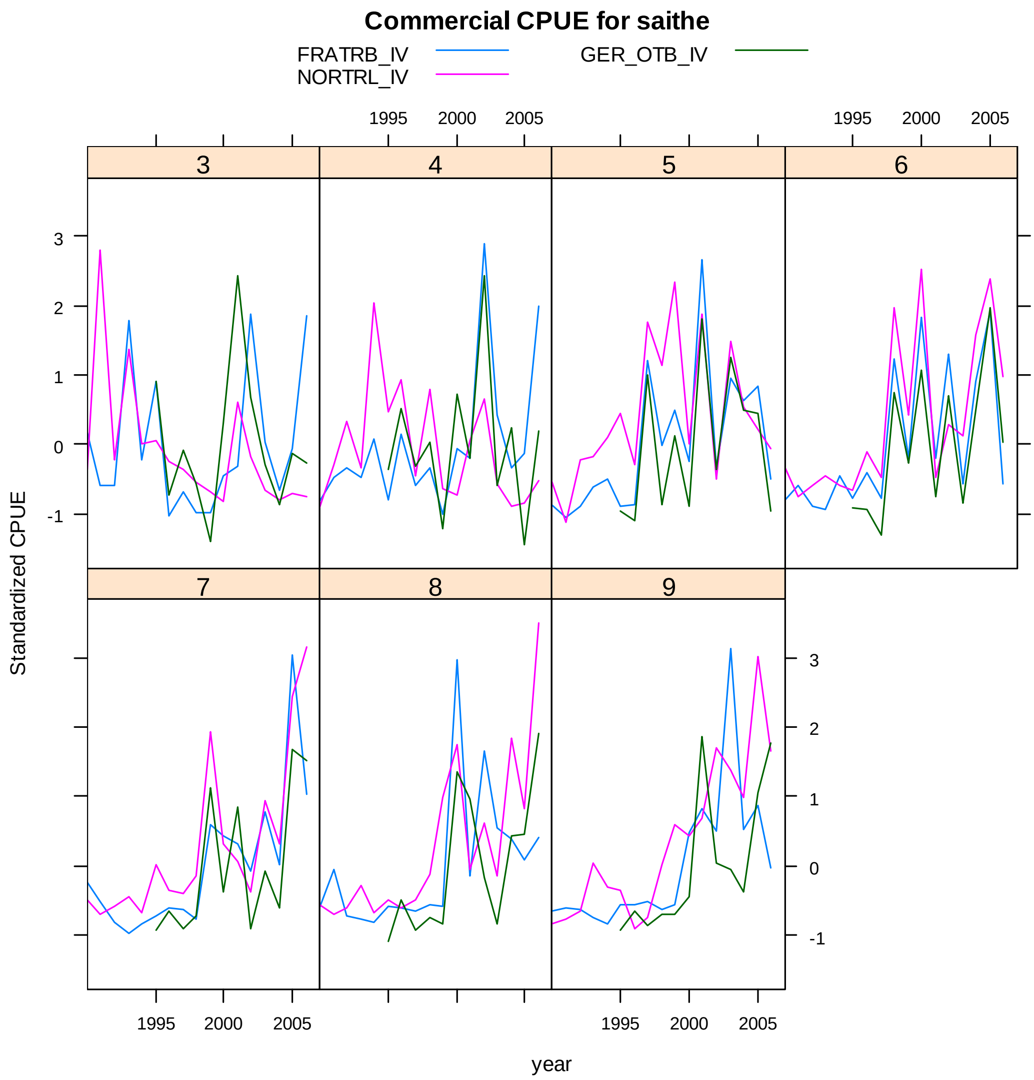


Figure 11.3.13. Saithe in Sub-Area IV, VI and Division IIIa. Standardised indices from the commercial tuning series.

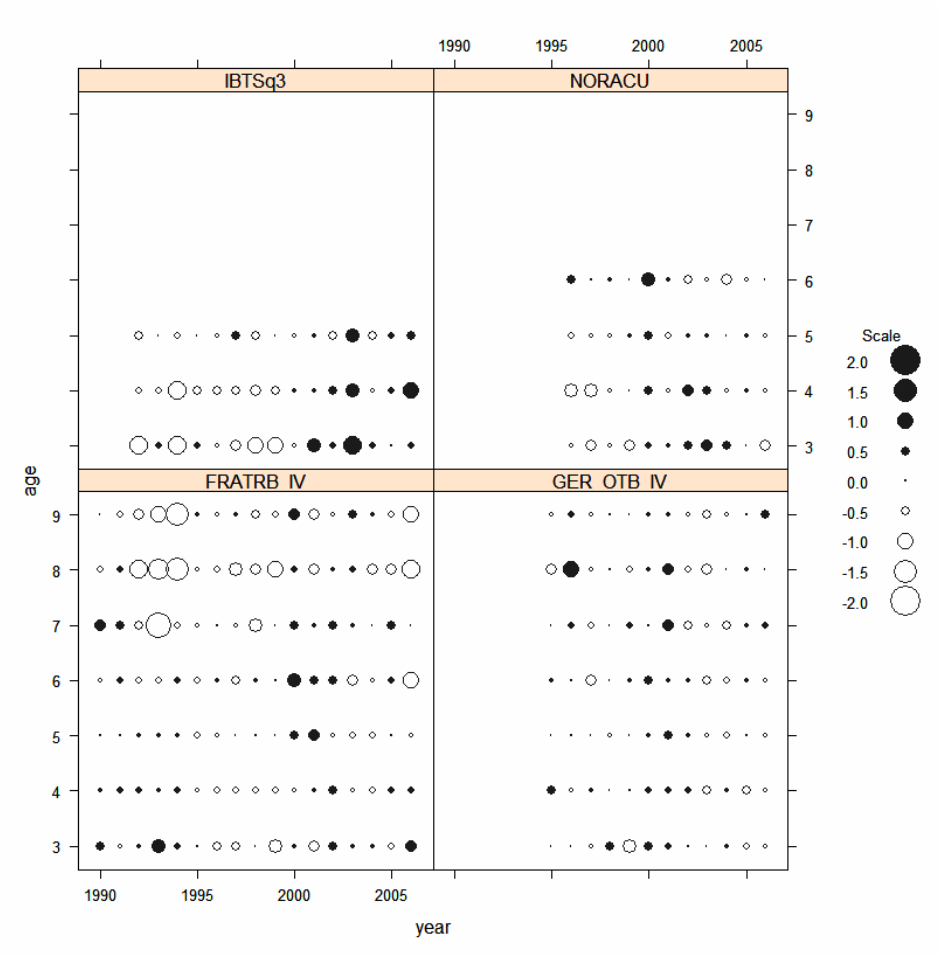


Figure 11.3.14. Saithe in Sub-Area IV, VI and Division IIIa. Log catchability residuals from the final XSA run,.

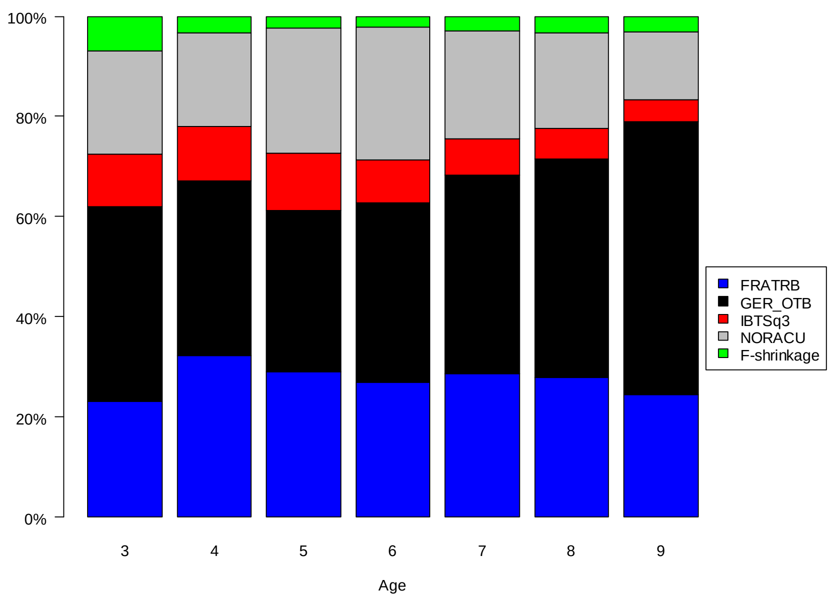


Figure 11.3.15. Saithe in Sub-Area IV, VI and Division IIIa. Relative weights of F-shrinkage and tuning fleets in the final XSA run.

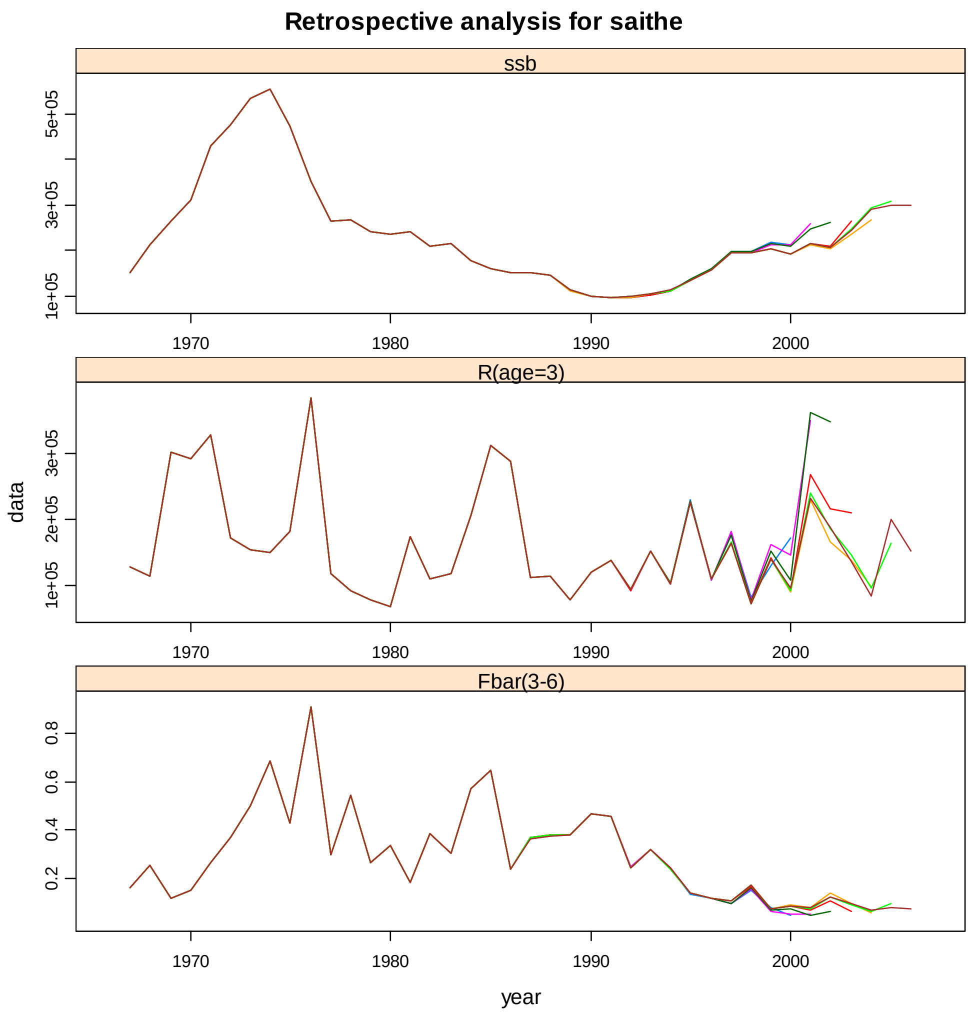


Figure 11.3.16. Saithe in Sub-Area IV, VI and Division IIIa. Retrospective analysis of the final XSA run.

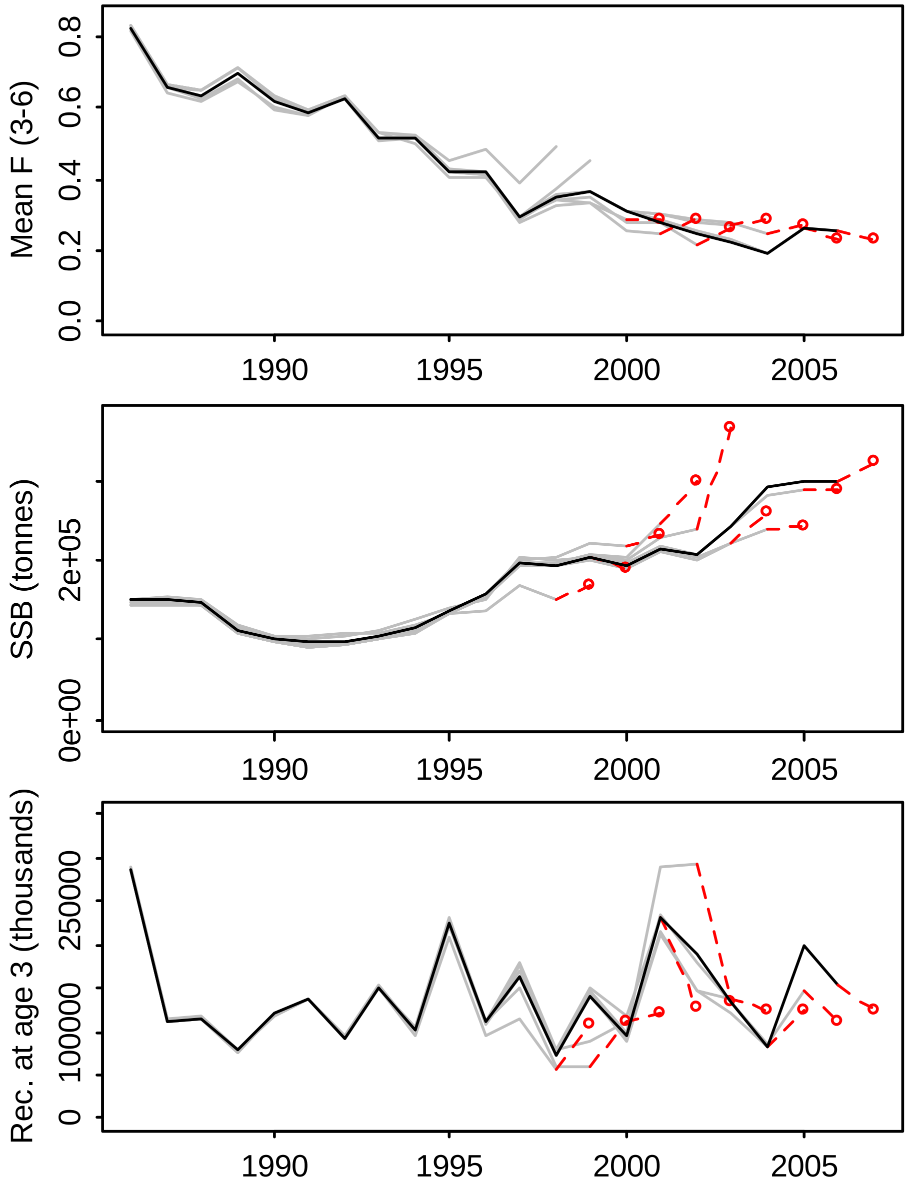


Figure 11.3.17. Saithe in Sub-Area IV, VI and Division IIIa. Assessments generated in successive working groups. Red circles represent forecasts for the assessment year.

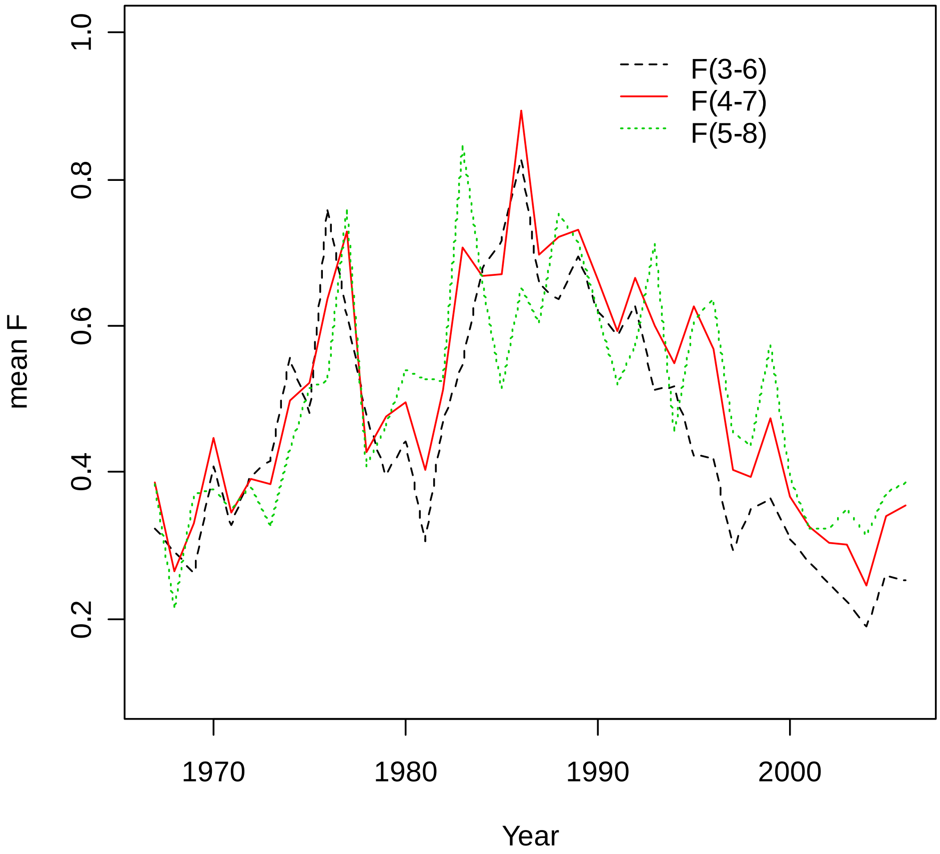


Figure 11.3.18. Saithe in Sub-Area IV, VI and Division IIIa. Average F (Fbar) using different age ranges.

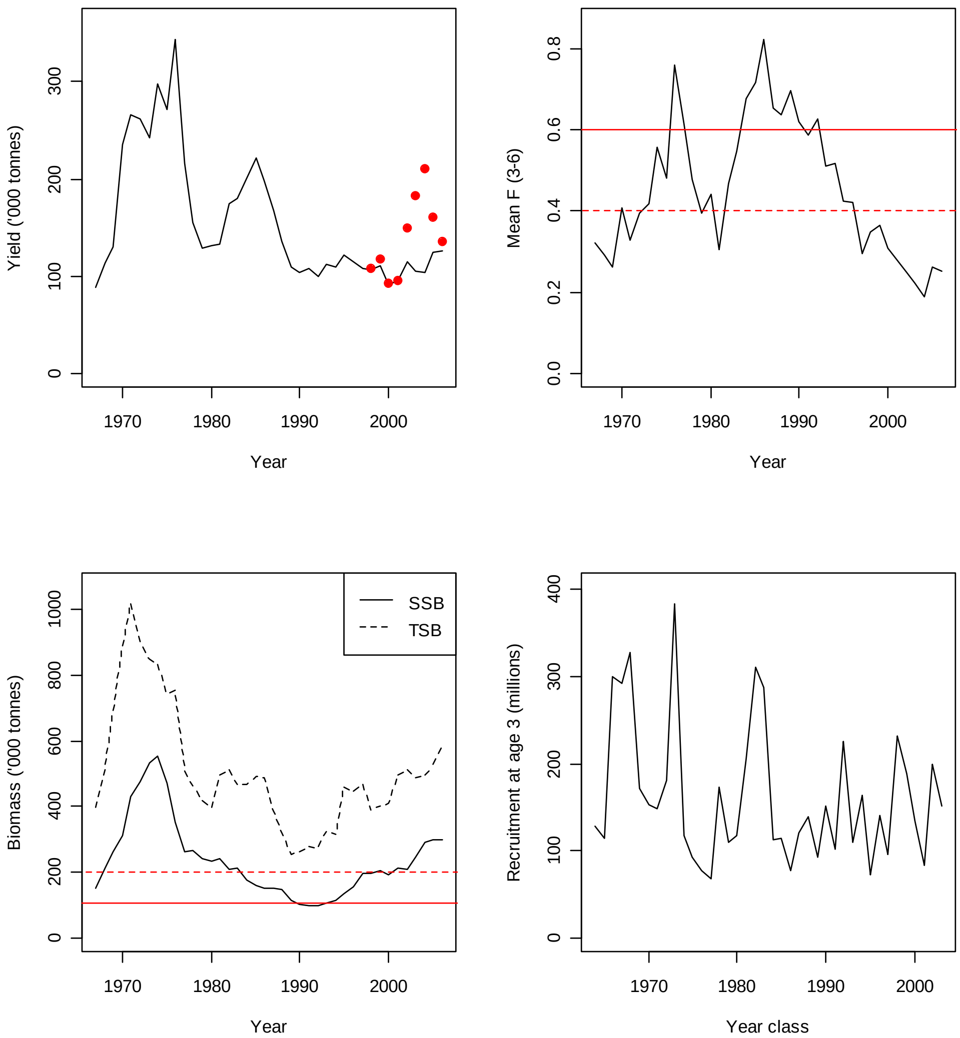
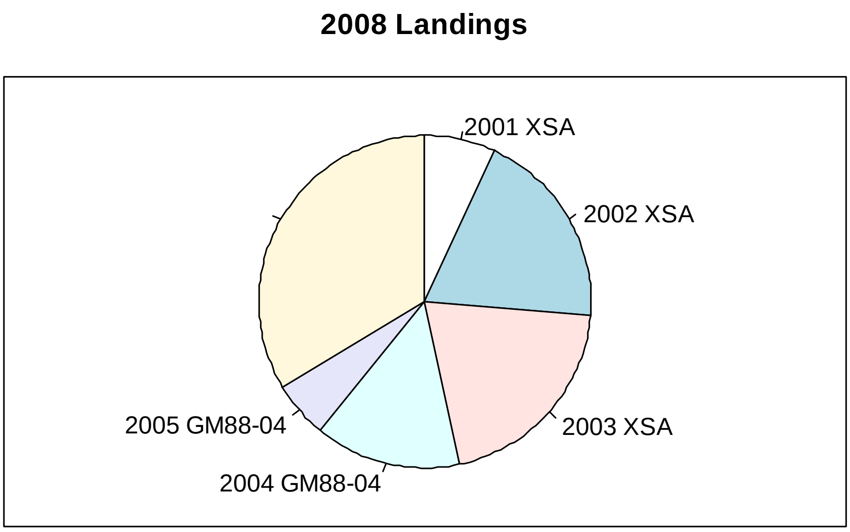


Figure 11.4.1. Saithe in Sub-Area IV, VI and Division IIIa. Stock summary. The red dots in the yield graph are TACs.



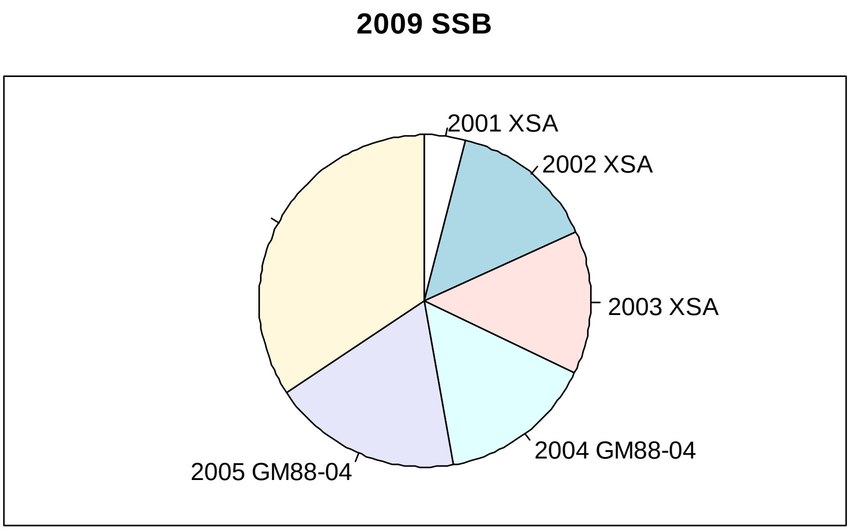


Figure 11.6.1 Saithe in Sub-Area IV, VI and Division IIIa. The relative biomass contribution (%) of recent year classes in the prediction with F status quo.

12 Whiting in Subarea IV and Divisions VIId and IIIa

Since 1996 this assessment has covered whiting in the North Sea (ICES Subarea IV) and eastern Channel (ICES Division VIId). Prior to 1996 whiting in these areas were assessed separately. The current assessment is formally classified as an update assessment. The assessment from the last working group meeting (2006), was accepted by the ACFM review group only as indicative of trends in the recent (decade) period.

12.1 General

12.1.1 Ecosystem aspects

Whiting are found throughout the North Sea, predominantly to the south of the Norwegian Deep and around the north of the Shetland Isles. The report of the SGSIMUW (ICES–WGNSSK, 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 bounded by the 50 m 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 an important predator. For ages three and above, the primary source of mortality is the fishery, followed by predation by seals. More notably, 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 spawnings over a protracted period, may provide continued food resources for earlier spawned 0–group whiting.

Results from SGMSNS (ICES – SGMSNS, 2005) show that that the main diet of whiting is commercially 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 120mm minimum mesh size. Some vessels operating to the east of this area are using 130 mm mesh. These are mixed demersal fisheries with more specific targeting of individual species in some areas and/or seasons. Cod, haddock and whiting form the predominant roundfish catch in the mixed fisheries, although there can be important by-catches of other species, notably saithe and anglerfish in the northern and eastern North Sea and of *Nephrops* in the more offshore *Nephrops* grounds. Minimum mesh size in *Nephrops* trawls is 80 mm but a range of larger mesh sizes are also used when targeting Nephrops. Whiting is becoming a more important species for the Scottish fleet, with many vessels actively targeting whiting during a fishing trip and Scottish single seiners have been working closer to shore to target smaller haddock and whiting. Technological developments have included a shift towards pair trawling and the development of double bag trawls which reduce costs compared to twin trawling. A recent derogation in the EU effort management scheme allows for extra days fishing by vessels using 90 mm mesh gears with a 120 mm square mesh panel close to the codend (a configuration which releases cod). Predictions suggest that losses of whiting would be high and so far, few vessels have taken up the derogation.

Recent fuel price increases and a lack of quota for deep-water species has resulted in some vessels formerly fishing in deep-water and along the shelf edge to move into the northern North Sea with the shift in fishing grounds likely to result in a change in the species composition of their catches from monkfish to roundfish species including whiting. Following the major decommissioning schemes a few years ago by the UK, there have not been further reductions, although a number of boats have taken advantage of oil support work and effort has probably been reduced.

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.

Whiting are an important component in the mixed fishery occurring along the English east coast. Industry reports suggest better catch rates here than are implied by the overall North Sea assessment. Darby (2006, 2007 WD7) analysed the catch per unit of effort (cpue) of the English fishery. In recent years the vessels have been reporting unusually high catch rates of large whiting. Recent catch rates appear to have peaked and have recently begun to decline (Figure 12.1.1) but are still well above historic levels. The Cefas–Industry Fisheries Science partnership survey conducted during the autumn of 2006 (Armstrong, 2006) reported that the majority of the catch (63%) taken by an 80 mm trawl survey of the area comprised whiting of ages 5 and older. Under an assumption that the current English fleet cpue represents these ages, comparisons can be made between i) English fleet cpue during the years 2000–2007 ii) the International Bottom Trawl Survey (IBTS) estimates of biomass and iii) the time series of older ages taken from the 2006 ICES assessment (considered by ICES ACFM (2006) to be indicative of trends in the stock only). The increase in the English otter trawler cpue of whiting clearly exceeds that of the survey and assessment by a factor of three to four. The degree of difference in the level of increase is dependent on the age ranges used in the analysis; there is more divergence for catches of 5+ whiting than for 6+ (Figure 12.1.1 c.f. Figure 12.1.2). The Industry Fisheries Science partnership survey has confirmed the increased cpue and that the local abundance of whiting and that the northeast coast fleet cannot avoid them without considerable displacement of vessels.

The current spatial distribution of North Sea whiting could result from local increases in the stock abundance or from a spatial contraction of the stock as its total abundance declines following recent poor recruitment. The latter hypothesis would seem to be indicated by the spatial distribution of IBTS whiting catch rates during recent years (Figures 12.2.5 and 12.2.6) that indicate that ages 3+ whiting are located primarily around the North east coast of England and the East coat of Scotland with very low catch rates in the southern North Sea. This appears to be confirmed by a displacement of some French vessels steaming from Boulogne-sur-Mer from their traditional grounds in the southern North Sea and English Channel where they have reported very low catch rates during the past two years.

12.1.3 ICES Advice

ICES ACFM advice for 2007:

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary considerations

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 total human consumption landings in 2007 should not be allowed to increase above the recent (2003–2005) average of 15 100t 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.

Advice for mixed fisheries management

For all demersal fisheries in the North Sea, ICES advice was based on mixed-fishery considerations. **Details are summarised in section 15.**

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 23 800t in 2006 and, again, 23 800 t in 2007.

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 120mm from the start of 2002, although under a transitional arrangement until 31 December 2002 vessels were allowed to fish with a 110mm codend provided that the trawl was fitted with a 90mm 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 120mm. Restrictions on fishing effort were introduced in 2003 and details of its implementation in 2004 can be found in Annex V of Council Regulation (EC) no. 2287/2003, for 2005 in Annex IVa of Council Regulation (EC) no 27/2005 and for 2006 in Annex IIa of Council Regulation (EC) 51/2006. Currently, vessels fishing with towed gears for roundfish in Subareas IV and VIId and Division IIa (EU waters) are restricted to 103 days at sea per year, excluding derogations. The minimum landing size for whiting in the North Sea is 27cm.

Whiting are a bycatch in some Nephrops fisheries that use a smaller mesh size, although landings are restricted through bycatch 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 (19 940t in 2006 and again 19 940t in 2007). The minimum mesh size for whiting in Division VIId is 80mm, with a 27cm 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 (Subarea IV) and Eastern Channel (Division VIId).

In 2002, the working group decided to truncate the catch data to start from 1980. This was due to the very large change in estimated recruitment levels around 1980 that was present in the assessment. The working group could not determine whether this was due to a shift in the recruitment regime or because discard data for years prior to 1978 were not measured but estimated according to a discard ogive. This may not have been representative of discarding during the earlier period. Biological reference points for this stock had originally been established on the basis of the truncated series, so this represented no change with respect to them.

Working group estimates of weights and numbers of the catch components for the North Sea and Eastern Channel are given in Tables 12.2.2 and 12.2.3, both tables cover the period 1980 to 2006.

For the North Sea the total international catches were 29 200t in 2006, of which 15 150t were human consumption landings, 11 860t discards and 2 190t industrial bycatch. Total catch shows a 7000 t increase on last year, with this increase being largely due to human consumption landings and industrial bycatch. The increase in discards was less marked. Although the reported tonnages of the catch components have increased from last year, they remain among the lowest in the series. The whiting industrial bycatch is a marked increase on last year which was 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 2006 (3440 t) is a reduction on the last two years total catch of around 4500t. As a proportion of total catch, the VIId catch has been increasing since the early nineties, but in 2006 shows a reduction.

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.

Figure 12.2.1 plots the trends in the commercial catch for each component, note that estimates of discards from VIId are not included. Each component shows a general decline. Industrial bycatch can be seen to be removing proportionately less through time. Human consumption landings have fluctuated around 45% of the total catch during the period 1980–2004, rising to 60% in the recent period. The proportion of discards has increased over the last ten years.

12.2.2 Age compositions

Proportion in number at age in the catch, human consumption landings, discards and industrial bycatch are plotted in Figure 12.2.2. 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 2006 after the introduction of the 120mm mesh. The proportion in the catch of older ages (6–7) has been increasing over the last three years. Problems with Danish sampling of industrial by-catch this year meant that a small sample from Norway was used to estimate age compositions for the entire North Sea industrial by-catch–this sampling is not considered representative.

Since only ages 1 to 8 are used in this assessment, proportion in number for these ages is presented in Figure 12.2.3. The noise created by estimates of numbers at age 0 in the industrial by-catch is removed from the catch data and shows a cleaner picture of the trends described above.

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 2006.

Total international catch numbers at age (IV and VIId combined) are presented in Table 12.2.4. Total catch comprises human consumption landings, discards and industrial by-catch for reduction purposes. Discards are for the North Sea (area IV) only. Total international human consumption landings (North Sea and Eastern Channel combined) are given in Table 12.2.5. Discard numbers at age for the North Sea are presented in Table 12.2.6. Industrial bycatch numbers at age for the North Sea are presented in Table 12.2.7.

Reference to data collation – section XX

12.2.3 Weight at age

Mean weights at age (Subarea IV and Division VIId combined) in the catch are presented in Table 12.2.8. These are also used as stock weights. Mean weights at age (both areas combined) in human consumption landings are presented in Table 12.2.9, and for the discards and industrial by-catch in the North Sea in Tables 12.2.10 and 12.2.11. These are shown graphically in Figure 12.2.4, 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.

Unrepresentative sampling of the 2006 industrial bycatch results in poor estimates of the mean weights at age of this component in 2006.

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.

12.2.5 Catch, effort and research vessel data

The full commercial cpue and survey tuning indices available to the working group are presented in Table 12.2.12. The report of the 2001 meeting of this WG (ICES WGNSSK, 2002), and the ICES advice for 2002 (ICES ACFM, 2001) provides arguments for the exclusion of commercial cpue tuning series from calibration of the catch-at-age analysis see section 14.2.4. Such arguments remain valid and only survey data have been considered for tuning purposes. A summary of all available tuning series is presented in the stock annex.

Data from the VIId French groundfish survey for 2004 to 2006 are available but in a form that was different from previous data and have not 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 working group 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.

Density maps for the IBTS Q1 survey are shown in Figure 12.2.5. These plots show a general decline in the numbers of young whiting in recent years. Large numbers of 3+ whiting were seen in 2003 and 2004, but numbers of these ages have declined in recent years. There are low numbers of whiting of all ages in the south eastern areas of the North Sea since 2004.

Density maps for the IBTS Q3 survey are shown in Figure 12.2.6. These plots show a marked decline in the numbers of whiting in recent years. It can also be seen that young whiting are historically distributed widely in the North Sea with concentrations mostly to the east coast of the UK and southern North Sea coast. Most recently observations of whiting have been restricted to the north eastern coast of the UK with sparse observation north of the Dogger bank.

12.3 Data analyses

The methods used in this section comprise 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 last year to assess stock trends in the North Sea and the Eastern Channel using only survey information. This analysis is presented again in this section as it provides a good summary of the issues with the current assessment.

12.3.1 Reviews of last year's assessment

Several comments were made by the RGNSSK regarding last year's assessment. These are summarised below. Review group comments are italicized and WG responses, where appropriate, follow in plain text.

1) Given the conflicting signals between cpue (surveys) and lpue (commercial) in the earlier period, the assessment is considered indicative of trends in the recent (decade) period.

2) Since stock status in recent years appears to be consistently estimated, a long term equilibrium analysis should be performed.

3) The WG agreed and a yield per recruit analysis was carried out–section 12.6.

4) The use of ages 2–6 to compute the mean F range should be investigated.

5) The WG considered this investigation to form part of a more thorough, benchmark, assessment. However, various summaries of trends in F-at-age of the final assessment are presented to help, in the interim, with the interpretation of the current perception of fishing mortality.

12.3.2 Exploratory catch-at-age-based analyses

Catch curve analysis provides a useful method of inspecting the data and looking for changes in 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 numbers of young fish in the catch and an increase in numbers in the catch of ages 6–8 year olds over the last three years. 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 decline in the recent period. The catch curves also show oscillating trend in catches of older ages (6 to 8+) in the recent period. This trend is not dissimilar to the trend in mean lengths at these ages.

Within cohort correlations between ages are presented as a scatter plot matrix in Figure 12.3.3. A linear regression is fitted for each scatter plot and if significant the regression line and an approximate pointwise 95% confidence interval is drawn in bold. In general catch numbers correlate well between cohorts with the relationship breaking down as you compare cohorts across increasing years.

Single fleet XSA runs were conducted to compare trends in the catch data with trends in the survey data. These used the same surveys (same age and year ranges) as in last year's final assessment, with the exclusion of the early Scottish groundfish survey series. No tapered weighting was used. 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. Residual patterns (Figure 12.3.5) show year effects at the start of the English groundfish survey series indicating a conflict in these years between this survey and the commercial catch data.

12.3.3 Exploratory survey-based analyses

Catch curve analyses are shown in Figure 12.3.6. The Scottish and English groundfish surveys show increasing catches of whiting of old fish. While the IBTS Q1 shows declining catches of young fish with increasing catches of older fish. The IBTS Q1 survey better reflects observed trends in the catch data than do the Scottish and English groundfish surveys. However the similarities between the catch curves of the IBTS Q1 and the commercial data do not extend prior to 1990.

Plots of negative gradients over ages 2–6 are shown in Figure 12.3.7, these plots show evidence of declining mortality from all three surveys.

The consistency within surveys is assessed using correlation plots as scatter plot matrices. Only survey indices used in the final assessment are presented as this is an update assessment. The English groundfish survey shows good internal consistency across all ages (Figure 12.3.8). The Scottish groundfish survey shows a lower degree of internal consistency (Figure 12.3.9), while the IBTS Q1 shows reasonable consistency over all ages (Figure 12.3.10).

Last year single fleet analyses were carried out using Surba. The mean standardised SSB for these runs, a multi-fleet Surba, and a multi-fleet XSA (using the same surveys) is presented in Figure 12.3.11. This figure is included as it provides a good summary the main issues with the current assessment.

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 internally consistent. All sources of information indicate a generally declining mortality in the recent period.

Surba and XSA analyses show that all three surveys are consistent with the catch data for the last decade.

12.3.5 Final assessment

The final assessment was fitted to the combined landings, discard and industrial by-catch data for the period 1980–2006. The settings are contained in the table below. Those from previous years are also presented.

	year range used	2005	2006	**This year(2007)**
Catch at age data		1980-2004 Ages 1 to 8+	1980-2005 Ages 1 to 8+	**1980-2006** **Ages 1 to 8+**
Calibration period		1990-2004	1990-2005	**1990-2006**
ENGGFS Q3 full series (1990-2006)	1990-2006	Ages 1 to 6	-	-
ENGGFS Q3 GRT (1990-1991	1990-1991	-	Ages 1 to 6	-
ENGGFS Q3 (GOV)	**1992-2006**	-	Ages 1 to 6	**Ages 1 to 6**
SCOGFS Q3 (continuous series)	1990-2006	Ages 1 to 6	-	-
SCOGFS Q3 (Scotia II)	1990-1997	-	Ages 1 to 6	-
SCOGFS Q3 (Scotia III)	**1998-2006**	-	Ages 1 to 6	**Ages 1 to 6**
IBTS Q1	**1990-2006**	Ages 0 to 4 (backshifted)	Ages 1 to 5	**Ages 1 to 5**
Catchability independent of stock size		Age 1	Age 1	**Age 1**
Catchability plateau		Age 4	Age 4	**Age 4**
Weighting		Tricubic over 15 years	Tricubic over 16 years	**Tricubic over 17 years**
Shrinkage		Last 3 years and 4 ages	Last 3 years and 4 ages	**Last 3 years and 4 ages**
Shrinkage SE		0.5	2.0	**2.0**
Minimum SE for fleet survivors estimates		0.3	0.3	**0.3**

Full diagnostics for the final XSA run are given in Table 12.3.1. Residual plots are presented in Figure 12.3.12 and show increasing trends in the beginning of the English groundfish survey. Final year contributions by tuning fleets to estimates of survivors are shown in Figure 12.3.13 and show an even contribution by all fleets at all ages.

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 12.3.14

A retrospective analysis (possible only over the last five years due to the short span of the second Scottish groundfish survey series) is shown in Figure 12.3.15.

12.4 Historic Stock Trends

A plot of estimated F-at-age over the years 1991 to 2006 is presented in Figure 12.4.1. This figure shows the recent decline in F at older ages and an increase in F at the younger ages, highlighting an apparent change in selection pattern in this fishery.

Contribution of age classes to TSB and SSB is shown in Figure 12.4.2. This shows the important contribution of ages 1 and 2 to the TSB. This figure also shows a recent uniformity with respect to contribution to TSB across ages 1 to 7.

The historic stock trends in F(2-6) are presented in Figure 12.4.3 alongside trends in F(2–4) and F(5–7) from the final assessment. Historic trends for SSB and recruitment are presented in Figures 12.4.4 and 12.4.5. Last year's assessment is also included in Figures 12.4.3 to 12.4.5 as a blue line. The only discernable difference is a slight upwards revision of F(2–6) in 2005.

The North Sea Fishers' Survey for 2007 had not yet been completed, so no comparison can be made between the stock trends observed from the assessment and the fishermen's perceptions from the Fishers' survey.

In a survey carried out in 2006 to assess French fishers' perception of the Eastern Channel ecosystem (Prigent *et al.*, 2007). 76% of the interviewees found the fisheries resources depleted, especially flatfish, whiting and cod.

12.5 Recruitment estimates

The IBTS survey has been seen to be internally consistent across all ages (Figure 12.3.10) and a regression of the IBTS age 1 index against recruitment estimated from the final XSA run for years 1990 to 2006 shows a highly significant relationship as indicated by Figure 12.5.1. The regression was carried out over the period 1990 to 2006 with tri-cubic weighting over 17 years following the same philosophy as the final assessment. A similar regression using the age 0 indices from the Scottish and English groundfish surveys show 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 2007 of approximately 150 million. This estimate is a weighted average of 814 million from the VPA mean and 100 million from the IBTS survey, with the IBTS getting the large majority of the weight. This predicts an historic low recruitment for the 2006 year class, the previous low was estimated at 394 million for the 2005 year class. The index for age 0 in 2007 is the lowest in the IBTS Q1 series by a large margin and as such means we are extrapolating outside the range of the data.

The RCT3 estimate was used as the estimate of recruitment for 2007 given the strength of the IBTS Q1 relationship. However the mean recruitment over the last 4 years was used as the estimates of recruitment for 2008 and 2009.

The following table summarises recruitment assumptions for the short term forecast together with XSA estimated recruitment from the previous two years.

year class	age in 2006	XSA (millions)	RCT3 (millions)
2004	2	389	-
2005	1	394	-
2006	0	-	150
2007	age 0 in 2007	-	391
2008	age 0 in 2008	-	391

12.6 Short-term forecasts

A short-term forecast was carried out based on the final XSA assessment. XSA survivors in 2007 were used as input population numbers for ages 2 and older. The RCT3 estimate of 150 million was used for one-year-old abundance in 2007, and a mean of the last four years (391 million) was used for 2008 and 2009.

The exploitation pattern was chosen as the mean F-at-age pattern over the years 2003–2005 as F-at-age 2006 was considered noisy. Given the recent increase in F(2-6) this exploitation pattern was scaled to the F(2-6) in 2006 for forecasts. This is shown in Figure 12.6.1. This reflects the levelling out of F-at-age in the recent period as is evident in Figure 12.3.16 and takes into account the increasing trend in F, especially for younger ages, in the last few years (Figure 12.6.2). Moreover, discard mortality is estimated to have been increasing in the recent period, going someway to explaining the changing selection pattern. The WG agreed that the exploitation pattern taken forward into the short term forecast reflects these changes.

In last year's report, regression analysis showed a general decline in mean weights at older ages. However, mean weights at older ages are showing signs of increasing in the last year (Figure 12.2.4). Thus, the mean over the last three years was used for the purposes of forecasting.

The input to the forecast is shown in Table 12.6.1. Results are presented in Tables 12.6.2 and 12.6.3.

The TAC for 2007 for area IV and VIId was 26 000t. Assuming F2007=F2006 results in human consumption landings in 2007 of 11 100t from a total catch of 27 100t resulting in an SSB in 2008 of 45 400t. For the same fishing mortality in 2008, human consumption landings are predicted to be 7900t resulting in an SSB in 2009 of 44 100t. Under the assumptions of the prediction, SSB in 2009 will be below Blim even in the absence of fishing in 2008 (but see discussion under sections 12.9 and 12.10).

Comparing catch in 2006 to that predicted in 2007 we see that total catch is predicted to decline from 29 000t to 27 000t. This separates into declining human consumption landings from 15 000t to 11 000t, increasing discards from 12 000t to 14 000t and stable industrial bycatch at 2000t.

A yield per recruit analysis was carried out. The input is presented in Table 12.6.3, and the output in Table 12.6.4 and Figure 12.6.2. Reference points were calculated for the human consumption fleet and were Fmax = 0.19 and F0.1 = 0.10

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 000t; Bpa=315 000t; Flim=0.90; Fpa = 0.65.

12.9 Quality of the assessment

Retrospective analysis indicates some systematic upwards revisions of F(2-6), downwards revisions of SSB and variable downwards revisions of recruitment. A similar pattern is exhibited in TSB as seen in SSB.

Previous meetings of this WG have concluded that the survey data and commercial catch data contain varying signals concerning the stock. Analyses by working group 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 working group considers that it is not possible categorically to classify the current state of the stock with reference to precautionary reference points as the biomass reference points are derived from a consideration of the stock dynamics at a time when the commercial catch-at-age data and the survey data conflict.

Due to the likely population structuring in the North Sea and Eastern Channel, it is probable that the overall stock estimates may not reflect trends in more localised areas.

Despite the minimum mesh-size increase in 2002 in the towed demersal roundfish gears and the decline in industrial by-catch as activity in the norway pout and sandeel fisheries have declined, the estimates of F on the young ages appears to be increasing disproportionately to that on older ages.

The historic performance of the assessment is summarised in Figure 5.9.1.

12.10 Status of the Stock

The working group considers the status of the stock unknown with respect to biological reference points, for the reasons given in Section 12.9. Nevertheless all indications are that the stock, at the level of the entire North Sea and Eastern Channel, is at or approaching a low level relative to the period since 1991. Fishing mortality, previously estimated to be low relative to the period since 1991, now appears to have increased, particularly at younger ages.

12.11 Management Considerations

Catches of whiting have been declining since 1980. Distribution maps of survey IBTS indices show a reduction and concatenation of the stock, perhaps due to recent poor recruitments. Furthermore mortality has been observed to have increased on younger ages due to increased discarding in recent years.

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 bycatch of whiting in the Norway pout and sandeel fisheries is dependent on activity in that fishery, which 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 12.12.1.

No assessment of this stock was possible.

With reference to Table 12.12.1 reported by-catches of whiting in the Danish small-meshed fisheries in Division IIIa covering 1989–2006 can be observed to decrease from 1989–1996, and then show a sharp decline from 1997–2005, and continue to fall in 2006.

The time series for whiting ln-cpue shows an oscillatory pattern without a clear trend during the past 25 years. Whiting seems to be somewhat spread over a larger area at high level of biomass, although the difference in spatial distribution at low and high levels of biomass is not very pronounced. This could be due to the relatively low difference in ln-cpue between the two periods.

12.13 Whiting (Update from September meeting)

This section presents the results of an updated short term forecast for whiting in 2008, based on the most recent information on the recruiting year class which has become available since the WG met in May. The recruitment estimates from 2007 are now estimated using the Q3 Scottish Ground Fish Survey (ScoGFS). All other parameters were kept the same.

12.13.1 New information from the 3rd quarter surveys

The 3rd quarter Scottish Groundfish Survey took place from 10 August to 1 September, with a total of 85 valid hauls completed. The numbers of 0-group whiting caught per ICES statistical rectangle are given in Figure 12.13.1. The survey index time series is given in Figure 12.13.2. The results indicate that the abundance of 0-group whiting in 2007 is the highest since 2003 (index of 4874). This is illustrated in Figure 12.13.2, which plots the survey abundance index for age 0 together with estimates of recruitment from the XSA final assessment.

12.13.2 Recruitment estimates

In the WG report from May, recruitment for 2007 was estimated using the age 0 index from the 2006 Q3 Scottish and English groundfish surveys and the age 1 index from the 2007 Q1 IBTS. The 2007 Q3 Scottish groundfish survey information normally used was not available at this time. Recruitment was estimated at 150 million. The estimates for recruitment for 2008 and 2009 were based on the geometric mean of recent past recruitments (391 million). For the updated forecast, recruitment in 2007 was estimated using the calibration regression method described by Shepherd (1997), implemented in the computer program RCT3. Tables 12.13.1 and 12.13.2 present the RCT3 inputs and outputs. The RCT3 estimates of recruitment were 156 million in 2007 and 794 million in 2008. The VPA mean took the majority of the weighting in the 2008 estimate but is consistent with the new information (Figure 12.13.2). Recruitments for 2008 and 2009 were taken from the RCT3 estimate of recruitment for 2008.

The following table summarises the recruitment assumptions for the short term forecast.

Year class	age in 2006	XSA (millions)	RCT3 (millions)
2004	2	389	-
2005	1	394	-
2006	0	-	156
2007	age 0 in 2007	-	794
2008	age 0 in 2008	-	794

12.13.3 Short-term forecasts

The same assumptions made at the May WG in relation to growth were made for the updated forecasts. Mean stock weights in the forecast where taken as an arithmetic mean of the last 3 years.

The mean exploitation pattern over the years 2003-2005 was used 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. The inputs to the short-term forecast are presented in Table 12.13.3. Results for the short-term forecasts are presented in Table 12.13.4, with detailed outputs given in Table 12.13.5. Status-quo F is assumed to be F (2-6) for 2006.

SSB is expected to fall to 68 500 tonnes in 2007 and fall further to 50 700 tonnes in 2008. The human consumption yield in 2007 will be around 11 100 tonnes. This is markedly lower than the TAC for 2007 (26 000 tonnes for areas IV and VIId). There is estimated to be around 14 100 tonnes of discards and 2 100 tonnes of industrial bycatch. Under status quo F in 2008, the human consumption yield will be around 8 800 tonnes with discards and industrial bycatch rising to 18 400 tonnes and 6 500 tonnes, respectively. The resulting SSB in 2009 is expected to be 68 100 tonnes.

In 2008 landings are predicted to be 11% greater than forecast in May, and discards 52% greater. These figures represent a substantial change in relation to the forecasts in May and as such should merit reconsideration by ACFM.

References

Shepherd, J.G. (1997). Prediction of year-class strength by calibration regression analysis of multiple recruit index series. *ICES J. Mar. Sci.* **54**: 741–752.

Table 12.2.1 Whiting in Subarea IV and Division VIId. Nominal landings (in tonnes) as officially reported to ICES.

Subarea IV

COUNTRY	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	944	1042	880	843	391	268	529	536	454	270	248	144	105	92
Denmark	1418	549	368	189	103	46	58	105	105	96	89	62	57	251
Faroe Islands	7	2	21	0	6	1	1	0	0	17	5	0	0	0
France	5502	4735	5963	4704	3526	1908	0	2527	3455	3314	2675	1721	1059	2445
Germany	441	239	124	187	196	103	176	424	402	354	334	296	149	252
Netherlands	4799	3864	3640	3388	2539	1941	1795	1884	2478	2425	1442	977	802	702
Norway	130	79	115	66	75	65	68	33	44	47	38	23	16	18
Poland	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Sweden	18	10	1	1	1	0	9	4	6	7	10	2	1	2
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	
UK (Total)														11481
Total	**47301**	**42216**	**41400**	**35116**	**31573**	**23938**	**22110**	**24453**	**18834**	**15608**	**11256**	**9491**	**10202**	**15242**
Unallocated landings	695	423	-549	812	-273	-50	3884	29	552	308	-597	-258	315	-92
WG estimate of H.Cons. landings	47996	42639	40851	35928	31300	23888	25994	24482	19386	15916	10659	9233.4	10517	15150
WG estimate of discards	42953	33050	30315	28156	17194	12721	23525	23214	16488	17509	24093	12561	10448	11860
WG estimate of Ind. By-catch	20140	10360	26544	4691	5974	3161	5160	8885	7357	7327	2743	1218	882	2190
WG estimate of total catch	**116284**	**92683**	**103095**	**73731**	**59087**	**44370**	**59108**	**60857**	**49011**	**46271**	**43208**	**27362**	**21847**	**29200**

Division VIId

COUNTRY	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	74	61	68	84	98	53	48	65	75	58	66	45	45	71
France	5032	6734	5202	4771	4532	4495	-	5875	6338	5172	6478	-	3819	3019
Netherlands	-	-	-	1	1	32	6	14	67	19	175	132	125	117
UK (E.&W)	321	293	280	199	147	185	135	118	134	112	109	80	86	
UK (Scotland)	2	-	1	1	1	+	-	-	-	-	-	-	-	-
UK (Total)													-	71
Total	**5429**	**7088**	**5551**	**5056**	**4779**	**4765**	**189**	**6072**	**6614**	**5361**	**6828**	**274**	**4074**	**3279**
Unallocated	-214	-463	-161	-104	-156	-167	4,242	-1775	-810	439	-1117	4076	713	161
W.G. estimate	5194	6633	5385	4956	4619	4599	4428	4275	5780	5519	5712	4350	4787	3440

Subarea IV and Division VIId

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
W.G. estimate	116284	92683	103095	73731	59087	44370	59108	60857	49011	46271	43208	27362	26633	32640

Annual TAC for Subarea IV and Division IIa

	2000	2001	2002	2003	2004	2005	2006	2006
TAC	29700	32358	16000	16000	16000	28500	23800	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 as a proportion of total HC
year	H.cons.	Disc.	Ind.BC	Tot.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	140.19	9.8%
1983	81.03	49.56	23.68	154.27	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	58.61	79.66	17.97	156.24	5.50	161.74	8.6%
1987	63.63	54.00	16.48	134.11	4.67	138.78	6.8%
1988	51.67	28.15	49.22	129.04	4.43	133.47	7.9%
1989	41.03	35.85	42.71	119.59	4.16	123.75	9.2%
1990	43.42	55.84	50.72	149.98	3.48	153.46	7.4%
1991	47.30	33.64	38.31	119.25	5.72	124.97	10.8%
1992	46.45	30.61	26.90	103.96	5.74	109.70	11.0%
1993	47.99	42.87	20.10	110.96	5.21	116.17	9.8%
1994	42.62	33.01	10.35	85.98	6.62	92.60	13.4%
1995	41.05	30.26	26.56	97.87	5.39	103.26	11.6%
1996	36.12	28.18	4.70	69.00	4.95	73.95	12.1%
1997	31.30	17.22	5.96	54.48	4.62	59.10	12.9%
1998	23.86	12.71	3.14	39.71	4.60	44.31	16.2%
1999	25.98	23.58	5.18	54.74	4.43	59.17	14.6%
2000	24.51	23.21	8.89	56.61	4.30	60.91	14.9%
2001	19.42	16.49	7.36	43.27	5.80	49.07	23.0%
2002	15.92	17.51	7.33	40.76	5.80	46.56	26.7%
2003	10.66	24.09	2.74	37.49	5.71	43.20	34.9%
2004	9.23	14.26	1.22	24.71	4.35	29.06	32.0%
2005	10.51	10.61	0.88	22.00	4.79	26.79	31.3%
2006	15.15	11.86	2.19	29.20	3.44	32.64	18.5%
min.	9.23	10.61	0.88	22.00	3.44	26.79	6.8%
mean	43.18	32.67	20.45	96.31	5.61	101.92	14.5%
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 as a proportion of total HC
year	H.cons.	Disc.	Ind.BC	Tot.Catch	H.cons.		
1980	304.8	471.2	644.5	1420.5	35.5	1456.0	10.4%
1981	261.3	213.9	929.3	1404.5	34.3	1438.8	11.6%
1982	238.2	173.2	333.3	744.7	33.0	777.7	12.2%
1983	260.6	370.2	697.2	1328.0	29.5	1357.5	10.2%
1984	252.1	326.8	296.6	875.5	33.4	908.9	11.7%
1985	156.7	231.2	280.1	668.0	19.6	687.6	11.1%
1986	204.3	582.6	398.6	1185.5	21.1	1206.6	9.4%
1987	226.8	415.9	285.2	927.9	18.2	946.1	7.4%
1988	193.7	231.4	951.7	1376.8	17.9	1394.7	8.5%
1989	155.3	280.3	430.8	866.4	16.9	883.3	9.8%
1990	163.6	539.0	577.9	1280.5	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	677.8	24.0	701.8	14.8%
1995	128.9	213.6	1659.5	2002.0	18.5	2020.5	12.6%
1996	120.5	177.1	128.3	425.9	22.4	448.3	15.7%
1997	108.5	100.6	61.3	270.4	22.6	293.0	17.2%
1998	86.6	83.2	97.2	267.0	23.0	290.0	21.0%
1999	98.3	178.5	160.1	436.9	18.9	455.8	16.1%
2000	91.6	142.3	55.0	288.9	22.1	311.0	19.4%
2001	73.6	114.3	281.7	469.6	28.6	498.2	28.0%
2002	56.8	96.3	205.0	358.1	19.7	377.8	25.8%
2003	34.4	209.6	84.2	328.2	22.8	351.0	39.9%
2004	30.6	56.9	42.4	129.9	16.4	146.3	34.9%
2005	36.8	59.4	24.2	120.4	19.6	140.0	34.8%
2006	52.3	74.2	7.4	133.9	11.7	145.6	18.3%
min.	30.6	56.9	7.4	120.4	11.7	140.0	7.4%
mean	147.2	236.2	418.0	801.4	22.2	823.5	16.2%
max.	304.8	582.6	1659.5	2002.0	35.5	2020.5	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.

year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**8+**
1980	332209	**265359**	**416008**	**286077**	**90718**	**52969**	**10751**	**1152**	689	58	14	5	1	**767**
1981	516869	**162899**	**346343**	**266517**	**102295**	**27776**	**12297**	**3540**	244	45	37	1	0	**326**
1982	101058	**192640**	**114444**	**245246**	**88137**	**26796**	**6909**	**2082**	400	53	26	4	1	**484**
1983	668604	**205646**	**184746**	**118412**	**131508**	**37231**	**8688**	**1780**	794	101	35	0	0	**930**
1984	157819	**323408**	**175965**	**124886**	**49504**	**59816**	**13860**	**2964**	410	182	21	0	0	**613**
1985	186723	**203321**	**141716**	**82037**	**37847**	**14420**	**17445**	**3328**	805	89	9	0	0	**904**
1986	225201	**576731**	**167077**	**169577**	**46517**	**13367**	**3487**	**3975**	497	71	0	1	0	**569**
1987	84863	**267051**	**368229**	**122748**	**85240**	**11392**	**4556**	**928**	929	98	7	0	0	**1035**
1988	416924	**430344**	**307428**	**179502**	**39634**	**17901**	**2175**	**544**	59	72	37	0	0	**168**
1989	87325	**331672**	**173676**	**191942**	**78464**	**14367**	**5050**	**516**	291	36	6	1	0	**334**
1990	284755	**253745**	**505010**	**129126**	**86324**	**32270**	**2002**	**735**	96	16	0	0	0	**112**
1991	1035089	**128507**	**191193**	**187195**	**36830**	**26209**	**5519**	**542**	255	17	1	0	0	**273**
1992	252963	**239791**	**165354**	**89563**	**93636**	**11967**	**6878**	**2609**	109	8	1	0	0	**117**
1993	622530	**217539**	**167577**	**124287**	**46543**	**46136**	**3946**	**1519**	698	58	16	0	0	**771**
1994	216868	**163609**	**147177**	**90611**	**47533**	**17384**	**17264**	**998**	386	74	0	0	0	**460**
1995	1571419	**137481**	**139010**	**111489**	**35728**	**15161**	**5158**	**4515**	317	101	55	0	0	**474**
1996	93296	**72645**	**113956**	**98476**	**48575**	**14235**	**4695**	**1294**	910	168	32	0	2	**1113**
1997	16893	**53408**	**74200**	**82944**	**42154**	**18492**	**3358**	**1020**	307	137	16	0	0	**460**
1998	68619	**71430**	**44697**	**42771**	**36459**	**17756**	**6392**	**1426**	306	66	34	0	0	**407**
1999	77814	**178079**	**91355**	**45627**	**34175**	**18528**	**7547**	**2049**	568	95	12	0	0	**676**
2000	1753	**66789**	**124365**	**63526**	**23888**	**16232**	**8791**	**4322**	970	244	48	3	0	**1265**
2001	230987	**84121**	**86178**	**58908**	**20559**	**9177**	**4814**	**2232**	897	246	124	2	0	**1268**
2002	137485	**49857**	**61239**	**82940**	**34006**	**8007**	**2043**	**1457**	620	102	13	9	10	**754**
2003	61111	**72709**	**104040**	**53560**	**42048**	**14305**	**2372**	**474**	329	50	16	1	0	**396**
2004	26426	**25440**	**16412**	**24354**	**25738**	**19126**	**7285**	**1193**	191	91	12	1	4	**299**
2005	13072	**25796**	**27907**	**11177**	**17135**	**13919**	**8295**	**2641**	426	24	29	1	0	**480**
2006	1394	**30784**	**39285**	**25958**	**9872**	**17076**	**13631**	**5739**	1584	206	48	0	0	**1838**

Table 12.2.5 Whiting in IV and VIId. Human consumption landings numbers at age (thousands).

year	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1980	0	3656	62405	152570	68422	41430	9911	1135	689	58	14	5	1	767
1981	6	4240	69211	104348	78253	23698	12036	3530	244	45	37	1	0	326
1982	0	10890	46703	124656	59393	21376	5664	2058	400	53	26	4	1	484
1983	1	10568	68640	67312	101342	31266	8330	1730	784	101	35	0	0	921
1984	0	14388	62693	99204	41277	51745	12735	2813	410	182	21	0	0	613
1985	1	2288	51194	57049	32340	12974	16361	3238	805	89	9	0	0	904
1986	28	12879	44500	111527	37287	11285	3379	3912	485	71	0	1	0	557
1987	22	11074	72372	70504	73742	10808	4506	928	899	98	7	0	0	1004
1988	0	7462	61360	94163	29147	16556	2158	544	56	72	37	0	0	164
1989	52	8636	28406	77009	44307	9249	3888	420	208	35	6	1	0	249
1990	23	6949	54361	45423	50603	17747	1407	622	94	16	0	0	0	110
1991	410	11610	43110	91129	26170	21697	4687	405	255	17	1	0	0	273
1992	297	9603	45154	48838	60806	9956	6223	1496	101	8	1	0	0	110
1993	719	5980	29305	64353	33514	34651	2990	1361	697	58	16	0	0	771
1994	76	17126	31660	46217	36814	14169	14706	928	372	74	0	0	0	446
1995	277	8832	28132	58538	28014	13767	4954	4402	311	101	55	0	0	467
1996	1015	12516	26768	47594	36288	12022	4453	1116	910	168	32	0	2	1113
1997	608	6522	23543	48238	31904	15824	2957	1017	291	137	15	0	0	443
1998	1202	17081	19894	25016	24713	14717	5446	1213	220	64	16	0	0	301
1999	68	16689	26966	25863	23792	14708	6660	1882	517	61	12	0	0	591
2000	0	15406	31989	28500	14327	11841	6657	3774	864	244	48	3	0	1159
2001	150	12257	28499	27332	17518	8640	4506	2092	878	246	124	2	0	1250
2002	0	2606	10343	30858	22328	6703	1710	1328	510	98	10	9	10	638
2003	20	403	11610	13991	18981	9514	1862	444	329	50	16	0	0	396
2004	0	3972	2813	9633	13312	11860	4411	747	174	84	12	1	4	274
2005	12	2242	4658	4345	9502	8942	5003	1900	204	18	30	0	0	252
2006	12	11104	11078	8544	5394	12329	10217	4144	1087	106	6	0	0	1199

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.

year	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1980	3144	103203	250735	88399	14135	10795	786	0	0	0	0	0	0	0
1981	867	50407	96509	57403	7313	1285	149	10	0	0	0	0	0	0
1982	18639	53753	26922	52349	18230	2972	343	22	0	0	0	0	0	0
1983	71016	152488	85318	33325	23442	4309	295	25	9	0	0	0	0	9
1984	16724	200589	82563	16814	4437	4495	1034	151	0	0	0	0	0	0
1985	8497	154232	48790	15117	2985	761	801	65	0	0	0	0	0	0
1986	7966	404604	120492	43479	5242	626	108	63	12	0	0	0	0	12
1987	9978	158531	202154	34824	9776	582	49	0	30	0	0	0	0	30
1988	21321	65021	87197	51135	5877	846	16	0	3	0	0	0	0	3
1989	6898	150598	36712	61442	21267	3276	102	8	12	0	0	0	0	12
1990	145308	79488	245128	33194	23488	12012	253	87	0	0	0	0	0	0
1991	6566	76938	77383	74005	4900	1828	89	60	0	0	0	0	0	0
1992	6880	98967	57629	26527	22976	1199	350	1064	2	0	0	0	0	2
1993	47769	124426	101119	49064	8992	10709	519	131	0	0	0	0	0	0
1994	8207	77783	97847	36762	9528	2856	2337	6	0	0	0	0	0	0
1995	32846	46209	77320	48600	6943	1318	205	113	6	0	0	0	0	6
1996	2388	30480	82020	48240	11319	2192	240	179	0	0	0	0	0	0
1997	9800	19347	28836	30616	9175	2392	399	2	16	0	1	0	0	17
1998	2850	29979	18755	16361	10992	2976	934	213	86	2	18	0	0	106
1999	14697	84613	51740	14422	8844	3077	857	166	51	34	0	0	0	85
2000	1685	33848	75869	23590	2898	2257	1548	474	107	0	0	0	0	107
2001	16865	27570	44645	21930	2528	385	268	140	19	0	0	0	0	19
2002	1158	8670	31959	43444	9491	1098	211	128	110	3	3	0	0	116
2003	3696	54781	87376	36989	21853	4400	461	31	0	0	0	1	0	1
2004	2618	8603	9086	13669	12279	7267	2862	446	17	7	0	0	0	24
2005	1134	12622	22530	6342	7604	4944	3236	730	214	6	0	0	0	219
2006	1383	19666	27769	15549	3022	3297	2307	772	352	57	12	0	0	422

Table 12.2.7 Whiting in IV and VIId. Industrial by-catch numbers at age (thousands). Representing the industrial fishery in the North Sea.

year	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1980	329065	158500	102869	45108	8162	744	55	18	0	0	0	0	0	0
1981	515996	108252	180623	104766	16729	2793	112	0	0	0	0	0	0	0
1982	82418	127998	40818	68242	10514	2448	902	2	0	0	0	0	0	0
1983	597587	42591	30789	17774	6723	1656	63	25	0	0	0	0	0	0
1984	141095	108431	30709	8868	3790	3577	91	0	0	0	0	0	0	0
1985	178224	46801	41731	9871	2522	685	284	26	0	0	0	0	0	0
1986	217207	159249	2086	14572	3987	1456	0	0	0	0	0	0	0	0
1987	74863	97446	93704	17420	1722	2	0	0	0	0	0	0	0	0
1988	395603	357861	158872	34205	4611	500	0	0	0	0	0	0	0	0
1989	80375	172438	108558	53491	12890	1842	1060	89	71	2	0	0	0	72
1990	139424	167308	205520	50508	12233	2511	342	26	2	0	0	0	0	2
1991	1028113	39959	70701	22062	5761	2684	743	78	0	0	0	0	0	0
1992	245786	131221	62571	14198	9854	812	305	49	6	0	0	0	0	6
1993	574042	87133	37153	10870	4037	776	437	27	0	0	0	0	0	0
1994	208585	68701	17670	7632	1192	359	222	64	14	0	0	0	0	14
1995	1538296	82439	33558	4351	772	76	0	0	0	0	0	0	0	0
1996	89893	29648	5168	2643	968	21	2	0	0	0	0	0	0	0
1997	6485	27539	21820	4091	1075	276	2	0	0	0	0	0	0	0
1998	64567	24370	6047	1395	754	63	12	0	0	0	0	0	0	0
1999	63048	76776	12648	5342	1539	743	30	0	0	0	0	0	0	0
2000	67	17535	16508	11436	6663	2134	586	74	0	0	0	0	0	0
2001	213973	44294	13034	9646	513	152	40	0	0	0	0	0	0	0
2002	136326	38580	18937	8638	2186	205	122	0	0	0	0	0	0	0
2003	57395	17525	5054	2580	1214	390	49	0	0	0	0	0	0	0
2004	23808	12865	4514	1052	148	0	11	0	0	0	0	0	0	0
2005	11926	10932	719	490	29	34	56	10	8	0	0	0	0	8
2006	0	14	438	1865	1456	1449	1107	823	145	43	30	0	0	218

Table 12.2.8 Whiting in IV and VIId. Total catch mean weights at age (kg).

year	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
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	0.735
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	0.625
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	0.400
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	0.381
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	0.345
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	0.360
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
2006	0.032	0.140	0.187	0.230	0.285	0.288	0.349	0.335	0.308	0.288	0.322	0.000	0.000	0.306

Table 12.2.9 Whiting in IV and VIId. Human consumption landings mean weights at age (kg).

year	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
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	0.735
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	0.539
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	0.406
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	0.400
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	0.502
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	0.381
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	0.295
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
2006	0.133	0.217	0.254	0.285	0.295	0.298	0.377	0.353	0.334	0.306	0.290	0.000	0.000	0.331

Table 12.2.10 Whiting in IV and VIId. Discard mean weights at age (kg), representing North Sea discards only.

year	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1980	0.030	0.107	0.166	0.202	0.244	0.253	0.264	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1981	0.071	0.131	0.164	0.197	0.230	0.289	0.252	0.268	0.000	0.000	0.000	0.000	0.000	0.000
1982	0.047	0.091	0.182	0.211	0.225	0.241	0.244	0.261	0.000	0.000	0.000	0.000	0.000	0.000
1983	0.036	0.114	0.167	0.235	0.264	0.290	0.317	0.277	0.365	0.000	0.000	0.000	0.000	0.365
1984	0.038	0.101	0.162	0.216	0.246	0.265	0.248	0.278	0.000	0.000	0.000	0.000	0.000	0.000
1985	0.022	0.105	0.169	0.213	0.238	0.242	0.253	0.255	0.000	0.000	0.000	0.000	0.000	0.000
1986	0.028	0.123	0.166	0.190	0.208	0.227	0.194	0.217	0.311	0.000	0.000	0.000	0.000	0.311
1987	0.016	0.090	0.149	0.206	0.205	0.263	0.257	0.000	0.292	0.000	0.000	0.000	0.000	0.292
1988	0.030	0.063	0.146	0.181	0.210	0.219	0.235	0.000	0.284	0.000	0.000	0.000	0.000	0.284
1989	0.033	0.083	0.164	0.191	0.213	0.227	0.241	0.351	0.221	0.000	0.000	0.000	0.000	0.221
1990	0.024	0.095	0.130	0.183	0.186	0.196	0.249	0.302	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.041	0.089	0.154	0.177	0.213	0.230	0.253	0.268	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.037	0.093	0.173	0.210	0.215	0.241	0.245	0.220	1.183	0.000	0.000	0.000	0.000	1.183
1993	0.023	0.087	0.160	0.205	0.237	0.235	0.225	0.213	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.040	0.090	0.151	0.203	0.230	0.244	0.254	0.332	0.000	0.000	0.000	0.000	0.000	0.000
1995	0.032	0.102	0.163	0.204	0.233	0.247	0.247	0.332	0.290	0.000	0.000	0.000	0.000	0.290
1996	0.031	0.094	0.151	0.198	0.225	0.281	0.265	0.304	0.000	0.000	0.000	0.000	0.000	0.000
1997	0.031	0.125	0.181	0.213	0.225	0.233	0.256	0.617	0.320	0.601	0.773	0.000	0.000	0.352
1998	0.026	0.086	0.173	0.204	0.228	0.234	0.224	0.247	0.191	0.180	0.284	0.000	0.000	0.206
1999	0.062	0.100	0.166	0.197	0.201	0.225	0.231	0.212	0.231	0.220	0.000	0.000	0.000	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	0.000	0.000	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	0.000	0.000	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	0.000	0.000	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	0.000	0.000	0.051
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
2006	0.032	0.096	0.160	0.193	0.249	0.246	0.248	0.269	0.235	0.277	0.289	0.000	0.000	0.242

Table 12.2.11 Whiting in IV and VIId. Industrial by-catch mean weights at age (kg).

year	0	1	2	3	4	5	6	7	8	9	10	11	12	8+
1980	0.013	0.051	0.164	0.281	0.412	0.380	0.389	0.561	0.000	1.000	0.000	0.000	0.000	0.000
1981	0.011	0.056	0.141	0.218	0.318	0.433	0.596	0.600	0.800	0.000	0.000	0.000	0.000	0.000
1982	0.025	0.038	0.133	0.232	0.320	0.366	0.674	0.284	0.800	1.000	1.200	0.000	0.000	0.000
1983	0.012	0.058	0.148	0.311	0.431	0.651	0.565	0.602	0.800	1.000	0.000	0.000	0.000	0.800
1984	0.018	0.053	0.173	0.289	0.343	0.390	0.228	0.600	0.800	1.000	0.000	0.000	0.000	0.000
1985	0.014	0.054	0.150	0.263	0.382	0.454	0.504	0.584	0.800	1.000	0.000	0.000	0.000	0.000
1986	0.014	0.054	0.150	0.262	0.381	0.455	0.500	0.600	0.800	0.000	0.000	0.000	0.000	0.000
1987	0.012	0.043	0.085	0.173	0.262	0.400	0.500	0.600	0.800	1.000	0.000	0.000	0.000	0.000
1988	0.012	0.050	0.115	0.197	0.245	0.380	0.500	0.600	0.800	0.000	0.000	0.000	0.000	0.800
1989	0.022	0.053	0.137	0.224	0.285	0.344	0.482	0.396	0.385	0.401	0.000	0.000	0.000	0.385
1990	0.006	0.073	0.123	0.181	0.199	0.280	0.355	0.335	0.473	0.000	0.000	0.000	0.000	0.473
1991	0.017	0.101	0.136	0.213	0.269	0.265	0.279	0.322	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.012	0.066	0.150	0.228	0.242	0.335	0.219	0.255	0.282	0.000	0.000	0.000	0.000	0.282
1993	0.011	0.044	0.155	0.259	0.264	0.308	0.235	0.392	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.012	0.042	0.132	0.242	0.374	0.521	0.555	0.440	0.555	0.000	0.000	0.000	0.000	0.555
1995	0.009	0.069	0.159	0.310	0.373	0.511	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1996	0.015	0.059	0.143	0.235	0.233	0.347	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1997	0.007	0.048	0.144	0.250	0.321	0.348	0.588	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1998	0.014	0.045	0.105	0.200	0.304	0.286	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1999	0.013	0.027	0.077	0.146	0.196	0.286	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2000	0.000	0.041	0.164	0.242	0.289	0.339	0.000	0.588	0.000	0.000	0.000	0.000	0.000	0.000
2001	0.009	0.040	0.164	0.132	0.320	0.351	0.386	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2002	0.010	0.044	0.101	0.184	0.293	0.415	0.380	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2003	0.010	0.035	0.101	0.189	0.302	0.418	0.462	0.000	0.000	0.000	0.000	0.000	0.000	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
2006	0.000	0.267	0.233	0.292	0.322	0.303	0.305	0.306	0.295	0.260	0.343	0.000	0.000	0.295

Table 12.2.12 Whiting in IV and VIId. Complete available tuning series. Data used in assessment is highlighted in bold.

ENGGFS_IV_GRT units = individuals

year	effort	0	1	2	3	4	5	6	7	8	9	10+
1977	100	28.43	**21.95**	**7.44**	**1.11**	**0.22**	**0.09**	**0.08**	0.00	0.00	0.00	0.00
1978	100	18.44	**24.71**	**5.15**	**1.06**	**0.35**	**0.05**	**0.02**	0.01	0.00	0.00	0.00
1979	100	35.48	**20.06**	**7.12**	**1.90**	**0.84**	**0.06**	**0.03**	0.00	0.00	0.00	0.00
1980	100	19.90	**35.33**	**12.51**	**4.81**	**1.21**	**0.31**	**0.06**	0.04	0.00	0.00	0.00
1981	100	34.94	**18.31**	**28.80**	**16.05**	**0.62**	**0.62**	**0.08**	0.01	0.00	0.00	0.00
1982	100	6.93	**27.72**	**7.93**	**8.59**	**2.22**	**0.34**	**0.05**	0.01	0.00	0.00	0.00
1983	100	71.67	**11.85**	**10.90**	**1.91**	**1.70**	**0.24**	**0.07**	0.02	0.01	0.01	0.00
1984	100	17.25	**50.61**	**10.82**	**3.01**	**0.89**	**0.77**	**0.38**	0.03	0.00	0.00	0.00
1985	100	19.99	**15.88**	**17.04**	**1.67**	**0.98**	**0.18**	**0.15**	0.03	0.01	0.00	0.00
1986	100	16.33	**15.16**	**6.59**	**3.85**	**0.41**	**0.10**	**0.01**	0.02	0.02	0.00	0.00
1987	100	13.73	**22.76**	**13.04**	**2.70**	**2.01**	**0.35**	**0.12**	0.00	0.00	0.00	0.00
1988	100	38.17	**18.81**	**13.16**	**4.55**	**0.65**	**0.17**	**0.02**	0.01	0.00	0.00	0.00
1989	100	116.95	**29.47**	**11.76**	**7.69**	**1.67**	**0.35**	**0.02**	0.01	0.00	0.00	0.00
1990	100	87.53	**19.01**	**12.84**	**3.85**	**2.32**	**0.33**	**0.05**	0.00	0.00	0.00	0.00
1991	100	16.73	**33.30**	**7.67**	**3.82**	**1.09**	**0.37**	**0.04**	0.02	0.00	0.00	0.00

ENGGFS_IV_GOV units = individuals

year	effort	0	1	2	3	4	5	6	7	8	9	10+
1992	100	83.55	**48.72**	**23.98**	**5.59**	**4.80**	**0.90**	**1.08**	0.00	0.00	0.00	0.00
1993	100	43.22	**46.17**	**17.75**	**6.91**	**2.14**	**1.37**	**0.35**	0.11	0.00	0.00	0.00
1994	100	38.75	**54.23**	**18.79**	**4.24**	**1.94**	**0.58**	**0.20**	0.04	0.00	0.00	0.00
1995	100	66.59	**65.11**	**43.16**	**13.12**	**2.77**	**0.56**	**0.19**	0.04	0.01	0.01	0.00
1996	100	18.26	**34.72**	**20.15**	**11.13**	**2.51**	**0.49**	**0.22**	0.13	0.07	0.00	0.00
1997	100	90.26	**28.39**	**16.06**	**13.88**	**4.18**	**1.57**	**0.88**	0.04	0.05	0.00	0.00
1998	100	292.56	**32.65**	**20.97**	**5.41**	**4.33**	**1.66**	**0.30**	0.12	0.05	0.00	0.00
1999	100	194.67	**82.02**	**18.42**	**6.92**	**2.63**	**1.44**	**0.29**	0.34	0.00	0.01	0.00
2000	100	129.29	**110.71**	**34.21**	**6.54**	**1.75**	**0.95**	**0.37**	0.31	0.03	0.00	0.00
2001	100	183.90	**100.93**	**27.28**	**9.49**	**2.35**	**0.61**	**0.70**	0.18	0.06	0.11	0.00
2002	100	9.77	**114.83**	**33.06**	**14.74**	**4.50**	**0.50**	**0.10**	0.03	0.08	0.00	0.00
2003	100	27.64	**13.33**	**25.91**	**18.34**	**9.31**	**3.97**	**0.75**	0.18	0.20	0.01	0.16
2004	100	117.52	**10.21**	**7.31**	**11.32**	**5.53**	**2.87**	**1.16**	0.46	0.16	0.02	0.00
2005	100	13.16	**23.13**	**7.05**	**4.69**	**9.19**	**10.24**	**3.97**	2.07	0.21	0.00	0.00
2006	100	20.35	**11.90**	**7.60**	**2.42**	**1.34**	**3.46**	**2.08**	0.99	0.25	0.00	0.00

SCOGFS_IV_old units = individuals

year	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	+

Table 12.2.12 (cont'd) Whiting in IV and VIId. Complete available tuning series.

SCOGFS_IV_new units = individuals

year	effort	0	1	2	3	4	5	6	7	8
1998	100	12302	4141	5426	649	321	131	62	0	0
1999	100	15276	5410	2090	615	329	129	58	0	0
2000	100	17076	6646	3329	676	202	130	81	0	0
2001	100	117	3499	2451	844	207	51	48	0	0
2002	100	1606	4980	2422	1608	724	94	44	0	0
2003	100	5393	1891	1433	1211	823	276	36	9	6
2004	100	2553	2580	440	583	566	408	96	19	6
2005	100	1765	1355	1015	304	411	289	248	46	5
2006	100	397	1580	699	333	121	280	197	135	54

IBTS_Q1v2 units = individuals

year	effort	1	2	3	4	5	6
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	184.61	89.73	173.00	100.03	48.97	22.17
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
2007	100	42.47	167.02	71.49	18.89	9.05	25.40

Table 12.2.12 (cont'd) **Whiting in IV and VIId. Complete available tuning series.**

FRAGFS_7d units = individuals

year	effort	0	1	2	3
1988	27	24.77	-9	-9	-9
1989	27	25.56	-9	-9	-9
1990	27	17.92	-9	-9	-9
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	16.35	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	64.26	27.45	2.58
2001	27	19.37	15.10	14.57	1.41
2002	-9	-9	-9	-9	-9
2003	27	19.56	6.84	30.65	4.12
2004	-9	-9	-9	-9	-9
2005	-9	-9	-9	-9	-9
2006	-9	-9	-9	-9	-9

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	0-8
		SCOGFS Scotia III	Q3	1998-2006	0-8
	Seiners[6]	SCOSEI IV	-	1978–2006	1–9
	Light trawlers[6]	SCOLTR IV	-	1978–2006	1–9
England	Groundfish survey	ENGGFS GRT	Q3	1977–1991	0-10
		ENGGFS GOV	Q3	1992-2006	0-10
France	Groundfish survey	FRAGFS 7d	Q3	1988–2003[1]	0–3
	Trawlers[6]	FRATRO IV	-	1986–2006[1]	0-8
		FRATRB IV	-	1978–2001	1-9
		FRATRO 7d	-	1986-2006	1-7
International	Groundfish survey[2]	IBTS_QI	Q1	1983–2007	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.
[6] Commercial tuning indices are tabled in the stock annex.

Table 12.3.1 Whiting in IV and VIId. XSA tunning diagnostics.

```
FLR XSA Diagnostics 2007-05-06 11:04:11

CPUE data from wk.index.xsa

Catch data for 27 years. 1980 to 2006. Ages 1 to 8.

       fleet first age last age first year last year alpha beta
1 EngGFS_GOV         1        6       1992      2006   0.5 0.75
2 ScoGFS_GOV         1        6       1998      2006   0.5 0.75
3    IBTS_Q1         1        5       1990      2006     0 0.25


 Time series weights :

   Tapered time weighting applied
   Power =   3 over  17 years

Catchability analysis :

    Catchability independent of size for all ages

    Catchability independent of age for ages >   4

Terminal population estimation :

    Survivor estimates shrunk towards the mean F
    of the final   3 years or the  4 oldest ages.

    S.E. of the mean to which the estimates are shrunk =   2

    Minimum standard error for population
    estimates derived from each fleet =  0.3

   prior weighting not applied

Regression weights
     year
age    1997  1998  1999  2000  2001  2002  2003  2004  2005 2006
  all 0.618 0.719 0.805 0.874 0.926 0.961 0.984 0.995 0.999    1


 Fishing mortalities
   year
age  1997  1998  1999  2000  2001  2002  2003  2004  2005  2006
  1 0.119 0.119 0.196 0.065 0.107 0.074 0.350 0.113 0.154 0.134
  2 0.299 0.241 0.392 0.363 0.191 0.181 0.388 0.211 0.382 0.480
  3 0.530 0.356 0.535 0.690 0.369 0.360 0.300 0.181 0.309 0.769
  4 0.636 0.554 0.640 0.719 0.588 0.441 0.363 0.265 0.232 0.507
  5 0.801 0.680 0.683 0.823 0.760 0.529 0.367 0.304 0.266 0.385
  6 0.505 0.788 0.759 0.908 0.666 0.393 0.308 0.343 0.245 0.438
  7 0.869 0.430 0.656 1.682 0.636 0.444 0.151 0.258 0.242 0.247
  8 0.869 0.430 0.656 1.682 0.636 0.444 0.151 0.258 0.242 0.247
```

Table 12.3.1 (cont.)

XSA population number (thousands)

year \ age	1	2	3	4	5	6	7	8
1997	762531	359744	240193	104015	38015	9598	1941	862
1998	1026589	261688	170133	99633	40774	13287	4511	1276
1999	1610712	352603	131169	83986	42430	16086	4707	1533
2000	1710831	512184	151881	54131	32804	16693	5867	1670
2001	1331156	620113	227275	53701	19541	11223	5243	2944
2002	1128105	462499	326587	110707	22088	7120	4492	2304
2003	396003	405279	246002	160518	52745	10136	3742	3113
2004	383532	107934	175340	128393	82723	28454	5801	1445
2005	389479	132507	55716	103116	72963	47546	15731	3343
2006	393961	129139	57656	28837	60547	43535	28997	9236

Estimated population abundance at 1st Jan 2007

year \ age	1	2	3	4	5	6	7	8
2007	0	133218	50973	18840	12866	32086	21877	18549

Fleet: EngGFS_GOV

Log catchability residuals.

age \ year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	-0.460	-0.624	-0.380	-0.068	-0.317	-0.200	-0.358	0.160	0.319	0.503	0.777	-0.158	-0.540	0.288	-0.400
2	-0.381	-0.485	-0.634	0.271	-0.382	-0.256	0.293	-0.040	0.187	-0.337	0.142	0.159	0.107	-0.028	0.133
3	-0.684	-0.501	-0.815	0.032	-0.082	0.203	-0.502	0.115	0.008	-0.222	-0.149	0.315	0.097	0.442	0.031
4	-0.621	-0.436	-0.444	-0.062	-0.453	0.027	0.054	-0.221	-0.140	0.082	-0.083	0.224	-0.135	0.572	0.092
5	0.178	-0.814	-0.523	-0.450	-0.728	0.125	0.036	-0.145	-0.217	-0.181	-0.645	0.456	-0.358	1.016	0.192
6	1.120	0.488	-1.448	-0.299	-0.047	0.739	-0.487	-0.730	-0.431	0.453	-1.207	0.402	-0.173	0.483	0.046

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	1	2	3	4	5	6
Mean_Logq	-13.938	-13.8999	-14.0190	-14.1708	-14.1708	-14.1708
S.E_Logq	0.416	0.3017	0.3664	0.3062	0.4897	0.7167

Table 12.3.1 (Cont.)

Fleet: ScoGFS_GOV

Log catchability residuals.

age \ year	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	-0.021	-0.157	-0.092	-0.457	0.041	0.291	0.487	-0.147	-0.017
2	1.233	0.075	0.149	-0.455	-0.180	-0.444	-0.412	0.325	0.039
3	-0.215	0.103	0.147	-0.233	0.043	0.006	-0.461	0.114	0.456
4	-0.235	0.014	0.015	-0.034	0.403	0.111	-0.101	-0.222	0.000
5	-0.190	-0.244	0.108	-0.349	-0.003	0.103	0.005	-0.238	-0.009
6	0.250	-0.026	0.363	0.087	0.286	-0.321	-0.351	0.024	0.002

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	1	2	3	4	5	6
Mean_Logq	-9.4320	-9.2839	-9.5196	-9.5765	-9.5765	-9.5765
S.E_Logq	0.2707	0.5303	0.2664	0.1907	0.1666	0.2500

Fleet: IBTS_Q1

Log catchability residuals.

age \ year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	-0.571	0.150	0.085	0.166	-0.132	-0.061	0.035	-0.205	0.133	-0.089	-0.052	0.049	0.244	-0.304	0.038	-0.069	0.203
2	-0.287	0.356	0.275	0.189	0.229	-0.036	0.167	0.181	-0.264	0.099	0.288	0.182	0.113	-0.063	0.036	-0.621	-0.082
3	-0.028	0.053	0.185	0.085	0.003	0.023	0.115	-0.203	-0.138	-0.137	0.389	0.443	-0.004	0.123	0.132	-0.410	-0.355
4	-0.202	0.319	-0.100	-0.037	0.051	0.010	-0.104	-0.225	-0.304	-0.061	0.308	0.917	-0.213	0.100	0.024	-0.334	-0.253
5	-0.766	0.195	-0.222	-0.072	-0.596	-0.475	0.127	-0.415	-0.650	-0.179	-0.160	0.602	0.300	0.193	-0.253	-0.389	-0.481

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	1	2	3	4	5
Mean_Logq	-12.1521	-11.6519	-11.5929	-11.7163	-11.7163
S.E_Logq	0.2047	0.2508	0.2247	0.3043	0.3748

Table 12.3.1 (Cont.)

Terminal year survivor and F summaries:

Age 1 Year class = 2005

source

	survivors	N	scaledWts
EngGFS_GOV	89294	1	0.175
ScoGFS_GOV	130922	1	0.407
IBTS_Q1	163133	1	0.407
fshk	79544	1	0.010

Age 2 Year class = 2004

source

	survivors	N	scaledWts
EngGFS_GOV	60704	2	0.308
ScoGFS_GOV	46279	2	0.266
IBTS_Q1	47239	2	0.418
fshk	79427	1	0.008

Age 3 Year class = 2003

source

	survivors	N	scaledWts
EngGFS_GOV	17530	3	0.306
ScoGFS_GOV	29560	3	0.304
IBTS_Q1	13545	3	0.382
fshk	71444	1	0.008

Age 4 Year class = 2002

source

	survivors	N	scaledWts
EngGFS_GOV	15276	4	0.338
ScoGFS_GOV	13575	4	0.326
IBTS_Q1	10136	4	0.331
fshk	25302	1	0.005

Age 5 Year class = 2001

source

	survivors	N	scaledWts
EngGFS_GOV	44883	5	0.295
ScoGFS_GOV	26835	5	0.382
IBTS_Q1	29061	5	0.319
fshk	40714	1	0.004

Age 6 Year class = 2000

source

	survivors	N	scaledWts
EngGFS_GOV	27190	6	0.271
ScoGFS_GOV	19333	6	0.460
IBTS_Q1	21517	5	0.263

Table 12.3.1 (Cont.)

```
fshk           34290 1     0.005

 Age 7 Year class = 1999

source
           survivors N scaledWts
EngGFS_GOV     18789 6     0.265
ScoGFS_GOV     18777 6     0.477
IBTS_Q1        18277 5     0.252
fshk            7448 1     0.006
```

Table 12.3.2 Whiting in IV and VIId. Final XSA fishing mortality.

year	1	2	3	4	5	6	7	8+	Fbar(2-6)
1980	0.101	0.440	0.822	0.975	1.230	0.944	1.004	1.004	0.882
1981	0.165	0.329	0.752	0.998	1.095	1.278	1.043	1.043	0.890
1982	0.173	0.293	0.531	0.719	0.893	1.010	0.796	0.796	0.689
1983	0.210	0.455	0.747	0.734	0.880	0.918	0.828	0.828	0.747
1984	0.223	0.516	0.871	1.028	1.048	1.122	1.029	1.029	0.917
1985	0.190	0.249	0.635	0.874	1.165	1.182	0.975	0.975	0.821
1986	0.270	0.425	0.705	1.192	1.047	1.156	1.037	1.037	0.905
1987	0.140	0.507	0.869	1.243	1.345	1.654	1.294	1.294	1.124
1988	0.358	0.430	0.655	0.965	1.147	1.191	1.001	1.001	0.878
1989	0.129	0.431	0.695	0.821	1.494	1.504	1.142	1.142	0.989
1990	0.227	0.551	0.910	0.980	1.169	0.964	1.017	1.017	0.915
1991	0.117	0.489	0.522	0.882	1.093	0.668	0.799	0.799	0.731
1992	0.237	0.388	0.580	0.644	0.930	1.104	0.826	0.826	0.729
1993	0.194	0.473	0.758	0.834	0.882	1.050	0.816	0.816	0.799
1994	0.159	0.345	0.669	0.918	1.022	1.139	0.888	0.888	0.819
1995	0.152	0.350	0.625	0.733	0.998	1.132	1.189	1.189	0.768
1996	0.118	0.321	0.585	0.742	0.837	1.142	1.081	1.081	0.725
1997	0.119	0.299	0.530	0.636	0.801	0.505	0.869	0.869	0.554
1998	0.119	0.241	0.356	0.554	0.680	0.788	0.430	0.430	0.524
1999	0.196	0.392	0.535	0.640	0.683	0.759	0.656	0.656	0.602
2000	0.065	0.363	0.690	0.719	0.823	0.908	1.682	1.682	0.701
2001	0.107	0.191	0.369	0.588	0.760	0.666	0.636	0.636	0.515
2002	0.074	0.181	0.360	0.441	0.529	0.393	0.444	0.444	0.381
2003	0.350	0.388	0.300	0.363	0.367	0.308	0.151	0.151	0.345
2004	0.113	0.211	0.181	0.265	0.304	0.343	0.258	0.258	0.261
2005	0.154	0.382	0.309	0.232	0.266	0.245	0.242	0.242	0.287
2006	0.134	0.480	0.769	0.507	0.385	0.438	0.247	0.247	0.516

Table 12.3.3 Whiting in IV and VIId. Final XSA stock numbers.

year	1	2	3	4	5	6	7	8+	total
1980	4423048	1463366	607921	169230	84825	19941	2010	1314	6771655
1981	1719960	1545551	600894	188246	47287	19317	6042	603	4127900
1982	1945656	563875	708926	199713	51410	12315	4192	1744	3487831
1983	1743369	632665	268157	293698	72091	16391	3494	1548	3031413
1984	2598980	546344	255883	89566	104387	23288	5098	1249	3624795
1985	1888968	804010	207854	75481	23743	28509	5906	1492	3035963
1986	3923612	604099	399497	77606	23342	5766	6807	1824	5042553
1987	3276278	1158761	251777	139168	17455	6383	1413	1976	4853211
1988	2298348	1100996	444822	74383	29731	3541	951	317	3953089
1989	4392040	621241	456539	162776	20990	7357	838	286	5662067
1990	2010020	1492320	257438	160591	53053	3668	1273	219	3978582
1991	1871651	619557	548287	73018	44669	12840	1089	377	3171488
1992	1825852	643928	242376	229229	22393	11659	5129	401	2980967
1993	1985027	557009	278549	95615	89224	6879	3010	1839	3017152
1994	1787498	632407	221352	91956	30774	28773	1875	1090	2795725
1995	1564109	589553	285717	79920	27211	8625	7173	632	2562940
1996	1047007	519408	264914	107751	28455	7812	2165	1788	1979300
1997	762531	359744	240193	104015	38015	9598	1941	601	1516638
1998	1026589	261688	170133	99633	40774	13287	4511	666	1617281
1999	1610712	352603	131169	83986	42430	16086	4707	2404	2244097
2000	1710831	512184	151881	54131	32804	16693	5867	2000	2486391
2001	1331156	620113	227275	53701	19541	11223	5243	893	2269145
2002	1128105	462499	326587	110707	22088	7120	4492	2273	2063871
2003	396003	405279	246002	160518	52745	10136	3742	2360	1276785
2004	383532	107934	175340	128393	82723	28454	5801	2635	914812
2005	389479	132507	55716	103116	72963	47546	15731	3670	820728
2006	393961	129139	57656	28837	60547	43535	28997	10115	752787
2007	0	133218	50973	18840	12866	32086	21877	18549	288409

Stock numbers are survivors from the previous year.

Table 12.3.4 Whiting in IV and VIId. Final XSA summary table.

	recruitment (age 1)	tsb	ssb	catch	landings	discards	industrial bycatch	Y/ssb	fbar(2-6)
1980	4423048	837376	521533	223517	100810	76950	45757	0.19	0.88
1981	1719960	637189	489364	192049	89524	35915	66609	0.18	0.89
1982	1945656	492541	378611	140195	80549	26604	33042	0.21	0.69
1983	1743369	513248	337560	161212	87972	49560	23680	0.26	0.75
1984	2598980	485479	271397	145741	86281	40563	18897	0.32	0.92
1985	1888968	441577	271196	106363	62127	28912	15325	0.23	0.82
1986	3923612	664426	288920	161744	64114	79664	17966	0.22	0.90
1987	3276278	537922	299679	138775	68300	53996	16479	0.23	1.12
1988	2298348	418906	295588	133470	56103	28147	49219	0.19	0.88
1989	4392040	561282	279855	123753	45189	35852	42711	0.16	0.99
1990	2010020	482268	317432	153453	46896	55839	50718	0.15	0.91
1991	1871651	456854	276904	124975	53025	33639	38311	0.19	0.73
1992	1825852	407827	265046	109704	52188	30615	26901	0.20	0.73
1993	1985027	376620	239855	116165	53196	42871	20099	0.22	0.80
1994	1787498	359541	223671	92606	49242	33010	10354	0.22	0.82
1995	1564109	361362	231716	103268	46442	30264	26561	0.20	0.77
1996	1047007	295069	201469	73957	41074	28181	4702	0.20	0.73
1997	762531	239892	173011	59102	35920	17217	5965	0.21	0.55
1998	1026589	227936	141024	44312	28464	12708	3141	0.20	0.52
1999	1610712	254860	141003	59179	30412	23584	5183	0.22	0.60
2000	1710831	354399	174883	60907	28807	23214	8886	0.16	0.70
2001	1331156	292086	197310	49062	25216	16488	7357	0.13	0.51
2002	1128105	263242	190201	46552	21716	17509	7327	0.11	0.38
2003	396003	178750	156374	43208	16372	24093	2743	0.10	0.35
2004	383532	174329	135482	29057	13583	14256	1218	0.10	0.26
2005	389479	138290	105121	26795	15304	10609	882	0.15	0.29
2006	393961	151204	96967	32644	18589	11860	2194	0.19	0.52
min	383532	138290	96967	26795	13583	10609	882	0.10	0.26
mean	1830901	392758	248192	101917	48793	32671	20453	0.19	0.70
max	4423048	837376	521533	223517	100810	79664	66609	0.32	1.12
units	thousands	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes		

Table 12.5.1 Whiting in IV and VIId. RCT3 input table

This table has been updated and can be found under Table 12.13.1

Table 12.5.2 Whiting in IV and VIId. RCT3 output table.

This table has been updated and can be found under Table 12 13.2

4

Table 12.6.1 Whiting in IV and VIId. Short term forecast input

MFDP version 1a
Run: whi.me
Time and date: 11:46 07/05/2007
Fbar age range (Total) : 2-6
Fbar age range Fleet 1 : 2-6
Fbar age range Fleet 2 : 2-6

2007

Age	N	M	Mat	PF	PM	SWt
1	149829	0.95	0.11	0	0	0.113
2	133218	0.45	0.92	0	0	0.188
3	50973	0.35	1	0	0	0.234
4	18840	0.3	1	0	0	0.265
5	12866	0.25	1	0	0	0.291
6	32086	0.25	1	0	0	0.315
7	21877	0.2	1	0	0	0.313
8	18549	0.2	1	0	0	0.32

Catch

Age	Sel	CWt	DSel	DCWt
1	0.019	0.212	0.218	0.128
2	0.0827	0.241	0.4339	0.189
3	0.156	0.27	0.2797	0.214
4	0.2482	0.286	0.2415	0.233
5	0.3486	0.314	0.1865	0.242
6	0.3451	0.35	0.1677	0.241
7	0.2755	0.337	0.1001	0.254
8	0.2976	0.349	0.0761	0.237

IndBycatch

Age	Sel	CWt
1	0.1195	0.114
2	0.0501	0.15
3	0.0207	0.21
4	0.0072	0.264
5	0.0062	0.335
6	0.0049	0.374
7	0.0005	0.424
8	0.0023	0.413

2008

Age	N	M	Mat	PF	PM	SWt
1	390714	0.95	0.11	0	0	0.113
2	.	0.45	0.92	0	0	0.188
3	.	0.35	1	0	0	0.234
4	.	0.3	1	0	0	0.265
5	.	0.25	1	0	0	0.291
6	.	0.25	1	0	0	0.315
7	.	0.2	1	0	0	0.313
8	.	0.2	1	0	0	0.32

Catch

Age	Sel	CWt	DSel	DCWt
1	0.019	0.212	0.218	0.128
2	0.0827	0.241	0.4339	0.189
3	0.156	0.27	0.2797	0.214
4	0.2482	0.286	0.2415	0.233
5	0.3486	0.314	0.1865	0.242
6	0.3451	0.35	0.1677	0.241
7	0.2755	0.337	0.1001	0.254
8	0.2976	0.349	0.0761	0.237

IndBycatch

Age	Sel	CWt
1	0.1195	0.114
2	0.0501	0.15
3	0.0207	0.21
4	0.0072	0.264
5	0.0062	0.335
6	0.0049	0.374
7	0.0005	0.424
8	0.0023	0.413

2009

Age	N	M	Mat	PF	PM	SWt
1	390714	0.95	0.11	0	0	0.113
2	.	0.45	0.92	0	0	0.188
3	.	0.35	1	0	0	0.234
4	.	0.3	1	0	0	0.265
5	.	0.25	1	0	0	0.291
6	.	0.25	1	0	0	0.315
7	.	0.2	1	0	0	0.313
8	.	0.2	1	0	0	0.32

Catch

Age	Sel	CWt	DSel	DCWt
1	0.019	0.212	0.218	0.128
2	0.0827	0.241	0.4339	0.189
3	0.156	0.27	0.2797	0.214
4	0.2482	0.286	0.2415	0.233
5	0.3486	0.314	0.1865	0.242
6	0.3451	0.35	0.1677	0.241
7	0.2755	0.337	0.1001	0.254
8	0.2976	0.349	0.0761	0.237

IndBycatch

Age	Sel	CWt
1	0.1195	0.114
2	0.0501	0.15
3	0.0207	0.21
4	0.0072	0.264
5	0.0062	0.335
6	0.0049	0.374
7	0.0005	0.424
8	0.0023	0.413

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: 11:46 07/05/2007
Fbar age range (Total) : 2-6
Fbar age range Fleet 1 : 2-6
Fbar age range Fleet 2 : 2-6

2007

Biomass	SSB	Catch FMult	Landings FBar	Yield	Discards FBar	Yield	IndBycatch FMult	Landings FBar	Yield
85530	68458	1	0.2361	11086	0.2619	14000	1	0.0178	2021

2008 / **2009**

2008 Biomass	2008 SSB	Catch FMult	Landings FBar	Yield	Discards FBar	Yield	IndBycatch FMult	Landings FBar	Yield	2009 Biomass	2009 SSB
85327	45422	0	0	0	0	0	1	0.0178	3768	102127	60816
.	45422	0.1	0.0236	933	0.0262	1386	1	0.0178	3726	100098	58834
.	45422	0.2	0.0472	1831	0.0524	2728	1	0.0178	3684	98147	56929
.	45422	0.3	0.0708	2693	0.0786	4028	1	0.0178	3643	96270	55098
.	45422	0.4	0.0944	3522	0.1047	5287	1	0.0178	3602	94466	53337
.	45422	0.5	0.1181	4320	0.1309	6506	1	0.0178	3563	92730	51644
.	45422	0.6	0.1417	5086	0.1571	7688	1	0.0178	3524	91060	50016
.	45422	0.7	0.1653	5824	0.1833	8834	1	0.0178	3485	89453	48451
.	45422	0.8	0.1889	6533	0.2095	9944	1	0.0178	3448	87907	46944
.	45422	0.9	0.2125	7215	0.2357	11021	1	0.0178	3411	86419	45496
.	**45422**	**1**	**0.2361**	**7872**	**0.2619**	**12065**	**1**	**0.0178**	**3374**	**84987**	**44101**
.	45422	1.1	0.2597	8504	0.288	13078	1	0.0178	3339	83608	42760
.	45422	1.2	0.2833	9112	0.3142	14061	1	0.0178	3304	82281	41469
.	45422	1.3	0.307	9697	0.3404	15015	1	0.0178	3269	81003	40227
.	45422	1.4	0.3306	10260	0.3666	15941	1	0.0178	3235	79772	39030
.	45422	1.5	0.3542	10802	0.3928	16841	1	0.0178	3202	78586	37879
.	45422	1.6	0.3778	11325	0.419	17714	1	0.0178	3169	77445	36770
.	45422	1.7	0.4014	11827	0.4452	18562	1	0.0178	3137	76345	35703
.	45422	1.8	0.425	12312	0.4713	19386	1	0.0178	3105	75285	34674
.	45422	1.9	0.4486	12779	0.4975	20186	1	0.0178	3074	74263	33684
.	45422	2	0.4722	13228	0.5237	20964	1	0.0178	3044	73279	32730

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: 11:46 07/05/2007
Fbar age range (Total) : 2-6
Fbar age range Fleet 1 : 2-6
Fbar age range Fleet 2 : 2-6

Year: 2007 F multiplier: 1 Fleet1 HCFbar: 0.2361 Fleet1 DFt 0.2619

Age	Catch F	CatchNos	Yield	DF	DCatchNos	DYield	IndBycatch F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.019	1589	337	0.218	18231	2334	0.1195	9994	1139	149829	16931	16481	1862	16481	1862
2	0.0827	6916	1667	0.4339	36285	6858	0.0501	4190	628	133218	25045	122561	23041	122561	23041
3	0.156	5458	1474	0.2797	9787	2094	0.0207	724	152	50973	11928	50973	11928	50973	11928
4	0.2482	3223	922	0.2415	3136	731	0.0072	93	25	18840	4993	18840	4993	18840	4993
5	0.3486	3099	973	0.1865	1658	401	0.0062	55	18	12866	3744	12866	3744	12866	3744
6	0.3451	7730	2705	0.1677	3756	905	0.0049	110	41	32086	10107	32086	10107	32086	10107
7	0.2755	4581	1544	0.1001	1665	423	0.0005	8	4	21877	6848	21877	6848	21877	6848
8	0.2976	4196	1464	0.0761	1073	254	0.0023	32	13	18549	5936	18549	5936	18549	5936
Total		36793	11086		75590	14000		15207	2021	438238	85530	294233	68458	294233	68458

Year: 2008 F multiplier: 1 Fleet1 HCFbar: 0.2361 Fleet1 DFt 0.2619

Age	Catch F	CatchNos	Yield	DF	DCatchNos	DYield	IndBycatch F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.019	4144	878	0.218	47542	6085	0.1195	26061	2971	390714	44151	42979	4857	42979	4857
2	0.0827	2106	508	0.4339	11050	2088	0.0501	1276	191	40569	7627	37323	7017	37323	7017
3	0.156	5161	1393	0.2797	9253	1980	0.0207	685	144	48197	11278	48197	11278	48197	11278
4	0.2482	3893	1113	0.2415	3788	883	0.0072	113	30	22758	6031	22758	6031	22758	6031
5	0.3486	2045	642	0.1865	1094	265	0.0062	36	12	8492	2471	8492	2471	8492	2471
6	0.3451	1405	492	0.1677	683	165	0.0049	20	7	5832	1837	5832	1837	5832	1837
7	0.2755	3118	1051	0.1001	1133	288	0.0005	6	2	14890	4661	14890	4661	14890	4661
8	0.2976	5141	1794	0.0761	1315	312	0.0023	40	16	22724	7272	22724	7272	22724	7272
Total		27013	7872		75857	12065		28236	3374	554174	85327	203193	45422	203193	45422

Year: 2009 F multiplier: 1 Fleet1 HCFbar: 0.2361 Fleet1 DFt 0.2619

Age	Catch F	CatchNos	Yield	DF	DCatchNos	DYield	IndBycatch F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.019	4144	878	0.218	47542	6085	0.1195	26061	2971	390714	44151	42979	4857	42979	4857
2	0.0827	5492	1324	0.4339	28815	5446	0.0501	3327	499	105792	19889	97329	18298	97329	18298
3	0.156	1572	424	0.2797	2818	603	0.0207	209	44	14677	3434	14677	3434	14677	3434
4	0.2482	3681	1053	0.2415	3582	835	0.0072	107	28	21518	5702	21518	5702	21518	5702
5	0.3486	2471	776	0.1865	1322	320	0.0062	44	15	10257	2985	10257	2985	10257	2985
6	0.3451	927	325	0.1677	451	109	0.0049	13	5	3849	1212	3849	1212	3849	1212
7	0.2755	567	191	0.1001	206	52	0.0005	1	0	2706	847	2706	847	2706	847
8	0.2976	4783	1669	0.0761	1223	290	0.0023	37	15	21144	6766	21144	6766	21144	6766
Total		23636	6640		85958	13740		29798	3577	570658	84987	214459	44101	214459	44101

Input units are thousands and kg - output in tonnes

Table 12.6.3 Whiting in IV and VIId Yield per recruit analysis input.

MFYPR version 2a
Run: whi.me.ypr
whiMFDP Index file 06/05/2007
Time and date: 13:28 07/05/2007
Fbar age range (Total) : 2-6
Fbar age range Fleet 1 : 2-6
Fbar age range Fleet 2 : 2-6

Age	M	Mat	PF	PM	SWt
1	0.95	0.11	0	0	0.113
2	0.45	0.92	0	0	0.188
3	0.35	1	0	0	0.234
4	0.3	1	0	0	0.265
5	0.25	1	0	0	0.291
6	0.25	1	0	0	0.315
7	0.2	1	0	0	0.313
8	0.2	1	0	0	0.32

Catch

Age	Sel	CWt	DSel	DCWt
1	0.019	0.212	0.218	0.128
2	0.0827	0.241	0.4339	0.189
3	0.156	0.27	0.2797	0.214
4	0.2482	0.286	0.2415	0.233
5	0.3486	0.314	0.1865	0.242
6	0.3451	0.35	0.1677	0.241
7	0.2755	0.337	0.1001	0.254
8	0.2976	0.349	0.0761	0.237

IndBycatch

Age	Sel	CWt
1	0.1195	0.114
2	0.0501	0.15
3	0.0207	0.21
4	0.0072	0.264
5	0.0062	0.335
6	0.0049	0.374
7	0.0005	0.424
8	0.0023	0.413

Weights in kilograms

Table 12.6.4 Whiting in IV and VIId. Yield per recruit analysis output.

MFYPR version 2a
Run: whi.me.ypr
Time and date: 13:28 07/05/2007
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	0.0178	0.0930	0.0120	0.0120	2.2290	0.4313	1.3115	0.3255	1.3115	0.3255
0.1000	0.0236	0.0189	0.0058	0.0262	0.0345	0.0061	1.0000	0.0178	0.0908	0.0115	0.0234	2.0373	0.3738	1.1205	0.2682	1.1205	0.2682
0.2000	0.0472	0.0307	0.0091	0.0524	0.0650	0.0113	1.0000	0.0178	0.0888	0.0112	0.0316	1.8996	0.3333	0.9834	0.2278	0.9834	0.2278
0.3000	0.0708	0.0382	0.0112	0.0786	0.0921	0.0159	1.0000	0.0178	0.0870	0.0108	0.0379	1.7959	0.3034	0.8803	0.1981	0.8803	0.1981
0.4000	0.0944	0.0431	0.0124	0.1047	0.1165	0.0198	1.0000	0.0178	0.0853	0.0106	0.0428	1.7149	0.2805	0.8000	0.1753	0.8000	0.1753
0.5000	0.1181	0.0463	0.0131	0.1309	0.1387	0.0234	1.0000	0.0178	0.0837	0.0103	0.0468	1.6499	0.2625	0.7355	0.1574	0.7355	0.1574
0.6000	0.1417	0.0484	0.0134	0.1571	0.1589	0.0265	1.0000	0.0178	0.0822	0.0101	0.0500	1.5963	0.2479	0.6825	0.1429	0.6825	0.1429
0.7000	0.1653	0.0498	0.0136	0.1833	0.1775	0.0293	1.0000	0.0178	0.0808	0.0098	0.0527	1.5513	0.2360	0.6381	0.1310	0.6381	0.1310
0.8000	0.1889	0.0507	0.0137	0.2095	0.1947	0.0318	1.0000	0.0178	0.0795	0.0096	0.0551	1.5129	0.2259	0.6002	0.1211	0.6002	0.1211
0.9000	0.2125	0.0513	0.0136	0.2357	0.2107	0.0341	1.0000	0.0178	0.0782	0.0095	0.0572	1.4797	0.2173	0.5675	0.1126	0.5675	0.1126
1.0000	0.2361	0.0516	0.0136	0.2619	0.2256	0.0362	1.0000	0.0178	0.0770	0.0093	0.0591	1.4506	0.2100	0.5389	0.1053	0.5389	0.1053
1.1000	0.2597	0.0518	0.0135	0.2880	0.2395	0.0381	1.0000	0.0178	0.0758	0.0091	0.0607	1.4248	0.2035	0.5137	0.0990	0.5137	0.0990
1.2000	0.2833	0.0519	0.0133	0.3142	0.2527	0.0399	1.0000	0.0178	0.0747	0.0089	0.0621	1.4018	0.1979	0.4912	0.0934	0.4912	0.0934
1.3000	0.3070	0.0519	0.0132	0.3404	0.2650	0.0416	1.0000	0.0178	0.0736	0.0088	0.0636	1.3811	0.1929	0.4709	0.0885	0.4709	0.0885
1.4000	0.3306	0.0518	0.0131	0.3666	0.2768	0.0431	1.0000	0.0178	0.0725	0.0086	0.0648	1.3624	0.1884	0.4527	0.0841	0.4527	0.0841
1.5000	0.3542	0.0518	0.0129	0.3928	0.2879	0.0446	1.0000	0.0178	0.0715	0.0085	0.0660	1.3453	0.1844	0.4361	0.0802	0.4361	0.0802
1.6000	0.3778	0.0517	0.0128	0.4190	0.2985	0.0459	1.0000	0.0178	0.0706	0.0084	0.0671	1.3297	0.1807	0.4209	0.0766	0.4209	0.0766
1.7000	0.4014	0.0516	0.0127	0.4452	0.3086	0.0472	1.0000	0.0178	0.0696	0.0082	0.0681	1.3153	0.1774	0.4069	0.0734	0.4069	0.0734
1.8000	0.4250	0.0515	0.0126	0.4713	0.3182	0.0484	1.0000	0.0178	0.0687	0.0081	0.0691	1.3020	0.1744	0.3940	0.0704	0.3940	0.0704
1.9000	0.4486	0.0514	0.0125	0.4975	0.3275	0.0495	1.0000	0.0178	0.0678	0.0080	0.0700	1.2896	0.1716	0.3821	0.0677	0.3821	0.0677
2.0000	0.4722	0.0513	0.0124	0.5237	0.3363	0.0506	1.0000	0.0178	0.0670	0.0079	0.0709	1.2781	0.1690	0.3711	0.0652	0.3711	0.0652

Reference point	F multiplier	Absolute F
Fleet1 Landings Fbar(2-6)	1.0000	0.2361
FMax	0.8078	0.1907
F0.1	0.4357	0.1029
F35%SPR		
0		

Weights in kilograms

Table 12.12.1 Nominal landings (t) of Whiting from Division IIIa as supplied by the Study Group on Division IIIa Demersal Stocks (ICES 1992b) and updated by the Working Group.

Year	Denmark (1)			Norway	Sweden	Others	Total
1975	19,018			57	611	4	19,690
1976	17,870			48	1,002	48	18,968
1977	18,116			46	975	41	19,178
1978	48,102			58	899	32	49,091
1979	16,971			63	1,033	16	18,083
1980	21,070			65	1,516	3	22,654
	Total consumption	**Total industrial**	**Total**				
1981	1,027	23,915	24,942	70	1,054	7	26,073
1982	1,183	39,758	40,941	40	670	13	41,664
1983	1,311	23,505	24,816	48	1,061	8	25,933
1984	1,036	12,102	13,138	51	1,168	60	14,417
1985	557	11,967	12,524	45	654	2	13,225
1986	484	11,979	12,463	64	477	1	13,005
1987	443	15,880	16,323	29	262	43	16,657
1988	391	10,872	11,263	42	435	24	11,764
1989	917	11,662	12,579	29	675	-	13,283
1990	1,016	17,829	18,845	49	456	73	19,423
1991	871	12,463	13,334	56	527	97	14,041
1992	555	3,340	3,895	66	959	1	4,921
1993	261	1,987	2,248	42	756	1	3,047
1994	174	1,900	2,074	21	440	1	2,536
1995	85	2,549	2,634	24	431	1	3,090
1996	55	1,235	1,290	21	182	-	1,493
1997	38	264	302	18	94	-	414
1998	35	354	389	16	81	-	486
1999	37	695	732	15	111	-	858
2000	59	777	836	17	138	1	992
2001	61	970[1]	1,031[1]	27	126	+	1,184[1]
2002	101	975[1]	1,076[1]	23	127	1	1,227[1]
2003	93	654[1]	747[1]	20	71	2	840[1]
2004	93	1,120[1]	1,213[1]	17	74	1	1,305[1]
2005	49	907[1]	956[1]	13	73	0	1,042[1]
2006	59[1]	290[1]	349[1]	n/a	n/a	n/a	349[1]

[1] Values from 1992 updated by WGNSSK (2007)

Table 12.13.1. Whiting in Sub-Area IV and Divisions VIId and IIIa update. Inputs to RCT3.

Whi4&7d (age 1)

8	27	2							
1981	1945656	-11	-11	-11	-11	-11	-11	-11	125.028
1982	1743369	-11	-11	-11	-11	-11	-11	126.62	177.966
1983	2598980	-11	-11	-11	-11	-11	-11	434.487	362.255
1984	1888968	-11	-11	-11	-11	-11	-11	339.177	268.265
1985	3923612	-11	-11	-11	-11	-11	-11	468.744	561.078
1986	3276278	-11	-11	-11	-11	-11	-11	684.898	865.722
1987	2298348	-11	-11	-11	-11	-11	-11	447.989	538.563
1988	4392040	-11	-11	-11	-11	-11	-11	1446.08	862.354
1989	2010020	-11	-11	-11	-11	-11	-11	518.936	686.445
1990	1871651	-11	-11	23.98	-11	-11	-11	1007.621	665.714
1991	1825852	-11	48.72	17.75	-11	-11	-11	907.297	522.811
1992	1985027	83.55	46.17	18.79	-11	-11	-11	1075.624	627.406
1993	1787498	43.22	54.23	43.16	-11	-11	-11	721.709	448.484
1994	1564109	38.75	65.11	20.15	-11	-11	-11	678.59	485.968
1995	1047007	66.59	34.72	16.06	-11	-11	-11	502.361	342.212
1996	762531.2	18.26	28.39	20.97	-11	-11	5426	287.733	160.695
1997	1026589	90.26	32.65	18.42	-11	4141	2090	543.117	305.445
1998	1610712	292.56	82.02	34.21	12302	5410	3329	676.27	537.86
1999	1710831	194.67	110.71	27.28	15276	6646	2451	756.865	598.388
2000	1331157	129.29	100.93	33.06	17076	3499	2422	648.649	416.818
2001	1128105	183.9	114.83	25.91	117	4980	1433	670.591	298.866
2002	396002.9	9.77	13.33	7.31	1606	1891	440	131.601	89.725
2003	383531.7	27.64	10.21	7.05	5393	2580	1015	184.612	55.97
2004	389479.4	117.52	23.13	7.6	2553	1355	699	167.629	92.382
2005	393960.6	13.16	11.9	-11	1765	1580	1108	223.005	167.019
2006	-11	20.35	-11	-11	397	960	-11	42.474	-11
2007	-11	-11	-11	-11	4874	-11	-11	-11	-11

egfs0
egfs1
egfs2
sgfs0
sgfs1
sgfs2
ibts1
ibts2

Table 12.13.2. Whiting in Sub-Area IV and Divisions VIId and IIIa update. RCT3 outputs.

Analysis by RCT3 ver3.1 of data from file :

Whirec1.txt

Whi4&7d (age 1)

Data for 8 surveys over 27 years : 1981 - 2007

Regression type = C
Tapered time weighting applied
power = 3 over 17 years
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 = 2005

Survey/Series	Slope	Intercept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction			---------I
egfs0	.99	9.48	.89	.358	13	2.65	12.10	1.157	.008
egfs1	.86	10.49	.39	.747	14	2.56	12.69	.495	.045
egfs2									
sgfs0	1.52	1.16	2.87	.069	7	7.48	12.55	3.703	.001
sgfs1	1.32	2.93	.33	.825	8	7.37	12.64	.461	.052
sgfs2	1.06	5.80	.58	.580	9	7.01	13.24	.716	.022
ibts1	.92	8.17	.15	.950	23	5.41	13.16	.185	.326
ibts2	.75	9.59	.12	.966	24	5.12	13.45	.147	.518
					VPA Mean =		13.73	.628	.028

Yearclass = 2006

Survey/Series	Slope	Intercept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction			---------I
egfs0	.83	10.19	.73	.470	14	3.06	12.72	.888	.061
egfs1									
egfs2									
sgfs0	1.49	1.51	2.55	.081	8	5.99	10.41	3.489	.004
sgfs1	1.26	3.43	.31	.847	9	6.87	12.08	.455	.230
sgfs2									
ibts1	.97	7.88	.17	.940	24	3.77	11.52	.284	.592
ibts2									
					VPA Mean =		13.61	.650	.113

Yearclass = 2007

Survey/Series	Slope	Intercept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction			---------I
egfs0									
egfs1									
egfs2									
sgfs0	1.56	.93	2.69	.074	8	8.49	14.19	3.394	.036
sgfs1									
sgfs2									
ibts1									
ibts2									
					VPA Mean =		**13.56**	.654	**.964**

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2005	**579585**	**13.27**	**.11**	**.10**	**.96**	**393961**	**12.88**
2006	**155588**	**11.95**	**.22**	**.34**	**2.45**		
2007	**793565**	**13.58**	**.64**	**.12**	**.03**		

Table 12.13.3. Whiting in Sub-Area IV and Divisions VIId and IIIa update. Short term forecast input.

MFDP version 1a
Run: whi.me.update
Time and date: 11:30 26/09/2007
Fbar age range (Total) : 2-6
Fbar age range Fleet 1 : 2-6
Fbar age range Fleet 2 : 2-6

2007

Age	N	M	Mat	PF	PM	SWt
1	155588	0.95	0.11	0	0	0.113
2	133218	0.45	0.92	0	0	0.188
3	50973	0.35	1	0	0	0.234
4	18840	0.3	1	0	0	0.265
5	12866	0.25	1	0	0	0.291
6	32086	0.25	1	0	0	0.315
7	21877	0.2	1	0	0	0.313
8	18549	0.2	1	0	0	0.32

Catch

Age	Sel	CWt	DSel	DCWt
1	0.019	0.212	0.218	0.128
2	0.0827	0.241	0.4339	0.189
3	0.156	0.27	0.2797	0.214
4	0.2482	0.286	0.2415	0.233
5	0.3486	0.314	0.1865	0.242
6	0.3451	0.35	0.1677	0.241
7	0.2755	0.337	0.1001	0.254
8	0.2976	0.349	0.0761	0.237

IndBycatch

Age	Sel	CWt
1	0.1195	0.114
2	0.0501	0.15
3	0.0207	0.21
4	0.0072	0.264
5	0.0062	0.335
6	0.0049	0.374
7	0.0005	0.424
8	0.0023	0.413

2008

Age	N	M	Mat	PF	PM	SWt
1	793565	0.95	0.11	0	0	0.113
2	.	0.45	0.92	0	0	0.188
3	.	0.35	1	0	0	0.234
4	.	0.3	1	0	0	0.265
5	.	0.25	1	0	0	0.291
6	.	0.25	1	0	0	0.315
7	.	0.2	1	0	0	0.313
8	.	0.2	1	0	0	0.32

Catch

Age	Sel	CWt	DSel	DCWt
1	0.019	0.212	0.218	0.128
2	0.0827	0.241	0.4339	0.189
3	0.156	0.27	0.2797	0.214
4	0.2482	0.286	0.2415	0.233
5	0.3486	0.314	0.1865	0.242
6	0.3451	0.35	0.1677	0.241
7	0.2755	0.337	0.1001	0.254
8	0.2976	0.349	0.0761	0.237

IndBycatch

Age	Sel	CWt
1	0.1195	0.114
2	0.0501	0.15
3	0.0207	0.21
4	0.0072	0.264
5	0.0062	0.335
6	0.0049	0.374
7	0.0005	0.424
8	0.0023	0.413

2009

Age	N	M	Mat	PF	PM	SWt
1	793565	0.95	0.11	0	0	0.113
2	.	0.45	0.92	0	0	0.188
3	.	0.35	1	0	0	0.234
4	.	0.3	1	0	0	0.265
5	.	0.25	1	0	0	0.291
6	.	0.25	1	0	0	0.315
7	.	0.2	1	0	0	0.313
8	.	0.2	1	0	0	0.32

Catch

Age	Sel	CWt	DSel	DCWt
1	0.019	0.212	0.218	0.128
2	0.0827	0.241	0.4339	0.189
3	0.156	0.27	0.2797	0.214
4	0.2482	0.286	0.2415	0.233
5	0.3486	0.314	0.1865	0.242
6	0.3451	0.35	0.1677	0.241
7	0.2755	0.337	0.1001	0.254
8	0.2976	0.349	0.0761	0.237

IndBycatch

Age	Sel	CWt
1	0.1195	0.114
2	0.0501	0.15
3	0.0207	0.21
4	0.0072	0.264
5	0.0062	0.335
6	0.0049	0.374
7	0.0005	0.424
8	0.0023	0.413

Input units are thousands and kg - output in tonnes

Table 12.13.4. Whiting in Sub-Area IV and Divisions VIId and IIIa update. Short term forecast output.

MFDP version 1a
Run: whi.me.update
Time and date: 11:30 26/09/2007
Fbar age range (Total) : 2-6
Fbar age range Fleet 1 : 2-6
Fbar age range Fleet 2 : 2-6

2007

Biomass	SSB	Catch FMult	Landings FBar	Yield	Discards FBar	Yield	IndBycatch FMult	Landings FBar	Yield
86181	68530	1	0.2361	11099	0.2619	14090	1	0.0178	2065

2008											2009	
Biomass	SSB	Catch FMult	Landings FBar	Yield	Discards FBar	Yield	IndBycatch FMult	Landings FBar	Yield		Biomass	SSB
131142	50700	0	0	0	0	0	1	0.0178	7148		173861	89957
.	50700	0.1	0.0236	1035	0.0262	2080	1	0.0178	7072		171212	87403
.	50700	0.2	0.0472	2031	0.0524	4101	1	0.0178	6998		168656	84941
.	50700	0.3	0.0708	2990	0.0786	6067	1	0.0178	6925		166189	82566
.	50700	0.4	0.0944	3915	0.1047	7980	1	0.0178	6853		163808	80274
.	50700	0.5	0.1181	4805	0.1309	9840	1	0.0178	6782		161509	78062
.	50700	0.6	0.1417	5663	0.1571	11650	1	0.0178	6712		159290	75928
.	50700	0.7	0.1653	6490	0.1833	13411	1	0.0178	6644		157147	73869
.	50700	0.8	0.1889	7288	0.2095	15126	1	0.0178	6577		155078	71880
.	50700	0.9	0.2125	8056	0.2357	16795	1	0.0178	6510		153079	69961
.	**50700**	**1**	**0.2361**	**8797**	**0.2619**	**18420**	**1**	**0.0178**	**6445**		**151148**	**68107**
.	50700	1.1	0.2597	9512	0.288	20003	1	0.0178	6381		149282	66317
.	50700	1.2	0.2833	10201	0.3142	21544	1	0.0178	6317		147479	64588
.	50700	1.3	0.307	10866	0.3404	23046	1	0.0178	6255		145737	62918
.	50700	1.4	0.3306	11507	0.3666	24510	1	0.0178	6194		144053	61305
.	50700	1.5	0.3542	12126	0.3928	25936	1	0.0178	6134		142426	59746
.	50700	1.6	0.3778	12723	0.419	27326	1	0.0178	6074		140852	58240
.	50700	1.7	0.4014	13300	0.4452	28682	1	0.0178	6016		139331	56784
.	50700	1.8	0.425	13857	0.4713	30003	1	0.0178	5958		137859	55377
.	50700	1.9	0.4486	14394	0.4975	31292	1	0.0178	5902		136436	54016
.	50700	2	0.4722	14913	0.5237	32549	1	0.0178	5846		135060	52701

Input units are thousands and kg - output in tonnes

Table 12.13.5. Whiting in Sub-Area IV and Divisions VIId and IIIa update. Detailed short term forecast output.

MFDP version 1a
Run: whi.me.update
Time and date: 11:30 26/09/2007
Fbar age range (Total) : 2-6
Fbar age range Fleet 1 : 2-6
Fbar age range Fleet 2 : 2-6

Year: 2007 F multiplier: 1 Fleet1 HCFbar: 0.2361 Fleet1 DFt 0.2619

	Catch						IndBycatch								
Age	F	CatchNos	Yield	DF	DCatchNos	DYield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.019	1650	350	0.218	18932	2423	0.1195	10378	1183	155588	17581	17115	1934	17115	1934
2	0.0827	6916	1667	0.4339	36285	6858	0.0501	4190	628	133218	25045	122561	23041	122561	23041
3	0.156	5458	1474	0.2797	9787	2094	0.0207	724	152	50973	11928	50973	11928	50973	11928
4	0.2482	3223	922	0.2415	3136	731	0.0072	93	25	18840	4993	18840	4993	18840	4993
5	0.3486	3099	973	0.1865	1658	401	0.0062	55	18	12866	3744	12866	3744	12866	3744
6	0.3451	7730	2705	0.1677	3756	905	0.0049	110	41	32086	10107	32086	10107	32086	10107
7	0.2755	4581	1544	0.1001	1665	423	0.0005	8	4	21877	6848	21877	6848	21877	6848
8	0.2976	4196	1464	0.0761	1073	254	0.0023	32	13	18549	5936	18549	5936	18549	5936
Total		36854	11099		76291	14090		15591	2065	443997	86181	294866	68530	294866	68530

Year: 2008 F multiplier: 1 Fleet1 HCFbar: 0.2361 Fleet1 DFt 0.2619

	Catch						IndBycatch								
Age	F	CatchNos	Yield	DF	DCatchNos	DYield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.019	8416	1784	0.218	96560	12360	0.1195	52931	6034	793565	89673	87292	9864	87292	9864
2	0.0827	2187	527	0.4339	11474	2169	0.0501	1325	199	42128	7920	38758	7286	38758	7286
3	0.156	5161	1393	0.2797	9253	1980	0.0207	685	144	48197	11278	48197	11278	48197	11278
4	0.2482	3893	1113	0.2415	3788	883	0.0072	113	30	22758	6031	22758	6031	22758	6031
5	0.3486	2045	642	0.1865	1094	265	0.0062	36	12	8492	2471	8492	2471	8492	2471
6	0.3451	1405	492	0.1677	683	165	0.0049	20	7	5832	1837	5832	1837	5832	1837
7	0.2755	3118	1051	0.1001	1133	288	0.0005	6	2	14890	4661	14890	4661	14890	4661
8	0.2976	5141	1794	0.0761	1315	312	0.0023	40	16	22724	7272	22724	7272	22724	7272
Total		31366	8797		125300	18420		55155	6445	958585	131142	248942	50700	248942	50700

Year: 2009 F multiplier: 1 Fleet1 HCFbar: 0.2361 Fleet1 DFt 0.2619

	Catch						IndBycatch								
Age	F	CatchNos	Yield	DF	DCatchNos	DYield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.019	8416	1784	0.218	96560	12360	0.1195	52931	6034	793565	89673	87292	9864	87292	9864
2	0.0827	11155	2688	0.4339	58525	11061	0.0501	6758	1014	214870	40396	197681	37164	197681	37164
3	0.156	1632	441	0.2797	2926	626	0.0207	217	45	15241	3566	15241	3566	15241	3566
4	0.2482	3681	1053	0.2415	3582	835	0.0072	107	28	21518	5702	21518	5702	21518	5702
5	0.3486	2471	776	0.1865	1322	320	0.0062	44	15	10257	2985	10257	2985	10257	2985
6	0.3451	927	325	0.1677	451	109	0.0049	13	5	3849	1212	3849	1212	3849	1212
7	0.2755	567	191	0.1001	206	52	0.0005	1	0	2706	847	2706	847	2706	847
8	0.2976	4783	1669	0.0761	1223	290	0.0023	37	15	21144	6766	21144	6766	21144	6766
Total		33632	8927		164794	25652		60107	7157	1083151	151148	359689	68107	359689	68107

Input units are thousands and kg - output in tonnes

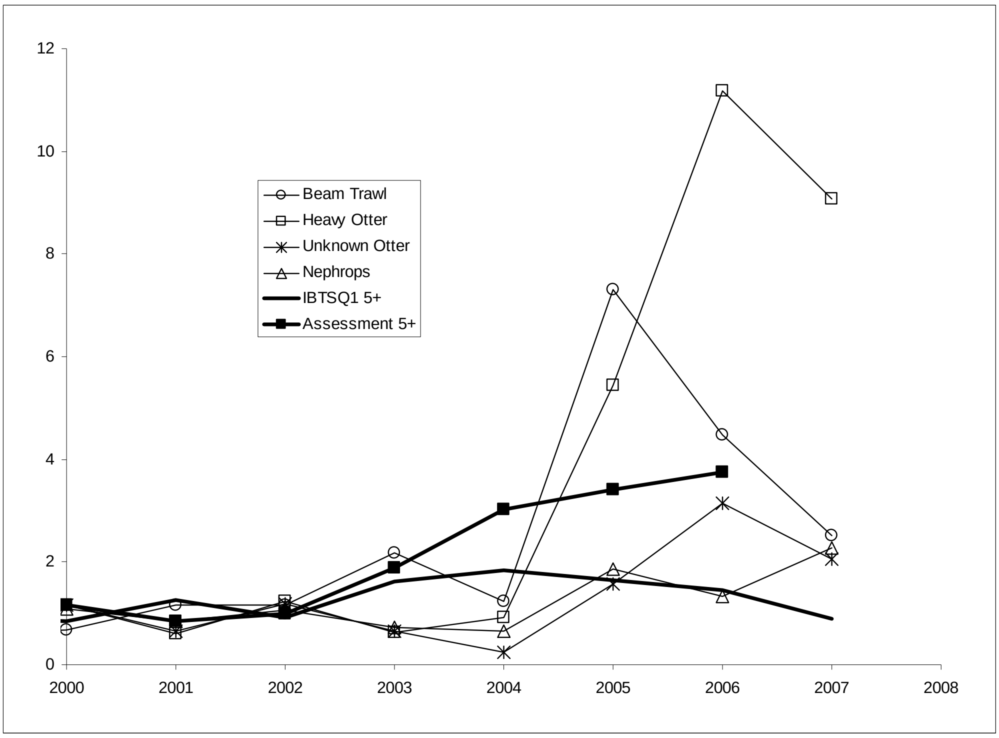


Figure 12.1.1. Whiting in IV and VIId. The time series of UK (Eng. & Wales) vessels, fishing on the northeast coast, standardised (to the average of 2000–2002) average quarter 1 North Sea whiting landings per unit effort (kg/hr uncorrected for kw) during the years 2000–2007; compared to the ICES assessment and IBTS derived estimate of 5+ biomass.

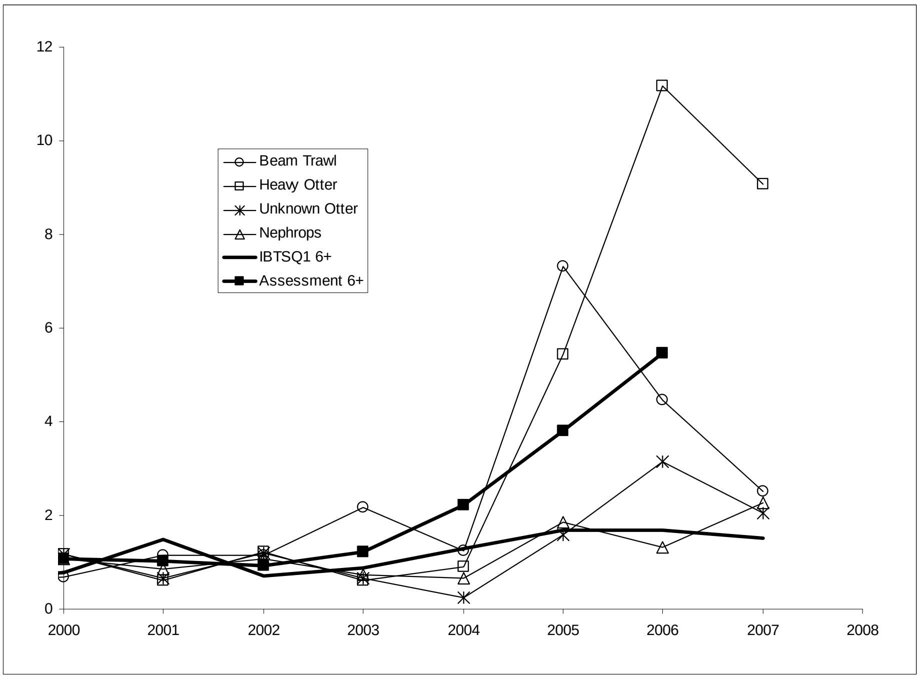


Figure 12.1.2. Whiting in IV and VIId. The time series of UK (Eng. & Wales) vessels, fishing on the northeast coast, standardised (to the average of 2000–2002) average quarter 1 North Sea whiting landings per unit effort (kg/hr uncorrected for kw) during the years 2000–2007; compared to the ICES assessment and IBTS derived estimate of 6+ biomass.

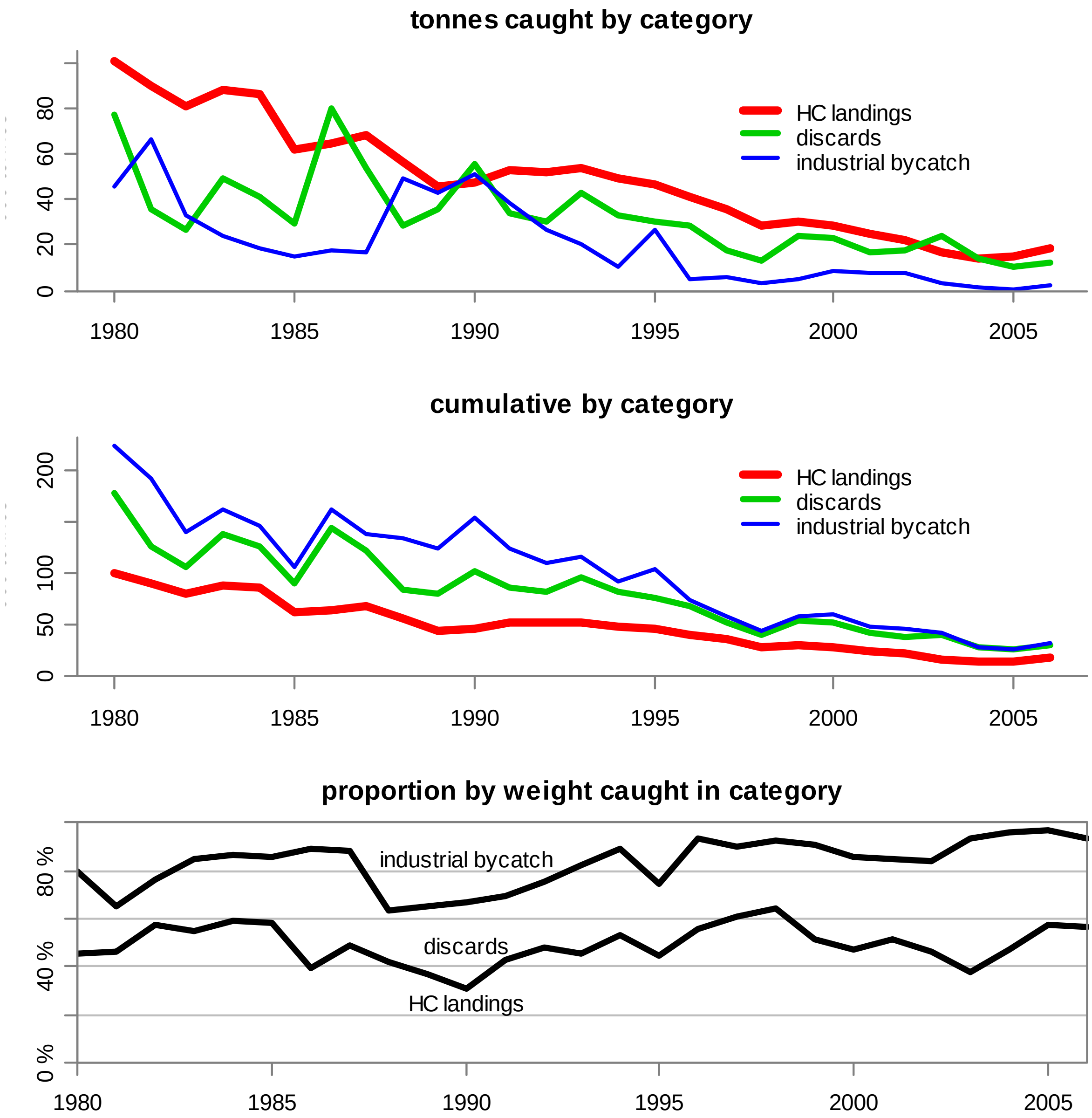


Figure 12.2.1 Whiting in IV and VIId. The contribution of different catch components to the total catch.

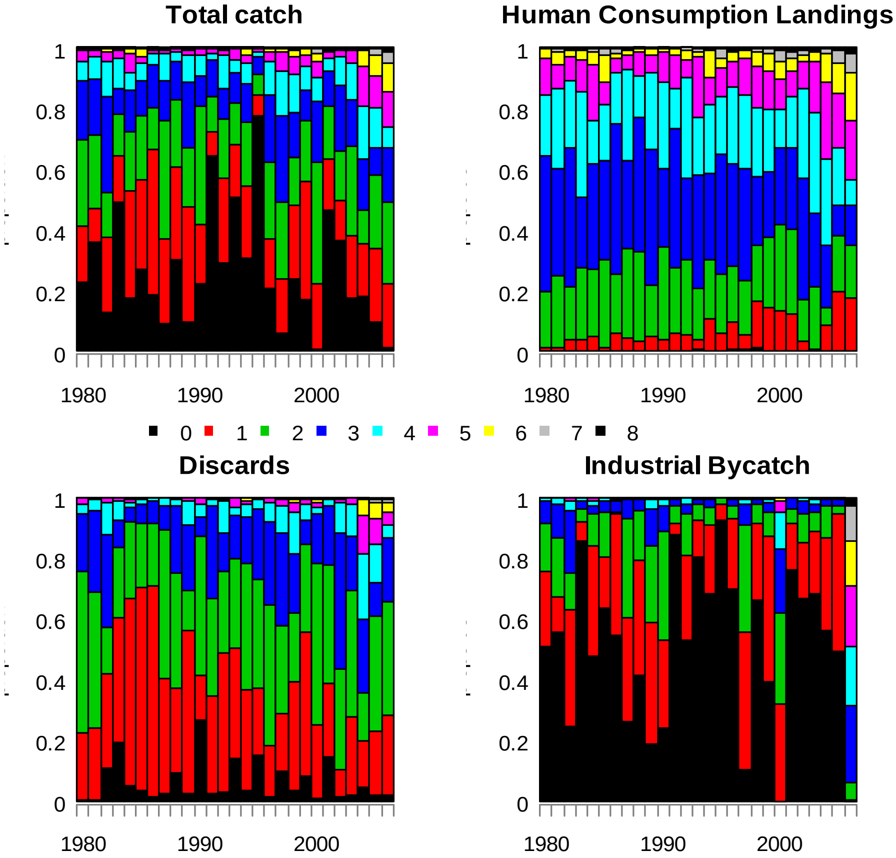


Figure 12.2.2 Whiting in IV and VIId. Proportion at age by number for each catch component.

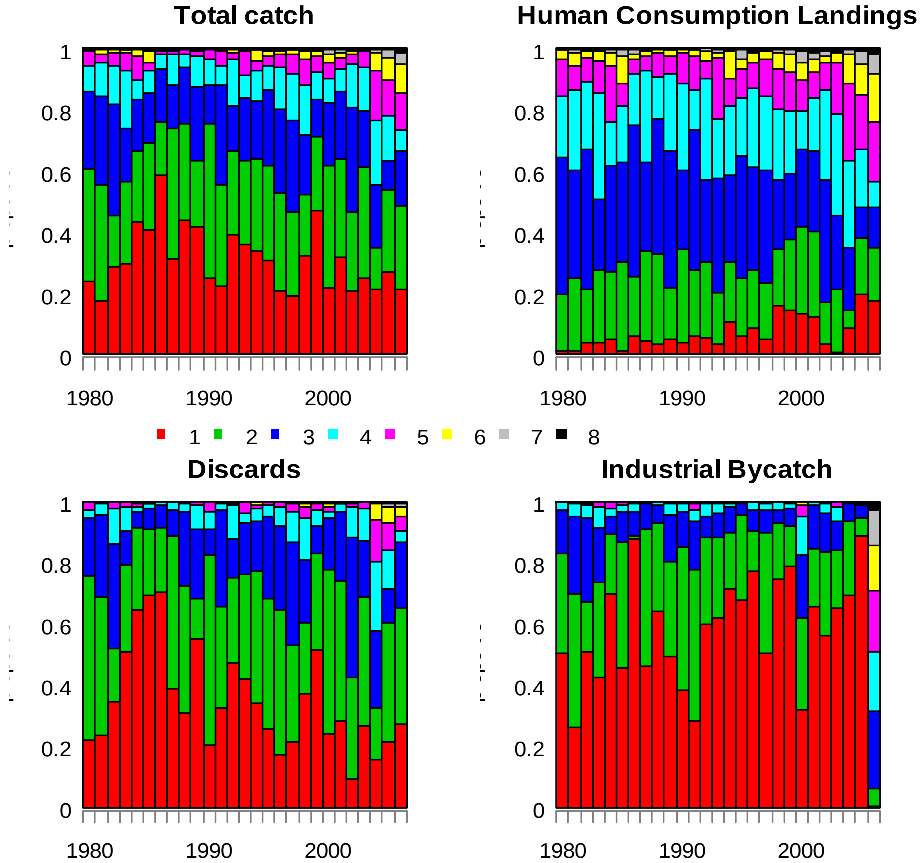


Figure 12.2.3 Whiting in IV and VIId. Proportion at age by number for each catch component excluding age 0.

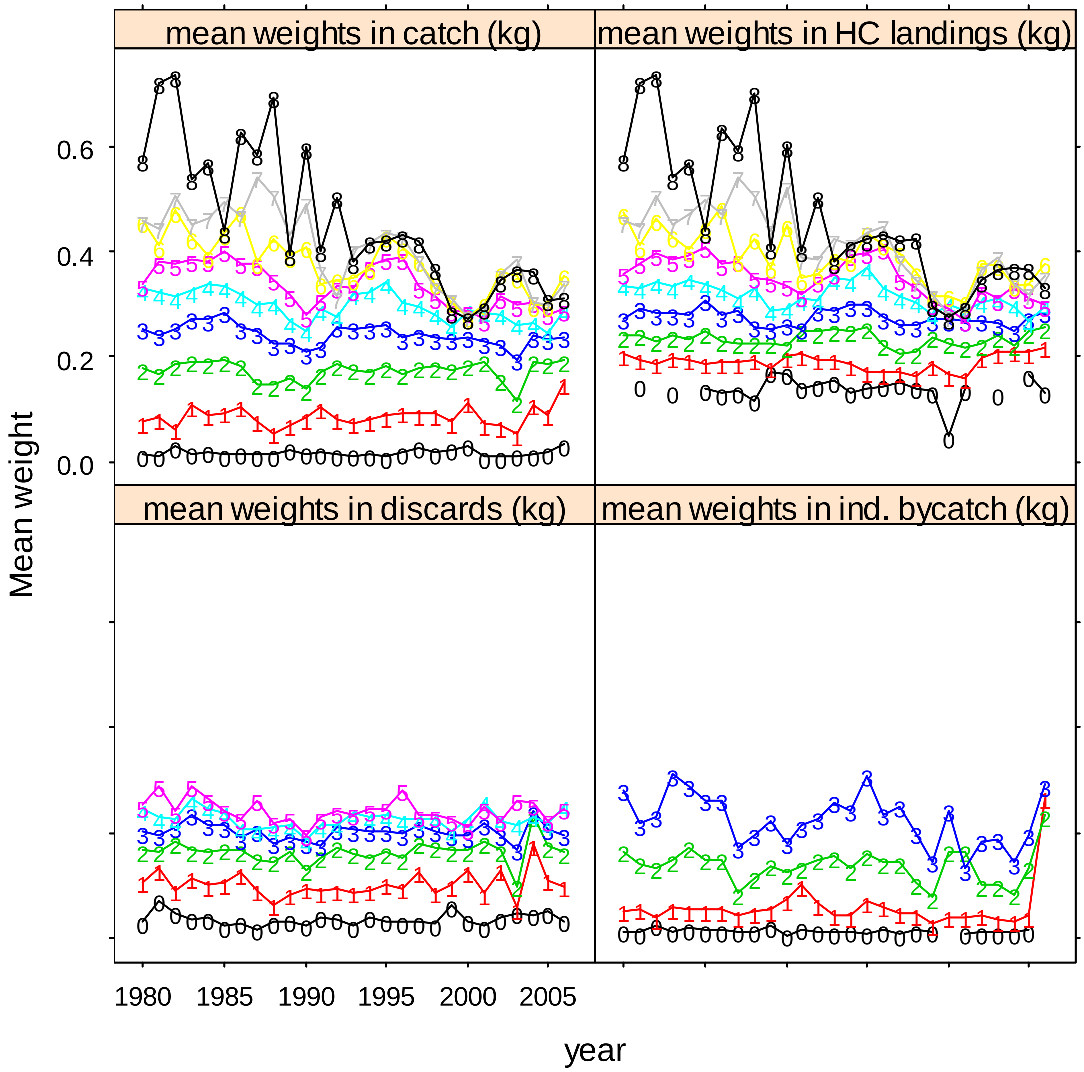


Figure 12.2.4 Whiting in IV and VIId. Mean weights at age (kg) by-catch component. Catch mean weights are also used as stock mean weights.

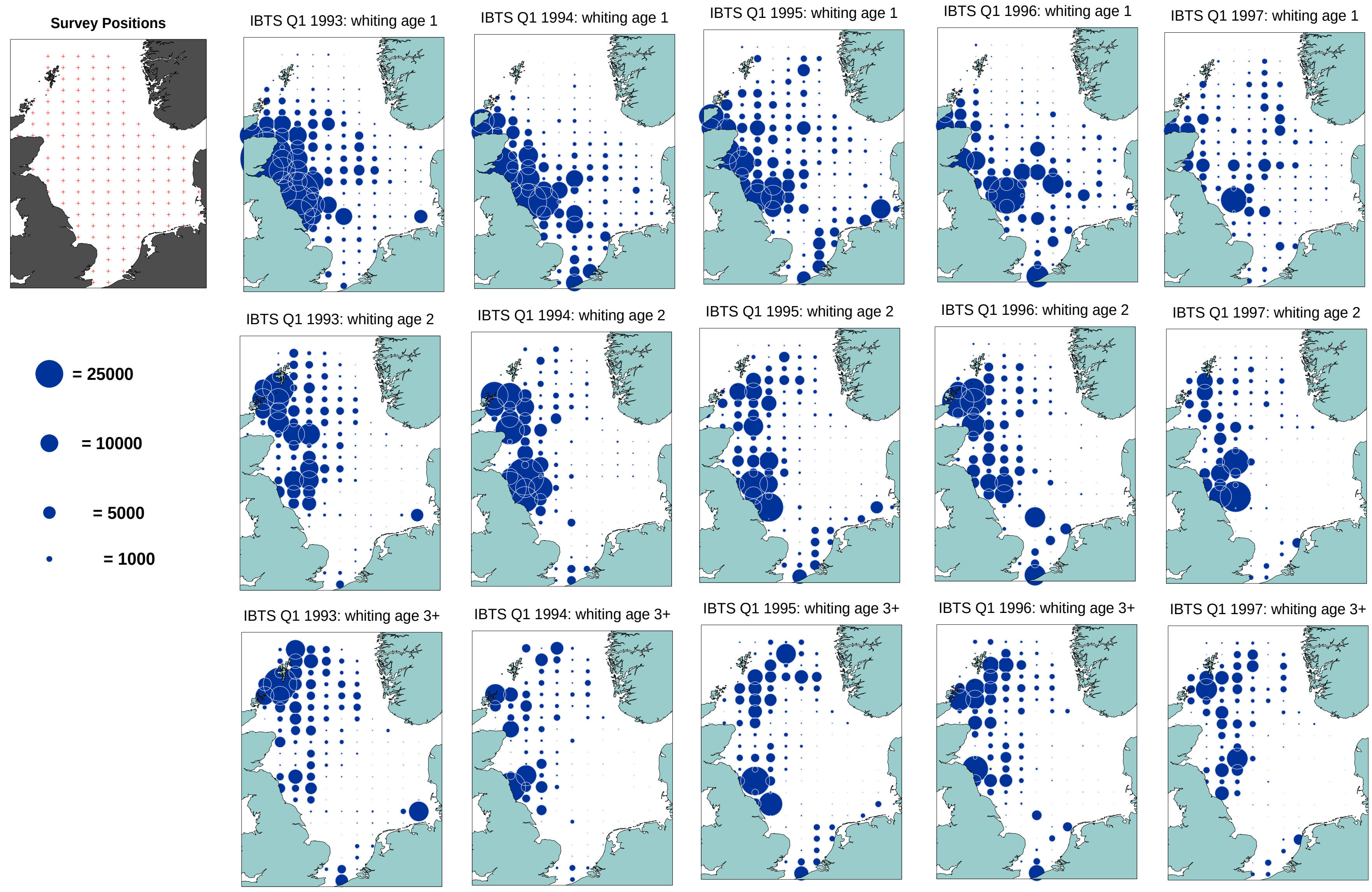


Figure 12.2.5 **Whiting in IV and VIId. Distribution plot of the IBTS quarter 1 Survey.**

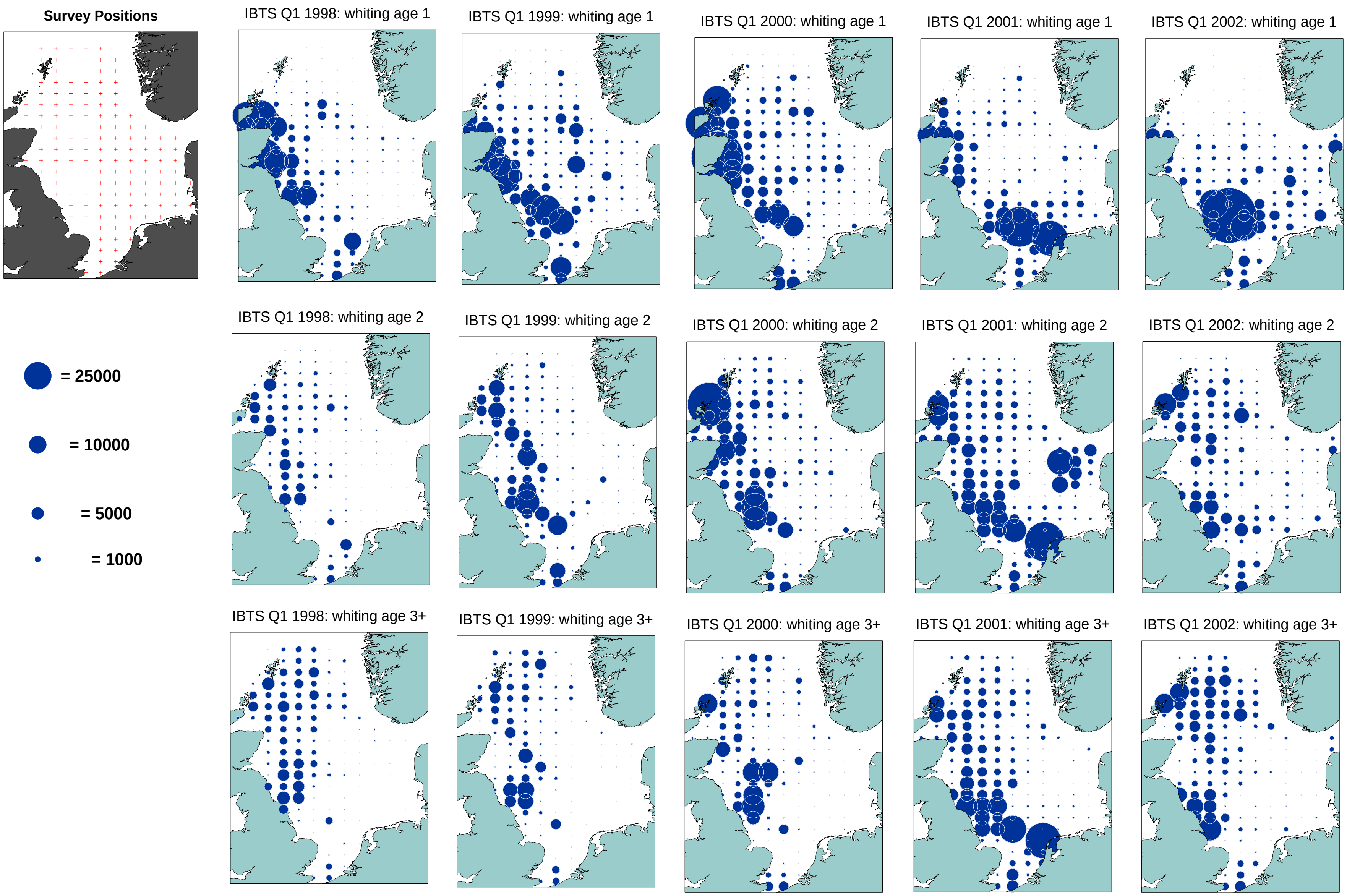


Figure 12.2.5 (cont.) **Whiting in IV and VIId. Distribution plot of the IBTS quarter 1 Survey.**

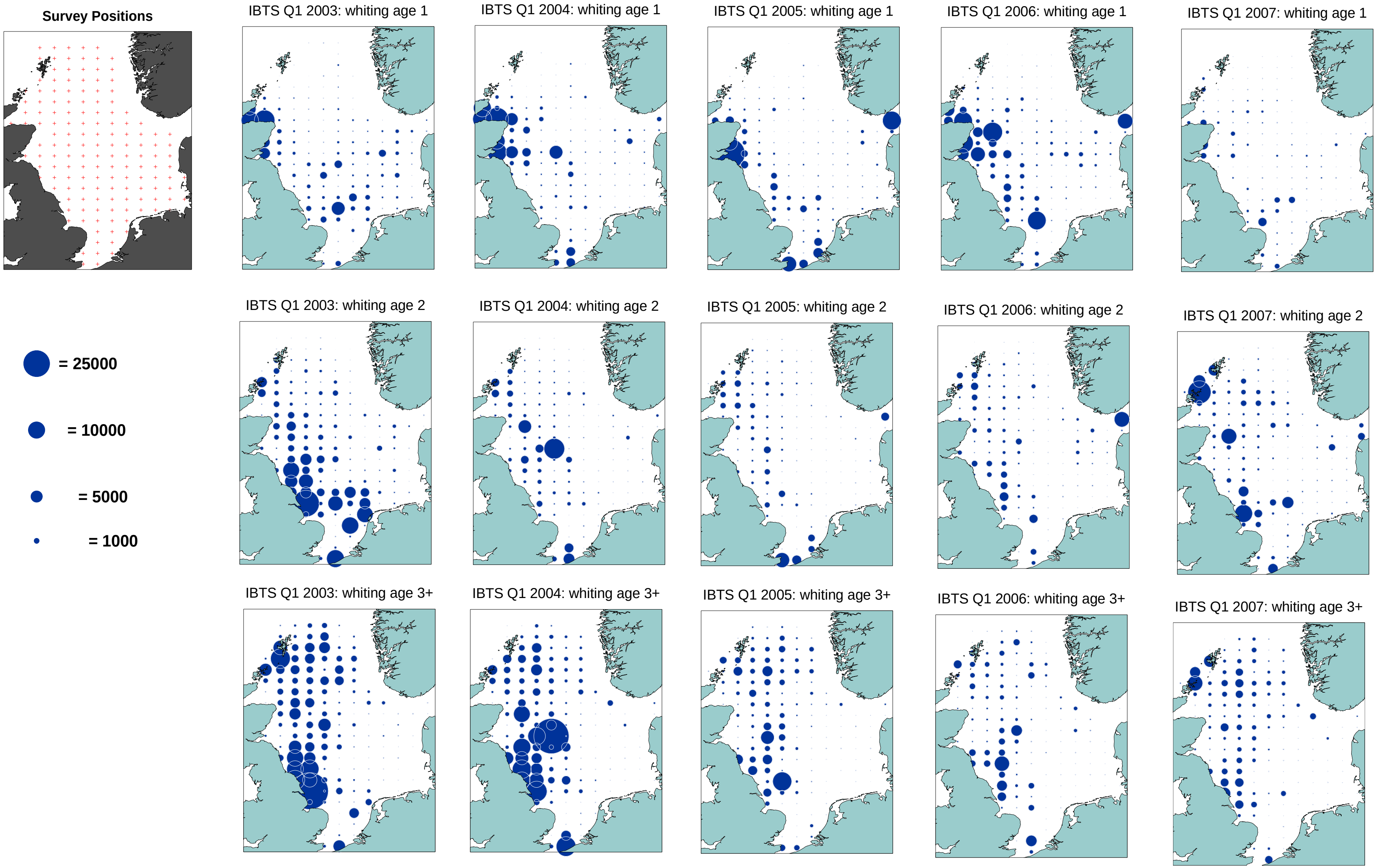


Figure 12.2.5 (cont.) **Whiting in IV and VIId. Distribution plot of the IBTS quarter 1 Survey.**

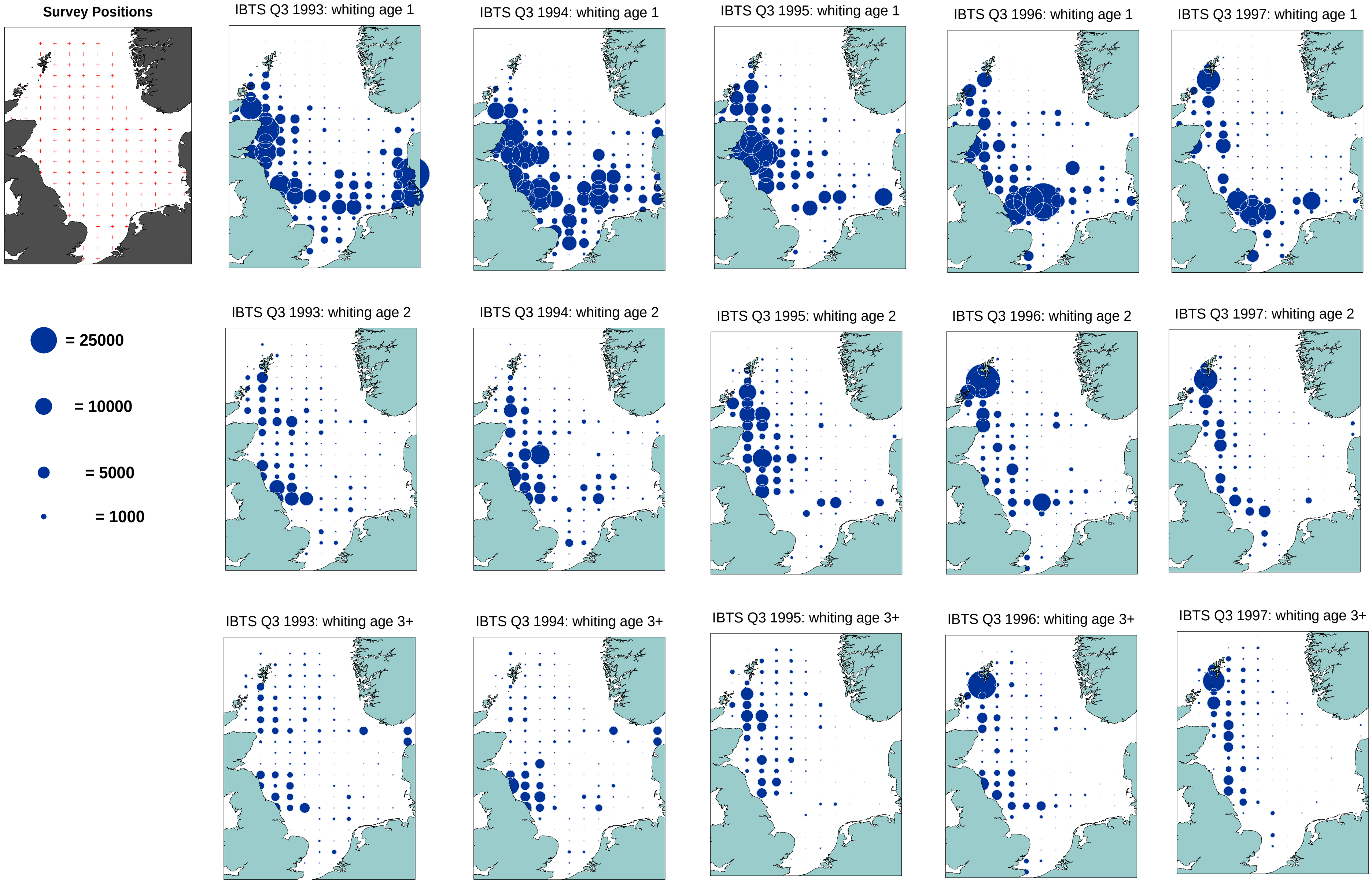


Figure 12.2.6 **Whiting in IV and VIId. Distribution plot of the IBTS quarter 3 Survey.**

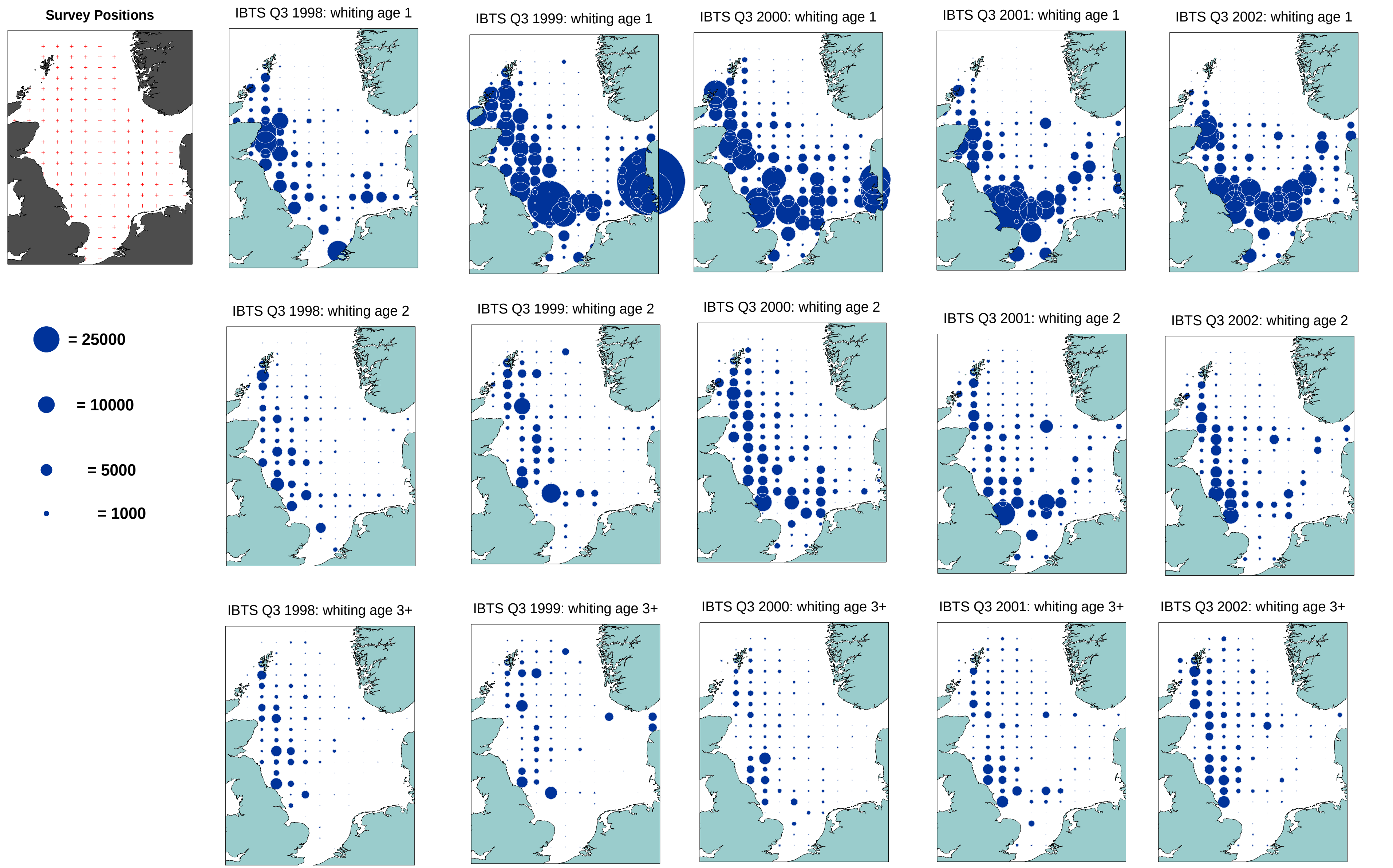


Figure 12.2.6 (cont.) **Whiting in IV and VIId. Distribution plot of the IBTS quarter 3 Survey.**

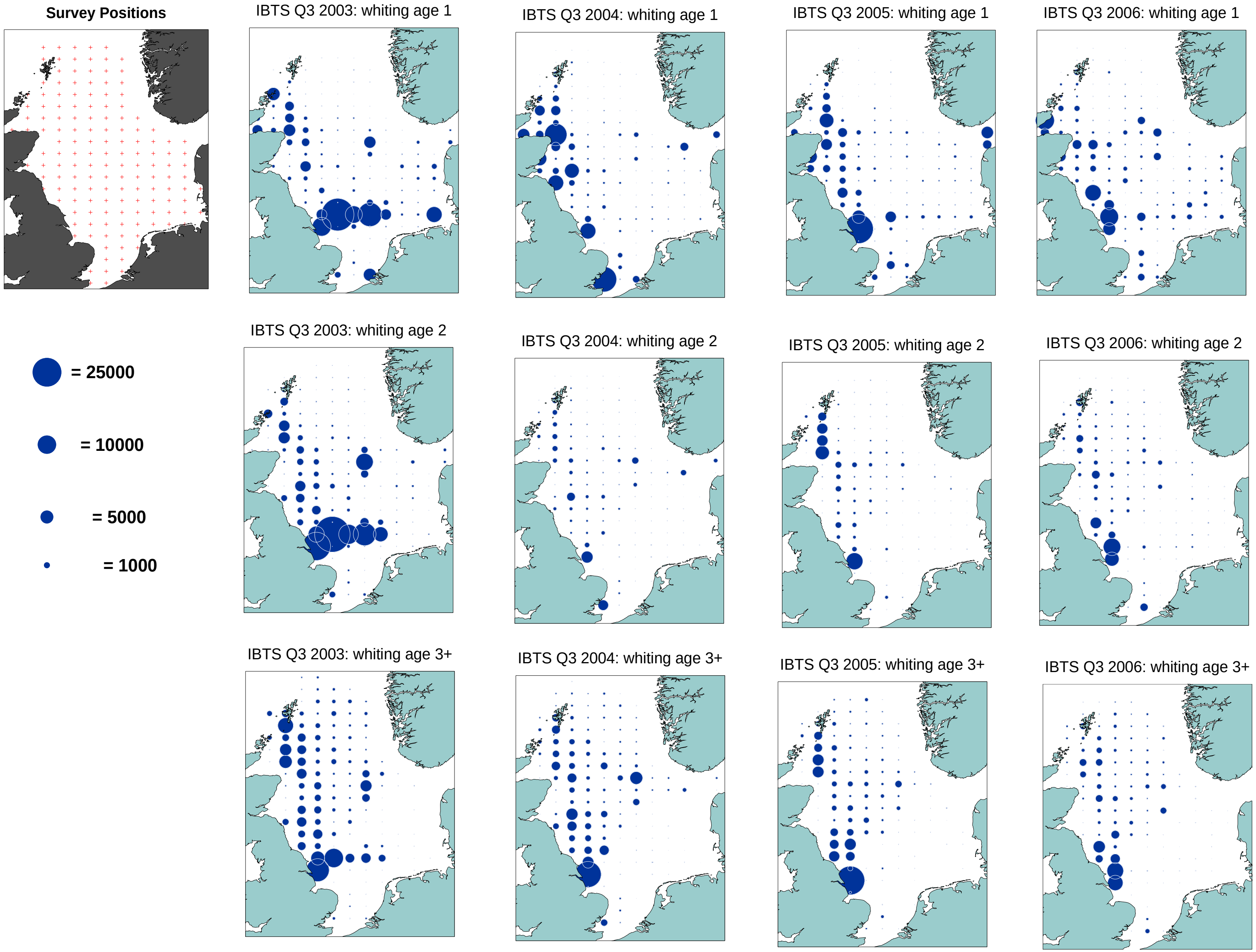


Figure 12.2.6 (cont.) **Whiting in IV and VIId. Distribution plot of the IBTS quarter 3 Survey.**

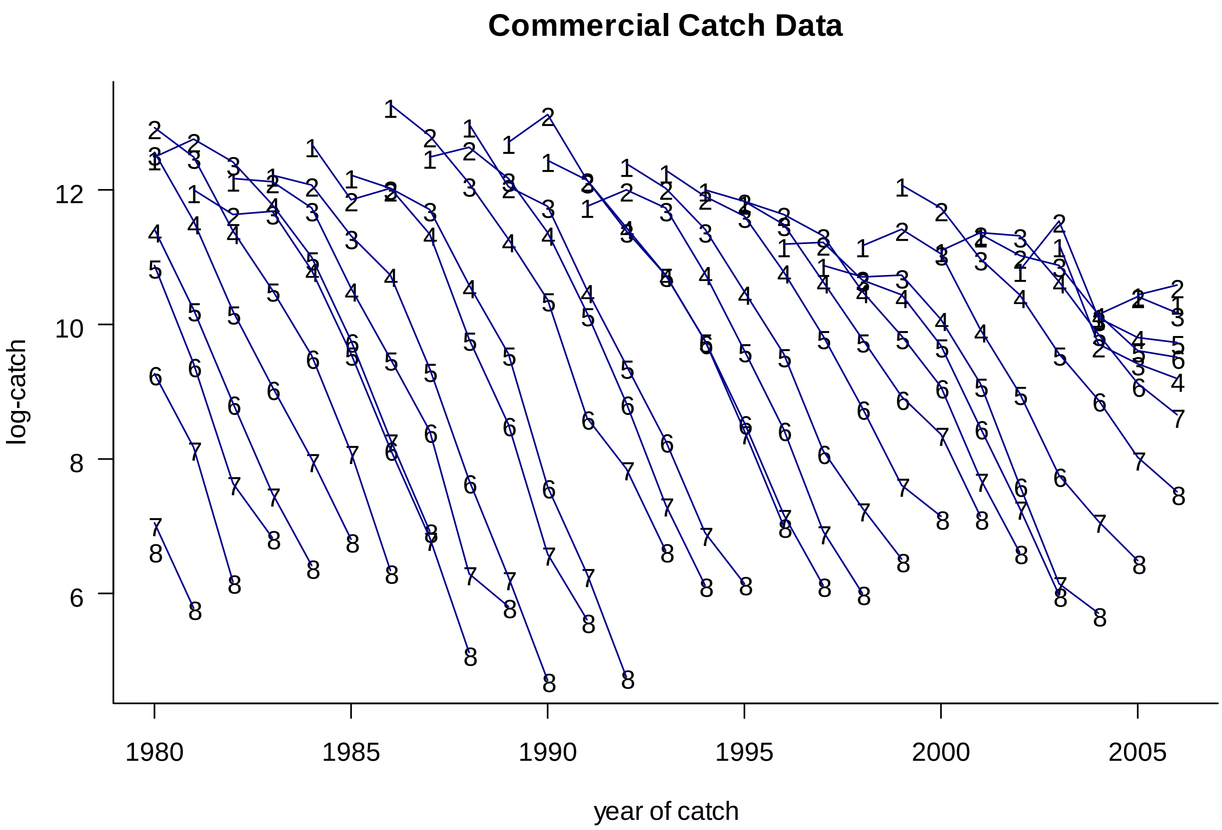


Figure 12.3.1 **Whiting in IV and VIId. Log catch-numbers linked by cohort for commercial catch data**

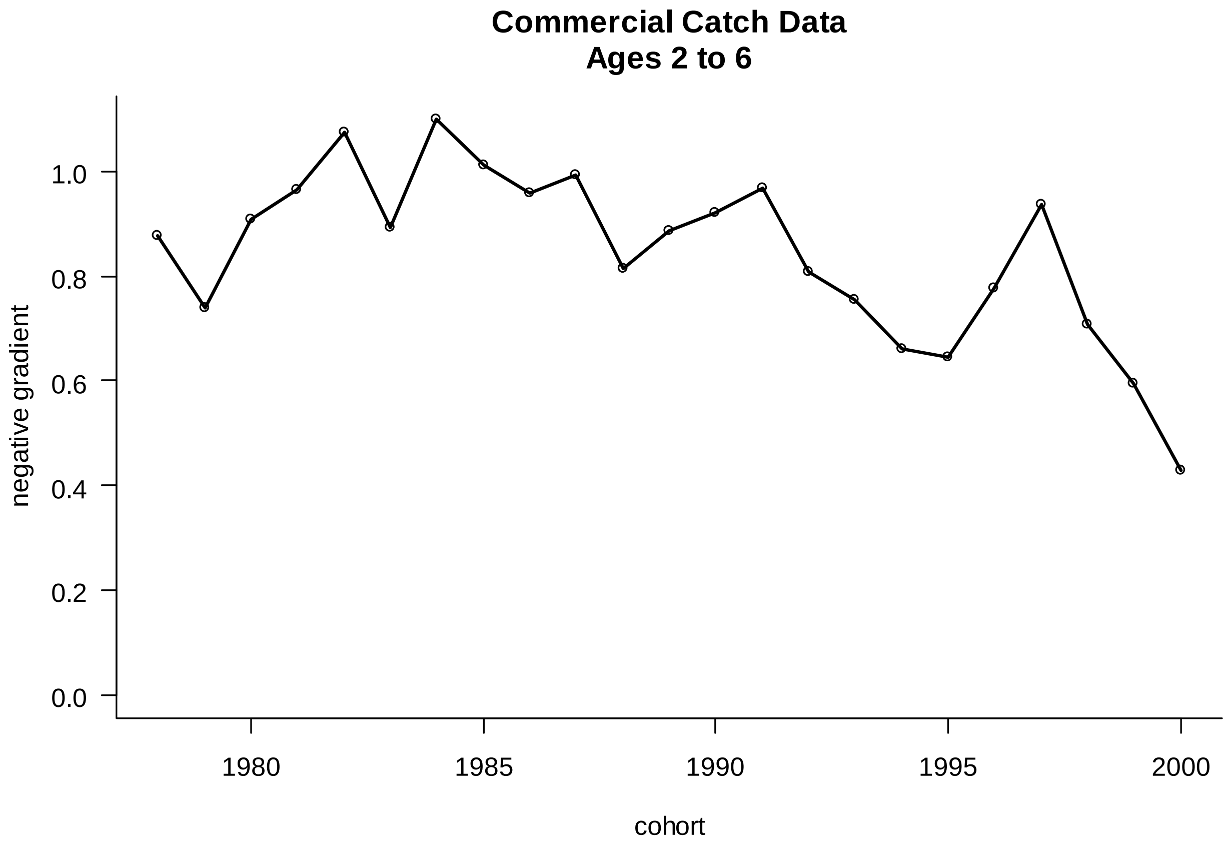


Figure 12.3.2 Whiting in IV and VIId. Gradients of log-catches per cohort for the age range specified (2–6).

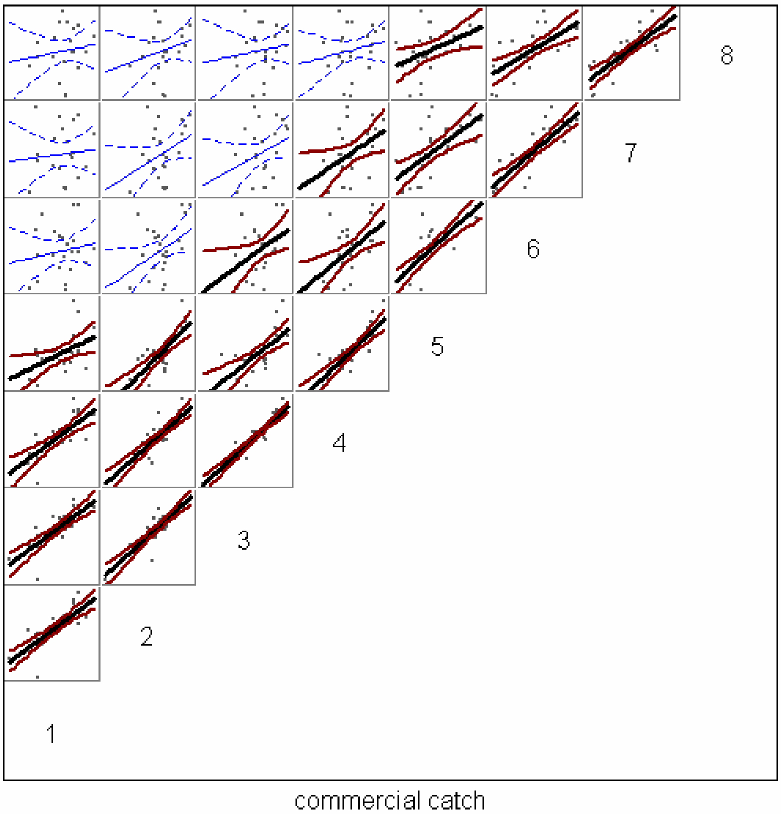


Figure 12.3.3 Whiting in IV and VIId. Correlations in the catch at age matrix (log numbers). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant (p<0.05) regression.

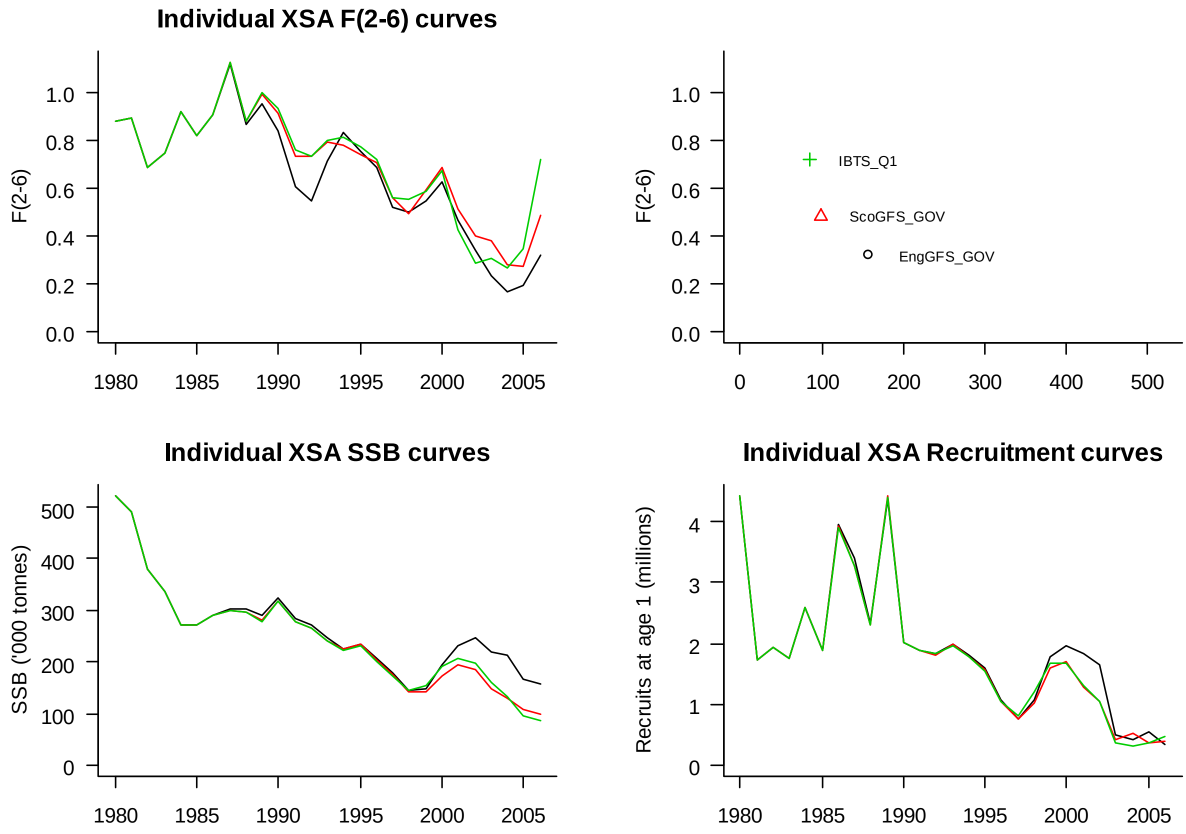


Figure 12.3.4 Whiting in IV and VIId. Comparison of F(2–6), SSB and recruitment time series for individual fleet XSA runs (with the same settings as this years final assessment).

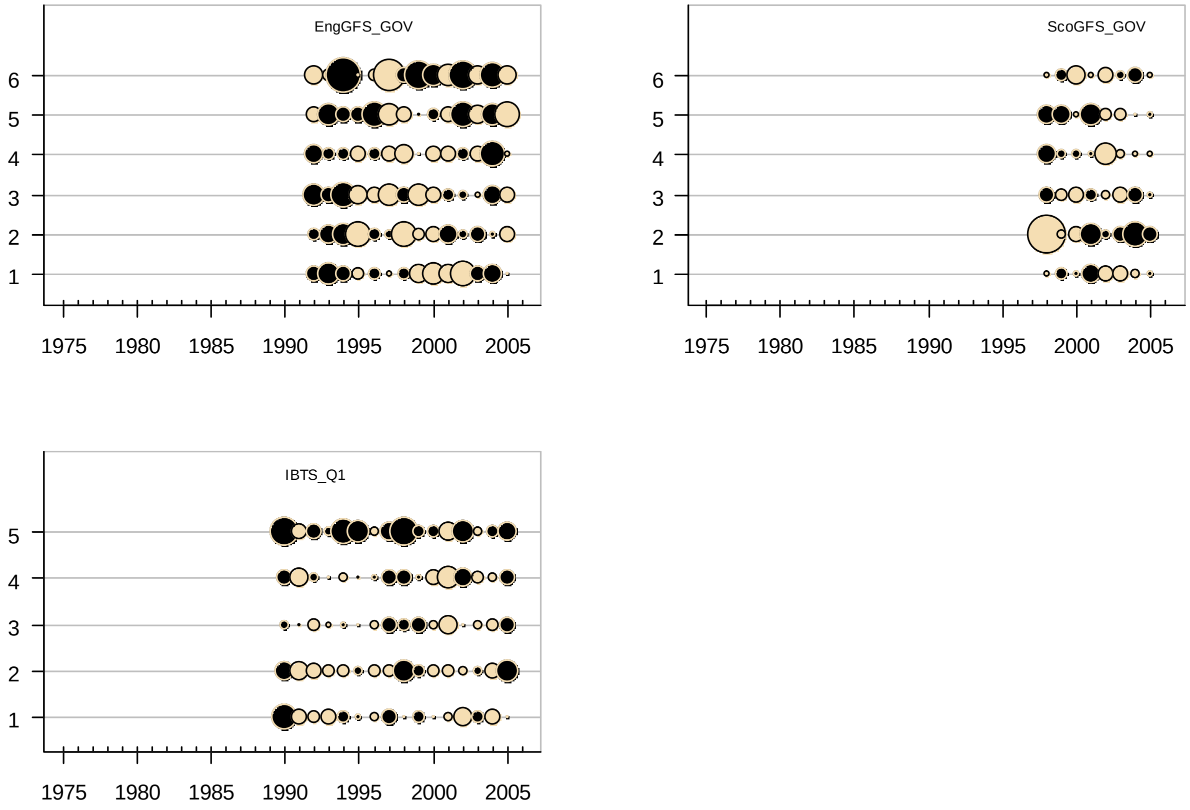


Figure 12.3.5 **Whiting in IV and VIId. Residuals from single fleet XSA runs.**

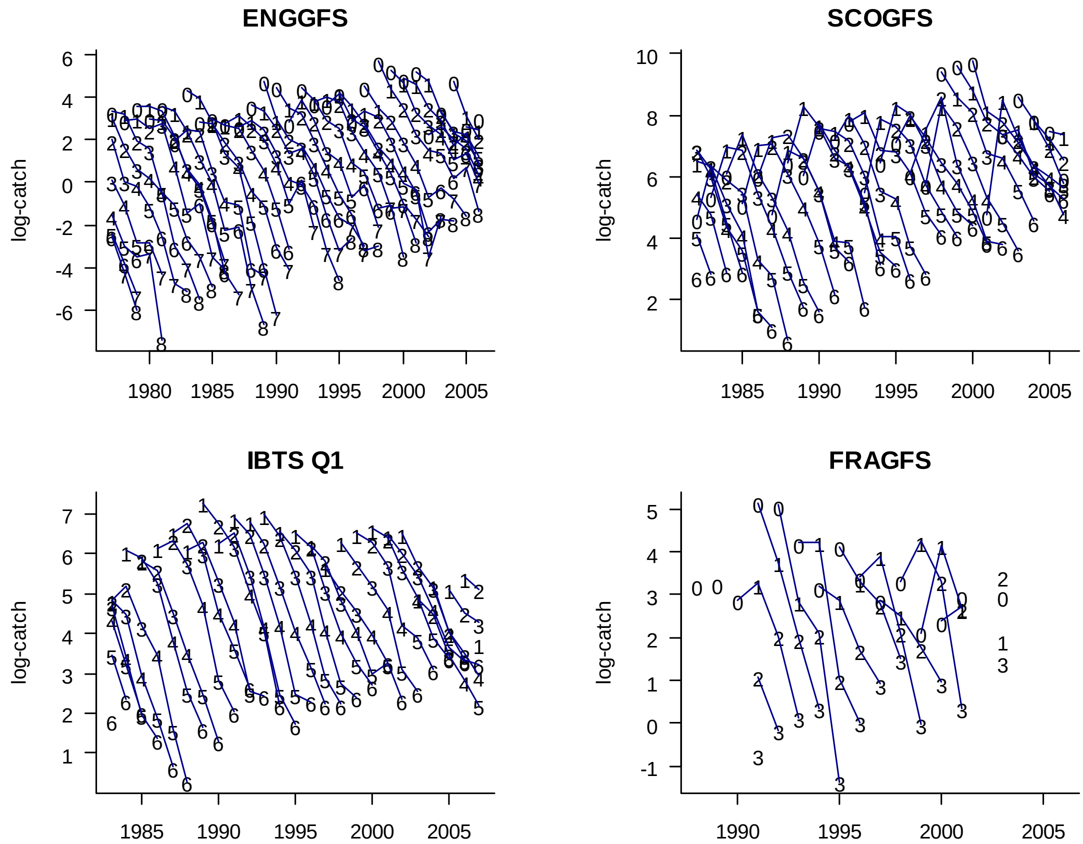


Figure 12.3.6 Whiting in IV and VIId. Log-abundance indices by cohort for each of the available survey series. (note for the IBTS Q1 age 6 is a plus group.)

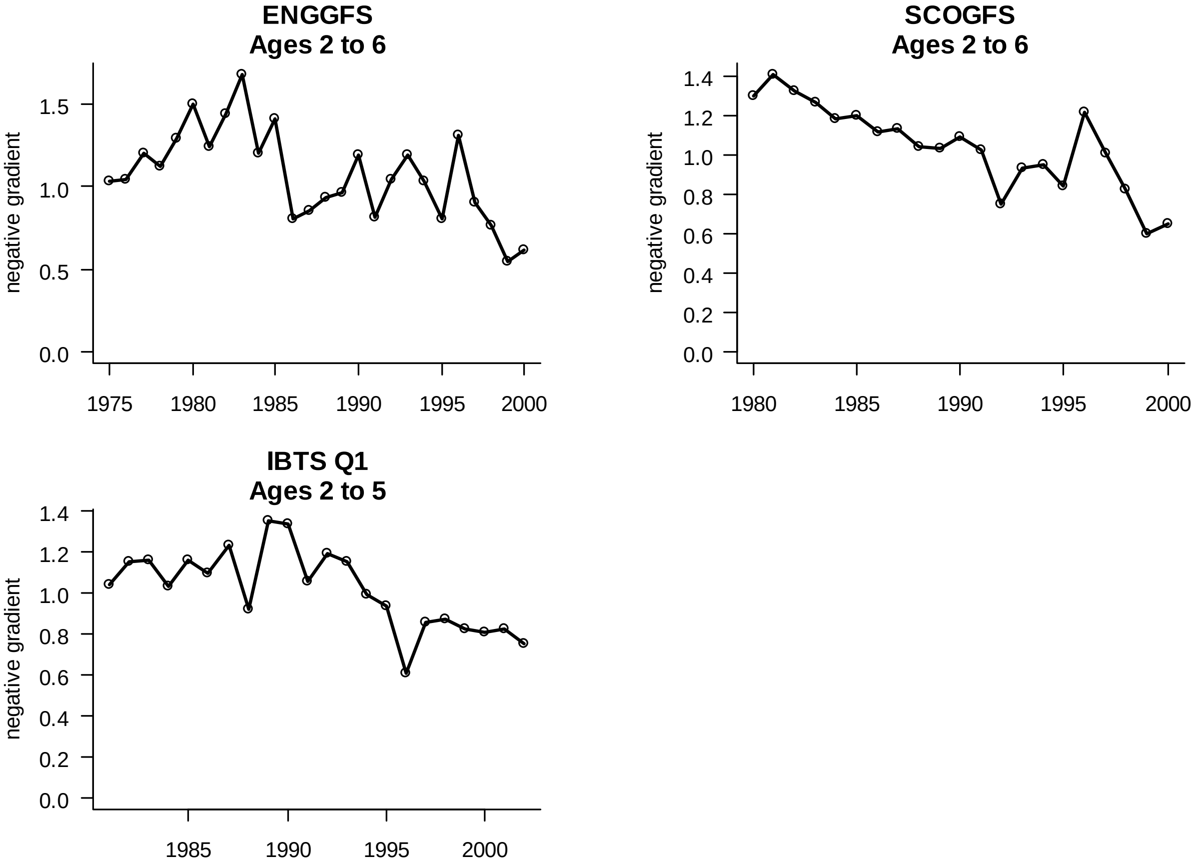


Figure 12.3.7 Whiting in IV and VIId. Gradients of log-abundance per cohort for each of the available survey series with the exception of the French GFS as this survey contains information few ages.

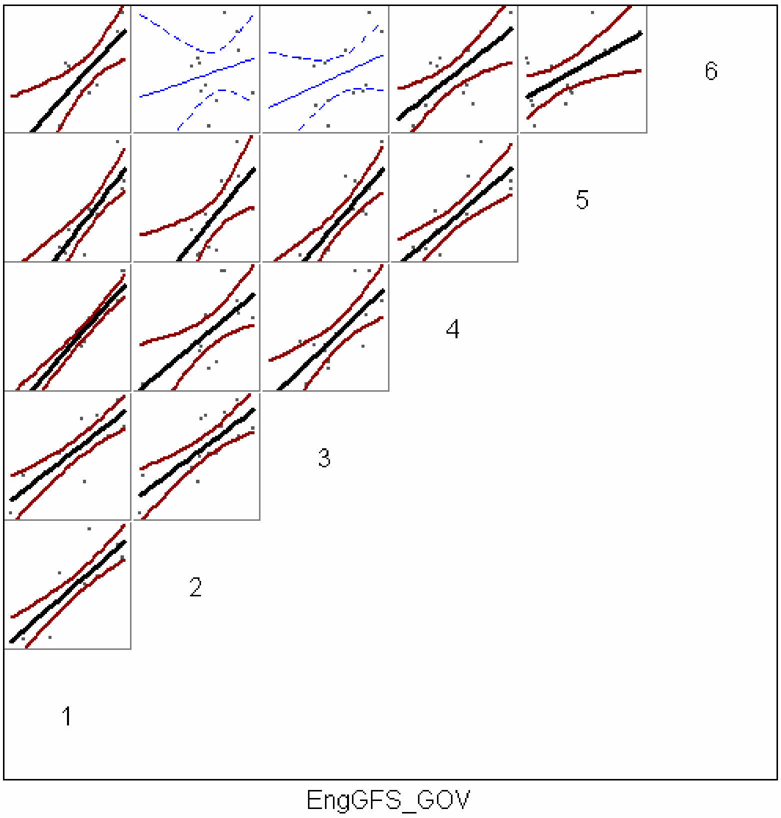


Figure 12.3.8 Whiting in IV and VIId. Within survey correlations for the English groundfish survey (1992–2006). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant (p<0.05) regression and the curved lines are approximate 95% confidence intervals.

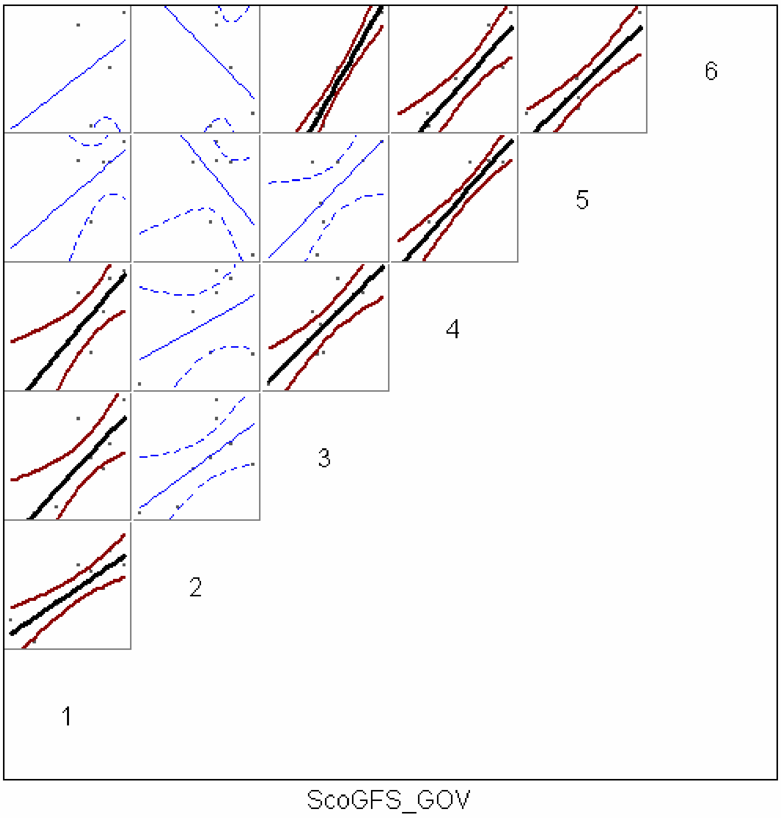


Figure 12.3.9 Whiting in IV and VIId. Within survey correlations for the Scottish groundfish survey (1998–2006). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant ($p<0.05$) regression and the curved lines are approximate 95% confidence intervals.

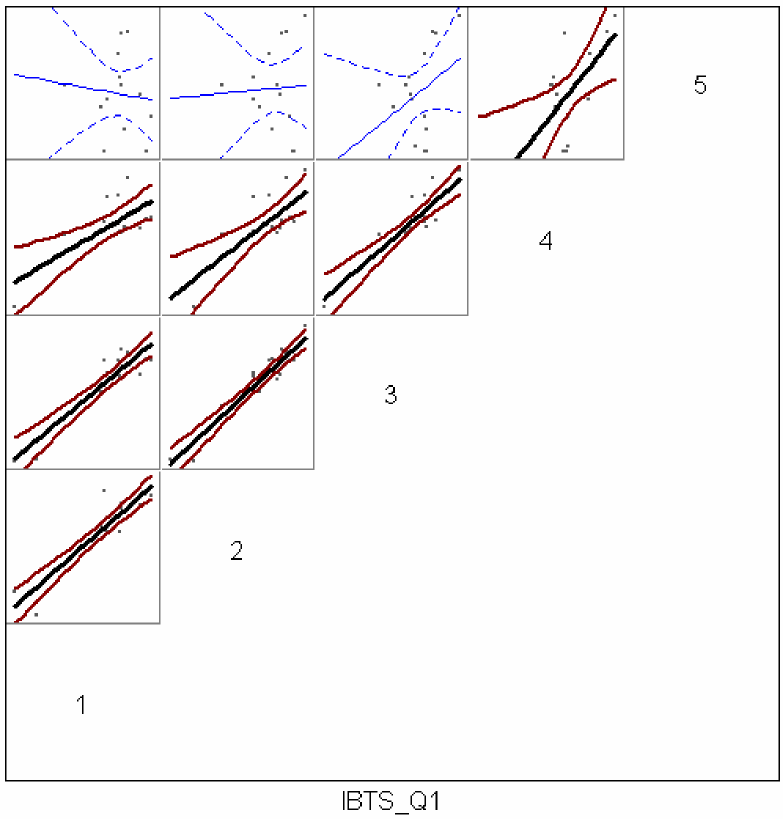


Figure 12.3.10 Whiting in IV and VIId. Within survey correlations for the IBTS quarter 1 survey (1990–2006). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant (p<0.05) regression and the curved lines are approximate 95% confidence intervals.

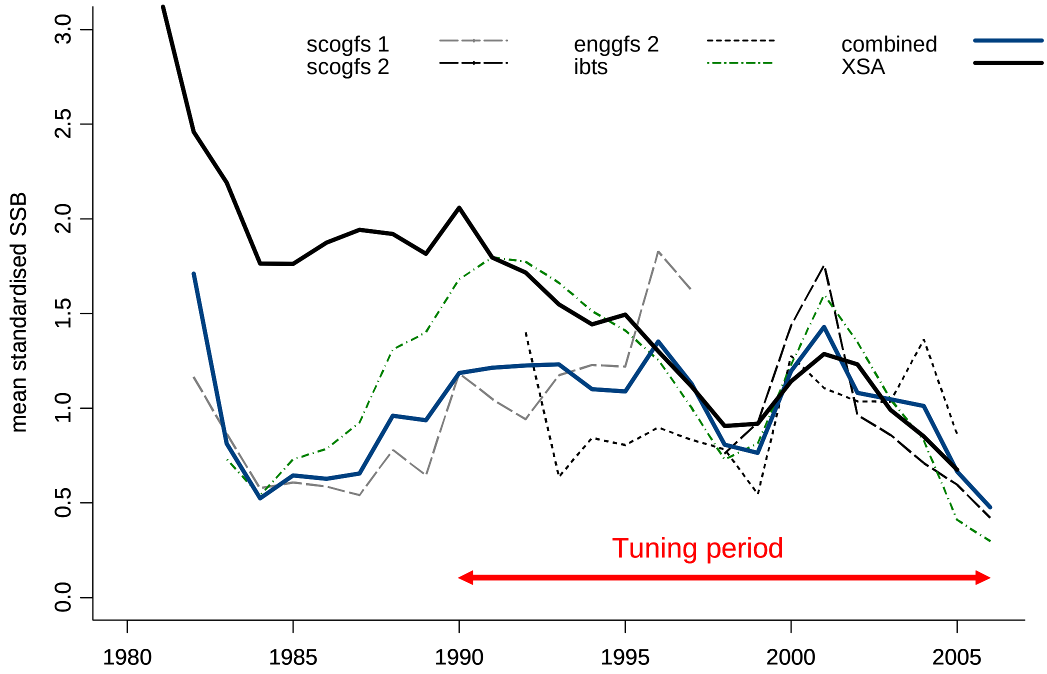


Figure 12.3.11 Whiting in IV and VIId. Comparison of SSB trends from SURBA runs and a mutli-fleet XSA run using the 2005 benchmark settings (with shrinkage reduced to 2.0).

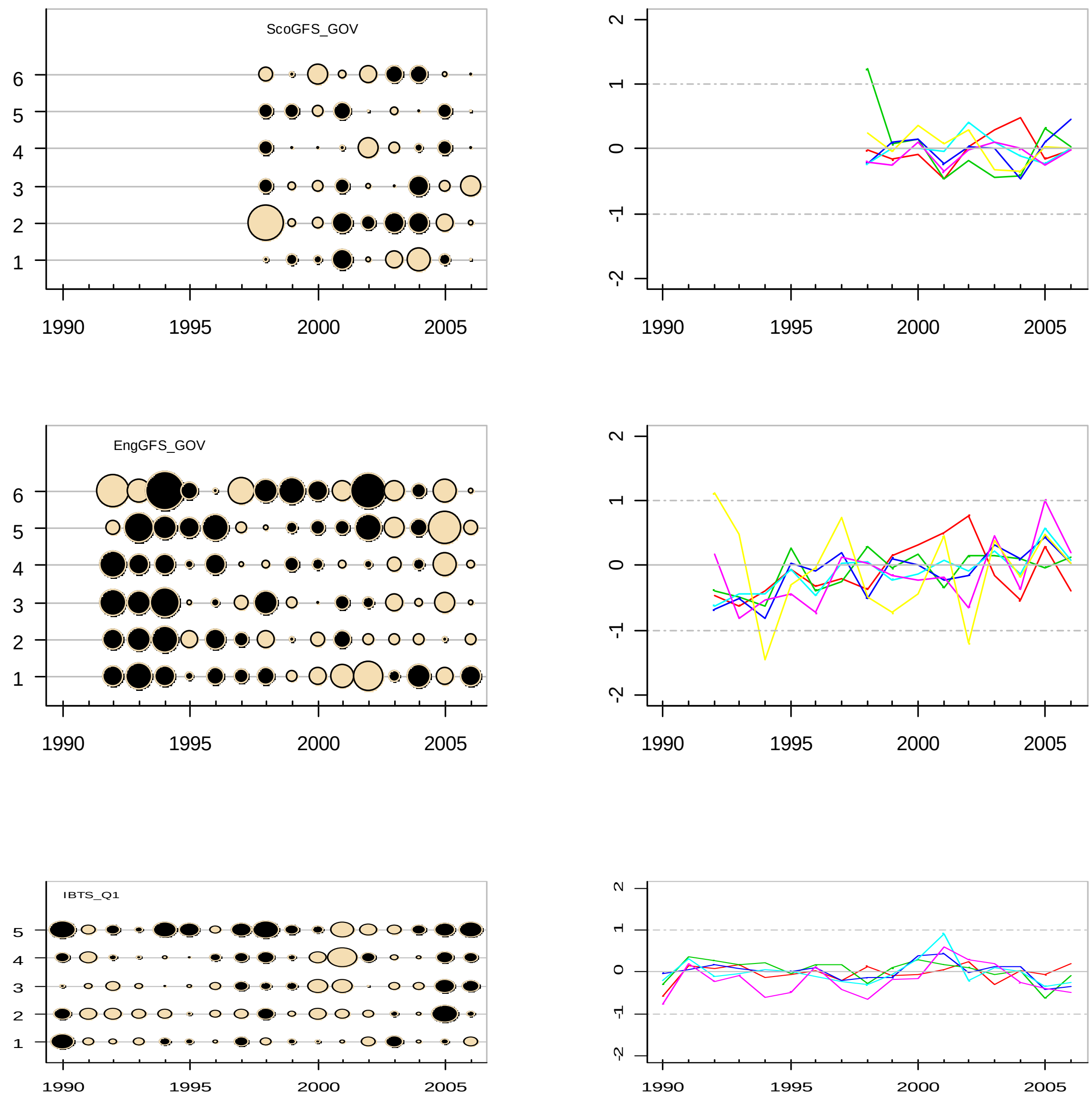


Figure 12.3.12 Whiting in IV and VIId. XSA final run: log catchability residuals.

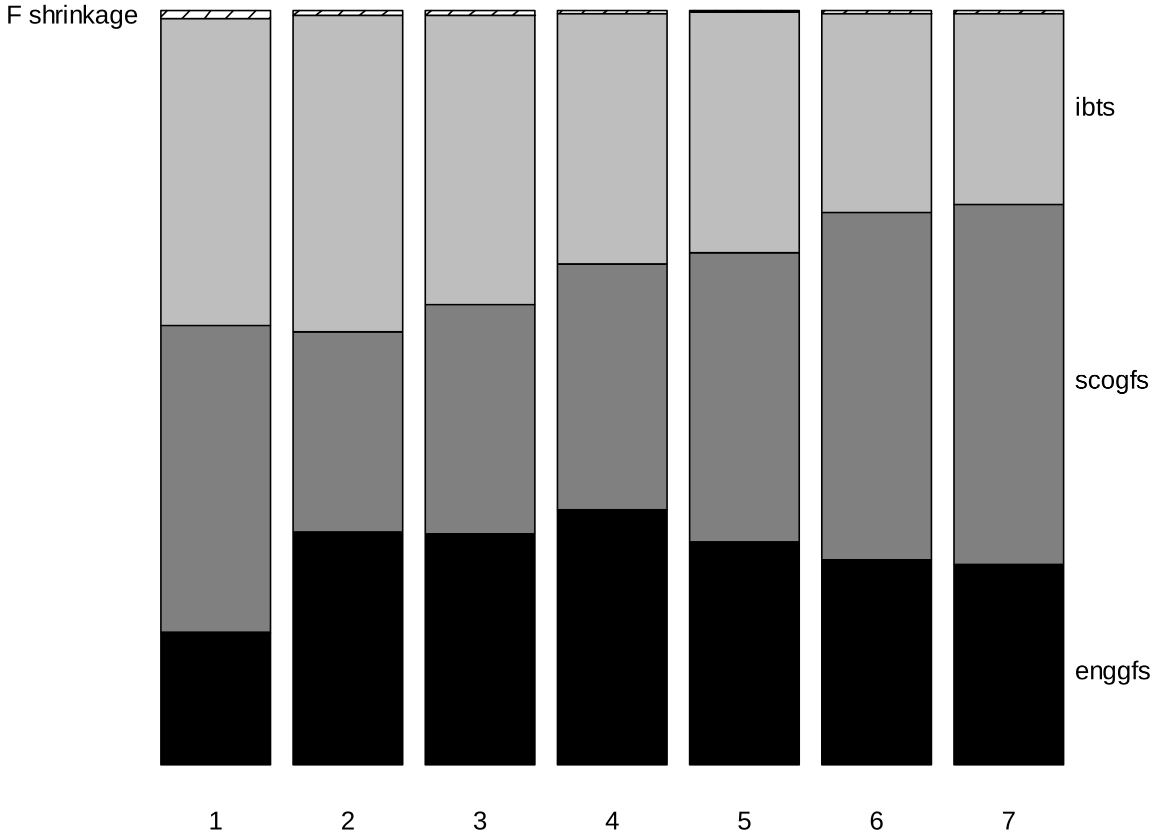


Figure 12.3.13 Whiting in IV and VIId. XSA final run: comparison of (a) fleet survivor ratios and (b) fleet weights. Note: only three fleets, ENGGFS (92–05), SCOGFS (98–05) and IBTS Q1, contribute to the survivor estimates in the final year.

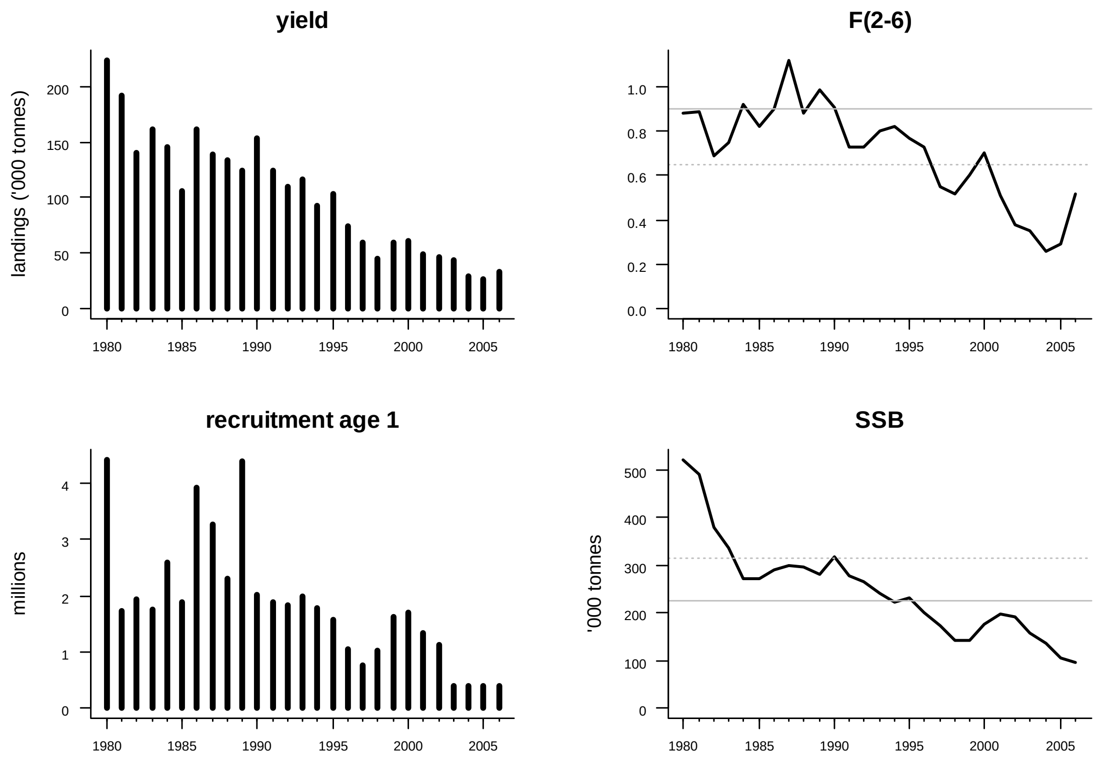


Figure 12.3.14 Whiting in IV and VIId. XSA final run: Summary plots. The dotted horizontal lines indicate Fpa, Flim, Bpa and Blim.

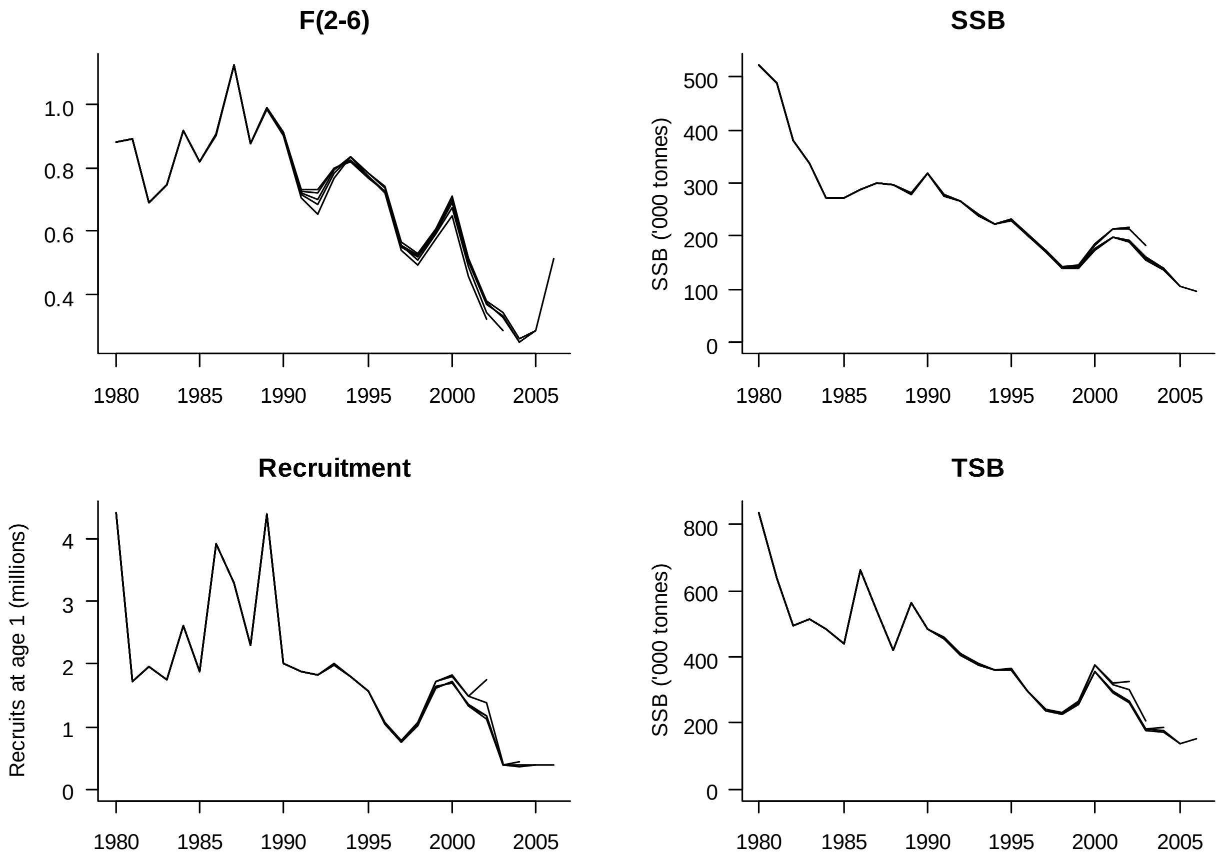


Figure 12.3.15 Whiting in IV and VIId. XSA spaly run: 5 year retrospective patterns.

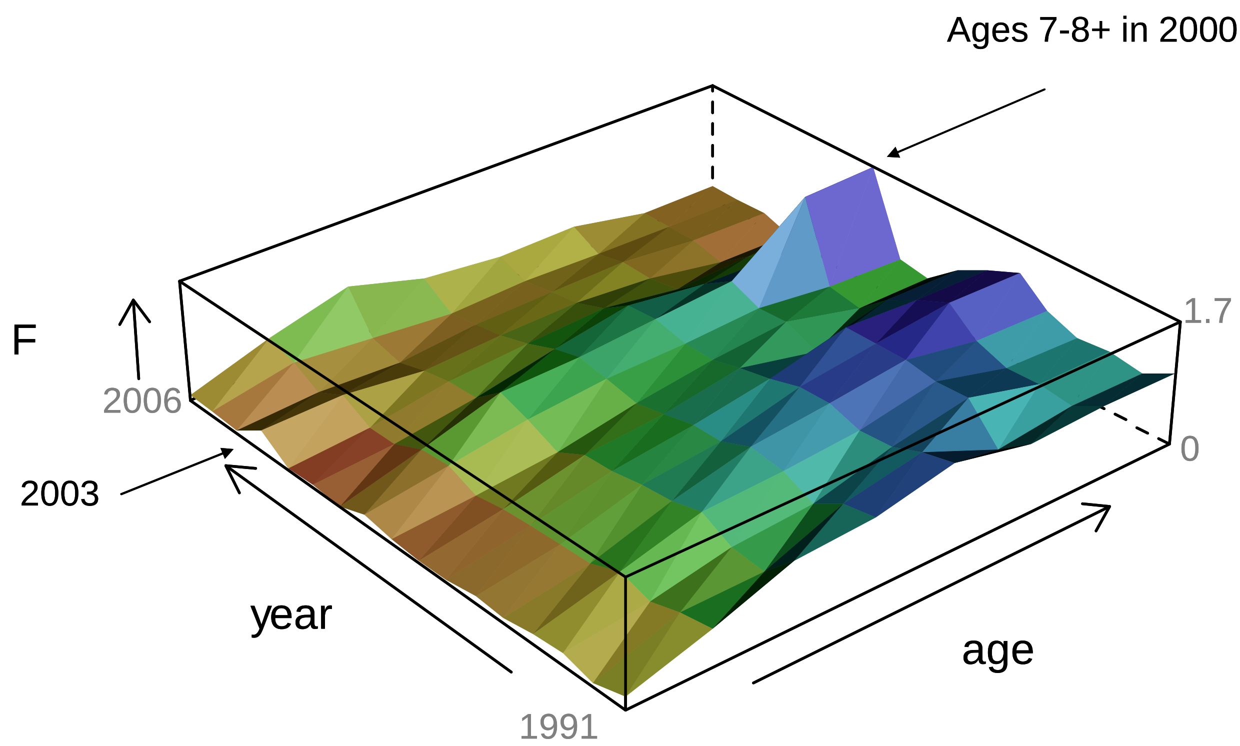


Figure 12.4.1 Whiting in IV and VIId. Changes in estimated exploitation pattern plotted as a wireframe.

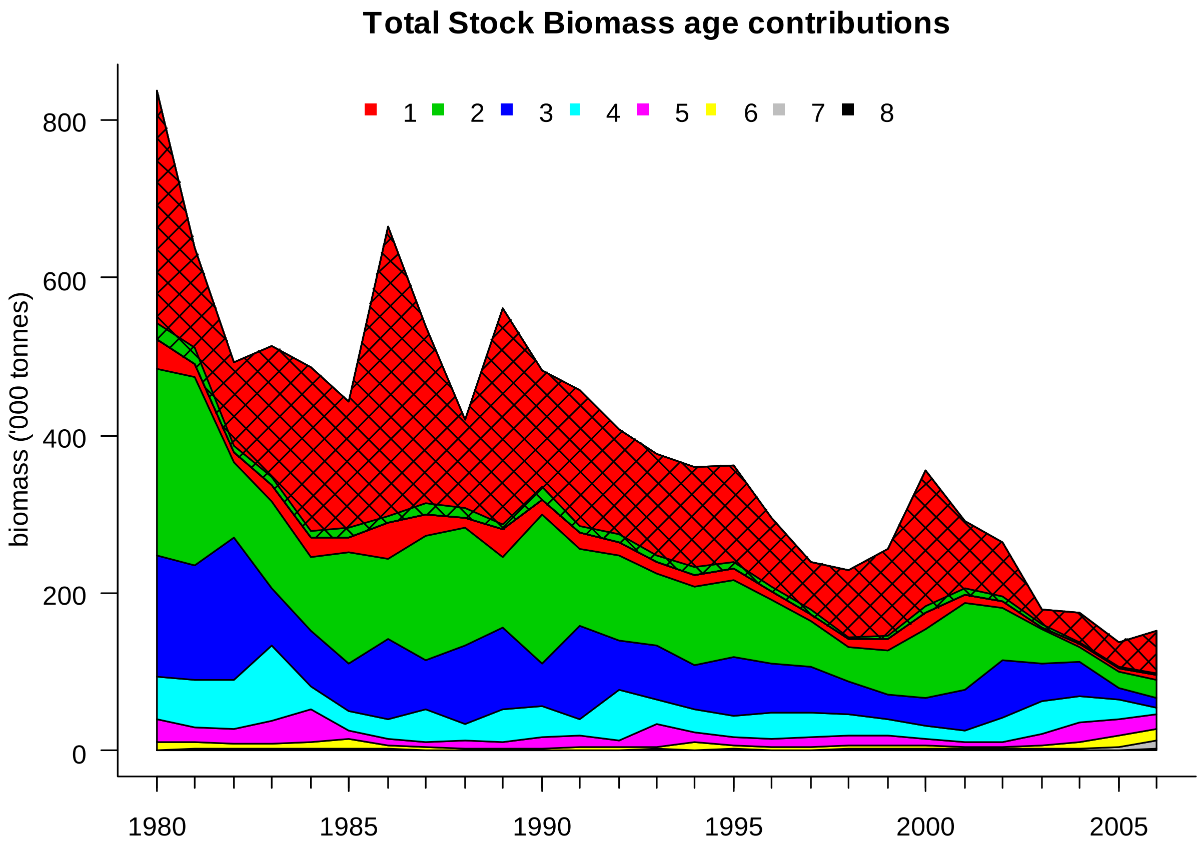


Figure 12.4.2 Whiting in IV and VIId. Age contributions to the SSB and TSB. Biomass not contributing to SSB is overlayed with hatched lines.

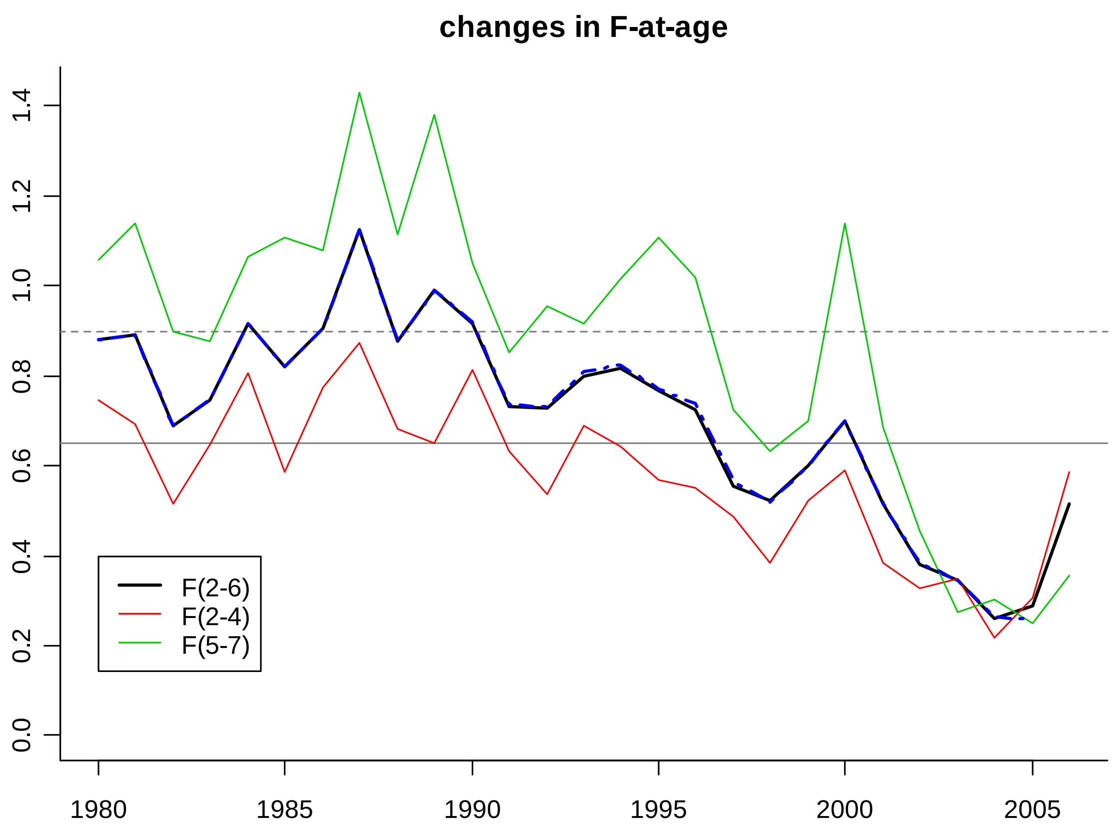


Figure 12.4.3 Whiting in IV and VIId Whiting in IV and VIId. Historical stock trends in F(2-6) (last years final runs shown as a dotted line), and changes in historic F-at-age in the recent period.

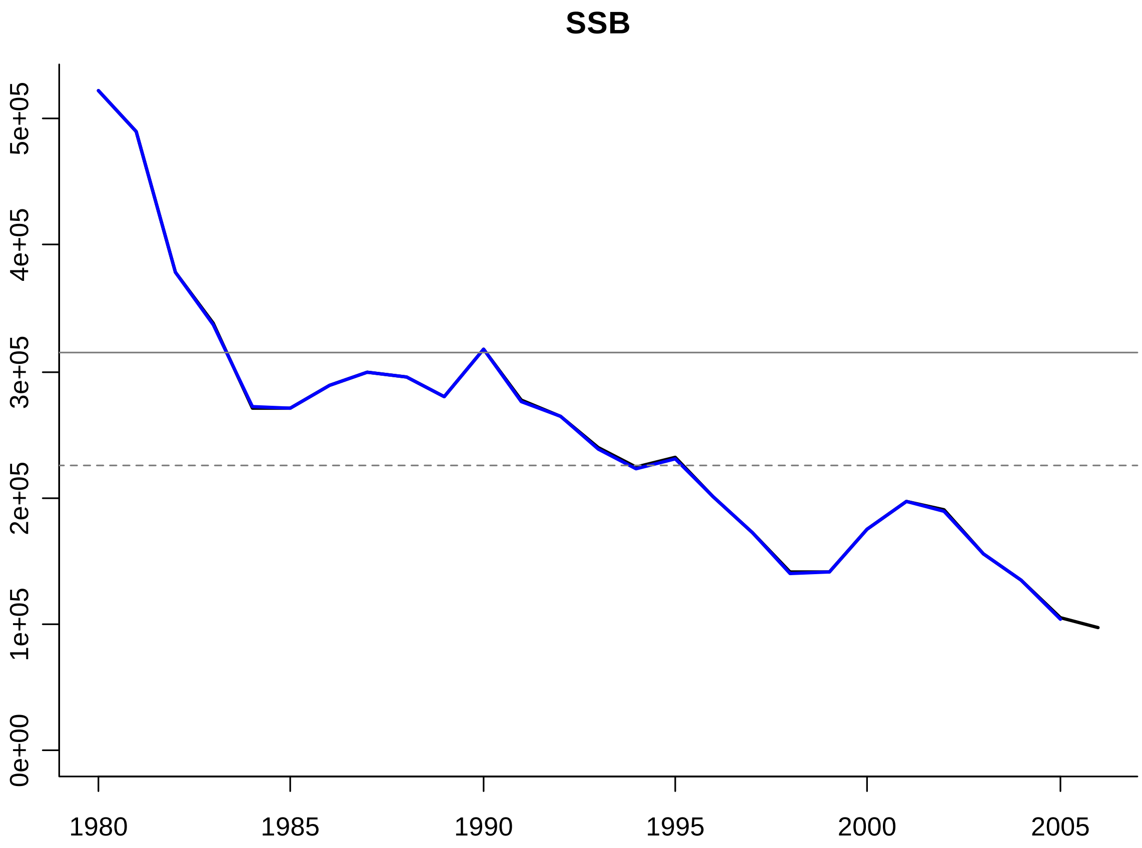


Figure 12.4.4 Whiting in IV and VIId. Historical stock trends in SSB (last years' final runs shown as a blue line).

Figure 12.4.5 Whiting in IV and VIId. Historical stock trends in recruitment (last years' final runs shown as a blue line).

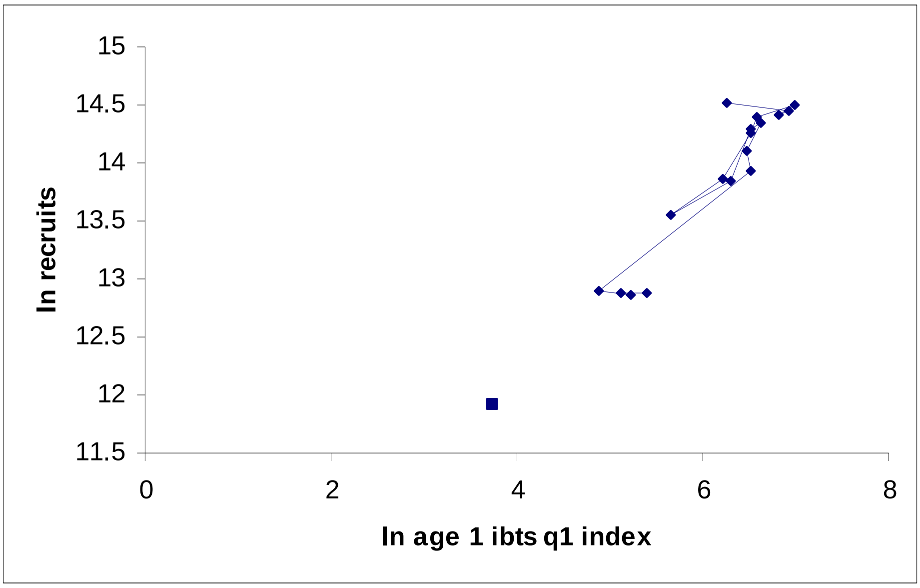


Figure 12.5.1 Whiting in IV and VIId. Log IBTS Q1 against log estimated recruitment from XSA over the period 1990–2006. Prediction for 2007 is shown as a square.

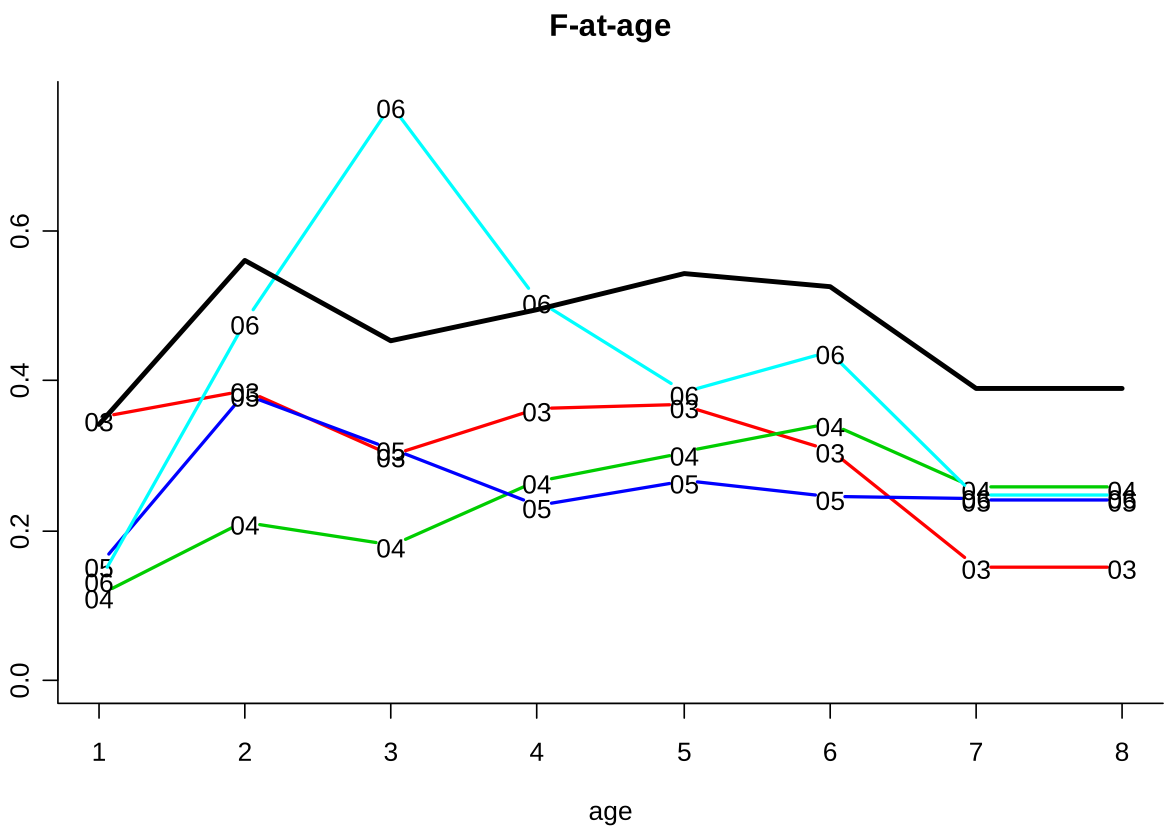


Figure 12.6.1 Whiting in IV and VIId. Estimated fishing mortality at age for the years 2003 to 2006. The black line shows the average exploitation pattern over years 2003-2005 scaled to F(2–6) of the final year.

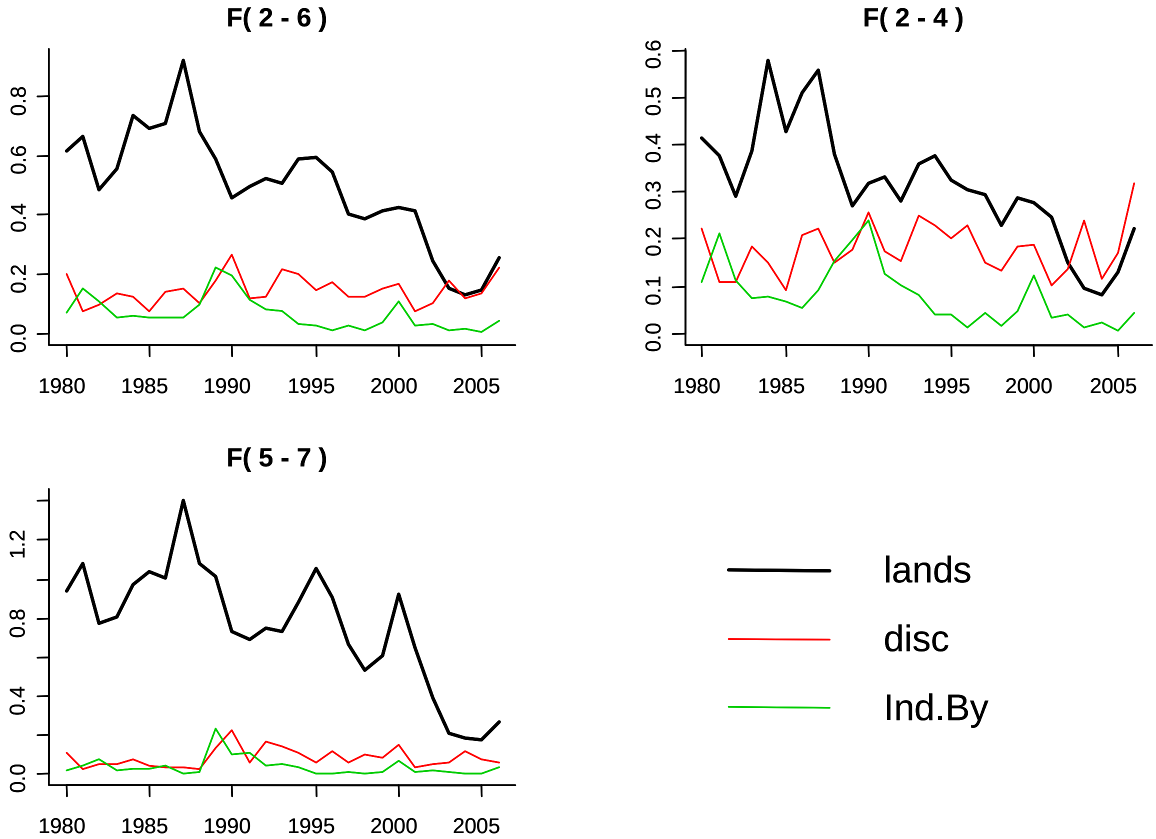
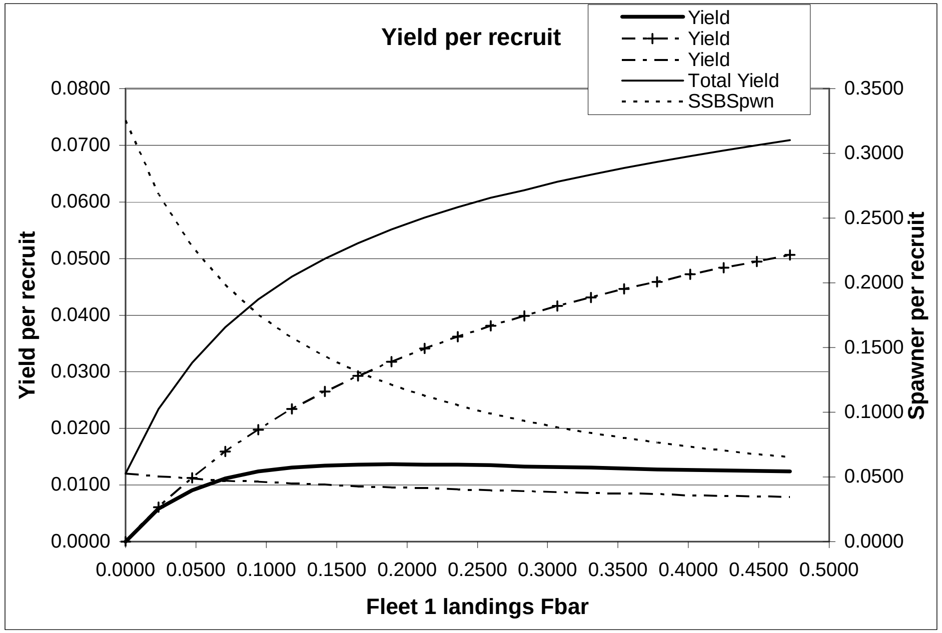
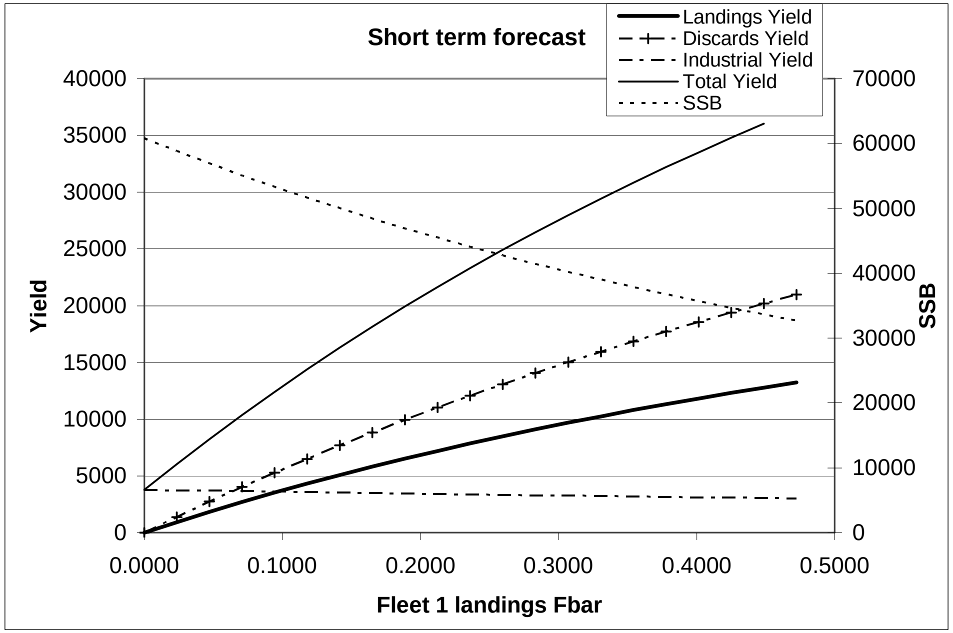


Figure 12.6.2 Whiting in IV and VIId. Trends in partial Fbar calculated over ages, 2–6, 2–4 and 3–5, for human consumption landings, discards and industrial by-catch.





MFYPR version 2a
Run: whi.me.ypr
Time and date: 13:28 07/05/2007

Reference point	F multiplier	Absolute F
Fleet1 Landings Fbar(2-6)	1.0000	0.2361
FMax	0.8078	0.1907
F0.1	0.4357	0.1029
F35%SPR		

Weights in kilograms

MFDP version 1a
Run: whi.me
Time and date: 11:46 07/05/2007
Fbar age range (Total) : 2-6
Fbar age range Fleet 1 : 2-6
Fbar age range Fleet 2 : 2-6

Input units are thousands and kg - output in tonnes

Figure 12.6.2 Whiting in IV and VIId. Results from yield per recruit analysis and short term forecast

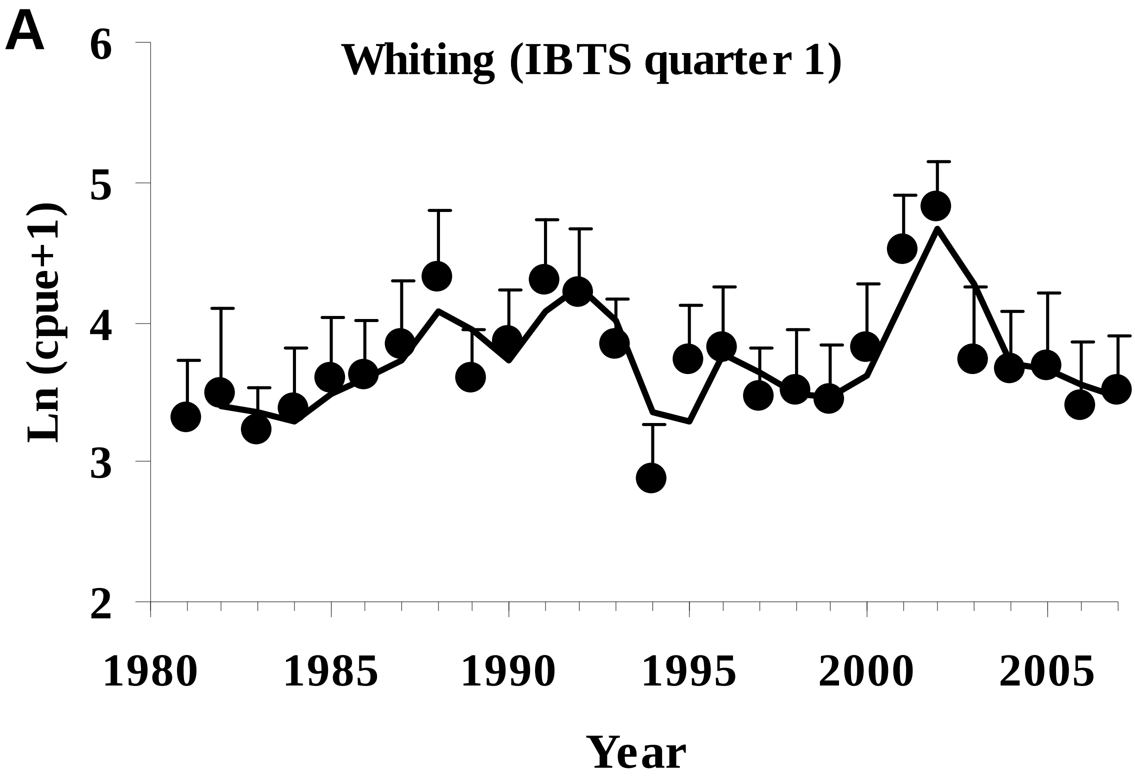


Figure 12.12.1 Whiting IIIa. Trends in ln-cpue (Kg per 1 hour trawling) of whiting during the IBTS (quarter 1) performed by the Swedish RV Argos in Kattegat and Skagerrak, between 1981–2007. Vertical bars represent upper 95% confidential intervals.

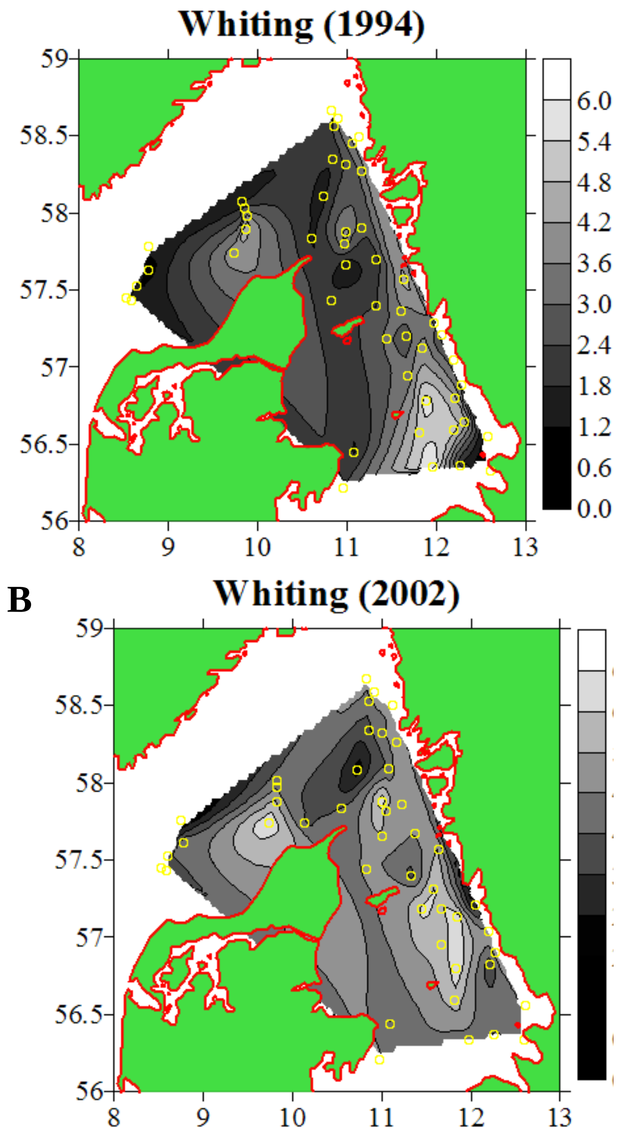


Figure 12.12.2 Whiting IIIa. Spatial distribution of whiting at the highest (left map) and lowest (right map) values of ln-cpue observed during the IBTS (quarter 1) performed by the Swedish RV Argos in Kattegat and Skagerrak, between 1981–2007. Circles represent haul position. Scale bars represent ln-cpue. The Natural Neighbour interpolation method was used to create the distribution maps. Modified from Casini *et al.* (2005).

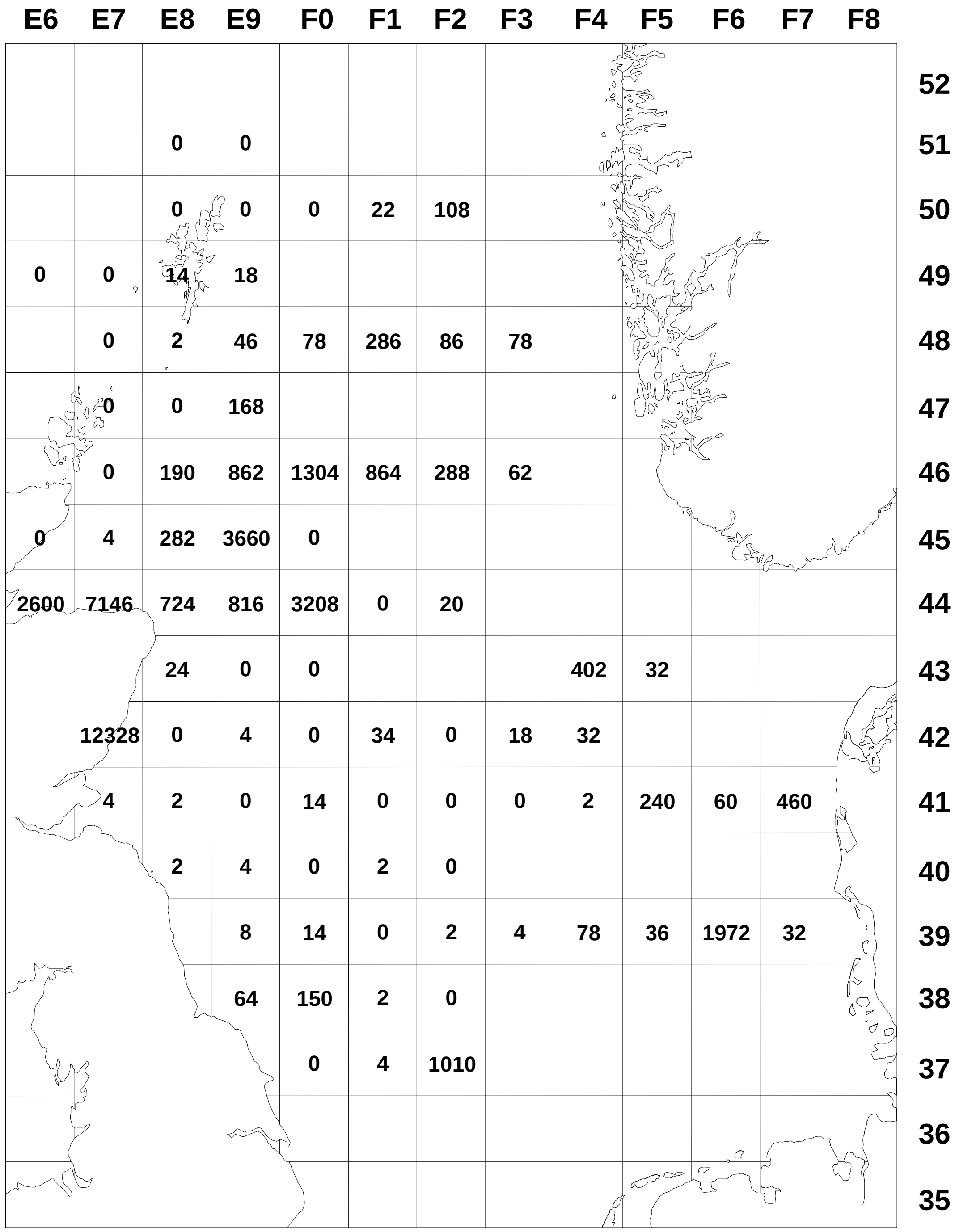


Figure 12.13.1. Whiting in Sub-Area IV and Divisions VIId and IIIa update. Spatial distribution of CPUE for age 0 whiting from the Scottish groundfish survey by ICES rectangle. It should be noted the distribution map relates to numbers caught per hours fishing, whilst the survey indices traditionally relate to numbers caught per 10 hours.

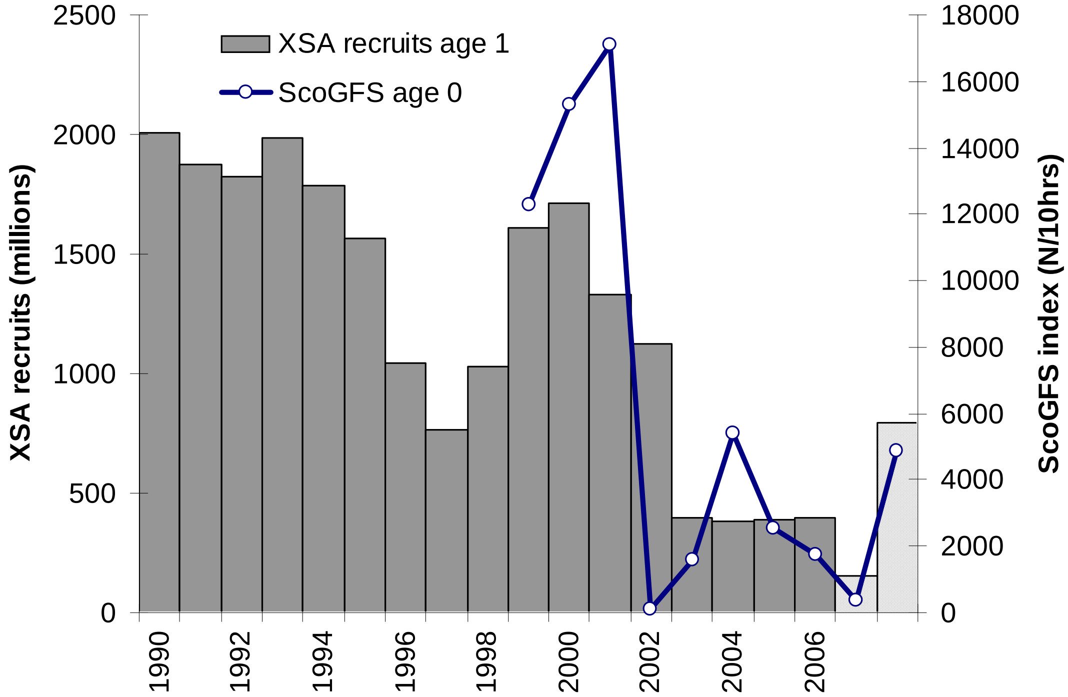


Figure 12.13.2. Whiting in Sub-Area IV and Divisions VIId and IIIa update. Scottish groundfish survey CPUE for age 0 in quarter 3 shifted forward by one year (blue line) compared to estimates of recruits at age 1 from the final XSA run (bars shaded grey), with the recruitment for 2007 and 2008 (estimated using RCT3) taken forward in the short term forecast (shaded).

13 Haddock

The assessment of haddock in Subarea IV and Division IIIa is modified to account for the large 1999 year class which in 2006 was 7 years old: in the previous assessment method this year class would now be entering the plus group.

13.1 General

13.1.1 Ecosystem aspects

Haddock in Subarea 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 300 m, but prefer depths between 50 m and 200 m. They are found as juvenile fish in coastal areas in particular in the Moray Firth, around Orkney and Shetland, along the continental shelf at around 200 m and continuing round to the Skagerrak. Adult fish are 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, mainly for 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 the largest proportion of the haddock stock. This fleet is not just confined to the North Sea, as boats will often operate in area VI off the west coast of Scotland.

The number of Scottish based vessels (over 10 m) 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. Amongst the remaining vessels there has been a reduction in the segment operating seine net or pair seine. The observed shift towards pair trawling from single boat seine and trawls in the early 2000’s may have implied an increase in catchability, but the decommissioning rounds in 2002 and 2003 included a slightly higher proportion of pair trawlers, resulting in no real overall change in fleet composition.

The number of Scottish based vessels (over 10 m) in the demersal sector was reduced by approximately 6% from 2004 to 2005. 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). The recent observed shift towards pair trawling from single seine may be explained by a standardization of reporting and recording of gear types. Vessels previously participating in the seine net class may have included vessels operating pair seine whereas this classification is now recorded as pair trawl. Although there have not been major decommissioning schemes affecting haddock fisheries in the most recent years, a number of Scottish vessels have been taking up opportunities for oil support work during 2006 (and early 2007) with a view to saving quota and days at sea.

In 2005, there was an expansion in the squid fishery in the Moray Firth area resulting from increased effort from smaller (<10m) vessels, and from a number of larger vessels that had switched from demersal fisheries for haddock and cod, to squid fisheries, in order to avoid days-at-sea restrictions (ICES-WGFTFB 2006). The mesh regulation for squid fishing is 40 mm codend, which could lead to bycatch/discard of young haddock and cod. In 2006, however, the squid fishery declined (from 1785 t in 2005 to 762 t in 2006), with the Moray Firth fishery in particular showing the biggest decrease (from 762 t to 155 t). Vessels that shifted away from squid targeted Nephrops instead.

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. Accompanying the change in emphasis towards the haddock fishery, there has also been a tendancy to target smaller fish in response to market demand. Some trawlers operating in the east of the North Sea are using 130 mm mesh (to ensure they meet regulations) – this is likely to improve selectivity for haddock. Information from Belgium also suggests that the use of larger meshes is reducing whiting and haddock catches. 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 still 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. Haddock uptake for UK vessels in the North Sea at the end of December 2006 stood at 32 378 tonnes, which represented 83% of the quota allocated. The producer organisations also adopted a conservative approach to quota management in the early part of the year which contributed to the lack of full quota uptake.

Technical developments include the development of double bag nets which increase efficiency at reduced cost. It is unclear whether these gears affect the selectivity of haddock (ICES-WGFTFB 2007). A new derogation introduced at the 2006 December Council (Council Regulation No. 41/2006) allows extra days fishing for the introduction of a 120 mm square mesh panel in 90 mm+ mesh nets. Observations suggest this increases the selectivity of haddock but uptake of this option has been limited, so its effect is not yet known. Increased uptake of the Swedish grid in IIIa and experimental uptake of a species selective trawl in the Farne Deeps Nephrops fishery may also enhance the selectivity of haddock.

13.1.3 ICES Advice

In 2006, 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 2005 was estimated at 256 000 t, with an estimated decrease to around 230 000 t for 2006. 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; and that the 2006 year class is low.

Fishing mortality for 2005 was estimated at 0.32, well below Fpa = 0.7. Following the agreed management plan (F=0.3) would imply human consumption landings of 55 400 t in 2007 which is expected to lead to an SSB of 291 100 t in 2008.

- For all demersal fisheries in the North Sea, ICES advice was based on mixed-fishery considerations.

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 December 2006.

The plan shall consist of the following elements:

1. Every effort shall be made to maintain a minimum level of Spawning Stock Biomass greater than 100,000 tonnes (Blim).

2. For 2007 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.3 for appropriate age-groups, when the SSB in the end of the year in which the TAC is applied is estimated above 140,000 tonnes (Bpa).

3. Where the rule in paragraph 2 would lead to a TAC which deviates by more than 15% from the TAC of the preceding year the Parties shall establish a TAC that is no more than 15% greater or 15% less than the TAC of the preceding year.

4. Where the SSB referred to in paragraph 2 is estimated to be below Bpa but above Blim the TAC shall not exceed a level which will result in a fishing mortality rate equal to 0.3-0.2(Bpa-SSB)/(Bpa-Blim). This consideration overrides paragraph 3.*

5. Where the SSB referred to in paragraph 2 is estimated to be below Blim the TAC shall be set at a level corresponding to a total fishing mortality rate of no more than 0.1. This consideration overrides paragraph 3.

6. In order to reduce discarding and to increase the spawning stock biomass and the yield of haddock, the Parties agreed that the exploitation pattern shall, while recalling that other demersal species are harvested in these fisheries, be improved in the light of new scientific advice from inter alia ICES.

7. In the event that ICES advices that changes are required to the precautionary reference points Bpa (140 000t) or Blim (100 000t) the parties shall meet to review paragraphs 1-5.

8. No later than 31 December 2009, the parties shall review the arrangements in paragraphs 1 to 7 in order to ensure that they are consistent with the objective of the plan. This review shall be conducted after obtaining inter alia advice from ICES concerning the performance of the plan in relation to its objective.

This arrangement enters into force on 1 January 2007."

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 2006 and 2007 TACs for haddock in Subarea IV and Division IIIa (EC waters) were 51 850 t and 54 640 t respectively, while these TACs for Divisions IIIa-d were 3 189 t and 3 360 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.

At the December Council 2006 (EC 41/2006), additional derogations were introduced to allow additional days fishing in the smaller mesh (90 mm) trawl fishery where vessels fitted a square mesh window close to the cod end to allow for improved selectivity of these gears (and hence the possibility of lower haddock discards). The change in mesh size 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 determine 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. A description of how the catch data are collated is provided in the stock annex. These data are illustrated in Figure 13.2.3.1: estimates of discards, which were declining from 2001 to 2005 have increased in 2006. Discard estimates from 2006 were provided for area IIIa from Sweden and Denmark; but these were not included in the assessment because no data is provided for the period prior to 2003 and only partial data is available for 2003-4.

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. A summary of the catch at age data is given in Figure 13.2.3.2 to allow one to see the contribution of each age-class to the total catch and the catch components (human consumption landings, discard estimates and industrial bycatch estimates). This plot shows the strong reliance of the recent [human consumption] fishery on the 1999 year class; and the prevalence of younger fish in the discard and industrial bycatch components.

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 bycatch. 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 and are illustrated in Figure 13.2.3.3: this shows the declining trend in weights at age, as well as evidence for reduced growth rates for large year classes.

13.2.4 Maturity and natural mortality

Maturity and natural mortality are assumed fixed over time and are given below. The basis for these estimates is described in the stock annex.

age	0	1	2	3	4	5	6	7+
Natural Mortality	2.05	1.65	0.40	0.25	0.25	0.20	0.20	0.20
Proportion Mature	0	0.01	0.32	0.71	0.87	0.95	1	1

13.2.5 Catch, effort and research vessel data

The spatial distribution of catches from the Scottish fleet is given in Figure 13.2.3.4. This shows how the fleet concentrated on the northern part of the North Sea. A breakdown by quarter is also given, indicating that catches are taken throughout the year in more or less the same areas with slightly lower catches in Quarter 2.

Survey distribution and annual density at age for recent years is given in Figure 13.2.5.1 for the IBTS Q1 survey and Figure 13.2.5.2 for the quarter 3 IBTS survey (incorporating the Scottish and English groundfish surveys). All plots show a north to north westerly distribution of haddock. Strong incoming year classes, such as the 1999 year class, and to a lesser extent the 2005 year class, can also be seen and tracked through time.

XSA uses survey data up to the last year of catch data but cannot use plus groups in the tuning index: therefore, the IBTS quarter 1 survey is backshifted three months so that, for example, the index for age 4 in 2007 becomes the index for age 3 in 2006, thus allowing the inclusion of the entire series. The units of the entire English Groundfish survey time series have been changed this year to reflect the units that are equivalent to the GOV index (previously they had been adjusted to match those of the Granton trawl).

Data available for calibration of the assessment are presented in Tables 13.2.5.1. Trends in survey CPUE are shown in Figure 13.2.5.3 and trends in commercial CPUE in Figure 13.2.5.4. 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 13.2.5.5) 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. Tabulated catch and effort data can be found in the stock annex.

Data available are summarised in the Table below, the series used are in bold.

Country	Fleet	Quarter	Code	Year range	Age range available	Age range used
Scotland	seine	Q1-4	ScoSEI	1978-2006	0 - 13	-
	light trawl	Q1-4	ScoLTR	1978-2006	0 - 13	-
	groundfish survey (Scotia II)	**Q3**	**ScoGFS (early)**	**1982-1997**	0 - 8	**0 - 7**
	groundfish survey (Scotia III)	**Q3**	**ScoGFS (recent)**	**1998-2006**	0 - 8	**0 - 7**
England	groundfish survey (Granton trawl)	**Q3**	**EngGFS (early)**	**1977-1991**	0 - 10+	**0 - 7**
	groundfish survey (GOV trawl)	**Q3**	**EngGFS (recent)**	**1992-2006**	0 - 10+	**0 - 7**
International	groundfish survey	**Q1**	IBTS	1983-2007	1 - 6+	1 - 5
			IBTS (backshifted) *	**1982-2006**	0 - 5+	**0 - 4**

* This survey is used as if it occurred at the end of the previous year

13.3 Data analyses

The consistency of the age information in the commercial catch and survey data is illustrated by catch curves (Figure 13.3.2.1) and correlation plots (Figure 13.3.2.3). Given problems with the recording of effort (Section 13.2.5), the available commercial CPUE series are not considered for further analysis. XSA (FLR version) was used as the principal method of assessment.

The primary intention for this year was to perform an update assessment, i.e. same procedure as last year (SPALY). However, the entry of the 1999 year class, as age 7 into the XSA plus group, presented some concerns that merited some exploratory assessments extending the age of the plus group to 8+. The conclusion drawn from these was to accept a final assessment which is a significant modification from the SPALY run: further details are given below.

13.3.1 Reviews of last year's assessment

Two relatively minor concerns were raised by the RGNSSK regarding last year's haddock assessment. These were summarized as follows:

- IBTS-Q1 is used from 1983, even though the survey starts in 1967. The Stock Annex now specifies why this early part of the series is not used.
- The review group requested that the WG make some comment on the yield per recruit analysis where these indicated changes in the estimated values of Fmax and F0.1. Due to the contracted time available for the WG this year a yield per recruit analysis was not possible.

The North Sea Commission Fisheries Partnership Review Group, which normally examines the assessments, did not meet in 2006.

13.3.2 Exploratory catch-at-age-based analyses

The catch-at-age data, in the form of log-catch curves linked by cohort (Figure 13.3.2.1), indicates partial recruitment to the fishery up to age 2. Gradients between consecutive values within a cohort are fairly constant from ages 2 to 7. Figure 13.3.2.2 plots the negative gradient fitted to each cohort over the age range 2–4, which can be viewed as a rough proxy for average total mortality for ages 2–4 in the cohort.

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): this 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). Analyses presented in 2006 investigated the hypothesis that the total mortality on a cohort is linked to the average growth of the cohort, showing 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.

Cohort correlations in the catch-at-age matrix (plotted as log-numbers) are shown in Figure 13.3.2.3. These correlations show good consistency within cohorts up to age 8–9, verifying the ability of the catch-at-age data to track relative cohort strengths. Standard linear regression lines are fitted to the data, along with confidence limits.

In order to investigate the sensitivity of XSA to the effects of tuning by individual fleets, single-fleet XSAs for the final assessment were produced. Results are shown in Figure 13.3.2.4 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 13.3.2.5 (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 XSA analyses

The XSA SPALY run (WGNSSK, 2006) uses a plus group at age 7. In 2006, the large 1999 year class (which still makes up over 40% of the human consumption catches by weight), is 7 years old and, therefore, enters the plus group. Conceptually, it is undesirable to include such a large component of the catches into a plus group which is usually used to integrate the smaller numbers in the older age classes into one age class. More importantly, in XSA, the fishing mortalities in the plus group are set to be the same as in the final true age. It would be preferable to estimate a specific fishing mortality for the large 1999 year class, particularly for the purposes of forecasts. The plus group was, therefore, extended to age 8. Furthermore, as XSA does not use plus group data in the tuning process, extending the plus group out to 8 allows the catch data at age 7 to be tuned. This is also desirable for this large year class, particularly as two of the tuning series have good data at ages 6 and 7, as evidenced from the survey catch curves (Figure 13.3.3.1 and 13.3.3.2) and within survey correlations at age (Figures 13.3.3.3–6). The ages considered from the surveys (tuning fleets) were then extended to age 7 to allow for tuning to these ages (SPALY would use survey ages 1–5). Finally, the age at which survey catchability is independent of age (q age) was extended from the SPALY setting of 3 to 6, in order to explore the effect of allowing the model to estimate the survey catchabilities at these ages. There were, therefore, three main exploratory assessments:

1) SPALY run (plus group=7; q age=3; survey ages 0-5) in accordance with the TOR to provide an update assessment.
2) SPALY run with the exception that q age = 6.
3) Run with the plus group extended to 8; survey ages 0-7; and q age = 6.

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 (Figures. 13.3.2.1 and 13.3.3.1). 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 and/or delayed recruitment to the fishery.

High within-cohort correlations for both commercial and survey catch-at-age data highlight once again that data for haddock track cohorts very well (Figures. 13.3.2.3 and 13.3.3.3–13.3.3.7). Furthermore, high correlations also exist between indices from independently conducted surveys for haddock for ages 0–7 indicate the suitability of the combined use of these indices for the assessment of haddock.

The residual patterns for the three assessment options: 1) SPALY; 2) SPALY with q age = 5; and 3) plus group 8; are given in Figures 13.3.5.1–3 respectively. The SPALY run has a series of negative residuals in the older ages (4 and 5) for the English Groundfish survey (Figure 13.3.5.1); the Scottish ground fish survey also has some indication of these at age 5. The SPALY run with a q age = 5 option has an improved set of residuals (smaller and more variable at the older ages – see Figure 13.3.5.2). The plus group 8 option, in common with the latter, has similarly reasonable residuals at ages 4-5, and although the residuals on the older ages (6 and 7) are larger there is no consistent pattern (Figure 13.3.5.3). The residuals from the IBTS were similar for all three options.

The differences in stock trends for the three options are illustrated in Figure 13.3.5.4. The patterns of fishing mortality at ages 2-4 are very similar for all three options, but the SPALY at q age=5 gives slightly lower mean F's. Recruitment and Total Stock Biomass trends are very similar for all three options with the exception of estimates in 1999 and 2000 where the SPALY at q age=5 option giving slightly higher values. The pattern of SSB is similar but the SPALY at q age=5 option gives higher SSBs since 2002. All options show a decreasing trend in SSB and result in quite similar estimates at 2006. The new 8 plus option gives almost identical trends to the SPALY run.

The final assessment, accepted by the WG, was that of the plus group 8 option. This is due to the advantages of tuning the older (6 and 7) ages to the survey; the estimation of fishing mortality for the large 1999 year class in 2006; and the good pattern of residuals in this option compared to the other options.

13.3.5 Final assessment

The XSA final assessment takes the plus group out to age 8, set the catchability to be dependent on stock size for age 0, assumes constant catchability for ages 6 and above, has the ENGGFS and SCOGFS tuning series out to age 7 and the IBTS Q1 series out to age 5 (backshifted to age 4). 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	2007
q plateau		2	3	3	6
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	fleet 1: 77-91 fleet 2: 92-06
	SCOGFS	82-03 (single fleet only)	fleet 1: 82-97 fleet 2: 98-04	fleet 1: 82-97 fleet 2: 98-05	fleet 1: 82-97 fleet 2: 98-06
	IBTS Q1*	82-03	82-04	82-05	82-06
Tuning fleet age ranges	ENGGFS	0-5	0-5 (both)	0-5 (both)	0-7 (both)
	SCOGFS	0-5	0-5 (both)	0-5 (both)	0-7 (both)
	IBTS Q1*	0-4	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 13.3.5.3, and a comparison of fleet-based contributions to survivors in Figure 13.3.5.5. 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 13.3.5.6. A retrospective analysis, shown in Figure 13.3.5.7, indicates a little retrospective bias in SSB.

The final estimates for the stock in 2006 are:

F(2-4) = 0.54

SSB = 168 kt

13.4 Historic Stock Trends

The historic stock and fishery trends are presented in Figure 13.3.5.6.

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. Recruitment in 2005 was moderate in size, much larger than those in 2001–2004, but still only a third of the size of the 1999 year class. The most recent recruitment (2006) is estimated to be very low.

Mean F (ages 2–4) has fluctuated above Fpa for most of the time series, with extended periods above Flim as well. Until 2006, mean F over recent years had declined and was estimated to have been well below Fpa (0.7) for the last four years, around the management plan target of F(2-4)=0.3. However, mean F(2-4) has risen to 0.54 in 2006, albeit still below Fpa.

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. SSB has declined to 168 kt in 2006.

The North Sea Fishers' survey has not yet been completed, so no comparison can be made between the stock trends observed from the assessment and the fishers' perception from the Fishers' survey.

13.5 Recruitment estimates

The shift in timing of the working group has meant that recruitment estimates from 2007, usually taken from the Q3 ScoGFS, were not available. Recruitment estimates were, therefore, based on the mean of past recruitments. Recruitment following a high year class has generally tended to be followed by a sequence of low recruitments (Figure 13.3.5.6). In order to take this feature into account, the average of the 5 lowest recruitment values over the period 1994–2003, 6269 million, has been assumed for recruitment in 2007, 2008 and 2009 (SPALY). The period considered for this value excludes 2004–2006 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 short term forecast.

Year Class	Age in 2007	XSA (millions)	Average Low Recruitment (5 lowest values for 1994-2003) (millions)
2005	2	838	
2006	1	783	
2007	0		6269
2008	Age 0 in 2007		6269
2009	Age 0 in 2008		6269

13.6 Short-term forecasts

The slow growth of the 1999 and 2000 year classes continues to pose a problem for the short-term forecast. Mean stock weights for the 1999 and 2000 year classes were calculated using proportional increments (i.e. 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). This method was approved by the review group as being appropriate to project the weights at age. Mean stock weights for other ages in the forecast where taken as a 5-year average (2002–2006), omitting the 1999 and 2000 year classes from the calculation where appropriate. The human consumption mean weights at age were derived in the same manner as for the stock weights-at-age. However, mean weights at age for the 1999 and 2000 year classes did not show unusual growth in the discard and industrial bycatch components, so future mean weights-at-age were set to the average for the years 2002–2006 for these components.

The 1999 and 2000 year-classes are part of the plus-group in 2008 and 2009. This required a re-calculation of the plus-group stock and human consumption mean weights for 2008 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 8-10+, where the low weight of the 1999 and 2000 year-classes were included at the appropriate age. The final stock weights at age estimates used are compared to estimates of weights at age in the stock from the catch and surveys in Figure 13.6.1.

The 2006 exploitation pattern was taken to represent the exploitation pattern for the forecast (SPALY). 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.

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 2006 only, given the upward trend in F (2–4) for 2003-6 (Figure 13.3.5.3).

At status-quo F in 2007 and 2008, SSB is expected to rise to 212 855 t in 2007, 219 017 t in 2008 and 185 092 t in 2009. The human consumption yield at status-quo F will be around 71 241 t in 2007, and around 65 000 t in 2008. Discards at status-quo F will be around 40 000 t in 2007, and around 22 000 t in 2008.

Taking the management plan F (0.3) corresponds to a human consumption yield of about 39 000 t in 2008 (TAC in 2007 was 58 000) and an SSB of 217 000 t in 2009.

A number of other forecast options are given in Tables 13.6.4–6 based on the following alternative assumptions about the exploitation pattern in 2007:

2) Constraining the human consumption catches in 2007 to the TAC (58 000 t in 2007). This implies an F(2-4) of 0.42; the yield in 2008 at the management plan F (0.3) would then be 42 500 t (Table 13.6.4) .

3) An exploitation pattern in 2007 that is the average of the pattern in 2004–2006, scaled to the average F(2-4) in 2006 of 0.54 (such that the exploitation pattern in 2007 also has an F(2–4) of 0.54). The human consumption yields are about 65 000 t in 2007 and 71 000 t in 2008 (Table 13.6.5). The human consumption yield in 2008 at the management plan F (0.3) would then be about 43 500 t (Table 13.6.4).

4) An exploitation pattern in 2007 that is the average of the pattern in 2004–2006. The human consumption yields are about 52 000 t in 2007 and 62 000 t in 2008 (Table 13.6.6). The human consumption yield in 2008 at the management plan F (0.3) would then be 48 000 t.

The three exploitation patterns used are illustrated in Figure 13.6.2. The forecast will have to be repeated in September once information on the recruiting year class becomes available from the Q3 survey. The WG felt that unless any new information from the fishery is available at that time, then the most appropriate forecast is that which is based on the 2006 exploitation pattern (SPALY option in Table 13.6.2).

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 (WGNSSK, 2006, 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. There is some retrospective bias in the assessment, with SSB being estimated to be slightly larger going back in time. However, the assessment now incorporates data (survey data out to age 7) which allows for tuning of the large 1999 year class and maintains the 1999 year class in a separate age group rather than in a plus group. The age at which survey catchability is independent of age (q age) was extended out to 6; which is also more appropriate as evidenced by the improved model fit. There is, therefore, a balance between incorporating the additional (survey) data and extending the plus group, as conceptual benefits (which have delivered good model fits), against some retrospective bias in the final assessment. The WG believe that the balance, as struck, is acceptable.

The slow growth of the 1999 and 2000 year classes, still raises some concern in dealing with forecasts. The mean weight at age in these cohorts appears to have increased only marginally year on year since 2003. 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 historic perception of the haddock stock remains unchanged from last year's assessment. However, fishing mortality has increased (0.54 in 2006 c.f to 0.36 in 2005). Although this is still below Fpa (0.7), it is now somewhat higher than the mortality rate recommended in the management plan (0.3). Spawning stock biomass is predicted to have continued in its decline from its peak in 2002–3, but remains above Bpa (140 000 t).

Although the fishery in 2006 is largely based on the 1999 year class (Figure 13.2.3.2), 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 about 10 times larger than the average for 2001–4. The 2005 year class entered the fishery as discards in 2006 and should contribute to landings from 2008 onwards. This is reflected in the high numbers of 1 year olds in the 2006 discard estimates (Table 13.2.2.3); 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 had reduced the mean fishing mortality over ages 2 to 4 effectively from 2002 to 2005. However, in 2006, this fishing mortality has increased, possibly due to the targeting of smaller haddock, or a movement inshore as fishermen try to avoid catching cod. This change in the exploitation pattern is consistent with the long term trend in the assessment which shows a reduction in mortality on the older ages relative to the younger ones in recent years. 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, this decline in SSB will be arrested in the short-term due to the moderately-sized 2005 year class starting to contribute to the SSB.

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 were fairly substantial in 2006. Improved gear selectivity measures, allowing for the release of small fish, would be highly beneficial not only for the haddock stock, but also for the survival of juveniles of other species that occur in mixed fisheries along with haddock.

The WG presents several options for the forecast depending on what is assumed about the exploitation in 2007. Given the increase in fishing mortality in the most recent year, after a period of stable fishing and relatively low mortality, it is difficult to predict which of these options is the more likely. As the forecasts will be repeated later in the year, the final option may be chosen on the basis of information from the fishery at that time. In the absence of any new information from the fishery, the WG recommends that the SPALY option be used, which uses the exploitation pattern from 2006.

Haddock is a specific target for some fleets, but is also caught as part of a mixed fishery catching cod, whiting and Nephrops. It is important to consider both the species-specific assessments of these species for effective management, as well as the latest developments in the mixed fisheries approach (ICES SG MIXMAN). However, from fishing patterns in Scotland, and the fact that haddock is now experiencing increased fishing mortality while the exploitation of cod appears to have decreased, there is a strong possibility that an amount of decoupling has occurred between these fisheries.

In 2006 EU-Norway agreed on a revised 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.

13.12 Haddock (Update from September meeting)

This section presents the results of an updated short term forecast for haddock in 2008, based on the most recent information on the recruiting year class which has become available since the WG met in May. The recruitment estimate from 2007 is taken from the Q3 Scottish Ground Fish Survey (ScoGFS). All other parameters were kept the same, i.e. the forecast is based on the 2006 exploitation pattern.

13.12.1 New information from the 3rd quarter surveys

The 3rd quarter Scottish Groundfish Survey took place from 10 August to 1 September, with a total of 85 valid hauls completed. The numbers of 0-group haddock caught per ICES statistical rectangle are given in Figure 13.12.1. The survey index time series is given in Figure 13.12.2. The results indicate that the abundance of 0-group haddock in 2007 is low (index of 1119), even smaller than recruitments in 2002-2004. This is illustrated in Figure 13.12.2, which plots the survey abundance index for age 0 together with estimates of recruitment from the XSA final assessment.

13.12.2 Recruitment estimates

In the WG report from May, recruitment estimates from 2007, usually taken from the Q3 ScoGFS, were not available. Instead, the estimates for recruitment in 2007, 2008 and 2009 were based on the mean of past 5 lowest recruitments (6,494 million). For the updated forecast, recruitment in 2007 was estimated using the calibration regression method described by Shepherd (1997), implemented in the computer program RCT3. Tables 13.12.1 and 13.12.2 present the RCT3 inputs and outputs. The RCT3 estimate of recruitment was 7,393 million. Recruitment following a high year class has generally tended to be followed by a sequence of low recruitments. In order to take this feature into account, the average of the 5 lowest recruitment values over the period 1994-2003, 6,494 million, has been assumed for recruitment in 2008 and 2009 (SPALY). The period considered for this value excludes 2004-2006 because recruitment estimates from the FLXSA 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 short term forecast.

Year Class	Age in 2007	XSA (millions)	RCT3 (using Q3 ScoGFS, 2007) (millions)	Average Low Recruitment (5 lowest values for 1994-2003) (millions)
2005	2	881		
2006	1	813		
2007	0		7393	
2008	Age 0 in 2008			6494
2009	Age 0 in 2009			6494

13.12.3 Short-term forecasts

The same assumptions made at the May WG in relation to the slow growth of the 1999 and 2000 year classes, were made for the updated forecasts: mean stock weights for the 1999 and 2000 year classes were calculated using proportional increments (i.e. 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). Mean stock weights for other ages in the forecast where taken as a 5-year average (2002-2006), omitting the 1999 and 2000 year classes from the calculation where appropriate. The human consumption mean weights at age were derived in the same manner as for the stock weights-at-age. However, mean weights at age for the 1999 and 2000 year classes did not show unusual growth in the discard and industrial bycatch components, so future mean weights-at-age were set to the average for the years 2002-2006 for these components. The 1999 and 2000 year-classes are part of the plus-group in 2008 and 2009. This required a re-calculation of the plus-group stock and human consumption mean weights for 2008 onwards. This was achieved by using the FLXSA final assessment estimates of stock numbers, appropriately adjusted for mortality, to provide a weighted average of mean weights for ages 8-10+, where the low weight of the 1999 and 2000 year-classes were included at the appropriate age

The 2006 exploitation pattern was used to represent the exploitation pattern for the forecast (SPALY). 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. The forecast was also constrained for the catch in 2007 to be equivalent to the 2007 TAC (58,000 t) and for no industrial bycatch in 2007. The inputs to the short-term forecast are presented in Table 13.12.3. Results for the short-term forecasts are presented in Table 13.12.4, with detailed outputs given in Table 13.12.5. Status-quo F is assumed to be the mean F (2-4) for 2006 only, given the upward trend in F (2-4) for 2003-6.

Constraining the human consumption catches in 2007 to the TAC (58 000 t in 2007), SSB is expected to rise to 288,767 t in 2007 and 317,501 t in 2008. The human consumption yield in 2007 is constrained to the TAC of 58,000 t and, at status-quo F, will be around 71,841 t in 2008. Discards at the constrained TAC in 2007 will be around 32,936 t in 2007, and at status-quo F around 24,351 t in 2008. Taking the management plan F (0.3) corresponds to a human consumption yield of 46,169 t in 2008 (TAC in 2007 was 58 000) and an SSB of 311,922 t in 2009. These figures represent a small change (less than 1%) in relation to the forecasts in May and as such do not merit reconsideration by ACFM.

References

Shepherd, J.G. (1997). Prediction of year class strength by calibration regression analysis of multiple recruit index series. *ICES J. Mar. Sci.* **54**: 741–752.

Table 13.2.1.1 Haddock in Subarea IV and Division IIIa. Nominal catch ('000 t) 1999–2006, 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	1001
Germany	3	1	128	239	113	69	69	186
Netherlands	0	0	0	0	6	1	0	
Norway	168	126	149	149	211	154	93	113
Sweden	206	367	283	393	165	158	175	246
UK – Scotland	0	0	7	0	0	0	0	
Total reported	1389	1527	2157	4572	2236	1498	952	1546
Unallocated	-29	-42	-254	-435	-428	-55	-188	-10
WG estimate of H.cons. landings	1360	1485	1903	4137	1808	1443	764	1536
WG estimate of industrial by-catch	334	617	218	0	0	0	0	0
WG estimate of total catch	**1694**	**2102**	**2121**	**4137**	**1808**	**1443**	**764**	**1536** **
TAC	*5400*	*4450*	*4000*	*6300*	*3150*	*4940*	*4018*	*3189* *

* Includes areas III bcd (EC waters)

** Discard estimate of 1038 not included in assessment due to lack of time series

Sub-area IV

Country	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	462	399	606	559	374	373	190	107
Denmark	2104	1670	2407	5123	3035	2075	1274	760
Faeroe Islands	55	0	1	25	12	22	11	4
France	0	724	485	914	1108	552	419	345
Germany	565	342	681	852	1562	1241	733	725
Greenland	0	0	0	0	149	10	0	
Ireland	0	0	0	0	1	0	0	
Netherlands	110	119	274	359	187	104	64	33
Norway	3830	3150	1902	2404	2196	2258	2069	1795
Poland	17	13	12	17	16	0	0	
Sweden	686	596	804	572	477	188	132	100
UK - Eng+Wales+N.Irl.	2398	1876	3334	3647	1561	1159	843	
UK – Scotland**	53628	37772	29263	39624	31527	39339	41584	32377
Total reported	63855	46661	39769	54096	42205	47321	47319	36246
Unallocated	354	-577	-811	75	74	-68	297	-216
WG estimate of H.cons. landings	64209	46084	38958	54171	42279	47253	47616	36030
WG estimate of discards	42562	48841	118320	45892	23499	17226	9508	16652
WG estimate of industrial by-catch	3834	8134	7879	3717	1149	554	168	536
WG estimate of total catch	**110605**	**103059**	**165157**	**103780**	**66927**	**65033**	**57292**	**53218**
TAC	*88550*	*73000*	*61000*	*104000*	*51735*	*77000*	*66000*	*51850* *

* Includes area II a (EC waters)

**2006 includes UK - Eng+Wales+N.Irl.

Division IIIa and Sub-area IV

	1999	2000	2001	2002	2003	2004	2005	2006
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 Subarea 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%
2006	36.0	16.7	0.5	53.2	1.5	1.0	2.6	55.8	4.0%
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 Subarea 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	**8+**
1963	**1367**	**1307178**	**335092**	**20963**	**13026**	**5781**	**502**	**653**	566	59	18	0	0	0	0	0	**642**
1964	**140235**	**7436**	**1296771**	**135227**	**9069**	**5350**	**2405**	**287**	236	231	25	0	0	0	0	0	**492**
1965	**652537**	**368593**	**15184**	**649840**	**29496**	**4662**	**1972**	**452**	107	90	41	0	0	0	0	0	**238**
1966	**1671205**	**1007322**	**25674**	**6425**	**412551**	**9980**	**1045**	**601**	165	90	23	2	0	0	0	0	**280**
1967	**306037**	**838189**	**89083**	**4863**	**3585**	**177857**	**2443**	**215**	216	57	34	0	0	0	0	0	**307**
1968	**11146**	**1098748**	**439511**	**19600**	**1947**	**2529**	**45973**	**325**	40	13	5	0	0	0	0	0	**59**
1969	**72670**	**20493**	**3578611**	**303489**	**7596**	**2411**	**2515**	**19129**	200	24	7	0	0	0	0	0	**231**
1970	**925768**	**266379**	**218480**	**1908736**	**57435**	**1178**	**1197**	**256**	5954	67	11	19	0	0	0	0	**6051**
1971	**333396**	**1815054**	**71035**	**47546**	**400469**	**10374**	**462**	**195**	147	1592	160	3	5	0	0	0	**1907**
1972	**244075**	**679205**	**587590**	**40604**	**21213**	**158000**	**3563**	**190**	34	27	408	11	0	0	0	0	**480**
1973	**60545**	**366830**	**570630**	**240604**	**6192**	**4470**	**39459**	**1257**	108	29	109	49	5	0	0	0	**299**
1974	**614903**	**1220855**	**176342**	**332967**	**54314**	**1875**	**1351**	**10922**	242	23	32	4	5	0	0	0	**306**
1975	**46388**	**2116937**	**641755**	**58991**	**109062**	**15813**	**983**	**620**	2714	266	63	11	0	8	0	0	**3062**
1976	**174161**	**170529**	**1062943**	**211544**	**9952**	**31311**	**4996**	**206**	76	759	60	3	0	0	0	0	**899**
1977	**120798**	**258923**	**107675**	**394175**	**40185**	**4318**	**6275**	**1300**	135	29	200	3	0	1	0	0	**368**
1978	**305115**	**463554**	**146957**	**30377**	**113703**	**8708**	**1264**	**2076**	402	116	15	64	13	2	0	0	**613**
1979	**881823**	**351451**	**204046**	**41297**	**7406**	**28024**	**2237**	**262**	483	152	54	12	11	1	0	0	**714**
1980	**399372**	**678499**	**333261**	**73043**	**10476**	**1901**	**8067**	**598**	121	162	75	31	9	3	1	0	**403**
1981	**646419**	**134470**	**423059**	**143151**	**15228**	**2034**	**458**	**2498**	125	64	23	30	4	1	3	0	**251**
1982	**278705**	**275686**	**86126**	**299895**	**41435**	**3407**	**713**	**279**	784	30	15	7	2	2	0	0	**840**
1983	**639814**	**157259**	**252258**	**73920**	**127250**	**16480**	**1708**	**297**	61	191	53	6	4	4	0	0	**319**
1984	**95502**	**432193**	**168273**	**122984**	**22079**	**32658**	**3789**	**596**	84	41	112	16	5	1	1	0	**261**
1985	**139579**	**178878**	**534269**	**78726**	**37445**	**5306**	**7355**	**965**	212	52	21	88	4	0	0	0	**378**
1986	**56503**	**160398**	**178824**	**323650**	**27685**	**9691**	**1237**	**1810**	237	117	49	32	36	13	4	1	**489**
1987	**13384**	**314017**	**250496**	**47432**	**67864**	**4761**	**2877**	**545**	778	135	36	50	27	29	5	8	**1068**
1988	**16535**	**30044**	**490706**	**89940**	**13431**	**18579**	**1602**	**639**	166	141	50	18	11	10	15	1	**412**
1989	**12042**	**47648**	**35358**	**182748**	**18106**	**2636**	**4058**	**510**	200	83	30	13	6	2	2	1	**338**
1990	**57702**	**86819**	**103021**	**18947**	**57830**	**3905**	**896**	**1380**	210	78	41	11	11	1	4	2	**358**
1991	**123910**	**228553**	**78258**	**23197**	**3888**	**12526**	**976**	**401**	614	148	54	6	5	1	2	1	**830**
1992	**270758**	**209879**	**253286**	**32494**	**6552**	**1250**	**4861**	**454**	301	293	124	22	6	2	0	0	**749**
1993	**141209**	**359995**	**262765**	**108421**	**7107**	**1698**	**450**	**1138**	146	103	144	59	3	2	0	0	**457**
1994	**85966**	**99260**	**296776**	**100476**	**29609**	**1920**	**573**	**191**	509	115	32	27	25	5	0	0	**713**
1995	**273689**	**301733**	**85925**	**167801**	**25875**	**7645**	**511**	**127**	45	62	19	8	6	2	1	0	**142**
1996	**347568**	**53415**	**357942**	**56894**	**55147**	**7503**	**3052**	**756**	52	31	25	5	8	3	1	0	**125**
1997	**40082**	**134642**	**86231**	**213293**	**15272**	**15406**	**1892**	**679**	62	15	12	4	4	4	2	0	**103**
1998	**23902**	**83557**	**167359**	**49648**	**108066**	**5743**	**3562**	**472**	140	14	6	5	2	2	1	1	**171**
1999	**108254**	**81423**	**121249**	**87242**	**24739**	**39860**	**2338**	**1595**	342	41	6	2	1	1	0	0	**393**
2000	**52181**	**350998**	**88624**	**43351**	**26356**	**6026**	**8707**	**560**	234	32	12	2	1	1	0	0	**282**
2001	**3510**	**86744**	**632880**	**32343**	**8886**	**4122**	**1561**	**1305**	195	64	17	3	1	0	0	0	**280**
2002	**50754**	**18400**	**66343**	**242196**	**6547**	**2038**	**1066**	**549**	458	265	15	8	5	0	0	0	**752**
2003	**6132**	**18616**	**14122**	**44745**	**109063**	**1970**	**602**	**271**	110	89	38	5	1	0	0	0	**244**
2004	**918**	**9872**	**18069**	**6574**	**34945**	**91121**	**723**	**147**	56	35	35	10	1	0	0	0	**137**
2005	**4447**	**9039**	**18135**	**11382**	**3329**	**25076**	**58753**	**314**	89	34	10	7	4	1	0	0	**145**
2006	**1480**	**108807**	**24759**	**16433**	**7177**	**2845**	**13093**	**28855**	117	28	15	6	3	0	0	0	**170**

Table 13.2.2.2 Haddock in Subarea 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	**8+**
1963	**0**	**27353**	**118185**	**16692**	**12212**	**5644**	**498**	**653**	566	59	18	0	0	0	0	0	**642**
1964	**0**	**48**	**250523**	**86368**	**8166**	**4689**	**2283**	**286**	236	231	25	0	0	0	0	0	**492**
1965	**0**	**2636**	**3445**	**335396**	**23479**	**4063**	**1852**	**446**	107	90	41	0	0	0	0	0	**238**
1966	**0**	**12976**	**6724**	**4250**	**372535**	**9188**	**1018**	**599**	165	90	23	2	0	0	0	0	**280**
1967	**0**	**54953**	**33894**	**3845**	**3345**	**174011**	**2421**	**215**	216	57	34	0	0	0	0	0	**307**
1968	**0**	**18443**	**139035**	**14557**	**1806**	**2495**	**45047**	**324**	40	13	5	0	0	0	0	0	**59**
1969	**0**	**139**	**713860**	**166997**	**6542**	**2014**	**2381**	**18876**	200	24	7	0	0	0	0	0	**231**
1970	**0**	**2259**	**51861**	**1133133**	**50823**	**1012**	**1131**	**254**	5954	67	11	19	0	0	0	0	**6051**
1971	**0**	**34019**	**25862**	**35168**	**369443**	**10006**	**455**	**195**	147	1592	160	3	5	0	0	0	**1907**
1972	**0**	**12778**	**207267**	**33215**	**19853**	**156344**	**3550**	**190**	34	27	408	11	0	0	0	0	**480**
1973	**0**	**6024**	**205717**	**193852**	**5829**	**4238**	**39336**	**1257**	108	29	109	49	5	0	0	0	**299**
1974	**0**	**23993**	**52416**	**227998**	**46793**	**1785**	**1232**	**10693**	242	23	32	4	5	0	0	0	**306**
1975	**0**	**24144**	**200961**	**38295**	**90302**	**15524**	**978**	**620**	2709	266	63	11	0	8	0	0	**3057**
1976	**0**	**2301**	**223465**	**142803**	**9721**	**28103**	**4978**	**206**	76	759	60	3	0	0	0	0	**899**
1977	**0**	**8484**	**31741**	**249285**	**37092**	**4057**	**6021**	**1300**	135	29	200	3	0	1	0	0	**368**
1978	**0**	**12883**	**54630**	**25305**	**100036**	**8568**	**1152**	**2070**	402	116	15	64	13	2	0	0	**612**
1979	**0**	**14009**	**110008**	**36486**	**7284**	**27543**	**2219**	**262**	483	152	54	12	11	1	0	0	**714**
1980	**0**	**8982**	**141895**	**61901**	**9063**	**1843**	**7975**	**591**	121	161	75	31	9	3	1	0	**402**
1981	**0**	**1759**	**153466**	**112407**	**14679**	**2025**	**455**	**2498**	125	64	23	30	4	1	3	0	**251**
1982	**0**	**7373**	**38819**	**236209**	**37728**	**2913**	**713**	**279**	784	30	15	7	2	2	0	0	**840**
1983	**0**	**7101**	**109201**	**52566**	**117819**	**15760**	**1603**	**297**	61	190	53	6	4	4	0	0	**319**
1984	**0**	**19501**	**75963**	**104651**	**21372**	**31874**	**3788**	**596**	84	41	112	16	5	1	1	0	**261**
1985	**0**	**2120**	**248125**	**70806**	**36734**	**5076**	**7329**	**965**	212	52	21	88	4	0	0	0	**378**
1986	**0**	**12132**	**62362**	**261225**	**27548**	**9671**	**1237**	**1810**	237	117	49	32	36	13	4	1	**489**
1987	**0**	**6896**	**113196**	**37763**	**66221**	**4760**	**2877**	**545**	778	135	36	50	27	29	5	8	**1068**
1988	**0**	**1524**	**146403**	**76925**	**12024**	**18310**	**1602**	**639**	166	141	50	18	11	10	15	1	**412**
1989	**0**	**4519**	**16387**	**128051**	**16762**	**2574**	**3916**	**498**	199	83	30	13	6	2	2	1	**337**
1990	**0**	**5493**	**43168**	**14338**	**45015**	**3269**	**775**	**1242**	202	78	41	11	11	1	4	2	**350**
1991	**0**	**19482**	**46902**	**21841**	**3812**	**12337**	**976**	**401**	614	148	54	6	5	1	2	1	**830**
1992	**0**	**2853**	**117953**	**28828**	**6485**	**1247**	**4779**	**454**	300	293	124	22	6	2	0	0	**748**
1993	**0**	**2488**	**77820**	**86806**	**6976**	**1686**	**450**	**1119**	146	103	144	59	3	2	0	0	**457**
1994	**0**	**467**	**69457**	**70354**	**27587**	**1860**	**524**	**191**	509	115	32	27	25	5	0	0	**713**
1995	**0**	**1870**	**29177**	**101663**	**24715**	**7565**	**511**	**127**	45	62	19	8	6	2	1	0	**142**
1996	**0**	**742**	**74892**	**36685**	**47168**	**7501**	**3052**	**756**	52	31	25	5	8	3	1	0	**125**
1997	**0**	**1409**	**23943**	**123178**	**14028**	**15208**	**1892**	**679**	62	15	12	4	4	4	2	0	**103**
1998	**0**	**822**	**38321**	**36736**	**92738**	**5607**	**3543**	**472**	140	14	6	5	2	2	1	1	**171**
1999	**0**	**994**	**25856**	**53192**	**23301**	**37630**	**2155**	**1595**	342	41	6	2	1	1	0	0	**393**
2000	**0**	**4750**	**30316**	**28653**	**23407**	**5873**	**8644**	**560**	234	32	12	2	1	1	0	0	**282**
2001	**0**	**611**	**67196**	**16117**	**7406**	**3929**	**1561**	**1295**	191	64	17	3	1	0	0	0	**276**
2002	**0**	**639**	**13666**	**111346**	**5640**	**2004**	**1066**	**419**	458	265	15	8	5	0	0	0	**752**
2003	**0**	**32**	**1091**	**13925**	**73059**	**1920**	**571**	**270**	109	89	38	5	1	0	0	0	**243**
2004	**0**	**481**	**2897**	**4101**	**22159**	**73191**	**710**	**139**	56	35	35	10	1	0	0	0	**137**
2005	**0**	**782**	**5490**	**8086**	**2926**	**21703**	**54742**	**313**	89	34	10	7	4	1	0	0	**145**
2006	**0**	**2061**	**9848**	**10266**	**6301**	**2705**	**12485**	**28157**	116	28	15	6	3	0	0	0	**169**

Table 13.2.2.3 Haddock in Subarea 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	8+
1963	42	1047925	193718	3476	708	51	2	0	0	0	0	0	0	0	0	0	0
1964	2395	4182	623111	13597	262	21	10	0	0	0	0	0	0	0	0	0	0
1965	5307	110628	4020	130369	3641	4	1	0	0	0	0	0	0	0	0	0	0
1966	7880	444111	12388	1166	24114	35	2	0	0	0	0	0	0	0	0	0	0
1967	6250	389691	49635	863	216	1576	9	0	0	0	0	0	0	0	0	0	0
1968	39	615649	219022	3006	94	15	186	0	0	0	0	0	0	0	0	0	0
1969	1732	5152	1158445	37686	420	16	8	0	0	0	0	0	0	0	0	0	0
1970	51717	92978	77992	289679	2640	13	4	0	0	0	0	0	0	0	0	0	0
1971	7586	1205838	35117	8960	24590	66	2	0	0	0	0	0	0	0	0	0	0
1972	4231	424657	322547	6353	1212	1212	13	0	0	0	0	0	0	0	0	0	0
1973	18540	241423	352310	46740	352	33	123	0	0	0	0	0	0	0	0	0	0
1974	24758	915157	90904	57011	2814	6	4	0	0	0	0	0	0	0	0	0	0
1975	630	1478590	353422	15781	13388	143	0	0	0	0	0	0	0	0	0	0	0
1976	2191	98420	648662	38317	183	137	0	0	0	0	0	0	0	0	0	0	0
1977	11812	95090	44918	73431	605	9	0	0	0	0	0	0	0	0	0	0	0
1978	5250	316339	80219	4207	12085	72	106	0	0	0	0	0	0	0	0	0	0
1979	1824	205555	75517	3232	34	84	0	0	0	0	0	0	0	0	0	0	0
1980	644	369727	168124	2346	39	0	0	0	0	0	0	0	0	0	0	0	0
1981	1509	33434	237524	25928	86	3	0	0	0	0	0	0	0	0	0	0	0
1982	3703	93865	31915	49462	1845	0	0	0	0	0	0	0	0	0	0	0	0
1983	151108	85338	128171	15966	7112	717	105	0	0	0	0	0	0	0	0	0	0
1984	2915	314421	80803	13430	327	240	0	0	0	0	0	0	0	0	0	0	0
1985	17501	165086	267747	6088	149	4	8	0	0	0	0	0	0	0	0	0	0
1986	23807	108204	114606	61612	31	12	0	0	0	0	0	0	0	0	0	0	0
1987	1166	188582	133010	9320	1506	0	0	0	0	0	0	0	0	0	0	0	0
1988	1528	24588	325259	9684	788	67	0	0	0	0	0	0	0	0	0	0	0
1989	1790	40211	16959	51491	814	20	42	0	0	0	0	0	0	0	0	0	1
1990	52477	68625	56359	3977	10190	235	77	0	0	0	0	0	0	0	0	0	0
1991	7001	182162	27942	725	27	145	0	0	0	0	0	0	0	0	0	0	0
1992	29056	110995	123961	3298	38	0	65	0	0	0	0	0	0	0	0	0	0
1993	16715	235123	170794	18375	48	3	0	1	0	0	0	0	0	0	0	0	0
1994	16059	82033	217538	29100	1862	53	48	0	0	0	0	0	0	0	0	0	0
1995	3228	191807	54448	65250	1095	79	0	0	0	0	0	0	0	0	0	0	0
1996	3968	35340	275597	16870	7872	2	0	0	0	0	0	0	0	0	0	0	0
1997	7162	85588	50976	85664	1061	182	0	0	0	0	0	0	0	0	0	0	0
1998	3132	72793	112075	10165	13766	71	18	0	0	0	0	0	0	0	0	0	0
1999	14588	69196	90861	31119	1094	2064	180	0	0	0	0	0	0	0	0	0	0
2000	2474	272894	36568	12614	2764	148	64	0	0	0	0	0	0	0	0	0	0
2001	545	61878	529908	6100	1446	186	0	10	4	0	0	0	0	0	0	0	4
2002	946	3872	48189	127212	403	8	0	130	0	0	0	0	0	0	0	0	0
2003	1987	12601	10930	29535	34480	37	31	1	0	0	0	0	0	0	0	0	1
2004	918	8801	14907	2388	12528	17177	5	3	0	0	0	0	0	0	0	0	0
2005	4447	8081	12548	3271	394	3369	3810	0	0	0	0	0	0	0	0	0	0
2006	1480	104974	14195	5927	828	94	533	591	0	0	0	0	0	0	0	0	0

Table 13.2.2.4 Haddock in Subarea 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	**8+**
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	**0**
1965	**647230**	**255329**	**7719**	**184075**	**2375**	**594**	**119**	**6**	0	0	0	0	0	0	0	0	**0**
1966	**1663325**	**550235**	**6562**	**1009**	**15901**	**757**	**25**	**2**	0	0	0	0	0	0	0	0	**0**
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	**0**
1969	**70938**	**15201**	**1706305**	**98806**	**633**	**380**	**126**	**253**	0	0	0	0	0	0	0	0	**0**
1970	**874052**	**171142**	**88628**	**485924**	**3972**	**153**	**61**	**2**	0	0	0	0	0	0	0	0	**0**
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	**0**
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	**0**
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	**1**
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	**0**
1990	**5225**	**12702**	**3494**	**632**	**2625**	**401**	**44**	**138**	8	0	0	0	0	0	0	0	**8**
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	**0**
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	**0**
2005	**0**	**176**	**97**	**26**	**9**	**5**	**201**	**1**	0	0	0	0	0	0	0	0	**0**
2006	**0**	**1772**	**716**	**241**	**47**	**46**	**74**	**108**	1	0	0	0	0	0	0	0	**1**

Table 13.2.3.1 Haddock in Subarea 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	**8+**
1963	**0.012**	**0.123**	**0.253**	**0.473**	**0.695**	**0.807**	**1.004**	**1.131**	1.173	1.576	1.825	0.000	0.000	0.000	0.000	0.000	**1.228**
1964	**0.011**	**0.118**	**0.239**	**0.403**	**0.664**	**0.814**	**0.908**	**1.382**	1.148	1.470	1.781	0.000	0.000	0.000	0.000	0.000	**1.331**
1965	**0.010**	**0.069**	**0.225**	**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	**1.696**
1966	**0.010**	**0.088**	**0.247**	**0.367**	**0.533**	**0.949**	**1.266**	**1.525**	1.938	1.727	2.963	2.040	0.000	0.000	0.000	0.000	**1.955**
1967	**0.011**	**0.115**	**0.281**	**0.461**	**0.594**	**0.639**	**1.057**	**1.501**	1.922	2.069	2.348	0.000	0.000	0.000	0.000	0.000	**1.996**
1968	**0.010**	**0.125**	**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	**2.342**
1969	**0.011**	**0.063**	**0.216**	**0.406**	**0.799**	**0.891**	**1.031**	**1.094**	2.040	3.034	3.264	0.000	0.000	0.000	0.000	0.000	**2.178**
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	**1.462**
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	**1.349**
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	**1.742**
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	**1.731**
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	**1.723**
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	**1.183**
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	**1.426**
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	**1.900**
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	**1.654**
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	**1.377**
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	**1.760**
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	**1.688**
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	**1.520**
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	**1.555**
1984	**0.010**	**0.141**	**0.302**	**0.489**	**0.671**	**0.805**	**1.097**	**1.100**	1.868	2.425	1.972	2.247	2.422	2.822	4.995	0.000	**2.051**
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	**1.937**
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	**1.915**
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	**1.673**
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	**1.783**
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	**1.756**
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	**1.851**
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	**1.583**
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	**1.784**
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	**1.753**
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	**1.616**
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	**1.842**
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	**1.925**
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	**1.922**
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	**1.328**
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	**0.829**
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	**1.225**
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	**1.761**
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	**1.636**
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	**1.629**
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	**1.643**
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	**1.340**
2006	**0.050**	**0.114**	**0.293**	**0.364**	**0.488**	**0.569**	**0.571**	**0.575**	1.046	1.663	2.236	2.641	1.926	3.022	2.901	2.709	**1.333**

Table 13.2.3.2 Haddock in Subarea 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	8+
1963	**0.000**	**0.233**	**0.326**	**0.512**	**0.715**	**0.817**	**1.009**	**1.131**	1.173	1.576	1.825	0.000	0.000	0.000	0.000	0.000	**1.228**
1964	**0.000**	**0.221**	**0.313**	**0.459**	**0.695**	**0.870**	**0.934**	**1.386**	1.148	1.470	1.781	0.000	0.000	0.000	0.000	0.000	**1.331**
1965	**0.000**	**0.310**	**0.357**	**0.410**	**0.679**	**0.907**	**1.242**	**1.182**	1.482	1.707	2.239	0.000	0.000	0.000	0.000	0.000	**1.696**
1966	**0.000**	**0.301**	**0.384**	**0.416**	**0.553**	**0.995**	**1.288**	**1.529**	1.938	1.727	2.963	2.040	0.000	0.000	0.000	0.000	**1.955**
1967	**0.000**	**0.260**	**0.404**	**0.510**	**0.614**	**0.645**	**1.063**	**1.501**	1.922	2.069	2.348	0.000	0.000	0.000	0.000	0.000	**1.996**
1968	**0.000**	**0.256**	**0.361**	**0.591**	**0.761**	**0.863**	**0.846**	**1.610**	2.260	2.702	2.073	0.000	0.000	0.000	0.000	0.000	**2.342**
1969	**0.000**	**0.178**	**0.302**	**0.506**	**0.870**	**0.984**	**1.065**	**1.102**	2.040	3.034	3.264	0.000	0.000	0.000	0.000	0.000	**2.178**
1970	**0.000**	**0.242**	**0.310**	**0.403**	**0.786**	**0.949**	**1.235**	**1.370**	1.437	2.571	3.950	3.869	0.000	0.000	0.000	0.000	**1.462**
1971	**0.000**	**0.256**	**0.335**	**0.399**	**0.524**	**0.905**	**1.281**	**1.534**	1.337	1.275	1.969	4.306	3.543	0.000	0.000	0.000	**1.349**
1972	**0.000**	**0.244**	**0.329**	**0.421**	**0.523**	**0.609**	**1.003**	**1.366**	2.241	2.006	1.651	2.899	0.000	0.000	0.000	0.000	**1.742**
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	**1.731**
1974	**0.000**	**0.275**	**0.320**	**0.389**	**0.585**	**0.908**	**0.954**	**0.963**	1.513	2.315	2.508	4.152	2.264	0.000	0.000	0.000	**1.723**
1975	**0.000**	**0.258**	**0.345**	**0.408**	**0.487**	**0.686**	**1.248**	**1.124**	1.094	1.720	2.217	2.854	0.000	3.426	0.000	0.000	**1.184**
1976	**0.000**	**0.250**	**0.344**	**0.467**	**0.516**	**0.614**	**0.923**	**1.933**	1.784	1.306	2.425	2.528	0.000	0.000	0.000	0.000	**1.426**
1977	**0.000**	**0.286**	**0.362**	**0.396**	**0.614**	**0.630**	**0.817**	**1.181**	1.943	2.322	1.780	3.189	0.000	4.119	0.000	0.000	**1.900**
1978	**0.000**	**0.275**	**0.356**	**0.457**	**0.470**	**0.725**	**0.789**	**0.956**	1.398	2.124	2.868	1.849	2.454	4.782	0.000	0.000	**1.654**
1979	**0.000**	**0.274**	**0.361**	**0.468**	**0.642**	**0.668**	**0.935**	**1.187**	1.187	1.468	2.679	1.624	1.760	1.643	0.000	0.000	**1.377**
1980	**0.000**	**0.299**	**0.367**	**0.526**	**0.750**	**1.056**	**0.934**	**1.392**	1.599	1.592	1.726	3.328	1.119	3.071	3.111	0.000	**1.761**
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	**1.688**
1982	**0.000**	**0.300**	**0.364**	**0.507**	**0.818**	**1.237**	**1.441**	**1.672**	1.456	2.634	2.164	1.924	1.886	3.179	0.000	0.000	**1.520**
1983	**0.000**	**0.312**	**0.387**	**0.482**	**0.663**	**0.925**	**1.243**	**1.162**	1.920	1.376	1.395	1.907	2.853	4.689	0.000	0.000	**1.555**
1984	**0.000**	**0.281**	**0.376**	**0.515**	**0.677**	**0.810**	**1.097**	**1.100**	1.868	2.425	1.972	2.247	2.422	2.822	4.995	0.000	**2.051**
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	**1.937**
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	**1.915**
1987	**0.000**	**0.274**	**0.345**	**0.451**	**0.622**	**1.029**	**1.276**	**1.433**	1.529	1.877	2.054	1.940	2.471	2.411	2.996	2.638	**1.673**
1988	**0.000**	**0.258**	**0.324**	**0.445**	**0.619**	**0.752**	**1.284**	**1.424**	1.551	1.627	1.680	3.068	2.468	2.885	3.337	2.863	**1.783**
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	**1.753**
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	**1.871**
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	**1.583**
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	**1.785**
1993	**0.000**	**0.326**	**0.393**	**0.483**	**0.684**	**0.896**	**1.173**	**1.111**	1.592	1.737	1.920	1.718	2.274	2.516	0.000	0.000	**1.753**
1994	**0.000**	**0.288**	**0.390**	**0.482**	**0.617**	**0.962**	**1.296**	**1.570**	1.469	1.620	2.418	2.108	2.849	2.403	2.580	0.000	**1.616**
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	**1.842**
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	**1.925**
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	**1.922**
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	**1.328**
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	**0.829**
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	**1.225**
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	**1.780**
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	**1.635**
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	**1.630**
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	**1.643**
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	**1.340**
2006	**0.000**	**0.396**	**0.389**	**0.422**	**0.514**	**0.581**	**0.582**	**0.580**	1.052	1.663	2.236	2.641	1.926	3.022	2.901	2.709	**1.339**

Table 13.2.3.3 Haddock in Subarea 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	8+
1963	0.064	0.139	0.218	0.327	0.397	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1964	0.065	0.177	0.249	0.306	0.337	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1965	0.064	0.131	0.200	0.341	0.613	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1966	0.063	0.141	0.208	0.244	0.310	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1967	0.064	0.171	0.209	0.274	0.306	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1968	0.063	0.186	0.212	0.256	0.318	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1969	0.064	0.129	0.216	0.237	0.301	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1970	0.063	0.129	0.210	0.238	0.263	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1971	0.063	0.134	0.201	0.242	0.263	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1972	0.063	0.139	0.206	0.237	0.261	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1973	0.063	0.131	0.201	0.235	0.263	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1974	0.062	0.145	0.200	0.233	0.259	0.321	0.321	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1975	0.050	0.123	0.200	0.257	0.275	0.348	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1976	0.079	0.176	0.197	0.237	0.292	0.337	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1977	0.071	0.196	0.197	0.216	0.309	0.347	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1978	0.037	0.180	0.199	0.222	0.224	0.265	0.284	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1979	0.053	0.118	0.219	0.242	0.259	0.340	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1980	0.051	0.149	0.231	0.274	0.324	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1981	0.073	0.160	0.198	0.290	0.650	0.727	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1982	0.072	0.197	0.248	0.271	0.264	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1983	0.067	0.187	0.237	0.347	0.476	0.711	0.792	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1984	0.046	0.162	0.245	0.317	0.300	0.314	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1985	0.040	0.155	0.214	0.264	0.336	0.423	0.421	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1986	0.045	0.138	0.184	0.245	0.408	0.329	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1987	0.023	0.159	0.200	0.225	0.287	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1988	0.063	0.172	0.170	0.238	0.254	0.360	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1989	0.085	0.187	0.229	0.268	0.335	0.708	0.844	0.000	2.572	0.000	3.048	0.000	0.000	0.000	0.000	0.000	2.810
1990	0.046	0.196	0.229	0.249	0.266	0.290	0.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.065	0.179	0.243	0.344	0.464	0.493	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.043	0.137	0.246	0.286	0.347	0.000	0.415	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1993	0.027	0.142	0.237	0.287	0.344	0.369	0.000	0.369	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.044	0.126	0.211	0.269	0.306	0.304	0.270	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1995	0.064	0.131	0.251	0.275	0.363	0.384	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1996	0.046	0.138	0.219	0.279	0.297	0.358	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1997	0.063	0.161	0.254	0.286	0.321	0.385	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1998	0.041	0.162	0.231	0.293	0.315	0.391	0.428	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1999	0.049	0.183	0.217	0.273	0.307	0.304	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2000	0.030	0.129	0.246	0.281	0.319	0.355	0.287	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2001	0.045	0.116	0.205	0.307	0.308	0.364	0.000	0.411	0.416	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.416
2002	0.042	0.166	0.226	0.268	0.352	0.378	0.000	0.357	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2003	0.067	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	1.015
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	0.000
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	0.000
2006	0.050	0.108	0.230	0.266	0.304	0.353	0.343	0.383	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 13.2.3.4 Haddock in Subarea 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	**8+**
1963	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1964	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.500**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.500**
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**
2006	**0.000**	**0.127**	**0.232**	**0.273**	**0.273**	**0.280**	**0.283**	**0.286**	0.287	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.286**

Table 13.2.5.1 Haddock in Subarea 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	**246.021**	**58.746**	**29.133**	**1.742**	**0.146**	**0.037**	**0.251**	**0.010**	0.135	0.000	0.016
1993	100	**40.336**	**73.145**	**17.435**	**4.951**	**0.176**	**0.048**	**0.000**	**0.026**	0.003	0.000	0.000
1994	100	**279.344**	**23.990**	**26.992**	**2.511**	**0.894**	**0.058**	**0.003**	**0.003**	0.000	0.003	0.000
1995	100	**53.435**	**113.775**	**13.223**	**11.032**	**0.827**	**0.275**	**0.021**	**0.000**	0.000	0.008	0.003
1996	100	**61.301**	**26.747**	**43.044**	**3.603**	**2.052**	**0.207**	**0.088**	**0.006**	0.000	0.003	0.000
1997	100	**40.653**	**45.346**	**12.608**	**19.968**	**0.719**	**0.718**	**0.067**	**0.019**	0.000	0.000	0.000
1998	100	**15.747**	**26.497**	**16.778**	**4.079**	**4.141**	**0.226**	**0.141**	**0.009**	0.021	0.000	0.000
1999	100	**626.100**	**16.551**	**8.404**	**3.663**	**1.258**	**1.201**	**0.040**	**0.036**	0.011	0.000	0.000
2000	100	**92.139**	**249.813**	**4.528**	**1.634**	**0.740**	**0.336**	**0.350**	**0.000**	0.004	0.000	0.000
2001	100	**1.097**	**28.622**	**96.498**	**3.039**	**0.828**	**0.350**	**0.135**	**0.058**	0.177	0.003	0.000
2002	100	**2.721**	**3.954**	**22.559**	**60.583**	**0.542**	**0.097**	**0.153**	**0.096**	0.034	0.007	0.000
2003	100	**3.199**	**6.015**	**1.247**	**13.967**	**45.079**	**0.719**	**0.026**	**0.221**	0.082	0.014	0.003
2004	100	**3.398**	**6.599**	**3.864**	**0.448**	**6.836**	**17.406**	**0.217**	**0.093**	0.089	0.083	0.082
2005	100	**122.383**	**9.740**	**5.992**	**2.584**	**1.249**	**6.617**	**3.654**	**0.021**	0.007	0.000	0.000
2006	100	**11.825**	**54.816**	**3.270**	**1.140**	**0.433**	**0.150**	**0.859**	**1.569**	0.020	0.011	0.003

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 Subarea IV and Division IIIa. Data available for calibration of the assessment. Data used in the assessment are highlighted in bold

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: 0-0.25. Span: 1983-2007

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
2007	10	**109.10**	**963.33**	**36.60**	**15.48**	**3.37**	21.39

Table 13.3.5.1 Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics.

```
FLR XSA Diagnostics 2007-05-06 11:53:14
CPUE data from wk.index.xsa.7
Catch data for 44 years. 1963 to 2006. Ages 0 to 8.
                  fleet first age last age first year last year alpha beta
1            EngGFS_GRT         0        7       1977      1991   0.5 0.75
2            EngGFS_GOV         0        7       1992      2006   0.5 0.75
3            ScoGFS_ABN         0        7       1982      1997   0.5 0.75
4            ScoGFS_GOV         0        7       1998      2006   0.5 0.75
5 IBTS_Q1 (backshifted)         0        4       1982      2006  0.99    1

 Time series weights :
   Tapered time weighting not applied
Catchability analysis :

    Catchability independent of size for ages >   0
    Catchability independent of age for ages >   6

Terminal population estimation :

    Survivor estimates shrunk towards the mean F
    of the final   5 years & the  3 oldest ages.

    S.E. of the mean to which the estimates are shrunk =   2

    Minimum standard error for population
    estimates derived from each fleet =  0.3

   prior weighting not applied

Regression weights
     year
age   1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
  all    1    1    1    1    1    1    1    1    1    1

 Fishing mortalities
   year
age  1997  1998  1999  2000  2001  2002  2003  2004  2005  2006
  0 0.009 0.007 0.003 0.007 0.004 0.041 0.004 0.001 0.000 0.001
  1 0.125 0.131 0.169 0.060 0.073 0.141 0.103 0.047 0.048 0.055
  2 0.460 0.617 0.836 0.816 0.370 0.177 0.392 0.346 0.285 0.471
  3 0.656 0.627 0.955 1.039 1.015 0.271 0.199 0.370 0.447 0.533
  4 0.778 0.923 0.816 0.969 0.656 0.611 0.198 0.249 0.344 0.608
  5 0.992 0.807 1.208 0.485 0.386 0.309 0.382 0.261 0.294 0.578
  6 1.005 0.652 0.961 0.984 0.220 0.161 0.140 0.234 0.268 0.246
  7 0.773 0.751 0.698 0.639 0.366 0.112 0.056 0.046 0.150 0.203
  8 0.773 0.751 0.698 0.639 0.366 0.112 0.056 0.046 0.150 0.203

 XSA population number ( thousands )
      age
year          0        1       2       3      4      5      6      7    8
  1997  12169140  2619592  285543  502511  32018  27067   3297   1394  208
  1998   9356944  1552212  444088  120805 203125  11458   8221    988  353
  1999 107543094  1195989  261485  160659  50269  62826   4185   3507  853
  2000  21916029 13805709  194007   76008  48130  17317  15371   1311  652
  2001   2487492  2802636 2497565   57488  20938  14225   8726   4706 1002
  2002   3524857   318968  500232 1156010  16229   8465   7917   5732 7813
  2003   3807934   435562   53194  280998 686564   6861   5086   5517 4934
  2004   3419349   488014   75491   24095 179354 438449   3835   3620 3365
  2005  35811759   439860   89397   35810  12964 108842 276522   2486 1143
  2006   6085578  4608628   80514   45077  17844   7158  66423 173235 1010


 Estimated population abundance at 1st Jan  2007
      age
year     0      1      2     3     4    5    6     7      8
  2007 9462 783805 838806 33801 20695 7611 3356 42849 118636

 Fleet:  EngGFS_GRT

 Log catchability residuals.

   year
age   1977   1978   1979   1980   1981  1982   1983   1984   1985   1986   1987
  0  0.389 -0.268 -0.116  0.588  0.994 0.127 -0.092  0.117 -0.116 -0.691 -0.386
  1 -0.505 -0.226 -0.003  0.168  0.450 0.299  0.354  0.158  0.388 -0.214 -0.331
  2  0.204 -0.299 -0.069  0.320  0.560 0.402  0.107 -0.046  0.055  0.066 -0.459
  3 -0.264 -0.865  0.145  0.681  0.832 0.388  0.352  0.173  0.202 -0.424 -0.541
  4  0.390  0.120 -0.282  0.444  0.744 0.049  0.067  0.166  0.096 -0.299 -0.516
  5  0.038  0.277 -0.202 -0.050  0.155 0.526 -0.015  0.060  0.824  0.104 -0.674
  6 -0.379 -1.008 -0.229  0.019 -1.479 1.699 -0.271  0.427  0.390  0.581  0.110
  7 -0.054  0.169  0.101  0.020  0.056 0.649  0.409 -0.849  0.278  0.283 -0.693
   year
age   1988   1989   1990   1991
  0 -0.252  0.044 -0.157 -0.180
  1 -0.127  0.202  0.018 -0.631
  2  0.168  0.043 -0.087 -0.966
  3  0.142  0.015 -0.134 -0.702
  4 -0.246 -0.074 -0.069 -0.591
  5  0.047 -0.590 -0.325 -0.176
  6  0.591  0.058  0.603 -1.113
  7  0.340  0.622 -0.341  0.539


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

                1        2        3        4        5        6        7
Mean_Logq -15.5097 -15.0236 -15.1814 -15.2713 -15.3567 -15.6564 -15.6564
S.E_Logq    0.3315   0.3700   0.4887   0.3603   0.3834   0.8018   0.4428
```

Table 13.3.5.1 Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics. (Cont'd)

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 0	0.8582344	16.96464

Fleet: EngGFS_GOV

Log catchability residuals.

age \ year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.072	0.120	-0.049	0.205	-0.033	0.147	-0.038	-0.176	0.088	-0.205
1	0.139	-0.018	0.029	0.095	0.082	0.151	0.141	-0.046	0.155	-0.408
2	0.374	-0.067	-0.144	0.258	-0.102	0.095	0.036	0.010	-0.322	-0.094
3	0.239	-0.038	-0.587	0.187	0.173	0.147	-0.034	-0.223	-0.230	0.654
4	-0.473	-0.577	-0.245	-0.160	-0.030	-0.124	-0.130	0.008	-0.384	0.366
5	-0.310	-0.140	-0.504	-0.106	-0.057	0.321	-0.089	0.127	-0.305	-0.130
6	1.016	NA	-1.015	-0.316	0.441	0.546	0.158	-0.235	0.647	-0.214
7	0.347	-0.130	0.151	NA	0.258	0.003	-0.413	-0.327	NA	-0.351

age \ year	2002	2003	2004	2005	2006
0	-0.078	-0.074	0.011	-0.106	0.115
1	-0.173	-0.088	-0.144	0.350	-0.267
2	-0.060	-0.580	0.172	0.404	0.018
3	0.184	0.087	-0.790	0.613	-0.381
4	0.170	0.589	0.077	1.063	-0.151
5	-0.942	1.317	0.271	0.718	-0.171
6	-0.028	-1.371	1.091	-0.342	-0.377
7	-0.202	0.635	0.185	-0.862	-0.760

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

	1	2	3	4	5	6	7
Mean_Logq	-14.6194	-14.1926	-14.3211	-14.5458	-14.7227	-15.2057	-15.2057
S.E_Logq	0.1935	0.2533	0.3973	0.4219	0.5250	0.7087	0.4340

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 0	0.6011963	16.33295

Fleet: ScoGFS_ABN

Log catchability residuals.

age \ year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	-0.155	-0.749	-0.275	-0.617	-0.682	0.077	-0.243	-0.224	0.274	0.374
1	-0.227	-0.119	-0.447	0.157	-0.060	-0.784	0.076	-0.005	0.140	-0.526
2	0.294	0.163	-0.130	-0.051	-0.014	-0.298	-0.085	0.105	-0.226	-0.680
3	0.244	0.635	-0.008	0.028	-0.123	-0.120	-0.033	0.116	-0.292	-1.063
4	0.022	0.664	0.299	0.343	-0.180	-0.035	0.137	-0.011	-0.051	-0.687
5	-0.797	0.573	0.262	0.381	0.434	-0.274	-0.251	-0.435	-0.050	-0.594
6	-0.247	0.455	-0.068	0.567	0.279	0.150	-0.490	-0.158	-0.727	-0.158
7	-0.088	-0.217	0.138	-0.105	-0.251	0.069	-0.174	-0.053	0.210	NA

age \ year	1992	1993	1994	1995	1996	1997
0	0.694	-0.020	0.839	0.421	0.179	0.107
1	0.314	0.358	-0.009	0.364	0.503	0.263
2	-0.232	0.200	0.096	0.171	0.488	0.201
3	-0.458	-0.056	-0.174	0.604	0.320	0.381
4	-0.491	-1.069	-0.185	0.313	0.557	0.374
5	0.009	0.207	-1.040	0.441	0.532	0.601
6	-0.038	0.036	NA	-0.275	0.148	0.526
7	NA	0.103	NA	NA	NA	NA

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

	1	2	3	4	5	6	7
Mean_Logq	-10.6163	-10.0882	-10.3078	-10.5241	-10.6462	-10.6904	-10.6904
S.E_Logq	0.3552	0.2785	0.4148	0.4576	0.5173	0.3674	0.1587

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 0	0.8757455	13.32747

Fleet: ScoGFS_GOV

Log catchability residuals.

age \ year	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	-0.033	-0.153	0.066	-1.186	0.477	0.408	0.360	-0.018	0.081
1	0.698	-0.221	0.041	-0.445	0.045	0.261	0.136	-0.214	-0.301
2	0.005	0.147	-0.474	-0.100	-0.074	0.152	0.351	0.327	-0.334
3	-0.031	0.227	-0.108	-0.055	0.139	0.311	-0.157	-0.091	-0.235
4	-0.210	0.167	-0.110	-0.165	0.136	0.263	-0.032	0.665	-0.713
5	-0.175	0.293	0.325	-0.142	0.251	-0.014	-0.079	-0.074	-0.386
6	0.259	0.028	0.245	-0.069	-0.008	0.364	0.069	-0.205	-0.682
7	0.243	0.196	0.584	0.388	-1.508	-0.524	-2.188	-0.360	-0.533

Table 13.3.5.1 Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics. (Cont'd)

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	1	2	3	4	5	6	7
Mean_Logq	-9.6971	-9.4189	-9.5360	-9.6509	-9.9716	-10.4581	-10.4581
S.E_Logq	0.3465	0.2801	0.1842	0.3790	0.2413	0.3118	0.9228

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 0	0.7614446	12.37937

Fleet: IBTS_Q1 (backshifted)

Log catchability residuals.

age \ year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	-0.428	-0.430	-0.517	-0.030	-0.318	0.079	0.098	0.058	-0.039	0.449
1	-0.183	-0.367	-0.258	0.032	-0.173	-0.202	0.366	-0.018	0.001	-0.308
2	-0.081	-0.251	0.004	-0.231	-0.297	-0.066	0.111	0.355	-0.191	-0.860
3	-0.040	-0.032	-0.125	-0.322	-0.132	0.011	-0.012	-0.098	-0.019	-0.760
4	-0.053	-0.205	-0.223	-0.229	-0.020	-0.059	-0.181	-0.060	-0.342	-0.598

age \ year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0.155	-0.236	-0.036	-0.106	0.455	0.186	-0.033	0.201	0.439	0.073	0.162
1	0.170	-0.253	0.009	-0.103	0.490	0.222	0.116	-0.320	0.173	0.259	-0.046
2	0.074	-0.270	-0.285	-0.175	0.223	0.142	0.061	-0.152	0.112	0.480	0.186
3	0.130	-0.262	-0.070	-0.186	0.300	-0.041	0.508	-0.126	-0.100	0.064	0.281
4	-0.312	-0.293	-0.330	0.223	0.114	0.421	0.151	0.585	0.011	0.564	0.218

age \ year	2003	2004	2005	2006
0	-0.140	-0.066	0.240	-0.216
1	0.329	-0.107	-0.246	0.416
2	0.684	0.204	-0.158	0.379
3	0.519	0.386	-0.137	0.264
4	0.409	0.119	0.207	-0.116

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	1	2	3	4
Mean_Logq	-11.7970	-11.8139	-12.0666	-12.2083
S.E_Logq	0.2496	0.3144	0.2751	0.3002

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 0	0.9382015	13.39513

Terminal year survivor and F summaries:

Age 0 Year class = 2006

source	survivors	N	scaledWts
EngGFS_GOV	948569	1	0.445
ScoGFS_GOV	870784	1	0.074
IBTS backshifted	621842	1	0.441
fshk	44097	1	0.010
nshk	2849129	1	0.030

Age 1 Year class = 2005

source	survivors	N	scaledWts
EngGFS_GOV	671201	2	0.413
ScoGFS_GOV	652257	2	0.171
IBTS backshifted	1172006	2	0.411
fshk	491147	1	0.005

Age 2 Year class = 2004

source	survivors	N	scaledWts
EngGFS_GOV	38274	3	0.388
ScoGFS_GOV	27017	3	0.241
IBTS backshifted	34114	3	0.366
fshk	54042	1	0.005

Age 3 Year class = 2003

source	survivors	N	scaledWts
EngGFS_GOV	19919	4	0.333
ScoGFS_GOV	21868	4	0.288
IBTS backshifted	20476	4	0.374
fshk	24516	1	0.005

Age 4 Year class = 2002

source	survivors	N	scaledWts
EngGFS_GOV	8050	5	0.300
ScoGFS_GOV	6885	5	0.290
IBTS backshifted	7790	5	0.404
fshk	12296	1	0.006

Age 5 Year class = 2001

source

	survivors	N	scaledWts
EngGFS_GOV	2876	6	0.287
ScoGFS_GOV	3042	6	0.388
IBTS backshifted	4287	5	0.319
fshk	6623	1	0.006

Age 6 Year class = 2000

source

	survivors	N	scaledWts
EngGFS_GOV	43012	7	0.282
ScoGFS_GOV	34782	7	0.423
IBTS backshifted	57691	5	0.291
fshk	51921	1	0.004

Age 7 Year class = 1999

source

	survivors	N	scaledWts
EngGFS_GOV	104370	8	0.324
ScoGFS_GOV	110018	8	0.412
IBTS backshifted	159900	5	0.259
fshk	42257	1	0.005

Table 13.3.5.2 Haddock in Subarea 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)

year	0	1	2	3	4	5	6	7	8+
1963	0.002	0.125	0.805	0.668	0.762	0.902	0.648	0.779	0.779
1964	0.044	0.059	0.457	1.174	0.751	0.886	1.366	1.012	1.012
1965	0.072	1.361	0.421	0.514	0.984	1.275	1.026	1.108	1.108
1966	0.070	1.305	0.828	0.367	0.793	1.237	1.225	1.098	1.098
1967	0.002	0.263	1.085	0.412	0.382	1.058	1.313	0.927	0.927
1968	0.002	0.052	0.578	0.908	0.304	0.529	0.900	0.582	0.582
1969	0.017	0.021	0.654	1.377	1.333	0.801	1.873	1.353	1.353
1970	0.030	0.503	1.036	1.145	1.274	0.781	1.364	1.153	1.153
1971	0.012	0.475	0.666	0.793	0.860	0.873	0.837	0.866	0.866
1972	0.032	0.168	0.794	1.379	1.182	1.121	0.880	1.073	1.073
1973	0.002	0.374	0.560	1.163	0.872	0.908	0.996	0.935	0.935
1974	0.013	0.352	0.936	0.933	1.014	0.750	0.790	0.860	0.860
1975	0.011	0.334	0.964	1.262	1.047	1.022	1.256	1.122	1.122
1976	0.030	0.306	0.811	1.347	0.796	1.093	1.160	1.028	1.028
1977	0.013	0.337	0.997	1.027	1.186	1.081	0.665	1.192	1.192
1978	0.022	0.387	1.006	1.102	1.090	0.959	1.190	0.481	0.481
1979	0.035	0.175	0.866	1.122	0.993	0.940	0.704	0.866	0.866
1980	0.074	0.189	0.702	1.146	1.122	0.791	0.795	0.406	0.406
1981	0.057	0.179	0.450	0.929	0.855	0.700	0.438	0.615	0.615
1982	0.038	0.174	0.432	0.816	0.842	0.475	0.569	0.526	0.526
1983	0.027	0.152	0.661	1.026	1.163	1.072	0.466	0.495	0.495
1984	0.016	0.125	0.671	0.999	1.160	1.228	0.775	0.292	0.292
1985	0.016	0.207	0.616	0.966	1.110	1.077	1.091	0.453	0.453
1986	0.003	0.128	1.028	1.249	1.327	1.076	0.802	0.903	0.903
1987	0.009	0.119	0.905	1.075	1.109	0.908	1.208	1.083	1.083
1988	0.005	0.137	0.796	1.316	1.210	1.191	0.937	1.011	1.011
1989	0.004	0.106	0.658	0.986	1.221	0.864	0.945	0.926	0.926
1990	0.006	0.195	1.123	1.173	1.147	1.039	0.843	1.059	1.059
1991	0.013	0.156	0.782	1.040	0.886	0.874	0.815	1.285	1.285
1992	0.019	0.148	0.738	1.143	1.090	0.853	1.085	1.256	1.256
1993	0.031	0.174	0.812	1.039	0.916	1.024	0.898	0.821	0.821
1994	0.004	0.153	0.572	1.087	1.024	0.707	1.331	1.402	1.402
1995	0.059	0.106	0.511	0.925	1.049	0.860	0.407	1.403	1.403
1996	0.047	0.079	0.459	0.943	1.029	1.118	1.092	2.384	2.384
1997	0.009	0.125	0.460	0.656	0.778	0.992	1.005	0.773	0.773
1998	0.007	0.131	0.617	0.627	0.923	0.807	0.652	0.751	0.751
1999	0.003	0.169	0.836	0.955	0.816	1.208	0.961	0.698	0.698
2000	0.007	0.060	0.816	1.039	0.969	0.485	0.984	0.639	0.639
2001	0.004	0.073	0.370	1.015	0.656	0.386	0.220	0.366	0.366
2002	0.041	0.141	0.177	0.271	0.611	0.309	0.161	0.112	0.112
2003	0.004	0.103	0.392	0.199	0.198	0.382	0.140	0.056	0.056
2004	0.001	0.047	0.346	0.370	0.249	0.261	0.234	0.046	0.046
2005	0.000	0.048	0.285	0.447	0.344	0.294	0.268	0.150	0.150
2006	0.001	0.055	0.471	0.533	0.608	0.578	0.246	0.203	0.203

Table 13.3.5.3 Haddock in Subarea 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. Stock numbers at age in 2007 are estimates of survivors from XSA.

year	0	1	2	3	4	5	6	7	8+
1963	2316936	25469772	740127	48737	27680	10748	1163	1334	1295
1964	9177147	297780	4318616	221772	19457	10062	3569	498	839
1965	26320755	1131103	53930	1833149	53379	7149	3397	746	385
1966	68979807	3154272	55698	23719	854176	15541	1635	997	455
1967	388564670	8280486	164334	16315	12802	301158	3694	393	552
1968	17124793	49912030	1222943	37221	8415	6807	85636	814	144
1969	12144176	2200559	9104091	459922	11691	4835	3284	28514	336
1970	87716493	1537306	413636	3172736	90359	2402	1777	413	9574
1971	78677565	10960012	178503	98393	786476	19686	900	372	3580
1972	21520107	10008927	1309449	61495	34669	259095	6731	319	791
1973	73057409	2682816	1624562	396672	12060	8280	69165	2287	537
1974	133740256	9383315	354477	621784	96596	3928	2734	20923	577
1975	11581014	16996414	1267043	93236	190404	27297	1519	1016	4920
1976	16522606	1474237	2336444	323900	20553	52040	8041	354	1517
1977	25954903	2064548	208395	695901	65567	7224	14275	2063	572
1978	39725190	3297960	283027	51535	194110	15600	2008	6010	1755
1979	72139122	5004544	430227	69401	13328	50831	4893	500	1339
1980	15628753	8970428	807104	121331	17605	3844	16259	1982	1321
1981	32463463	1868673	1425428	268167	30033	4466	1427	6013	595
1982	20567908	3947248	299949	609121	82518	9951	1816	754	2246
1983	66859995	2547809	637253	130548	209728	27699	5064	841	895
1984	17194588	8377652	420390	220632	36437	51038	7766	2601	1127
1985	24010989	2179278	1419525	144026	63296	8892	12237	2930	1134
1986	49901335	3040972	340140	514114	42692	16250	2479	3363	894
1987	4192877	6403771	513726	81594	114772	8817	4535	911	1750
1988	8432732	534968	1092230	139272	21687	29495	2910	1110	703
1989	8700632	1079654	89574	330388	29094	5037	7337	933	606
1990	28194941	1115754	186466	31095	96032	6680	1739	2335	595
1991	27414068	3608970	176233	40646	7496	23755	1935	613	1242
1992	40804808	3484689	592942	54061	11184	2407	8115	701	1131
1993	12768700	5155856	577258	190088	13427	2928	839	2245	888
1994	53592803	1593112	832419	171814	52360	4185	861	280	1020
1995	13259043	6868420	262458	315008	45139	14648	1689	186	205
1996	21317439	1608703	1186849	105581	97244	12320	5075	920	147
1997	12169140	2619592	285543	502511	32018	27067	3297	1394	208
1998	9356944	1552212	444088	120805	203125	11458	8221	988	353
1999	107543094	1195989	261485	160659	50269	62826	4185	3507	853
2000	21916029	13805709	194007	76008	48130	17317	15371	1311	652
2001	2487492	2802636	2497565	57488	20938	14225	8726	4706	1002
2002	3524857	318968	500232	1156010	16229	8465	7917	5732	7813
2003	3807934	435562	53194	280998	686564	6861	5086	5517	4934
2004	3419349	488014	75491	24095	179354	438449	3835	3620	3365
2005	35811759	439860	89397	35810	12964	108842	276522	2486	1143
2006	6085578	4608628	80514	45077	17844	7158	66423	173235	1010
2007	0	783805	838806	33801	20695	7611	3356	42849	118636

Table 13.3.5.4 Haddock in Subarea IV and Division IIIa. XSA final assessment: Stock summary table.

	recruitment	tsb	ssb	catch	landings	discards	bycatch	yield/ssb	F (2-4)
1963	**2316936**	3403068	**136860**	271531	68779	188969	13783	0.5	**0.75**
1964	**9177147**	1283765	**418161**	380158	130944	160318	88896	0.31	**0.79**
1965	**26320755**	1070525	**522431**	299464	162307	62236	74921	0.31	**0.64**
1966	**68979807**	1464341	**427940**	346726	226335	73572	46819	0.53	**0.66**
1967	**388564670**	5485807	**224670**	246589	147778	78056	20755	0.66	**0.63**
1968	**17124793**	6823944	**259090**	302043	105830	161886	34327	0.41	**0.6**
1969	**12144176**	2474397	**810772**	930538	331419	260232	338887	0.41	**1.12**
1970	**87716493**	2546353	**899883**	806674	525325	101380	179969	0.58	**1.15**
1971	**78677565**	2528881	**420366**	446634	237340	177482	31812	0.56	**0.77**
1972	**21520107**	2192663	**303240**	353606	195494	128130	29983	0.64	**1.12**
1973	**73057409**	4120381	**298056**	307688	181518	114719	11451	0.61	**0.86**
1974	**133740256**	4775345	**262240**	368797	153116	166786	48895	0.58	**0.96**
1975	**11581014**	2384270	**239780**	454536	151386	260424	42726	0.63	**1.09**
1976	**16522606**	1104890	**310984**	377118	172607	154264	50246	0.56	**0.98**
1977	**25954903**	1064134	**242821**	226411	145083	44347	36982	0.6	**1.07**
1978	**39725190**	1106251	**138579**	180144	91674	76878	11592	0.66	**1.07**
1979	**72139122**	1330298	**113236**	146001	87094	41732	17175	0.77	**0.99**
1980	**15628753**	1428853	**160045**	223610	105071	94743	23796	0.66	**0.99**
1981	**32463463**	972386	**247163**	217151	138731	60115	18306	0.56	**0.74**
1982	**20567908**	1073941	**306544**	237842	176635	40549	20658	0.58	**0.7**
1983	**66859995**	2233817	**257233**	253594	167353	65925	20316	0.65	**0.95**
1984	**17194588**	1667269	**203034**	222563	134504	75294	12764	0.66	**0.94**
1985	**24010989**	1172808	**242955**	258117	165672	85444	7001	0.68	**0.9**
1986	**49901335**	1960072	**219963**	225697	169157	52209	4331	0.77	**1.2**
1987	**4192877**	1032238	**154946**	176880	111779	59212	5889	0.72	**1.03**
1988	**8432732**	609635	**156519**	175516	107978	62062	5475	0.69	**1.11**
1989	**8700632**	611607	**126871**	108772	80288	25713	2770	0.63	**0.96**
1990	**28194941**	1520515	**79305**	92720	55558	32603	4559	0.7	**1.15**
1991	**27414068**	1534728	**61772**	97021	48731	40276	8014	0.79	**0.9**
1992	**40804808**	1326278	**100396**	138001	74614	47967	15420	0.74	**0.99**
1993	**12768700**	974818	**133692**	174296	81539	79601	13156	0.61	**0.92**
1994	**53592803**	1413718	**153999**	153864	82730	65392	5741	0.54	**0.89**
1995	**13259043**	1099612	**149823**	144773	77503	57360	9909	0.52	**0.83**
1996	**21317439**	974750	**180459**	159671	79176	72522	7973	0.44	**0.81**
1997	**12169140**	855563	**193840**	141900	82496	52105	7299	0.43	**0.63**
1998	**9356944**	717734	**164913**	131621	81070	45175	5376	0.49	**0.72**
1999	**107543094**	2749772	**120224**	112299	65569	42562	4168	0.55	**0.87**
2000	**21916029**	3016114	**95203**	105161	47569	48841	8751	0.5	**0.94**
2001	**2487492**	942708	**219219**	167278	40861	118320	8097	0.19	**0.68**
2002	**3524857**	635710	**348477**	107917	58308	45892	3717	0.17	**0.35**
2003	**3807934**	558318	**332101**	68735	44087	23499	1149	0.13	**0.26**
2004	**3419349**	577112	**271793**	66476	48697	17226	554	0.18	**0.32**
2005	**35811759**	2381664	**222043**	58056	48380	9508	168	0.22	**0.36**
2006	**6085578**	1038703	**168177**	54753	37565	16652	536	0.22	**0.54**
mean	**39470232**	1823631	**252269**	239067	125583	83822	29662	0.53	**0.84**
units	thousands	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes		

Table 13.6.1 Haddock in Subarea IV and Division IIIa. Short term forecast input.

MFDP version 1a
Run: final run
Time and date: 18:08 07/05/2007
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2007

Age	N	M	Mat	PF	PM	SWt
0	6269273	2.05	0	0	0	0.041
1	783805	1.65	0.01	0	0	0.14
2	838806	0.4	0.32	0	0	0.263
3	33801	0.25	0.71	0	0	0.379
4	20695	0.25	0.87	0	0	0.508
5	7611	0.2	0.95	0	0	0.66
6	3356	0.2	1	0	0	0.807
7	42849	0.2	1	0	0	0.673
8	118636	0.2	1	0	0	0.73

Catch

Age	Sel	CWt	DSel	DCWt
0	0	0	0.0007	0.054
1	0.001	0.356	0.0534	0.155
2	0.1873	0.393	0.27	0.232
3	0.3329	0.434	0.1922	0.272
4	0.534	0.534	0.0702	0.322
5	0.55	0.667	0.0191	0.383
6	0.2343	0.81	0.01	0.495
7	0.1985	0.712	0.0042	0.611
8	0.202204	0.765	0	1.015

Industrialbycatch

Age	Sel	CWt
0	0	0.014
1	0.0009	0.089
2	0.0136	0.167
3	0.0078	0.256
4	0.004	0.303
5	0.0094	0.357
6	0.0014	0.473
7	0.0008	0.582
8	0.001196	0.287

2008

Age	N	M	Mat	PF	PM	SWt
0	6269273	2.05	0	0	0	0.041
1	.	1.65	0.01	0	0	0.14
2	.	0.4	0.32	0	0	0.263
3	.	0.25	0.71	0	0	0.379
4	.	0.25	0.87	0	0	0.508
5	.	0.2	0.95	0	0	0.66
6	.	0.2	1	0	0	0.807
7	.	0.2	1	0	0	0.976
8	.	0.2	1	0	0	0.873

Catch

Age	Sel	CWt	DSel	DCWt
0	0	0	0.0007	0.054
1	0.001	0.356	0.0534	0.155
2	0.1873	0.393	0.27	0.232
3	0.3329	0.434	0.1922	0.272
4	0.534	0.534	0.0702	0.322
5	0.55	0.667	0.0191	0.383
6	0.2343	0.81	0.01	0.495
7	0.1985	1.018	0.0042	0.611
8	0.202204	0.916	0	1.015

Industrialbycatch

Age	Sel	CWt
0	0	0.014
1	0.0009	0.089
2	0.0136	0.167
3	0.0078	0.256
4	0.004	0.303
5	0.0094	0.357
6	0.0014	0.473
7	0.0008	0.582
8	0.001196	0.287

2009

Age	N	M	Mat	PF	PM	SWt
0	6269273	2.05	0	0	0	0.041
1	.	1.65	0.01	0	0	0.14
2	.	0.4	0.32	0	0	0.263
3	.	0.25	0.71	0	0	0.379
4	.	0.25	0.87	0	0	0.508
5	.	0.2	0.95	0	0	0.66
6	.	0.2	1	0	0	0.807
7	.	0.2	1	0	0	0.976
8	.	0.2	1	0	0	1.022

Catch

Age	Sel	CWt	DSel	DCWt
0	0	0	0.0007	0.054
1	0.001	0.356	0.0534	0.155
2	0.1873	0.393	0.27	0.232
3	0.3329	0.434	0.1922	0.272
4	0.534	0.534	0.0702	0.322
5	0.55	0.667	0.0191	0.383
6	0.2343	0.81	0.01	0.495
7	0.1985	1.018	0.0042	0.611
8	0.202204	1.071	0	1.015

Industrialbycatch

Age	Sel	CWt
0	0	0.014
1	0.0009	0.089
2	0.0136	0.167
3	0.0078	0.256
4	0.004	0.303
5	0.0094	0.357
6	0.0014	0.473
7	0.0008	0.582
8	0.001196	0.287

Input units are thousands and kg - output in tonnes

Table 13.6.2 Haddock in Subarea IV and Division IIIa. Short term forecast output.

MFDP version 1a
Run: final run
Time and date: 18:08 07/05/2007
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2007

Biomass	SSB	Catch FMult	Landings FBar	Yield	Discards FBar	Yield	Industrialbycatch FMult	Landings FBar	Yield
733876	212855	1	0.3514	71241	0.1775	39974	1	0.0085	1435

2008 / 2009

Biomass (2008)	SSB (2008)	Catch FMult	Landings FBar	Yield	Discards FBar	Yield	Industrialbycatch FMult	Landings FBar	Yield	Biomass (2009)	SSB (2009)
653211	219017	0	0	0	0	0	1	0.0085	994	692648	267406
.	219017	0.1	0.0351	7767	0.0177	2667	1	0.0085	972	681083	257403
.	219017	0.2	0.0703	15212	0.0355	5224	1	0.0085	950	670035	247845
.	219017	0.3	0.1054	22351	0.0532	7676	1	0.0085	929	659479	238713
.	219017	0.4	0.1406	29197	0.071	10027	1	0.0085	909	649390	229986
.	219017	0.5	0.1757	35764	0.0887	12284	1	0.0085	889	639746	221643
.	219017	0.6	0.2108	42065	0.1065	14449	1	0.0085	870	630526	213667
.	219017	0.7	0.246	48112	0.1242	16528	1	0.0085	851	621710	206041
.	219017	0.8	0.2811	53916	0.142	18525	1	0.0085	834	613277	198746
.	219017	0.9	0.3163	59490	0.1597	20443	1	0.0085	816	605210	191769
.	219017	1	0.3514	64843	0.1775	22287	1	0.0085	799	597492	185092
.	219017	1.1	0.3865	69985	0.1952	24059	1	0.0085	783	590105	178703
.	219017	1.2	0.4217	74926	0.213	25763	1	0.0085	767	583033	172587
.	219017	1.3	0.4568	79675	0.2307	27403	1	0.0085	752	576263	166731
.	219017	1.4	0.492	84241	0.2485	28981	1	0.0085	737	569779	161124
.	219017	1.5	0.5271	88631	0.2662	30500	1	0.0085	723	563568	155753
.	219017	1.6	0.5622	92854	0.2839	31963	1	0.0085	709	557617	150608
.	219017	1.7	0.5974	96918	0.3017	33373	1	0.0085	695	551914	145678
.	219017	1.8	0.6325	100828	0.3194	34732	1	0.0085	682	546447	140952
.	219017	1.9	0.6677	104592	0.3372	36042	1	0.0085	669	541206	136422
.	219017	2	0.7028	108217	0.3549	37306	1	0.0085	657	536179	132078

Input units are thousands and kg - output in tonnes

Table 13.6.3 Haddock in Subarea IV and Division IIIa. Short term forecast output.

MFDP version 1a
Run: final run
Time and date: 18:08 07/05/2007
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

Year:	2007	F multiplier:	1	Fleet1 HCFbar:	0.3514	Fleet1 DFbar:	0.1775								
	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	0.0007	1865	101	0	0	0	6269273	257040	0	0	0	0
1	0.001	376	134	0.0534	20084	3113	0.0009	338	30	783805	109733	7838	1097	7838	1097
2	0.1873	104888	41221	0.27	151200	35078	0.0136	7616	1272	838806	220606	268418	70594	268418	70594
3	0.3329	7803	3387	0.1922	4505	1225	0.0078	183	47	33801	12811	23999	9096	23999	9096
4	0.534	7418	3961	0.0702	975	314	0.004	56	17	20695	10513	18005	9146	18005	9146
5	0.55	2908	1940	0.0191	101	39	0.0094	50	18	7611	5023	7230	4772	7230	4772
6	0.2343	634	514	0.01	27	13	0.0014	4	2	3356	2708	3356	2708	3356	2708
7	0.1985	6999	4983	0.0042	148	90	0.0008	28	16	42849	28837	42849	28837	42849	28837
8	0.2022	19740	15101	0	0	0	0.0012	117	34	118636	86604	118636	86604	118636	86604
Total		150767	71241		178905	39974		8391	1435	8118832	733876	490331	212855	490331	212855

Year:	2008	F multiplier:	1	Fleet1 HCFbar:	0.3514	Fleet1 DFbar:	0.1775								
	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	0.0007	1865	101	0	0	0	6269273	257040	0	0	0	0
1	0.001	387	138	0.0534	20666	3203	0.0009	348	31	806510	112911	8065	1129	8065	1129
2	0.1873	17810	6999	0.27	25674	5956	0.0136	1293	216	142431	37459	45578	11987	45578	11987
3	0.3329	81055	35178	0.1922	46797	12729	0.0078	1899	486	351103	133068	249283	94478	249283	94478
4	0.534	5538	2957	0.0702	728	234	0.004	41	13	15450	7848	13441	6828	13441	6828
5	0.55	3353	2236	0.0191	116	45	0.0094	57	20	8773	5790	8334	5501	8334	5501
6	0.2343	661	535	0.01	28	14	0.0014	4	2	3494	2820	3494	2820	3494	2820
7	0.1985	351	357	0.0042	7	5	0.0008	1	1	2149	2098	2149	2098	2149	2098
8	0.2022	17950	16442	0	0	0	0.0012	106	30	107876	94176	107876	94176	107876	94176
Total		127104	64843		95882	22287		3751	799	7707059	653211	438222	219017	438222	219017

Year:	2009	F multiplier:	1	Fleet1 HCFbar:	0.3514	Fleet1 DFbar:	0.1775								
	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	0.0007	1865	101	0	0	0	6269273	257040	0	0	0	0
1	0.001	387	138	0.0534	20666	3203	0.0009	348	31	806510	112911	8065	1129	8065	1129
2	0.1873	18326	7202	0.27	26418	6129	0.0136	1331	222	146557	38545	46898	12334	46898	12334
3	0.3329	13763	5973	0.1922	7946	2161	0.0078	322	83	59618	22595	42329	16043	42329	16043
4	0.534	57525	30718	0.0702	7562	2435	0.004	431	131	160482	81525	139619	70926	139619	70926
5	0.55	2503	1669	0.0191	87	33	0.0094	43	15	6550	4323	6222	4107	6222	4107
6	0.2343	761	617	0.01	32	16	0.0014	5	2	4028	3250	4028	3250	4028	3250
7	0.1985	365	372	0.0042	8	5	0.0008	1	1	2238	2184	2238	2184	2238	2184
8	0.2022	12230	13098	0	0	0	0.0012	72	21	73502	75119	73502	75119	73502	75119
Total		105861	59788		64584	14083		2554	505	7528756	597492	322900	185092	322900	185092

Input units are thousands and kg - output in tonnes

Table 13.6.4 Haddock in Subarea IV and Division IIIa. Short term forecast output restraining catch to the TAC of 2007 (58 000 tonnes).

MFDP version 1a
Run: runtotalTAC
Time and date: 12:41 08/05/2007
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2007

Biomass	SSB	Catch FMult	Landings FBar	Yield	Discards FBar	Yield	Industrialby FMult	Landings FBar	Yield
733876	212855	0.784	0.2755	58000	0.1391	32617	1	0.0085	1496

2008											2009	
Biomass	SSB	Catch FMult	Landings FBar	Yield	Discards FBar	Yield	Industrialby FMult	Landings FBar	Yield	Biomass	SSB
673926	235245	0	0	0	0	0	1	0.0085	1069	713626	286351
.	235245	0.1	0.0351	8404	0.0177	2844	1	0.0085	1045	701119	275508
.	235245	0.2	0.0703	16458	0.0355	5569	1	0.0085	1021	689175	265152
.	235245	0.3	0.1054	24178	0.0532	8181	1	0.0085	999	677766	255260
.	235245	0.4	0.1406	31578	0.071	10685	1	0.0085	977	666865	245810
.	235245	0.5	0.1757	38675	0.0887	13087	1	0.0085	955	656449	236779
.	235245	0.6	0.2108	45482	0.1065	15390	1	0.0085	935	646495	228148
.	235245	0.7	0.246	52012	0.1242	17600	1	0.0085	915	636978	219897
.	235245	0.8	0.2811	58279	0.142	19722	1	0.0085	895	627880	212009
.	235245	0.9	0.3163	64294	0.1597	21759	1	0.0085	877	619179	204465
.	235245	1	0.3514	70069	0.1775	23715	1	0.0085	858	610857	197249
.	235245	1.1	0.3865	75615	0.1952	25595	1	0.0085	841	602895	190346
.	235245	1.2	0.4217	80942	0.213	27402	1	0.0085	824	595276	183741
.	235245	1.3	0.4568	86060	0.2307	29139	1	0.0085	807	587984	177420
.	235245	1.4	0.492	90979	0.2485	30810	1	0.0085	791	581003	171368
.	235245	1.5	0.5271	95707	0.2662	32418	1	0.0085	776	574319	165574
.	235245	1.6	0.5622	100254	0.2839	33966	1	0.0085	760	567917	160025
.	235245	1.7	0.5974	104626	0.3017	35456	1	0.0085	746	561785	154709
.	235245	1.8	0.6325	108833	0.3194	36891	1	0.0085	732	555908	149617
.	235245	1.9	0.6677	112882	0.3372	38274	1	0.0085	718	550276	144736
.	235245	2	0.7028	116778	0.3549	39608	1	0.0085	704	544877	140058

Input units are thousands and kg - output in tonnes

Table 13.6.5 Haddock in Subarea IV and Division IIIa. Short term forecast output taking F at age as an average of F at ages over years 2004–2006, scaled to the Fbar of 2006.

MFDP version 1a
Run: fbar
Time and date: 16:10 08/05/2007
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2007									
		Catch	Landings		Discards		Industrialbycatch	Landings	
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	FMult	FBar	Yield
733876	212855	1	0.3243	65431	0.207	48357	1	0.006	1038

2008										2009	
		Catch	Landings		Discards		Industrialbycatch	Landings			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	FMult	FBar	Yield	Biomass	SSB
647072	213799	0	0	0	0	0	1	0.006	798	686978	262099
.	213799	0.1	0.0324	8628	0.0207	2933	1	0.006	779	674166	250986
.	213799	0.2	0.0649	16866	0.0414	5735	1	0.006	762	661978	240414
.	213799	0.3	0.0973	24733	0.0621	8413	1	0.006	745	650380	230355
.	213799	0.4	0.1297	32248	0.0828	10972	1	0.006	728	639343	220782
.	213799	0.5	0.1622	39428	0.1035	13420	1	0.006	712	628836	211669
.	213799	0.6	0.1946	46290	0.1242	15763	1	0.006	697	618832	202994
.	213799	0.7	0.227	52849	0.1449	18004	1	0.006	682	609306	194733
.	213799	0.8	0.2595	59122	0.1656	20151	1	0.006	667	600232	186866
.	213799	0.9	0.2919	65120	0.1863	22207	1	0.006	653	591587	179371
.	213799	1	0.3243	70859	0.207	24178	1	0.006	640	583349	172230
.	213799	1.1	0.3568	76351	0.2277	26067	1	0.006	627	575496	165425
.	213799	1.2	0.3892	81607	0.2484	27879	1	0.006	614	568010	158938
.	213799	1.3	0.4216	86639	0.2691	29617	1	0.006	602	560872	152753
.	213799	1.4	0.4541	91458	0.2898	31287	1	0.006	590	554063	146856
.	213799	1.5	0.4865	96075	0.3105	32890	1	0.006	579	547567	141231
.	213799	1.6	0.5189	100498	0.3312	34431	1	0.006	568	541369	135864
.	213799	1.7	0.5514	104738	0.3519	35912	1	0.006	557	535452	130744
.	213799	1.8	0.5838	108802	0.3726	37336	1	0.006	547	529803	125856
.	213799	1.9	0.6162	112700	0.3933	38708	1	0.006	537	524408	121190
.	213799	2	0.6487	116438	0.414	40028	1	0.006	527	519254	116735

Input units are thousands and kg - output in tonnes

Table 13.6.6 Haddock in Subarea IV and Division IIIa. Short term forecast output taking F at age as a straight average of F at ages over years 2004–2006.

MFDP version 1a
Run: straight_average
Time and date: 15:58 08/05/2007
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2007

Biomass	SSB	Catch FMult	Landings FBar	Landings Yield	Discards FBar	Discards Yield	Industrialbycatch FMult	Landings FBar	Landings Yield
733876	212855	1	0.2453	51820	0.1567	38394	1	0.0047	852

2008										2009	
Biomass	SSB	Catch FMult	Landings FBar	Landings Yield	Discards FBar	Discards Yield	Industrialbycatch FMult	Landings FBar	Landings Yield	Biomass	SSB
672207	233600	0	0	0	0	0	1	0.0047	704	712776	285428
.	233600	0.1	0.0245	7231	0.0157	2405	1	0.0047	691	702062	276116
.	233600	0.2	0.0491	14212	0.0313	4727	1	0.0047	679	691747	267152
.	233600	0.3	0.0736	20951	0.047	6970	1	0.0047	667	681816	258522
.	233600	0.4	0.0981	27459	0.0627	9135	1	0.0047	656	672254	250211
.	233600	0.5	0.1227	33744	0.0783	11228	1	0.0047	645	663045	242208
.	233600	0.6	0.1472	39814	0.094	13249	1	0.0047	634	654175	234500
.	233600	0.7	0.1717	45678	0.1097	15203	1	0.0047	623	645632	227076
.	233600	0.8	0.1963	51344	0.1253	17092	1	0.0047	613	637402	219925
.	233600	0.9	0.2208	56819	0.141	18918	1	0.0047	603	629473	213035
.	233600	1	0.2453	62110	0.1567	20685	1	0.0047	593	621832	206396
.	233600	1.1	0.2699	67224	0.1723	22393	1	0.0047	584	614469	199999
.	233600	1.2	0.2944	72168	0.188	24046	1	0.0047	574	607373	193834
.	233600	1.3	0.3189	76948	0.2037	25646	1	0.0047	565	600532	187891
.	233600	1.4	0.3435	81570	0.2193	27195	1	0.0047	557	593937	182163
.	233600	1.5	0.368	86040	0.235	28694	1	0.0047	548	587579	176641
.	233600	1.6	0.3925	90364	0.2507	30147	1	0.0047	540	581447	171316
.	233600	1.7	0.4171	94548	0.2663	31554	1	0.0047	531	575534	166181
.	233600	1.8	0.4416	98596	0.282	32917	1	0.0047	523	569830	161229
.	233600	1.9	0.4661	102513	0.2977	34239	1	0.0047	516	564328	156453
.	233600	2	0.4907	106304	0.3133	35520	1	0.0047	508	559019	151846

Input units are thousands and kg - output in tonnes

Table 13.12.1. Haddock in Sub-Area IV and Division IIIa update. Inputs to RCT3.

HADDOCK IN IV, RCT3 INPUT VALUES

8	27	2							
'YEARCLASS	'VPA'	'IBTS1'	'IBTS2'	'EGFS0'	'EGFS1'	'EGFS2'	'SGFS0'	'SGFS1'	'SGFS2'
1981	32469.901	-1	403.079	-1	-1	-1	-1	-1	-1
1982	20570.629	302.278	221.275	-1	-1	-1	-1	-1	-1
1983	66872.868	1072.285	833.257	-1	-1	-1	-1	-1	-1
1984	17193.144	230.968	266.912	-1	-1	-1	-1	-1	-1
1985	24013.365	573.023	328.062	-1	-1	-1	-1	-1	-1
1986	49935.672	912.559	677.641	-1	-1	-1	-1	-1	-1
1987	4196.488	101.691	98.091	-1	-1	-1	-1	-1	-1
1988	8434.582	219.705	139.114	-1	-1	-1	-1	-1	-1
1989	8703.422	217.448	134.076	-1	-1	-1	-1	-1	-1
1990	28264.915	680.231	331.044	-1	-1	29.133	-1	-1	-1
1991	27519.832	1141.396	519.521	-1	58.746	17.435	-1	-1	-1
1992	41333.444	1242.121	491.051	246.021	73.145	26.992	-1	-1	-1
1993	12962.009	227.919	201.069	40.336	23.990	13.223	-1	-1	-1
1994	54522.956	1355.485	813.268	279.344	113.775	43.044	-1	-1	-1
1995	13932.478	267.411	353.882	53.435	26.747	12.608	-1	-1	-1
1996	21690.035	849.943	420.926	61.301	45.346	16.778	-1	-1	1924.000
1997	12488.656	357.597	222.907	40.653	26.497	8.404	-1	6349.000	1141.000
1998	9653.396	211.139	107.060	15.747	16.551	4.528	3280.000	1907.000	460.000
1999	122401.614	3734.185	2255.213	626.100	249.813	96.498	66067.000	30611.000	11352.000
2000	24344.813	894.651	492.299	92.139	28.622	22.559	11902.000	3790.000	2632.000
2001	2681.687	58.211	38.585	1.097	3.954	1.247	79.000	675.000	307.000
2002	3660.529	89.958	79.622	2.721	6.015	3.864	2149.000	1172.000	547.000
2003	3983.628	71.875	60.993	3.199	6.599	5.992	2159.000	1198.000	657.000
2004	3594.863	69.976	47.784	3.398	9.740	3.270	1729.000	761.000	272.000
2005	37580.229	1212.163	963.325	122.383	54.816	-1	19708.000	7275.000	**5527.486**
2006	6319.652	109.096	-1	11.825	-1	-1	2280.000	**1809.595**	-1
2007	-1	-1	-1	-1	-1	-1	**1118.878**	-1	-1

Table 13.12.2. Haddock in Sub-Area IV and Division IIIa update. RCT3 outputs.

```
Analysis by RCT3 ver3.1 of data from file : hadivrct.in

 "HADDOCK IN IV, RCT3 INPUT VALUES"

 Data for    8 surveys over   27 years :  1981 - 2007

 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 =   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
 IBTS1     .96   4.01    .29   .931     23   7.10    10.80     .314     .136
 IBTS2    1.06   3.83    .25   .946     24   6.87    11.11     .276     .176
 EGFS0     .64   7.25    .18   .978     13   4.82    10.35     .209     .306
 EGFS1    1.03   6.14    .20   .973     14   4.02    10.27     .225     .264
 EGFS2
 SGFS0     .78   2.89    .85   .763      7   9.89    10.58    1.139     .010
 SGFS1    1.04   1.01    .40   .924      8   8.89    10.29     .511     .051
 SGFS2    1.09   1.73    .41   .912      9   8.62    11.09     .547     .045
                                        VPA Mean =    9.69    1.021     .013


 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
 IBTS1     .95   4.05    .28   .932     24   4.70     8.51     .309     .258
 IBTS2
 EGFS0     .65   7.24    .18   .977     14   2.55     8.90     .207     .576
 EGFS1
 EGFS2
 SGFS0     .77   2.91    .77   .790      8   7.73     8.90     .948     .028
 SGFS1    1.07    .85    .39   .928      9   7.50     8.86     .465     .114
 SGFS2
                                        VPA Mean =    9.72    1.014     .024


 Yearclass =   2007

         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights
 IBTS1
 IBTS2
 EGFS0
 EGFS1
 EGFS2
 SGFS0     .78   2.86    .72   .791      9   7.02     8.32     .877     .571
 SGFS1
 SGFS2
                                        VPA Mean =    9.69    1.011     .429


 Year     Weighted      Log     Int      Ext      Var      VPA       Log
 Class     Average      WAP     Std      Std     Ratio               VPA
          Prediction           Error    Error
 2005       38085     10.55     .12      .13      1.31   37581     10.53
 2006        6722      8.81     .16      .11       .49    6320      8.75
 2007        7393      8.91     .66      .67      1.04
```

Table 13.12.3. Haddock in Sub-Area IV and Division IIIa update. Short term forecast input.

MFDP version 1a
Run: update_noIBC2007
Time and date: 15:48 25/09/2007
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2007

Age	N	M	Mat	PF	PM	SWt
0	7393000	2.05	0.00	0	0	0.041
1	813037	1.65	0.01	0	0	0.140
2	881138	0.40	0.32	0	0	0.263
3	36609	0.25	0.71	0	0	0.379
4	22871	0.25	0.87	0	0	0.508
5	8928	0.20	0.95	0	0	0.660
6	4885	0.20	1.00	0	0	0.807
7	58906	0.20	1.00	0	0	0.673
8	197711	0.20	1.00	0	0	0.730

Catch

Age	Sel	CWt	DSel	DCWt
0	0.000	0.000	0.001	0.054
1	0.001	0.356	0.052	0.155
2	0.180	0.393	0.260	0.232
3	0.311	0.434	0.180	0.272
4	0.474	0.534	0.062	0.322
5	0.409	0.667	0.014	0.383
6	0.176	0.810	0.008	0.495
7	0.121	0.712	0.003	0.611
8	0.124	0.765	0.000	1.015

Industrialbycatch

Age	Sel	CWt
0	0	0.014
1	0	0.089
2	0	0.167
3	0	0.256
4	0	0.303
5	0	0.357
6	0	0.473
7	0	0.582
8	0	0.287

2008

Age	N	M	Mat	PF	PM	SWt
0	6493579	2.05	0.00	0	0	0.041
1	.	1.65	0.01	0	0	0.140
2	.	0.40	0.32	0	0	0.263
3	.	0.25	0.71	0	0	0.379
4	.	0.25	0.87	0	0	0.508
5	.	0.20	0.95	0	0	0.660
6	.	0.20	1.00	0	0	0.807
7	.	0.20	1.00	0	0	0.976
8	.	0.20	1.00	0	0	0.873

Catch

Age	Sel	CWt	DSel	DCWt
0	0.000	0.000	0.001	0.054
1	0.001	0.356	0.051	0.155
2	0.175	0.393	0.253	0.232
3	0.307	0.434	0.177	0.272
4	0.471	0.534	0.062	0.322
5	0.403	0.667	0.014	0.383
6	0.175	0.810	0.007	0.495
7	0.121	1.018	0.003	0.611
8	0.123	0.916	0.000	1.015

Industrialbycatch

Age	Sel	CWt
0	0.000	0.014
1	0.001	0.089
2	0.013	0.167
3	0.007	0.256
4	0.004	0.303
5	0.007	0.357
6	0.001	0.473
7	0.001	0.582
8	0.001	0.287

2009

Age	N	M	Mat	PF	PM	SWt
0	6493579	2.05	0.00	0	0	0.04
1	.	1.65	0.01	0	0	0.14
2	.	0.40	0.32	0	0	0.26
3	.	0.25	0.71	0	0	0.38
4	.	0.25	0.87	0	0	0.51
5	.	0.20	0.95	0	0	0.66
6	.	0.20	1.00	0	0	0.81
7	.	0.20	1.00	0	0	0.98
8	.	0.20	1.00	0	0	1.02

Catch

Age	Sel	CWt	DSel	DCWt
0	0	0	0.001	0.054
1	0.001	0.356	0.051	0.155
2	0.175	0.393	0.253	0.232
3	0.307	0.434	0.177	0.272
4	0.471	0.534	0.062	0.322
5	0.403	0.667	0.014	0.383
6	0.175	0.81	0.007	0.495
7	0.121	1.018	0.003	0.611
8	0.123	1.071	0	1.015

Industrialbycatch

Age	Sel	CWt
0	0.000	0.014
1	0.001	0.089
2	0.013	0.167
3	0.007	0.256
4	0.004	0.303
5	0.007	0.357
6	0.001	0.473
7	0.001	0.582
8	0.001	0.287

Input units are thousands and kg - output in tonnes

Table 13.12.4. Haddock in Sub-Area IV and Division IIIa update. Short term forecast output restraining catch to the TAC of 2007 (58,000 tonnes) and no industrial bycatch in 2007.

MFDP version 1a
Run: update_noIBC2007
Time and date: 15:48 25/09/2007
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2007

Biomass	SSB	Catch FMult	Landings FBar	Yield	Discards FBar	Yield	Industrialbycatch FMult	Landings FBar	Yield	Total Yield
867978	288767	0.7712	0.2481	58000	0.1290	32936	1.0000	0.0000	0	90936

2008											2009		
Biomass	SSB	Catch FMult	Landings FBar	Landings Yield	Discards FBar	Discards Yield	Industrialbycatch FMult	Landings FBar	Industrial Yield	Total Yield	Biomass	SSB	F_{2-4}
790269	317501	0.0000	0.0000	0	0.0000	0	1.0000	0.0078	1064	1064	818606	370987	0.01
.	317501	0.1000	0.0318	8421	0.0164	2875	1.0000	0.0078	1042	12338	806064	360124	0.06
.	317501	0.2000	0.0635	16534	0.0328	5641	1.0000	0.0078	1020	23195	794025	349693	0.10
.	317501	0.3000	0.0953	24353	0.0492	8302	1.0000	0.0078	1000	33655	782464	339676	0.15
.	317501	0.4000	0.1271	31891	0.0656	10862	1.0000	0.0078	979	43732	771361	330053	0.20
.	317501	0.5000	0.1588	39159	0.0820	13326	1.0000	0.0078	960	53445	760696	320807	0.25
	317501	**0.6000**	**0.1906**	**46169**	**0.0984**	**15699**	**1.0000**	**0.0078**	**941**	**62809**	**750448**	**311922**	**0.30**
.	317501	0.7000	0.2224	52932	0.1148	17984	1.0000	0.0078	923	71839	740600	303380	0.35
	317501	0.8000	0.2541	59458	0.1312	20185	1.0000	0.0078	905	80548	731133	295168	0.39
.	317501	0.9000	0.2859	65758	0.1476	22306	1.0000	0.0078	887	88951	722032	287271	0.44
.	317501	1.0000	0.3177	71841	0.1640	24351	1.0000	0.0078	871	97063	713278	279674	0.49
.	317501	1.1000	0.3494	77716	0.1804	26323	1.0000	0.0078	854	104893	704858	272365	0.54
.	317501	1.2000	0.3812	83391	0.1968	28224	1.0000	0.0078	838	112453	696757	265331	0.59
.	317501	1.3000	0.4130	88876	0.2132	30058	1.0000	0.0078	823	119757	688960	258559	0.63
.	317501	1.4000	0.4447	94178	0.2296	31829	1.0000	0.0078	808	126815	681454	252039	0.68
.	317501	1.5000	0.4765	99304	0.2460	33538	1.0000	0.0078	793	133635	674227	245759	0.73
.	317501	1.6000	0.5083	104262	0.2624	35189	1.0000	0.0078	779	140230	667265	239709	0.78
.	317501	1.7000	0.5400	109059	0.2788	36783	1.0000	0.0078	765	146607	660559	233879	0.83
.	317501	1.8000	0.5718	113702	0.2952	38324	1.0000	0.0078	752	152778	654096	228260	0.87
.	317501	1.9000	0.6036	118196	0.3116	39814	1.0000	0.0078	739	158749	647866	222842	0.92
.	317501	2.0000	0.6353	122548	0.3280	41255	1.0000	0.0078	726	164529	641859	217617	0.97

Input units are thousands and kg - output in tonnes

Table 13.12.5 Haddock in Sub-Area IV and Division IIIa update. Detailed short term forecast output restraining catch to the TAC of 2007 (58,000 tonnes) and no industrial bycatch in 2007.

MFDP version 1a
Run: update_noIBC2007
Time and date: 15:48 25/09/2007
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

Year: 2007 F multiplier: 0.7712 Fleet1 HCFbar: 0.2481 Fleet1 DFbar: 0.129

	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	0.0008	2422	131	0	0	0	7393000	303113	0	0	0	0
1	0.0008	302	108	0.0401	15727	2438	0	0	0	813037	113825	8130	1138	8130	1138
2	0.1388	86452	33975	0.2005	124874	28971	0	0	0	881138	231739	281964	74157	281964	74157
3	0.2398	6518	2829	0.1388	3772	1026	0	0	0	36609	13875	25992	9851	25992	9851
4	0.3655	6111	3263	0.0478	799	257	0	0	0	22871	11619	19898	10108	19898	10108
5	0.3154	2190	1461	0.0108	75	29	0	0	0	8928	5893	8482	5598	8482	5598
6	0.1357	562	455	0.0062	26	13	0	0	0	4885	3942	4885	3942	4885	3942
7	0.0933	4759	3388	0.0023	118	72	0	0	0	58906	39644	58906	39644	58906	39644
8	0.0956	16368	12521	0	0	0	0	0	0	197711	144329	197711	144329	197711	144329
Total		123260	58000		147814	32936		0	0	9417085	867978	605969	288767	605969	288767

Year: 2008 F multiplier: 1 Fleet1 HCFbar: 0.3177 Fleet1 DFbar: 0.164

	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	0.001	2759	149	0	0	0	6493579	266237	0	0	0	0
1	0.001	457	163	0.051	23293	3610	0.0009	411	37	951003	133140	9510	1331	9510	1331
2	0.175	17741	6972	0.253	25648	5950	0.0127	1287	215	149890	39421	47965	12615	47965	12615
3	0.307	91211	39586	0.177	52588	14304	0.0072	2139	548	420691	159442	298691	113204	298691	113204
4	0.471	6367	3400	0.062	838	270	0.0035	47	14	19524	9918	16986	8629	16986	8629
5	0.403	3532	2356	0.014	123	47	0.0068	60	21	11781	7776	11192	7387	11192	7387
6	0.175	767	621	0.007	31	15	0.001	4	2	5275	4257	5275	4257	5275	4257
7	0.121	359	365	0.003	9	5	0.0005	1	1	3470	3387	3470	3387	3470	3387
8	0.123	20063	18378	0	0	0	0.0007	114	33	190940	166691	190940	166691	190940	166691
Total		140497	71841		105288	24351		4065	871	8246155	790269	584030	317501	584030	317501

Year: 2009 F multiplier: 1 Fleet1 HCFbar: 0.3177 Fleet1 DFbar: 0.164

	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	0.001	2759	149	0	0	0	6493579	266237	0	0	0	0
1	0.001	401	143	0.051	20455	3171	0.0009	361	32	835115	116916	8351	1169	8351	1169
2	0.175	20503	8058	0.253	29642	6877	0.0127	1488	248	173230	45559	55433	14579	55433	14579
3	0.307	14020	6085	0.177	8083	2199	0.0072	329	84	64664	24508	45911	17400	45911	17400
4	0.471	65379	34912	0.062	8606	2771	0.0035	486	147	200477	101842	174415	88603	174415	88603
5	0.403	2666	1778	0.014	93	35	0.0068	45	16	8892	5869	8447	5575	8447	5575
6	0.175	918	744	0.007	37	18	0.001	5	2	6314	5095	6314	5095	6314	5095
7	0.121	372	378	0.003	9	6	0.0005	2	1	3597	3510	3597	3510	3597	3510
8	0.123	14779	15828	0	0	0	0.0007	84	24	140648	143742	140648	143742	140648	143742
Total		119037	67926		69683	15225		2799	556	7926514	713278	443116	279674	443116	279674

Input units are thousands and kg - output in tonnes

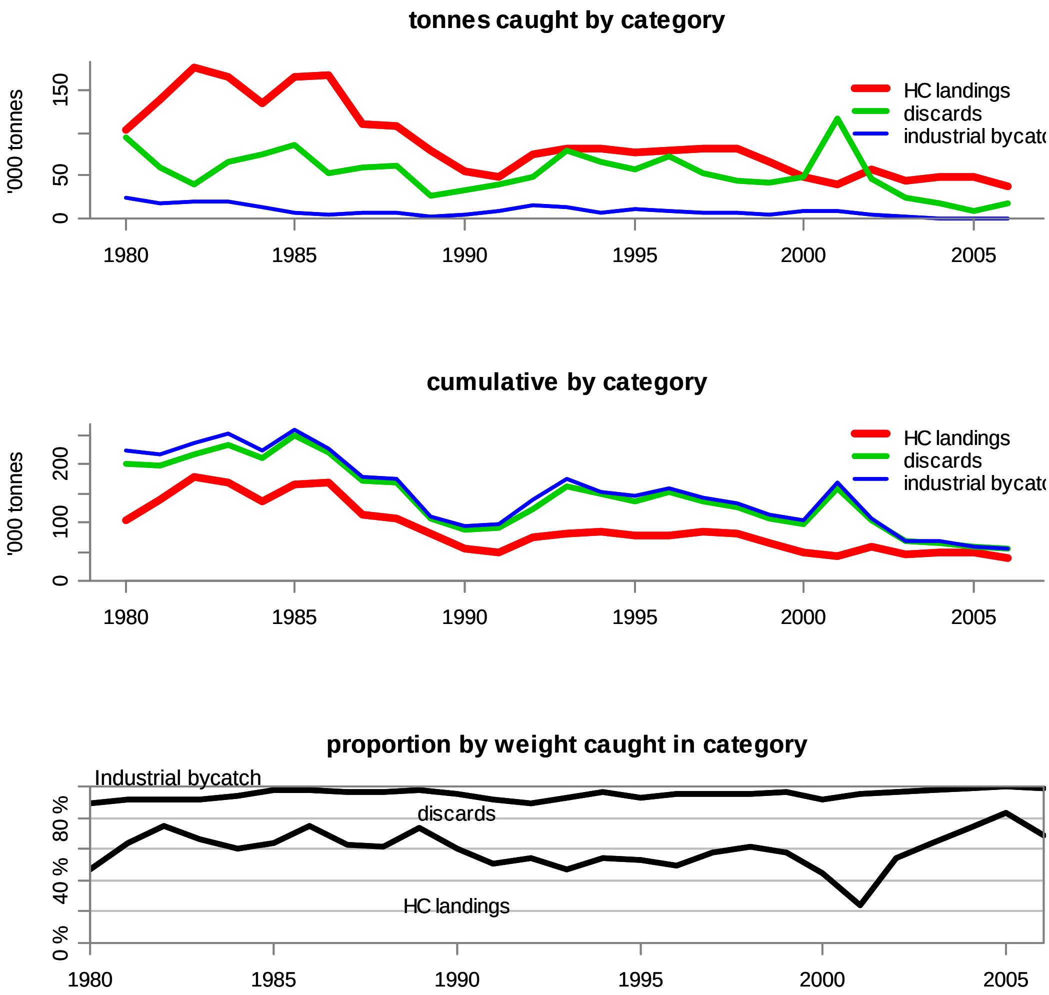


Figure 13.2.3.1 Haddock in Subarea IV and Division IIIa. The contribution of different catch components to the total catch.

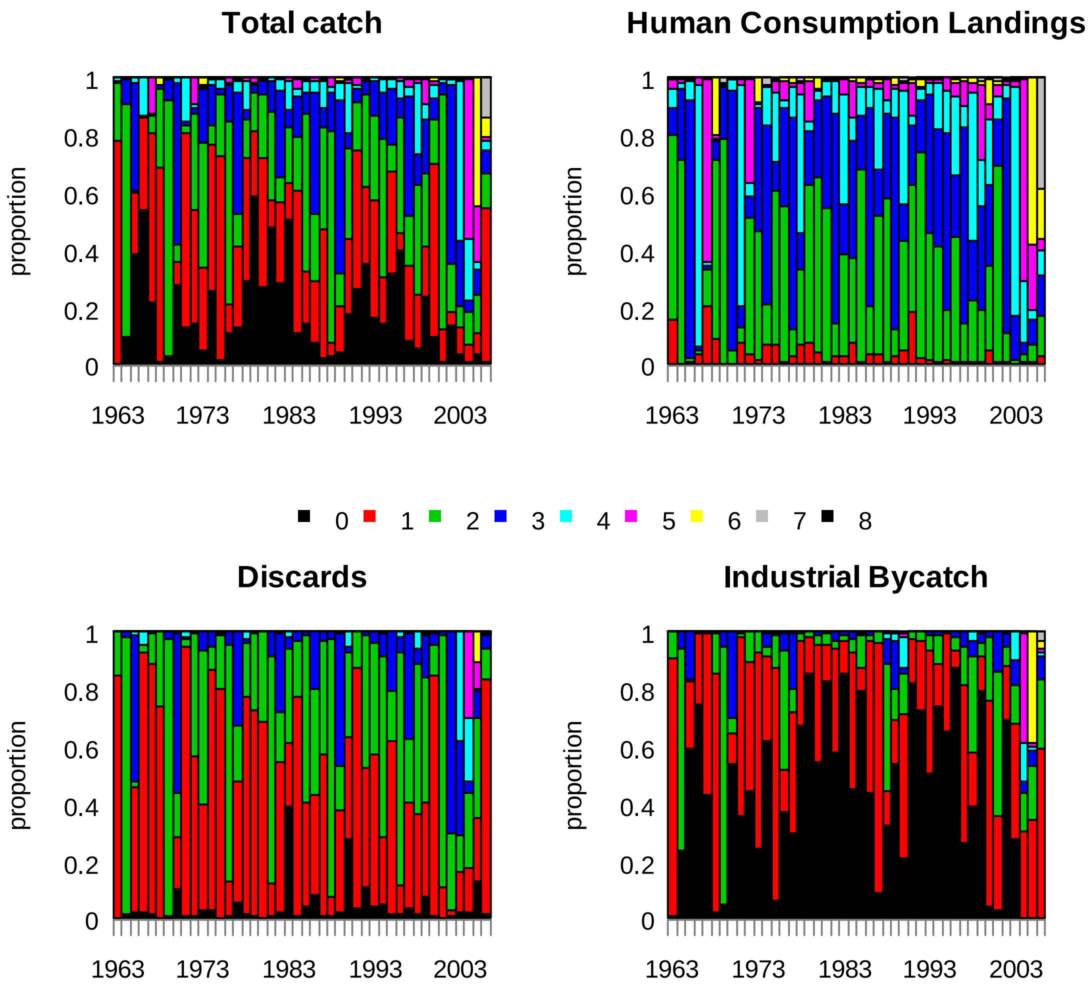
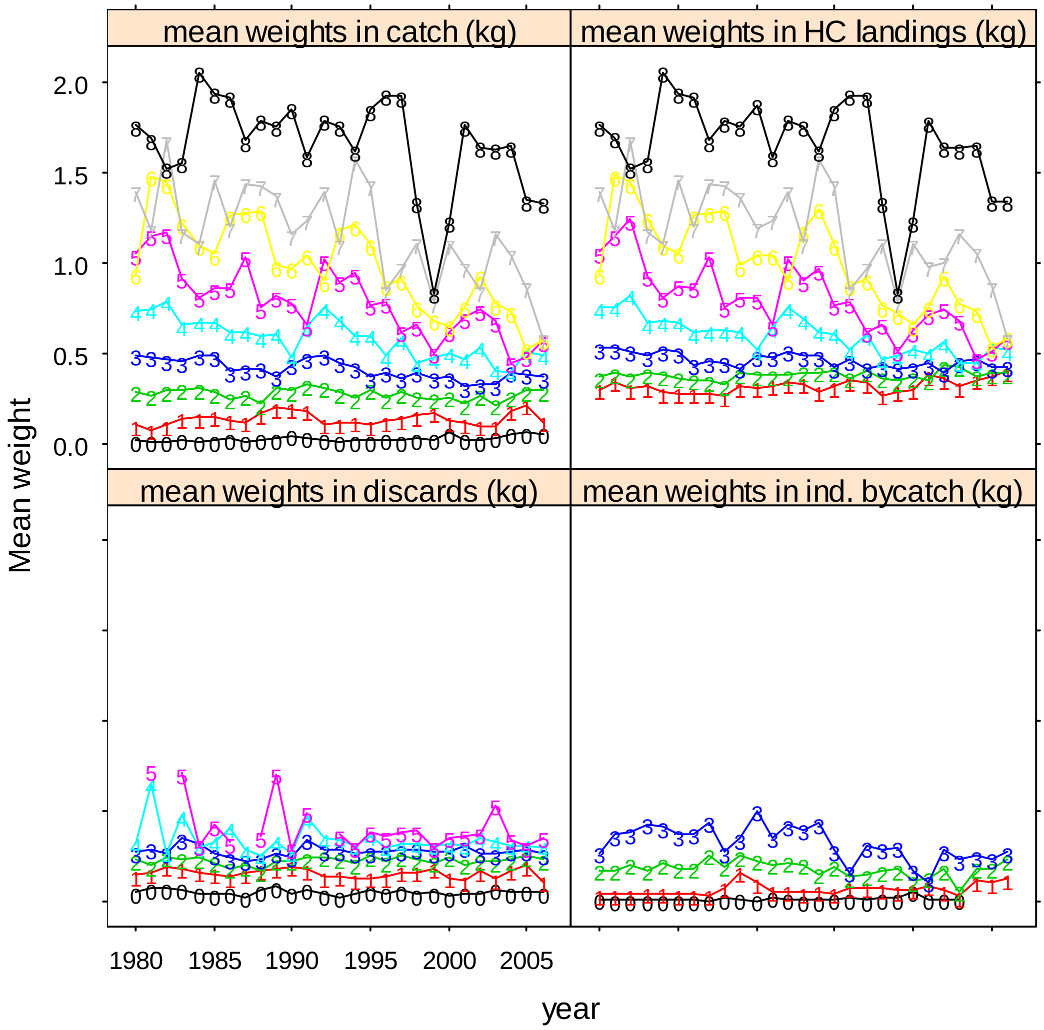
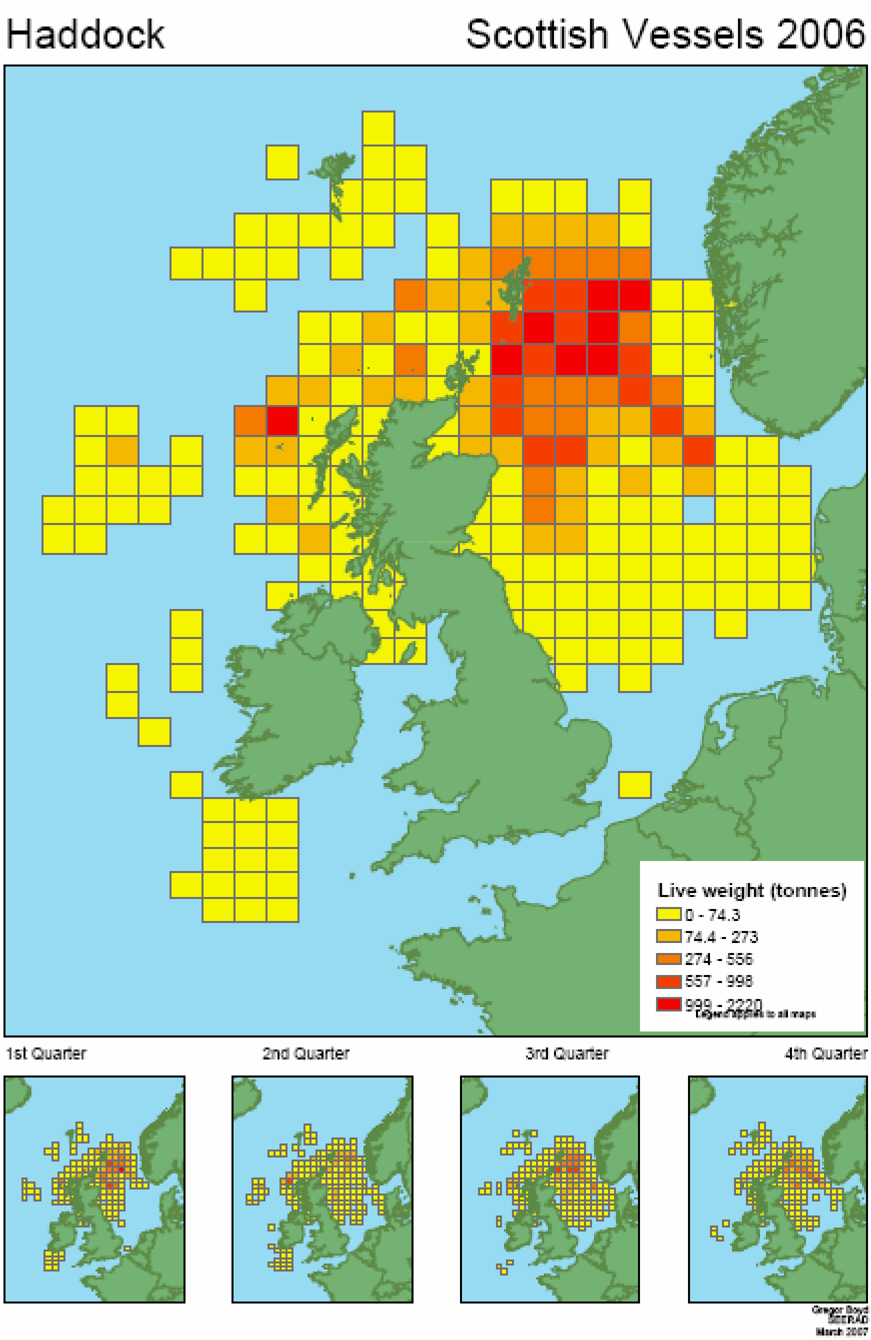


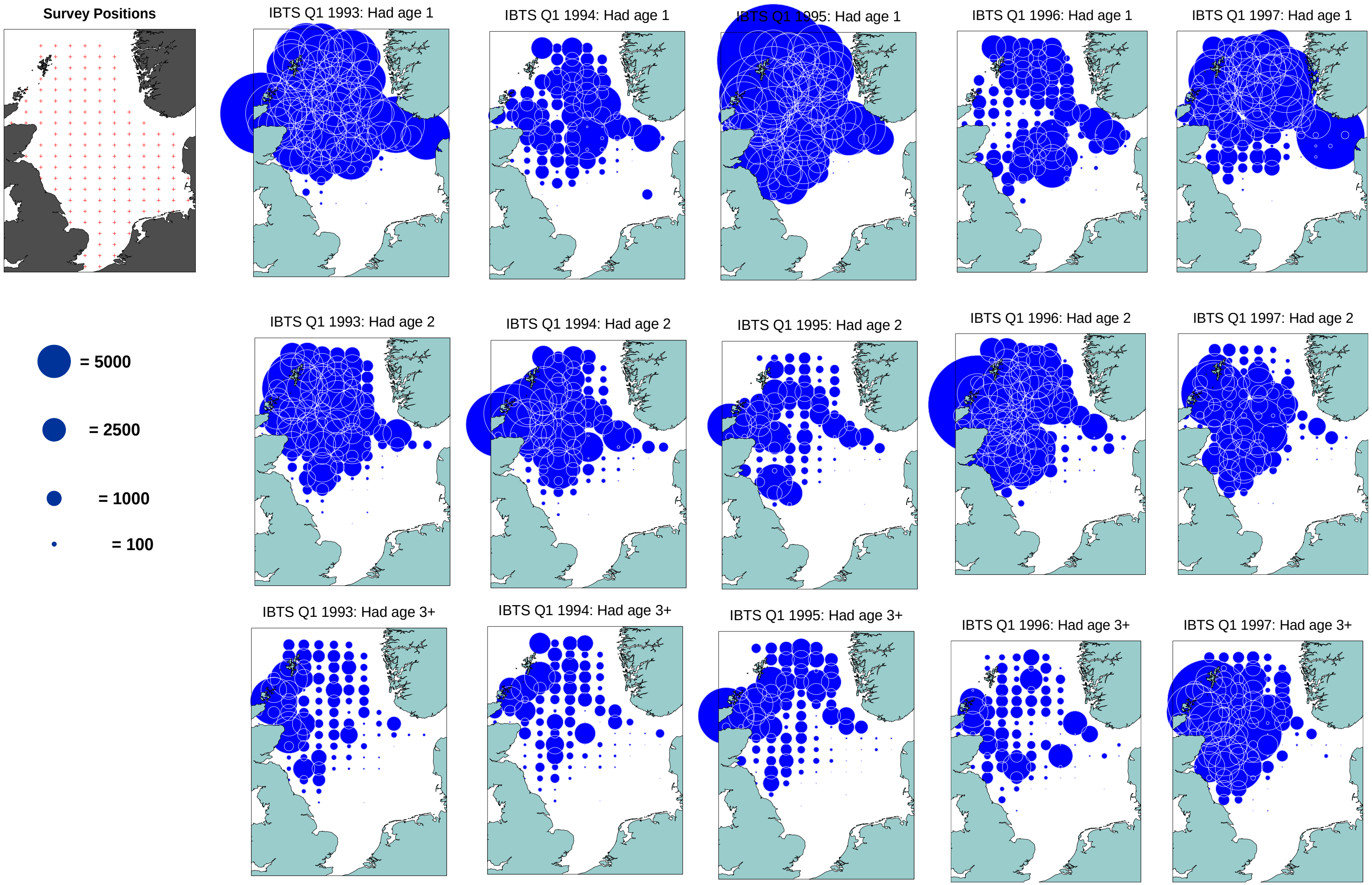
Figure.13.2.3.2 Haddock in Subarea IV and Division IIIa. Proportion at age by number for each catch component.



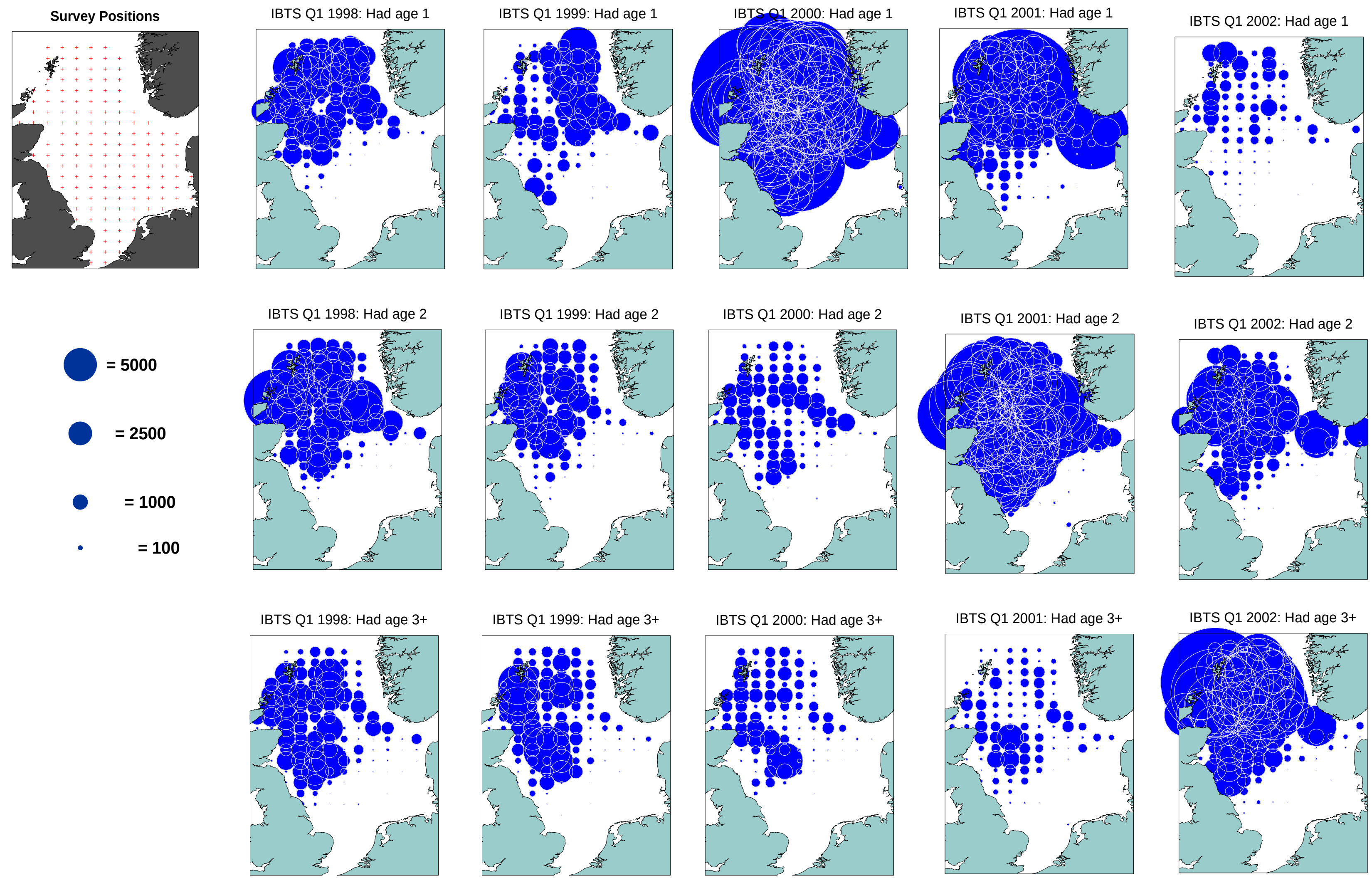
13.2.3.3 Haddock in Subarea IV and Division IIIa. Mean weights at age (kg) by catch component. Catch mean weights are also used as stock weights.



12.2.3.4 Haddock in Subarea IV and Division IIIa. Distribution maps of landings of haddock by Scottish vessels in 2006.



13.2.5.1 Haddock in Subarea IV and Division IIIa. Spatial distribution of haddock from IBTS Q1.



13.2.5.1 cont **Haddock in Subarea IV and Division IIIa. Spatial distribution of haddock from IBTS Q1.**

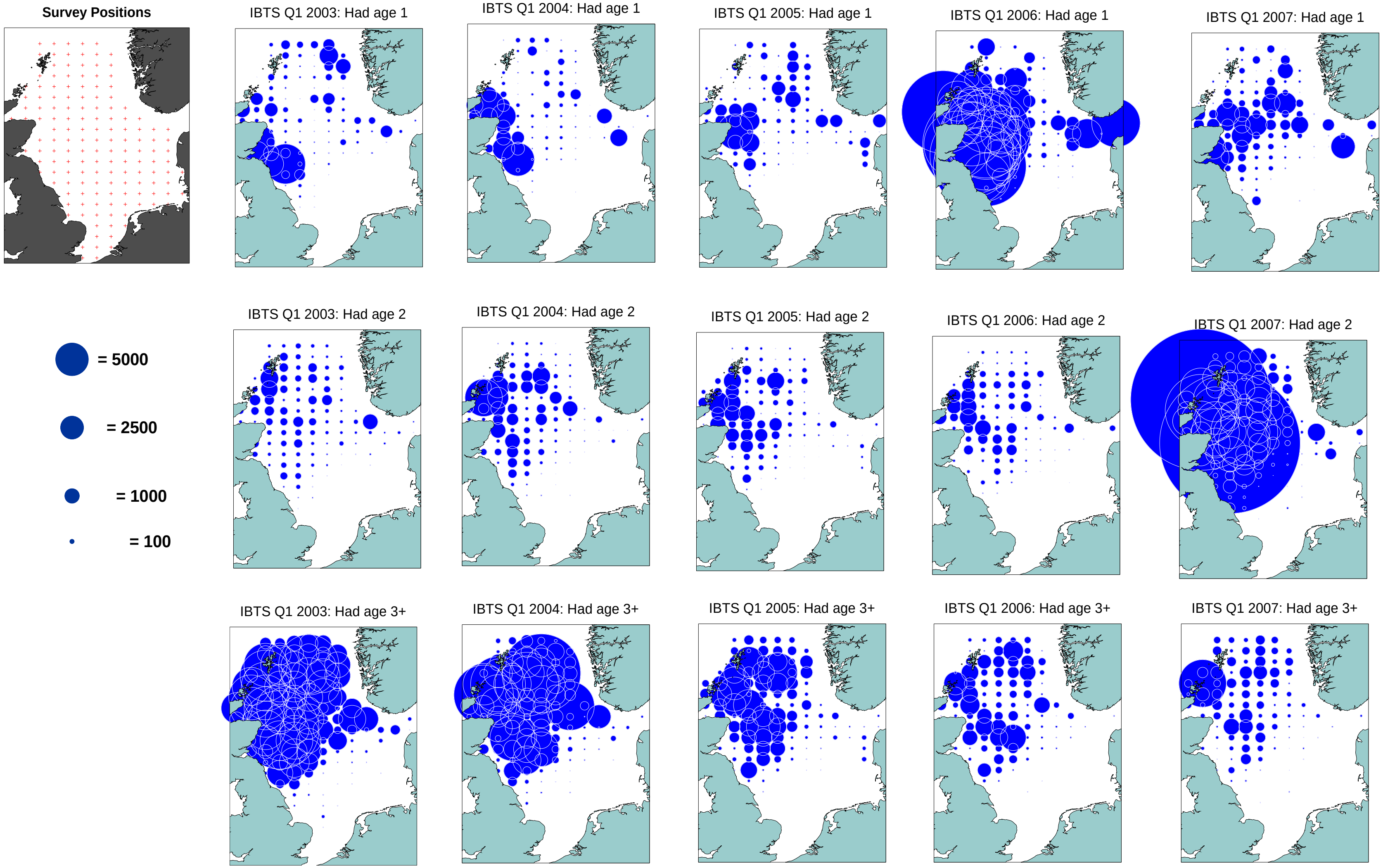


Figure 13.2.5.1 cont **Haddock in Subarea IV and Division IIIa. Spatial distribution of haddock from IBTS Q1.**

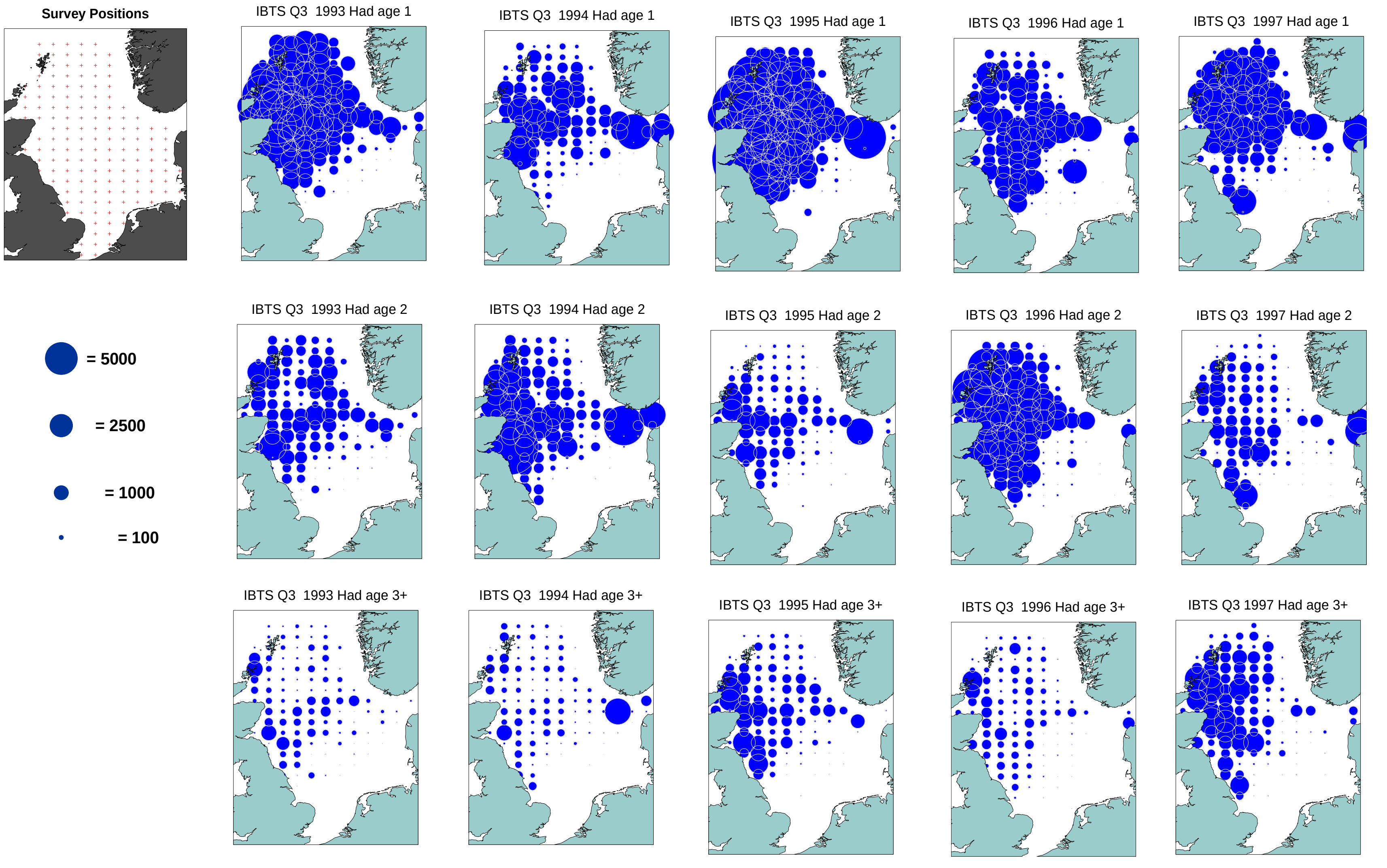


Figure 13.2.5.2 Haddock in Subarea IV and Division IIIa. Spatial distribution of haddock from IBTS Q3.

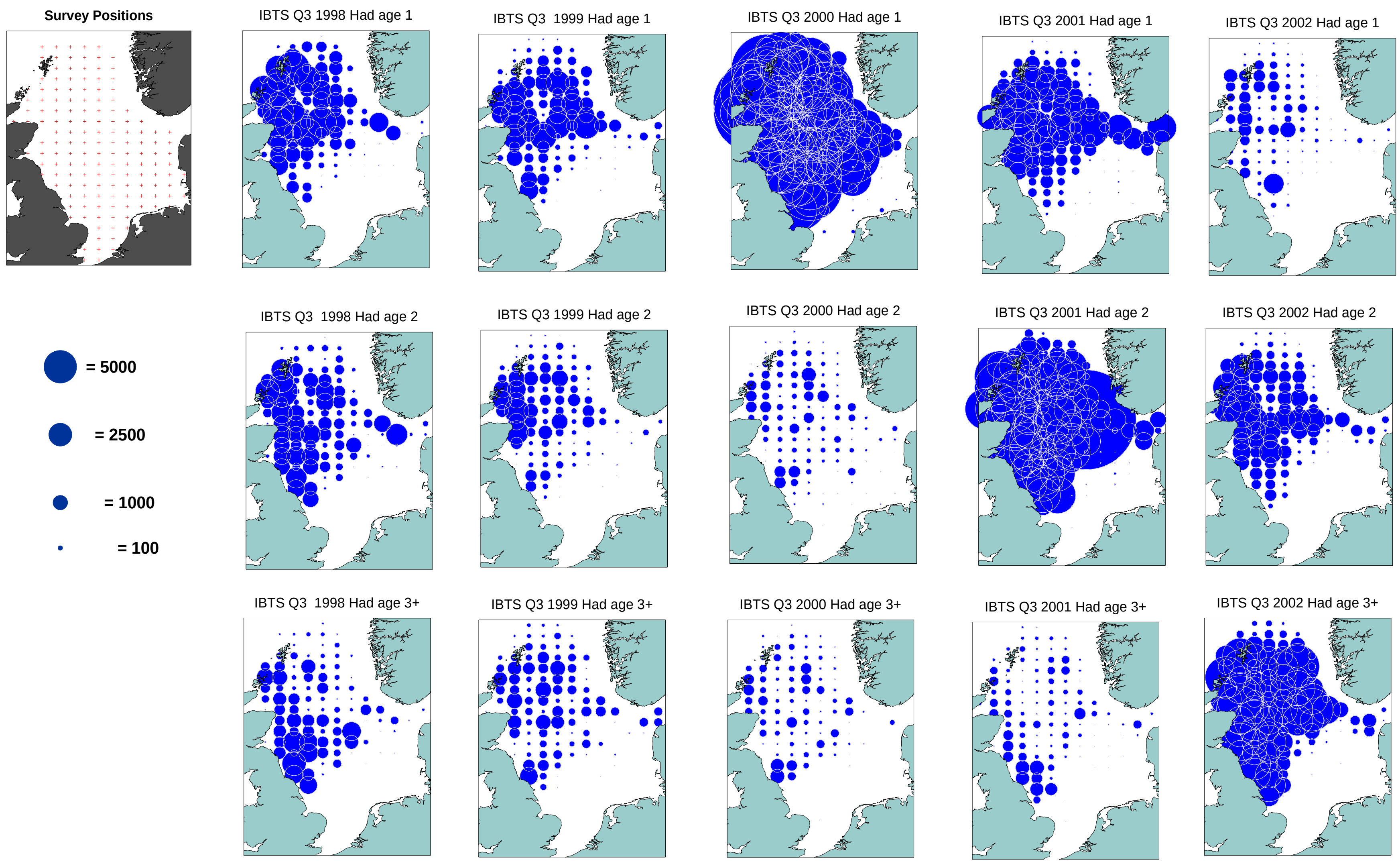


Figure 13.2.5.2 cont **Haddock in Subarea IV and Division IIIa. Spatial distribution of haddock from IBTS Q3..**

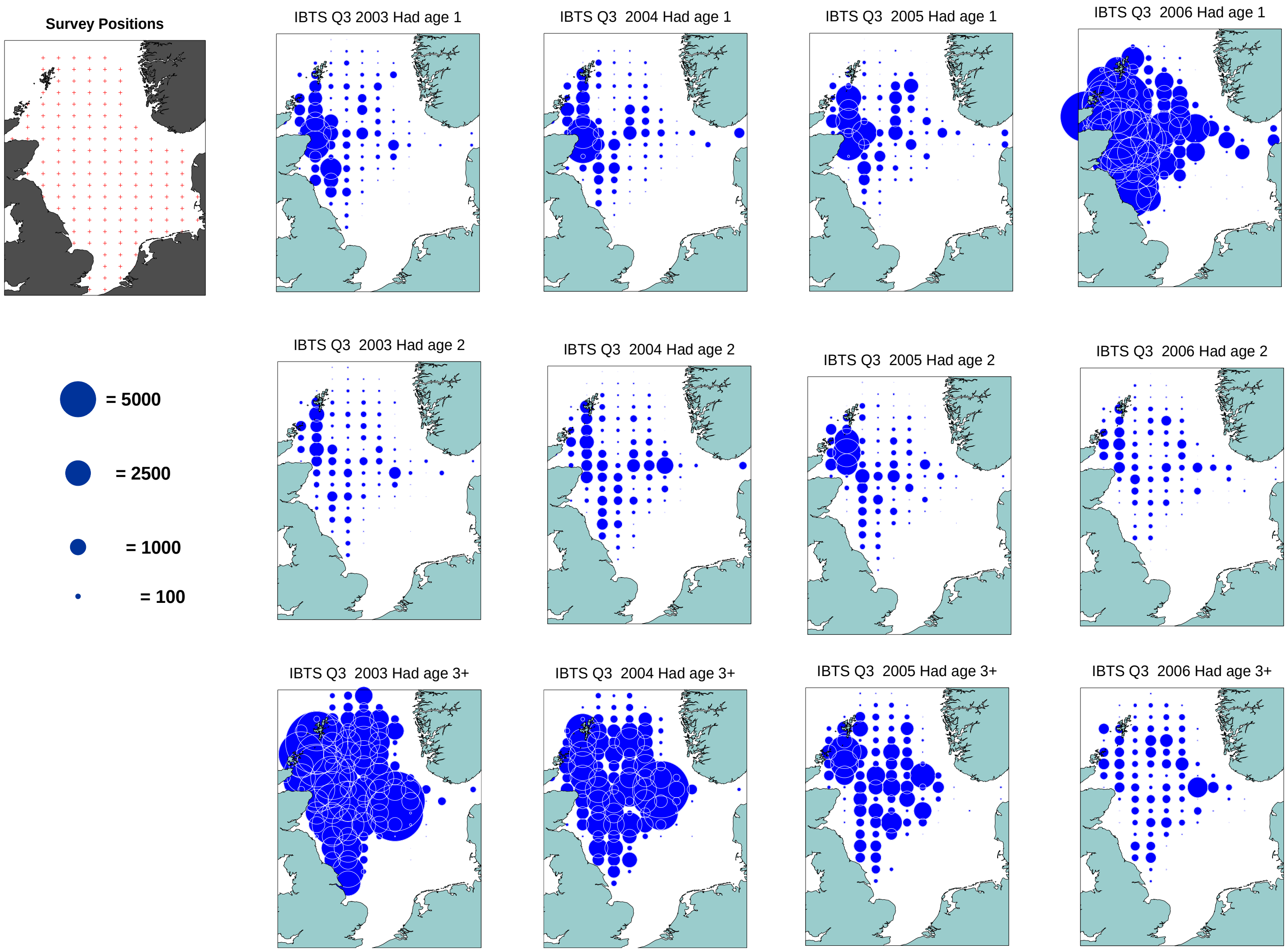


Figure 13.2.5.2 cont **Haddock in Subarea IV and Division IIIa. Spatial distribution of haddock from the IBTS Q3.**

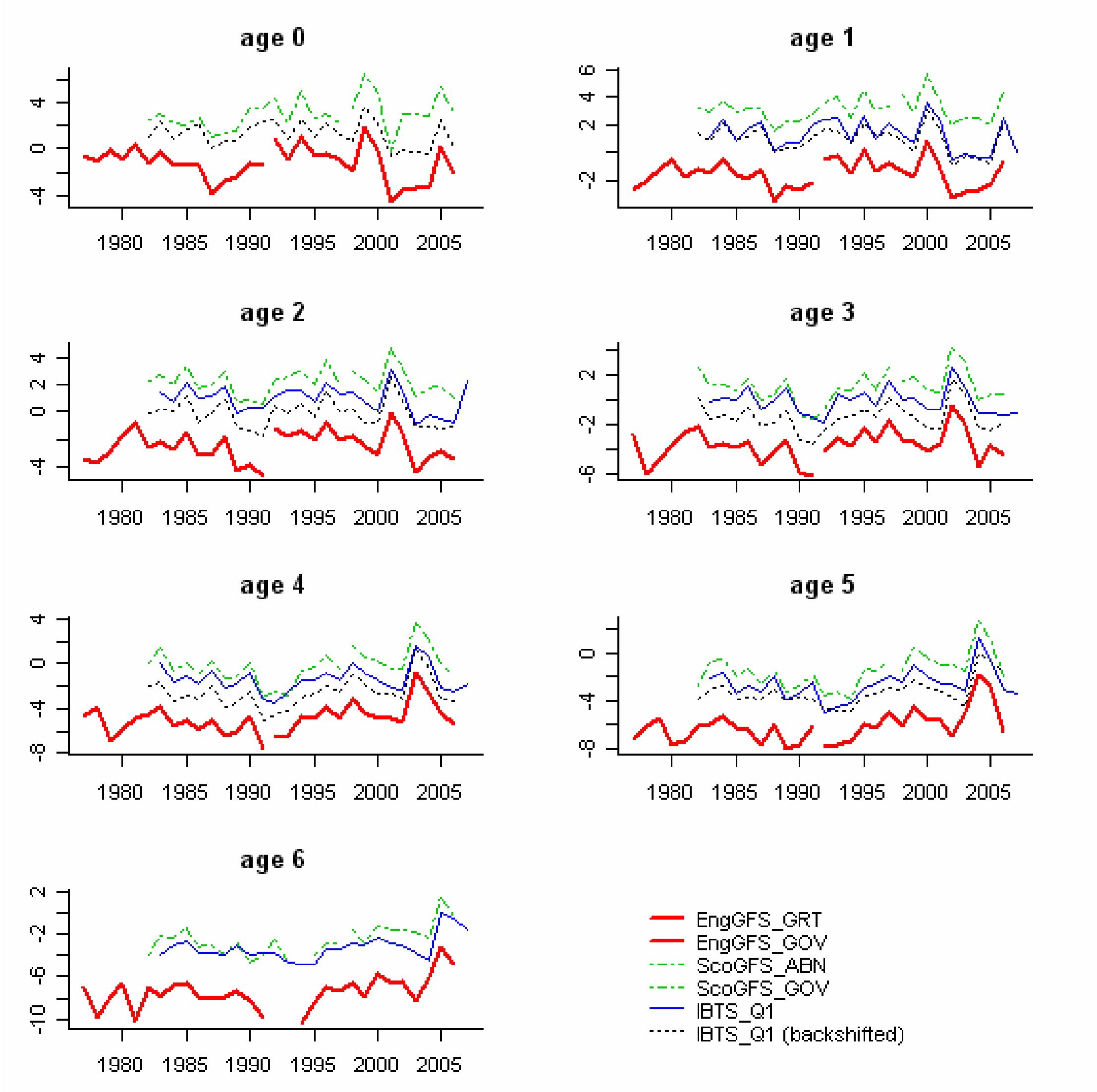


Figure 13.2.5.3 Haddock in Subarea IV and Division IIIa. Survey log-CPUE data at age.

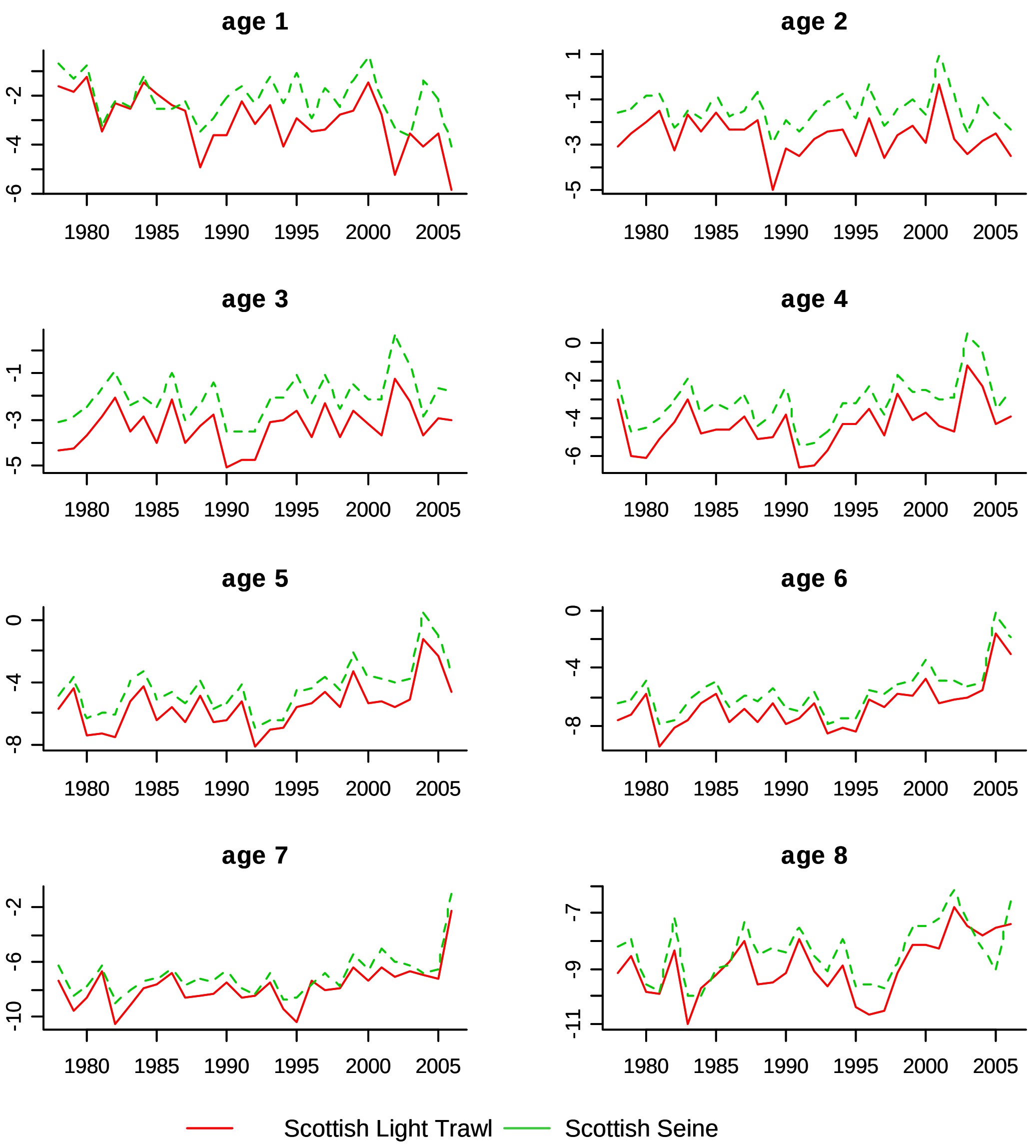


Figure 13.2.5.4 Haddock in Subarea IV and Division IIIa. Commercial log-CPUE data at age.

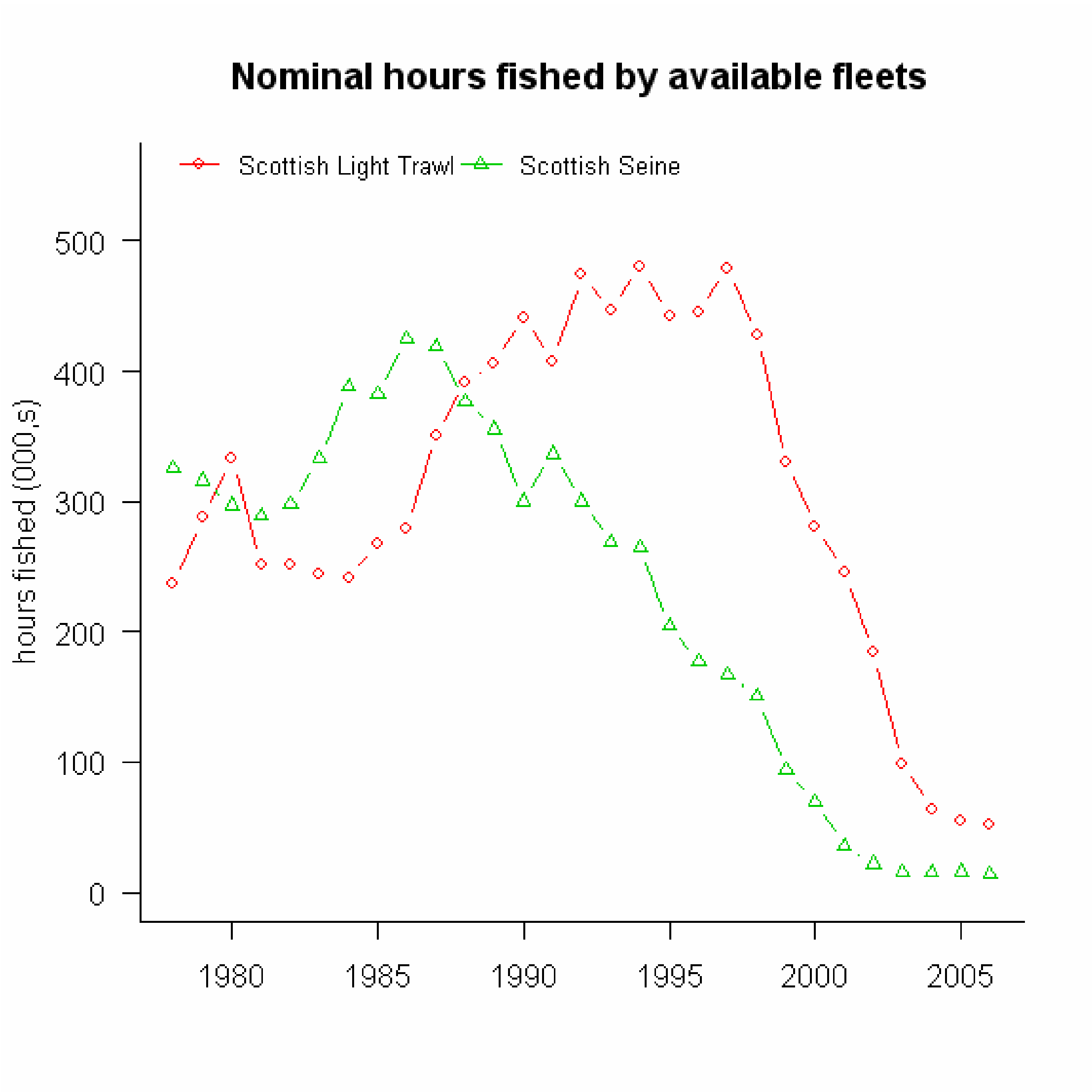


Figure 13.2.5.5 Haddock in Subarea IV and Division IIIa. Nominal hours fished by UK fleets. The values plotted are those from Table 13.2.5.2, indicating the catch at age fleet information available to the WG. Recording of hours fished is not mandatory in logbooks in the UK and is not considered to be representative of deployed fishing effort.

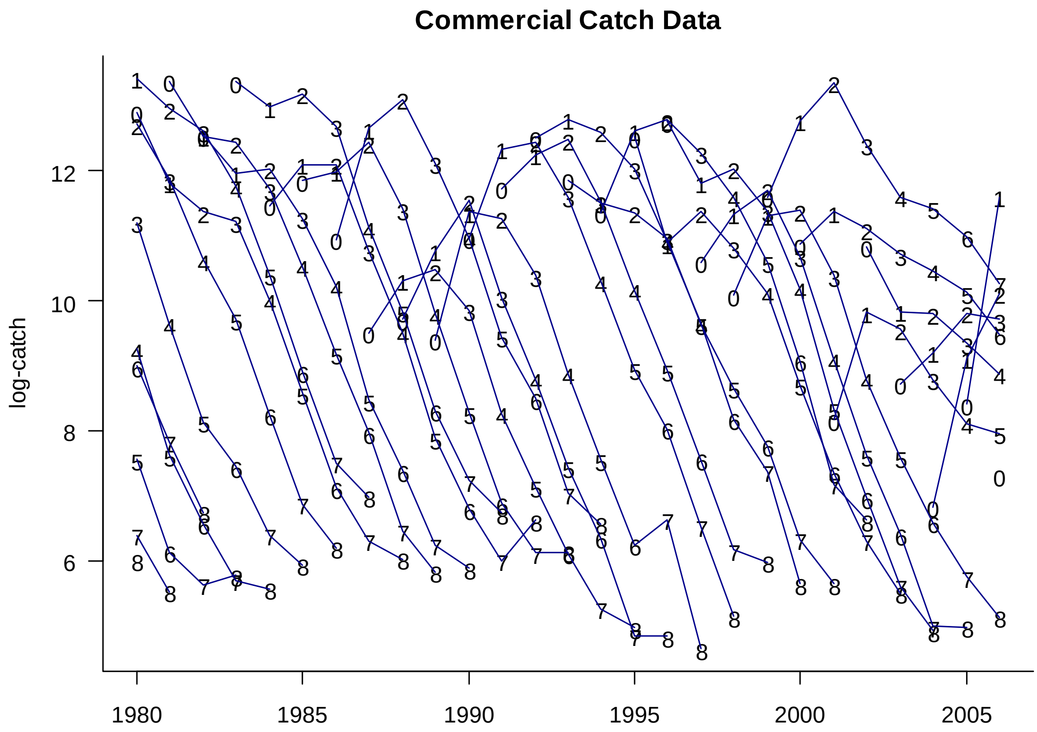


Figure 13.3.2.1 Haddock in Subarea IV and Division IIIa. Log-catch by cohort for total catches.

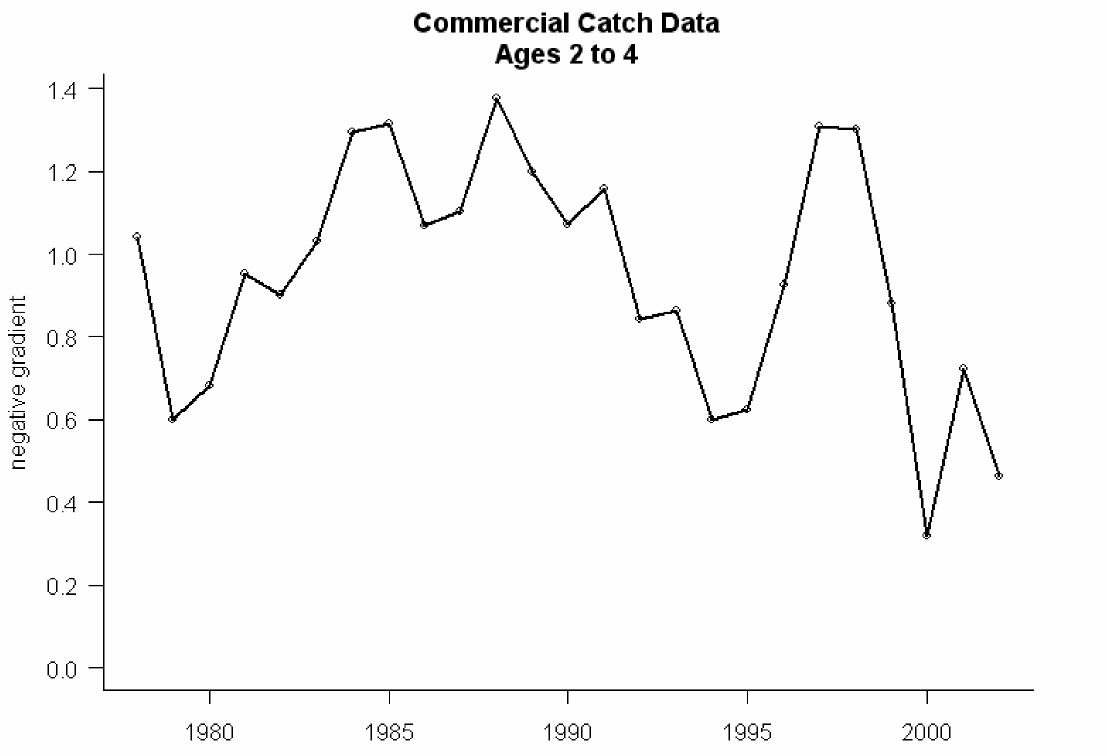


Figure 13.3.2.2 Haddock in Subarea IV and Division IIIa. Negative gradients of log-catches per cohort for the age-range 2-5.

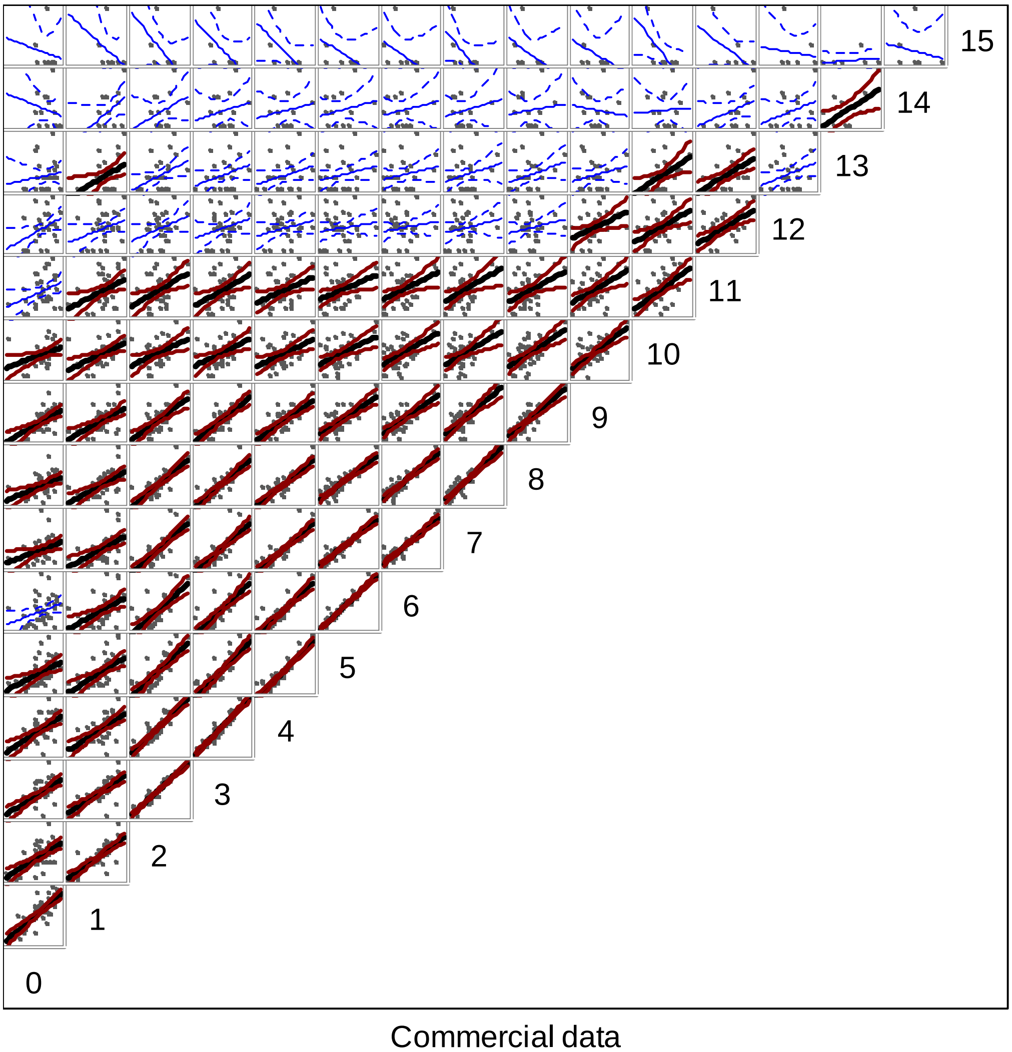


Figure 13.3.2.3 Haddock in Subarea IV and Division IIIa. Correlations in the catch-at-age matrix (log-numbers). Individual points are given by cohort (year-class), the line is a normal linear model fit. .

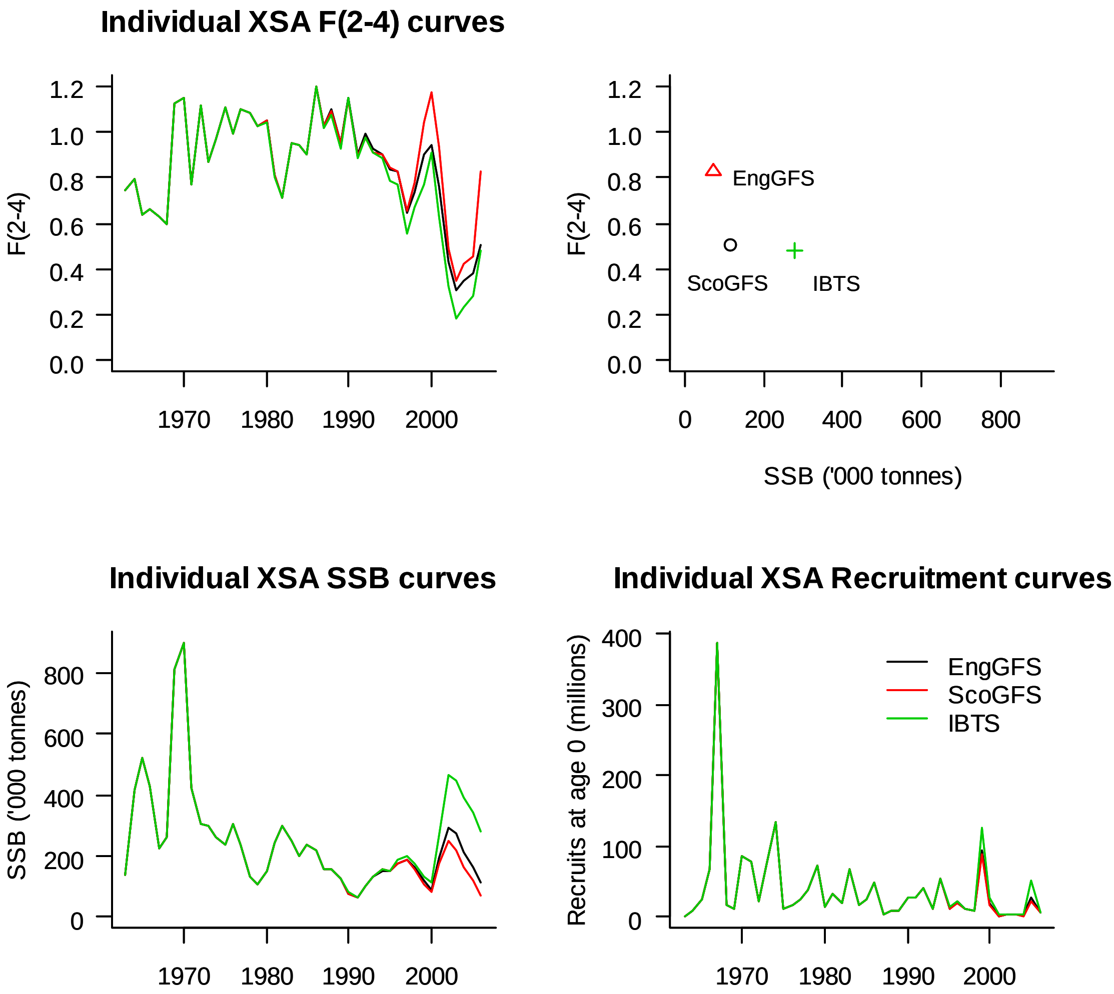


Figure 13.3.2.4 Haddock in Subarea IV and Division IIIa. Comparison of F (2-4), SSB and Recruitment time series for individual-fleet XSA runs,, together with final-year estimates for F (2-4) and SSB shown on a single plot (top-right).

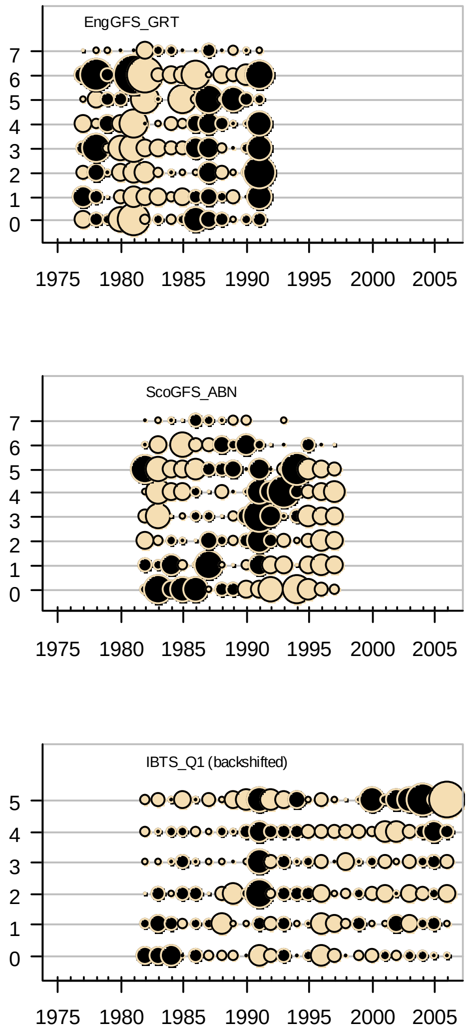


Figure 13.3.2.5 Haddock in Subarea IV and Division IIIa. Log-catchability residuals corresponding to the individual-fleet XSA runs, shown in Figure 13.3.2.4.

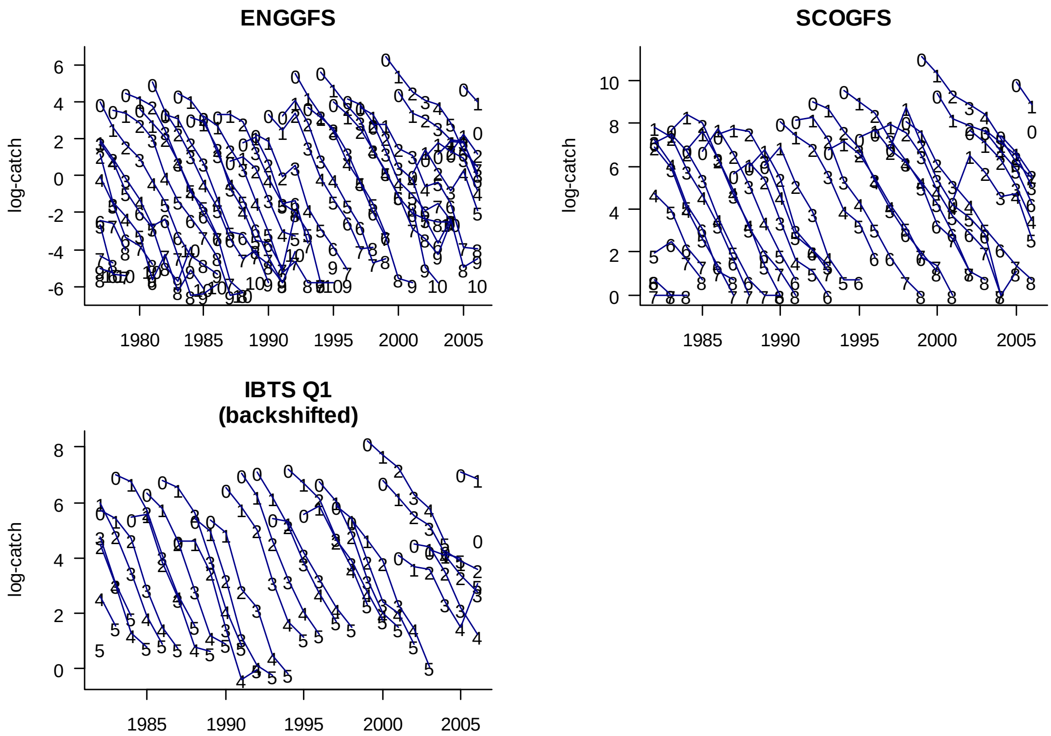


Figure 13.3.3.1 Haddock in Subarea IV and Division IIIa. Log-abundance indices by cohort for each of the three surveys (Note: age 5 for the IBTS Q1 survey is a plusgroup).

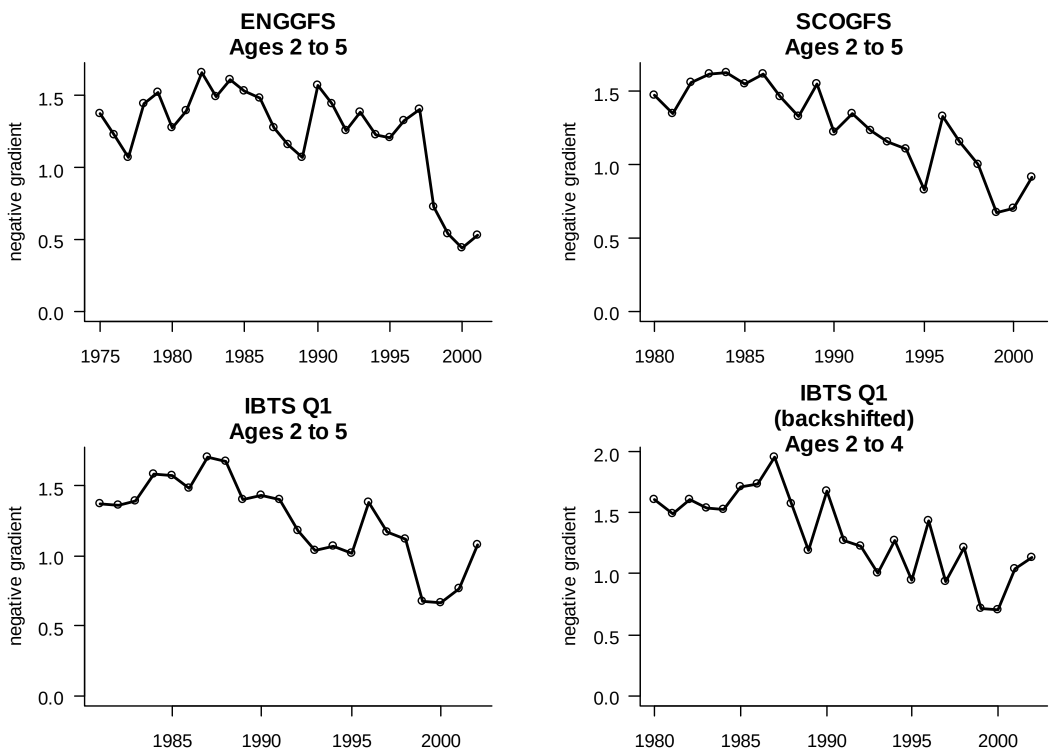


Figure 13.3.3.2 Haddock in Subarea IV and Division IIIa. Negative gradients of log-abundance per cohort for each of the surveys for the age-ranges specified separately for each survey.

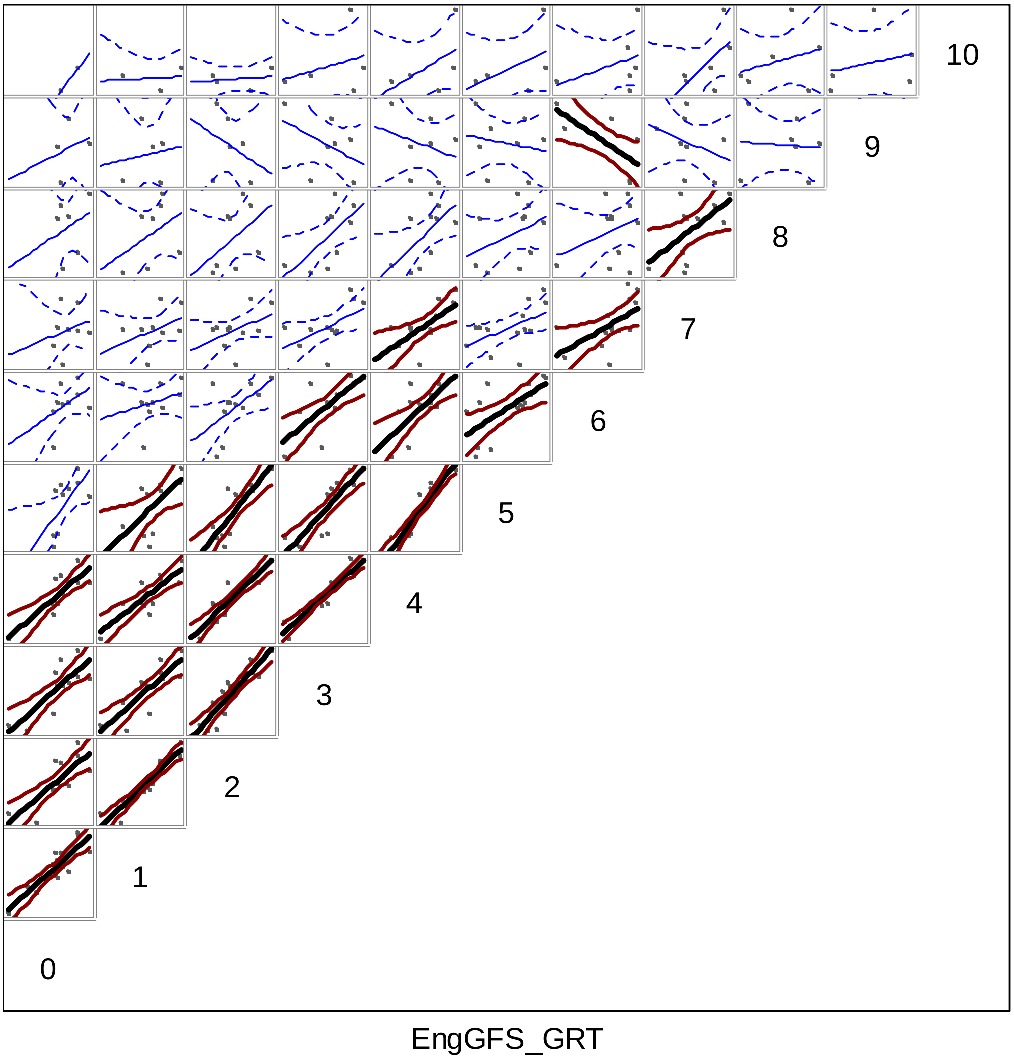


Figure 13.3.3.3 Haddock in Subarea IV and Division IIIa. Within-survey correlations for ENGGFS for the period 1977-1991. Individual points are given by cohort (year-class), the line is a normal linear model fit. Thick lines represent a significant ($p<0.05$) regression and the curved lines are approximate 95% confidence intervals.

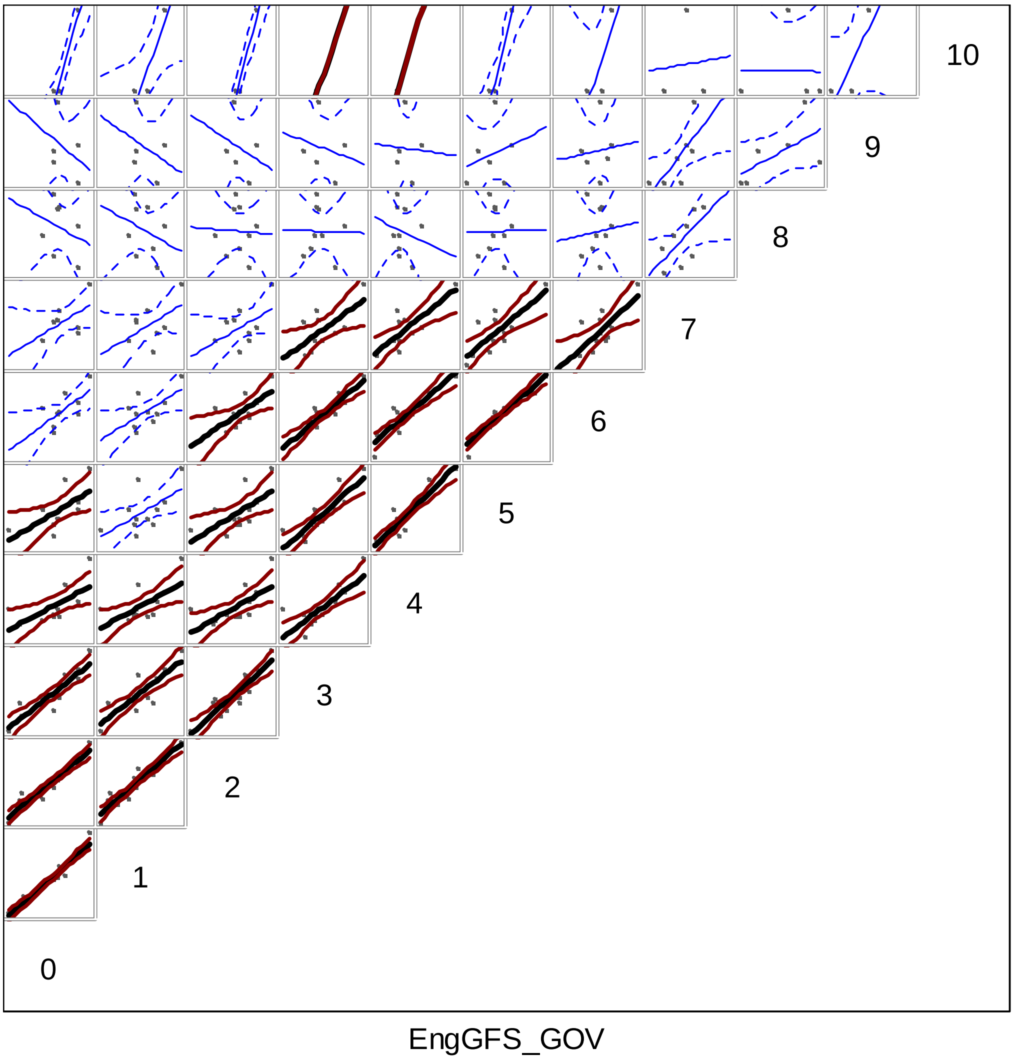


Figure 13.3.3.4 Haddock in Subarea IV and Division IIIa. Within-survey correlations for ENGGFS for the period 1992-2006. Individual points are given by cohort (year-class), the line is a normal linear model fit. Thick lines represent a significant ($p<0.05$) regression and the curved lines are approximate 95% confidence intervals.

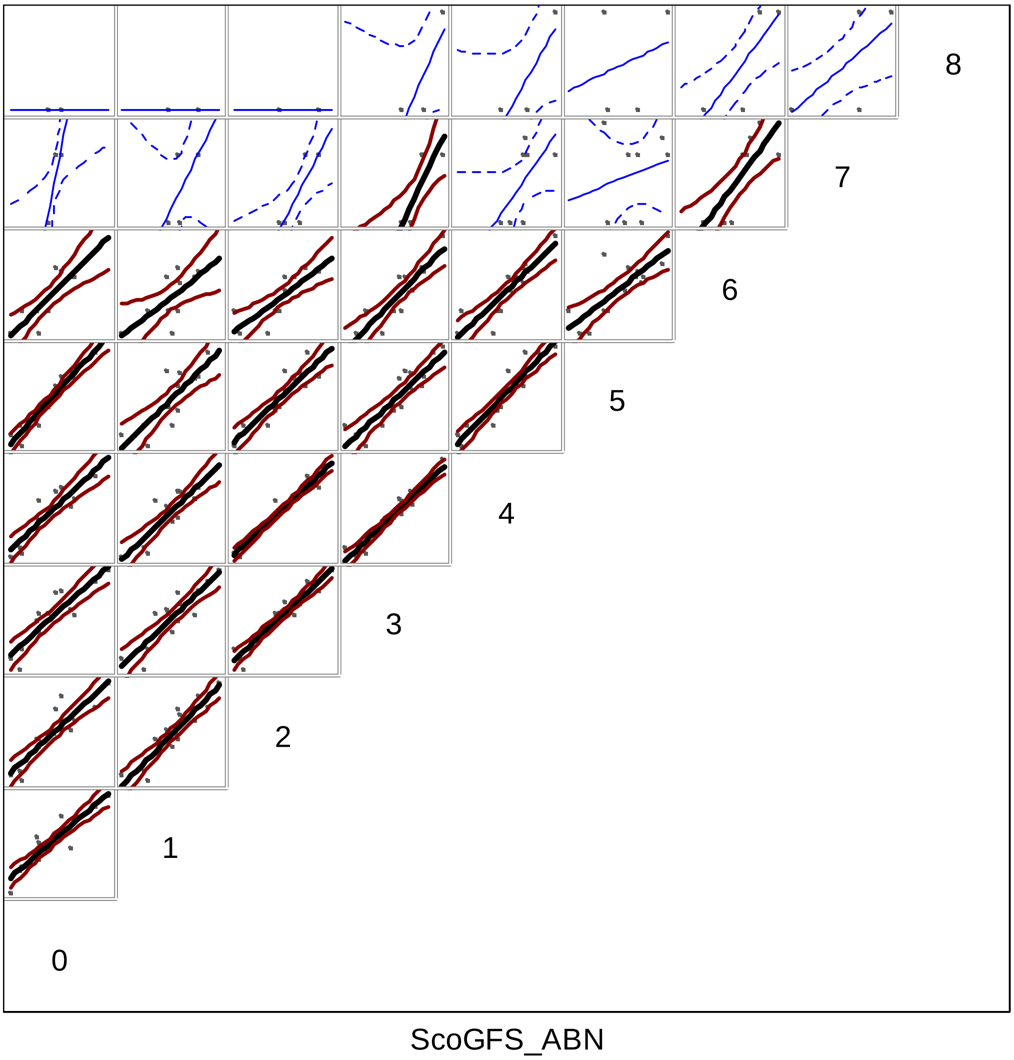


Figure 13.3.3.5 Haddock in Subarea IV and Division IIIa. Within-survey correlations for SCOGFS for the period 1982-1997. Individual points are given by cohort (year-class), the line is a normal linear model fit. Thick lines represent a significant (p<0.05) regression and the curved lines are approximate 95% confidence intervals.

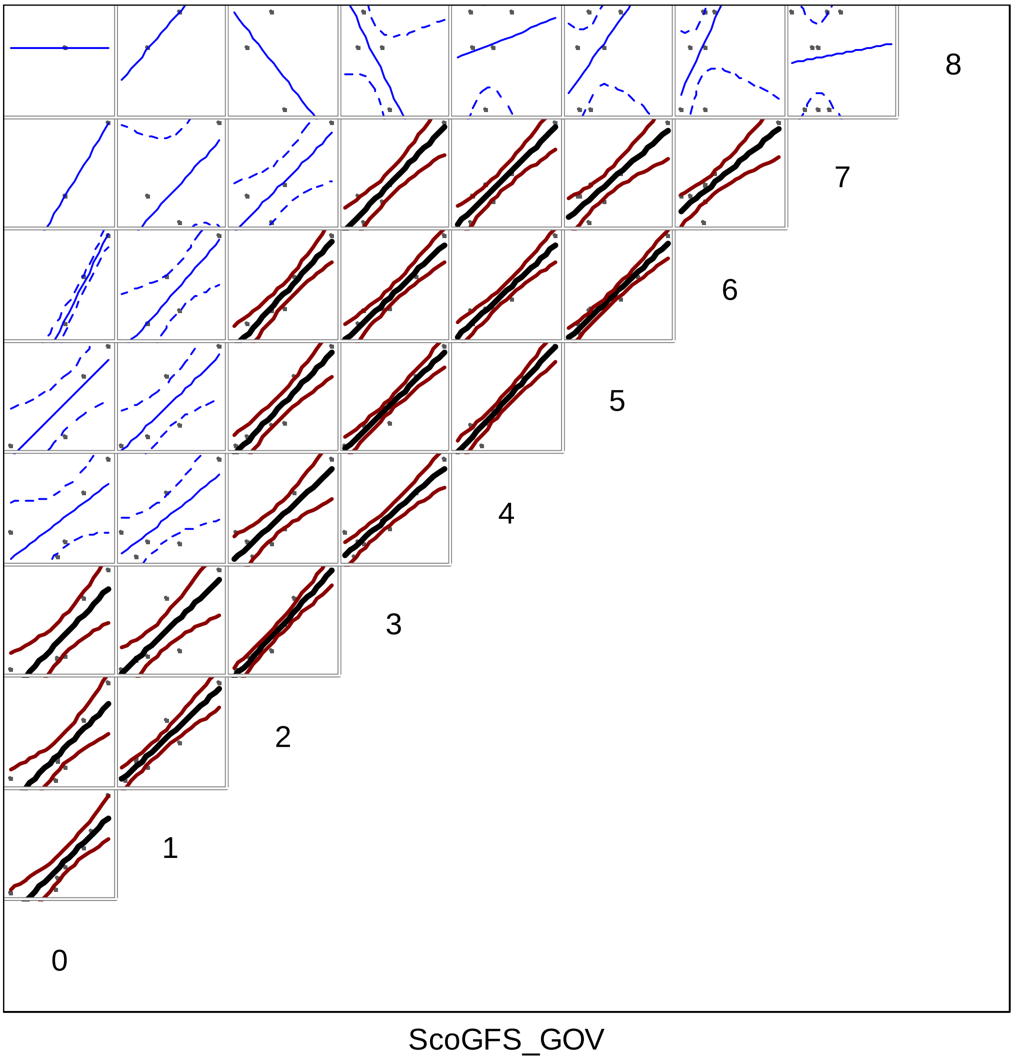


Figure 13.3.3.6 Haddock in Subarea IV and Division IIIa. Within-survey correlations for SCOGFS for the period 1998-2006. Individual points are given by cohort (year-class), the line is a normal linear model fit. Thick lines represent a significant (p<0.05) regression and the curved lines are approximate 95% confidence intervals.

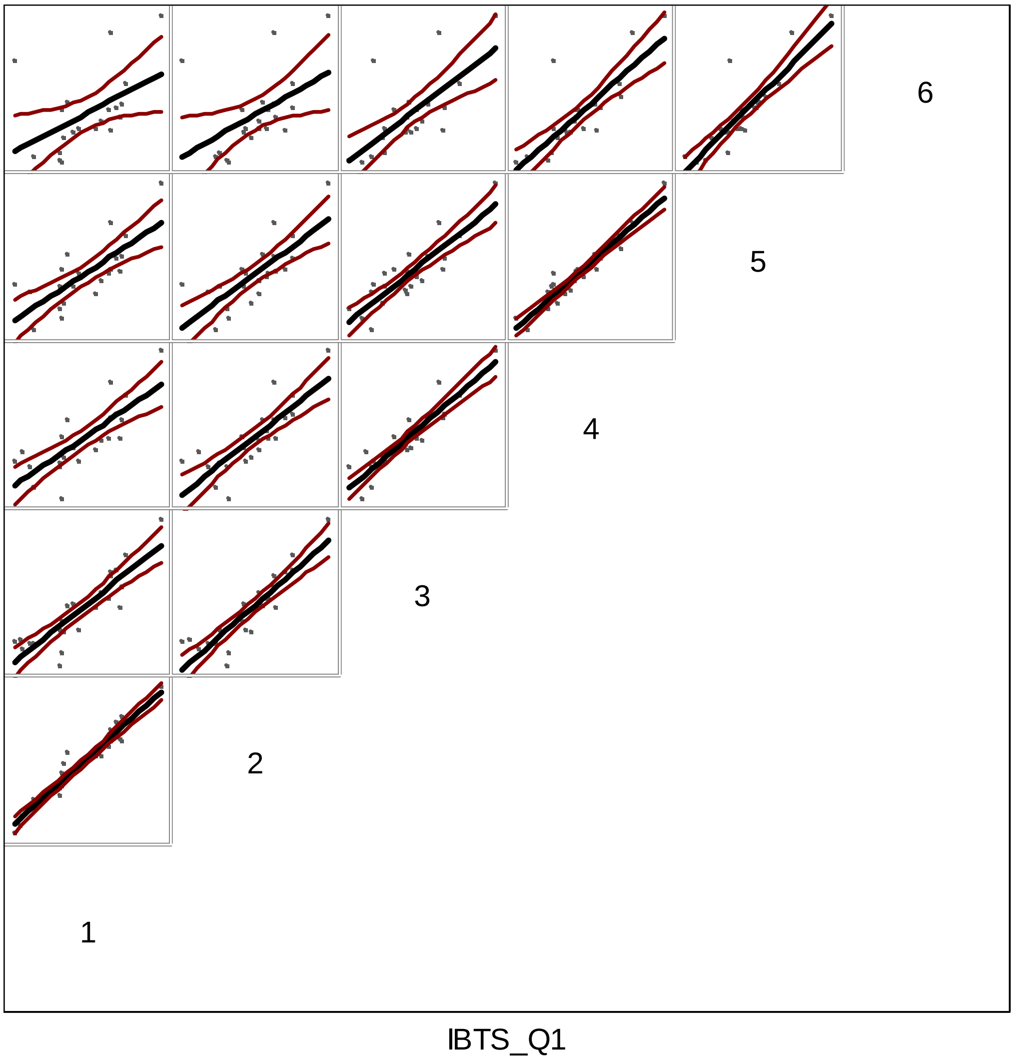


Figure 13.3.3.7 Haddock in Subarea IV and Division IIIa. Within-survey correlations for IBTS Q1 (backshifted; note: age 5 is a plusgroup) for the period 1982-2006. Individual points are given by cohort (year-class), the line is a normal linear model fit. Thick lines represent a significant ($p<0.05$) regression and the curved lines are approximate 95% confidence intervals.

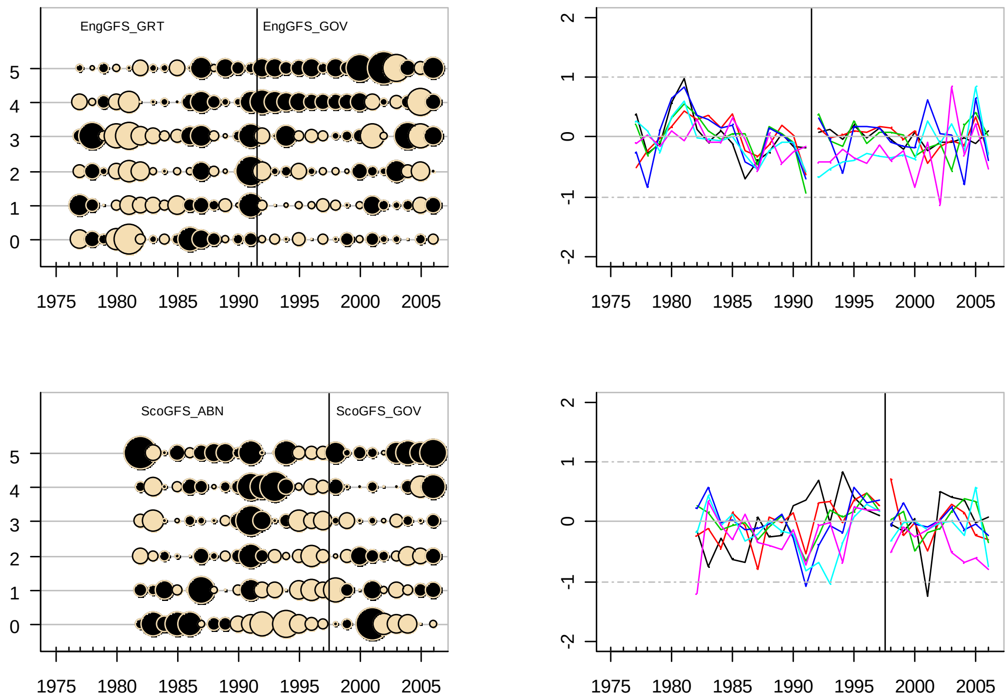


Figure 13.3.5.1 Haddock in Sub-Area IV and Division IIIa. SPALY XSA assessment: log catchability residuals. The two halves of each of ENGGFS and SCOGFS are treated as independent tuning series, hence the residuals are separated by a solid vertical line indicating the appropriate split in the time series.

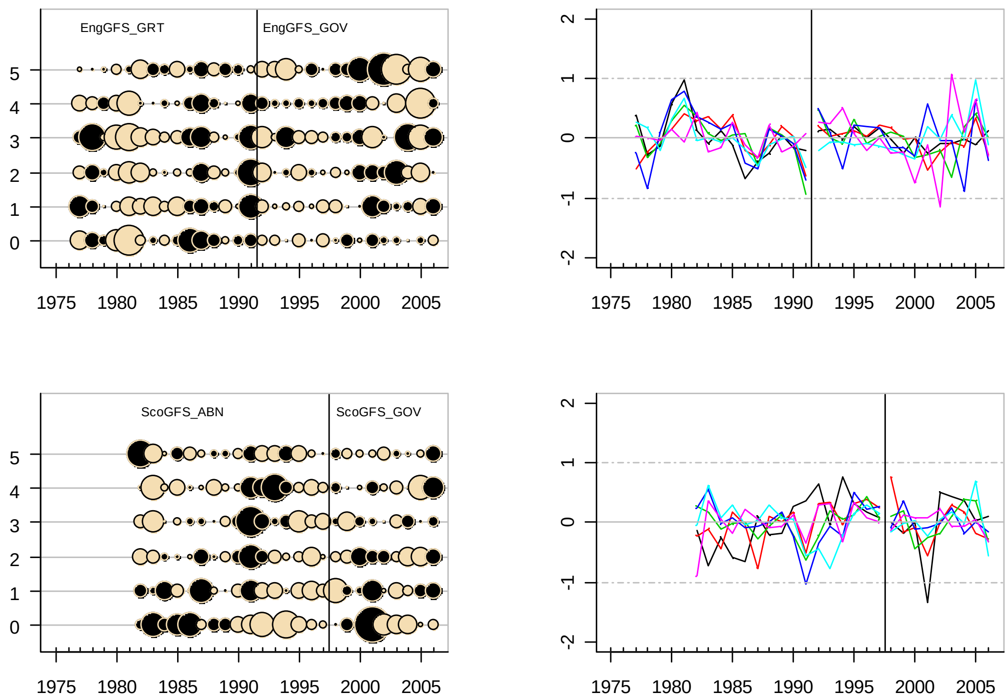


Figure 13.3.5.2 Haddock in Subarea IV and Division IIIa. SPALY XSA assessment with catchability plateau set to age 6: log catchability residuals. The two halves of each of ENGGFS and SCOGFS are treated as independent tuning series, hence the residuals are separated by a solid vertical line indicating the appropriate split in the time series.

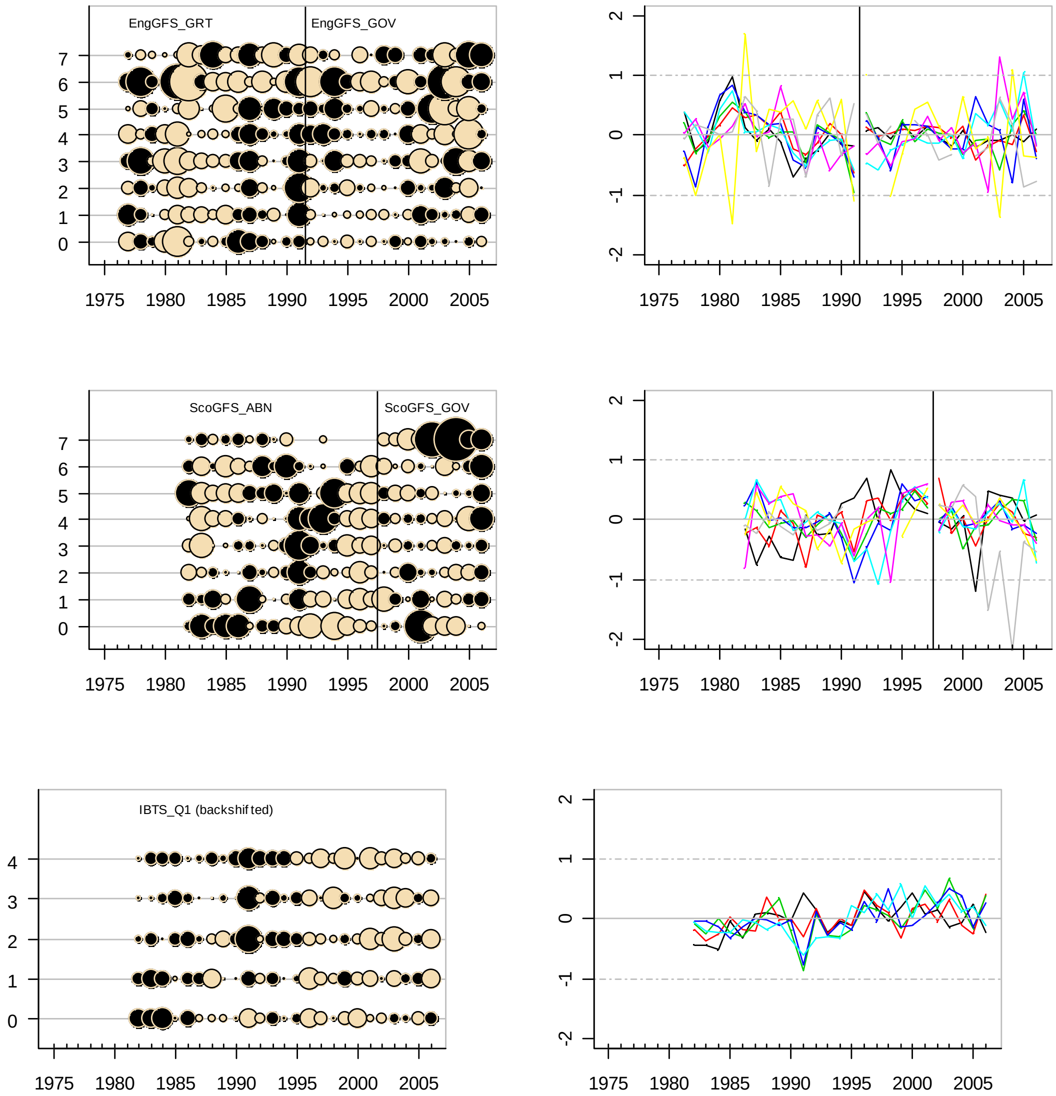


Figure 13.3.5.3 Haddock in Subarea IV and Division IIIa. XSA final assessment: log catchability residuals. The two halves of each of ENGGFS and SCOGFS are treated as independent tuning series, hence the residuals are separated by a solid vertical line indicating the appropriate split in the time series.

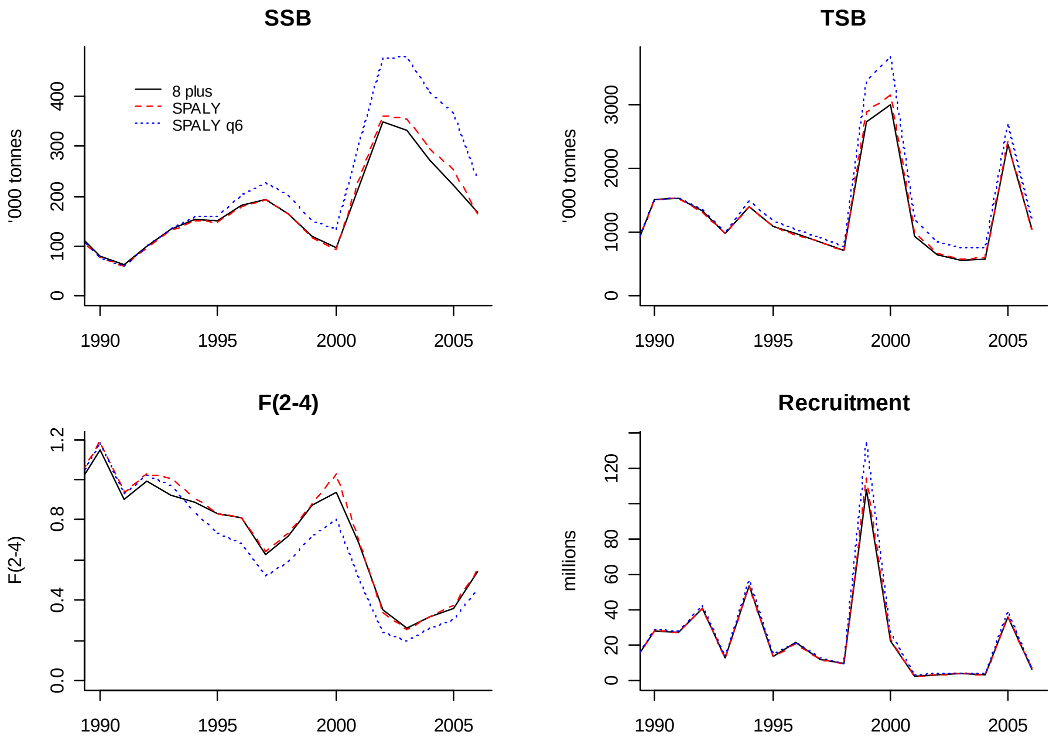


Figure 13.3.5.4 Comparison of XSA runs using different settings: Category 8Plus increases the plus group to 8 and the ages used from the tuning series to 7 (the backshifted IBTS remains at 4 as this is the last true age), and catchability plateau (qage) of 6. The SPALY run uses the same settings as last year. The SPALY run with q6 increases the catchability to age 6, but keeps the rest of last year's settings the same.

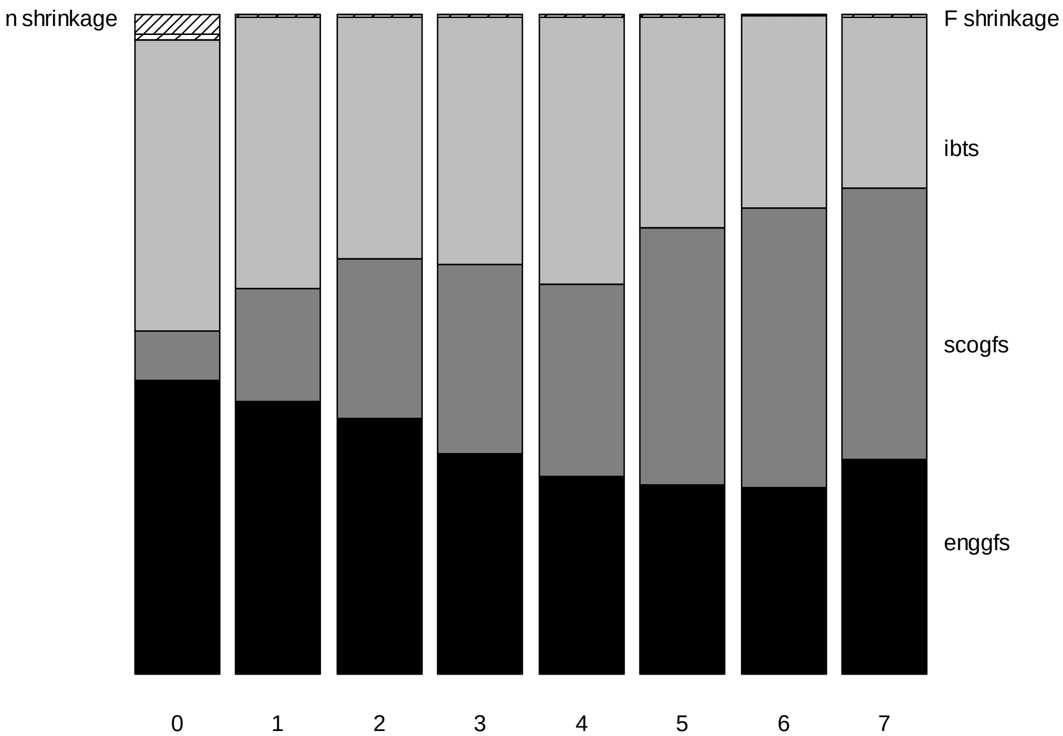


Figure 13.3.5.5 Haddock in Subarea IV and Division IIIa. XSA final assessment: contribution to survivors by fleet. Note: only 3 fleets, ENGGFS (92-05), SCOGFS (98-05) and IBTS Q1 contribute to survivor estimates in the final year.

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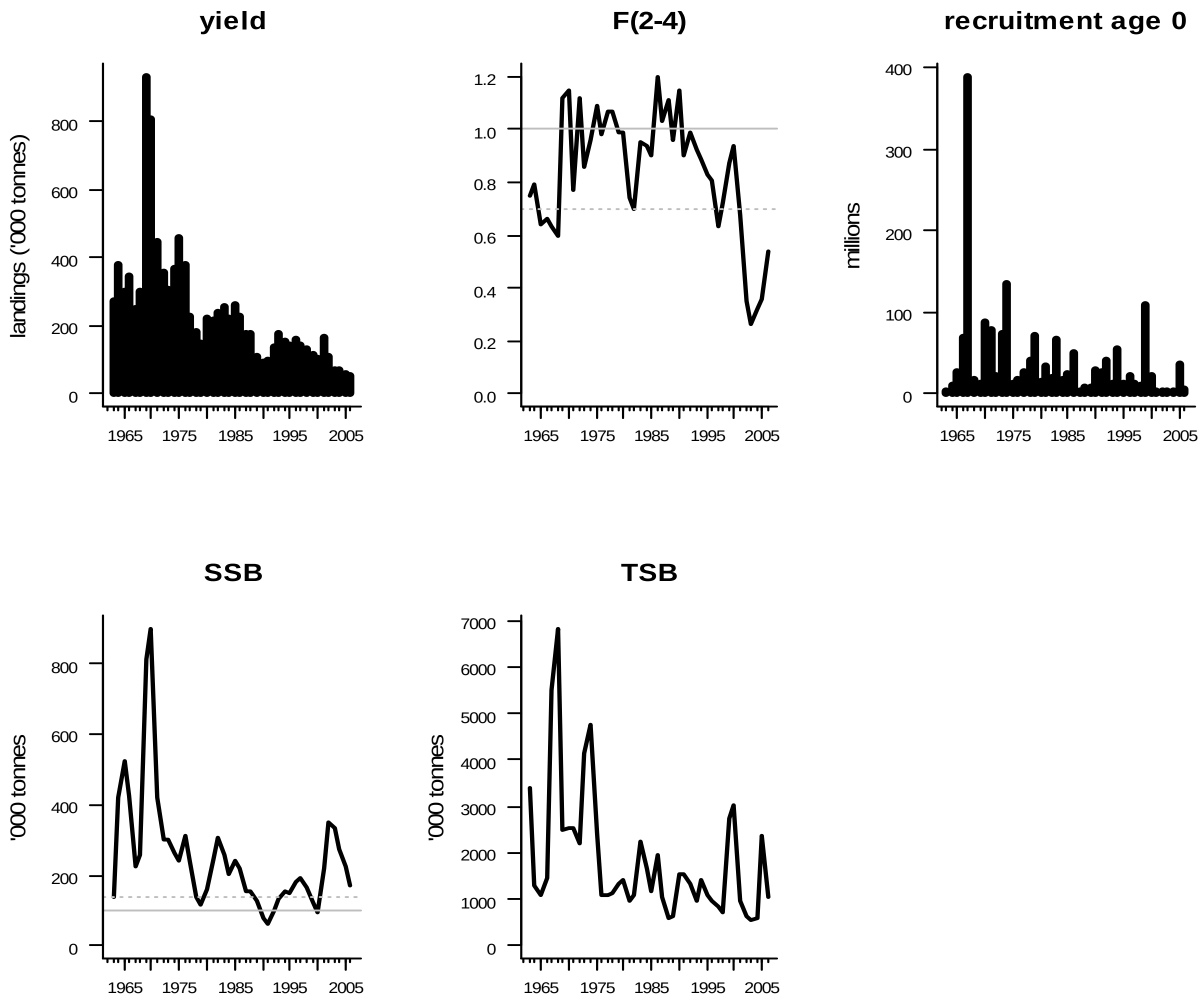


Figure 13.3.5.6 Haddock in Subarea IV and Division IIIa. XSA final assessment: Summary plots. The dotted horizontal lines indicate Fpa (top centre plot) and Bpa (bottom left plot), while the solid ones indicate Flim (top centre plot) and Blim (bottom left plot).

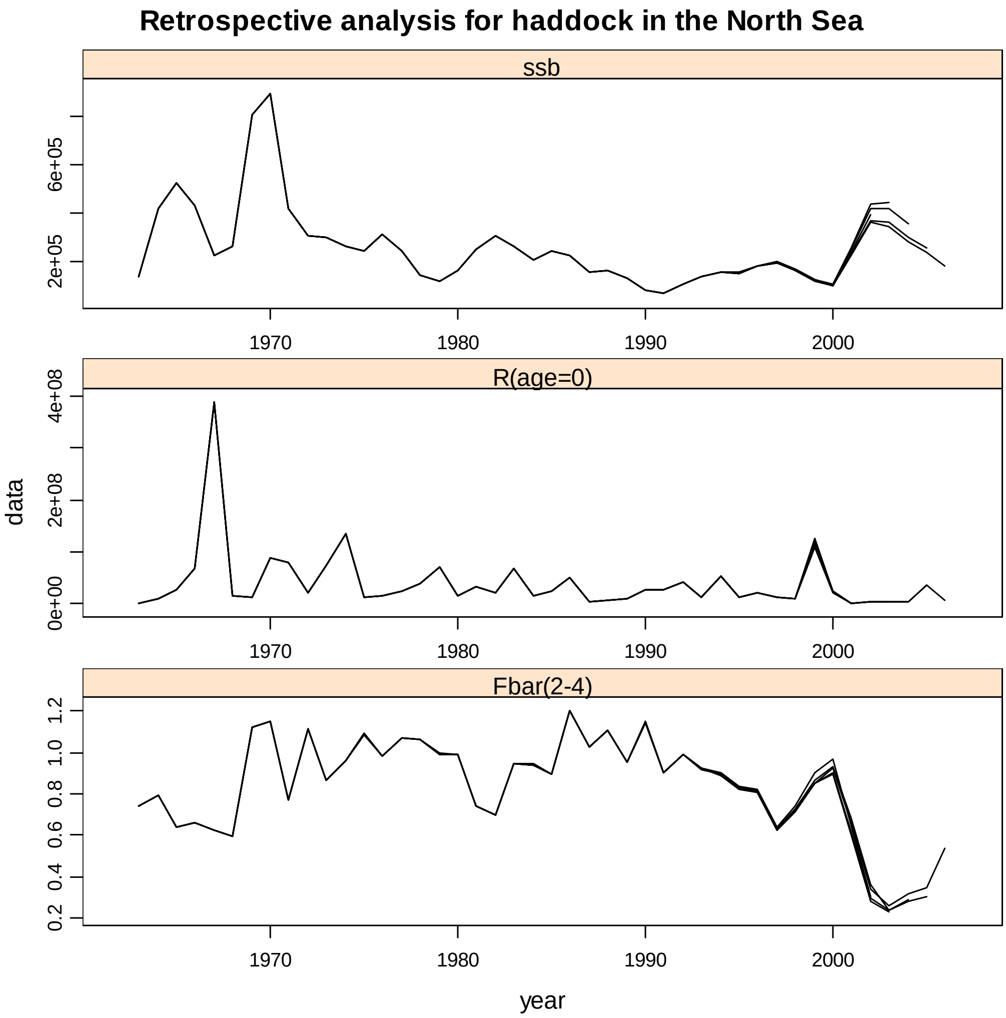


Figure 13.3.5.7 Haddock in Subarea IV and Division IIIa. XSA final assessment: retrospective patterns (last 4 years).

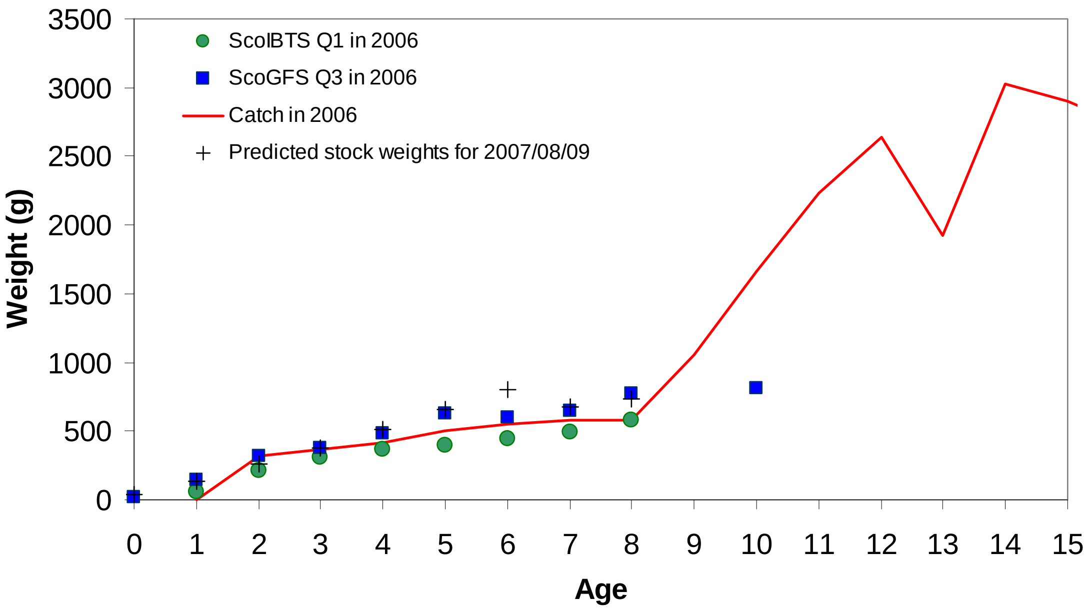


Figure 13.6.1. Haddock in Subarea IV and Division IIIa. Stock weight predictions (+) compared to the observed stock weights-at-age from the total catch in 2006 (solid line), while the solid circles and solid squares are observed weights-at-age from the 2006 Q1 and Q3 Scottish groundfish surveys respectively.

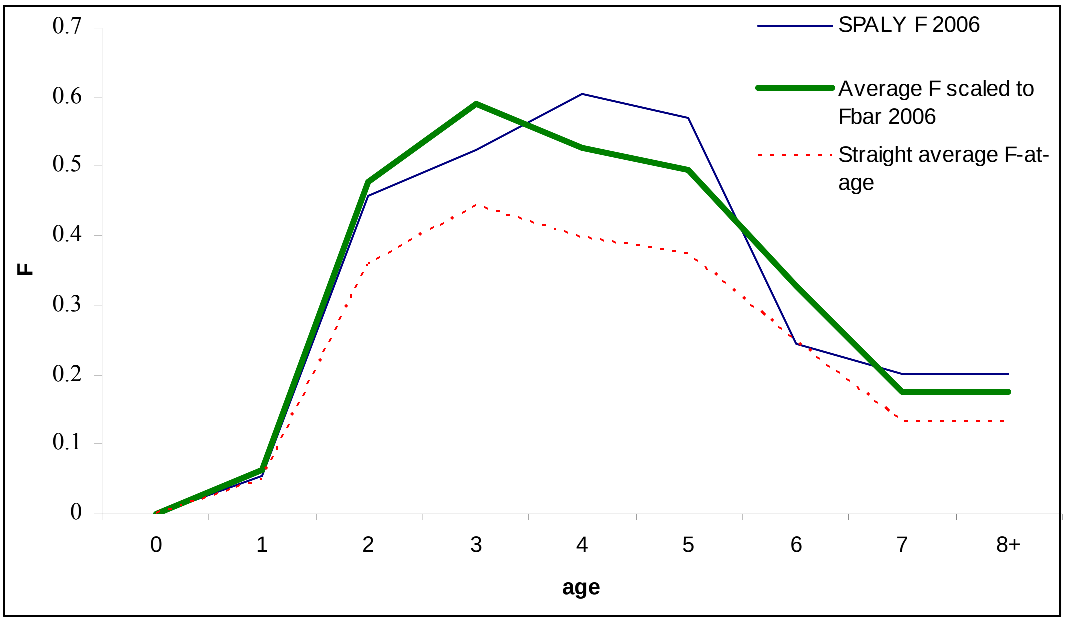
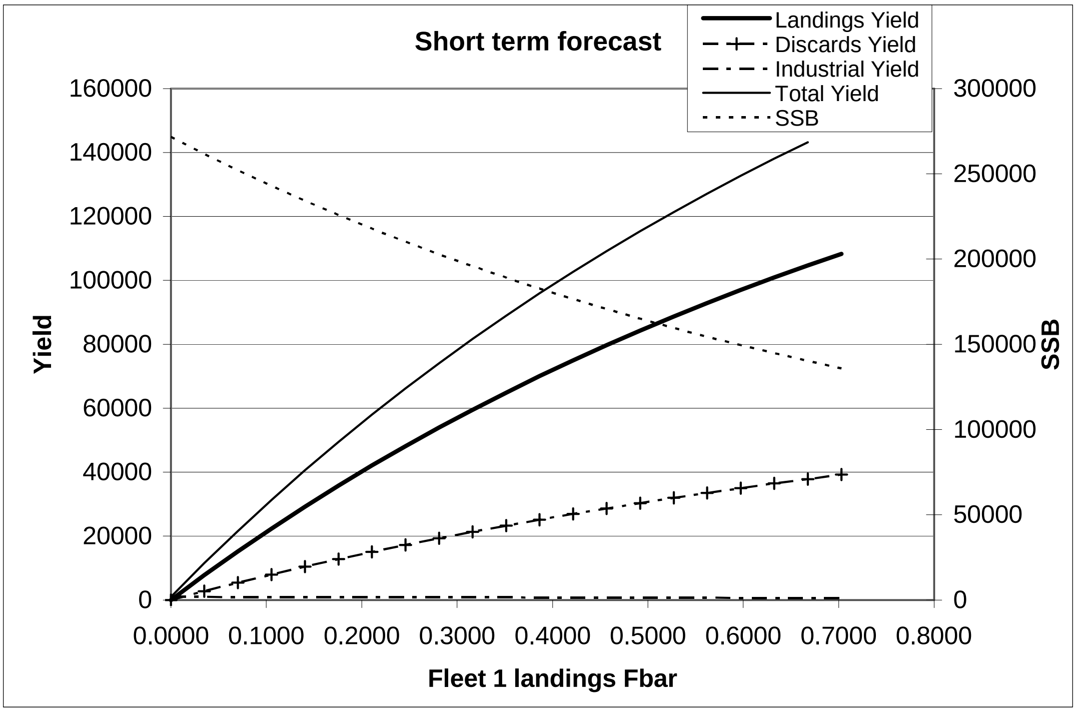


Figure 13.6.2. Haddock in Subarea IV and Division IIIa. Exploitation patterns used in the short term forecast: Option 1 and 2 (SPALY F 2006 – thin solid line) use the exploitation pattern as estimated for 2006; Option 3 (Average F scaled to Fbar 2006 – thick solid line); Option 4 (Straight average F-at-age – red dotted line).



MFDP version 1a
Run: run2
Time and date: 11:34 07/05/2007
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

Input units are thousands and kg - output in tonnes

Figure 13.6.3 Haddock in Subarea IV and Division IIIa. Results from the short term forecast.

Quarter 3 – Scottish groundfish Survey 2007

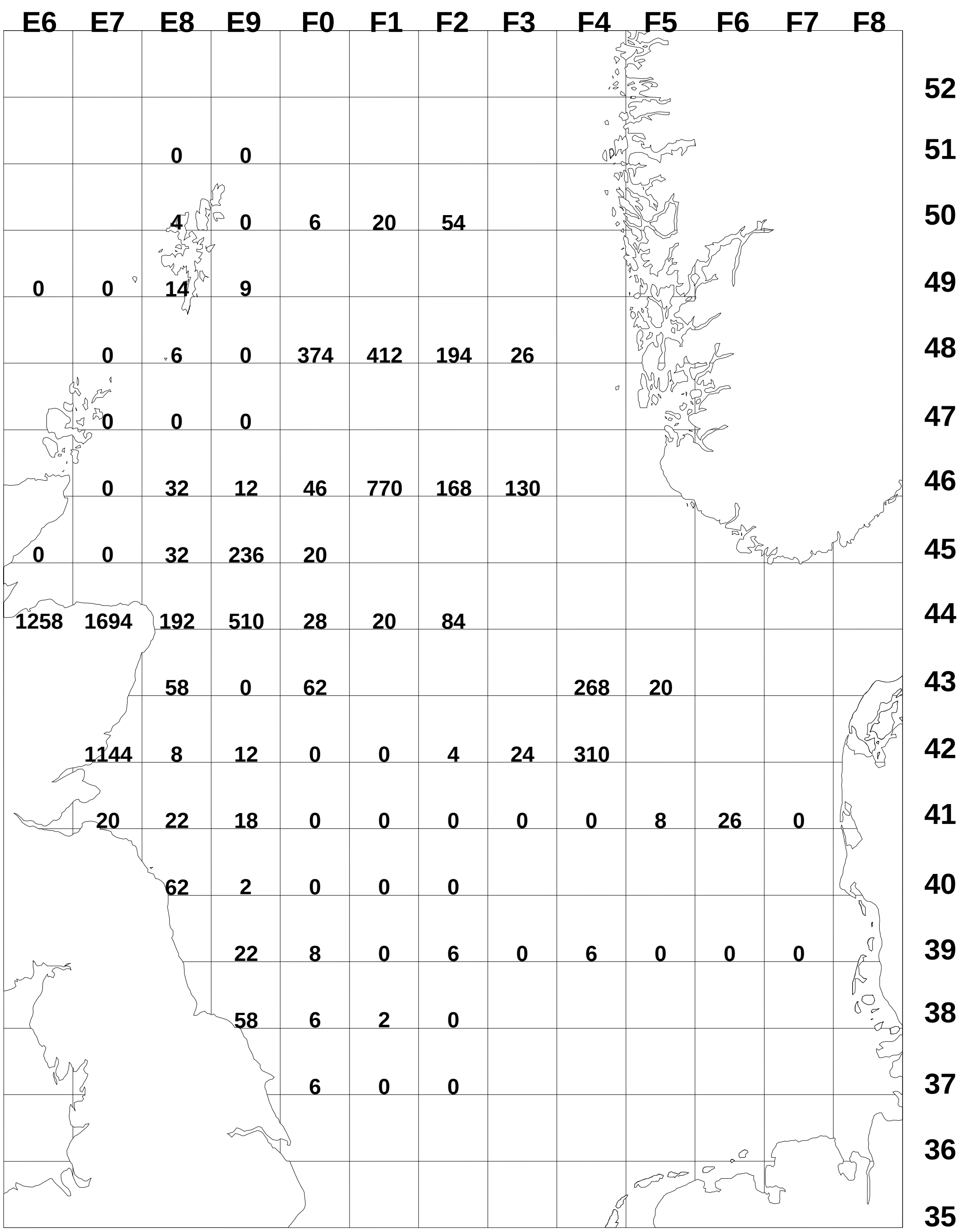


Figure 13.12.1. Haddock in Sub-Area IV and Division IIIa update. Spatial distribution of CPUE for age 0 haddock from the Scottish groundfish survey by ICES rectangle. It should be noted the distribution map relates to numbers caught per hours fishing, whilst the survey indices traditionally relate to numbers caught per 10 hours.

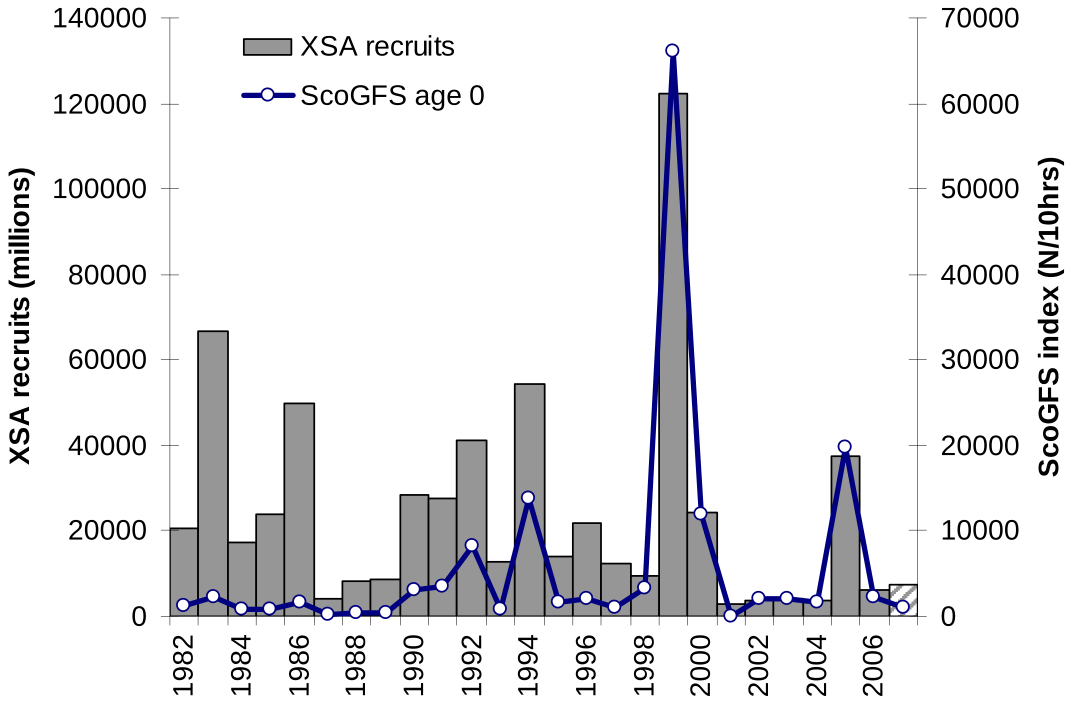


Figure 13.12.2. Haddock in Sub-Area IV and Division IIIa update. Scottish groundfish survey CPUE for age 0 in quarter 3 (blue line) compared to estimates of recruits at age 0 from the final XSA run (bars shaded grey), with the recruitment for 2007 (estimated using RCT3) taken forward in the short term forecast, shaded with a hashed pattern.

14 Cod

Since 1996, this assessment has related to the cod stock in the North Sea (Sub-area IV), the Skagerrak (Division IIIaN-Skagerrak) and the eastern Channel (Division VIId). 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), but they did not meet in 2006.

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 central to northern 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.

At the North Sea scale, there has been a northerly shift in the mean latitudinal distribution of the stock (e.g. Perry *et al.*, 2005). However the evidence for this being a migratory response is slight or non-existent. More likely, cod in the North Sea are composed of a complex of more or less isolated sub-stocks (as indicated above) and the southern units have been subjected to disproportionately high rates of fishing mortality. Blanchard *et al.* (2005) demonstrated that the contraction in range of the North Sea cod stock could be linked to reduced abundance as well as temperature, and they also noted that the combined negative effects of increased temperature on recruitment rates and the reduced availability of optimal habitat may have increased the vulnerability of the cod population to fishing mortality. Rindorf and Lewy

(2006) linked the northward shift in distribution to the effect of a series of warm, windy winters on larvae and the resultant distribution of recently settled cod. They also note that this effect is emphasised by the low abundance of older age cod due to heavy fishing pressure (STECF-SGRST-07–01).

The consumption of cod in the North Sea in 2002 by grey seals (*Halichoerus grypus*) has recently been estimated (Hammond and Grellier, 2006). For the North Sea it was estimated that in 1985 grey seals consumed 4 150 tonnes of cod (95% confidence intervals: 2484–5760 tonnes), and in 2002 the population tripled in size (21–68 000) and consumed 8 344 tonnes (95% confidence intervals: 5028–14 941 tonnes). These consumption estimates were compared to the Total Stock Biomass (TSB) for cod of 475 000 tonnes and 225 000 tonnes for 1985 and 2002 respectively. The mean length of cod in the seal diet was estimated as 37.1cm and 35.4cm in 1985 and 2002 respectively. It should be noted, however, that seal diet analysis must be treated with a degree of caution because of the uncertainties related to modelling complex processes (e.g. using scat analysis to estimate diet composition involves complex parameters, and can overestimate species with more robust hard parts), and the uncertainties related to estimating seal population size from pup production estimates (involving assumptions about the form of density-dependent dynamics). The analysis may also be subject to bias because scat data from haul-out sites may reflect the composition of prey close to the sites rather than further offshore. Furthermore, seals may be exploiting components of the cod stock unavailable to the fishery (STECF-SGRST-07–01).

The effect seal predation has on cod mortality rates has been estimated for the North Sea within a multi-species assessment model (MSVPA), which was last run in 2005 (ICES-SGMSNS, 2005). At the time the revised estimates of cod consumption by grey seals were not available and data was not available to allow the inclusion of common seals into the key run of the model. The grey seal population size was obtained from WGMME (ICES-WGMME, 2005) and was assumed to be 68 000 in 2002 and 2003 respectively. Estimates of cod consumption were 19 000 tonnes in 2002 and 11 000 tonnes in 2003, higher than the values estimated by Hammond and Grellier (2006). Sensitivity analysis of the North Sea cod stock assessment estimates to the inclusion of the revised multi-species mortality rates were carried out at the 2003 meeting of the WGNSSK (ICES-WGNSSK, 2003). Inclusion of the multi-species mortality rates had a relatively minor effect on the high levels of estimated fishing mortality rates and low levels of spawning stock biomass abundance. Inclusion of the new grey seal diet data and seal population abundance are expected to reduce historic estimates of cod consumption in the North Sea by seals generated from the MSVPA model and therefore this suggests that the new estimates of seal predation will not alter the current perception of North Sea cod stock dynamics (STECF-SGRST-07–01).

A recent meeting of the STECF reviewed the broad scale environmental changes in the north-eastern Atlantic that has influenced all areas under the cod recovery plan (STECF-SGRST-07–01), and concluded that:

- Warming has occurred in all areas of the NW European shelf seas, and is predicted to continue.
- A regime shift in the North Sea ecosystem occurred in the mid-1980s.
- These ecological changes have, in addition to the decline in spawning stock size, negatively affected cod recruitment in all areas.
- Biological parameters and reference points are dependent on the time-period over which they are estimated. For example, for North Sea cod FMSY, MSY and BMSY are lower when calculated for the recent warm period (after 1988) compared to values derived for the earlier cooler period.
- The decline in FMSY, MSY and BMSY can be expected to continue due to the predicted warming, and possible future change should be accounted for in stock assessment and management regimes.

- Modelling shows that under a changing climate, reference points based on fishing mortality are more robust to uncertainty than those based on biomass.
- Despite poor recruitment, modelling suggests that cod recovery is possible, but ecological change may affect the rate of recovery, and the magnitude of achievable stock sizes.
- Recovery of cod populations may have implications to their prey species, including *Nephrops*.

With the exception of the general effects noted above, the overall conclusion from the STECF meeting (STECF-SGRST-07–01) for the North Sea was that there is no specific significant environmental or ecosystem change in the Skagerrak, North Sea and eastern Channel (e.g. the effects of gravel extraction, etc.) affecting potential cod recovery. The conclusions from the STECF meeting merit further discussion within ICES, which is ongoing (e.g. ICES-WKREF, 2007).

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. 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

The present technical regulations for EU waters came into force on 1 January 2000 (Council Regulation (EC) 850/98 and its amendments). The regulation prescribes the minimum target species' composition for different mesh size ranges. Additional measures were introduced in Community waters from 1 January 2002 (Council regulation (EC) 2056/2001).

The provisions on mesh size and target species composition differ in the North Sea and the Skagerrak (see tables that follow, reflecting only those measures that have changed). The main difference is the minimum mesh size for towed gears for which cod is accepted as a target species. The minimum mesh size for cod is 120 mm in the North Sea and 90 mm in the Skagerrak.

Skagerrak: Changes in technical measures relating to gear design and maximum allowed percentages of cod in the landings implemented since 2000:

Gear	Mesh size mm	Year	Max % cod	Selectivity devises
Towed gear	=> 90	2000 – 2004	100	
		2005 - present		Possibility for extra days fishing with 120 mm square mesh panel
Towed gear	=>70 and < 90	2000 – 31/3 2004	30 to 60	None
		1/4 2004 – 31/12 2004	10	Square mesh codend
		2005 - present	5	Square mesh codend and sorting grid
Fixed gear	< 120	2000 – present	30	None
Fixed gear	=> 120	2000 – present	100	None

North Sea: Changes in Technical Measures relating to gear design in force in 2001 (Council Regulation (EC) No 850/98) and 2002 (Council Regulation (EC) No 2056/2001) in the North Sea (ICES Sub-area IV and IIIa).

	Year	Mesh size (mm)	Twine thickness (mm)	Cod-end: max number of meshes round	Square mesh panel	Large mesh panel	Others
Demersal towed gears - whitefish	2001	100	8 S / 2x6 D	100	No	No	
	2002	110 (2002 only) 120	8 S / 2x5 D 8 S / 2x5 D	100 100	YES – 90mm No	No No	
Demersal towed gears - saithe	2001	100	8 S / 2x6 D	100	No	No	
	2002	110	8 S / 2x5 D	100	No	No	
Demersal towed gears - Nephrops	2001	70	8 S / 2x6 D	No	Yes – 80mm	No	
	2002	70 (2002 only) 80 100	8 S / 2x5 D 8 S / 2x5 D 8 S / 2x5 D	120 120 100	Yes – 80mm Yes – 80mm Yes – 90mm	Yes – 140 mm Yes – 140 mm No	Square mesh cod-end
Beam trawl - Sth 56°N-5°E	2001	80	8 S / 2x6 D	N/A	No	No	
	2002	80	8 S / 2x5 D	N/A	No	Yes – 180 mm	
Beam trawl - Nth 56°N-5°E (sole)	2001	100	8 S / 2x6 D	N/A	No	No	
	2002	120	8 S / 2x5 D	N/A	No	Yes – 180 mm	
Fixed gears	2001	120	N/A				
	2002	140	N/A				

In 2001, the European Commission implemented an emergency closure of a large area of the North Sea from 14 February to 30 April 2001. The details of the emergency regulation are given in Commission Regulation (EC) 259/2001 of 7 February 2001. The EU-Norway expert group in 2003 concluded that the emergency closure had an insignificant effect upon the spawning potential for cod in 2001. There are several reasons for the lack of impact. The redistribution of the fishery, especially along the edges of the box coupled to the increases in proportional landings from January and February appear to have been able to negate the potential benefits of the box. The conclusion from this study is therefore that the box would have to be extended in both space and time to be more effective.

Apart from the technical measures set by the Commission, additional unilateral measures are in force in the UK and Denmark. In August and December 2000 Scottish Statutory Instruments 227 and 405 introduced additional measures on square mesh panels and multiple rigs (equivalent Westminster Statutory Instruments 649 and 650 followed in April 2001). These also implemented, in March 2001, a further restriction on twine size in both whitefish and Nephrops gears. In August 2001, Scottish Statutory Instrument 250 banned lifting bags and limited extension length for whitefish gear. A useful summary of the UK unilateral measures is given in Anon. (2002). Denmark is operating with a minimum landing size of 40cm. EU minimum landing size is 35cm. In 2001, vessels fishing in the Norwegian sector of the North Sea had to comply with Norwegian regulations setting the minimum mesh size at 120mm.

Effort regulations in days at sea per vessel and gear category are summarised in the following table, which only shows changes in 2007 compared to 2006.

Maximum number of days a vessel can be present in the North Sea, Skagerrak and Eastern Channel, by gear category and special condition (see Council regulation (EC) 41/2006 for more details). The table shows only changes in 2007 compared to 2006.

DESCRIPTION OF GEAR AND SPECIAL CONDITION (IF APPLICABLE)	AREA			MAX DAYS AT SEA	
	IV,II	SKAG	VIID	2006	2007
Trawls or Danish seines with mesh size ≥120mm	x	x	x	103	96
Trawls or Danish seines with mesh size ≥120mm with a 140mm square mesh window and operating undar a system of automatic suspension of fishing licences	x		x		127
Trawls or Danish seines with mesh size ≥100mm and <120mm	x	x	x	103	95
Trawls or Danish seines with mesh size ≥90mm and <100mm	x		x	227	209
Trawls or Danish seines with mesh size ≥90mm and <100mm complying with the condition in Appendix 3 to Annex IIA [Council Regulation (EC)No 41/2006 of 21 December 2006][(1)]	x		x		238
Trawls or Danish seines with mesh size ≥90mm and <100mm		x		103	95
Trawls or Danish seines with mesh size ≥90mm and <100mm with 120mm square mesh window		x		137	126
Trawls or Danish seines with mesh size ≥90mm and <100mm complying with the condition in Appendix 3 to Annex IIA [Council Regulation (EC)No 41/2006 of 21 December 2006][(1)]		x			132
Trawls or Danish seines with mesh size ≥70mm and <90mm	x			227	204
Trawls or Danish seines with mesh size ≥70mm and <90mm, track records represent less than 5% cod	x				215
Trawls or Danish seines with mesh size ≥70mm and <90mm			x	227	221
Trawls or Danish seines with mesh size ≥70mm and <90mm, track records represent less than 5% cod			x		227
Beam trawls with mesh size ≥80mm and <90mm	x	x		143	132
Gillnets and entangling nets with mesh sizes ≥150mm and <220mm	x	x	x	140	130

[(1)] In essence, the towed net should have an escape window, inserted in the top panel of the cod-end of mesh size no smaller than 95mm, and ending no more than 4m from the cod-line. The window should be at least 5m in length with meshes that have a minimum opening of 120mm.

The April 2007 ICES-WGFTFB meeting reported some evidence of a small uptake in voluntary technical control measures with mixed motives, including increased days at sea, improved quality and local pressure. For example, the use of a 120mm square mesh panel at 4–9m has had no uptake in the Scottish *Nephrops* fishery, despite its use allowing for 11 extra days per year, because the loss of marketable haddock and whiting far outweighs the benefit of extra days. On the other hand, 50% of the Swedish *Nephrops* trawl effort uses the 120mm square mesh panel in the 90mm trawl because of the additional days at sea, and the experimental use of species selective trawls in the Farne Deeps *Nephrops* fishery (reducing discards of haddock and whiting by more than 50%) has been taken up by some English vessels because of the improved catch quality and value. The overall impact of the uptake of voluntary technical control measures is likely to be small.

Changes in fleet dynamics

There has been no major decommissioning of North Sea fleets between 2005 and 2007 (ICES-WGFTFB, 2007). However, over this period there has been a marked switch of vessels to *Nephrops* from other species (i.e. from larger to smaller mesh sizes). TAC limitations on plaice and sole, coupled with rising fuel costs, have caused Dutch vessels to gradually shift from beam trawling on flatfish to twin trawling on other species (notably gurnards and *Nephrops*). Some larger powered Scottish vessels in the whitefish fishery have moved to the Fladden *Nephrops* fishery during late summer 2006, and there was a return of inshore Scottish vessels to their traditional inshore *Nephrops* grounds because of the diminished importance of the squid fishery in 2006. Scottish single seiners have been working more inshore in IVa to target smaller haddock and whiting, which allows more landings for days at sea. Apart from *Nephrops* (involving mesh size changes), there has been little evidence for a change in target species within a mesh class in the North Sea.

There has been some voluntary use of larger meshes for fuel and other reasons, such as the usage of bigger meshes in the top panel of Belgian beam trawls to reduce fuel consumption, the use of 130mm mesh by Scottish whitefish vessels fishing in the eastern side of the North Sea to ensure meshes above the regulation size.

A lot of experimentation has taken place with different gears and with modifications to existing gears. There is evidence of a switch to twin trawling in several fisheries in the northern North Sea, or the use of double bags, which could be viewed as an increase in effort in relation to days at sea. Vessels are also switching from beam trawls to towing two otter trawls on the outriggers in the southern North Sea, but the impact of this is unknown. New instrumentation on nets and in navigation has been introduced, notably for door attitude, believed to give a small increase in efficiency. Some changes in twines have been used in order to improve fuel efficiency.

The temporal dynamics of the catch rates of the fishery exploiting North Sea cod was examined by Darby (2007 WD4). Catch per unit effort by trawlers and gill netters fishing in the first quarter of the year is compared with stock assessment estimates of biomass and biomass indices from the first quarter IBTS survey for the years 1995–2007.

English trawlers

Figure 14.1a illustrates the relative catch rates of North Sea cod recorded by English trawlers fishing in the first quarter of the year and the 2+ cod biomass as estimated by the 2006 ICES WGNSSK assessment and recorded by the IBTS quarter 1 survey.

The English fleet catch rates have exhibited similar trends in time to the survey and assessment estimates of 2+ biomass. In recent years catch rates from all time series have shown a slight improvement following the recruitment of the 2005 year class of cod.

However, current catch rates are still well below the levels recorded during the late 1990's when the stock was closer to safe biological limits.

English gill-netters

Two English gill netters fishing in the Southern North Sea have been reporting higher catch rates of large cod in recent years. Therefore data retrievals from their landing were also compared to the time series of assessment and IBTS survey data (Figures 14.1b and 14.1c). Unfortunately age compositions from the boats could not be obtained in order to ascertain the age groups that the boats are landing therefore comparisons have been made with the estimates of 4+ and 5+ biomass.

The English boats catch rates have exhibited similar historic trends to the survey and assessment estimates of 4+ and 5+ biomass. In recent years catch rates from both vessels have been increasing since a low in 2002/2003 with catch rates that are above the relative increase in the level of the survey and assessment in 2006. The catch rates are still below the levels recorded between 1985–1990 but are indicative of an improvement in the rate of catch by this subset of vessels that are targeting older fish. Analysis of information will be developed further in collaboration with the fishing industry in order to explore the use of the vessel catch rates as a monitored sentinel fishery.

In a survey of French fishers' perception of the Eastern Channel ecosystem (Prigent *et al.*, 2007), 76% of the interviewees expressed their concern about the depletion of fish resources, particularly flatfish and gadoids.

Summary of the STECF Working Group on the Evaluation of the Cod Recovery Plan

An analysis of landings and estimated discards of cod by gear category (excluding Norwegian data) highlighted the following fleets as the most important in terms of cod for 2003–5 (accounting for close to 88% of the EU landings), listed with the main use of each gear (STECF SGRST-07-01):

- Otter trawl, ≥ 120mm, a directed roundfish fishery.
- Otter trawl, 70–89mm, comprising a 70–79mm French whiting trawl fishery centered in the Eastern Channel, but extending into the North Sea, and a 80–89mm UK *Nephrops* fishery (with smaller landings of roundfish and anglerfish) occurring entirely in the North Sea.
- Otter trawl, 90–99mm, a Danish and Swedish mixed demersal fishery centered in the Skagerrak, but extending into the Eastern North Sea.
- Beam trawl, 80–89mm, a directed flatfish fishery.
- Gillnets, 110–219mm, a targeted cod and plaice fishery.

With regard to trends in effort for these major cod fisheries since 2000, the largest changes to have happened in North Sea fisheries have involved an overall reduction in trawl effort and changes in the mesh sizes in use. In particular 100–119mm meshes have now virtually disappeared, and instead vessels are using either 120mm+ (in the directed whitefish fishery) or 80–99mm (primarily in the *Nephrops* fisheries and in a variety of mixed fisheries). The use of other mesh sizes largely occurs in the adjacent areas, with the 70–79mm gear being used in the Eastern Channel/Southern North Sea Whiting fishery, and the majority of the landings by 90–99mm trawlers coming from the Skagerrak. Higher discards are associated with these smaller mesh trawl fisheries, but even when these are taken into account, the directed roundfish fishery (trawls with ≥ 120mm mesh) still has the largest impact of any single fleet on the cod stock, followed by the mixed demersal fishery (90–99mm trawls) in the Skagerrak. For all the gear categories considered above, effort has been relatively stable over 2003–5 (STECF SGRST-07–01).

The STECF report concludes that the management measures applied to the cod stock in the North Sea, Skagerrak and Eastern Channel have not yet been sufficient to allow rebuilding (STECF SGRST-07–01). Although the most recent stock assessment (ICES-WGNSSK, 2006) indicates a recent reduction in fishing mortality, the estimates are subject to high uncertainty, and fishing mortality is still high. Furthermore, although there has been a substantial reduction in the amount of effort by trawlers in the North Sea over the last five years, there are also important fisheries on the stock in the Skagerrak and the Eastern Channel, and there does not appear to have been any corresponding reduction in effort in these fisheries. Clearly, management needs to address these fisheries as well as those in the North Sea. This is particularly important in the light of cod stock structure information, which suggests that the overall population is a meta-population in which a series of smaller sub-stocks contribute to the whole. Failure to adequately apply measures to protect all components may be contributing to shortfalls in recovery.

Summary of the NSRAC and NWWRAC cod recovery symposium

Regional Advisory Councils for the North Sea (NSRAC) and the North-Western Waters (NWWRAC) held a cod recovery symposium in Edinburgh (UK), 9–10 March 2007.

The STECF report (STECF-SGRST-07–01) provides a summary of the main conclusions from the cod recovery symposium, as follows:

- The cod stocks in the Kattegat (1), in the Skagerrak, North Sea and Eastern Channel (2), to the West of Scotland (3) and in the Irish Sea (4) do not show clear signs of increase in SSB. Observed decreases in fishing mortality have been insufficient to ensure quick and safe recovery. Contrary opinions of some fishermen could not be confirmed by data.
- The cod stock can recover, despite potential negative ecological conditions (temperature, plankton regime shift). Environmental change is however, expected to cause recovery to be to a lower level of biomass than if environmental conditions had remained unchanged. Ecological effects were interpreted as a matter of changes over decadal periods rather than short term.
- There is a huge market demand for cod (i.e. everybody should be interested to contribute to the recovery).
- The EU-Commission expressed its intention to discuss a revised cod recovery plan during the second half of this year. A revised recovery plan would, however, not enter into force until 2009.

The stakeholders outlined the following concerns and ideas:

- The regional aspects in the plan should be strengthened (our cod is different!).
- Fleet definitions and days at sea regulations are too complex and not transparent. No further days at sea reductions possible.
- Technical measures to avoid catching cod and respective incentives should be considered.
- The cooperation between fishermen and scientists should be intensified.
- The revised cod recovery plan should consider the mixed fisheries aspects, including the economic consequences.
- There should be better control and enforcement.

14.1.3 ICES Advice

ICES ACFM advice for 2006:

In 2005, ICES could not calculate exploitation boundaries in relation to existing management plans because of the lack of a short-term forecast. ICES was also not able to identify any non-zero catch that would be compatible with the Precautionary Approach, given the low stock size and series of poor recruitment. For all demersal fish stocks in the North Sea , ICES advice was based on mixed fisheries considerations.

ICES ACFM advice for 2007:

In 2006, ICES accepted the assessment and were able to make a forecast.

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

Blim cannot be reached with a 30% increase in SSB. The management plan stipulates that in such cases a TAC should be set allowing Blim to be reached within one year. Simulations indicate that this could be achieved with 50% probability if F were reduced to 30% of the current F, corresponding to total removals (landings, discards, and unaccounted removals) in

2007 of 35 000t. ICES is unable to translate this figure into a TAC with the required precision.

Exploitation boundaries in relation to precautionary limits

Given the low stock size and recent poor recruitment, the stock cannot be rebuilt to Bpa in 2008 even with a zero catch. Simulations indicate that with the recent poor recruitment, a zero catch would be required in 2007 and 2008 to achieve the rebuilding of the stock to Bpa by 2009.

Conclusions regarding exploitation boundaries

Because the existing recovery plan does not include the elements or measures necessary for rebuilding the stock at the current SSB (well below Blim), ICES continues to advise on exploitation boundaries in relation to precautionary limits and recommends that the fisheries for cod be closed until an initial recovery of the cod SSB has been proven. Any catches that are taken in 2007 will prolong the recovery to Bpa.

Short-term implications

Outlook for 2007

With zero catch in 2007 in all fisheries, SSB in 2008 could rise above Blim, but would still be well below Bpa.

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)	2004	2005	2006	2007
IIIa (Skagerrak)	3.9	3.9	3.3	2.9
IIa + IV	27.3	27.3	23.2	20.0

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.

Cod Recovery plan

A Cod Recovery Plan is in place because cod is still not considered to be recovered. ICES has previously concluded that a precautionary recovery plan must include an adaptive element, implying that fisheries for cod remain closed until an initial recovery of the cod SSB has been proven. Such an element is not included in the existing plan. ICES therefore considers the recovery plan as not consistent with the precautionary approach.

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 1. This Regulation establishes a recovery plan for the following cod stocks (hereinafter referred to as "depleted cod stocks"):

a) cod in the Kattegat;
b) cod in the North Sea, in the Skagerrak and the eastern Channel;
c) cod to the west of Scotland;
d) cod in the Irish Sea.

Article 2. Definitions of geographical areas

For the purposes of this Regulation, the following definitions of geographical areas shall apply:

a) "Kattegat" means that part of division III a, as delineated by ICES, that is bounded on the north by a line drawn from the Skagen lighthouse to the Tistlarna lighthouse, and from this point to the nearest point on the Swedish coast, and on the south by a line drawn from Hasenore to Gnibens Spids, from Korshage to Spodsbjerg and from Gilbjerg Hoved to Kullen;

b) "North Sea" means ICES subarea IV and that part of ICES division III a not covered by the Skagerrak and that part of ICES division II a which lies within waters under the sovereignty or jurisdiction of Member States;

c) "Skagerrak" means that part of ICES division III a bounded on the west by a line drawn from the Hanstholm lighthouse to the Lindesnes lighthouse and on the south by a line drawn from the Skagen lighthouse to the Tistlarna lighthouse and from that point to the nearest point on the Swedish coast;

d) "eastern Channel" means ICES division VII d;

e) "Irish Sea" means ICES division VII a;

f) "west of Scotland" means ICES division VI a and that part of ICES division V b which lies within waters under the sovereignty or jurisdiction of Member States.

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 stocks concerned 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 100mm 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.

Cod long-term Management Plan

Once cod is considered to have recovered, the 2005 agreement between the EU and Norway (a renewal of the 1999 agreement) comes into force, and states that the EU and Norway *"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 (Blim).
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 (Bpa) 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 has not evaluated the consistency of the new management plan with the precautionary approach.

14.2 Data available

14.2.1 Catch

Landings data from human consumption fisheries for recent years as officially reported to ICES together with those estimated by the WG are given for each area separately and combined in Table 14.1 The WG estimate for landings from the three areas (IV, IIIa-Skagerrak and VIId) in 2006 were based on annual data, as opposed to quarterly data in the past, because of data co-ordination and timing difficulties in 2006. The landings estimate for 2006 is 26.8 thousand tonnes, split as follows for the separate areas (thousand tonnes):

	Landings	TAC	Discards
IIIa(Skagerrak)	3.4	3.3	2.9
IV	22.2	23.2	5.2
VIId	1.0	Comb VII	Comb IV
Total	26.8		8.1

WG estimates of landings indicate that the TACs for Subarea IV was not fully taken in 2006. This is in keeping with previous years. WG estimates of discards are also shown above.

Discard numbers-at-age were estimated for areas IV and VIId by applying the Scottish discard ogives to the international landings-at-age. For 2006, Danish discard ogives were applied to the Danish landings-at-age, and Scottish discards to the remaining international landings at age. Discard numbers-at-age for IIIa were based on observer sampling estimates. For 2006, a combination of Danish and Swedish discard ogives were applied. Although in some cases other nations' discard proportions are available for a range of years, these have not been transmitted to the relevant WG data coordinator in an appropriate form for inclusion in the international dataset. Because of the data co-ordination difficulties in 2006, it was not possible to consistently apply Danish discard age compositions to other years, even though these are now available.

For cod in IV, IIIa-Skagerrak and VIId, ICES first raised concerns about the mis-reporting and non-reporting of landings in the early 1990s, particularly when TACs became intentionally restrictive for management purposes. Some WG members have since provided estimates of under-reporting of landings to the WG, but by their very nature these are difficult to quantify. In terms of events since the mid-1990s, the WG 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 3 000t of under-reported catch. The 1998 catch estimates remain unchanged in the present assessment.

For 1999 and 2000, the WG has no a priori reason to 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. Buyers and Sellers legislation introduced in the UK towards the end of 2005 is expected to have improved the accuracy of reported cod landings for the UK.

The by-catch of cod from the Danish and Norwegian industrial fisheries that was sent for reduction to fishmeal and oil in 2006 was 82 tonnes.

Age compositions

Age compositions were provided by Denmark, Germany, England, the Netherlands, Norway, Sweden and Scotland.

Landings in numbers at age for age groups 1–11+ and 1963–2006 are given in Table 14.2. SOP values are shown. These data form the basis for the catch at age analysis but do not include industrial fishery by-catches landed for reduction purposes for the years prior to 2006.

By-catch estimates are available for the total Danish and Norwegian small-meshed fishery in Sub-area IV and separately for the Skagerrak (Table 14.1). During the last five years an average of 83% (87% in 2006) of the international landings in number were accounted for by juvenile cod aged 1-3. In 2006, age 1 cod comprised 62% of the total catch by number.

Discard numbers-at-age are shown in Table 14.3. The proportions of the estimated total numbers discarded are plotted in Figure 14.2a and the proportion of the estimated discards for ages 1–3, in Figure 14.2b. Estimated total numbers discarded have been constant at around 50% since 1995, but have shown an increase in 2006, due to the stronger 2005 year class entering the fishery (estimated to be almost the size of the 1999 year class). 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 four years, it is estimated to be at around 90%. At ages 2 and 3 discard proportions have been increasing steadily and at age 2 are currently estimated to be around 50% in 2006. Note that these observations refer to **numbers** discarded, not weight.

14.2.2 Weight at age

Mean weight at age data for landings, discards and catch, are given in Tables 14.4-6. Total catch mean weight values were also used as stock mean weights. Long-term trends in mean catch weight at age for ages 1–9 are plotted in Figure 14.3, 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 fishing effort actually deployed.

The WG has previously argued that, although they are in general agreement with the survey information, commercial cpue tuning series should not be used for the calibration of assessment models due to potential problems with effort recording and hyper-stability (ICES-WGNSSK, 2001), and also changes in gear design and usage, as discussed by ICES-WGFTFB (2006, 2007). Therefore, although the commercial fleet series are available, only survey and commercial landings and discard information are analysed within the assessment presented.

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 should be used for calibration, as catch rates for older ages are very low.

- Scottish third-quarter groundfish survey (ScoGFS): ages 1–8. This survey covers the period 1982–2006. This survey is undertaken during August each year using a fixed station design and the GOV trawl. Coverage was restricted to the northern part of the North Sea until 1998, corresponding to only the northernmost distribution of cod in the North Sea. Since 1999, it has been extended into the central North Sea and made use of a new vessel and gear. Only ages 1–6 should be used for calibration, as catch rates for older ages are very low.
- Quarter 1 international bottom-trawl survey (IBTSQ1): ages 1–6+, covering the period 1976–2007. 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 1991–2006. 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. The Scottish and English third quarter surveys described above contribute to this index.

The data used for calibrating the catch-at-age analysis are shown in Table 14.8.

Maps showing the IBTS distribution of cod are presented in Figures 14.4a-b (ages 1–3+). The recent dominant effect of the size and distribution of the 1996 and, to a lesser extent, the 1999 and 2005 year-classes are clearly apparent from these charts. However, fish of older ages have continued to decline due to the very weak 2000, 2002 and 2004 year classes. The abundance of 3+ fish is at a low level in recent years.

An analysis of the of the third quarter Scottish and English survey data by Parker-Humphries and Darby (WD 24 in ICES-WGNSSK, 2006) showed that the extremely high catch rates estimated for ages 2–4 in a single station in the third quarter Scottish survey in 2004 resulted in the estimation of a strong reduction in mortality in 2004 followed by high mortality in 2005. When the station with high catch rates was removed, total mortality was then consistent with values obtained in previous years. The WG agreed that it would be *ad hoc* and statistically inappropriate to remove the station from the calculation of the Scottish index. After reviewing the information available on survey catch rates and spatial distribution, the WG decided to discontinue the use of the English and Scottish surveys on their own in the cod assessment because of the current low catch rates recorded by these surveys and the potential for noise at the oldest ages due to low sampling levels. Instead, the WG decided to use the IBTSQ3 survey, which incorporates both the Scottish and English surveys, together with the IBTSQ1 survey.

Long-term trends in the distribution of cod

The distribution of cod by roundfish areas in the North Sea and Skagerrak was estimated from IBTSQ1 (1983–2006). An index of stock number within a roundfish area was calculated from the product of the area of the roundfish area (< 200m) and the average cpue at age (ages 1, 2, 3 and 4+) within the roundfish area. It was assumed that the catchability at age has remained constant during the full period and that catchability is independent of area, vessel, depth etc. (see WD XX for details##)

The long term trend in the distribution of cod by roundfish area is shown in Figure 14.5a. It is clearly seen that the index of number of cod has declined for age 4+ for all roundfish areas in the period 1983–2006. For age 1 the index has declined in mainly area 6 and 7, while the index has remained rather high and stable in area 8 (Skagerrak). For age 2 and 3 there is a significant (Pearson correlation coefficients of log-index against year significant at 0.05 level or better) decline in area 1, 3, 6 and 7.

Figure 14.5b shows the index of number at age as proportion of the sum of indices at age in each roundfish area. The proportion of age 1 has increased for area 3 and especially for area 8, while the proportion from area 6 has decreased significantly (Pearson correlation coefficients of proportion against year significant at 0.05 level or better). The proportion of age 2 has increased significantly in area 8 and decreased significantly in area 6. For age 4+ the proportion in area 2 and 4 has decreased significantly and increased for area 1. Even though the proportion of age 1–3 has increased significantly in area 8 the increase of the age 4+ proportions in this area is not significant.

The presentation of the time series illustrates the increased importance of recruitment from area 8 (Skagerrak). The survey indices from IBTSQ1 and Q3 used in the stock assessment only include catch rates from the three most easterly rectangles of Skagerrak. More of the Skagerrak area should be considered for inclusion in the IBTS standard areas for abundance indices, in order to produce an unbiased abundance index for the management unit (IV, IIIaN and VIId) of cod.

Area 8 is almost entirely covered by a Swedish vessel in both the IBTSQ1 and Q3 surveys. This is disadvantageous as it does not allow for a comparison of cod catchability between vessels which is essential for comparison of catch rates between roundfish areas. In the North Sea each rectangle is covered by at least 2 nations to reduce bias in indices.

14.3 Data analyses

14.3.1 Reviews of last year's assessment

In 2006 the ACFM review group raised the following issues (given in italics in quotes), and the WG responds as follows (given in normal text):

a) "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." Section 6 on plaice in VIId highlights the problems with the above-mentioned survey, which is being investigated.

b) "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)." There was not sufficient time at this year's WG to respond to this request.

c) "The labeling of the forecast output should be 'removals' from fishing and extra natural mortality, without the key to split the two components." The appropriate labeling has been introduced in the forecast tables.

d) "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 estimate of Fsq incorporates the level of "unallocated removals" as estimated by the assessment, so that if Fsq (or a multiplier of it) is assumed in projections, the corresponding levels of "unallocated removals" are also assumed to continue in future.

e) "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." Given the truncated time of this year's WG, a stock annex was not immediately possible.

f) "Y/R should be performed for each of the bootstrap output…to obtain a probabilistic Y/R." There was not sufficient time at this year's WG to respond to this request.

g) “Natural mortality estimate from MSVPA should be considered.” Comments on the use of MSVPA-derived estimates of natural mortality are given in Section 14.9

h) “Suggested look at transformation in calculating survey indices which may be heavily influenced by the increasing numbers of zero tows.” This is a topic that has been considered during the ICES Methods Working Group for 2007, and should be handled by that group in future.

14.3.2 Exploratory survey-based analyses

Survey abundance indices are plotted in log-mean standardised form by year and cohort in Figure 14.6a for the IBTSQ1 survey, together with log-abundance curves and associated negative gradients for the age range 2–4. Similar plots are shown for the IBTSQ3 survey in Figure 14.6b. The log-mean standardised curves indicate no obvious year effects (top-left plots), and tracks cohort signals well (top right). The log abundance curves for each survey series indicate consistent gradients (bottom left), with less steep gradients in recent years (bottom right).

Figures 14.7a and b shows within-survey consistency (in cohort strength) for the IBTSQ1 and Q3 surveys, while Figure 14.7c shows between-survey consistency (for each age) for the two surveys. These show generally good consistency, justifying their use for survey tuning. Correlations deteriorate for age 5 for the IBTSQ3 survey, and this age is not used for tuning.

The SURBA survey analysis model was fitted to the survey data for the IBTSQ1 and IBTSQ3. The summary plots are presented in Figures 14.8a-b.

Biomass - Both time series indicate that spawning stock biomass is at its lowest level in the time series because of a series of poor recruitments coupled with high fishing mortality and discard rates at the youngest ages. The total stock biomass estimated from the IBTSQ1 survey, which incorporates more recent data than the IBTSQ3 survey, shows an increase due to the stronger 2005 year class.

Total mortality – In all model fits, there is a high level of uncertainty in the model estimates, and trends in mean Z cannot be determined with any confidence.

Recruitment–Estimates of recruitment are unreliable for the IBTSQ3 survey. The IBTSQ1 survey indicates that the recruiting years classes since 1996 have been relatively weak, but that the 2005 year class is one of the highest of the recent low values. The variation recorded in year class strength at age 1 is substantially higher than that recorded subsequently at ages 2 and 3, indicating that the high rates of discarding (90%) and high mortality rates at this age are resulting in reduced contributions from one year old fish to the stock and catches.

14.3.3 Exploratory catch-at-age-based analyses

Catch-at-age matrix and Separable VPA

The total catch-at-age matrix (combination of landings and discards shown in Tables 14.2 and 14.3) is expressed as proportions-at-age, standardised over time in Figure 14.9. It shows clearly the contribution of the 1996 and 1999 year classes to catches in recent years, with the larger 1996 year class disappearing more rapidly from the catches compared to the 1999 year class. It also shows the greater proportion of older fish in the catches at the start of the time series relative to recent years.

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 indicated no strong patterns or large values for ages less than age 8. 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

The top panel of Figure 14.10 presents the log catch curve plot for the catch at age data. Through time there is an increase in the slope of the cohort plots indicating faster removal rates or high total mortality. In the most recent years there has been a gradual decrease in the slope at the youngest ages–a sign of decreased mortality rates. The bottom panel plots the negative slope of a regression fitted to the ages 2–4, the ages range used as the reference for mortality trends. The decrease in the negative slope indicates that total mortality rates at the ages comprising the dominant ages within the fishery are declining.

B-ADAPT

The following table presents a selection of the exploratory runs considered, comprising single fleet B-ADAPT runs fitted to the IBTSQ1 and IBTSQ3 groundfish surveys respectively, two candidate assessments, and sensitivity of the candidate selected as the final assessment. Additional exploratory runs were conducted but are not discussed (these can be found within ICES files).

DESCRIPTION	Q-PLATEAU IBTSQ1	Q-PLATEAU IBTSQ3	PERIOD FOR CATCH MULTIPLIER
Single Fleet Runs			
1. IBTSQ1	5	-	1998–2006
2. IBTSQ3	-	3	1998–2006
Candidate Assessments			
3. SPALY (same procedure as last year)	4	3	1993–2006
4. Increase q-plateau for IBTSQ1	5	3	1993–2006
Sensitivity Runs			
5. No final-year catch multiplier	5	3	1993–2005
6. Catch multiplier not estimated	5	3	-

Single fleet runs of the B-ADAPT model were fitted to the IBTSQ1 (run 1) and IBTSQ3 (run 2) groundfish surveys in order to examine the time series of estimates derived from independent survey data sets. Because B-ADAPT requires a reasonable period of overlap (at least 5 years) between the survey data and the period for which a catch multiplier is not estimated, and because run 4 estimated catch multipliers close to 1 for 1997, the IBTSQ3 run only estimated the catch multiplier for the period 1998–2006, with the values used for the period 1993–2007 taken from run 4. To ensure consistency between the single fleet runs, the same procedure was used for IBTSQ1 (setting multipliers for 1993–1997 equal to run 4 values, and estimating those from 1998), despite enough data being available for estimating catch multpliers from 1993.

Figure 14.11 plots trajectories of SSB, TSB, mean F(2–4) and the catch multiplier for the two single fleet runs. Both surveys indicate that the estimated removals since 1998 are higher than indicated by the catch data, that SSB is at or around its lowest level in the time series, and that TSB has been increasing with the incoming 1995 year class. The IBTSQ3 survey indicates that estimated removals have remained relatively unchanged in 2006 compared to 2005, but the IBTSQ1 survey indicates they have come down in 2006. The IBTSQ1 run provides a more precise estimate of the catch multiplier in 2006 than the Q3 run.

Residual plots are shown in Figures 14.12a-b for runs 3 (SPALY) and 4 (increase q-plateau for IBTSQ1) respectively. These Figures highlight a problem of bias in the IBTSQ1 log-q residuals at age 5 for the SPALY run, which is caused by forcing a q-plateau at age 4. This problem is removed when the q-plateau assumption is changed for run 4. A closer inspection of the log-abundance ratios for the two surveys helps to explain the problem. Figure 14.13 plots the negative gradients for the log-abundance curves for the IBTSQ1 and IBTSQ3 surveys (same as shown in Figures 14.6a and b respectively) for the age range 2–4 and 4–5. This Figure illustrates that the negative gradients for the IBTSQ1 survey consistently decrease for ages 4–5 compared to ages 2–4 to a greater extent than explained by natural mortality declining from 0.35 to 0.2, indicating that the IBTSQ1 survey observes more fish at age 5 than expected under assumptions of constant survey q- and F-at-age (the separable VPA indicates flat-topped selection for cod). The Figure also illustrates almost no overlap between the 50% bands for the two gradients in the case of the IBTSQ1 survey, but this is not the case for the IBTSQ3 survey (these bands overlap almost entirely)–although this may be caused by noisier survey data at the older ages for the IBTSQ3 survey, it may also indicate a difference in survey catchability at age 5 compared to younger ages in the IBTSQ1 survey data. It is therefore justifiable to relax the q-plateau assumption for the IBTSQ1 survey.

Figures 14.14a and b present retrospective plots for runs 3 and 4, and highlight the improved retrospective pattern of run 4 compared to run 3, particularly with regard to the estimation of the catch multiplier.

Sensitivity of run 4 to fixing the catch multiplier to 1 in the final year (run 5) and to fixing the catch multiplier to 1 for all years (i.e. not estimating it, run 6) is shown in Figure 14.15. Forcing the multiplier to equal 1 in the final year (run 6) results in a greater decline in F than estimated for run 4, but SSB and TSB trajectories are relatively insensitive to this–associated residuals (not shown) are negatively biased in the final year compared to run 4. Run 6 results in greater differences, with lower SSB and TSB levels estimated in recent years, but this is associated with residual trends (not shown).

14.3.4 Conclusions drawn from exploratory analyses

Conclusions related to the estimation of stock parameters

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 or around 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 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 1998, average recruitment has been lower than at any other time (see e.g. Figure 14.14b).

Mortality trends cannot be determined from the fit of the survey-only models. The B-Adapt model estimates indicate that the mortality rate remained high 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.

Conclusions related to the selection of a final run

Increasing the q-plateau to age 5 for IBTSQ1 both removes bias in the log-q residuals at age 5 and reduces retrospective bias, particularly for the estimated catch multiplier. The WG therefore considered run 4 as appropriate to take forward as the final assessment for cod.

14.3.5 Final assessment

Run 4 (Increase q-plateau for IBTSQ1) was accepted as the final assessment. The B-ADAPT model structure was fitted to landings data for the years 1963–2006 and ages 1–7+, adjusted for discarding as described in Section 14.2. Survey data used for tuning are the International Bottom Trawl Survey Q1 (1983–2007, ages 1–5) and Q3 (1991–2006, ages 1–4). Surviving population numbers at ages 1–5 were estimated in 2007 with fishing mortality at age 6 in all years calculated as the average of ages 3–5. Bias parameters (catch multipliers) were estimated in the years 1993–2006. A smoothing weight of 0.5 was applied to between-year residuals of the log-total landings in tonnes. No time series weighting was applied and survey residuals were given equal weight in the analysis. Survey catchability was assumed to be constant in time and independent of age for ages 1–5 for the IBTSQ1 survey, and 1–3 for the IBTSQ3 survey.

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 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 14.12b presents the time series of log catchability residuals from the fitted smoothed B-ADAPT model. Figure 14.16 presents the time series of B-ADAPT derived assessment estimates of the stock, recruitment, exploitation trends, catch, and the catch multipliers, together with estimates of precision represented by bootstrap percentiles.

Retrospective estimates of median fishing mortality, SSB, recruitment and the catch multiplier from the B-ADAPT bootstrap model are presented in Figure 14.14b.

14.4 Historic Stock Trends

The historic stock and fishery trends are presented in Figures 14.16 and Table 14.12.

Recruitment has fluctuated at a relatively low level since 1998. The 1996 year class was the last large year class that contributed to the fishery, and subsequent year classes have been the lowest in the time series apart from the 1999 and 2005 year classes. 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 2006 is estimated to be 0.75.

SSB declined steadily during the 1970’s and 80’s. There was a small increase in SSB following the recruitment of the 1995 and 1996 year classes, but with low recruitment abundance since 1998 and continued high mortality rates, SSB has continued to decline. SSB is estimated to have decreased in 2006 to 29 000t, the lowest level in the time series. In contrast, TSB estimates are showing slight increases in recent years as a result of the incoming 2005 year class. The 2005 year class has yet to mature and contribute to SSB.

The North Sea Fishers’ Survey has not yet been updated to reflect perceptions since mid-2006, so no comparisons are made between the stock trends observed from the assessment and the fishermen’s perception from the Fishers’ survey.

14.5 Recruitment estimates

Estimates of recruitment were sampled from the 1997–2005 year classes, reflecting recent low levels of recruitment, but including the stronger 1999 and 2005 year classes. These are only used for B-ADAPT medium term forecasts in order to evaluate future stock dynamics.

14.6 Short-term forecasts

Due to the uncertainty in the final year estimates of fishing mortality the WG agreed that a standard (deterministic) short-term forecast was not appropriate for this stock.

14.7 Medium-term forecasts

Stochastic projections were run carried out using each of 1000 non-parametric bootstrap iterations. Starting populations were taken from each bootstrap iteration, fishing mortalities were taken as a three year average scaled to the final year. Weights and mortalities were taken from the average of the final three years of assessment data. Recruitment was re-sampled from the 1997–2005 year-classes, seven years with low recruitment and two with the slightly higher levels (1999 and 2005 year classes). This is a conservative estimate to account for the possibility that the low levels estimated in the last few years may continue.

All the scenarios assume a 14% reduction in fishing mortality in 2007 to account for the reduction in TAC achieved in the 2006 EU-Norway agreement. The scenarios explored were:

1) a reduction in fishing mortality by 14% in 2007, followed by constant fishing mortality at the 2007 level for 2008 onwards;

2) a reduction in fishing mortality by 14% in 2007, followed by a further reduction of 15% in 2008 (relative to 2007), then held constant at the 2008 level for 2009 onwards;

3) a reduction in fishing mortality by 14% in 2007, followed by further reductions (relative to 2006) in fishing mortality for 2008 onwards of:

   a) 20%;

   b) 40%;

   c) 60%;

   d) 80%;

   e) 100%;

4) a reduction in fishing mortality by 14% in 2007, followed by a further reduction to the target fishing mortality of 0.4 for 2008 onwards.

Tables 14.13–14.20 present the results of the stochastic projections, while Table 14.21 summarises outcomes for all options in a single table for ease of comparison. For each scenario, the associated figures present fishing mortality, catch, SSB and recruitment. The 5th, 25th, median, 75th and 95th percentiles from the bootstrap distributions are plotted. Percentiles of fishing mortality, SSB and catch in 2006, 2007, 2008 and 2009 are tabulated with the probability that SSB in a year exceeds the SSB estimated for 2006 and the ratio of median SSB at the start of the year to the end of the year in order to quantify stock rebuilding.

In each of the stock projections SSB starts to increase following a historic low in 2006, due to a combination of lower fishing mortality and the 2005 year class starting to mature. Subsequent increases in SSB rely on the scale of the reduction in fishing mortality.

All options considered result both in a greater than 30% increase in SSB from 2007 to 2008, and a return of SSB to levels above Blim (70 000t) by 2009, with options 1 and 3a only just surpassing Blim in 2009:

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 000t.	Bpa	150 000t.
Flim:	0.86	Fpa	0.65

Technical basis:

Blim	Rounded Bloss. The lowest observed spawning stock biomass.
Bpa	The previously agreed MBAL and affords a high probability of maintaining SSB above Blim, 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 000t.
Flim	Floss
Fpa	Approx. 5th percentile of Floss

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. For 2006 only, Scottish discard sampling was used to raise all landings data apart from Danish landings, because Danish discard data were provided. It was not possible to use Danish discard data for earlier years, even though these were also provided, because of problems with data co-ordination and timing of the WG meeting for 2006.

The North Sea surveys have good consistency within and between the indices. The indication that SSB in 2006 is at or around a historical 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, which also confirm a higher 2005 year class compared to recent years.

The survey indices from IBTSQ1 and Q3 used in the stock assessment only include catch rates from the three most easterly rectangles of Skagerrak. More of the Skagerrak area should be considered for inclusion in the IBTS standard areas for abundance indices, in order to produce an unbiased abundance index for the management unit (IV, IIIaN and VIId) of cod. Any such review of the area coverage of IBTS should also include a consideration of the north westerly extent of the survey, west of Shetland, where good catches of cod are being reported.

The B-ADAPT model was developed to correct for retrospective bias by estimating the quantity of additional “unallocated removals” that would be required to be added or removed from the catch-at-age data in order to remove any persistent trends in survey catchability. The unallocated removals figures given by B-ADAPT could potentially include components due to increased natural mortality and discarding as well as misreported landings.

The estimates of bias can also be influenced by any trends in survey catchability or outlying values, particularly where the calibration period surveys are noisy at the oldest and youngest ages. For this reason, the bootstrap percentiles are used to provide stock and exploitation trends and the estimated values should not be over-interpreted.

Retrospective plots (Figure 14.14b) show a slight under-estimation of fishing mortality with the end points of each of the historic time series lying within the 5th and 95th percentiles shown in Figure 14.16. The perception of a decrease in mortality rates for the stock is robust to the period over which the model is fitted.

Values for natural mortality 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 MSVPA estimates of natural mortality are based on diet data from more than 15 years age. Due to the change in the stock distributions of both predator and prey species since this data was collected, the estimates of natural mortality from MSVPA are probably biased, and should not be used without additional sampling of diet data.

Similarly the estimated constant maturity ogive should be examined in order to investigate its relevance in the current low stock situation.

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 start to increase in 2007 due to lower fishing mortality levels and a higher 2005 year class relative to recent year classes.

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. Less than 2% of individuals at age 1 survive to age 5.

Recruitment of 1 year old cod has varied considerably since the 1960s, but since 1998, average recruitment has been lower than any other time. The 2005 year class is of higher abundance than the recent low levels (about the size of the 1999 year class), especially in the central and northern North Sea (Figures 14.4a and b). There have been indications of relatively larger numbers of 0–group cod in the south eastern North Sea and Skagerrak in 2006.

High rates of discarding in 2006 and 2007 could reduce the contribution that the 2005 year class makes to the catches and the stock in future years. The last substantial year class to enter the fishery was the 1996 year class. This year class was a prominent feature in all surveys, was heavily exploited and discarded by the fishery at ages 1–5, and disappeared relatively quickly from the fishery (Figure 14.9).

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 year class to the fishery may have no beneficial effect on the stock if it is caught and heavily discarded. In 2006, age 1 cod comprised 62% of the total catch by number. The last substantial year class to enter the fishery was the 1996 year class. This year class was a prominent feature in all surveys, was heavily exploited and discarded by the fishery at ages 1–5, and disappeared relatively quickly from the fishery. In the first half of 2007, reports from the industry indicate that there is an increased rate of high-grading and discarding of cod.

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, particularly using 120mm mesh. 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. Comparisons between the 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 2006 year class 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.

14.12 Cod

This section presents new information from the Q3 surveys and assesses whether there is any need to provide an update of the forecast conducted in May 2007, based on the new information.

14.12.1 Status of the Stock (repeated from WGNSSK 2007 May report)

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 start to increase in 2007 due to lower fishing mortality levels and a higher 2005 year class relative to recent year classes.

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. Less than 2% of individuals at age 1 survive to age 5.

Recruitment of 1-year-old cod has varied considerably since the 1960s, but since 1998, average recruitment has been lower than any other time. The 2005 year-class is of higher abundance than the recent low levels (about the size of the 1999 year class), especially in the central and northern North Sea. There have been indications of relatively larger numbers of 0-group cod in the south-eastern North Sea and Skagerrak in 2006.

High rates of discarding in 2006 and 2007 could reduce the contribution that the 2005 year-class makes to the catches and the stock in future years. The last substantial year class to enter the fishery was the 1996 year class. This year class was a prominent feature in all surveys, was heavily exploited and discarded by the fishery at ages 1-5, and disappeared relatively quickly from the fishery.

14.12.2 New information from the 3rd quarter surveys

The IBTS_Q3 index is now available, and together with the Scottish and English Q3 groundfish surveys (SCO_Q3 and ENG_Q3 respectively) have been used to analyse the 2007 estimates of age 1 (recruitment) and 2. Note that the SCO_Q3 and ENG_Q3 surveys are not included in the North Sea cod assessment on their own (only as part of the IBTS_Q3 survey), and therefore any update of the medium-term forecast (by re-running the stochastic B-Adapt program) will include only the IBTS_Q1 and IBTS_Q3 surveys. All four surveys are used here to assess whether an appropriate range of estimates for 2007 was considered when the medium-term forecast was conducted in May.

Survey results are shown in Figure 14.12.1 by year and cohort for the four surveys.

14.12.3 Comparison of new information to that used in May 2007

Figure 14.12.2 plots within-survey correlations between cohort ages 1 and 2 in order to assess the ability of each survey to detect cohort strength, for the two surveys used in the assessment: IBTS_Q1 and IBTS_Q3, and the two additional Q3 surveys considered here: SCO_Q3 and ENG_Q3. All four surveys show good performance in this regard. Figure 14.12.3 plots between survey correlations at age 1 to assess the consistency of data across surveys. There is good agreement between all surveys. On the basis of Figures 14.12.2 and 14.12.3, the use of the IBTS_Q3, SCO_Q3 and ENG_Q3 surveys, in order to assess whether an appropriate range of recruitment estimates for 2007 were considered in the medium-term forecast in May, is justified.

In order to compare the recruitment (age 1) estimates from the IBTS_Q3, SCO_Q3 and ENG_Q3 surveys with the recruitment estimates for 2007 used in the medium-term forecast, it was necessary to first calculate a catchability coefficient for estimates prior to 2007, which was done using the time series of recruitment estimates (medians) from the May assessment together with the estimates for the relevant survey, and the following equation:

$$q^{ind} = \exp\left(\frac{1}{(2006 - y^{ind} + 1)} \sum_{y=y^{ind}}^{2006} \left[\ln(I_{y,1}^{ind}) - \ln(N_{y,1}^{med}) \right] \right)$$

where *ind* indicates the survey (*ibts_q3*, *sco_q3* or *eng_q3*), y^{ind} the first year of the time-series (y^{ibts_q3} = 1991, y^{sco_q3} = 1982, y^{eng_q3} = 1992), $I_{y,1}^{ind}$ the index value at age 1 in year *y*, and $N_{y,1}^{med}$ the median of the assessment estimate at age 1 in year *y*.

Figure 14.12.4 plots a frequency distribution for the actual recruitment estimates at age 1 in 2007 used in the medium-term forecast in May (1000 values in total), together with the index values for 2007 from the IBTS_Q3, SCO_Q3 and ENG_Q3 surveys, adjusted for catchability (i.e. $I_{2007,1}^{ind} / q^{ind}$). Also included in Figure 14.12.4 for comparison is the index value for IBTS_Q1 (also adjusted for catchability, but because this index was used in the assessment, the catchability equation was as above, but included 2007).

In order to assess whether an appropriate range of values for age 2 in 2007 (i.e. the 2005 year-class) were used in the forecast, a similar plot as Figure 14.12.4 was obtained for age 2 in 2007, shown in Figure 14.12.5. The IBTS_Q3, SCO_Q3 and ENG_Q3 estimates are substantially higher than that for IBTS_Q1, lying towards the upper end of the distribution used in the forecast, indicating that either the 1995 year-class has had better survival than expected in 2007, or that the IBTS_Q1 survey underestimated this year class at age 2. Although the SCO_Q3 and ENG_Q3 estimates fall within the central part of the distribution shown in Figure 14.12.5 that contains 95% of the values used in the forecast, the IBTS_Q3 estimates falls outside the upper end of this range.

Figure 14.12.6 plots between-survey comparisons for age 2, which indicates that the IBTS_Q3, SCO_Q3 and ENG_Q3 surveys have yielded higher-than-expected results for the 2005 year-class when compared to the IBTS_Q1 survey (two top plots, and middle-left plot). Furthermore, Figure 14.12.2 indicates that the 2005 year-class at age 2 was slightly lower than expected for the IBTS_Q1 survey, and higher than expected for the IBTS_Q3 and ENG_Q3 surveys (much less so for the SCO_Q3 survey) when compared to age 1 of the same cohort within each survey. All these estimates are nevertheless within the confidence bounds in each case.

In order to investigate whether there is any indication of a drop in mortality on cod in recent years, Figure 14.12.7 plots log-catch curves for all four surveys considered here (left-hand column) and associated negative gradients over ages 2-4 (a proxy for total mortality on these ages in a cohort under the assumption that they are fully selected and survey catchability remains constant; right-hand column). A clear and consistent picture of total mortality trends is not apparent, although there is some indication of a drop in the most recent years (right plots), a pattern that the log-catch curves themselves seem to indicate may continue (left plots indicate shallower gradients for the most recent cohorts, which do not yet include age 4 and above, and therefore do not yet appear in the right-hand plots).

14.12.4 Is there a reason for changing the May 2007 advice

All the Q3 survey estimates of age 1 in 2007 lie well-within the range of recruitment estimates used in the medium-term forecast, and two (SCO_Q3 and ENG_Q3) are very similar to the IBTS_Q1 estimate already used in the forecast. The medium-term forecast therefore considers an appropriate range of values for recruitment in 2007. However, the 2007 age 2 estimates from the IBTS_Q3, SCO_Q3 and ENG_Q3 are towards the upper end of the values used in the forecast, the IBTS_Q3 falling outside the upper range that includes 95% of the values used in the forecast. This implies that the May medium-term forecast has yielded an underestimate of total removals and SSB. There is therefore a need to provide an update of the cod medium-term forecast.

14.12.5 Update assessment and forecast

The forecast and assessment for North Sea cod are bundled together, so that any addition of new data means that both the assessment and forecast are updated (the assessment model is refitted to include the new data, and the forecast relies on the new fit). An update assessment is therefore presented, with all settings kept unchanged compared to the May assessment. The only difference compared to May is the inclusion of 2007 estimates from the IBTS_Q3 survey.

Residual plots for the May final and September update assessments are shown in Figures 14.12.8a and b respectively, and are similar apart from minor changes to fits towards the end of each survey time series. Figures 14.12.9a and b show corresponding summary plots, the main changes for the update assessment being the lower F (2-4) estimate for 2006 (the median is now estimated to be below $\mathbf{F}_{pa}$), and the lower catch multiplier estimate for 2006 (the 95% probability interval now includes 1). The drop in the catch multiplier as a consequence of including an additional year of data for IBTS_Q3 was anticipated because single B-Adapt runs in May had demonstrated that the IBTS_Q3-based runs (which lacked the most recent data) did not show a drop in F to the same extent as the IBTS_Q1-based runs. The additional data have now made these surveys more consistent, and resulted in a lower estimate for the catch multiplier. The summary table is shown in Table 14.12.1.

The medium-term forecasts were re-run based on the updated assessment, and results are shown in Table 14.12.2. Short-term implications are shown in the following table (median values only are presented in this table.

Basis: $\mathbf{F}_{sq}$ = $\mathbf{F}_{04\text{-}06}$ scaled to $\mathbf{F}_{06}$ = 0.63; $\mathbf{F}_{07}$ = 0.54; R07-09 = re-sampled from 1997-2005 YC; SSB(2008) = 62.3; Removals (2007) = 60.7.

Rationale	Total Removals (2008)	Basis	F total (2008)	SSB (2009)	%SSB change
Zero Catch	0.0	F=0	0.00	167.4	+169%
Plan	62.4	$\mathbf{F}_{sq}$*0.635 (Plan)	0.40	112.6	+81%
Status quo options	22.2	$\mathbf{F}_{sq}$*0.2	0.13	147.8	+137%
	42.1	$\mathbf{F}_{sq}$*0.4	0.25	130.2	+109%
	59.6	$\mathbf{F}_{sq}$*0.6	0.38	115.0	+84%
	70.0	$\mathbf{F}_{sq}$*0.731	0.46	106.0	+70%
	75.2	$\mathbf{F}_{sq}$*0.8	0.50	101.4	+63%
	79.6	$\mathbf{F}_{sq}$*0.86 (=F_{07})	0.54	97.6	+57%

Weights in ‘000 t.

Total removal estimates in 2004-6: 56% are accounted for by official landings, 13% by discards, and 31% are unaccounted removals. For 2006-only these figures are 61%, 18% and 21% respectively.

Table 14.1. Nominal landings (in tonens) of COD in IIIa (Skagerrak), IV and VIId, 1987–2006 as officially reported to ICES, and as used by the Working Group.

Sub-area IV										
Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Belgium	6,693	5,508	3,398	2,934	2,331	3,356	3,374	2,648	4,827	3,458
Denmark	36,948	34,905	25,782	21,601	18,998	18,479	19,547	19,243	24,067	23,573
Faroe Islands	57	46	35	96	23	109	46	80	219	44
France	8,199	8,323	2,578	1,641	975	2,146	1,868	1,868	3,040	1,934
Greenland									9,457	8,344
Germany	8,230	7,707	11,430	11,725	7,278	8,446	6,800	5,974		
Netherlands	21,347	16,968	12,028	8,445	6,831	11,133	10,220	6,512	11,199	9,271
Norway	5,000	3,585	4,813	5,168	6,022	10,476	8,742	7,707	7,111	5,869
Poland	13	19	24	53	15	-	-	-	-	18
Sweden	688	367	501	620	784	823	646	630	709	617
UK (E/W/NI)	29,960	23,496	18,375	15,622	14,249	14,462	14,940	13,941	14,991	15,930
UK (Scotland)	49,671	41,382	31,480	31,120	29,060	28,677	28,197	28,854	35,848	35,349
United Kindom										
Total Nominal Catch	166,806	142,306	110,444	99,025	86,566	98,107	94,380	87,457	111,468	104,407
Unallocated landings	15,288	14,253	5,256	5,726	1,967	-758	10,200	7,066	8,555	2,161
WG estimate of total landings	**182,094**	**156,559**	**115,700**	**104,751**	**88,533**	**97,349**	**104,580**	**94,523**	**120,023**	**106,568**
Agreed TAC	**175,000**	**160,000**	**124,000**	**105,000**	**100,000**	**100,000**	**101,000**	**102,000**	**120,000**	**130,000**
	1.04	0.98	0.93	1.00	0.89	0.97	1.04	0.93		
Division VIId										
Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Belgium	815	486	173	237	182	187	157	228	377	321
Denmark	-	+	+	-	-	1	1	9	-	-
France	7,541	8,795	n/a	n/a	n/a	2,079	1,771	2,338	3,261	2,808
Netherlands	-	1	1	-	-	2	-	-	-	+
UK (E/W/NI)	1,044	867	562	420	341	443	530	312	336	414
UK (Scotland)	-	-	-	7	2	22	2	+	+	4
United Kingdom										
Total Nominal Catch	9,400	10,149	n/a	n/a	n/a	2,734	2,461	2,887	3,974	3,547
Unallocated landings	4,819	580	-	-	-	-65	-29	-37	-10	-44
WG estimate of total landings	**14,219**	**10,729**	**5,538**	**2,763**	**1,886**	**2,669**	**2,432**	**2,850**	**3,964**	**3,503**
Division IIIa (Skagerrak)										
Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Denmark	17,824	14,806	16,634	15,788	10,396	11,194	11,997	11,953	8,948	13,573
Sweden	1,924	1,648	1,902	1,694	1,579	2,436	2,574	1,821	2,658	2,208
Norway	152	392	256	143	72	270	75	60	169	265
Germany	-	-	12	110	12	-	-	301	200	203
Others	-	106	34	65	12	102	91	25	134	-
Norwegian coast *	838	769	888	846	854	923	909	760	846	748
Danish industrial by-catch *	491	1,103	428	687	953	1,360	511	666	749	676
Total Nominal Catch	19,900	16,952	18,838	17,800	12,071	14,002	14,737	14,160	12,109	16249
Unallocated landings	0	0	-141	0	-12	0	0	-899	0	0
WG estimate of total landings	**19,900**	**16,952**	**18,697**	**17,800**	**12,059**	**14,002**	**14,737**	**13,261**	**12,109**	**16,249**
Agreed TAC	**22,500**	**21,500**	**20,500**	**21,000**	**15,000**	**15,000**	**15,000**	**15,500**	**20,000**	**23,000**
Sub-area IV, Divisions VIId and IIIa (Skagerrak) combined										
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Total Nominal Catch	196,106	169,407	n/a	n/a	n/a	114,843	111,578	104,504	127,551	124,203
Unallocated landings	20,106	14,833	-	-	-	-823	10,171	6,130	8,545	2,117
WG estimate of total landings	**216,212**	**184,240**	**139,936**	**125,314**	**102,478**	**114,020**	**121,749**	**110,634**	**136,096**	**126,320**

* 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	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Norwegian coast *					854.00	923.00	909.00	760.00	846.00	748.00
Danish industrial by-catch					953.00	1,360.00	511.00	666.00	749.00	676.00
Total					**1,807.00**	**2,283.00**	**1,420.00**	**1,426.00**	**1,595.00**	**1,424.00**

Table 14.1. cont. Nominal landings (in tonens) of COD in IIIa (Skagerrak), IV and VIId, 1987–2006 as officially reported to ICES, and as used by the Working Group.

Sub-area IV

Country	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	4,642	5,799	3,882	3,304	2,470	2,616	1,482	1,615	1,715	1,316
Denmark	21,870	23,002	19,697	14,000	8,358	9,022	4,676	5,889	6,291	5,104
Faroe Islands	40	102	96		9	34	36		15	4
France	3,451	2,934	1,750	1,222	717	1,777	617		515	227
Germany	5,179	8,045	3,386	1,740	1,810	2,018	2,048	2,212	2,648	2,526
Greenland							1,352			
Netherlands	11,807	14,676	9,068	5,995	3,574	4,707	2,305	1,728	1,659	1,585
Norway	5,814	5,823	7,432	6,410	4,383	4,994	4,518	3,205	2,886	2,733
Poland	31	25	19	18	18	39	35			
Sweden	832	540	625	640	661	463	252	226	306	309
UK (E/W/NI)	13,413	17,745	10,344	6,543	4,087	3,112	2,213	1,889	1,364	
UK (Scotland)	32,344	35,633	23,017	21,009	15,640	15,416	7,852	6,644	6,667	
United Kindom										8341.1
Total Nominal Catch	99,423	114,324	79,316	60,881	41,727	44,198	27,386	23,408	24,065	22,144
Unallocated landings	2,746	7,779	-924	-1,114	-754	102	-1,539	141	-194	49
WG estimate of total landings	**102,169**	**122,103**	**78,392**	**59,767**	**40,973**	**44,300**	**25,847**	**23,549**	**23,870**	**22,193**
Agreed TAC	**115,000**	**140,000**	**132,400**	**81,000**	**48,600**	**49,300**	**27,300**	**27,300**	**27,300**	**23,205**

Division VIId

Country	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	310	239	172	110	93	51	54	47	50	80
Denmark	-	-	-	-	-	-				
France	6,387	7,788		3,084	1,677	1,361	1,127		467	668
Netherlands	-	19	3	4	17	6	36	14	9	9
UK (E/W/NI)	478	618	454	385	249	145	121	100	179	
UK (Scotland)	3	1	-	-	-	-				
United Kingdom										269.4
Total Nominal Catch	7,178	8,665	629	3,583	2,036	1,563	1,338	161	705	1,026
Unallocated landings	-135	-85	6,229	-1,258	-463	1,534	-104	646	328	101
WG estimate of total landings	**7,043**	**8,580**	**6,858**	**2,325**	**1,573**	**3,097**	**1,234**	**807**	**1033**	**1127**

Division IIIa (Skagerrak)

Country	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Denmark	12,164	12,340	8,734	7,683	5,901	5,526	3,071	3,039	3,613	3,054
Sweden	2,303	1608	1,909	1,350	1,035	1,716	509	495	824	688
Norway	348	303	345	301	134	146	193	133	120	101
Germany	81	16	54	9	32	83	-			82
Others	-	-	-	-	-	-	-			47
Norwegian coast *	911	976	788	624	846	n/a	n/a	720	759	524
Danish industrial by-catch *	205	97	62	99	687	n/a	n/a	10	18	9
Total Nominal Catch	14896	14267	11042	9343	7102	7471	3773	3667	4557	3972
Unallocated landings	50	1,064	-68	-66	-16	-3	18	120	-752	-606
WG estimate of total landings	**14,946**	**15,331**	**10,974**	**9,277**	**7,086**	**7,468**	**3,791**	**3,787**	**3,805**	**3,366**
Agreed TAC	**16,100**	**20,000**	**19,000**	**11,600**	**7,000**	**7,100**	**3,900**	**3,900**	**3,900**	**3,315**

Sub-area IV, Divisions VIId and IIIa (Skagerrak) combined

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2005
Total Nominal Catch	121,497	137,256	90,987	73,807	50,865	53,232	32,497	27,236	29,327	27,142
Unallocated landings	2,661	8,758	5,238	-2,438	-1,233	1,633	-1,625	907	-618	-457
WG estimate of total landings	**124,158**	**146,014**	**96,225**	**71,369**	**49,632**	**54,865**	**30,872**	**28,143**	**28,708**	**26,686**

* 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	1997	1998	1999	2000	2001	2002	2003	2003	2005	2005
Norwegian coast *	911.00	976.00	788.00	624.00	846.00	n/a	n/a	720	759	524
Danish industrial by-catch	205.00	97.00	62.00	99.00	687.00	n/a	n/a	10	18	9
Total	**1,116.00**	**1,073.00**	**850.00**	**723.00**	**1,533.00**	**0.00**	**0.00**	**730.00**	**777.00**	**533.00**

Table 14.2 Cod 347d: Landings numbers at age (Thousands).

Landings numbers at age (thousands)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	3214	5029	15813	18224	10803	5829	2947	54493	44824	3832	25966
2	42591	22486	51888	62516	70895	83836	22674	33917	155345	187686	31755
3	7030	20104	17645	29845	32693	42586	31578	18488	17219	48126	54931
4	3536	4306	9182	6184	11261	12392	13710	13339	6754	5682	14072
5	2788	1917	2387	3379	3271	6076	4565	6297	7101	2726	2206
6	1213	1818	950	1278	1974	1414	2895	1763	2700	3201	1109
7	81	599	658	477	888	870	588	961	893	1680	1060
8	492	118	298	370	355	309	422	209	458	612	489
9	14	94	51	126	138	151	147	186	228	390	80
10	6	12	75	56	40	111	46	98	77	113	58
+gp	0	4	8	83	17	24	78	40	94	18	162
TOTALNUM	60965	56486	98957	122538	132335	153600	79651	129791	235691	254064	131888
TONSLAND	116457	126041	181036	221336	252977	288368	200760	226124	328098	353976	239051
SOPCOF %	100	100	100	100	100	100	100	100	100	100	100

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	15562	33378	5724	75413	29731	34837	62605	20279	66777	25733	64751
2	58920	47143	100283	51118	175727	91697	104708	189007	65299	129632	66428
3	11404	18944	18574	25621	17258	44653	35056	34821	60411	21662	31276
4	15824	4663	6741	4615	9440	4035	12316	9019	9567	11900	4264
5	4624	7563	1741	2294	3003	3395	1965	4118	3476	2830	3436
6	961	2067	3071	836	1108	712	1273	785	2065	1258	1019
7	438	449	924	1144	410	398	495	604	428	595	437
8	395	196	131	371	405	140	197	134	236	181	244
9	332	229	67	263	153	158	74	65	78	90	60
10	81	95	63	26	36	42	55	37	27	28	45
+gp	189	63	43	96	44	17	25	21	16	23	20
TOTALNUM	108729	114791	137361	161797	237314	180085	218770	258889	208380	193932	171978
TONSLAND	214279	205245	234169	209154	297022	269973	293644	335497	303251	259287	228286
SOPCOF %	100	100	100	100	100	101	100	100	99	100	100

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	8845	100239	24915	21480	22239	11738	13466	27668	4783	15557	15717
2	118047	32437	128282	55330	36358	54290	23456	32059	55272	25279	63586
3	18995	34109	9800	43955	18193	11906	16776	8682	11360	21144	12943
4	7823	5814	8723	3134	9866	4339	3310	5007	3190	3083	5301
5	1377	2993	1534	2557	1002	2468	1390	1060	1577	870	802
6	1265	604	1075	655	1036	310	1053	491	435	519	286
7	373	556	235	295	251	310	225	329	204	142	151
8	173	171	215	66	140	54	139	52	108	58	42
9	79	69	55	63	27	60	28	40	18	32	15
10	16	44	48	23	31	12	4	17	10	7	13
+gp	31	23	12	18	10	9	10	9	13	16	5
TOTALNUM	157022	177058	174895	127577	89153	85496	59857	75415	76970	66706	98861
TONSLAND	214629	204053	216212	184240	139936	125314	102478	114020	121749	110634	136096
SOPCOF %	100	101	100	100	100	99	100	99	99	99	98

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	4938	23769	1255	5941	8294	2220	7192	400	1589	1502	2074
2	36805	29194	81737	9731	23033	20832	7870	9615	4083	8210	5102
3	23364	18646	16958	32224	6472	6200	13252	3511	4949	2865	4464
4	3169	6499	5967	4034	6697	1142	2519	2660	1965	1628	1019
5	1860	1238	2402	1446	1021	1080	366	449	988	474	472
6	399	700	509	626	385	144	349	66	150	392	152
7	162	153	236	223	139	84	51	49	43	44	117
8	88	47	41	91	40	27	31	13	23	11	22
9	43	14	16	14	18	14	13	7	8	8	4
10	4	15	4	10	5	6	5	3	3	2	2
+gp	8	10	12	2	1	1	0	1	0	0	0
TOTALNUM	70837	80285	109137	54342	46105	31750	31649	16774	13800	15135	13427
TONSLAND	126320	124158	146014	96225	71371	49694	54865	30872	28188	28708	26768
SOPCOF %	100	100	100	100	100	100	100	102	100	100	103

Table 14.3 Cod 347d: Discard numbers at age (Thousands).

Discards numbers at age (thousands)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	16231	8089	98414	108921	50467	31272	2515	53225	260226	38442	86349
2	20003	6199	6632	22236	24861	23073	10331	8700	37412	59641	17475
3	33	116	90	71	160	198	113	153	47	178	247
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0
TOTALNUM	36267	14404	105136	131229	75489	54542	12959	62078	297686	98261	104071
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	2006
1	14451	87308	15608	31550	37981	5600	13373	8511	11865	11290	26798
2	23376	13892	91140	5737	5650	33946	2622	9976	4661	5673	5575
3	774	41	1514	8437	0	773	1972	1118	1158	108	805
4	0	0	0	0	0	0	0	69	0	19	53
5	0	0	0	0	0	0	0	11	0	4	12
6	0	0	0	0	0	0	0	2	0	3	2
7	0	0	0	0	0	0	0	1	0	0	1
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0
TOTALNUM	38601	101241	108262	45725	43631	40319	17967	19688	17684	17097	33247
TONSLAND	14255	33616	40480	14180	13713	13871	5706	6372	5849	6272	8075
SOPCOF %	100	100	100	102	100	100	100	101	102	103	102

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	0.590	0.640	0.544	0.626	0.579	0.616	0.559
2	1.004	0.863	0.965	0.994	1.035	0.973	0.921	0.961	0.941	0.836	0.869
3	2.657	2.377	2.304	2.442	2.404	2.223	2.133	2.041	2.193	2.086	1.919
4	4.491	4.528	4.512	4.169	3.153	4.094	3.852	4.001	4.258	3.968	3.776
5	6.794	6.447	7.274	7.027	6.803	5.341	5.715	6.131	6.528	6.011	5.488
6	9.409	8.520	9.498	9.599	9.610	8.020	6.722	7.945	8.646	8.246	7.453
7	11.562	10.606	11.898	11.766	12.033	8.581	9.262	9.953	10.356	9.766	9.019
8	11.942	10.758	12.041	11.968	12.481	10.162	9.749	10.131	11.219	10.228	9.810
9	13.383	12.340	13.053	14.060	13.589	10.720	10.384	11.919	12.881	11.875	11.077
10	13.756	12.540	14.441	14.746	14.271	12.497	12.743	12.554	13.147	12.530	12.359
+gp	0.000	18.000	15.667	15.672	19.016	11.595	11.175	14.367	15.544	14.350	12.886

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.594	0.619	0.568	0.541	0.573	0.550	0.550	0.723	0.589	0.632	0.594
2	1.039	0.899	1.029	0.948	0.937	0.936	1.003	0.837	0.962	0.919	1.007
3	2.217	2.348	2.470	2.160	2.001	2.411	1.948	2.190	1.858	1.835	2.156
4	4.156	4.226	4.577	4.606	4.146	4.423	4.401	4.615	4.130	3.880	3.972
5	6.174	6.404	6.494	6.714	6.530	6.579	6.109	7.045	6.785	6.491	6.190
6	8.333	8.691	8.620	8.828	8.667	8.474	9.120	8.884	8.903	8.423	8.362
7	9.889	10.107	10.132	10.071	9.685	10.637	9.550	9.933	10.398	9.848	10.317
8	10.791	10.910	11.340	11.052	11.099	11.550	11.867	11.519	12.500	11.837	11.352
9	12.175	12.339	12.888	11.824	12.427	13.057	12.782	13.338	13.469	12.797	13.505
10	12.425	12.976	14.139	13.134	12.778	14.148	14.081	14.897	12.890	12.562	13.408
+gp	13.731	14.431	14.760	14.362	13.981	15.478	15.392	18.784	14.608	14.426	13.472

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.590	0.583	0.635	0.585	0.673	0.737	0.670	0.699	0.699	0.677	0.721
2	0.932	0.856	0.976	0.881	1.052	0.976	1.078	1.146	1.065	1.075	1.021
3	2.141	1.834	1.955	1.982	1.846	2.176	2.038	2.546	2.479	2.201	2.210
4	4.164	3.504	3.650	3.187	3.585	3.791	3.971	4.223	4.551	4.471	4.293
5	6.324	6.230	6.052	5.992	5.273	5.931	6.082	6.247	6.540	7.167	7.220
6	8.430	8.140	8.307	7.914	7.921	7.890	8.033	8.483	8.094	8.436	8.980
7	10.362	9.896	10.243	9.764	9.724	10.235	9.545	10.101	9.641	9.537	10.282
8	12.074	11.940	11.461	12.127	11.212	10.923	10.948	10.482	10.734	10.323	11.743
9	13.072	12.951	12.447	14.242	12.586	12.803	13.481	11.849	12.329	12.223	13.107
10	14.443	13.859	18.691	17.787	15.557	15.525	13.171	13.904	13.443	14.247	12.052
+gp	16.588	14.707	16.604	16.477	14.695	23.234	14.989	15.794	13.961	12.523	13.954

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.699	0.656	0.542	0.640	0.611	0.725	0.758	0.608	0.700	0.828	0.710
2	1.117	0.960	0.922	0.935	1.021	1.004	1.082	1.174	0.997	1.190	1.134
3	2.147	2.120	1.724	1.663	1.747	2.303	1.916	1.849	2.014	1.978	2.192
4	4.034	3.821	3.495	3.305	3.216	3.663	3.857	3.256	3.096	3.690	3.731
5	6.637	6.228	5.387	5.726	4.903	5.871	5.372	5.186	5.172	5.060	5.660
6	8.494	8.394	7.563	7.403	7.488	7.333	7.991	7.395	7.426	7.551	6.882
7	9.729	9.979	9.628	8.582	9.636	9.264	9.627	8.703	8.675	9.607	8.896
8	11.080	11.424	10.643	10.365	10.671	10.081	10.403	12.178	9.797	11.229	10.640
9	12.264	12.300	11.499	11.600	10.894	12.062	10.963	12.846	11.684	11.501	12.217
10	12.756	12.761	13.085	12.330	11.414	12.009	12.816	10.771	13.058	13.333	9.223
+gp	11.304	13.416	14.921	11.926	15.078	10.196	11.842	17.494	14.140	15.340	10.773

Table 14.5 Cod 347d: Discard weights at age (kg).

Discards weights at age (kg)

AGE/YEAF	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.270	0.270	0.269	0.269	0.269	0.269	0.268	0.268	0.268	0.268	0.268
2	0.393	0.393	0.392	0.392	0.392	0.392	0.392	0.392	0.392	0.392	0.392
3	0.505	0.508	0.506	0.509	0.506	0.505	0.504	0.505	0.508	0.507	0.507
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
+gp	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

AGE/YEAF	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.268	0.227	0.189	0.255	0.287	0.276	0.242	0.279	0.274	0.297	0.270
2	0.392	0.359	0.354	0.382	0.309	0.361	0.411	0.396	0.489	0.458	0.469
3	0.508	0.000	0.412	0.376	0.000	0.000	0.000	0.517	0.593	0.534	0.509
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
+gp	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

AGE/YEAF	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.276	0.242	0.237	0.300	0.326	0.260	0.315	0.314	0.274	0.287	0.316
2	0.376	0.365	0.353	0.339	0.431	0.371	0.366	0.408	0.429	0.362	0.404
3	0.652	0.437	0.000	0.463	0.484	0.526	0.395	2.309	0.705	0.483	0.553
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
+gp	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

AGE/YEAF	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.342	0.313	0.358	0.257	0.298	0.232	0.294	0.259	0.293	0.284	0.179
2	0.380	0.453	0.375	0.389	0.422	0.361	0.420	0.344	0.384	0.468	0.426
3	0.515	0.616	0.481	0.422	0.000	0.406	0.340	0.540	0.427	1.084	0.751
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.675	0.000	4.099	1.301
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.272	0.000	4.501	2.863
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.849	0.000	8.197	4.663
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.585	0.000	0.000	10.895
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.033	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
+gp	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.771	0.000	0.000	0.000

Table 14.6 Cod 347d: Catch and stock weights at age (kg).

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	0.300	0.335
2	0.808	0.762	0.900	0.836	0.868	0.847	0.755	0.845	0.834	0.729	0.700
3	2.647	2.367	2.295	2.437	2.395	2.215	2.127	2.028	2.188	2.080	1.912
4	4.491	4.528	4.512	4.169	3.153	4.094	3.852	4.001	4.258	3.968	3.776
5	6.794	6.447	7.274	7.027	6.803	5.341	5.715	6.131	6.528	6.011	5.488
6	9.409	8.520	9.498	9.599	9.610	8.020	6.722	7.945	8.646	8.246	7.453
7	11.562	10.606	11.898	11.766	12.033	8.581	9.262	9.953	10.356	9.766	9.019
8	11.942	10.758	12.041	11.968	12.481	10.162	9.749	10.131	11.219	10.228	9.810
9	13.383	12.340	13.053	14.060	13.589	10.720	10.384	11.919	12.881	11.875	11.077
10	13.756	12.540	14.441	14.746	14.271	12.497	12.743	12.554	13.147	12.530	12.359
+gp	0.000	18.000	15.667	15.672	19.016	11.595	11.175	14.367	15.544	14.350	12.886

AGE/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	0.760	0.722	0.673	0.743	0.905	0.917	0.769	0.908	0.882	0.921
3	2.206	2.348	2.449	2.128	2.001	2.411	1.948	2.186	1.856	1.833	2.156
4	4.156	4.226	4.577	4.606	4.146	4.423	4.401	4.615	4.130	3.880	3.972
5	6.174	6.404	6.494	6.714	6.530	6.579	6.109	7.045	6.785	6.491	6.190
6	8.333	8.691	8.620	8.828	8.667	8.474	9.120	8.884	8.903	8.423	8.362
7	9.889	10.107	10.132	10.071	9.685	10.637	9.550	9.933	10.398	9.848	10.317
8	10.791	10.910	11.340	11.052	11.099	11.550	11.867	11.519	12.500	11.837	11.352
9	12.175	12.339	12.888	11.824	12.427	13.057	12.782	13.338	13.469	12.797	13.505
10	12.425	12.976	14.139	13.134	12.778	14.148	14.081	14.897	12.890	12.562	13.408
+gp	13.731	14.431	14.760	14.362	13.981	15.478	15.392	18.784	14.608	14.426	13.472

AGE/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	0.420
2	0.800	0.782	0.773	0.753	0.931	0.690	0.889	0.970	0.845	0.788	0.768
3	2.132	1.822	1.955	1.974	1.810	2.165	1.994	2.545	2.478	2.188	2.207
4	4.164	3.504	3.650	3.187	3.585	3.791	3.971	4.223	4.551	4.471	4.293
5	6.324	6.230	6.052	5.992	5.273	5.931	6.082	6.247	6.540	7.167	7.220
6	8.430	8.140	8.307	7.914	7.921	7.890	8.033	8.483	8.094	8.436	8.980
7	10.362	9.896	10.243	9.764	9.724	10.235	9.545	10.101	9.641	9.537	10.282
8	12.074	11.940	11.461	12.127	11.212	10.923	10.948	10.482	10.734	10.323	11.743
9	13.072	12.951	12.447	14.242	12.586	12.803	13.481	11.849	12.329	12.223	13.107
10	14.443	13.859	18.691	17.787	15.557	15.525	13.171	13.904	13.443	14.247	12.052
+gp	16.588	14.707	16.604	16.477	14.695	23.234	14.989	15.794	13.961	12.523	13.954

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.433	0.386	0.372	0.317	0.354	0.372	0.456	0.275	0.341	0.348	0.217
2	0.831	0.797	0.633	0.732	0.903	0.605	0.916	0.752	0.671	0.895	0.764
3	2.095	2.117	1.622	1.405	1.747	2.093	1.712	1.533	1.713	1.945	1.972
4	4.034	3.821	3.495	3.305	3.216	3.663	3.857	3.191	3.096	3.695	3.610
5	6.637	6.228	5.387	5.726	4.903	5.871	5.372	5.113	5.172	5.055	5.590
6	8.494	8.394	7.563	7.403	7.488	7.333	7.991	7.270	7.426	7.555	6.849
7	9.729	9.979	9.628	8.582	9.636	9.264	9.627	8.630	8.675	9.607	8.911
8	11.080	11.424	10.643	10.365	10.671	10.081	10.403	12.056	9.797	11.229	10.640
9	12.264	12.300	11.499	11.600	10.894	12.062	10.963	12.846	11.684	11.501	12.217
10	12.756	12.761	13.085	12.330	11.414	12.009	12.816	10.771	13.058	13.333	9.223
+gp	11.304	13.416	14.921	11.926	15.078	10.196	11.842	17.351	14.140	15.340	10.773

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 14.8 Cod 347d: Survey tuning cpue. Data used in the assessment are highlighted in bold text.

North Sea/Skagerrak/Eastern Channel Cod, Tuning data.
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IBTS_Q1, 6 is a plusgroup

1983	2007							
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	**6.74**	**1.985**	**1.288**	**0.347**	**0.432**	0.224		2004
1	**2.272**	**2.197**	**0.629**	**0.551**	**0.227**	0.424		2005
1	**6.642**	**1.644**	**0.994**	**0.293**	**0.152**	0.27		2006
1	**3.091**	**5.83**	**1.222**	**0.423**	**0.261**	0.286		2007

IBTS_Q3, 6 is a plusgroup

1991	2006							
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
1	7.329	**15.215**	**1.89**	**1.252**	**0.219**	0.044	0.059	2006

Table 14.9a Cod 347d: B-ADAPT tuning model specification.

Lowestoft VPA Program
6/05/2007 9:33
Adapt Analysis
North Sea/Skagerrak Tuning data. INCLUDES DISCARDS

CPUE data from file Cod347_2007.tun

Catch data for 44 years : 1963 to 2006. Ages 1 to 7+

Fleet	First year	Last year	First age	Last age	Alpha	Beta
IBTS_Q1	1983	2007	1	5	0	0.25
IBTS_Q3	1991	2006	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	1	5
IBTS_Q3	1	3

Catchability independent of stock size for all ages

Bias estimation : Bias estimated for the final 14 years.
Oldest age F estimates in 1963 to 2007 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 =	31.86941	SSQ =	23.58338	IFAIL =	0
PARAMETERS =	19	QSSQ =	22.85937	IFAILCV = 0	
OBSERVATIONS =	203	CSSQ =	0.724		

Table 14.9b Cod 347d: B-ADAPT IBTSQ1 tuning diagnostics.

Fleet : IBTS_Q1

Log index residuals

Age	1983	1984	1985	1986	1987
1	-0.49	-0.42	-1.6	-0.51	0.37
2	0.1	0.01	0.14	-0.21	0.36
3	-0.05	-0.15	0.08	0.35	-0.04
4	-0.18	0.01	0.01	0.71	0.05
5	-0.14	-0.16	-0.01	0.27	0.18

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.26	0.29	0.07	-0.68	0.21	0.95	-0.23	0.16	-0.31	0.91
2	-0.25	0.18	0.44	0.15	-0.21	0.54	-0.34	0.32	-0.18	0.09
3	0.03	0.64	0.01	0.44	-0.31	-0.01	-0.25	0.03	0.24	-0.28
4	0.06	0.23	0.15	0.19	-0.08	-0.04	0.13	-0.33	-0.26	-0.24
5	0.01	0.25	0.09	-0.11	-0.32	-0.02	0.39	-0.42	-0.18	0.09

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	0.26	-0.54	0.03	0.33	0.71	-1.03	0.97	0.12	0.17	99.99
2	0.28	-0.46	-0.03	0.08	0.15	-0.47	0.08	-0.41	-0.35	-0.23
3	-0.3	0.36	-0.25	0.15	0.27	-0.29	0.01	-0.36	-0.31	0.12
4	-0.24	-0.03	0.57	-0.16	-0.25	0.19	-0.35	0.12	-0.25	-0.36
5	-0.33	-0.02	0.39	0	-0.21	0.67	-0.14	-0.06	-0.2	0.15

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	-10.7761	-9.4904	-9.2006	-8.9748	-8.5432
S.E(Log q)	0.6247	0.2901	0.2755	0.266	0.258

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	1.04	-0.237	10.7	0.61	24	0.66393	-10.78
2	0.81	3.251	9.87	0.93	24	0.19812	-9.49
3	0.81	2.482	9.4	0.89	24	0.20227	-9.2
4	0.91	0.899	8.98	0.83	24	0.24399	-8.97
5	1.07	-0.68	8.59	0.79	24	0.28068	-8.54

Table 14.9c Cod 347d: B-ADAPT IBTSQ3 tuning diagnostics.

Fleet : IBTS_Q3

Log index residuals

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	99.99	99.99	99.99	-0.31	0.59	-0.15	0.13	0.12	-0.15	0.41
2	99.99	99.99	99.99	-0.18	-0.07	0.08	0.26	0.56	-0.13	0.11
3	99.99	99.99	99.99	-0.24	-0.25	-0.18	0.15	0.11	-0.15	0.03
4	99.99	99.99	99.99	-0.69	-0.08	-0.48	-0.47	0.11	0.04	0.02
5	No data for this fleet at this age									

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	-0.73	0.37	-0.38	-0.1	0.19	-0.76	0.65	0.02	0.1	99.99
2	0.47	-0.63	-0.15	-0.07	-0.17	-0.09	0.13	-0.16	0.04	99.99
3	0.02	0.57	-0.73	-0.06	-0.07	-0.36	0.45	0.22	0.48	99.99
4	-0.14	0.02	0.25	0.17	0.53	0.06	-0.07	0.15	0.17	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	-9.3597	-9.2019	-9.2308	-9.2308
S.E(Log q)	0.4125	0.2811	0.3349	0.306

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	0.8	1.852	9.97	0.86	16	0.30724	-9.36
2	0.8	3.007	9.62	0.94	16	0.18192	-9.2
3	0.88	0.873	9.34	0.79	16	0.29742	-9.23
4	1.04	-0.237	9.27	0.7	16	0.32783	-9.26

Table 14.9d Cod 347d: B-ADAPT parameter estimates.

Parameters

Age	Survivors	s.e log est
1	109041	0.23
2	12034	0.25
3	5277	0.26
4	1333	0.25
5	293	0.85

Year	Multiplier	s.e log est
1993	1.24	0.19
1994	1.01	0.22
1995	1.44	0.20
1996	1.48	0.19
1997	1.00	0.22
1998	1.10	0.19
1999	1.25	0.19
2000	1.15	0.19
2001	1.08	0.22
2002	1.44	0.20
2003	2.36	0.18
2004	1.27	0.23
2005	1.81	0.20
2006	1.45	0.28

Variance covariance matrix

0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
0.00	0.06	0.01	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.0
0.00	0.01	0.07	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.0
0.00	0.01	0.01	0.06	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
0.00	0.03	0.04	0.02	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.0
0.00	0.00	0.00	0.01	0.00	0.04	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.0
0.00	0.00	0.00	0.00	0.00	0.00	0.05	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
0.00	0.00	0.00	0.00	0.00	0.01	0.00	-0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.05	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.0
0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	-0.01	0.03	-0.01	0.00	0.00	0.00	0.00	0.00	0.0
0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.0
0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.0
0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	-0.01	0.00	0.00	0.0
0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.0
0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.03	0.00	0.0
0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	-0.0
0.00	0.00	0.00	0.00	-0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.0
0.00	-0.02	-0.02	-0.01	-0.11	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

Table 14.10 Cod 347d: B-ADAPT median fishing mortality at age.

At 6/05/2007 9:33

Table 8 Fishing mortality (F) at age

AGE\YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	0.1307	0.0487	0.3157	0.2953	0.1554	0.2259	0.0352	0.1817	0.3671	0.2552
2	0.7065	0.4656	0.5105	0.6941	0.6354	0.7478	0.5262	0.6908	1.0117	1.0478
3	0.3951	0.6023	0.6849	0.6194	0.7507	0.7724	0.5983	0.7531	0.7932	0.9151
4	0.5009	0.4628	0.6372	0.5655	0.5215	0.7559	0.6358	0.5680	0.7178	0.6965
5	0.4232	0.5623	0.5077	0.5131	0.6741	0.5989	0.7104	0.6892	0.6858	0.7289
6	0.4397	0.5425	0.6099	0.5660	0.6488	0.7091	0.6482	0.6701	0.7323	0.7802
+gp	0.4397	0.5425	0.6099	0.5660	0.6488	0.7091	0.6482	0.6701	0.7323	0.7802
FBAR 2- 4	0.5342	0.5102	0.6109	0.6263	0.6359	0.7587	0.5868	0.6706	0.8409	0.8865

AGE\YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.4107	0.5415	0.3245	0.6564	0.6161	0.1740	0.9836	1.0840	0.6057	0.5075
2	0.9380	0.9533	0.9049	1.3386	1.2759	1.2662	0.8271	0.9735	1.0755	1.0105
3	0.8348	0.6865	0.8023	0.9001	0.8020	0.9601	0.9553	0.9979	1.0208	1.2422
4	0.7979	0.6386	0.7011	0.8003	0.6047	0.8200	0.6475	0.8128	0.8122	0.9501
5	0.6496	0.6751	0.7361	0.6233	0.7142	1.0656	0.8167	0.7775	0.7194	0.8892
6	0.7608	0.6668	0.7465	0.7746	0.7070	0.9485	0.8065	0.8627	0.8508	1.0271
+gp	0.7608	0.6668	0.7465	0.7746	0.7070	0.9485	0.8065	0.8627	0.8508	1.0271
FBAR 2- 4	0.8569	0.7595	0.8028	1.0130	0.8942	1.0154	0.8099	0.9281	0.9695	1.0676

AGE\YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.3169	0.8906	0.5052	0.8302	0.2237	0.2529	0.5747	0.3834	0.3893	0.3847
2	1.1285	1.0575	1.1502	0.9997	1.1579	1.0634	0.9957	1.2913	0.8913	0.8940
3	1.1985	1.0094	0.9709	1.0682	0.9204	1.1752	1.0980	0.9648	0.9351	0.7637
4	0.9494	0.8589	0.8001	0.9885	0.9435	0.9354	0.9984	0.8823	0.8340	0.8360
5	0.8531	0.8205	0.7708	0.8493	0.7886	0.8274	0.9280	0.7459	0.8094	0.7140
6	1.0004	0.8963	0.8473	0.9686	0.8842	0.9793	1.0081	0.8643	0.8595	0.7714
+gp	1.0004	0.8963	0.8473	0.9686	0.8842	0.9793	1.0081	0.8643	0.8595	0.7714
FBAR 2- 4	1.0922	0.9753	0.9737	1.0188	1.0073	1.0580	1.0307	1.0461	0.8868	0.8312

AGE\YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.2880	0.6199	0.3017	0.1678	0.2382	0.2419	0.4008	0.2333	0.1377	0.2282
2	1.1130	0.7631	1.1479	1.0884	0.8403	1.0798	0.8776	0.9504	0.9156	0.5210
3	1.0704	0.8560	1.0583	1.2052	1.0456	1.1210	1.5976	1.2454	0.8300	1.0275
4	1.0618	0.7666	0.8733	0.9577	0.9668	1.0572	1.3203	1.3321	0.9003	1.0898
5	0.9757	0.7228	0.7013	1.0072	0.9137	1.0424	1.2613	1.4196	0.9003	1.0415
6	1.0358	0.7818	0.8772	1.0565	0.9751	1.0737	1.3927	1.3324	0.8770	1.0532
+gp	1.0358	0.7818	0.8772	1.0565	0.9751	1.0737	1.3927	1.3324	0.8770	1.0532
FBAR 2- 4	1.0817	0.7953	1.0265	1.0837	0.9509	1.0860	1.2652	1.1760	0.8820	0.8794

AGE\YEAR	2003	2004	2005	2006
1	0.3419	0.2516	0.306	0.226
2	1.1271	0.7747	0.753	0.731
3	0.9925	1.0847	0.782	0.825
4	0.9875	1.1213	1.089	0.715
5	1.1428	0.8140	0.951	1.181
6	1.0396	1.0059	0.939	0.907
+gp	1.0396	1.0059	0.939	0.907
FBAR 2- 4	1.0357	0.9936	0.874	0.757

Table 14.11 Cod 347d: B-ADAPT median population numbers at age.

At 6/05/2007 9:33

Table 10 Stock number at age (start of year) Numbers*10**-3

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	228540	399440	600419	708510	612282	262675	228851	930946	1407998	268138
2	143487	90105	170946	196744	236947	235526	94166	99272	348820	438245
3	24260	49885	39859	72302	69256	88447	78577	39207	35061	89377
4	9821	12727	21273	15650	30311	25460	31816	33643	14379	12353
5	8853	4873	6560	9209	7278	14731	9789	13793	15608	5743
6	3734	4747	2274	3232	4514	3037	6626	3939	5669	6436
+gp	1823	2157	2608	2812	3289	3146	2932	3339	3673	5654
TOTAL	420520	563935	843939	1008461	963876	633023	452759	1124139	1831208	825947

AGE/YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	471634	470721	876157	675946	1668609	528504	1350157	2566638	544676	883775
2	93345	140541	123065	284582	157542	404910	199542	226882	390097	133547
3	108306	25746	38174	35087	52583	30994	80438	61496	60395	93776
4	27877	36604	10092	13327	11109	18365	9242	24099	17657	16947
5	5040	10277	15824	4098	4901	4968	6622	3960	8753	6417
6	2269	2155	4283	6206	1799	1965	1401	2396	1490	3490
+gp	3782	3216	2139	2481	4090	1858	1484	1595	1634	1327
TOTAL	712252	689260	1069735	1021728	1900634	991563	1648886	2887066	1024701	1139278

AGE/YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	425491	1409442	256980	1626330	354533	236225	641956	204363	270446	585641
2	239055	139261	259928	69670	318581	127365	82422	162353	62581	82365
3	34259	54497	34085	57986	18067	70527	30990	21458	31453	18092
4	21089	8048	15468	10054	15519	5605	16958	8050	6368	9620
5	5366	6681	2791	5690	3063	4946	1801	5116	2728	2265
6	2159	1872	2408	1057	1993	1140	1770	583	1987	994
+gp	1573	1478	1278	1511	1047	809	784	837	766	907
TOTAL	728991	1621279	572939	1772298	712802	446617	776682	402761	376327	699884

AGE/YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	274374	1030953	458718	260259	843142	110817	204289	359678	105803	198223
2	179051	92103	247574	152056	98654	297856	38893	61292	128093	41425
3	23728	41320	30078	55282	35901	29975	71005	11371	16657	36012
4	6562	6294	13531	8130	12814	9811	7569	11157	2541	5646
5	3412	1844	2376	4631	2533	3980	2773	1650	2403	842
6	907	1046	728	964	1373	830	1141	641	326	797
+gp	737	512	573	736	471	504	620	338	300	232
TOTAL	488771	1174072	753579	482057	994888	453774	326291	446128	256122	283176

AGE/YEAR	2003	2004	2005	2006	2007
1	93349	136512	107475	301881	141330
2	70893	29678	47454	35605	109313
3	17328	16082	9568	15704	11960
4	10038	4988	4210	3397	5281
5	1559	3052	1319	1147	1355
6	244	404	1094	417	285
+gp	263	208	182	392	268
TOTAL	193674	190925	171303	358545	269792

Table 14.12.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. September update median stock and management metrics.

Run title: North Sea/Skagerrak/Eastern Channel Cod
Tuning data. INCLUDES DISCARDS
At 1/10/2007 12:02

B-ADAPT median values

	RECRUITS Age 1 ('000)	TSB (tons)	SSB (tons)	CATCH (tons)	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	1409447	779630	125187	379974	3.035	0.975
1985	256979	478359	118027	247031	2.093	0.974
1986	1626329	732363	109156	341047	3.124	1.019
1987	354530	540578	101932	244809	2.402	1.007
1988	236220	410917	92695	194798	2.102	1.058
1989	641944	459317	87467	202639	2.317	1.031
1990	204371	311267	75954	153021	2.015	1.046
1991	270410	290224	72173	121204	1.679	0.887
1992	585735	430043	72222	151755	2.101	0.832
1993	275172	367341	74645	178447	2.391	1.080
1994	1035248	534321	70530	212460	3.012	0.802
1995	457388	539814	90757	233656	2.575	1.030
1996	259189	431677	96414	204140	2.117	1.087
1997	840465	559737	84646	175474	2.073	0.947
1998	110224	345744	72177	185388	2.569	1.096
1999	202799	246784	67860	138560	2.042	1.272
2000	359295	253098	45517	94982	2.087	1.174
2001	105635	180218	35398	76935	2.173	0.882
2002	196850	223504	42759	82218	1.923	0.874
2003	92257	148999	39914	77322	1.937	1.037
2004	134210	129581	35987	54385	1.511	1.021
2005	111368	129845	31432	52502	1.670	0.873
2006	332785	156429	28481	43856	1.540	0.630
2007			37193			

Table 14.12.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. September update median term forecast summary, ordered by size of F-multiplier assumed for 2008-9.

	2006	2007	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
F2006 mult	1.000	0.860	0.860	0.860	0.800	0.800	0.731	0.731	0.635	0.635	0.600	0.600	0.400	0.400	0.200	0.200	0.000	0.000

Fbar(2-4)		Year																		
Percentile	2006	2007	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
0.05	0.47	0.40	0.40	0.40	0.37	0.37	0.34	0.34	0.30	0.30	0.28	0.28	0.19	0.19	0.09	0.09	0.00	0.00
0.25	0.56	0.48	0.48	0.48	0.45	0.45	0.41	0.41	0.35	0.35	0.33	0.33	0.22	0.22	0.11	0.11	0.00	0.00
0.5	0.63	0.54	0.54	0.54	0.50	0.50	0.46	0.46	0.40	0.40	0.38	0.38	0.25	0.25	0.13	0.13	0.00	0.00
0.75	0.71	0.61	0.61	0.61	0.57	0.57	0.52	0.52	0.45	0.45	0.43	0.43	0.28	0.28	0.14	0.14	0.00	0.00
0.95	0.82	0.70	0.70	0.70	0.65	0.65	0.60	0.60	0.52	0.52	0.49	0.49	0.33	0.33	0.16	0.16	0.00	0.00

SSB		Year																		
Percentile	2006	2007	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
0.05	23871	30960	48216	68282	48216	71179	48216	74847	48216	80169	48216	82197	48216	94804	48216	109943	48216	127806
0.25	26421	34507	56121	84273	56121	88187	56121	92037	56121	98182	56121	100518	56121	114366	56121	131102	56121	148973
0.5	28479	37191	62327	97563	62327	101407	62327	105966	62327	112606	62327	114991	62327	130232	62327	147775	62327	167406
0.75	30515	40014	68217	111144	68217	114949	68217	119639	68217	126352	68217	128872	68217	145880	68217	164615	68217	186404
0.95	33754	44320	77389	135118	77389	139563	77389	144349	77389	151722	77389	154505	77389	172140	77389	193693	77389	217543

Removals		Year																		
Percentile	2006	2007	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
0.05	30667	44503	59061	66836	55614	64705	51624	62407	45796	58265	43669	56673	30580	44059	16202	25453	0	0
0.25	38064	53710	71267	79259	67324	77173	62652	74609	55773	69912	53206	67972	37406	53490	19706	31422	0	0
0.5	43855	60673	79566	91011	75200	88415	69961	85319	62407	80072	59585	77773	42052	60911	22244	35960	0	0
0.75	50001	69091	90735	105844	85737	103038	79712	99417	71147	93219	67873	90442	47950	70918	25535	42272	0	0
0.95	60869	81869	112409	128645	106425	126169	99097	122612	88524	115872	84400	112898	59834	89794	31699	53718	0	0

P(SSBYear > SSB 2006)																				
2007	2008	2009	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
0.83	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

In year SSB change											
	2006	2007	2008	2008	2008	2008	2008	2008	2008	2008
Median	1.31	1.68	1.57	1.63	1.70	1.81	1.84	2.09	2.37	2.69
P25/P75	1.13	1.40	1.24	1.29	1.35	1.44	1.47	1.68	1.92	2.18

Table 14.13 Cod 347d: B-ADAPT median term forecast Option 1: reduction in fishing mortality by 14% in 2007, followed by constant fishing mortality at the 2007 level for 2008 onwards.

	2006	2007	2008	2009
F2006 mult	1.000	0.860	0.860	0.860

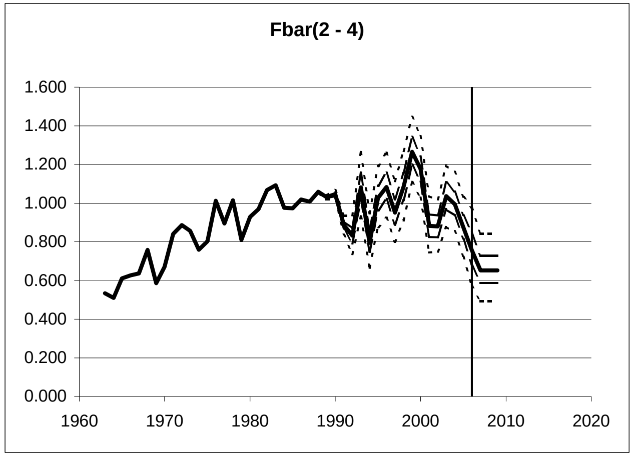
Fbar(2-4)	Year			
Percentile	2006	2007	2008	2009
0.05	0.57	0.49	0.49	0.49
0.25	0.68	0.59	0.59	0.59
0.5	0.76	0.65	0.65	0.65
0.75	0.85	0.73	0.73	0.73
0.95	0.98	0.84	0.84	0.84

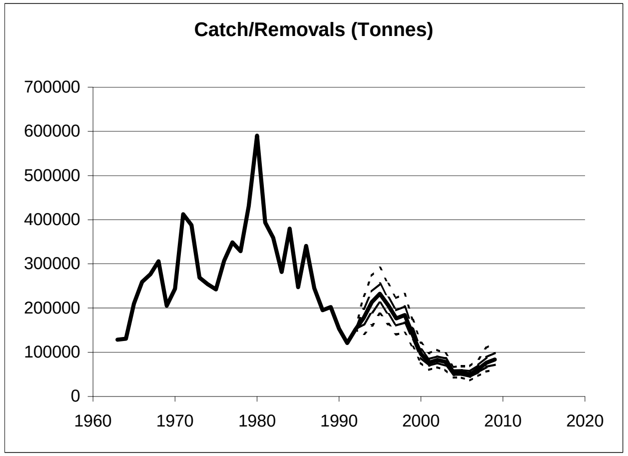
SSB	Year			
Percentile	2006	2007	2008	2009
0.05	24671	26680	35706	44450
0.25	26997	30093	42608	57517
0.5	28920	32675	48622	70634
0.75	31063	35825	55362	83877
0.95	34386	40273	65081	105094

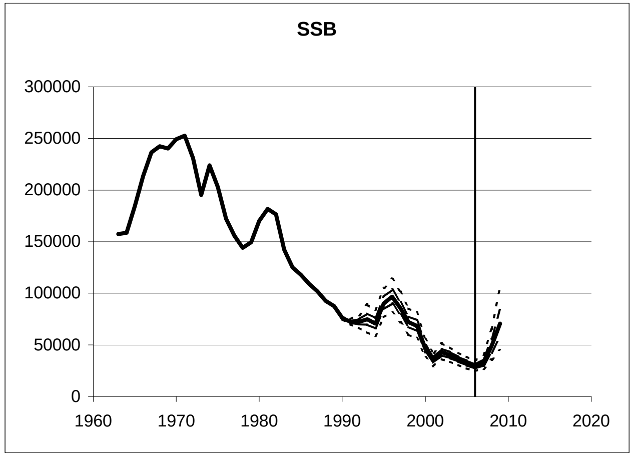
Removals	Year			
Percentile	2006	2007	2008	2009
0.05	36434	46270	56499	59999
0.25	44044	55035	66916	71850
0.5	50142	62553	76453	83993
0.75	57367	71285	88885	98726
0.95	68810	85284	109367	121726

P(SSBYear > SSB 2006)				
2007	2008	2009	2010	2011
0.83	0.99	1.00	1.00	0.99

In year SSB change			
	2006	2007	2008
Median	1.13	1.49	1.45
P25/P75	0.97	1.19	1.04







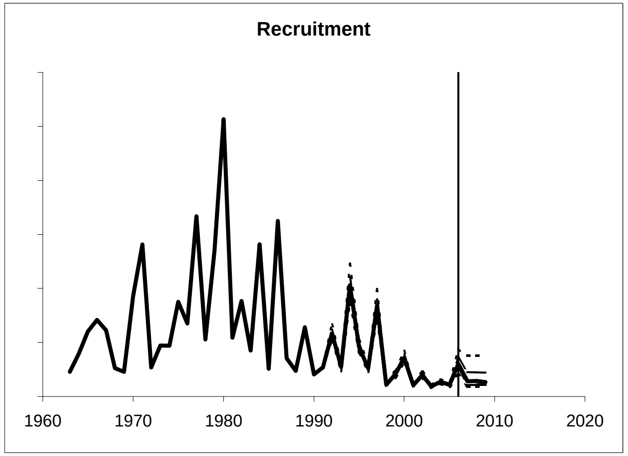


Table 14.14 Cod 347d: B-ADAPT median term forecast Option 2: reduction in fishing mortality by 14% in 2007, followed by a further reduction of 15% in 2008 (relative to 2007), then held constant for at the 2008 level for 2009 onwards.

	2006	2007	2008	2009
F2006 mult	1.000	0.860	0.731	0.731

Fbar(2-4)	Year			
Percentile	2006	2007	2008	2009
0.05	0.57	0.49	0.42	0.42
0.25	0.68	0.59	0.50	0.50
0.5	0.76	0.65	0.55	0.55
0.75	0.85	0.73	0.62	0.62
0.95	0.98	0.84	0.71	0.71

SSB	Year			
Percentile	2006	2007	2008	2009
0.05	24671	26680	35706	49789
0.25	26997	30093	42608	64091
0.5	28920	32675	48622	77643
0.75	31063	35825	55362	92173
0.95	34386	40273	65081	113797

Removals	Year			
Percentile	2006	2007	2008	2009
0.05	36434	46270	49901	57340
0.25	44044	55035	59144	68567
0.5	50142	62553	67665	79876
0.75	57367	71285	78549	94389
0.95	68810	85284	96916	115623

P(SSBYear > SSB 2006)				
2007	2008	2009	2010	2011
0.83	0.99	1.00	1.00	1.00

In year SSB change			
	2006	2007	2008
Median	1.13	1.49	1.60
P25/P75	0.97	1.19	1.16

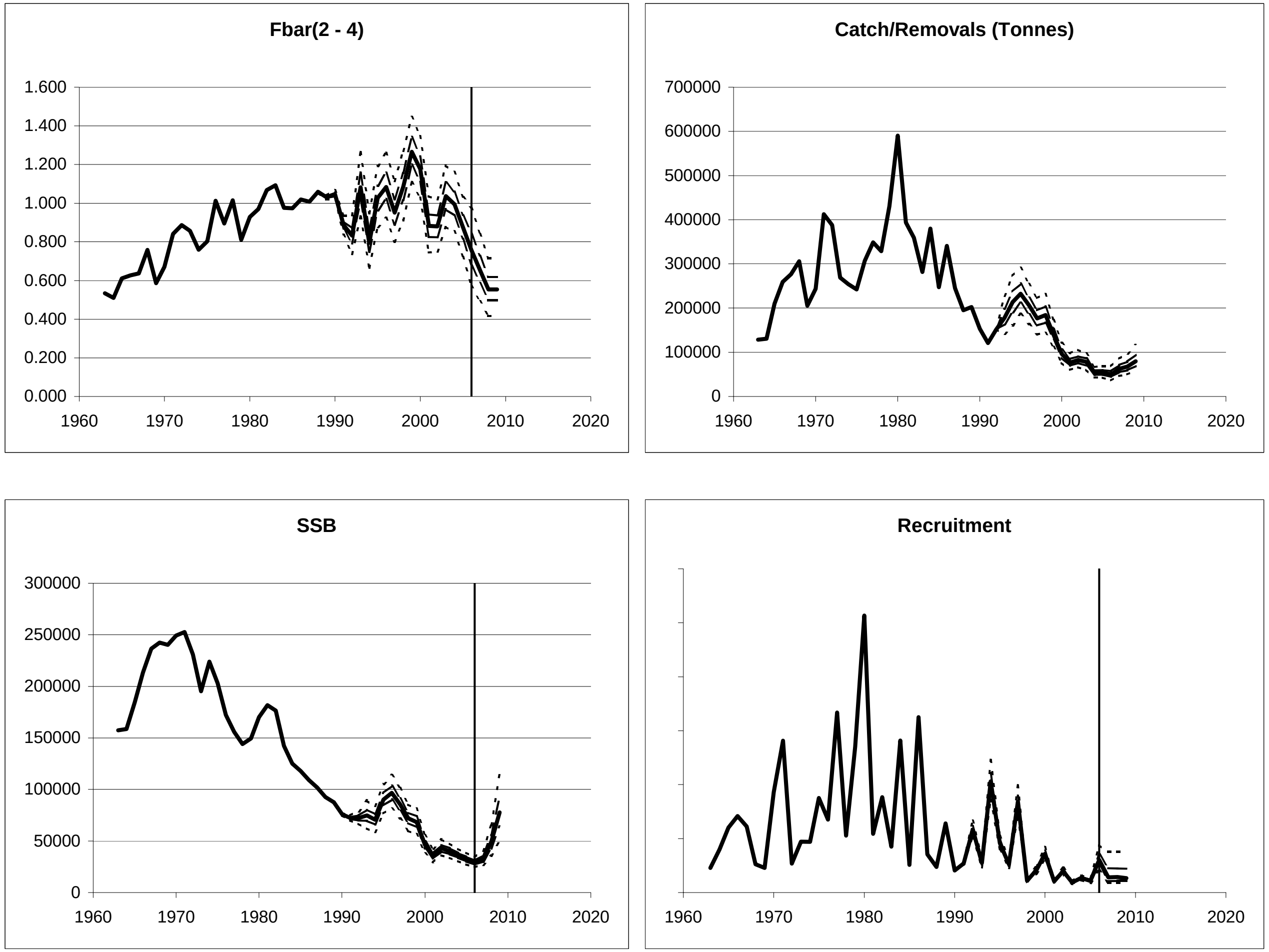


Table 14.15 Cod 347d: B-ADAPT median term forecast Option 3a: reduction in fishing mortality by 14% in 2007, followed by a further reduction (relative to 2006) in fishing mortality of 20% for 2008 onwards.

	2006	2007	2008	2009
F2006 mult	1.000	0.860	0.800	0.800

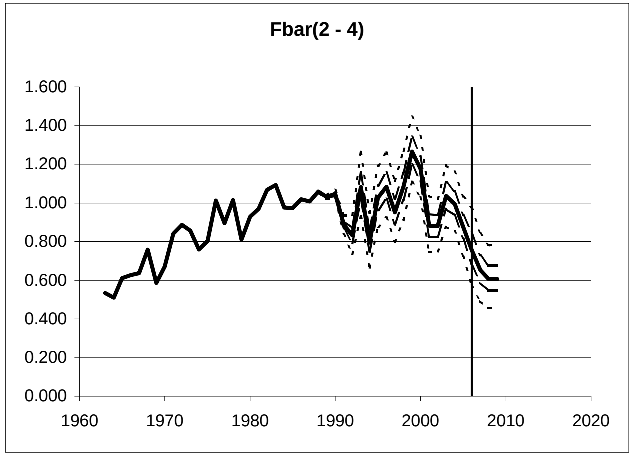
Fbar(2-4)	Year			
Percentile	2006	2007	2008	2009
0.05	0.57	0.49	0.46	0.46
0.25	0.68	0.59	0.55	0.55
0.5	0.76	0.65	0.61	0.61
0.75	0.85	0.73	0.68	0.68
0.95	0.98	0.84	0.78	0.78

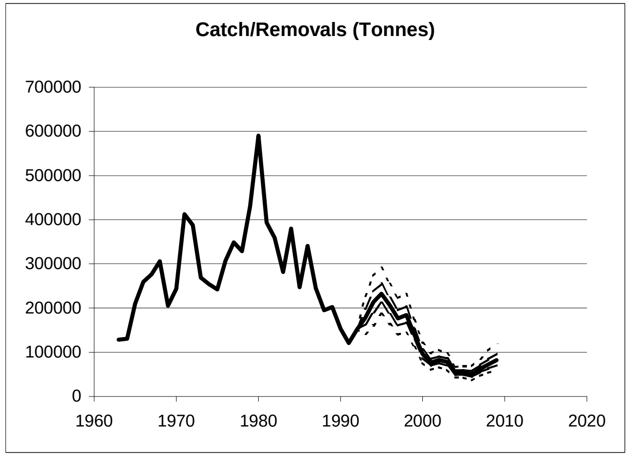
SSB	Year			
Percentile	2006	2007	2008	2009
0.05	24671	26680	35706	47029
0.25	26997	30093	42608	60412
0.5	28920	32675	48622	73894
0.75	31063	35825	55362	87531
0.95	34386	40273	65081	109054

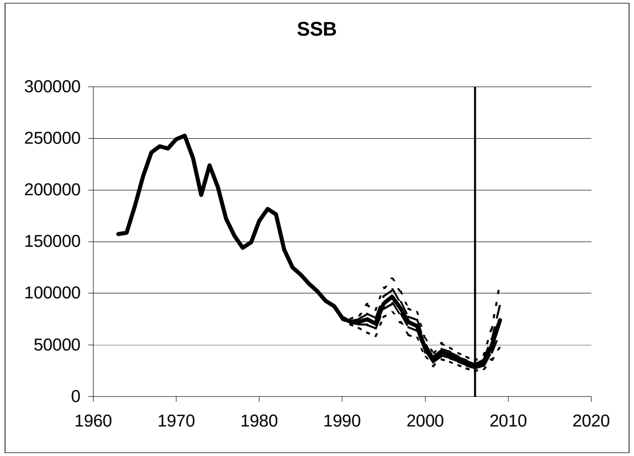
Removals	Year			
Percentile	2006	2007	2008	2009
0.05	36434	46270	53451	59156
0.25	44044	55035	63378	70553
0.5	50142	62553	72457	82054
0.75	57367	71285	84094	96818
0.95	68810	85284	103618	119238

P(SSBYear > SSB 2006)				
2007	2008	2009	2010	2011
0.83	0.99	1.00	1.00	1.00

In year SSB change			
	2006	2007	2008
Median	1.13	1.49	1.52
P25/P75	0.97	1.19	1.09







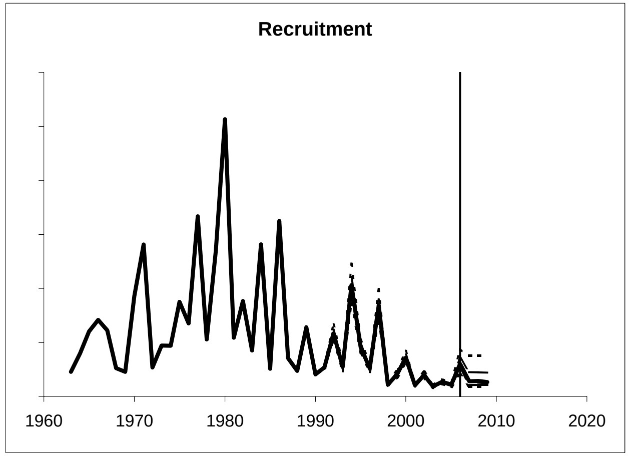


Table 14.16 Cod 347d: B-ADAPT median term forecast Option 3b: reduction in fishing mortality by 14% in 2007, followed by a further reduction (relative to 2006) in fishing mortality of 40% for 2008 onwards.

	2006	2007	2008	2009
F2006 mult	1.000	0.860	0.600	0.600

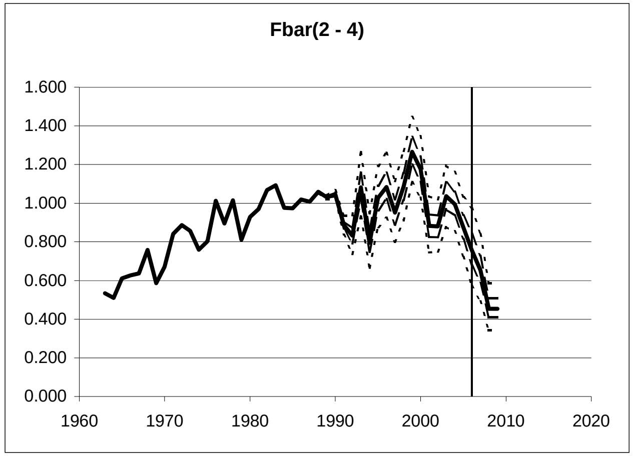
Fbar(2-4)	Year			
Percentile	2006	2007	2008	2009
0.05	0.57	0.49	0.34	0.34
0.25	0.68	0.59	0.41	0.41
0.5	0.76	0.65	0.45	0.45
0.75	0.85	0.73	0.51	0.51
0.95	0.98	0.84	0.59	0.59

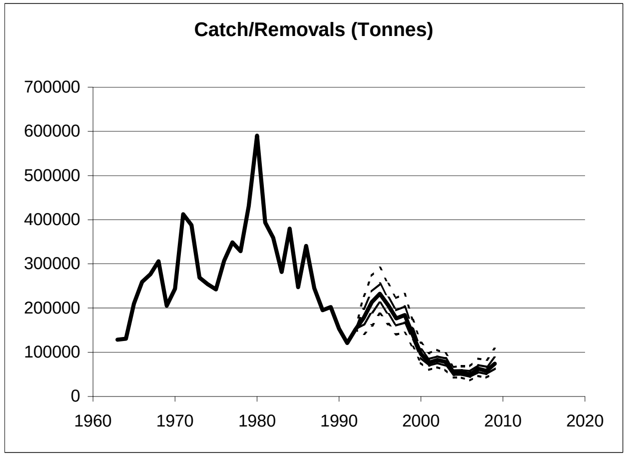
SSB	Year			
Percentile	2006	2007	2008	2009
0.05	24671	26680	35706	55603
0.25	26997	30093	42608	71644
0.5	28920	32675	48622	85475
0.75	31063	35825	55362	100938
0.95	34386	40273	65081	123834

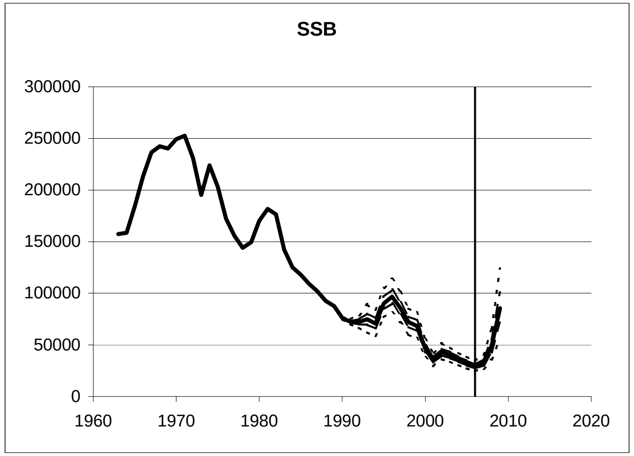
Removals	Year			
Percentile	2006	2007	2008	2009
0.05	36434	46270	42527	53267
0.25	44044	55035	50447	63701
0.5	50142	62553	57897	73797
0.75	57367	71285	67408	87145
0.95	68810	85284	83060	107319

P(SSBYear > SSB 2006)				
2007	2008	2009	2010	2011
0.83	0.99	1.00	1.00	1.00

In year SSB change			
	2006	2007	2008
Median	1.13	1.49	1.76
P25/P75	0.97	1.19	1.29







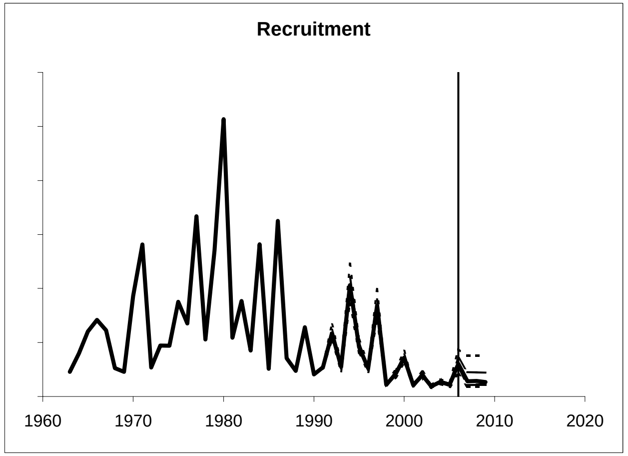


Table 14.17 Cod 347d: B-ADAPT median term forecast Option 3c: reduction in fishing mortality by 14% in 2007, followed by a further reduction (relative to 2006) in fishing mortality of 60% for 2008 onwards.

	2006	2007	2008	2009
F2006 mult	1.000	0.860	0.400	0.400

Fbar(2-4)	Year			
Percentile	2006	2007	2008	2009
0.05	0.57	0.49	0.23	0.23
0.25	0.68	0.59	0.27	0.27
0.5	0.76	0.65	0.30	0.30
0.75	0.85	0.73	0.34	0.34
0.95	0.98	0.84	0.39	0.39

SSB	Year			
Percentile	2006	2007	2008	2009
0.05	24671	26680	35706	66361
0.25	26997	30093	42608	83976
0.5	28920	32675	48622	99563
0.75	31063	35825	55362	115542
0.95	34386	40273	65081	140121

Removals	Year			
Percentile	2006	2007	2008	2009
0.05	36434	46270	30065	42167
0.25	44044	55035	35868	51219
0.5	50142	62553	41362	59537
0.75	57367	71285	47865	70482
0.95	68810	85284	59272	87574

P(SSBYear > SSB 2006)				
2007	2008	2009	2010	2011
0.83	0.99	1.00	1.00	1.00

In year SSB change			
	2006	2007	2008
Median	1.13	1.49	2.05
P25/P75	0.97	1.19	1.52

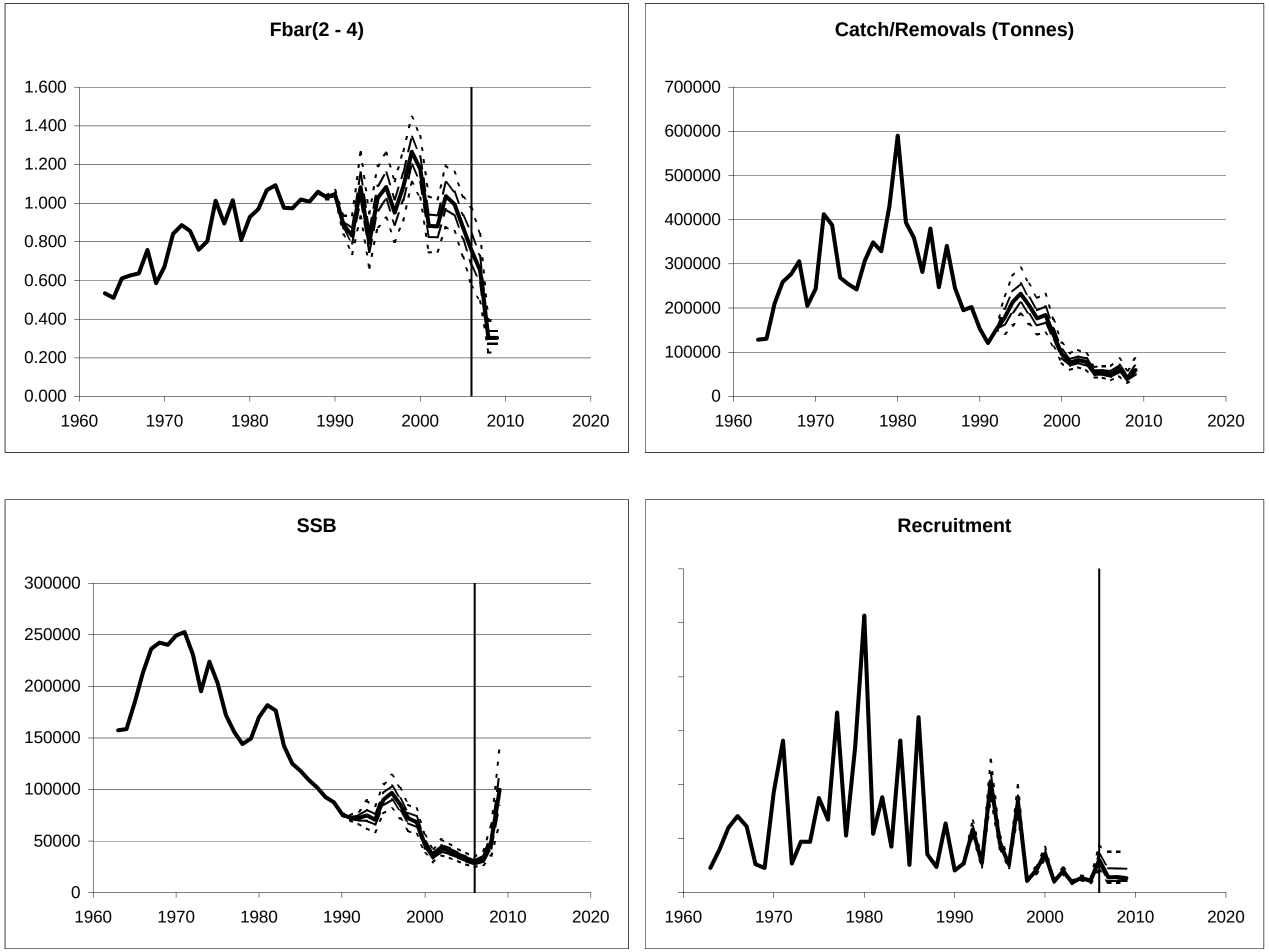


Table 14.18 Cod 347d: B-ADAPT median term forecast Option 3d: reduction in fishing mortality by 14% in 2007, followed by a further reduction (relative to 2006) in fishing mortality of 80% for 2008 onwards.

	2006	2007	2008	2009
F2006 mult	1.000	0.860	0.200	0.200

Fbar(2-4)	Year			
Percentile	2006	2007	2008	2009
0.05	0.57	0.49	0.11	0.11
0.25	0.68	0.59	0.14	0.14
0.5	0.76	0.65	0.15	0.15
0.75	0.85	0.73	0.17	0.17
0.95	0.98	0.84	0.20	0.20

SSB	Year			
Percentile	2006	2007	2008	2009
0.05	24671	26680	35706	79573
0.25	26997	30093	42608	98063
0.5	28920	32675	48622	115996
0.75	31063	35825	55362	133597
0.95	34386	40273	65081	159771

Removals	Year			
Percentile	2006	2007	2008	2009
0.05	36434	46270	16109	25266
0.25	44044	55035	19159	31226
0.5	50142	62553	22078	36073
0.75	57367	71285	25591	42643
0.95	68810	85284	31925	54140

P(SSBYear > SSB 2006)				
2007	2008	2009	2010	2011
0.83	0.99	1.00	1.00	1.00

In year SSB change			
	2006	2007	2008
Median	1.13	1.49	2.39
P25/P75	0.97	1.19	1.77

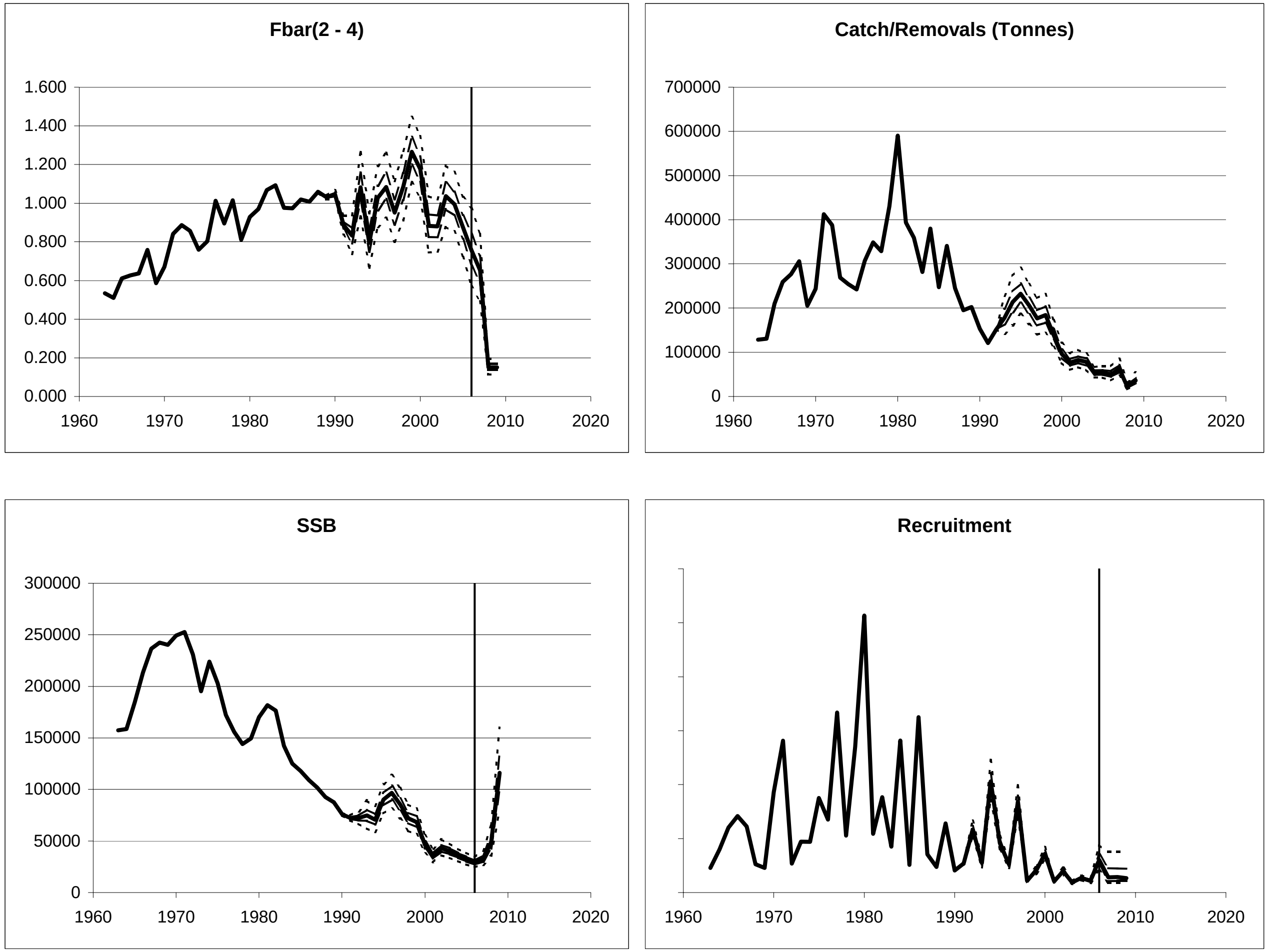


Table 14.19 Cod 347d: B-ADAPT median term forecast Option 3e: reduction in fishing mortality by 14% in 2007, followed by a further reduction (relative to 2006) in fishing mortality of 100% for 2008 onwards.

	2006	2007	2008	2009
F2006 mult	1.000	0.860	0.000	0.000

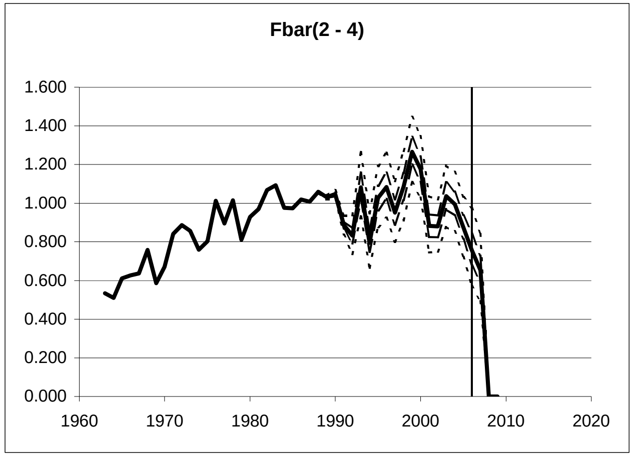
Fbar(2-4)	Year			
Percentile	2006	2007	2008	2009
0.05	0.57	0.49	0.00	0.00
0.25	0.68	0.59	0.00	0.00
0.5	0.76	0.65	0.00	0.00
0.75	0.85	0.73	0.00	0.00
0.95	0.98	0.84	0.00	0.00

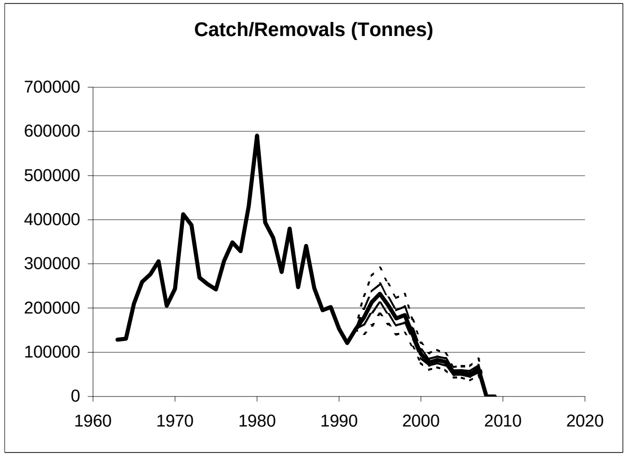
SSB	Year			
Percentile	2006	2007	2008	2009
0.05	24671	26680	35706	96705
0.25	26997	30093	42608	115784
0.5	28920	32675	48622	134887
0.75	31063	35825	55362	153912
0.95	34386	40273	65081	183711

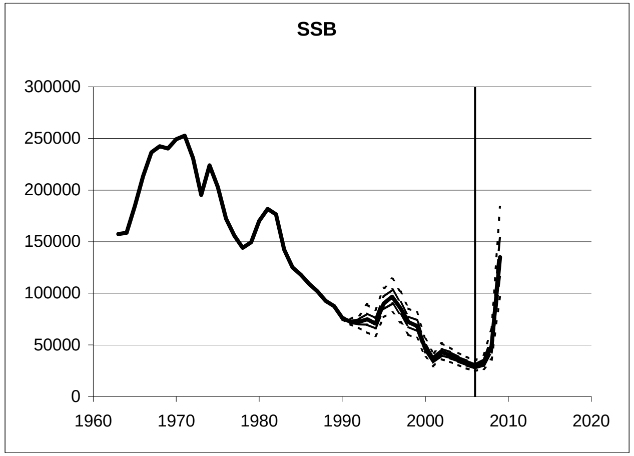
Removals	Year			
Percentile	2006	2007	2008	2009
0.05	36434	46270	0	0
0.25	44044	55035	0	0
0.5	50142	62553	0	0
0.75	57367	71285	0	0
0.95	68810	85284	0	0

P(SSBYear > SSB 2006)				
2007	2008	2009	2010	2011
0.83	0.99	1.00	1.00	1.00

In year SSB change	2006	2007	2008
Median	1.13	1.49	2.77
P25/P75	0.97	1.19	2.09







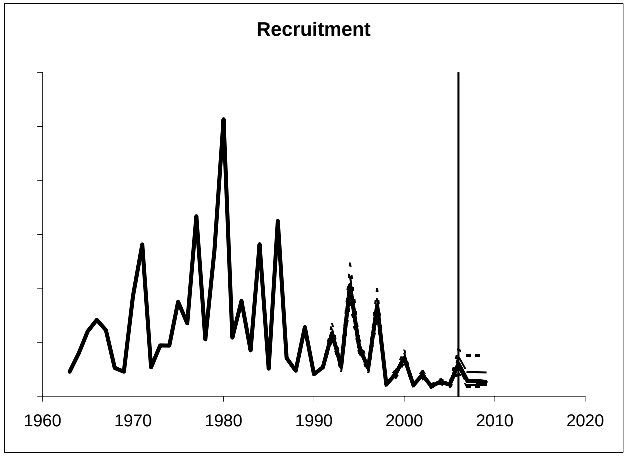


Table 14.20 Cod 347d: B-ADAPT median term forecast Option 4: reduction in fishing mortality by 14% in 2007, followed by a further reduction to the target fishing mortality of 0.4 for 2008 onwards.

	2006	2007	2008	2009
F2006 mult	1.000	0.860	0.528	0.528

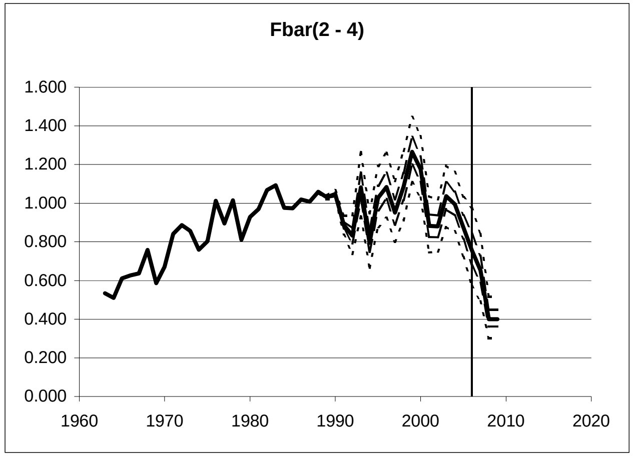
Fbar(2-4)	Year			
Percentile	2006	2007	2008	2009
0.05	0.57	0.49	0.30	0.30
0.25	0.68	0.59	0.36	0.36
0.5	0.76	0.65	0.40	0.40
0.75	0.85	0.73	0.45	0.45
0.95	0.98	0.84	0.52	0.52

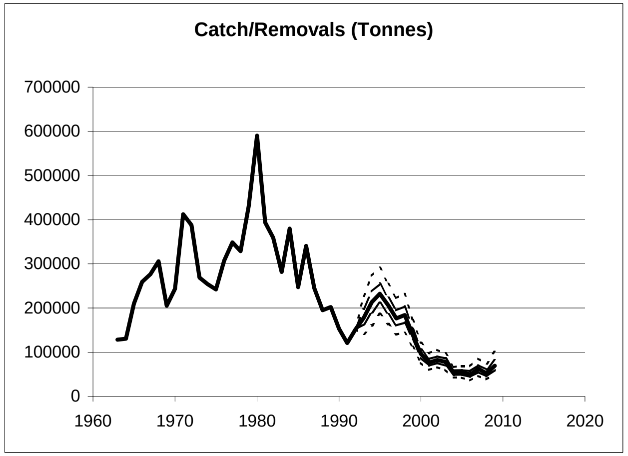
SSB	Year			
Percentile	2006	2007	2008	2009
0.05	24671	26680	35706	59359
0.25	26997	30093	42608	75975
0.5	28920	32675	48622	90328
0.75	31063	35825	55362	106079
0.95	34386	40273	65081	129521

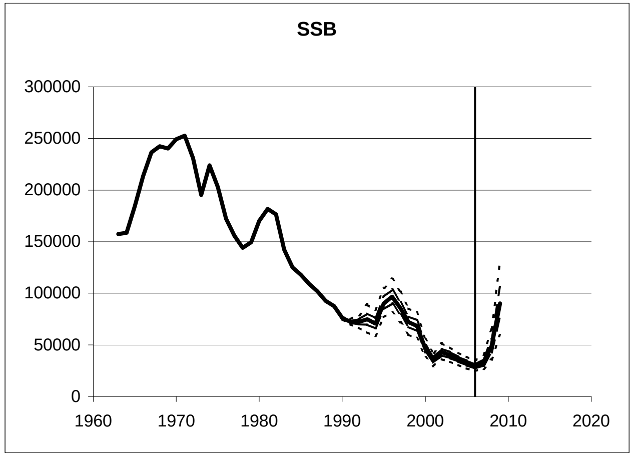
Removals	Year			
Percentile	2006	2007	2008	2009
0.05	36434	46270	38214	49987
0.25	44044	55035	45497	60005
0.5	50142	62553	52267	69412
0.75	57367	71285	60641	81707
0.95	68810	85284	74655	101194

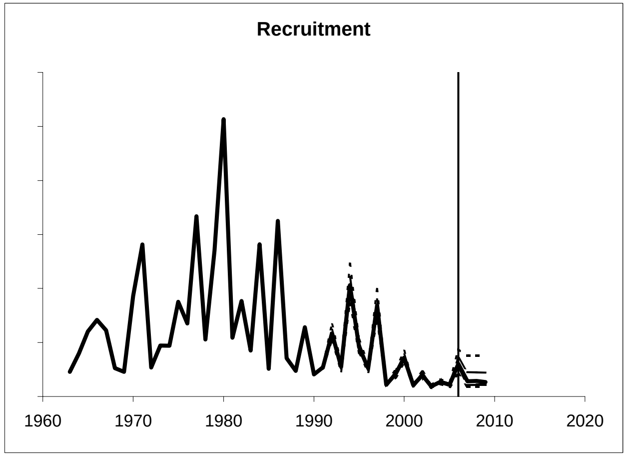
P(SSBYear > SSB 2006)				
2007	2008	2009	2010	2011
0.83	0.99	1.00	1.00	1.00

In year SSB change			
	2006	2007	2008
Median	1.13	1.49	1.86
P25/P75	0.97	1.19	1.37









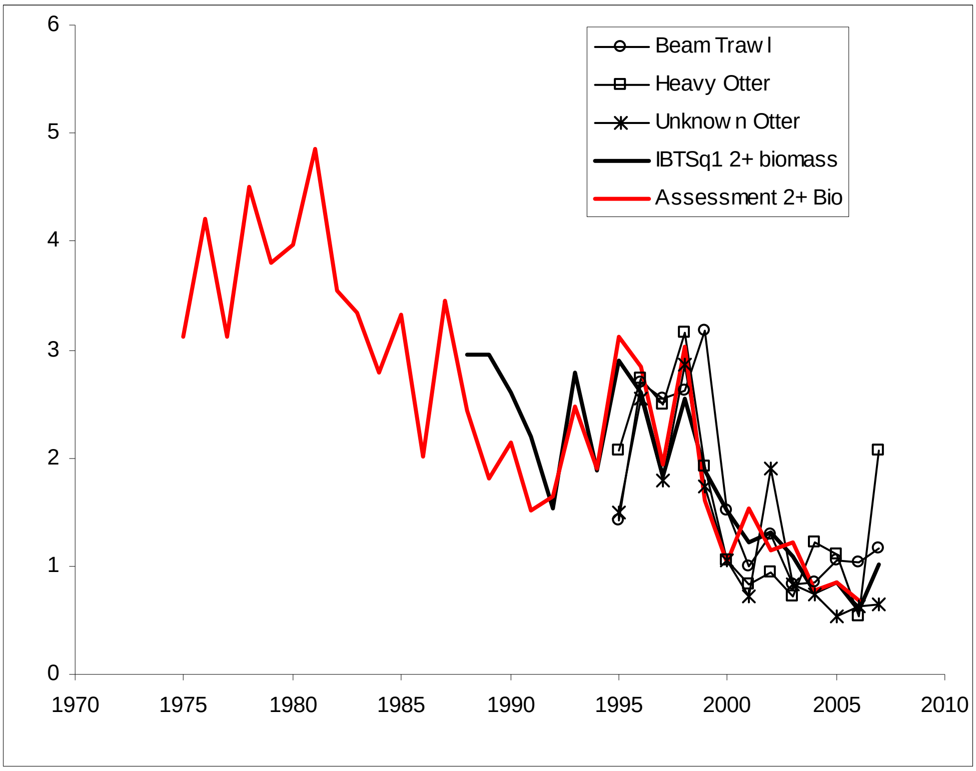


Figure 14.1a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Mean-standardised catch rates of North Sea cod recorded by English trawlers fishing in the first quarter of the year and the 2+ cod biomass as estimated by the 2006 ICES WGNSSK assessment and recorded by the IBTSQ1 survey.

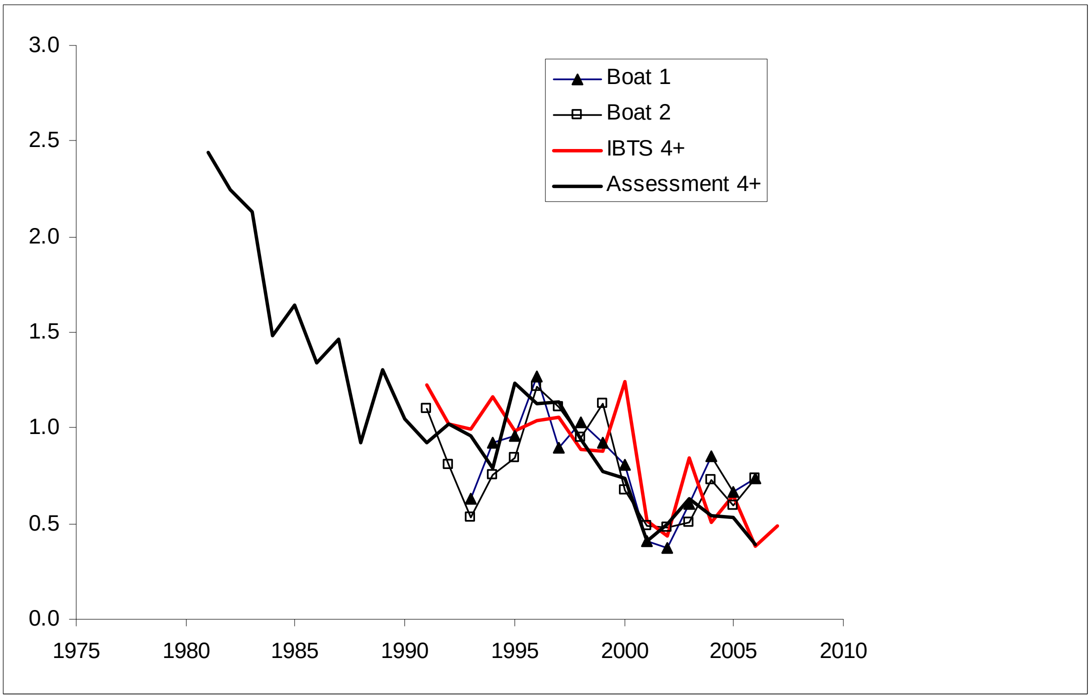


Figure 14.1b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Mean-standardised catch rates of North Sea cod recorded by two English gillnetters fishing in the first quarter of the year and the 4+ cod biomass as estimated by the 2006 ICES WGNSSK assessment and recorded by the IBTSQ1 survey.

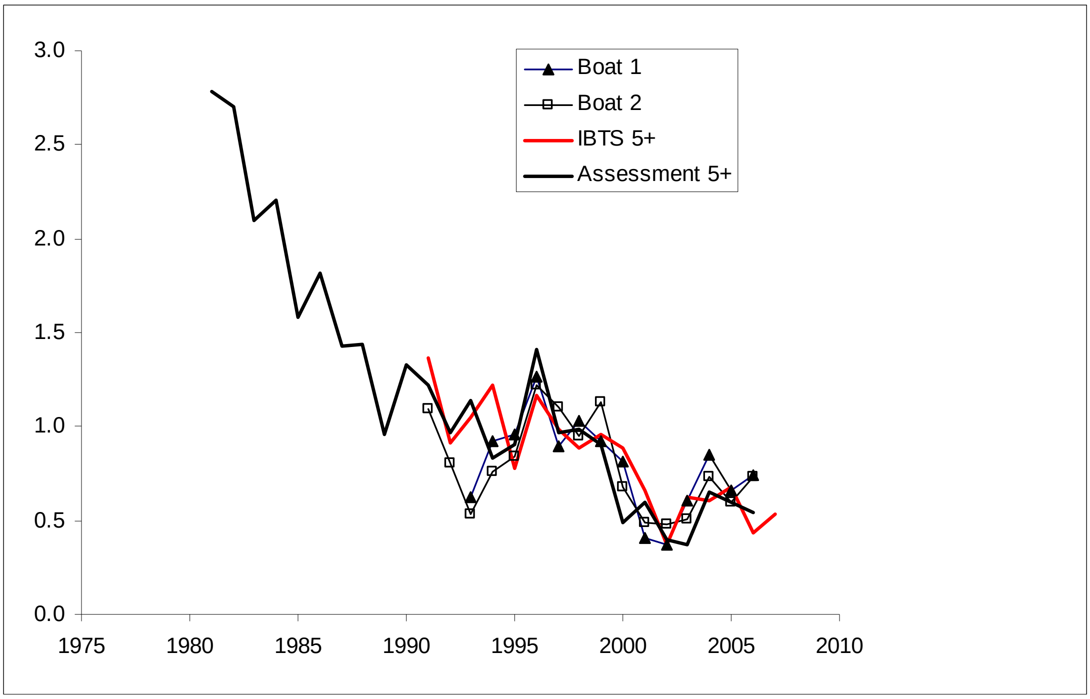


Figure 14.1c Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Mean-standardised catch rates of North Sea cod recorded by two English gillnetters fishing in the first quarter of the year and the 5+ cod biomass as estimated by the 2006 ICES WGNSSK assessment and recorded by the IBTSQ1 survey.

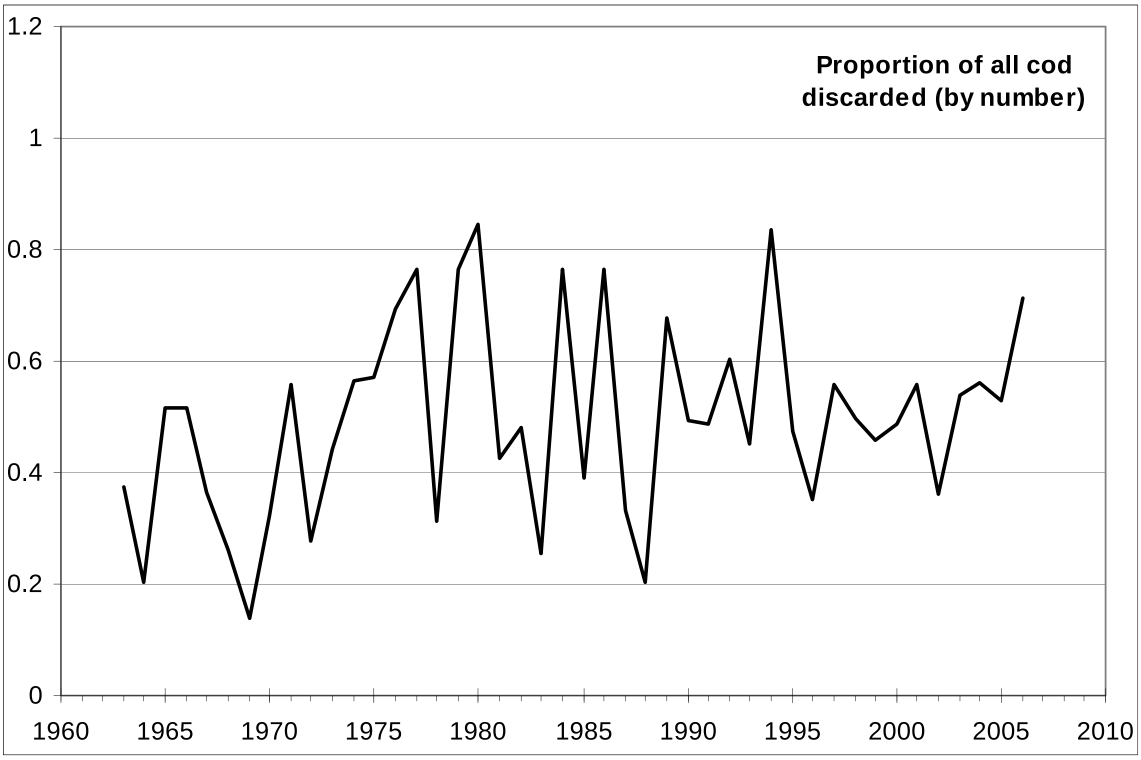


Figure 14.2a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Proportion of total numbers caught that are discarded.

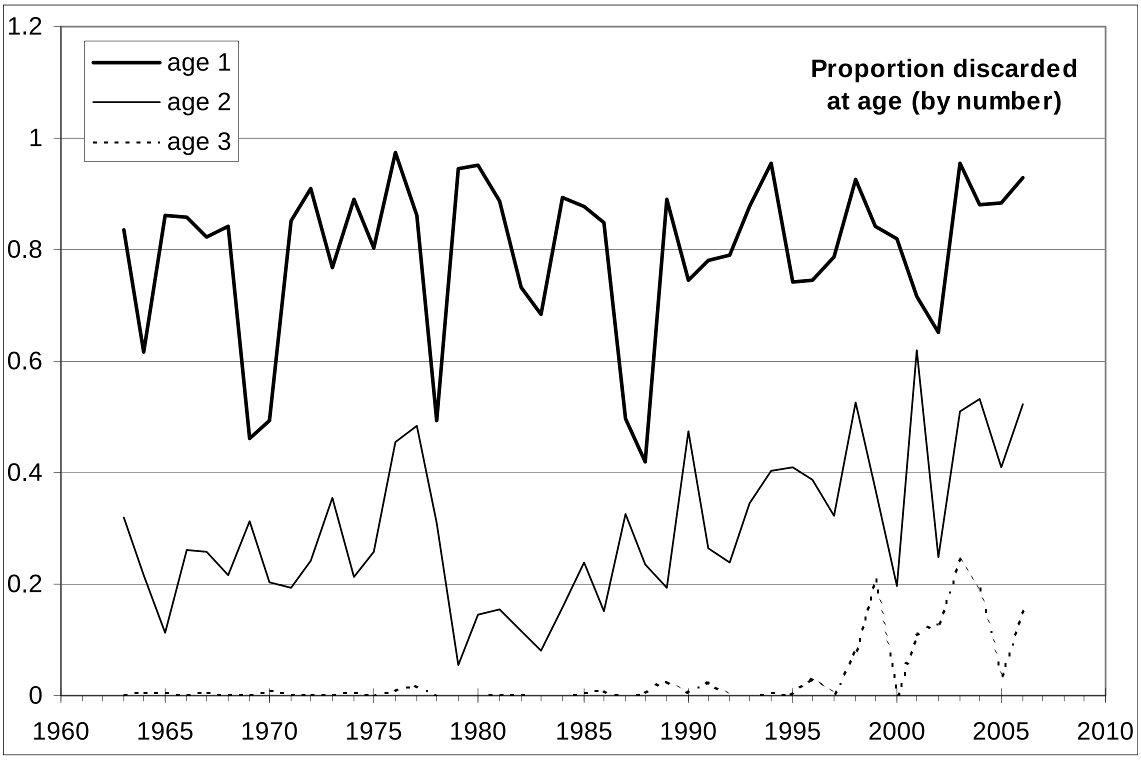


Figure 14.2b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Proportion of total numbers caught at age that are discarded.

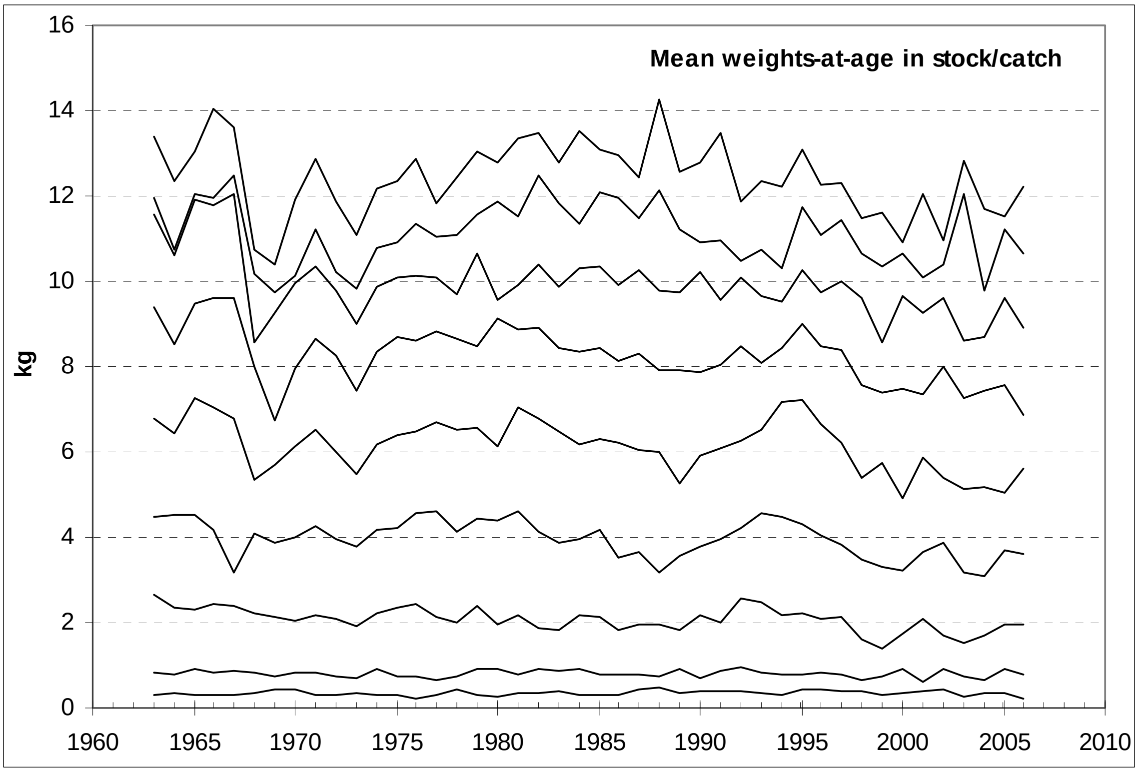


Figure 14.3 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Mean weight at age in the catch for ages 1–9.

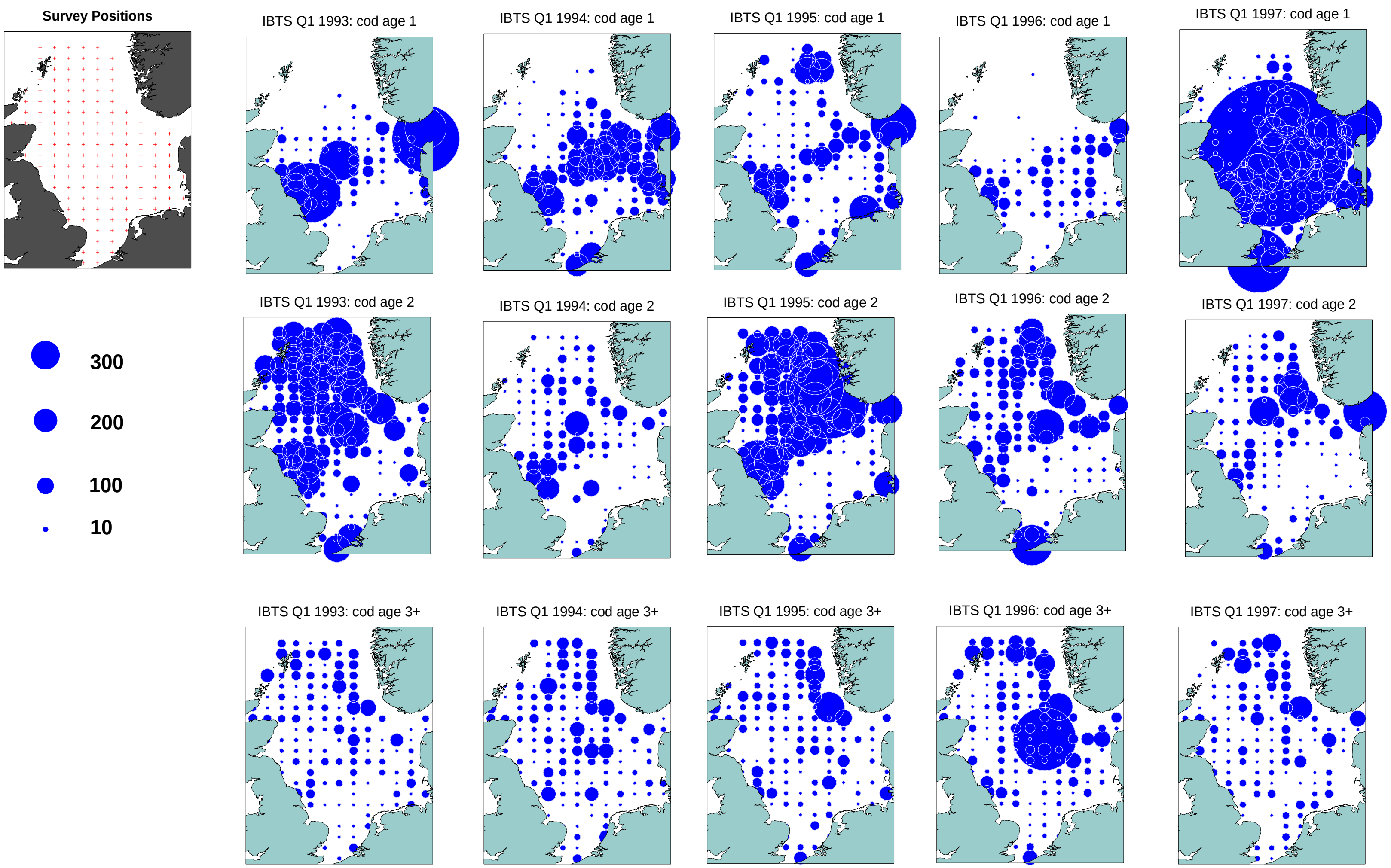


Figure 14.4 (a) Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1–3+ caught in the IBTS Q1 survey 1993–2007 in the North Sea.

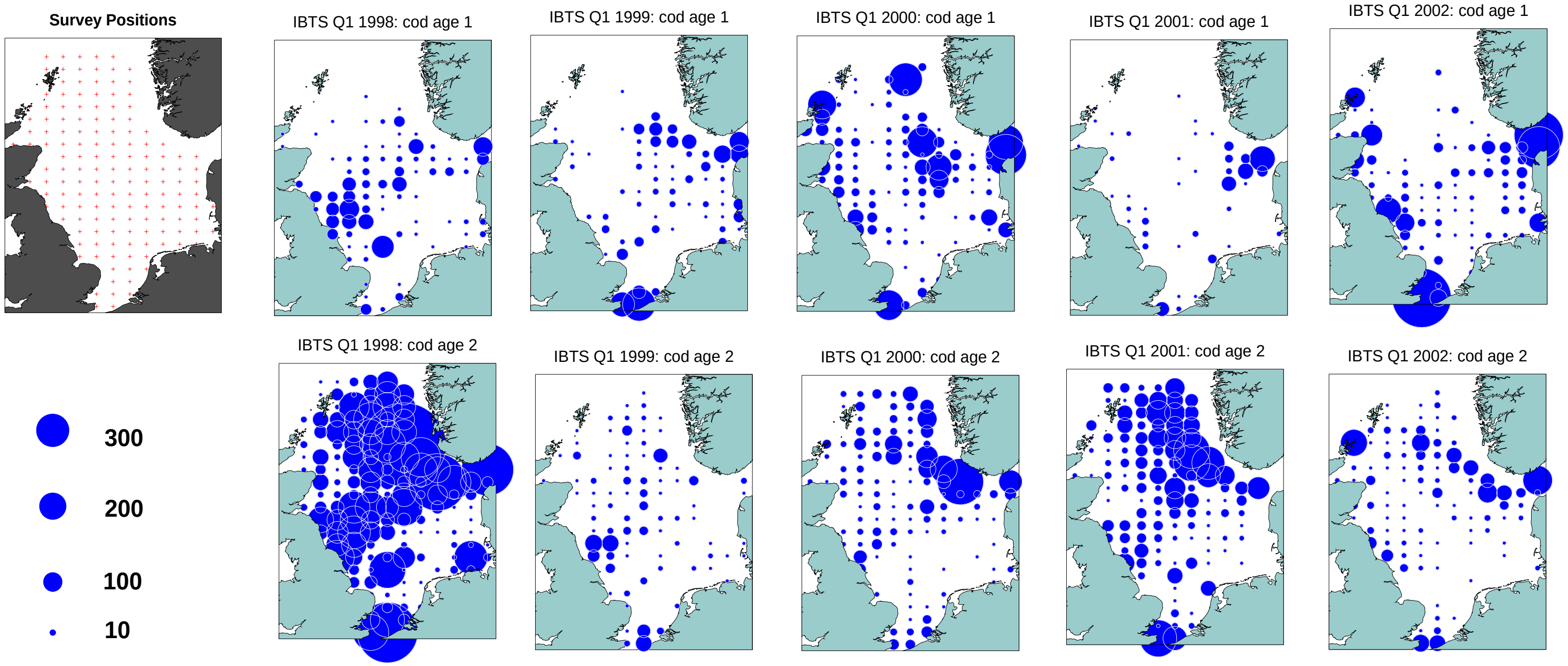


Figure 14.4 (a) contd. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1–3+ caught in the IBTS Q1 survey 1993–2007 in the North Sea.

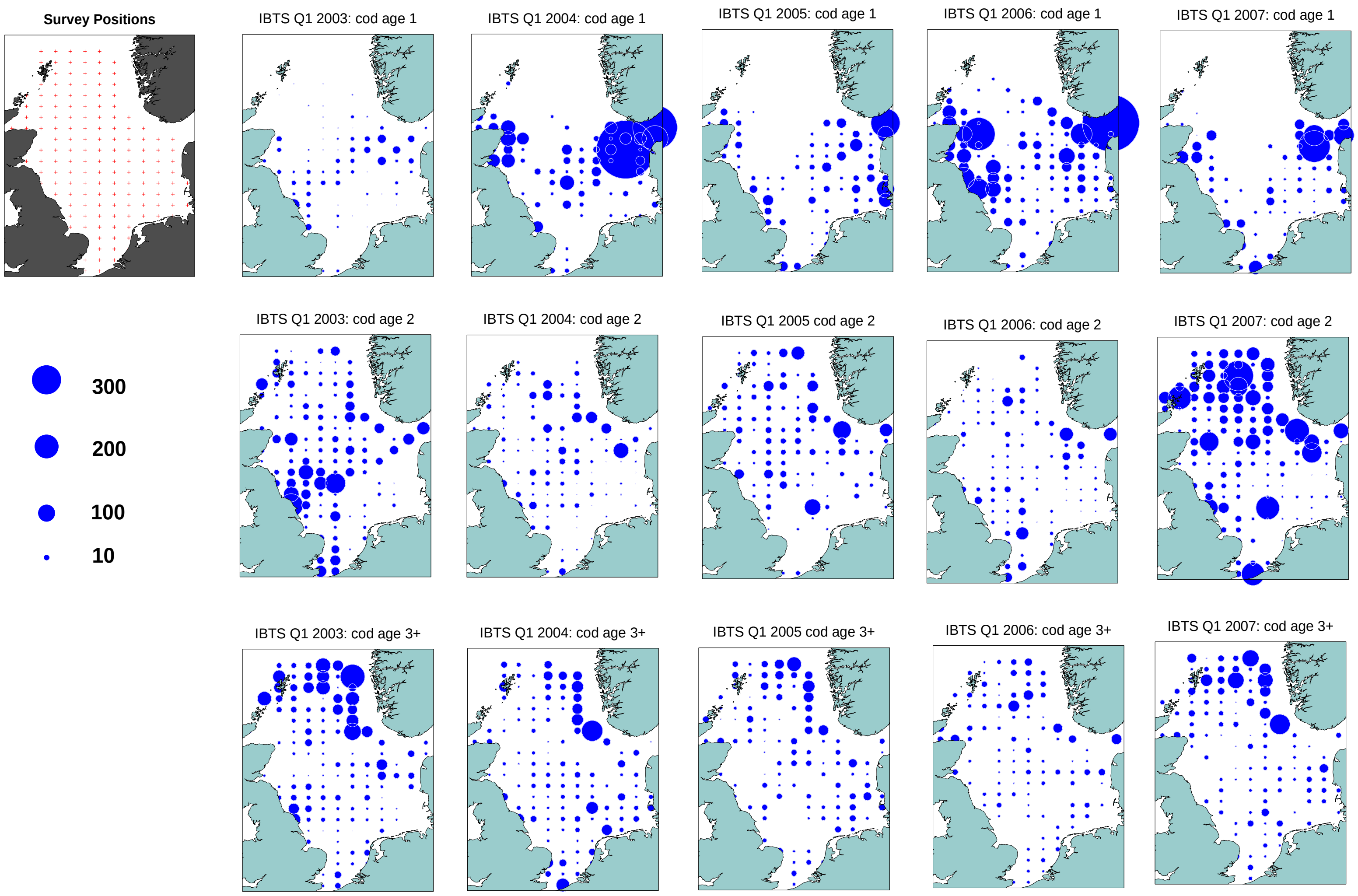


Figure 14.4 (a) contd. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1–3+ caught in the IBTS Q1 survey 1993–2007 in the North Sea.

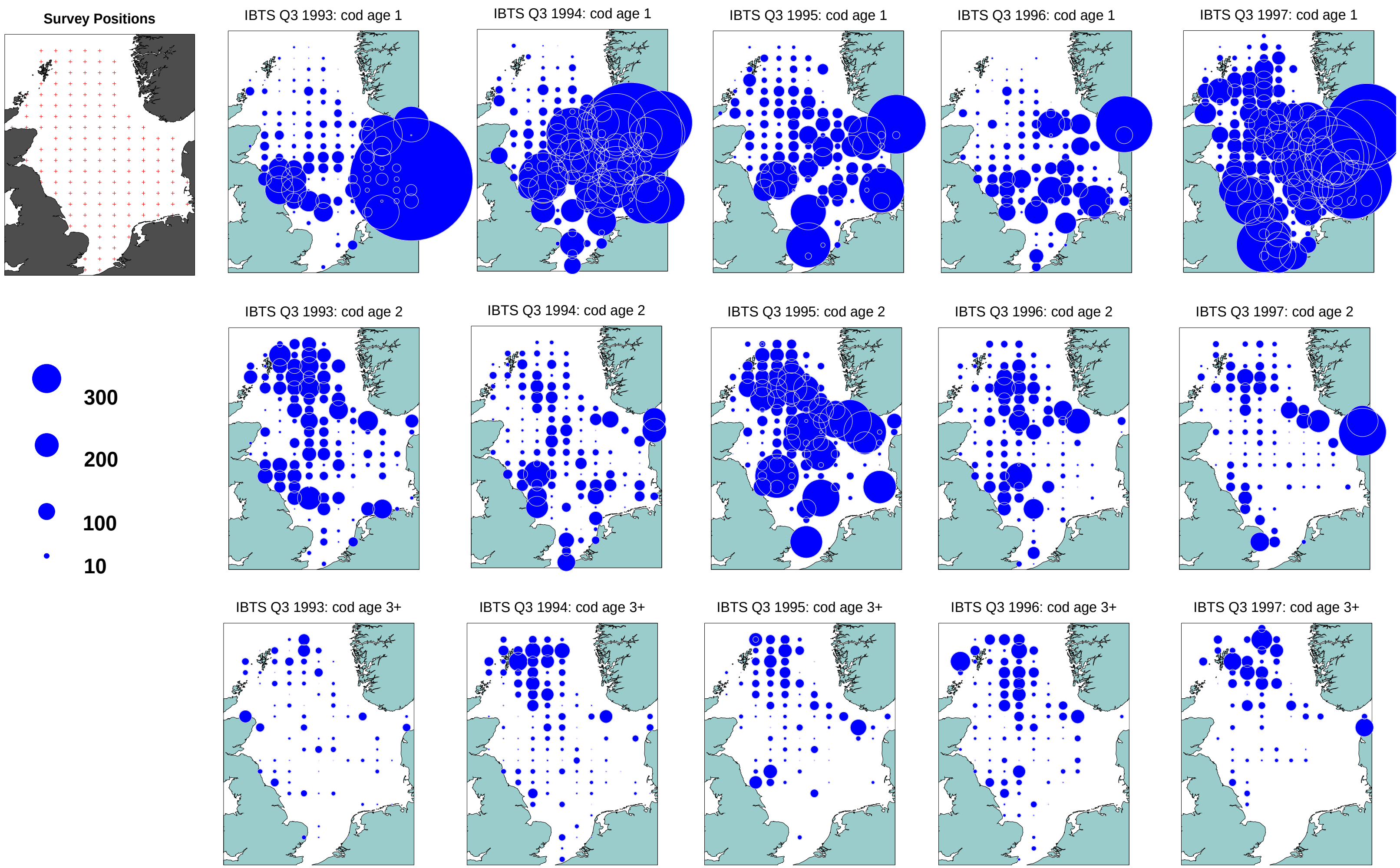


Figure 14.4 (b). Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1–3+ caught in the IBTS Q3 survey 1993–2006 in the North Sea.

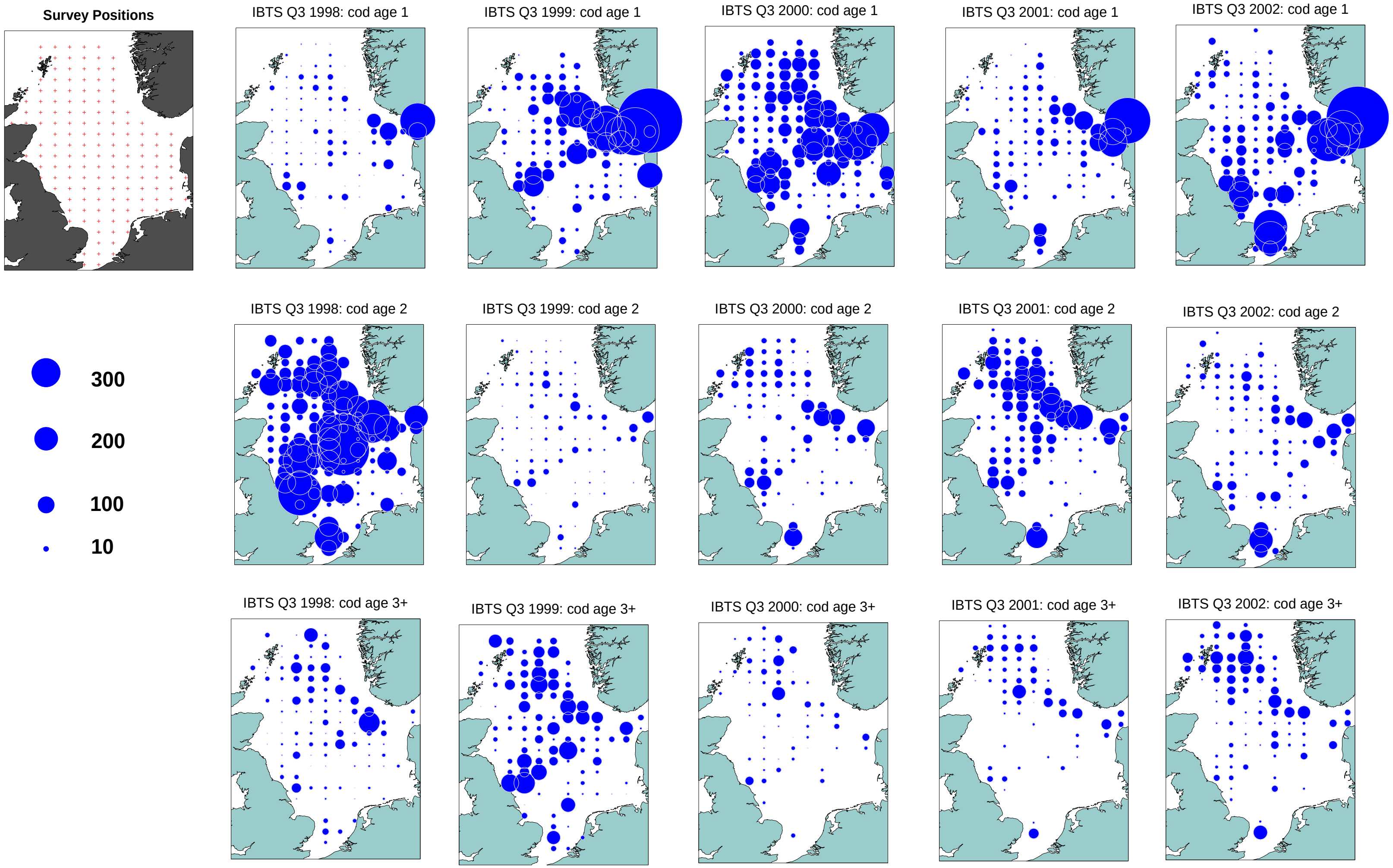


Figure 14.4 (b) contd. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1–3+ caught in the IBTS Q3 survey 1993–2006 in the North Sea.

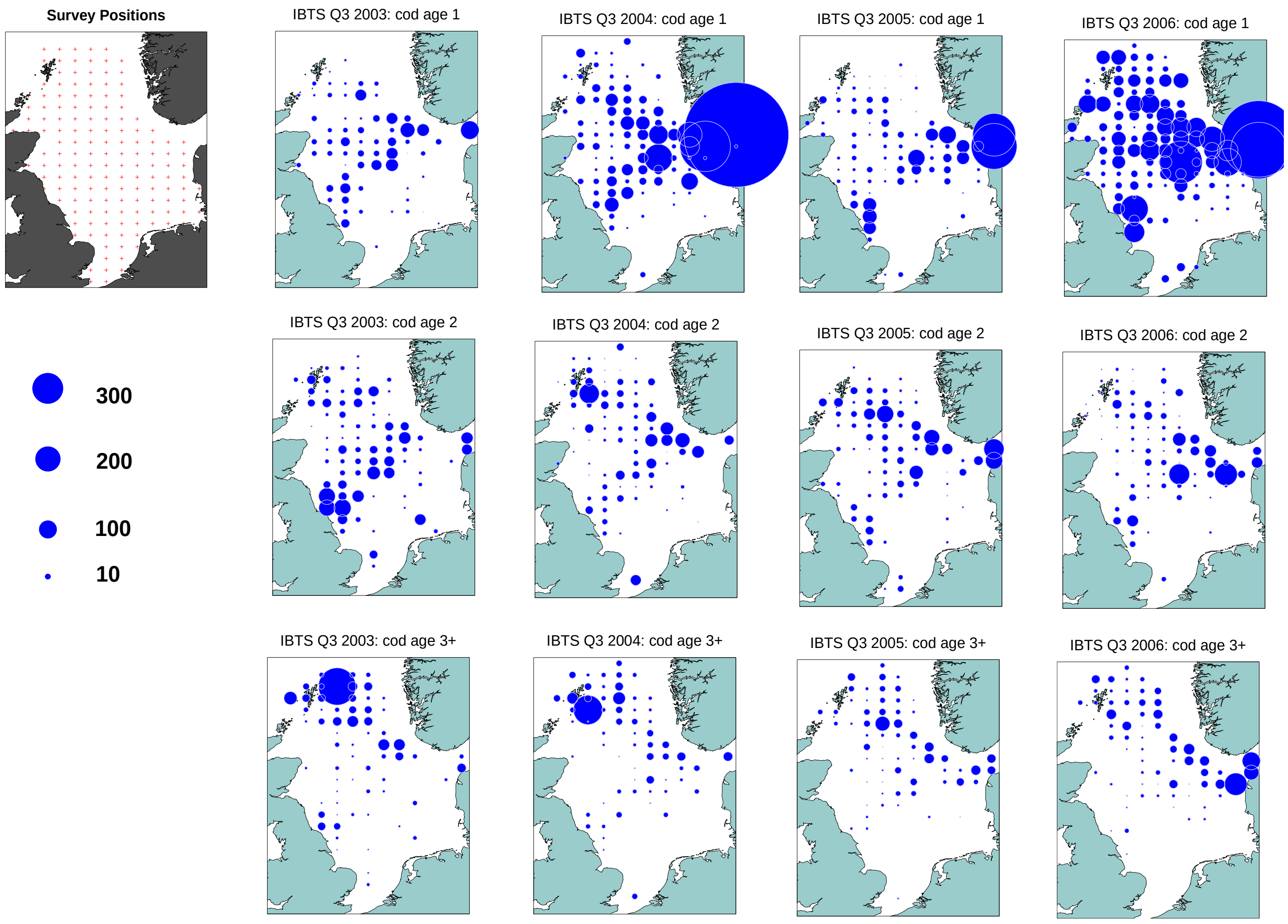


Figure 14.4 (b) contd. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1–3+ caught in the IBTS Q3 survey 1993–2006 in the North Sea.

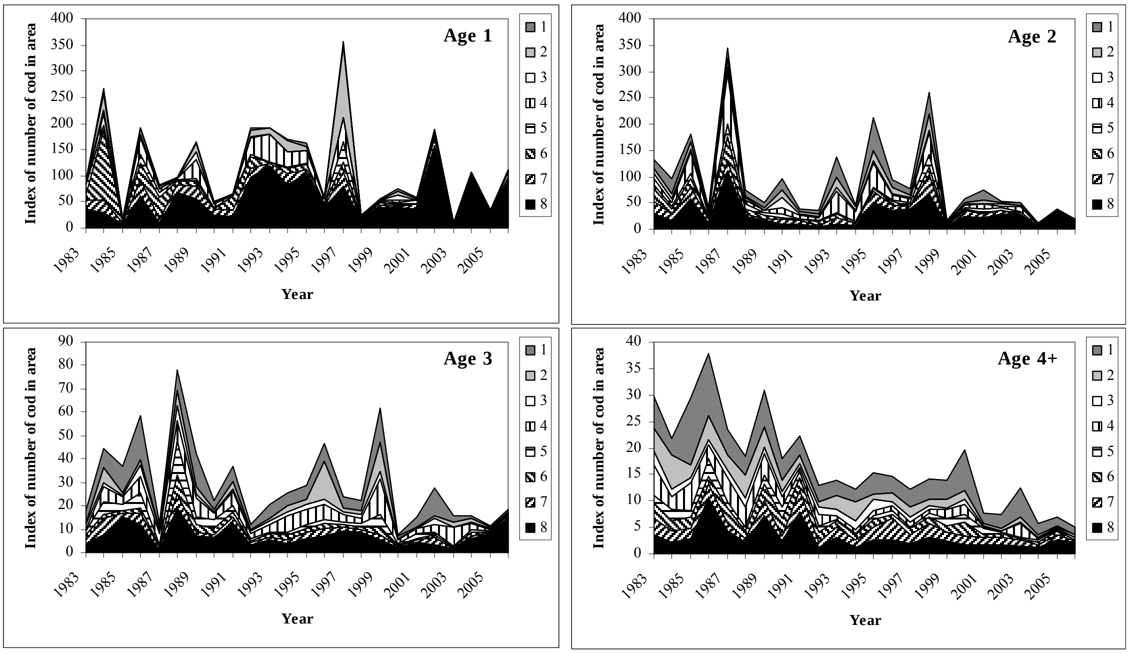


Figure 14.5a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Index of the number of cod of a given age in each roundfish area, numbered and shaded according to the legend. Roundfish areas are as follows: 1 Northern North Sea; 2 Central NS (mainly Fladden ground); 3 North Western NS; 4 Mid Western NS; 5 South Western NS; 6 South Eastern NS (German Bight); 7 Mid Eastern NS (Fisher bank); 8 Skagerrak.

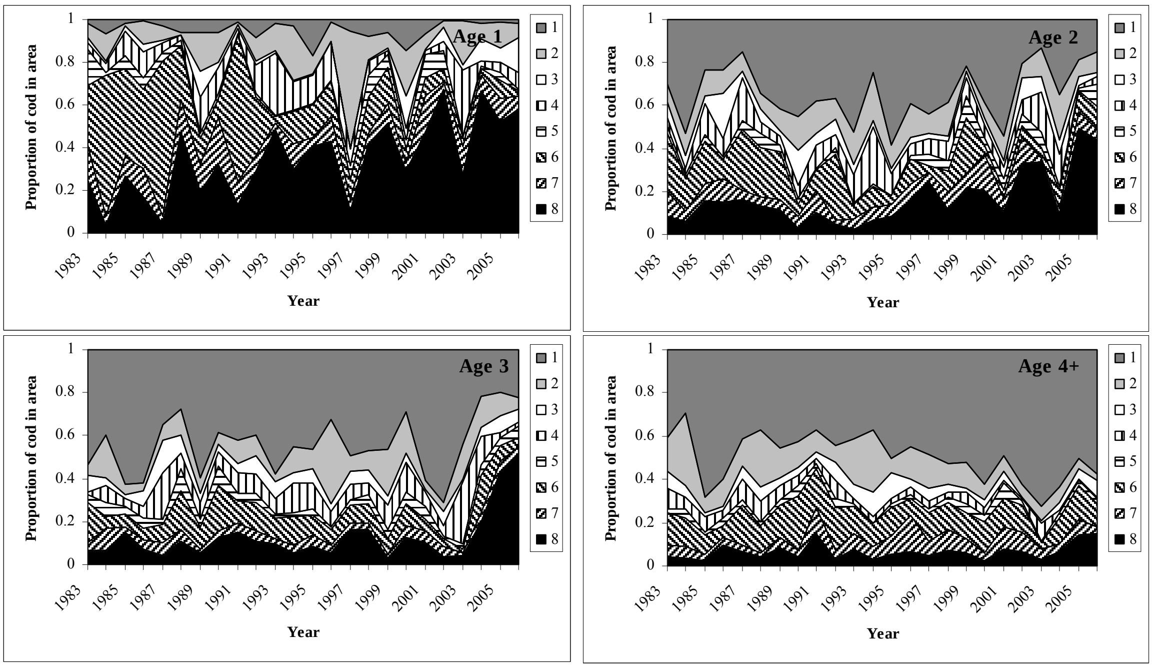


Figure 14.5b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Proportion of cod of a given age in each roundfish area, numbered and shaded according to the legend. Roundfish areas are noted in the caption to Figure 14.5a.

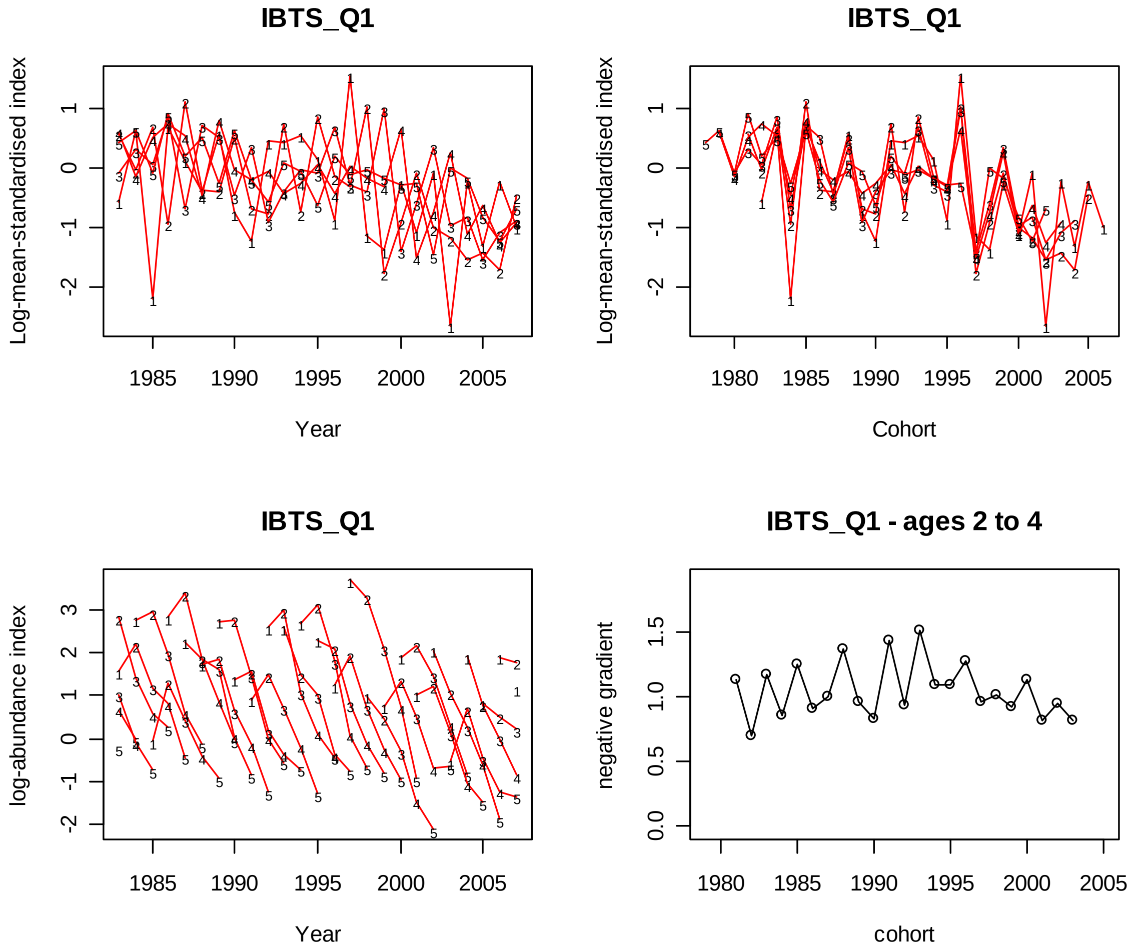


Figure 14.6a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Log mean standardised indices plotted by year (top left) and cohort (top right), log abundance curves (bottom left) and associated negative gradients for each cohort across the reference fishing mortality of age 2–4 (bottom right), for the IBTSQ1 groundfish survey.

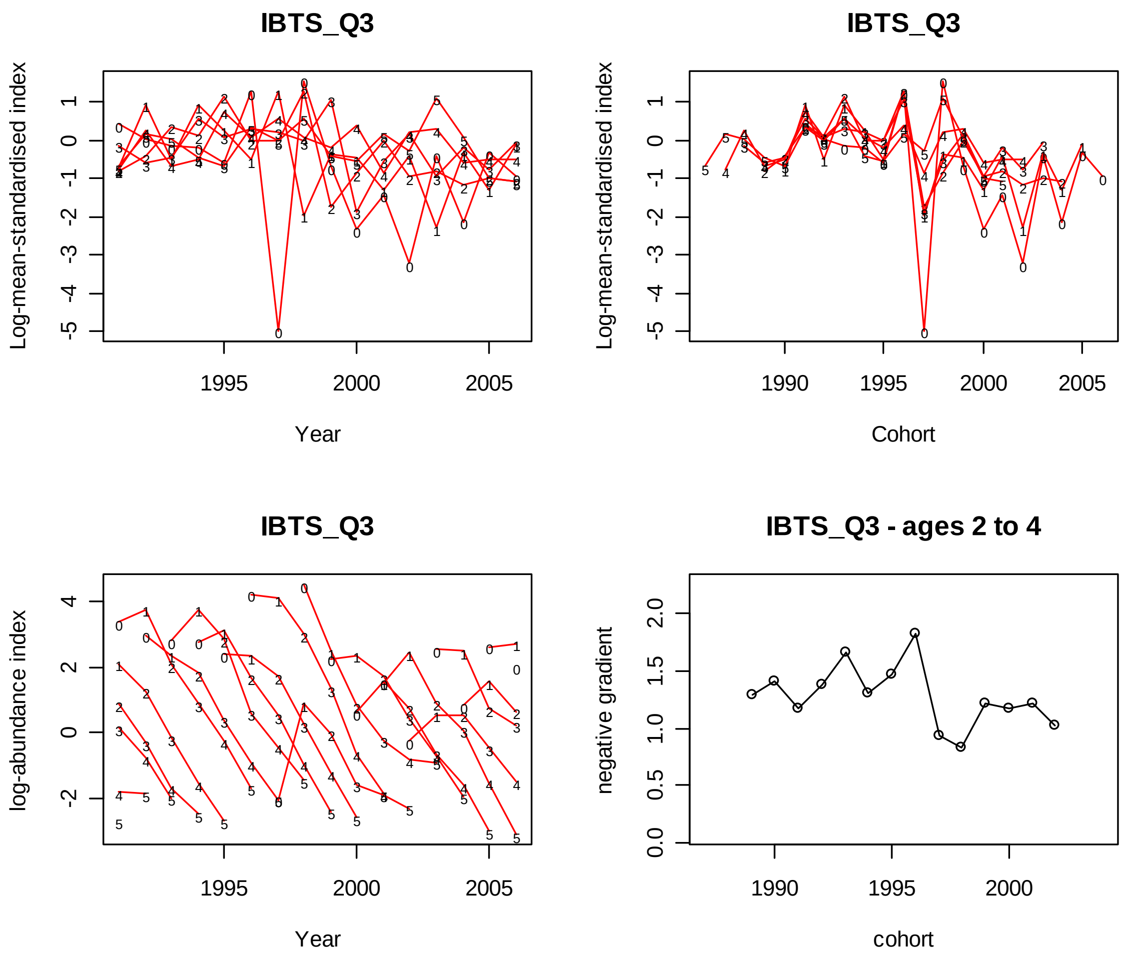


Figure 14.6b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Log mean standardised indices plotted by year (top left) and cohort (top right), log abundance curves (bottom left) and associated negative gradients for each cohort across the reference fishing mortality of age 2–4 (bottom right), for the IBTSQ3 groundfish survey.

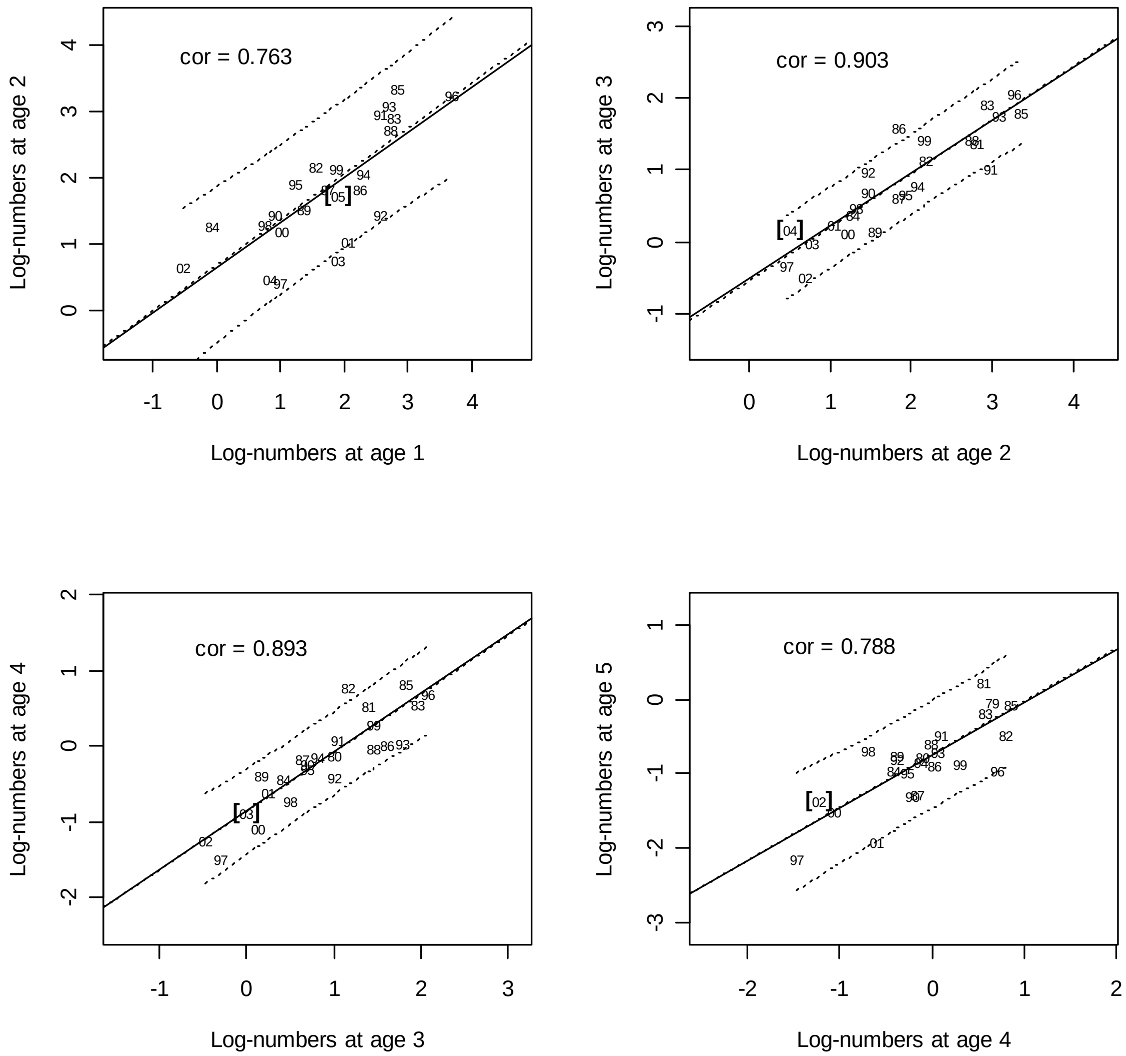


Figure 14.7a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Within-survey correlations for IBTSQ1 for the period 1983–2007. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line nearest to it a robust linear regression line, and "cor" denotes the correlation coefficient. The pair of broken lines on either side of the solid line indicate prediction intervals. The most recent data appear in square brackets.

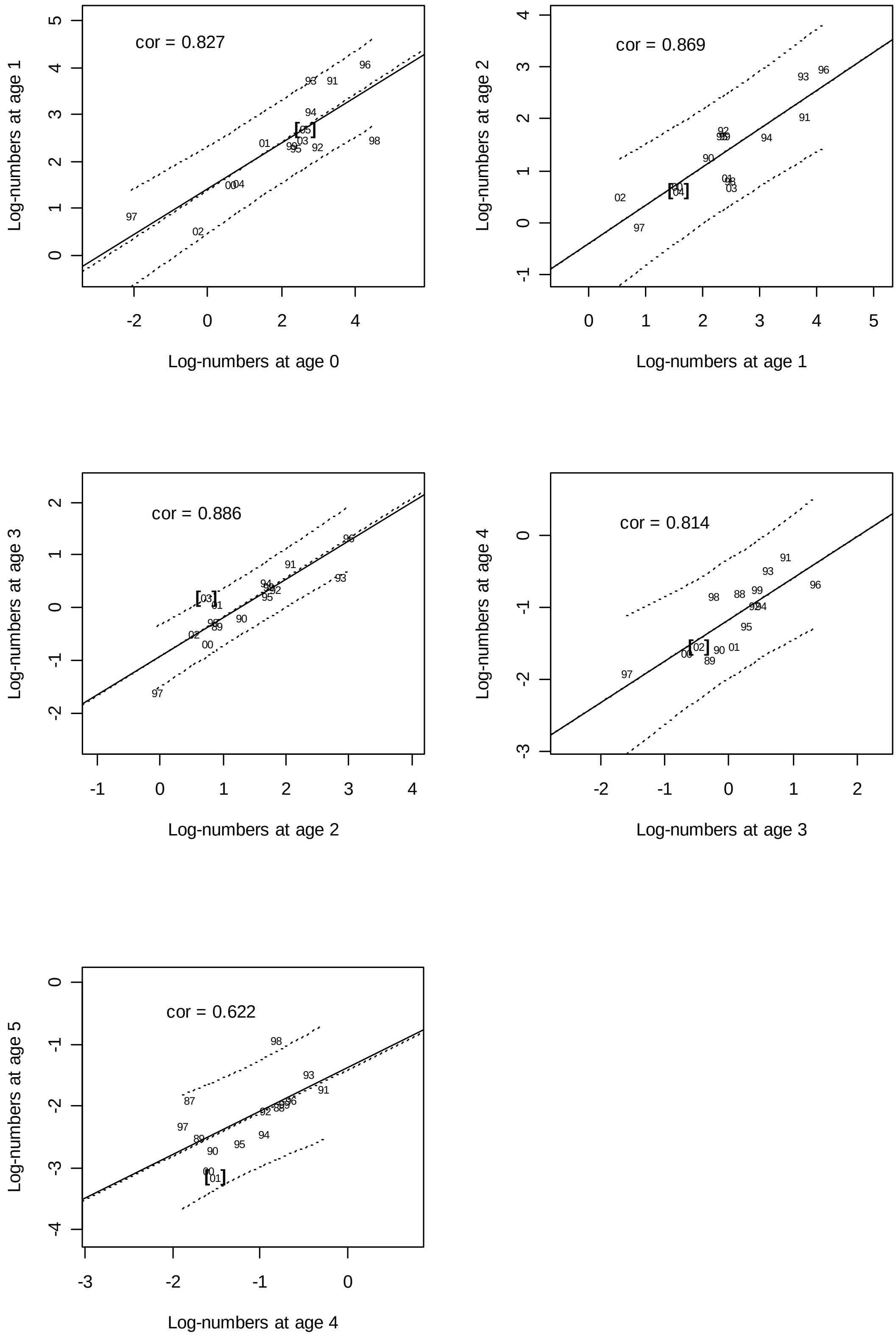


Figure 14.7b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Within-survey correlations for IBTSQ3 for the period 1991–2006. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line nearest to it a robust linear regression line, and "cor" denotes the correlation coefficient. The pair of broken lines on either side of the solid line indicate prediction intervals. The most recent data appear in square brackets.

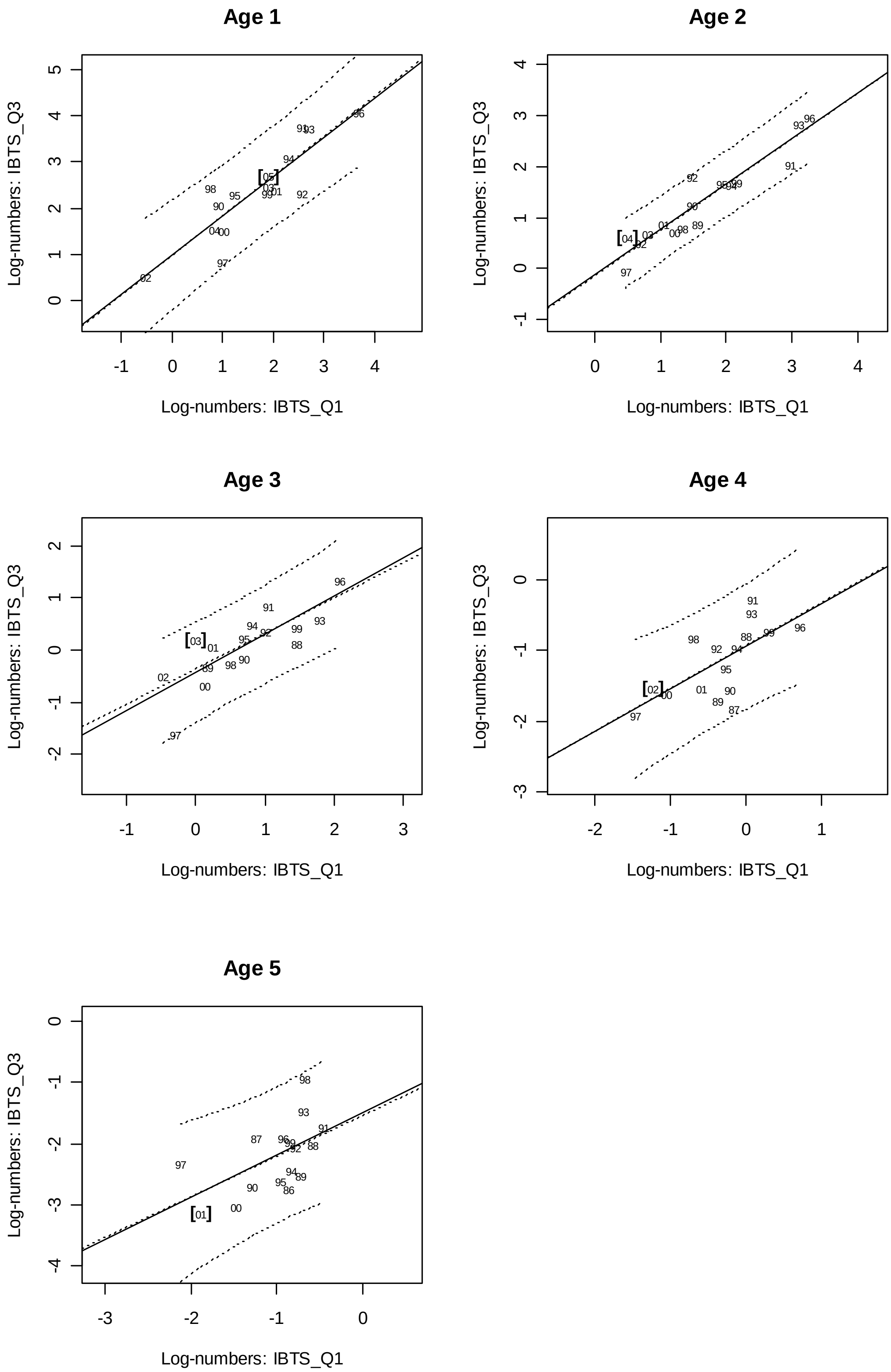


Figure 14.7c Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Between-survey correlations for IBTSQ1 and Q3 surveys for the period 1991–2006. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, and the broken line nearest to it a robust linear regression line. The pair of broken lines on either side of the solid line indicate prediction intervals. The most recent data appear in square brackets.

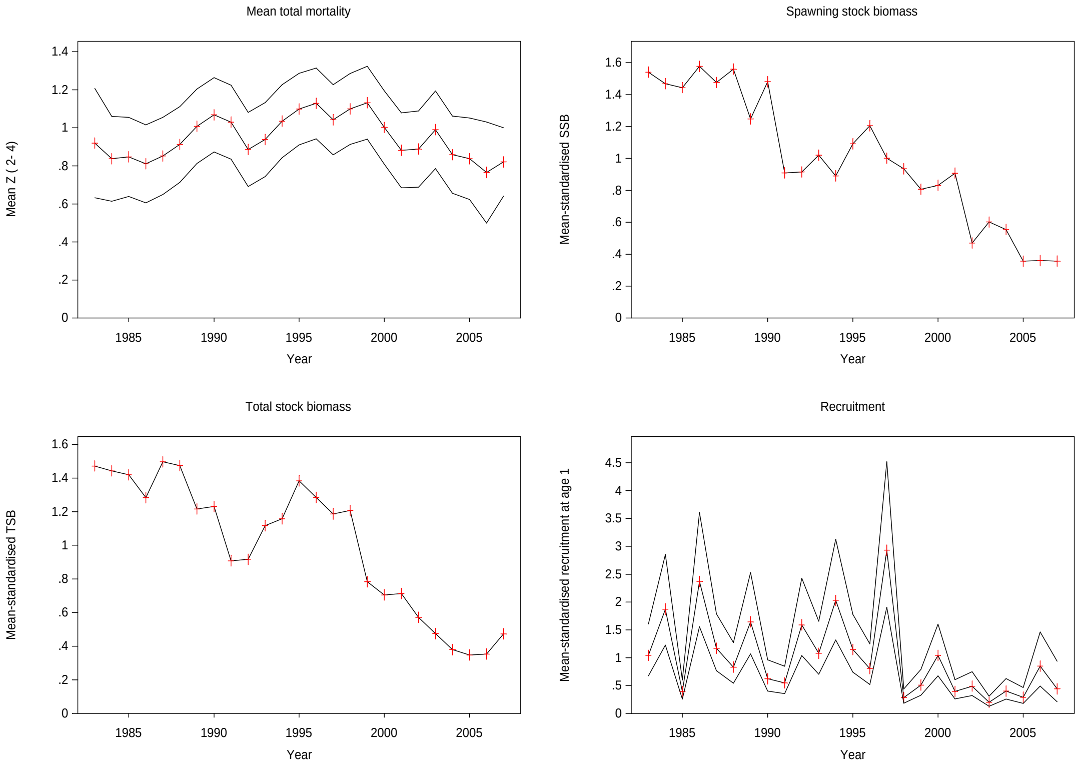


Figure 14.8a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Surba summary plots for estimates of total mortality, spawning stock biomass, total biomass and recruitment for the IBTSQ1 survey. The smoothing parameter λ is set to 2.

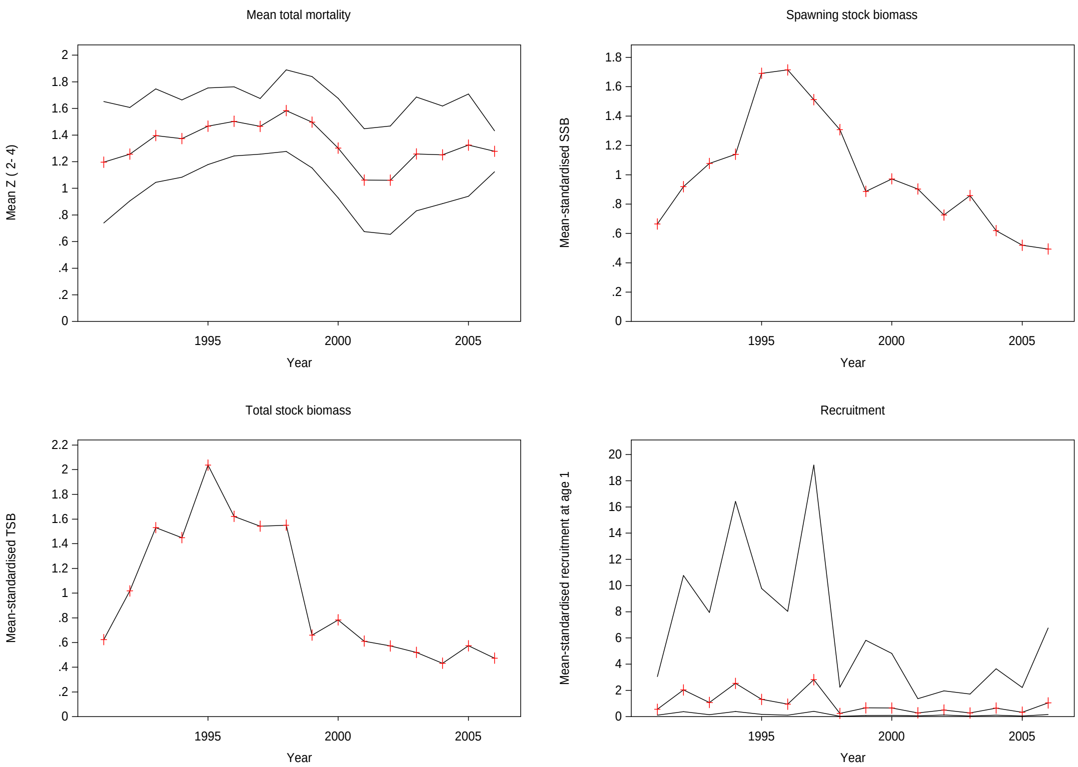


Figure 14.8b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Surba summary plots for estimates of total mortality, spawning stock biomass, total biomass and recruitment for the IBTSQ3 survey. The smoothing parameter λ is set to 2.

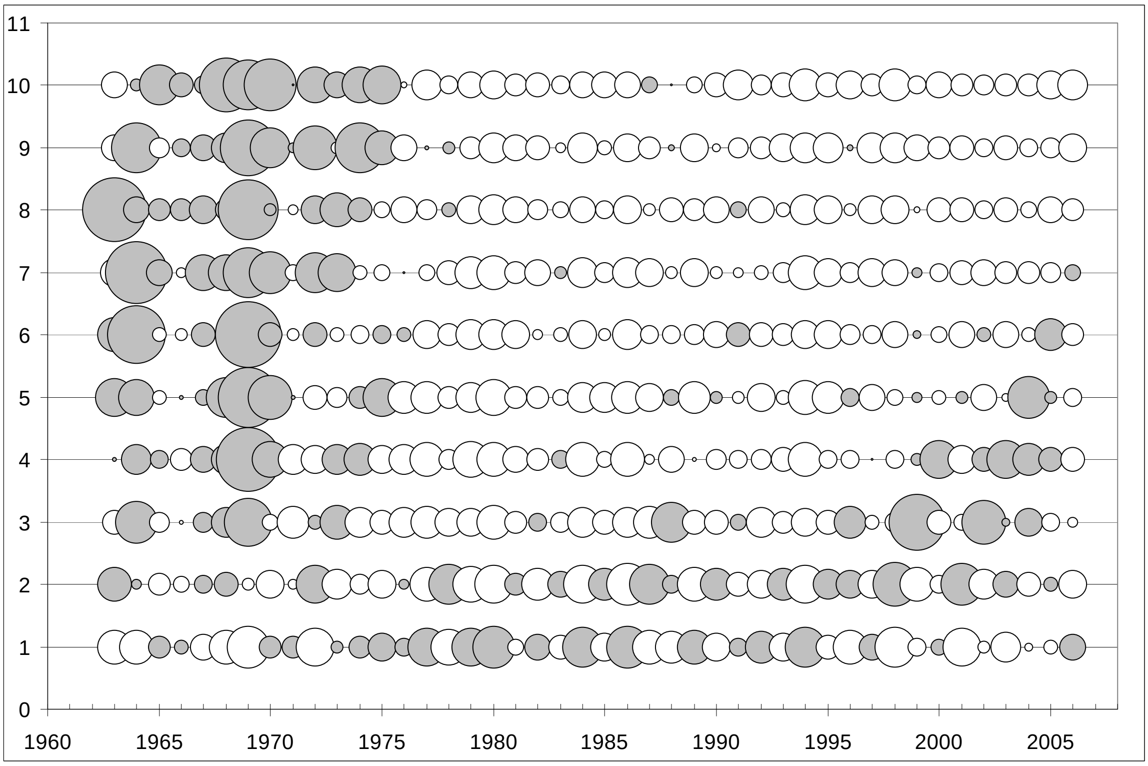


Figure 14.9 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Total catch-at-age matrix expressed as proportions-at-age which have been standardised over time (for each age, this is achieved by subtracting the mean proportion-at-age over the time series, and dividing by the corresponding variance). Grey bubbles indicate proportions above the mean over the time series at each age.

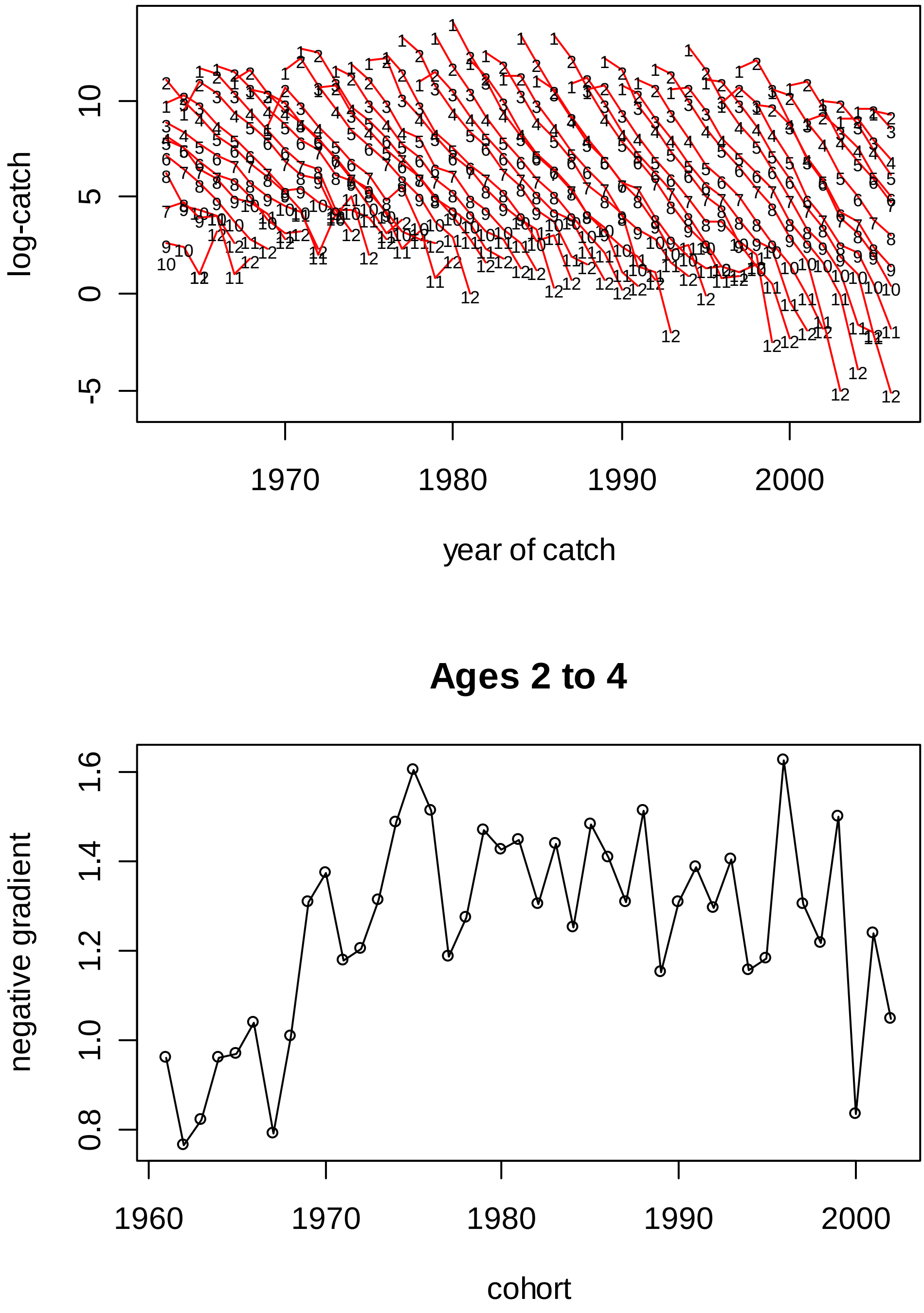


Figure 14.10 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Log-catch cohort curves (top panel) and the associated negative gradients for each cohort across the reference fishing mortality of age 2–4.

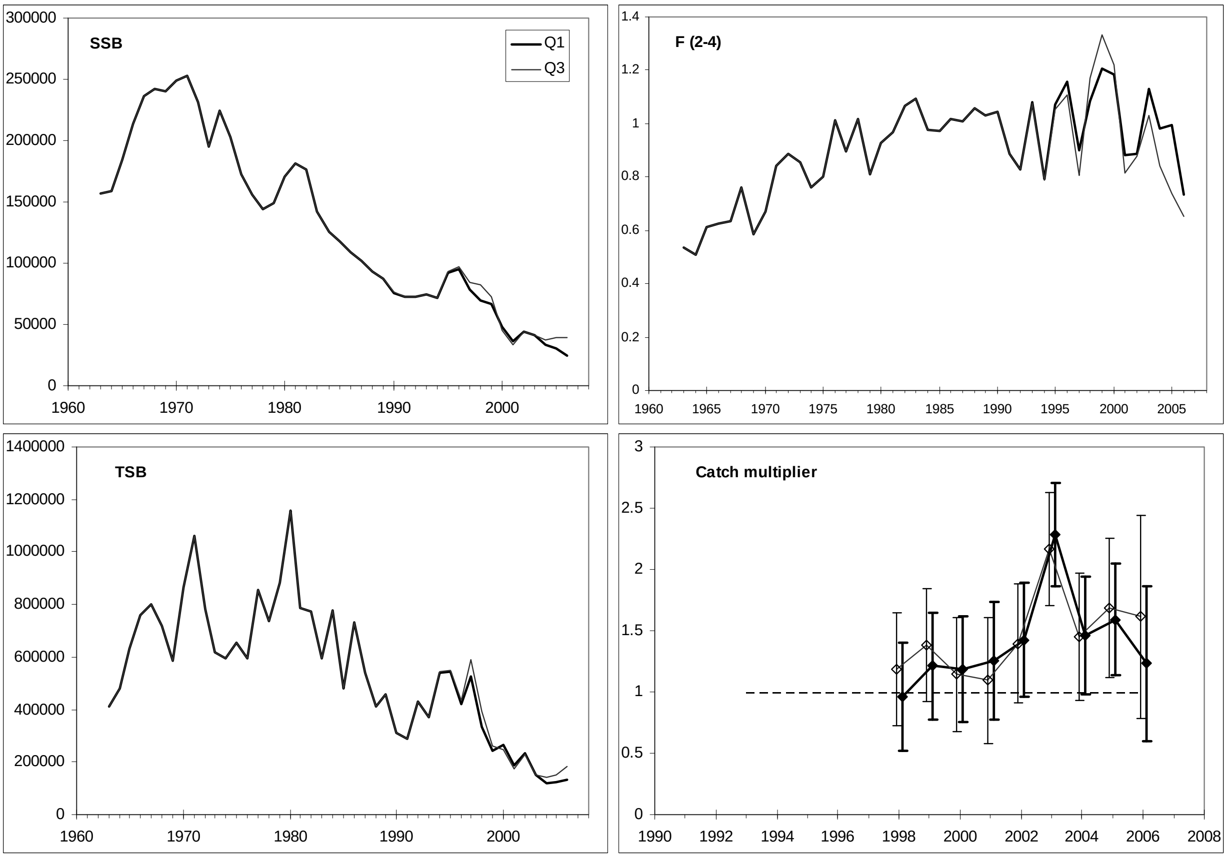


Figure 14.11 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Point estimates of spawning stock biomass (SSB), total stock biomass (TSB), average fishing mortality (F (2–4)) and the catch multiplier for B-ADAPT single fleet runs for the IBTSQ1 and Q3 groundfish surveys. The error bars in the catch multiplier plot indicate ±2 standard deviation.

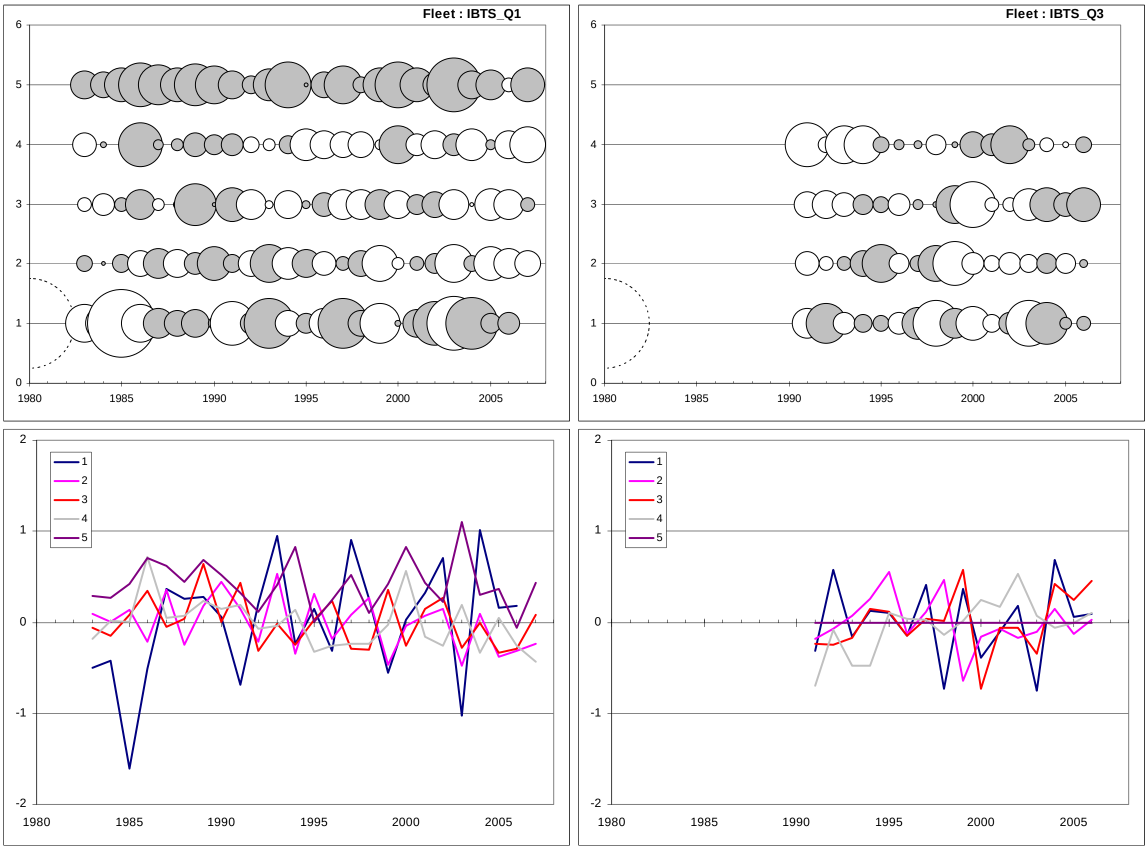


Figure 14.12a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Residual plots for B-Adapt run 3 (SPALY). In the top row grey bubbles indicate positive values, and white ones negative. The partially displayed dotted bubble indicates an absolute residual of size 3. The bottom row provides an alternative display of the residuals.

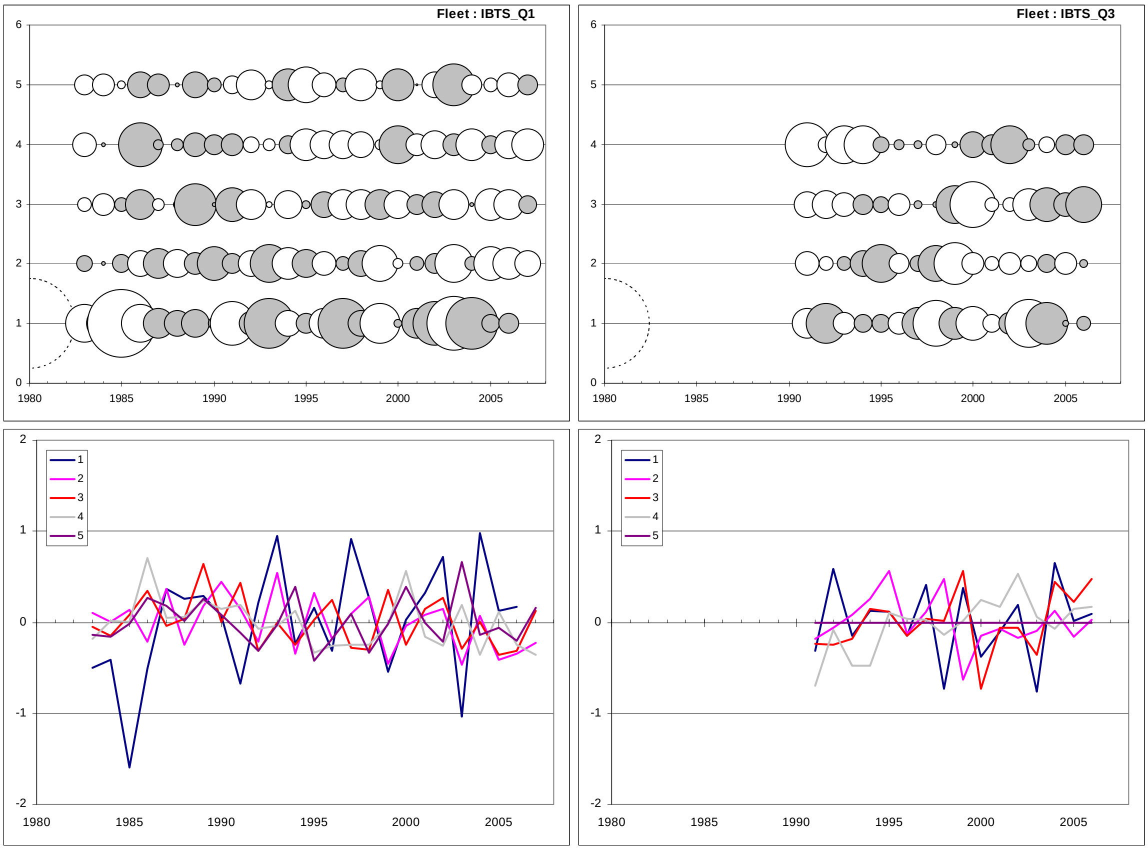
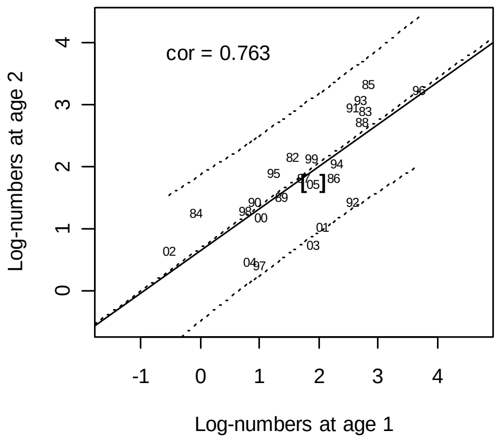
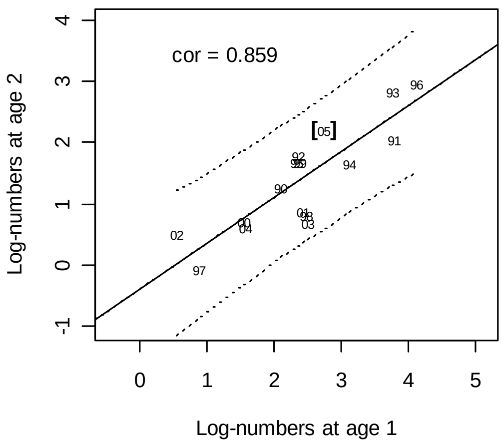


Figure 14.12b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Residual plots for B-Adapt run 4 (Increase q-plateau for IBTSQ1). In the top row grey bubbles indicate positive values, and white ones negative. The partially displayed dotted bubble indicates an absolute residual of size 3. The bottom row provides an alternative display of the residuals.

IBTS_Q1 IBTS_Q3





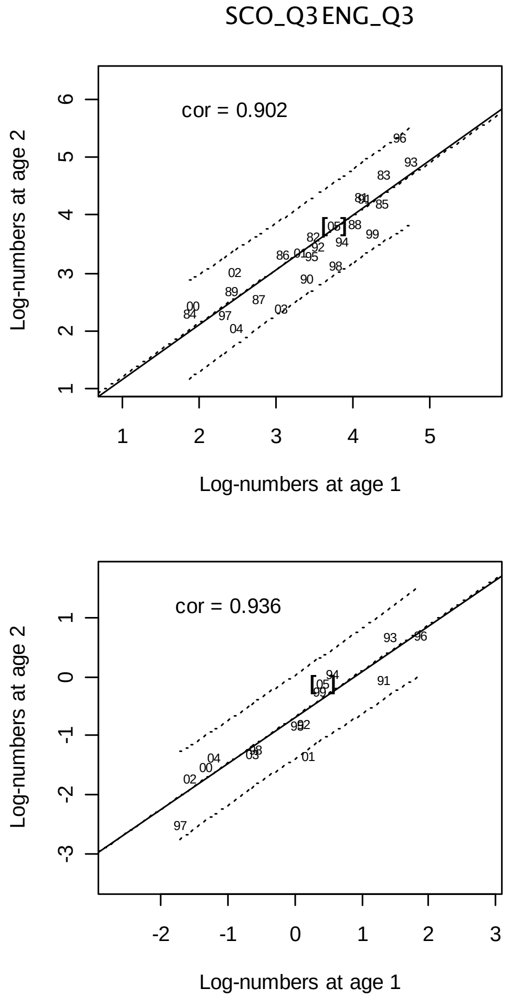
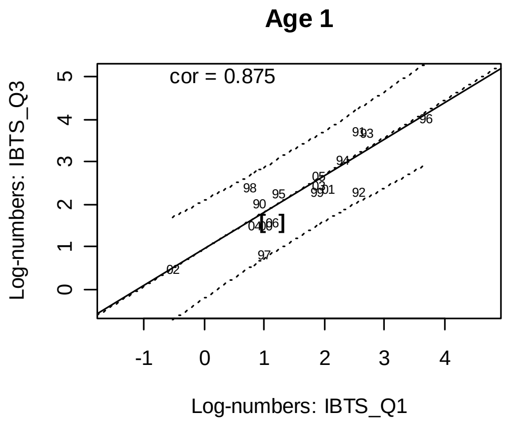
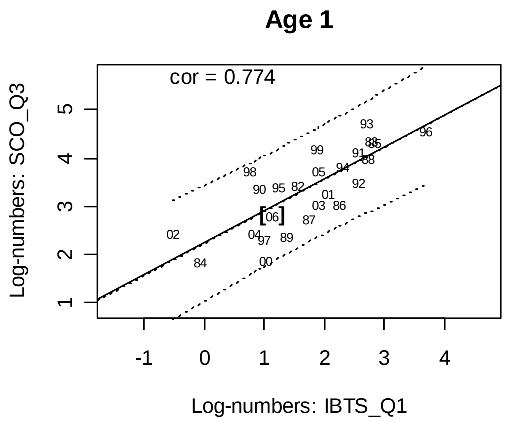


Figure 14.12.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Log mean standardised indices plotted by year (left) and cohort (right) for the IBTS_Q1, IBTS_Q3, SCO_Q3 and ENG_Q3 surveys.

IBTS_Q1 vs IBTS_Q3 IBTS_Q1 vs SCO_Q3





IBTS_Q1 vs ENG_Q3

IBTS_Q3 vs SCO_Q3

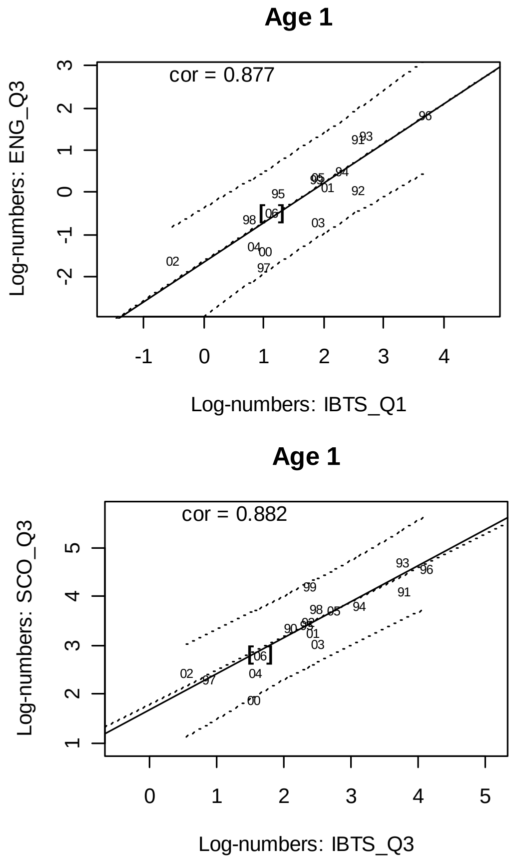
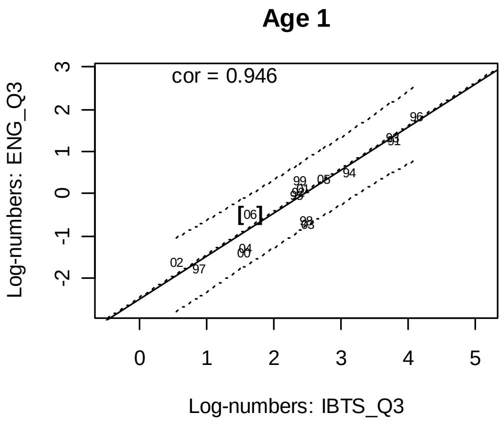


Figure 14.12.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Within-survey consistency plots between cohort ages 1 and 2, with the most recent cohort highlighted in square parentheses.

IBTS_Q3 vs ENG_Q3 SCO_Q3 vs ENG_Q3



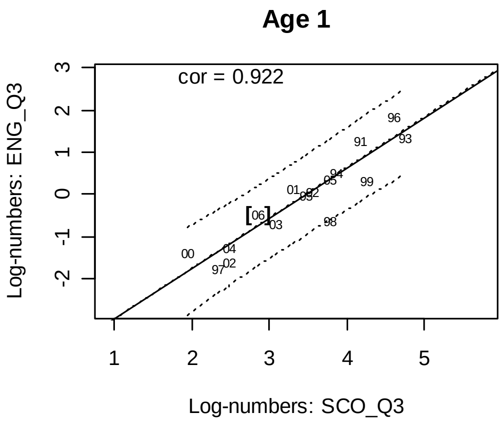


Figure 14.12.3 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Between-survey consistency plots for age 1, with the most recent cohort highlighted in square parentheses.

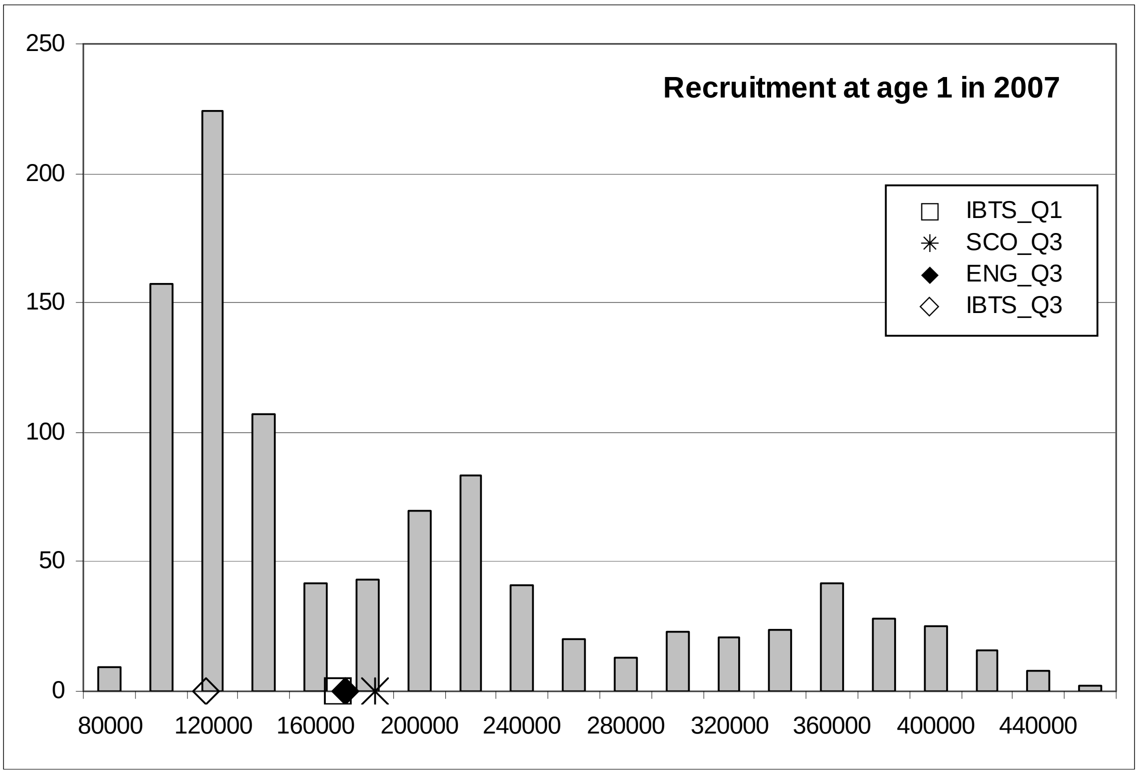


Figure 14.12.4 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Frequency distribution for recruitment at age 1 in 2007 used in the stochastic medium-term forecast for North Sea cod in May 2007, together with estimates of age 1 fish from the 2007 IBTS_Q3, SCO_Q3 and ENG_Q3 surveys, and the 2007 IBTS_Q1 survey, all four estimates being adjusted for catchability. [Note that for the forecast, recruitment for 2007 is sampled with replacement from the 1998-2006 values, hence the reason for the highly skewed distribution.]

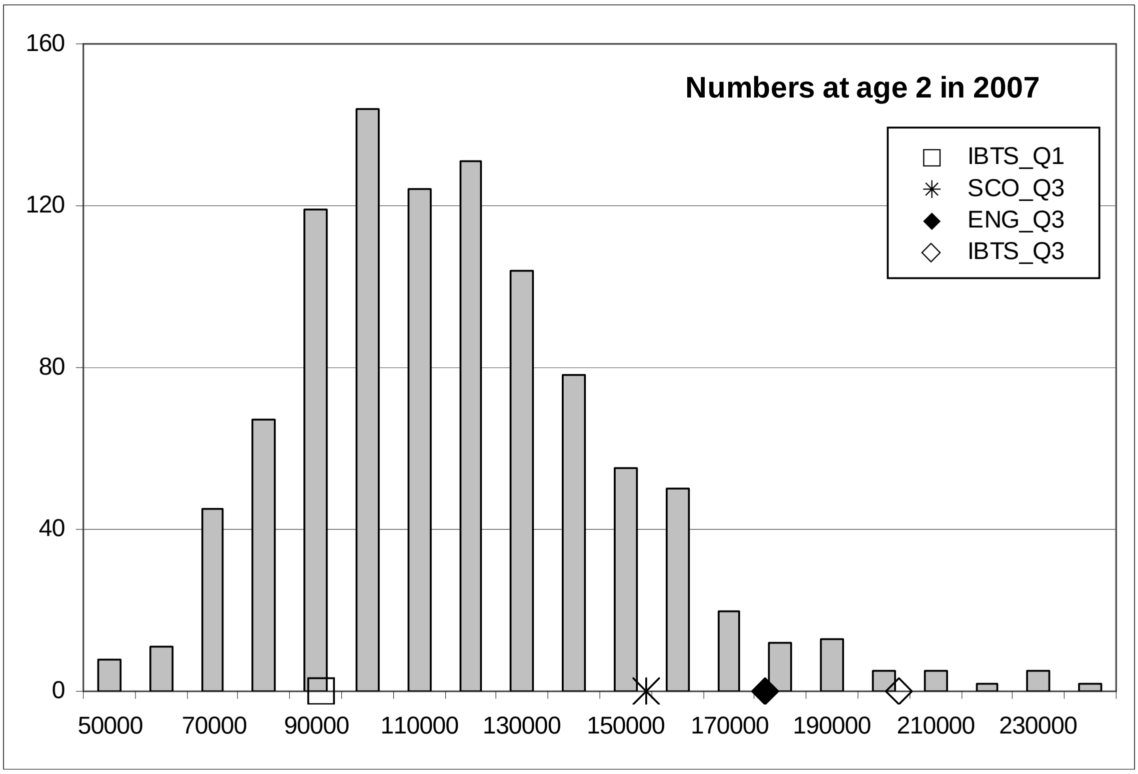
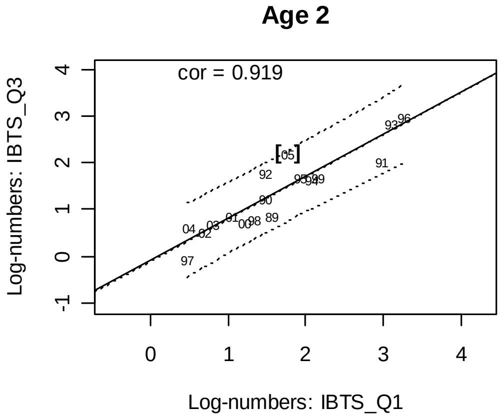
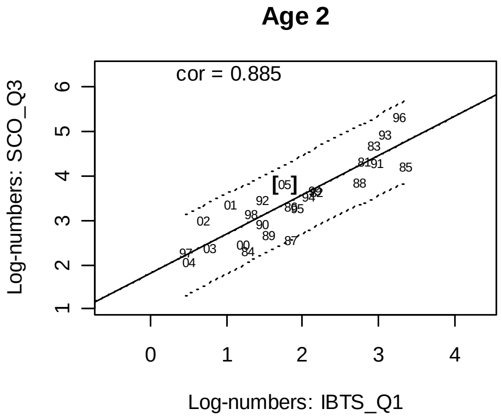


Figure 14.12.5 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Frequency distribution for numbers at age 2 in 2007 used in the stochastic medium-term forecast for North Sea cod in May 2007, together with estimates of age 2 fish from the 2007 IBTS_Q3, SCO_Q3 and ENG_Q3 surveys, and the 2007 IBTS_Q1 survey, all three estimates being adjusted for catchability.

IBTS_Q1 vs IBTS_Q3

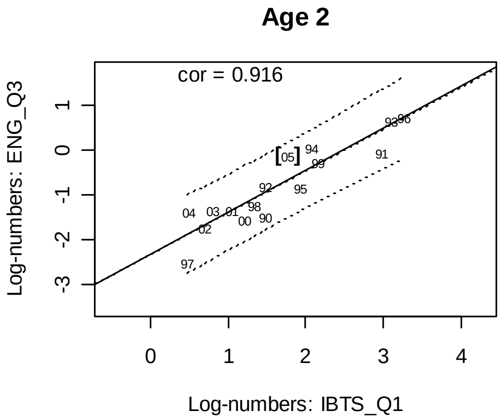
IBTS_Q1 vs SCO_Q3

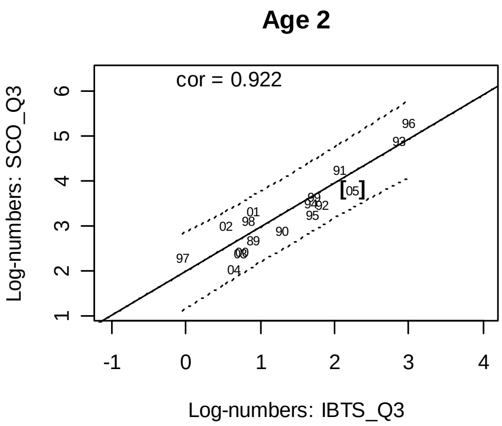




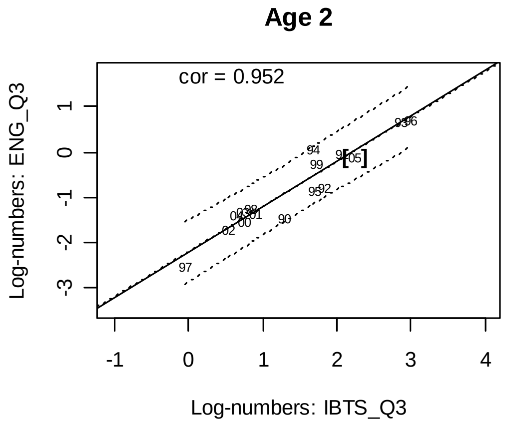
IBTS_Q1 vs ENG_Q3

IBTS_Q3 vs SCO_Q3





IBTS_Q3 vs ENG_Q3



SCO_Q3 vs ENG_Q3

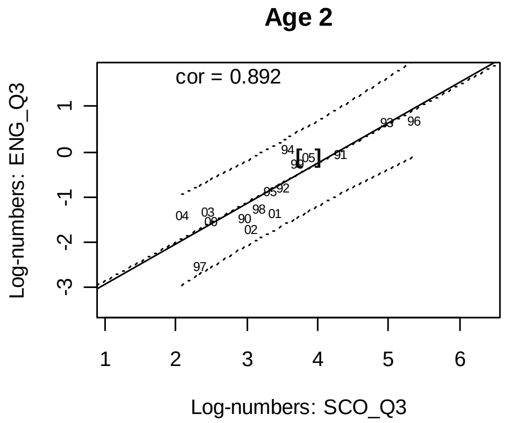


Figure 14.12.6 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Between-survey consistency plots for age 2, with the most recent cohort highlighted in square parentheses.

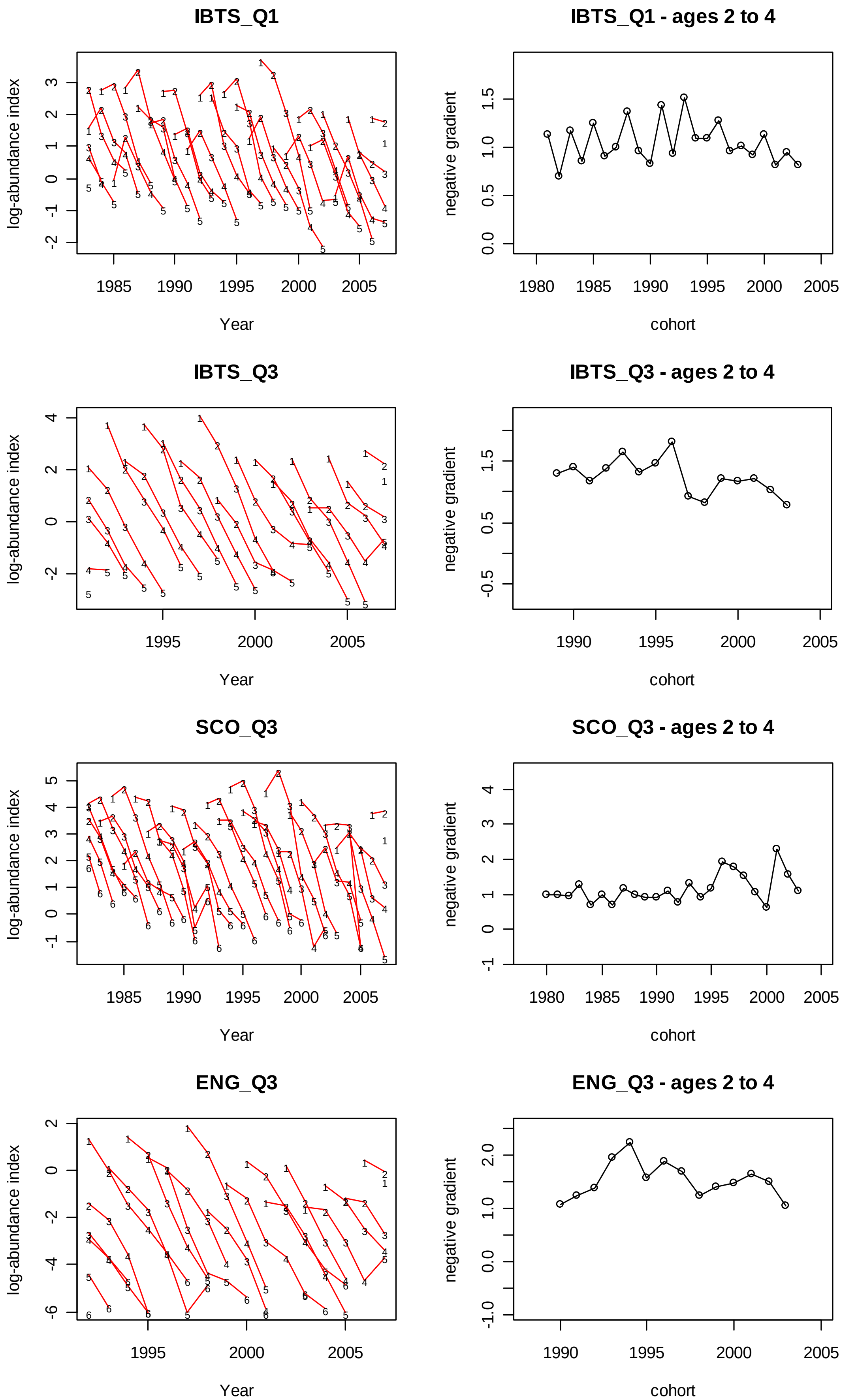


Figure 14.12.7 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Log-catch-curves and negative gradients (ages 2-4) for the four surveys.

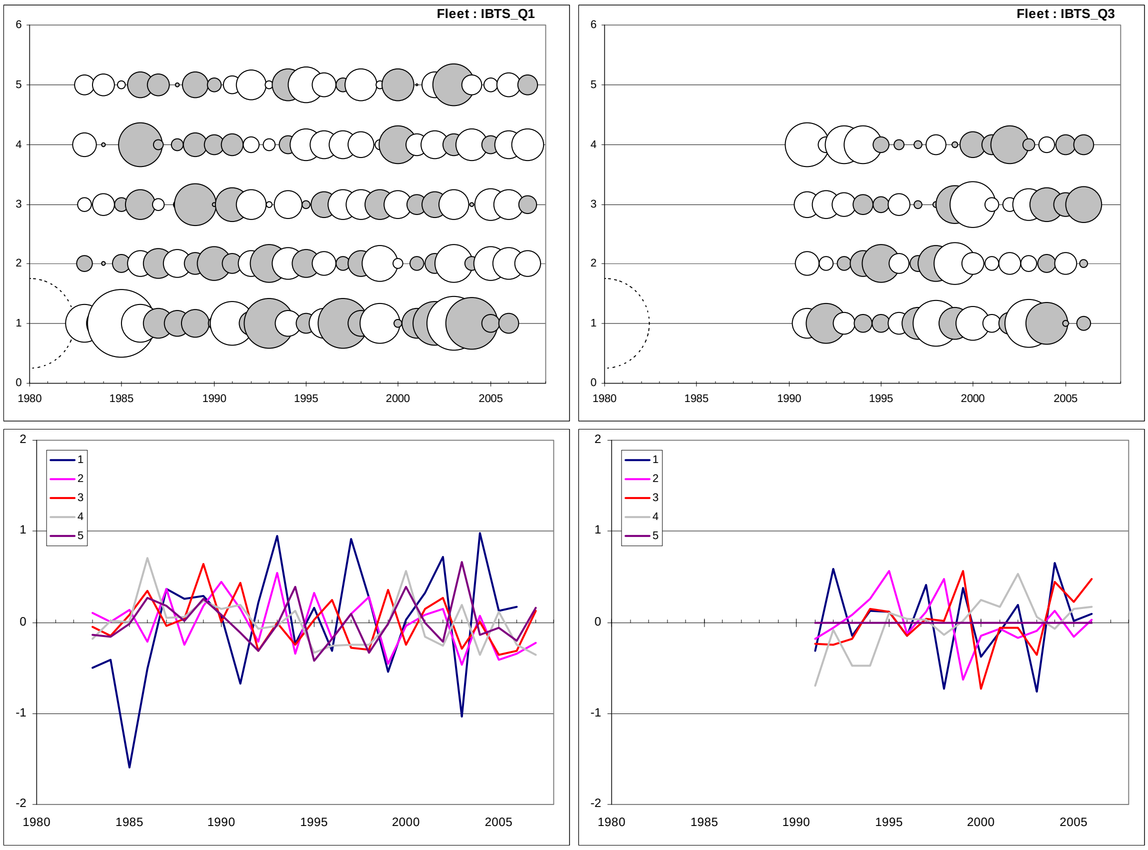


Figure 14.12.8a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. May final assessment residual plots. In the top row, grey bubbles indicate positive values, and white ones negative. The partially displayed dotted bubble indicates an absolute residual of size 3. The bottom row provides an alternative display of the residuals.

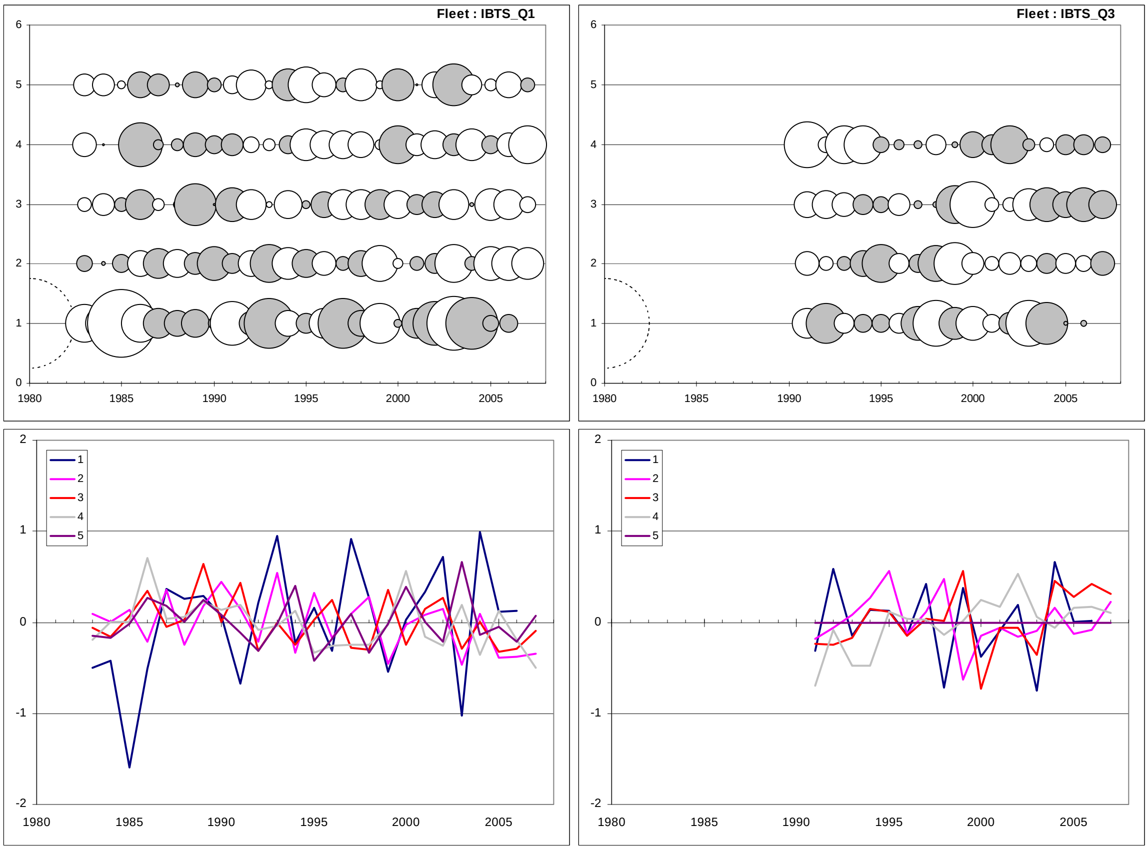


Figure 14.12.8b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. September update assessment residual plots. Details as in caption to Figure 14.12.8a.

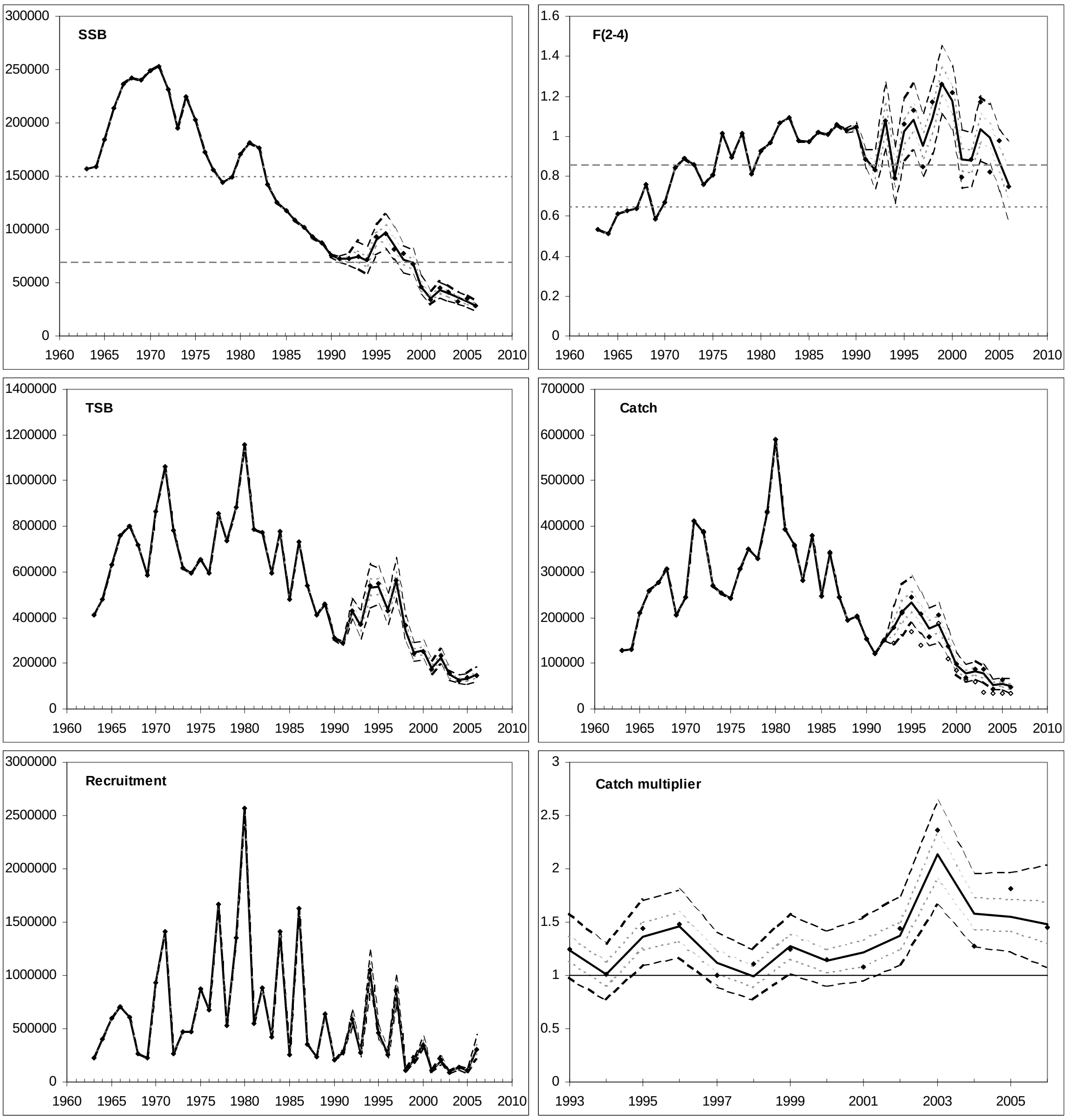


Figure 14.12.9a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. May final assessment summary plots. Clockwise from top left, percentiles (5,25,50,75,95) of the estimated spawning stock biomass (SSB), total stock biomass (TSB), recruitment, the catch multiplier, catch and mean fishing mortality for ages 2-4 (F(2-4)), from the B-ADAPT model applied with smoothing. The heavy lines represent the bootstrap median, the light broken lines the 25th and 75th percentiles and the heavy broken lines the 5th and 95th percentiles. The solid diamonds represent point estimates, and the open diamonds given in the catch plot the recorded total catch. The horizontal broken lines in the SSB plot indicate Blim=70 000t and Bpa=150 000t, those in the F(2-4) plot Fpa=0.65 and Flim=0.86. The horizontal solid line in the catch multiplier plot indicates a multiplier of 1.

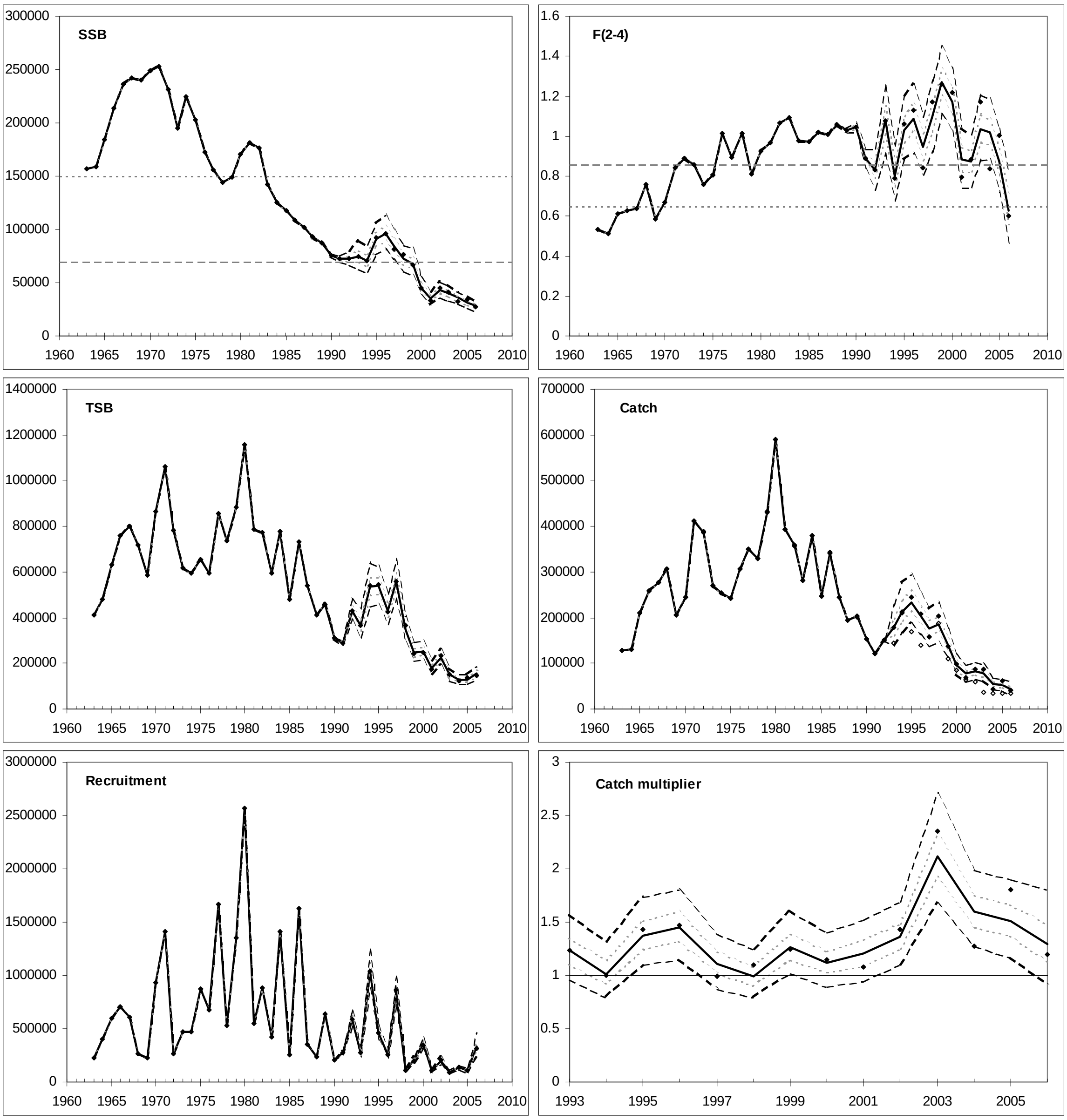


Figure 14.12.9b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. September update assessment summary plots. Details as in caption to Figure 14.12.9a.

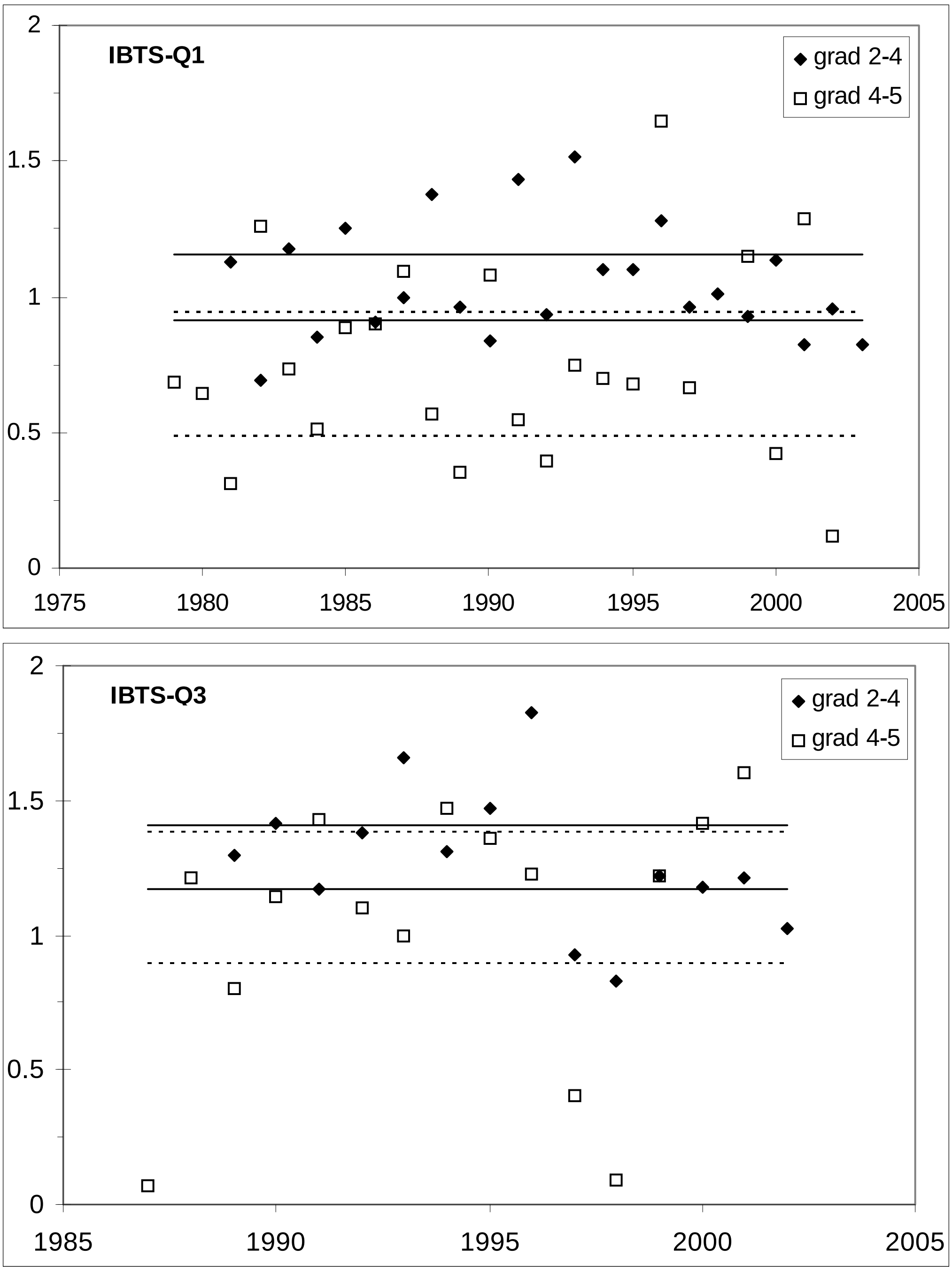


Figure 14.13 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. The negative gradients of the log-abundance curves shown in Figures 14.6a and b for IBTSQ1 and Q3 surveys respectively, are plotted for each cohort (indicated on the horizontal axis) for the same age range (2–4), shown as solid diamonds, and for age range 4–5, shown as open squares. The solid lines indicate that 50% of the age 2–4 gradients (solid diamonds) fall within these lines, and the broken line indicating to the same for the age 4–5 gradients (open squares).

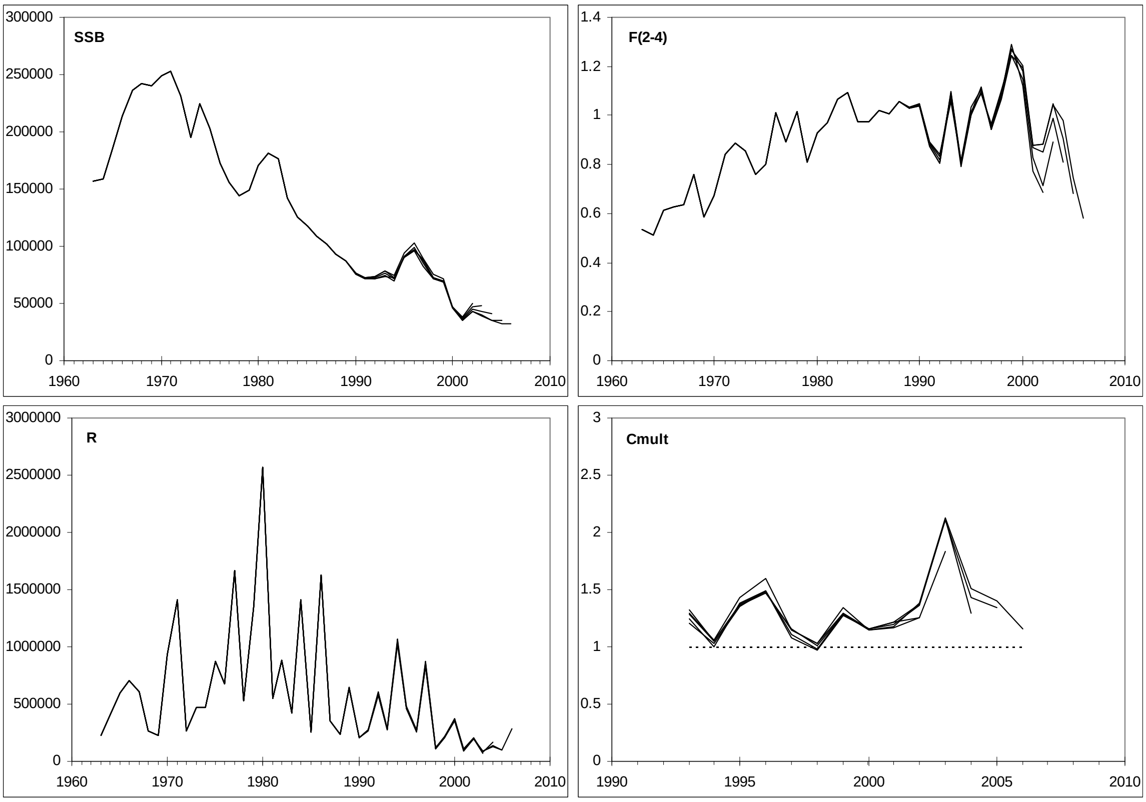


Figure 14.14a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. 5–year retrospective plots of SSB, Recruitment, F(2–4) and the catch multiplier for B-Adapt run 3 (SPALY).

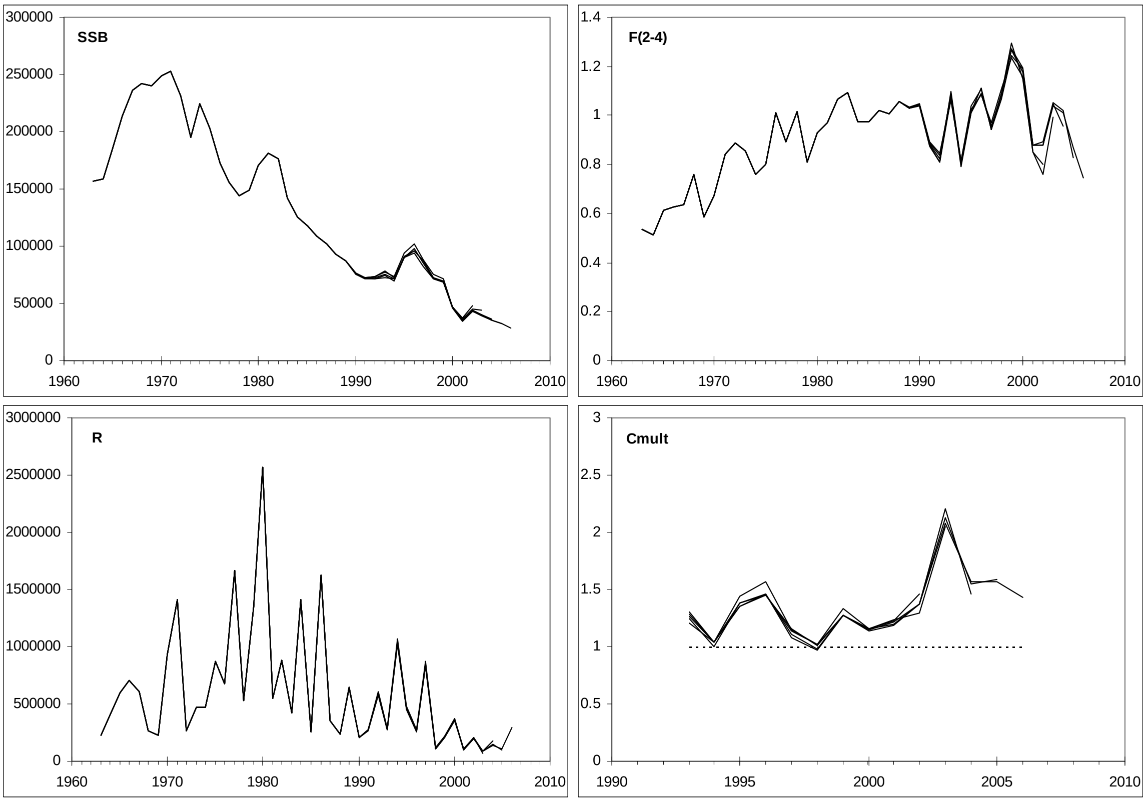


Figure 14.14b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. 5–year retrospective plots of SSB, Recruitment, F(2–4) and the catch multiplier for B-Adapt run 4 (Increase q-plateau for IBTSQ1).

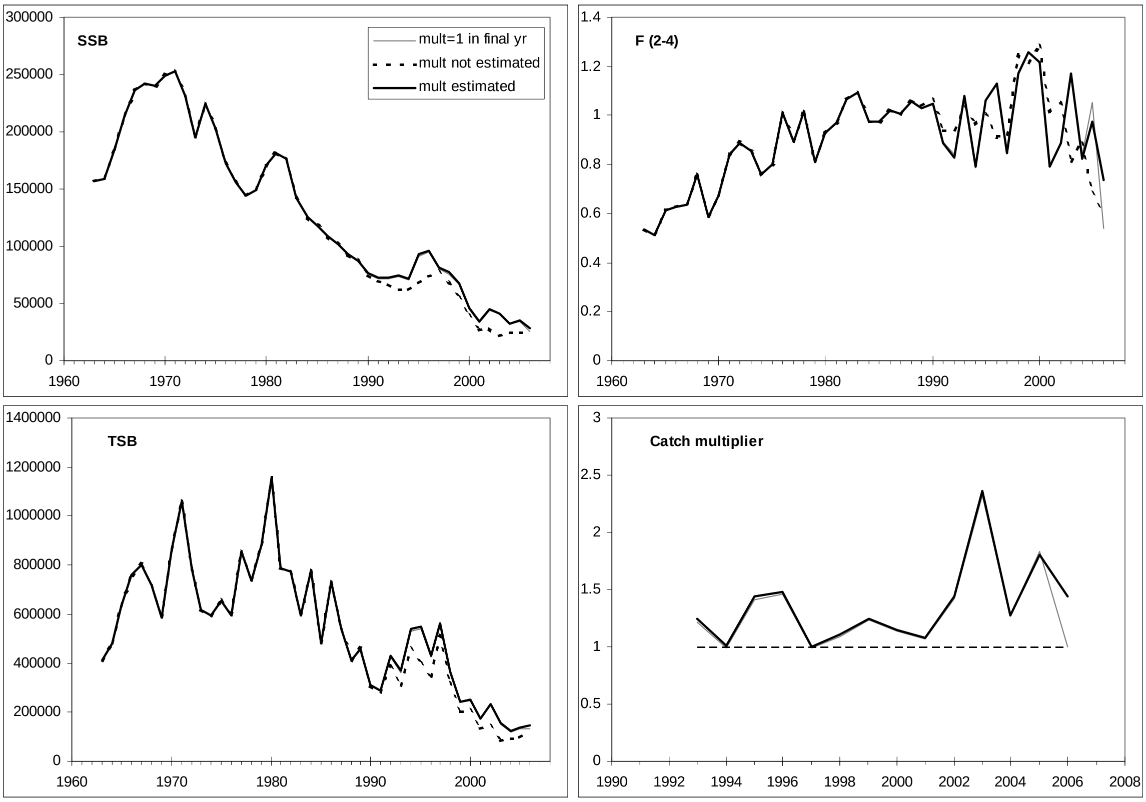


Figure 14.15 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Sensitivity of B-Adapt run 4 (indicated as "mult estimated" to fixing the catch multiplier at 1 in 2006 (run 5 "mult=1 in final yr") and not estimating the catch multiplier (run 6, "mult not estimated").

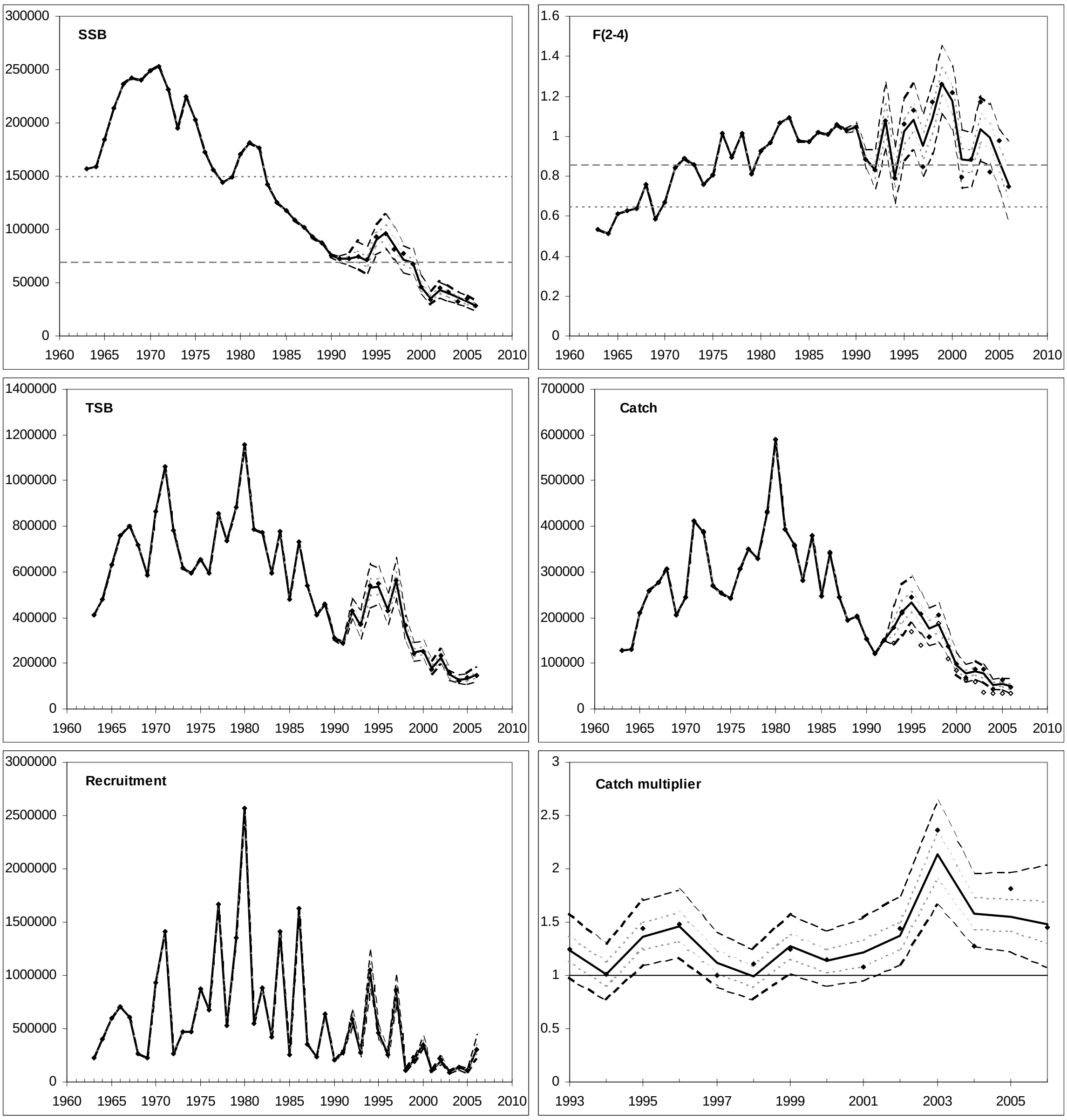


Figure 14.16 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Clockwise from top left, percentiles (5, 25, 50, 75, 95) of the estimated spawning stock biomass (SSB), total stock biomass (TSB), recruitment, the catch multiplier, catch and mean fishing mortality for ages 2-4 (F(2–4)), from the B-ADAPT model applied with smoothing. The heavy lines represent the bootstrap median, the light broken lines the 25th and 75th percentiles and the heavy broken lines the 5th and 95th percentiles. The solid diamonds represent point estimates, and the open diamonds given in the catch plot the recorded total catch. The horizontal broken lines in the SSB plot indicate Blim=70 000t and Bpa=150 000t, those in the F(2–4) plot Fpa=0.65 and Flim=0.86. The horizontal solid line in the catch multiplier plot indicates a multiplier of 1.

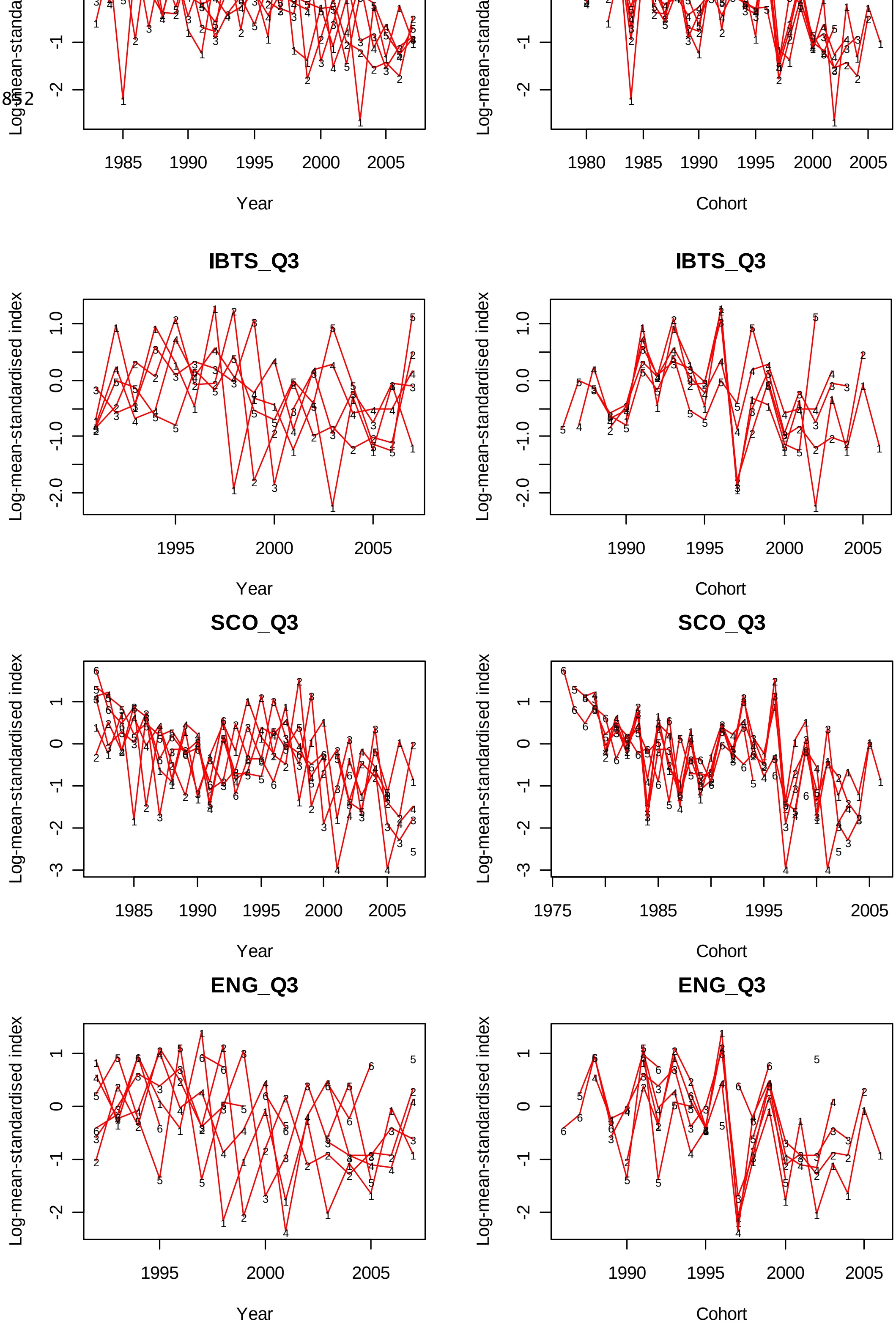


Figure 14.17. Cod in Sub-Area IV and Divisions IIIa and VIId. Historical performance of the assessment. Circles indicate forecasts.

15 Management Plan Evaluations

15.1 Norway Pout Harvest Control Rule simulations

In response to a request from the European Commission, the ad hoc group on real time management and harvest control rules for Norway pout in the North Sea and Skagerrak (AGNOP) was convened earlier in 2007.

The group were requested to explore Harvest Control Rules (HCRs) which

i) allow the Maximum Sustainable Yields (MSY) to be obtained and are consistent with the precautionary approach,

ii) take into account the function of Norway pout in the ecosystem.

The request included an expectation that management of the Norway Pout fishery may include the setting of preliminary catch and/or fishing effort limits at the beginning of the year followed by an in-year revision in response to additional information. 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. Furthermore, the monitoring systems and assessment methodologies required to implement the advised harvest control rules should be advised. In addition to this type of management, strategies which fixed either the TAC or an effort level were investigated.

A presentation was made to WGNSSK outlining the results of the investigations undertaken by AGNOP. The escapement HCR which attempts to provide maximum landings whilst ensuring the SSB in the following year remains at or above B_{pa} was the most successful in terms of long term yield, however the fishery was subject to frequent closures followed by fishing at full capacity. The fixed TAC HCR is unsatisfactory in that in order to have a reasonable probability that B_{lim} will be avoided, the TAC would be at an extremely low level. The fixed F HCR appears to be a feasible approach due to the well defined relationship between effort and F (Figure 15.1). This approach could be implemented through the capping of effort (e.g. KW hours) and was found to fit with ICES precautionary approach when F is less than 0.35.

AGNOP recommended that the escapement HCR with in-year revisions would be the preferable way forward for the management of Norway Pout fisheries. The findings of AGNOP have been discussed with the industry who stated that they would like to see a more stable fishery, preferably one based upon a constant TAC but if that proved too restrictive then constant effort would be their second choice.

WGNSSK raised some points of concern with the approach taken by AGNOP, principally regarding the choice of stock-recruit model. AGNOP used a stochastic, hockey-stick approach to the modelling of recruitment which although it satisfies the long-term range of observed recruitments, fails to adequately deal with the trend for low recruitment currently observed. This would have the consequence of underestimating the risk to the stock of falling below B_{lim}. Discussion ensued as to whether a sequence of low recruitments would represent a regime shift or not, and if so at what point would reference points need to be amended. A suggestion that including an auto-correlative function in the recruitment model may enable the probability of several low recruitments to be encapsulated without demanding recursive amendments to reference points. Although AGNOP discuss the potential influence of uncertainty surrounding other parameters such as weight at age, maturity and natural mortality the effects of uncertainty in these parameters was not considered and WGNSSK felt that this omission may influence the level of F required to maintain the stock above B_{pa} and B_{lim}.

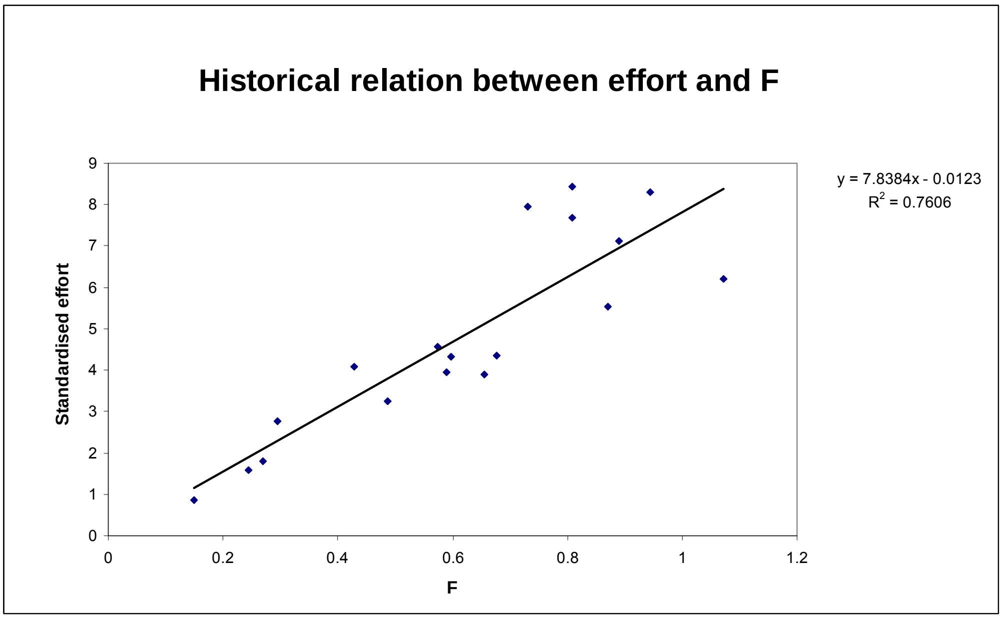

Historical relation between effort and F
y = 7.8384x - 0.0123
R2 = 0.7606
Standardised effort
F
0
1
2
3
4
5
6
7
8
9
0
0.2
0.4
0.6
0.8
1
1.2

Figure 15.1

15.2 Section 2 Evaluation of the EU – Norway, North Sea, west of Scotland and the Skagerrak saithe management plan

In 2007 ICES was requested to:

DRAFT REQUEST TO ICES BY NORWAY AND THE EUROPEAN COMMUNITY CONCERNING SAITHE IN THE NORTH SEA AND WEST OF SCOTLAND

15.2.1 Background

The Community and Norway have implemented long-term management plans concerning saithe in the North Sea, west of Scotland and the Skagerrak. These arrangements are to be reviewed in 2007.

15.2.2 Request concerning saithe in the North Sea and West of Scotland.

ICES is requested to evaluate the management plans agreed between Norway and the European Community (Annex A) concerning saithe of North Sea origin with particular respect to:

(a) *achieving the highest yields long-term from these stocks;*
(b) *ensuring conformity with the precautionary approach;*
(c) *achieving yields as stable as possible, consistent with achieving a high yield from the stocks and achieving conformity with precautionary principles.*

ICES is invited to provide recommendations on any appropriate alterations to the target fishing mortality rate(s) (para. 2), the rule concerning stability of TACs (para 5), or the degressive rate of fishing mortality at lower stock sizes (para. 3).

ICES is further invited comment on any other pertinent aspect of the management plan.

15.2.3 Background

Management of saithe in ICES Sub-areas IV and VI and Division IIIa 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.

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 than 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."

The agreement is due for revision in 2007. This report attempts to investigate the likely effects of the management plan using computer simulations based on the recent dynamics of the stock and the fishery. ICES has been requested to "*evaluate the management plans agreed between Norway and the European Community (Annex A) concerning saithe of North Sea origin with particular respect to:*

(d) achieving the highest yields long-term from these stocks;
(e) ensuring conformity with the precautionary approach;
(f) achieving yields as stable as possible, consistent with achieving a high yield from the stocks and achieving conformity with precautionary principles.

ICES is invited to provide recommendations on any appropriate alterations to the target fishing mortality rate(s) (para. 2), the rule concerning stability of TACs (para 5), or the degressive rate of fishing mortality at lower stock sizes (para. 3).

ICES is further invited comment on any other pertinent aspect of the management plan.

15.2.4 The EU-Norway saithe management plan agreement

The 2004 management plan is the starting point for these evaluations; the interpretation of the management plan in terms of an algorithm is given below.

For the algorithm, assessment year = y-1, and TAC year = y, the year in which the level of SSB is evaluated against reference levels; γ is the permitted maximum annual increase or decrease in the annual catch (i.e $\gamma = 0.15$ => +/-15%)

For this agreement in order allow simulation testing of modifications to this algorithm it is assumed that the current management plan constants are equivalent to:

$F_{max}= 0.3$, $F_{low} = 0.1$, $F_{max} – F_{low} = 0.2$
$B_{pa} = 200000$, $B_{lim} = 106000$, $B_{pa} – B_{lim} = 94000$
$\gamma = 0.15$

A graphical representation of the harvest control rule is presented in Figure 15.2.1, the EU - Norway agreement can be transcribed as

(a) *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.*

If $SSB_y \geq B_{pa}$, then:
(Case 5) Set $F_{target} = F_{max}$
(Case 4) Meet constraint $MAX(1-\gamma; 0)\cdot TAC_{y-1} \leq TAC_y \leq (1+\gamma)\cdot TAC_{y-1}$

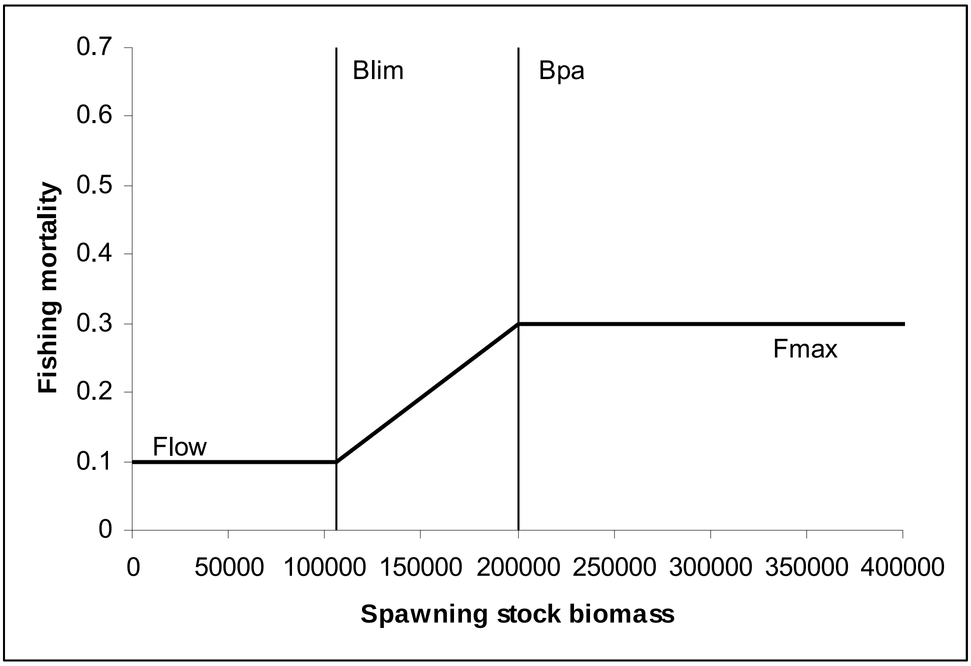
(b) Where the SSB is estimated to be below 200 000 tonnes but above 106 000 tonnes the TAC shall not exceed a level which, on the basis of a scientific evaluation by ICES, will result in a fishing mortality rate equal to 0.30-0.20(200 000-SSB)/94 000.*

If $B_{lim} \leq SSB_y < B_{pa}$, then
(Case 3) Set $F_{target} = F_{max} – (F_{max}-F_{low})\cdot(B_{pa}-SSB_y)/(B_{pa}-B_{lim})$
(Case 2) Meet constraint $MAX(1-\gamma; 0)\cdot TAC_{y-1} \leq TAC_y \leq (1+\gamma)\cdot TAC_{y-1}$

(c) *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.*

$SSB_y < B_{lim}$, then:
(Case 1) Set $F_{target} = F_{low}$
Apply no TAC constraints

(d) *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 than 15% greater or 15% less than the TAC of the preceding year.*



Meet constraint $MAX(1-\gamma; 0)\cdot TAC_{y-1} \leq TAC_y \leq (1+\gamma)\cdot TAC_{y-1}$

Figure 15.2.4.1 A graphical representation of the suggested EU – Norway harvest control rule for North Sea, west of Scotland and the Skagerrak saithe

15.3

The preceding algorithm assumes that the trigger biomass for the harvest control rule (the x-axis in Figure 15.2.4.1) is measured at the beginning (Jan 1) of the quota year (denoted above by y). This is appropriate if the HCR is viewed as a true F-based management plan, in which the current SSB is used to determine the future target F.

However, another interpretation is possible, namely that the trigger biomass should be measured at the start of the year after the quota year (which we can denote by y+1). This is more in line with historic management practice (at least in some cases), as managers have considered the implications for future SSB of any quota that they specify, and this cannot be done if SSB(y) is used as the trigger metric.

An MSE implementation of this alternative interpretation is available, although it is very slow to run (because of the additional iterative loop that is required) and has not yet been well tested. The problem remains that the HCR itself makes no mention of when the trigger SSB is to be measured: this is an important omission as early results indicate that the performance of the HCR is quite different for different trigger SSBs."

15.4 Stochastic stock projections

15.4.1 The stochastic projection program

The current executable program is called CS_HCR.exe, a modification of the original CS4.exe. CS_HCR is a simple simulation approach developed to evaluate the likely effects and consequences of applying the saithe single species harvest control rule (HCR) and for making a comparison of associated risks. In each year, the components of the harvest rules are:

15.4.1.1 The CS algorithm

Population abundance at age a in the starting year ($N_{a,y}$) is assumed to be observed with log-normal error with age-specific standard deviation s_a and age-specific bias B_a, according to :

$$\hat{N}_{a,y} = N_{a,y} B_a \exp(-s^2/2) \exp(h_{a,y}) \qquad 1$$

where h is a random number drawn from the distribution $\mathbf{N}(0,s^2)$.

Recruitment $N_{1,y}$ is modelled as a stochastic variable dependent on spawning stock biomass (SSB) according to either a parametric or a simple non-parametric spawning stock and recruitment relationship. All other population dynamic parameters (weights at age, maturity, natural mortality) are assumed known precisely and time-invariant.

Fishing mortality in the starting year is constrained equal to a user specified target fishing mortality or that required to achieve a user defined catch.

In years following the starting year, it is assumed that an effort limitation system is in place such that no effort is directed at the fish stocks in excess of that required to take the TACs set according to the harvest rules.

15.4.1.2 Recruitment

The structure of the North Sea, west of Scotland and the Skagerrak saithe stock and recruitment shows no obvious relationship between the level of recruitment and the spawning stock abundance Figure 15.3.1, therefore a segmented or Ockham stock and recruitment model was fitted for use in the simulations as follows:

$$\hat{R}_{y,i} = \begin{cases} \alpha & , \quad SSB_y \geq \beta \\ \dfrac{\alpha \, SSB_y}{\beta} & , \quad SSB_y < \beta \end{cases} \qquad 2$$

where α (the geometric mean) and β (the lowest observed biomass) are the Ockham stock-recruit parameters, and SSB_y are the SSB estimates from the most recent assessment (WGNSSK 2007).

The North Sea working group (WGNSSK 2007) have also commented that prior to 1988 the recruitment dynamics appear to be quite different to that estimated more recently (a change of level, Figure 15.3.2) and so the model was fitted to the observations from the most recent saithe stock assessment from 1988 – 2004.

The standard error (recruitment variation about the stock-recruit curve, denoted $\zeta_{,i}$) is calculated as follows:

$$\zeta_i = \sqrt{\frac{\sum_{y \in Y_i} \left(\ln(R_y) - \ln(\hat{R}_{y,i}) \right)^2}{\left(\sum_{y \in Y_i} 1 \right) - p_i}} \qquad 3$$

where the R_y are recruitment estimates associated with SSB_y, the $\hat{R}_{y,i}$ are from equation 2, Y_i denotes the period considered when defining stock-recruit curve i, and p_i are the number of parameters estimated from the stock-recruit pairs. When generating recruitment in the simulation runs, the following is used:

$$\hat{R}_{y,i} = f_i(SSB_y) e^{\varepsilon_{y,i} - \zeta_i^2 / 2} \qquad 4$$

where f_i represents stock-recruit curve i (from equation 2) and $\varepsilon_{y,i}$ is drawn from a N[0; ζ_i^2] distribution.

15.4.1.3 Data Input

The programme takes a single ASCII file as input. This file must always be named "initdata.txt". There is no other user interface. An example of the input data file, used for the analysis of the base case of the harvest control run is listed in Table 15.3.1.

15.4.1.4 Output

The programme generates files, named *case*, *yield*, *fref*, *ssb*, *recruits* and *change*. SSB is recorded in tonnes; recruits in thousands of fish, fref is the average F over the defined age-range. Files with extension .mc hold the raw iteration outputs (years across, iterations down). Files with extension .pby hold the percentiles of iteration outputs in a format suitable for plotting by a spreadsheet. Files with extension .t hold the same information as the .pby files in a "data table" format suitable for plotting.

15.4.1.5 Post-Processing and Results

Results can be summarised by running the R script "EU_CS_HCR.r". Run titles and the directory containing the run output files are entered in the final lines of the script.

The plotted graphs are self-explanatory. In Figure 15.3.3, time trends in yield, SSB and fishing mortality are plotted along with the risk that spawning stock biomass falls below B_{lim} in any year. In Figure 15.3.4 annual percentage changes in yield SSB and fishing mortality are presented along with the proportion of cases are invoked in any year (e.g. SSB > Bpa but increase in catch restricted to 15% - Case 4). The monitoring statistic provides a summary of the clause within the harvest control algorithm that will constrain the management decision in any year.

15.4.1.6 Interpretation of the results

Any inference from using levels of probability less than 10% or greater than 90% would be ill-advised. This is especially true where a high coefficient of variation at age gives spurious projection probabilities. This is consistent with the findings of the EU sponsored Concerted Action (Gavaris *et al*., 2000) which looked at the estimation of uncertainty. The models should not be used to estimate absolute probabilities but to compare strategies. It would be more appropriate to categorise the risk as high medium and low.

In some cases bias in the expected value results from skewed distributions of projected time series as a result of the imposition of constraints within the HCR, consequently the median of the distributions should be used for comparison between control rules rather than the mean.

15.4.1.7 Assumptions / limitations of the CS_HCR program

Compliance and assessment feedback bias

The simulations assume that compliance with the regulations is 100%. Variability in harvesting is a result of random errors and is not subject to the bias induced by mis-reporting, discarding etc. Similarly within the CS_HCR simulations it is assumed that the spawning stock abundance is estimated by the assessment working group providing management advice, without bias.

Changes in management practices

The model assumes that the harvest control rule is adhered to by managers for the duration of the simulation.

Constancy of the input data

CS_HCR does not represent the true uncertainty or the real range of expected outcomes. A number of events may occur, as the stock abundance increases, that would invalidate the simple assumptions made here, for example:

- Density dependence in growth (examined in section 15.4);
- Changes in natural mortality;
- Changes in discarding or catch reporting practices;
- Environmentally-driven changes in recruitment;
- Changes in maturation.

A thorough exploration of the state of knowledge and beliefs about uncertainties is a much larger task than that attempted here. This approach predicates the forecasts on simple assumptions based on recent experience (e,.g. three year means). Real uncertainties are much larger than those represented here.

Table 15.3.1 Input data to CS_HCR simulation model for North Sea saithe

Starting year,Last year, first age,lastage

2007, 2027, 1, 8

N, selog(Nhat), Bias(Nhat), M, Mat, Expl, WEST, WECA

124451	0.29	1	0.2	0	0.324439701	0.812	0.812
115594	0.29	1	0.2	0.15	0.934898613	1.029	1.029
98165	0.16	1	0.2	0.7	1.374599787	1.302	1.302
22030	0.12	1	0.2	0.9	1.3660619	1.64	1.64
24791	0.11	1	0.2	1	1.660618997	2.183	2.183
16769	0.11	1	0.2	1	1.686232657	2.896	2.896
12378	0.11	1	0.2	1	1.946638207	3.955	3.955
6145	0.11	1	0.2	1	1.946638207	5.263	5.263

SRR parameters (if the last no. is -1 then use Ockham, otherwise Shepherd/Ricker)

124500 97000 0.0 0.0 0.45 -1

HCR % change (up, down), target F, base F, SSBincr% (disabled)

15, 15, 0.3, 0.1, -1000

Spawning Time as fraction of year

0.0

Catch in StartingYear-1 (2007)

127000

Catch in the starting year, or (if negative) F constraint (F SQ = 0.23, TAC = ?, SQ = ?)

-0.23

Ages for calculating reference F

1 4

Reference Biomass to calculate probabilities - Blim, Bpa

106000 200000

SSB in StartingYear-1 (2007)

325000

COMMENTS

****

RUN id : NS saithe EU Norway Recent S/R model (Occam based on short term GM recruits)

Stock : North Sea saithe

Starting Point : 2007 WG assessment

Constraint : 15% Target 0.3

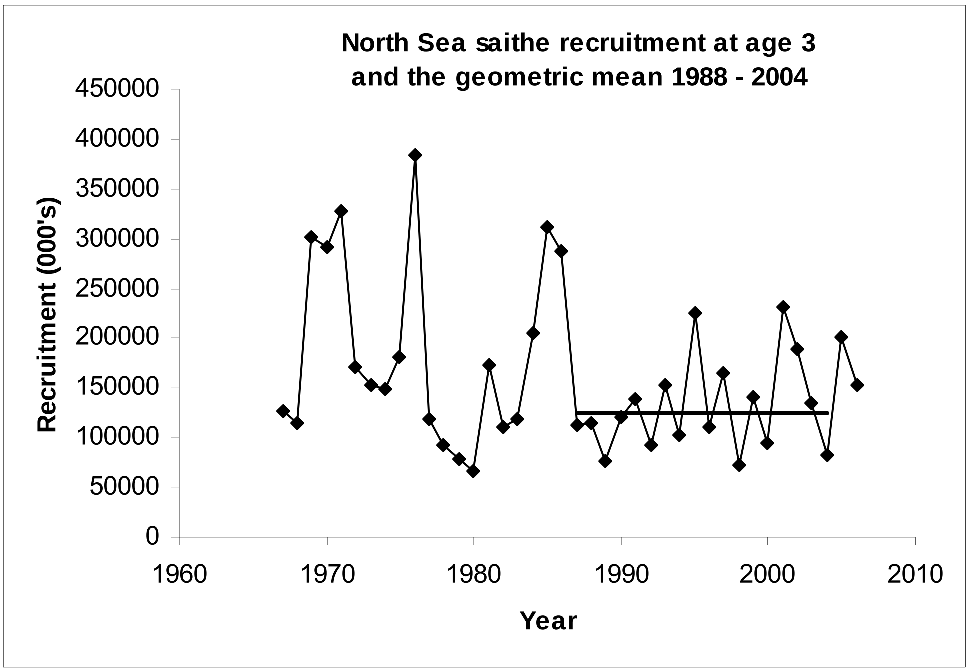


Figure 15.3.1 The time series of North Sea, west of Scotland and the Skagerrak saithe recruitment (age 3) estimates and the geometric mean recruitment 1988 – 2004 used for the stock projections.

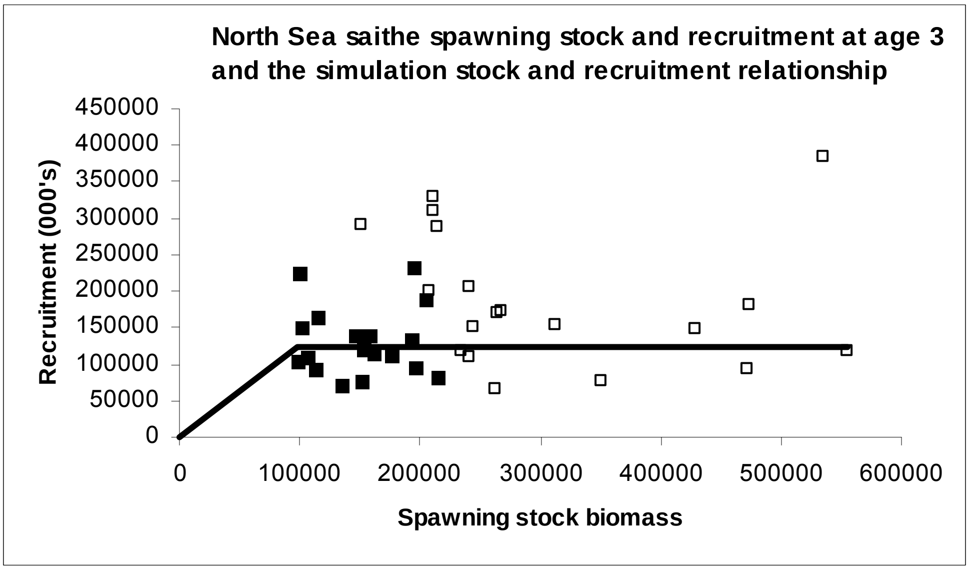


Figure 15.3.2 The North Sea, west of Scotland and the Skagerrak saithe stock and recruitment (age 3) estimates and the geometric mean recruitment model 1988 – 2004 used for the stock projections. Open squares illustrate pre 1988 data, solid squares the most recent estimates used for the geometric mean recruitment.

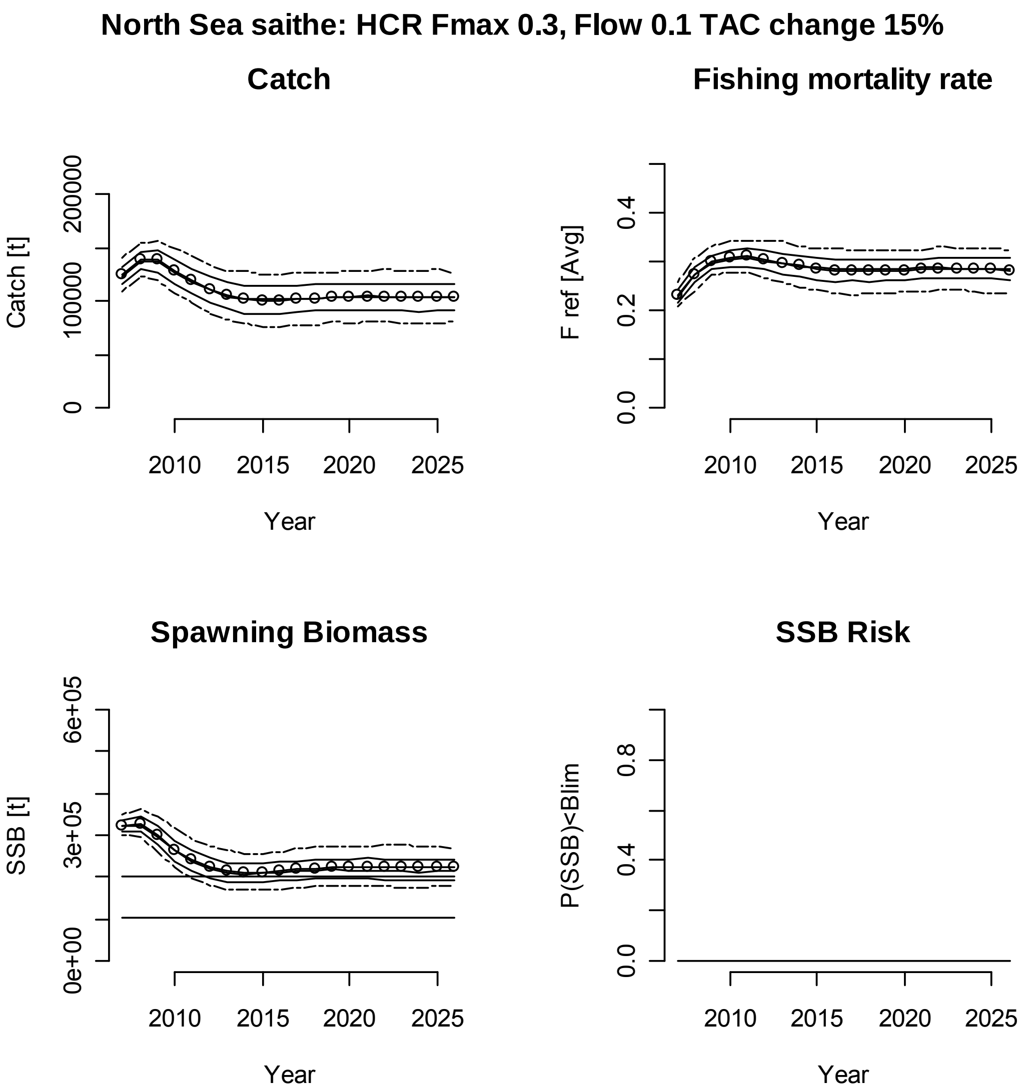


Figure 15.3.3 Example North Sea, west of Scotland and the Skagerrak saithe projections for yield, fishing mortality and SSB and the risk that SSB < B_{lim}, based on the current management agreement. Fmax = 0.3, Flow = 0.1, Bpa = 200000, Blim = 106000, annual catch constraint 15%

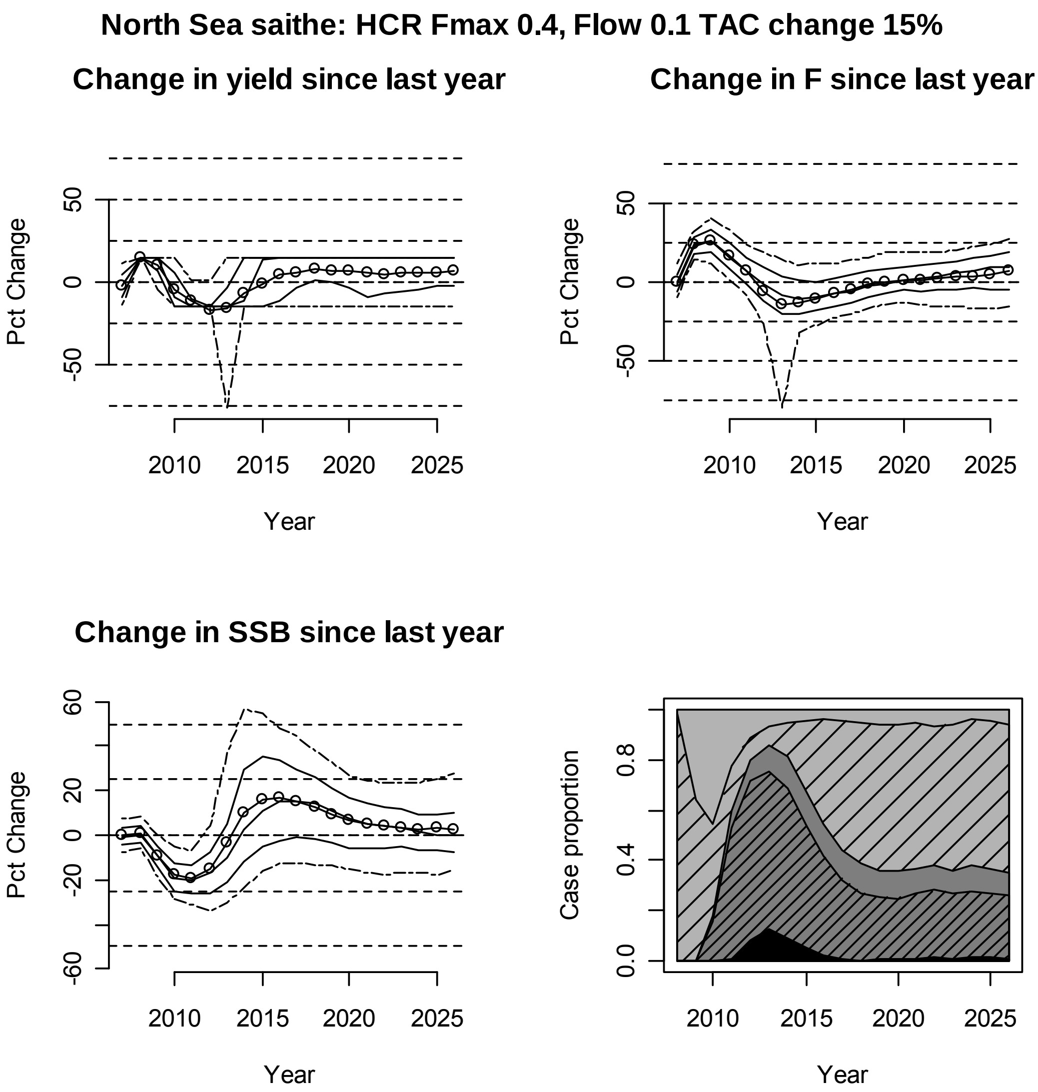


Figure 15.3.4 Example North Sea, west of Scotland and the Skagerrak saithe projections for Fmax = 0.4, Flow = 0.1, Bpa = 200000, Blim = 106000, annual catch constraint 15%. Illustrating annual change in yield, fishing mortality and SSB and the proportion of cases in which the HCR clauses are invoked, based on the current management agreement (solid black - SSB < Blim F = Flow, dark grey - Blim < SSB < Bpa and no constraint, hatched dark grey Blim < SSB < Bpa but catch constrained, light grey SSB > Bpa F = Fmax and no constraint, hatched light grey SSB > Bpa but catch constrained)

15.5 Time series variation in saithe weight at age

The weight at age of North Sea, west of Scotland and the Skagerrak saithe has exhibited a strong decrease during the last 10 years (Figure 15.4.1); the decreases are recorded in survey and catch data and its underlying cause uncertain. There are corresponding declines in the weights at age of the Icelandic (Va), Faeroes (Vb , Figure 15.4.2) and the North East Arctic stocks (Sub-areas I and II, Figure 15.4.3), in fact the time series of weights at age show close similarity for three of the stocks for which data were available (Figure 15.4.4). The similarity in the time series trends could result from a common environmental signal affecting all regions simultaneously, given their close geographical location, or could suggest a single stock complex.

Within each stock the patterns in the weight at age time series suggest a cohort effect moving diagonally across the age data. This would suggest that it is growth at an early age, possibly during recruitment to the offshore stock (juvenile saithe are coastal in their distribution) that may have been influenced by any common factor.

One process that may influence the growth rate of young saithe is density dependent effects on growth. Figures 15.4.5 – 15.4.7 illustrate the time series total biomass indices and weight at age 6 for each stock for which data is available. For North East Arctic and Faeroes saithe there are strong indications of a negative relationship between catch weight and stock biomass. For North Sea, west of Scotland and the Skagerrak saithe the correlation is less clear, the stock biomass has increased in recent years and weight decreased, however historically stock biomass high coincident with high weights.

Although substantial reduction in weight at age has been recorded for the saithe stock in the North Sea, in common with adjacent saithe stocks from other areas, modelling such changes and predicting future dynamics cannot be achieved without further information and analysis. Therefore the forecast yield from the CS_HCR simulations was based on an average of the weight at age over recent years, representing an analysis of the potential yield from stock under the harvest control rule within the current, relatively, low productivity biological state.

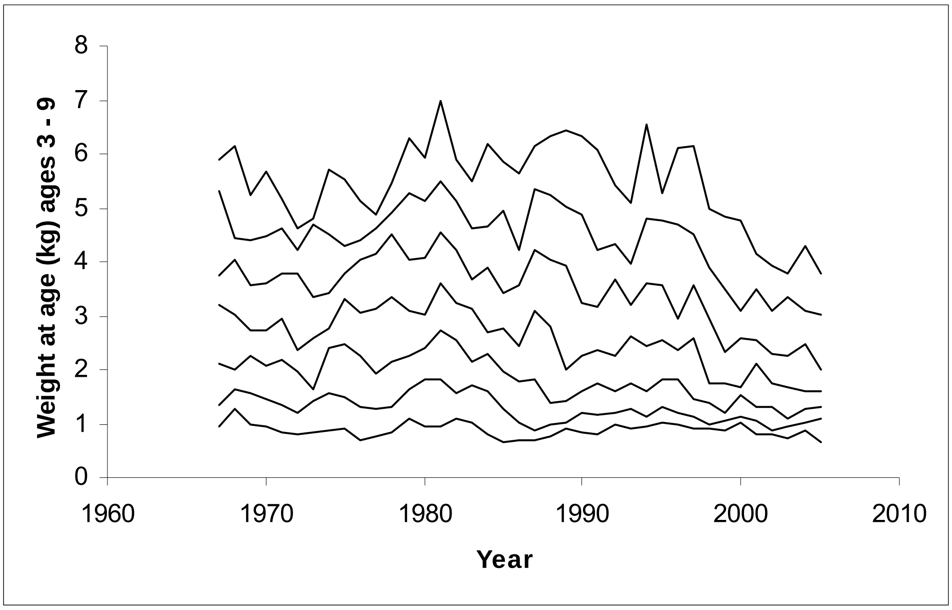


Figure 15.4.1 The time series of North Sea, west of Scotland and the Skagerrak saithe catch weight at age for ages 3 – 9 illustrating the decrease in weight in recent years.

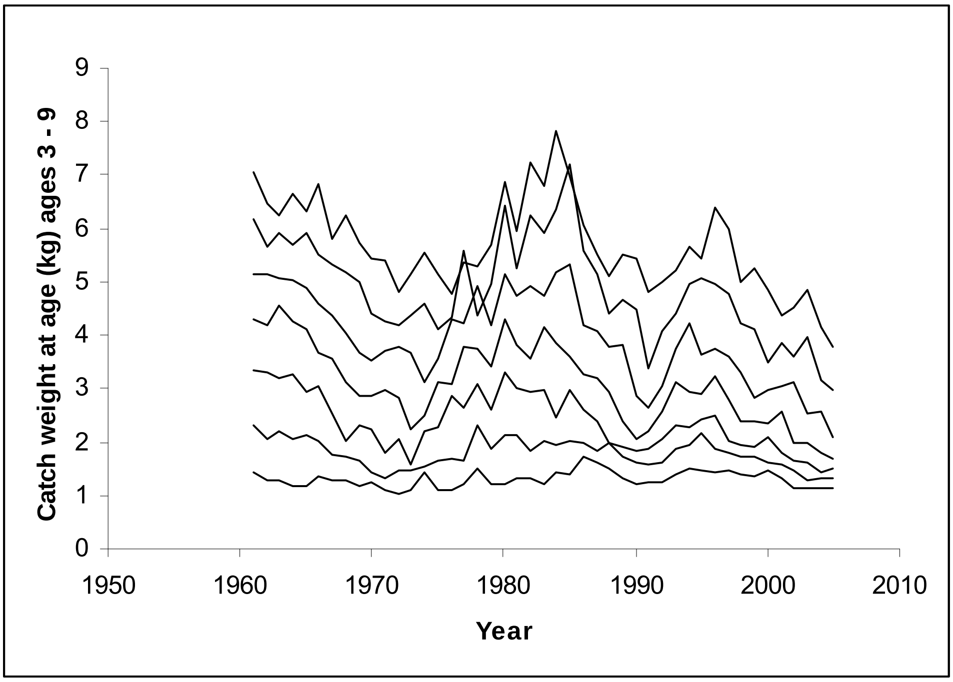


Figure 15.4.2 The time series of Faeroes saithe catch weight at age for ages 3 – 9

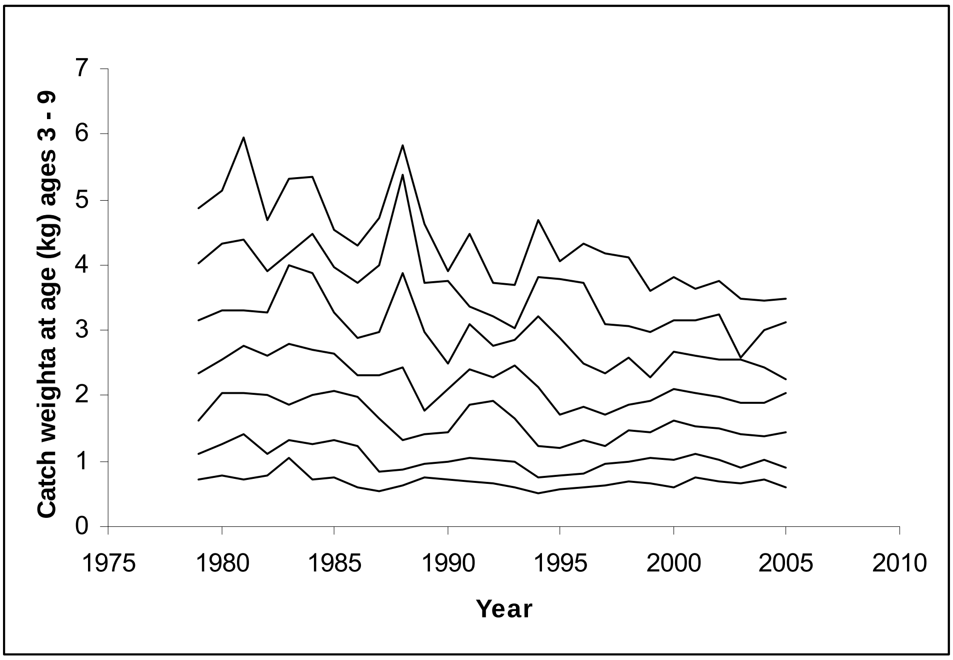


Figure 15.4.3 The time series of North East Arctic saithe catch weight for ages 3–9.

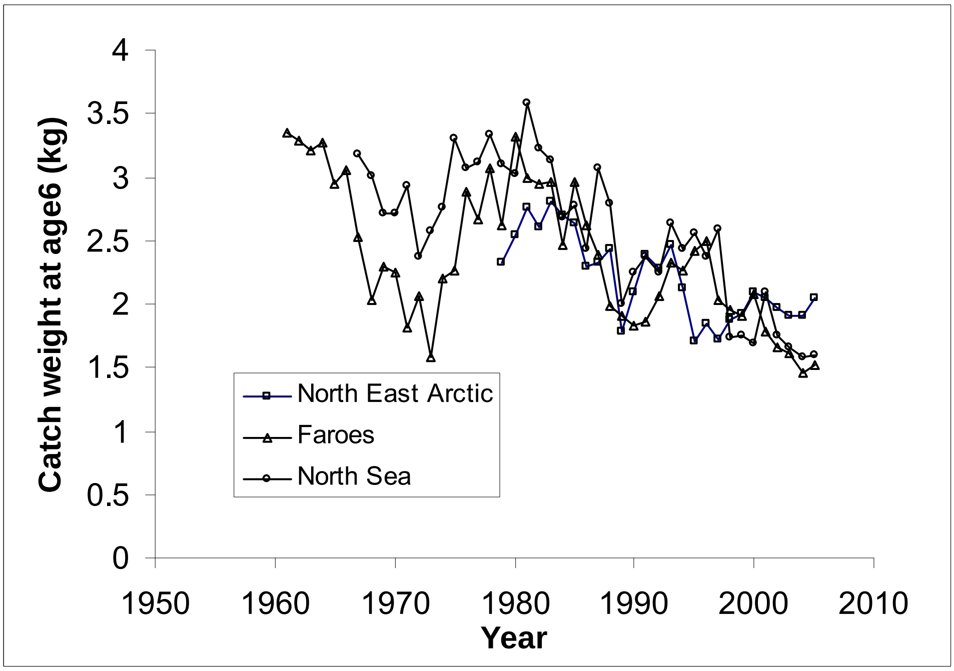


Figure 15.4.4 The time series of North Sea, North East Arctic and Faeroes saithe catch weights at age 6, illustrating the similarity in the dynamics of the series.

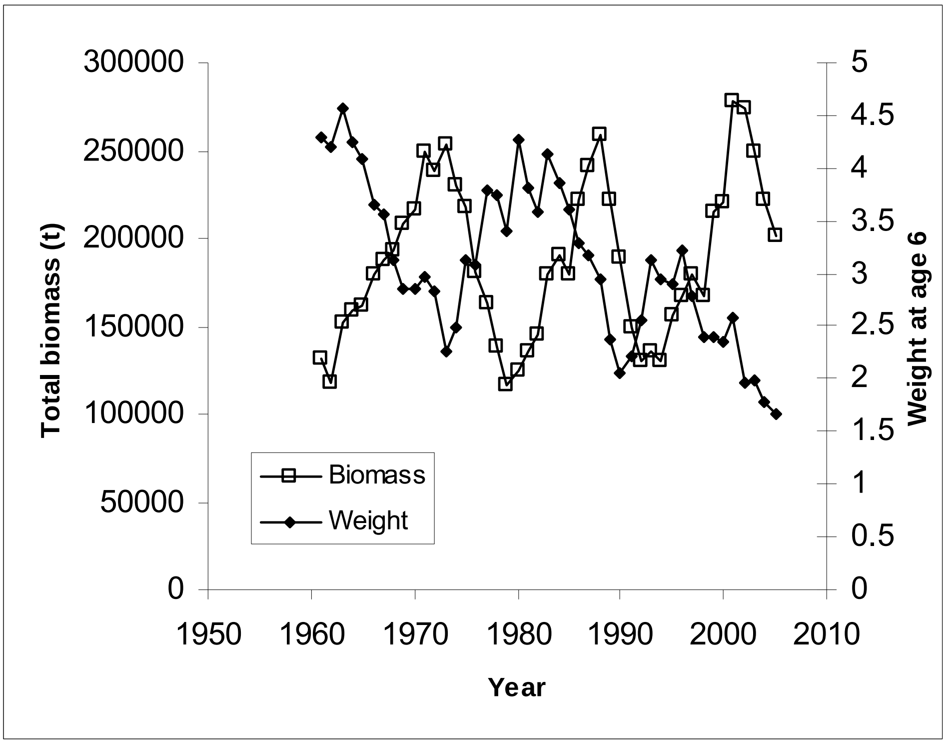


Figure 15.4.5 The time series of Faeroes saithe catch weights at age 6 and total biomass taken from the ICES 2006 assessment of the stock illustrating potential density dependence in growth to age 6.

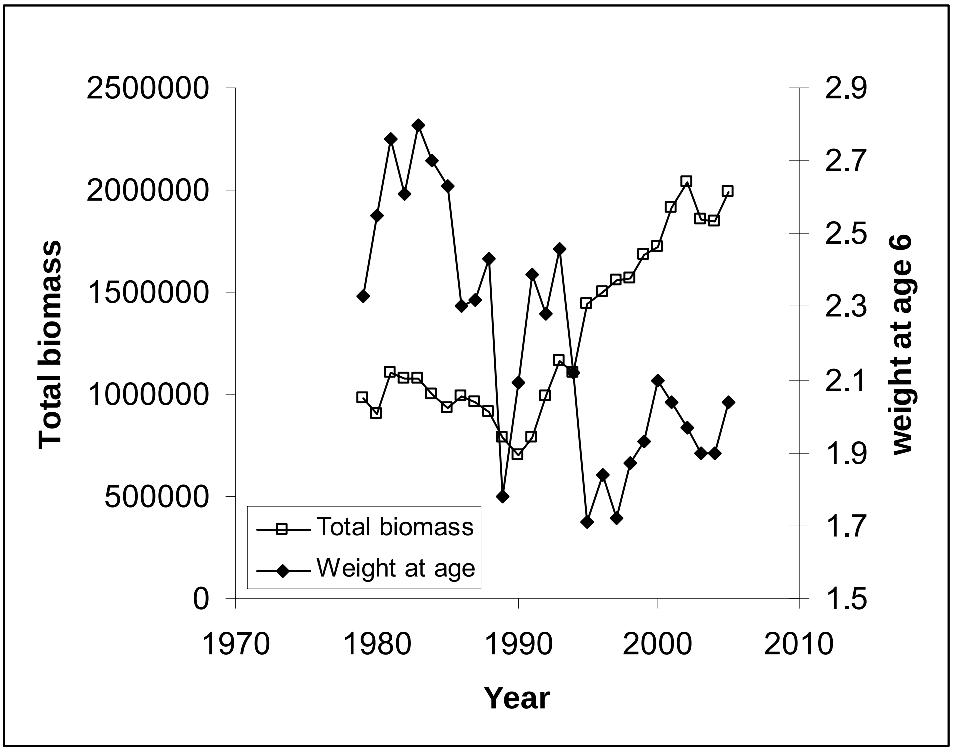


Figure 15.4.6 The time series of North East Arctic stocks (Sub-areas I and II), saithe catch weights at age 6 and total biomass taken from the ICES 2006 assessment of the stock illustrating potential density dependence in growth to age 6.

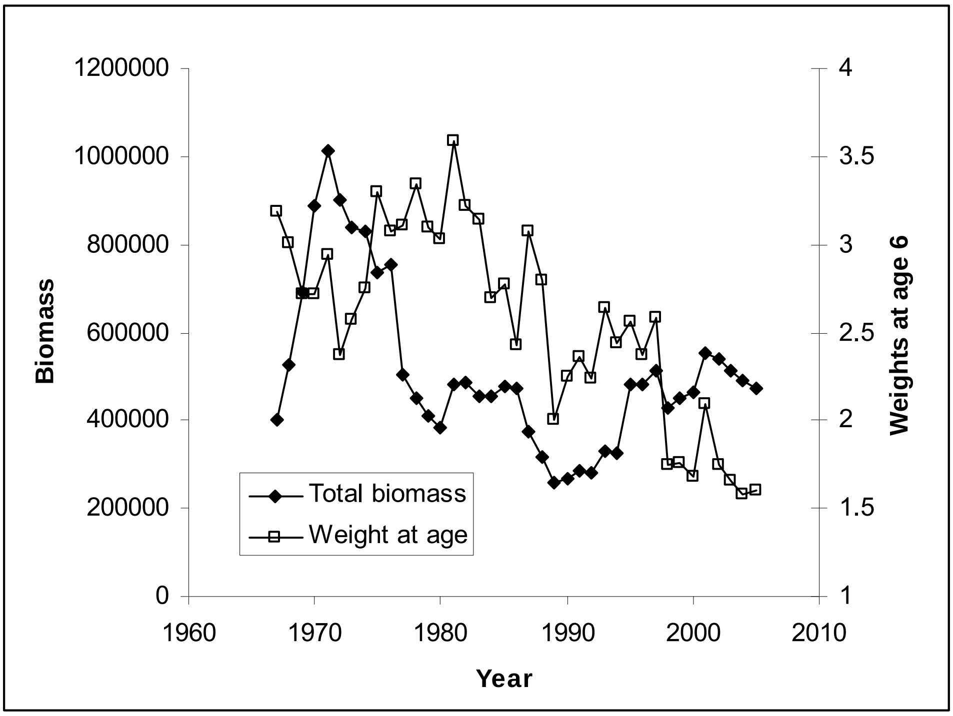


Figure 15.4.7 The time series of North East Arctic stocks (Sub-areas I and II), saithe catch weights at age 6 and total biomass.

15.6 Stock Evaluations

Scenarios evaluated

For North Sea, west of Scotland and the Skagerrak saithe four sets of four different scenarios were evaluated using the CS_HCR software. Simulations were continued for 20 years with 1000 iterations. Each set of four scenarios assumed a different level of between year catch constraints, each scenario assumed a different target fishing mortality. The models were:

a) A between year catch constraint of 0, 10%, 15% and 20%

b) When SSB was estimated to be above Bpa a target fishing mortality of 0.1, 0.2, 0.3, 0.4

All scenarios assume that the catch taken in 2007 will be at status quo fishing mortality (0.23) for 2006 as estimated by the WGNSSK (2007).

15.6.1 Current North Sea, west of Scotland and the Skagerrak saithe HCR

Fmax = 0.3, Flow = 0.1, Bpa = 200000, Blim = 106000, annual catch constraint 15%

Figures 15.5.1 and 15.5.2 summarise the results of the simulations for the current management plan.

Yield, spawning biomass, fishing mortality

Catch initially increases from current levels as F is increased from the recent average of 0.23 to the target value of 0.3 and then stabilizes at a lower level as relatively higher recent recruitments are replaced by a slightly lower geometric mean in the simulations. Median catch is around 100,000t and median fishing mortality just below the target of 0.3. The target of 0.3 is not achieved in all simulations because SSB stabilizes at around B_{pa} and a significant proportion of the simulations use a lower F from the sliding scale activated when SSB lies between B_{pa} and B_{lim}.

Risk

The scenario indicates that there is a negligible risk of SSB falling below Blim within 20 years if the agreed management plan is followed and recruitment, selection, growth and maturity patterns are unchanged.

Changes in yield, spawning biomass, fishing mortality

Annual variation in yield falls within the required +/- 15% because the stock does not fall below Blim and invoke stronger management action. Variation in F and SSB are similarly reduced to between similar levels.

Invoked HCR constraints

The proportion of cases in which the HCR clauses are invoked is split 65:35 between the clause for which SSB is above B_{pa} with that for SSB between B_{pa} and B_{lim}. In each case about 50% of the decisions will be restricted by the +/- 15% constraint on the TAC.

15.6.1.1 North Sea, west of Scotland and the Skagerrak saithe HCR – variation in Fmax

F_{max} = 0.1, 0.2, 0.3, 0.4,

F_{low} = 0.1, B_{pa} = 200000, B_{lim} = 106000, annual catch constraint 15%

Figures 15.5.3 – 15.5.8 summarise the results of the simulations used for investigating changes to the current management plan value of F_{max}. Figures 15.5.1 and 15.5.2, presented above illustrate the case for F_{max} = 0.3 the current value.

Yield, spawning biomass, fishing mortality

With reductions in target fishing mortality by 1/3 and 2/3 below the current level of effort yield decreases from the current level to eventually stabilize at around 100,000t. There is little gain in overall yield. Spawning stock biomass increases, stabilizing at levels well above B_{pa} with a negligible risk of falling below B_{lim}. The dominant clause in the harvest control rule is the F = F_{max} and there is a decreased incidence of the 15% constraint as variation is catch is generally below the threshold.

Increasing F_{max} to 0.4 initially increases catch but is followed by a prolonged reduction as SSB is reduced to levels below B_{pa} at which F is reduced by the sliding scale. Only after about 15 years are catches returned to around ~100,000t. Spawning stock biomass is quickly reduced below B_{pa} and fishing mortality reduced to the extent that in only a very low proportion of the scenarios is the mortality target ever reached in subsequent years. Uncertainty as to the trajectory of spawning stock is increased substantially and the risk of the spawning stock falling below B_{lim} is like wise increased.

Invoked HCR constraints

The number of clauses invoked within the HCR reduces with reduced target fishing mortality and increase as it is raised to 0.4. At low levels of fishing mortality the target F is the dominant management advice, at levels of F higher than the current 0.3 spawning stock and catch exhibit greater variation and the management advice is dominated by the change in catch constraint. Since change in catch is restricted by the constraint variation in the level of fishing mortality increases and the more restrictive HCR clauses are invoked more frequently.

15.6.1.2 North Sea, west of Scotland and the Skagerrak saithe HCR – variation in annual catch constraint

F_{max} = 0.3,F_{low} = 0.1, B_{pa} = 200000, B_{lim} = 106000,

annual catch constraint 10%, 15%, 20%, unlimited (1000%)

Figures 15.5.9 – 15.5.14 summarise the results of the simulations used for investigating changes to the current management plan annual catch constraint at a fixed F_{max} = 0.3. Figures 15.5.1 and 15.5.2, presented above illustrate the case for 15% the current value.

Yield, spawning biomass, fishing mortality

Increasing restrictions on the annual variation in catches reduces the proportion of scenarios in which the target fishing mortality level can be achieved. The variation in the level and interannual change in fishing mortality and spawning stock biomass increase. Control over the level of fishing mortality is relaxed in favour of stable catches therefore the risk that the stock declines below precautionary reference points is increased. If catch constraints are tightened reductions in target fishing mortality are required to balance the increased risk to the stock. Decreasing restrictions on the annual variation in catches reduces the proportion of scenarios in which the catch constraint is applied and allows more control on the level of fishing mortality; allowing greater flexibility in the control of exploitation reduces risk to the stock. The level of catch derived from the stock is fairly insensitive to the catch constraint, obviously its interannual variation is.

Invoked HCR constraints

The number of clauses invoked within the HCR reduces with reduced target fishing mortality and increase as it is raised to 0.4. At low levels of fishing mortality the target F is the dominant management advice, at levels of F higher than the current 0.3 spawning stock and catch exhibit greater variation and the management advice is dominated by the change in catch constraint. Since change in catch is restricted by the constraint variation in the level of fishing mortality increases and the more restrictive HCR clauses are invoked more frequently.

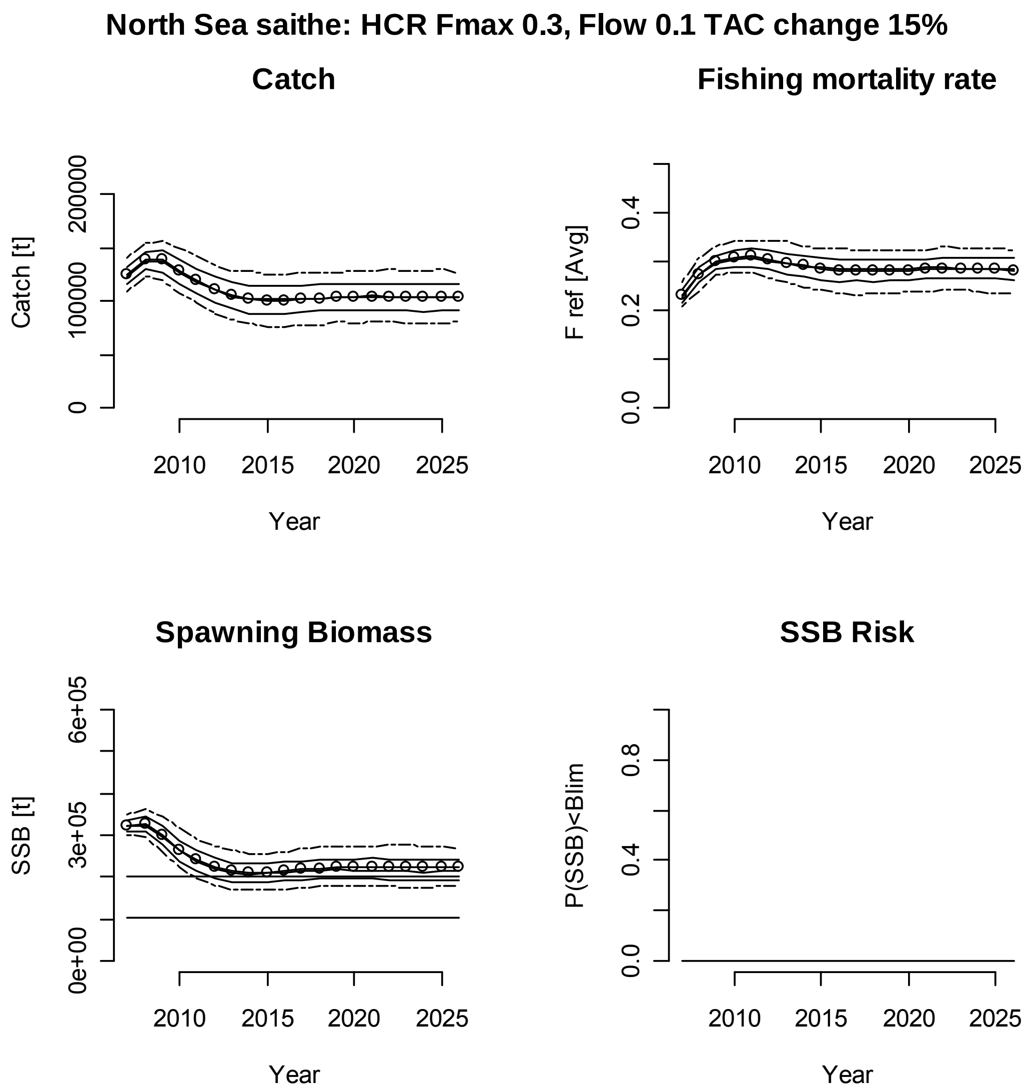


Figure 15.5.1 North Sea, west of Scotland and the Skagerrak saithe projections for yield, fishing mortality and SSB and the risk that SSB < B_{lim}, based on the current management agreement. Fmax = 0.3, Flow = 0.1, Bpa = 200000, Blim = 106000, annual catch constraint 15%

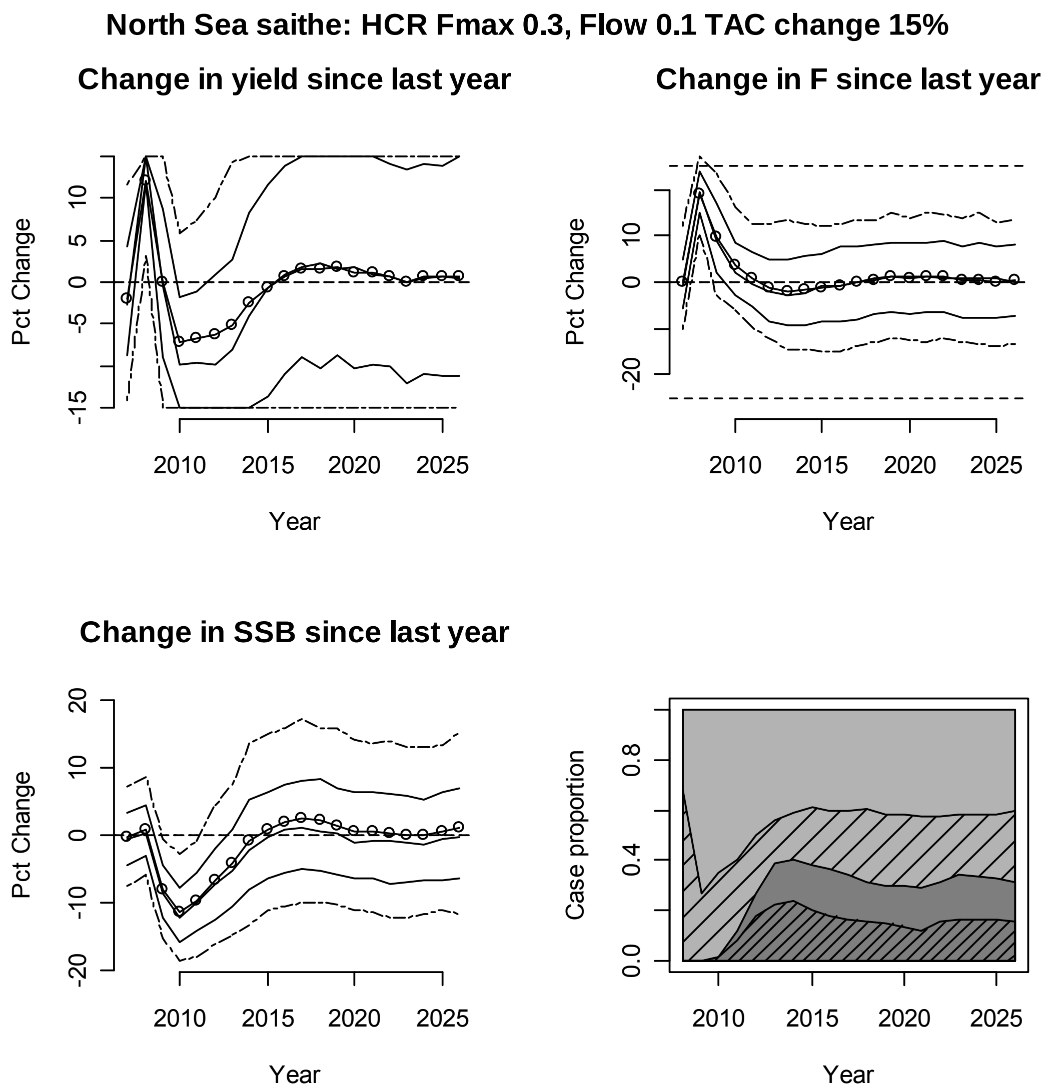


Figure 15.5.2 North Sea, west of Scotland and the Skagerrak saithe projections for Fmax = 0.3, Flow = 0.1, Bpa = 200000, Blim = 106000, annual catch constraint 15%. Illustrating annual change in yield, fishing mortality and SSB and the proportion of cases in which the HCR clauses are invoked, based on the current management agreement (solid black - SSB < Blim F = Flow, dark grey - Blim < SSB < Bpa and no constraint, hatched dark grey Blim < SSB < Bpa but catch constrained, light grey SSB > Bpa F = Fmax and no constraint, hatched light grey SSB > Bpa but catch constrained)

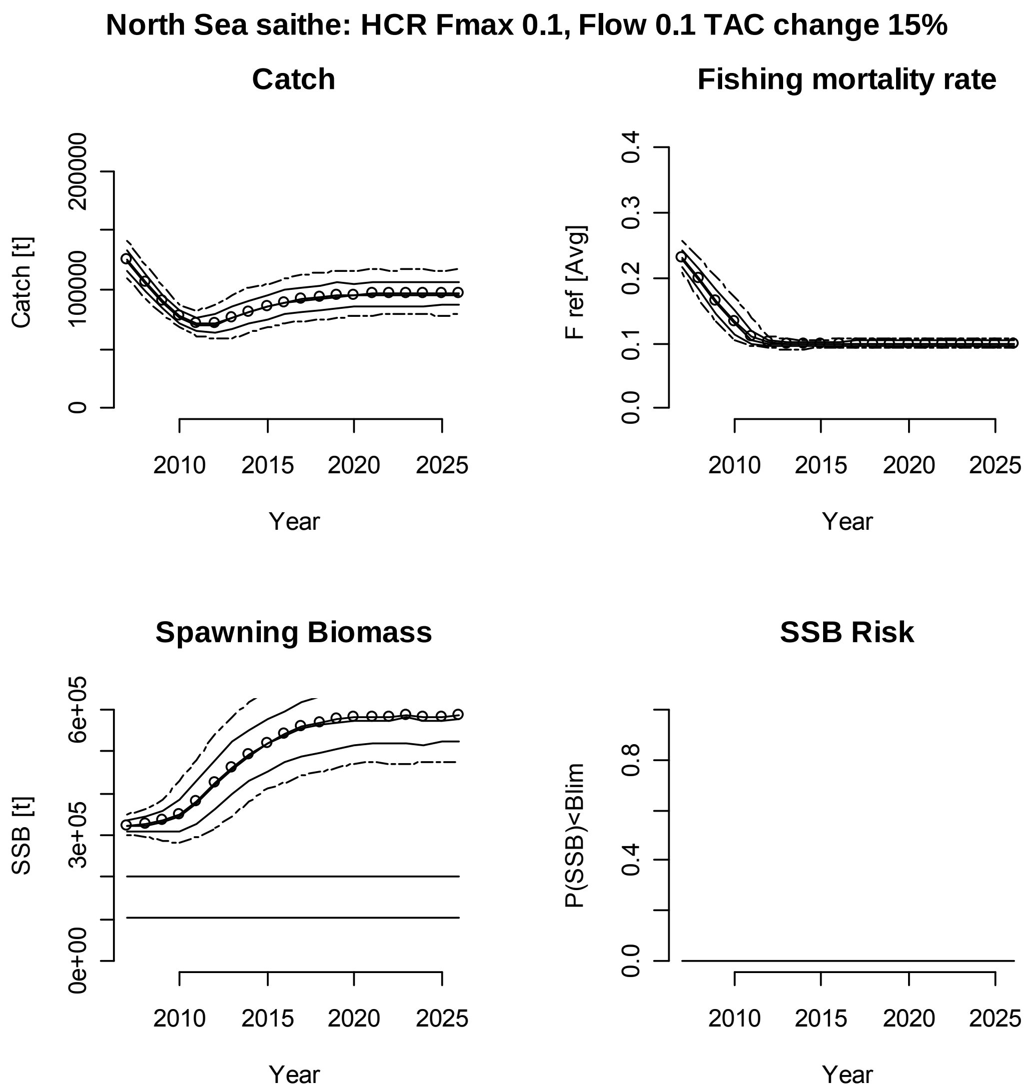


Figure 15.5.3 North Sea, west of Scotland and the Skagerrak saithe projections for yield, fishing mortality and SSB and the risk that SSB < B_{lim}, based on the current management agreement. Fmax = 0.1, Flow = 0.1, Bpa = 200000, Blim = 106000, annual catch constraint 15%

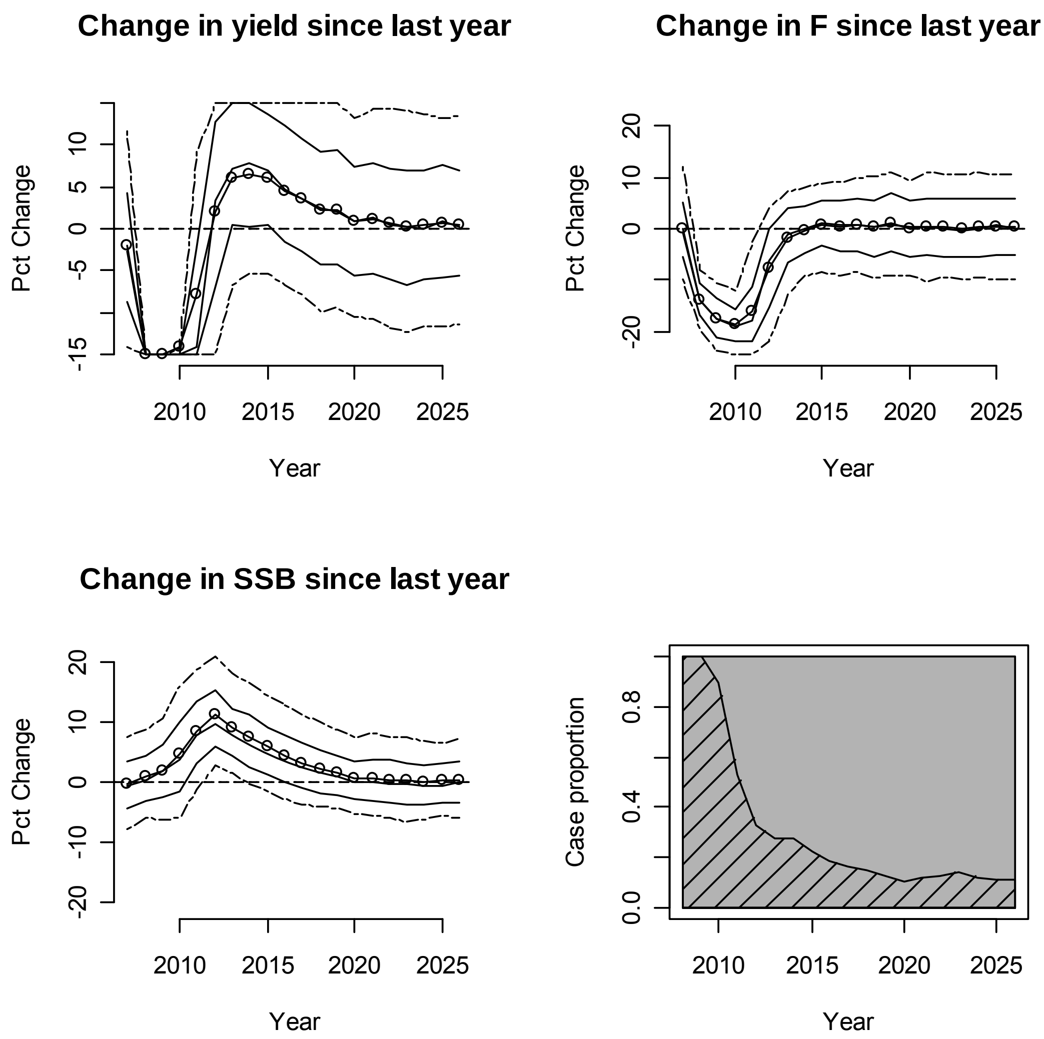


Figure 15.5.4 North Sea, west of Scotland and the Skagerrak saithe projections for Fmax = 0.1, Flow = 0.1, Bpa = 200000, Blim = 106000, annual catch constraint 15%. Illustrating annual change in yield, fishing mortality and SSB and the proportion of cases in which the HCR clauses are invoked, based on the current management agreement (solid black - SSB < Blim F = Flow, dark grey - Blim < SSB < Bpa and no constraint, hatched dark grey Blim < SSB < Bpa but catch constrained, light grey SSB > Bpa F = Fmax and no constraint, hatched light grey SSB > Bpa but catch constrained)

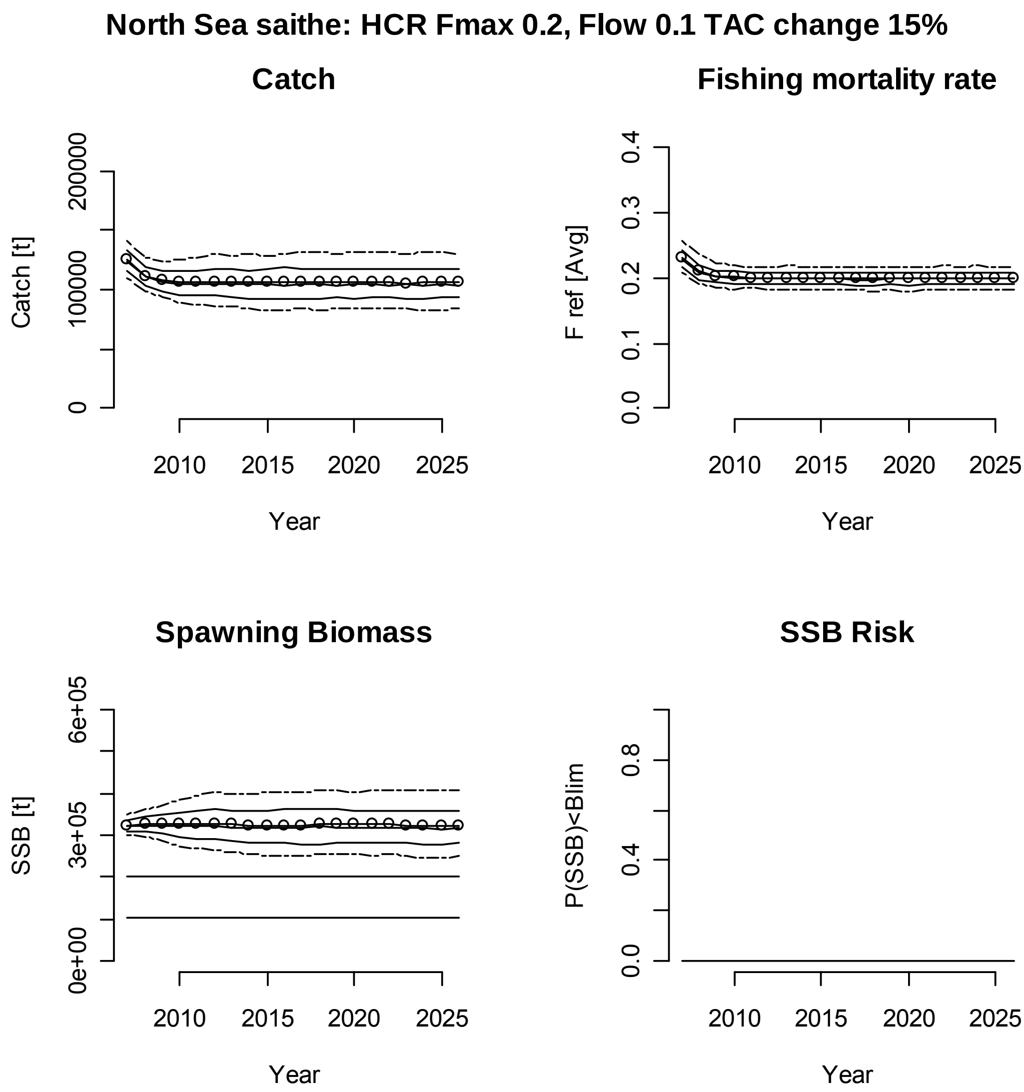


Figure 15.5.5 North Sea, west of Scotland and the Skagerrak saithe projections for yield, fishing mortality and SSB and the risk that SSB < B_{lim}, based on the current management agreement. Fmax = 0.2, Flow = 0.1, Bpa = 200000, Blim = 106000, annual catch constraint 15%

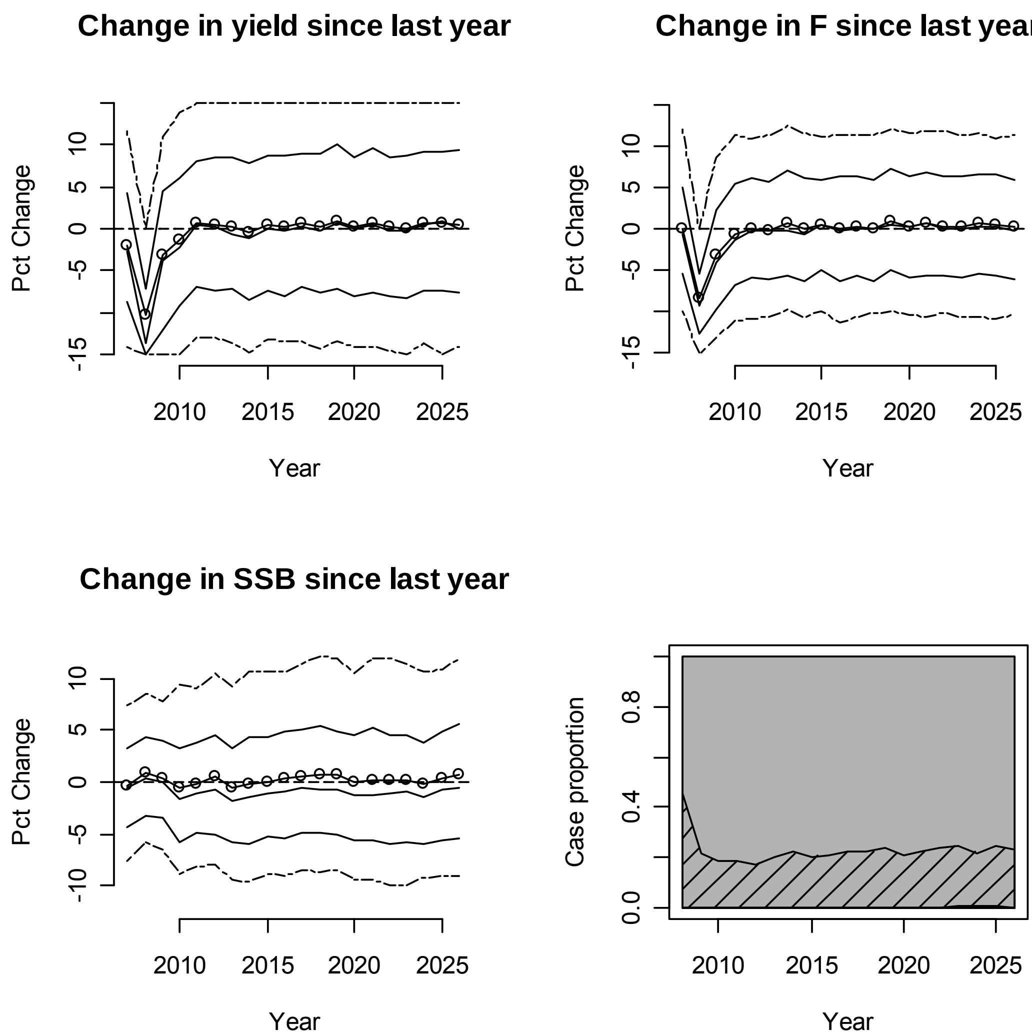


Figure 15.5.6 North Sea, west of Scotland and the Skagerrak saithe projections for Fmax = 0.2, Flow = 0.1, Bpa = 200000, Blim = 106000, annual catch constraint 15%. Illustrating annual change in yield, fishing mortality and SSB and the proportion of cases in which the HCR clauses are invoked, based on the current management agreement (solid black - SSB < Blim F = Flow, dark grey - Blim < SSB < Bpa and no constraint, hatched dark grey Blim < SSB < Bpa but catch constrained, light grey SSB > Bpa F = Fmax and no constraint, hatched light grey SSB > Bpa but catch constrained)

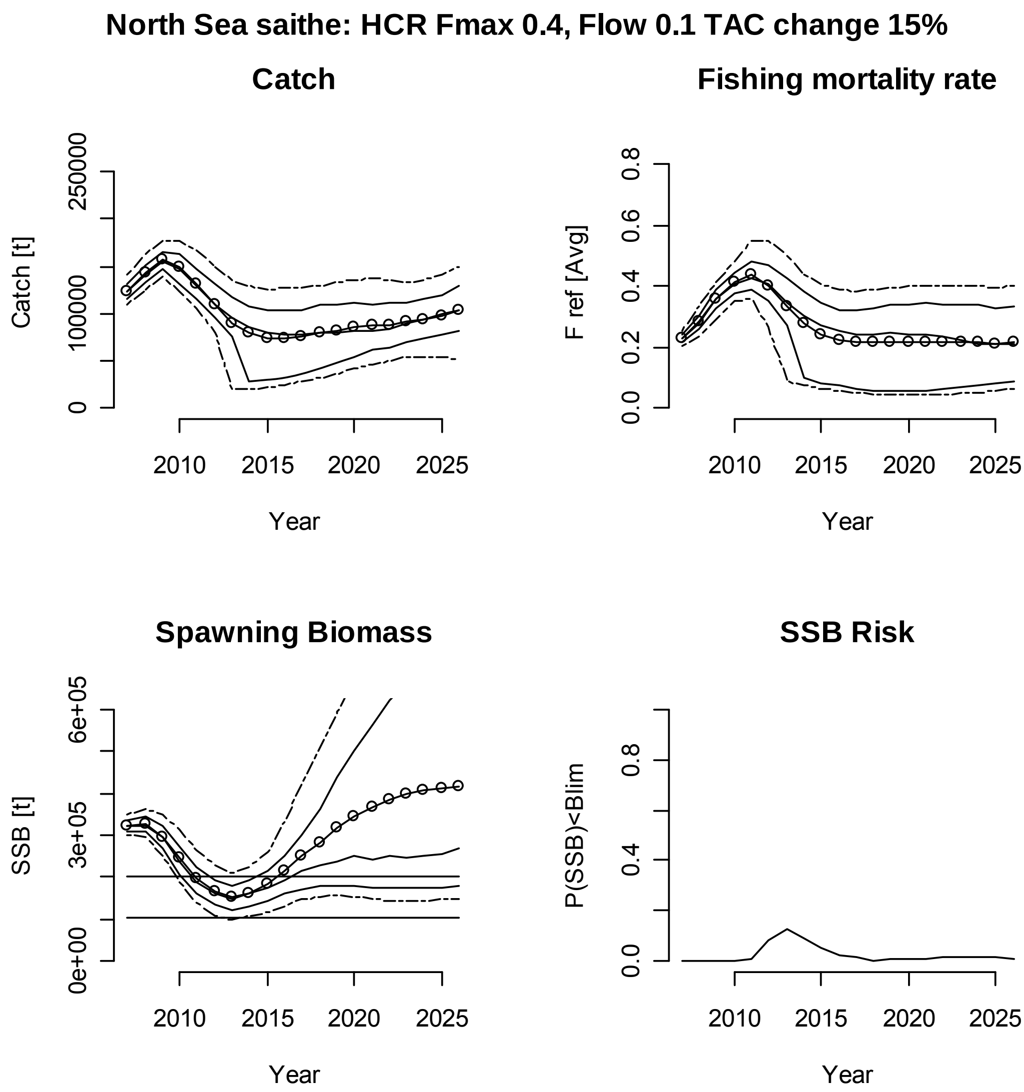


Figure 15.5.7 North Sea, west of Scotland and the Skagerrak saithe projections for yield, fishing mortality and SSB and the risk that SSB < B_{lim}, based on the current management agreement. Fmax = 0.4, Flow = 0.1, Bpa = 200000, Blim = 106000, annual catch constraint 15%

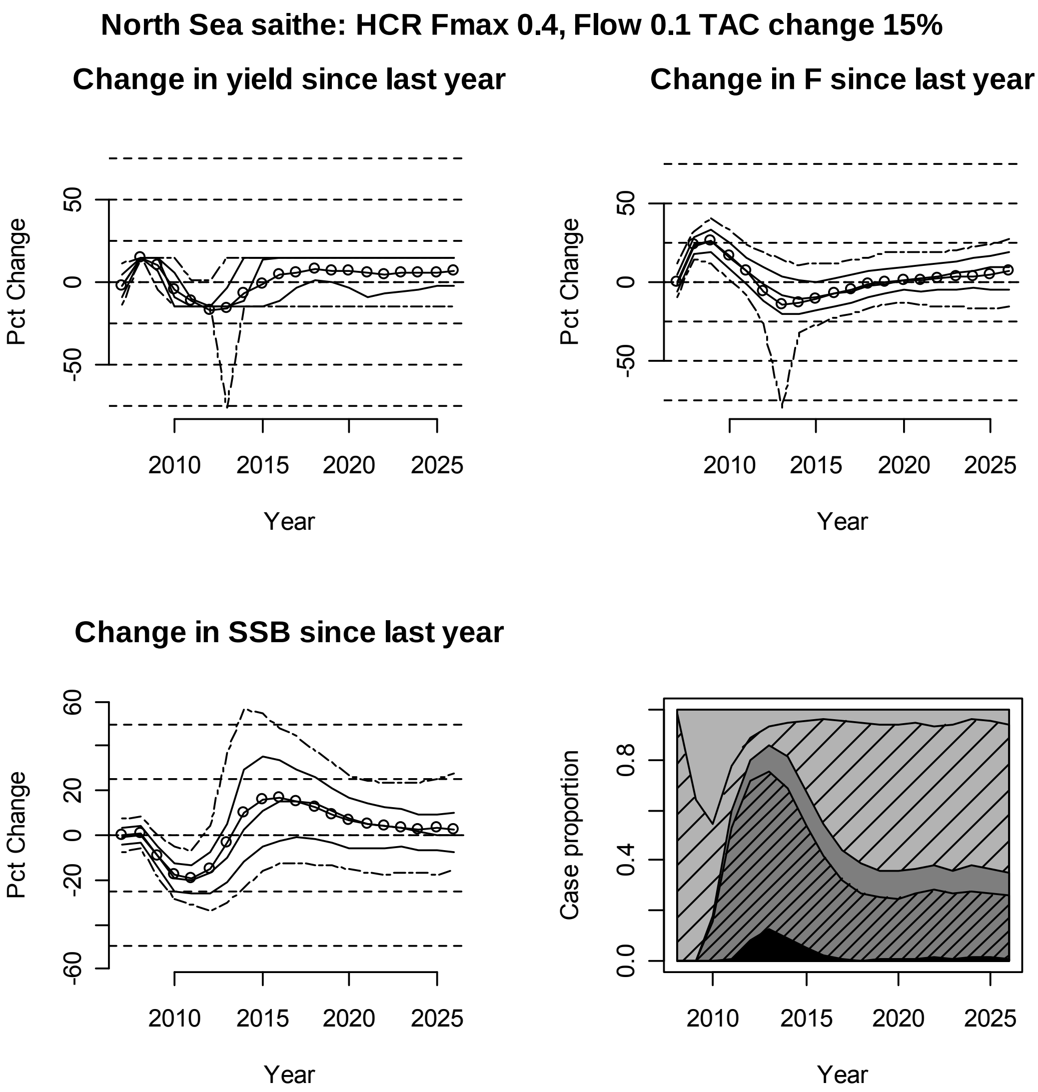


Figure 15.5.8 North Sea, west of Scotland and the Skagerrak saithe projections for Fmax = 0.4, Flow = 0.1, Bpa = 200000, Blim = 106000, annual catch constraint 15%. Illustrating annual change in yield, fishing mortality and SSB and the proportion of cases in which the HCR clauses are invoked, based on the current management agreement (solid black - SSB < Blim F = Flow, dark grey - Blim < SSB < Bpa and no constraint, hatched dark grey Blim < SSB < Bpa but catch constrained, light grey SSB > Bpa F = Fmax and no constraint, hatched light grey SSB > Bpa but catch constrained)

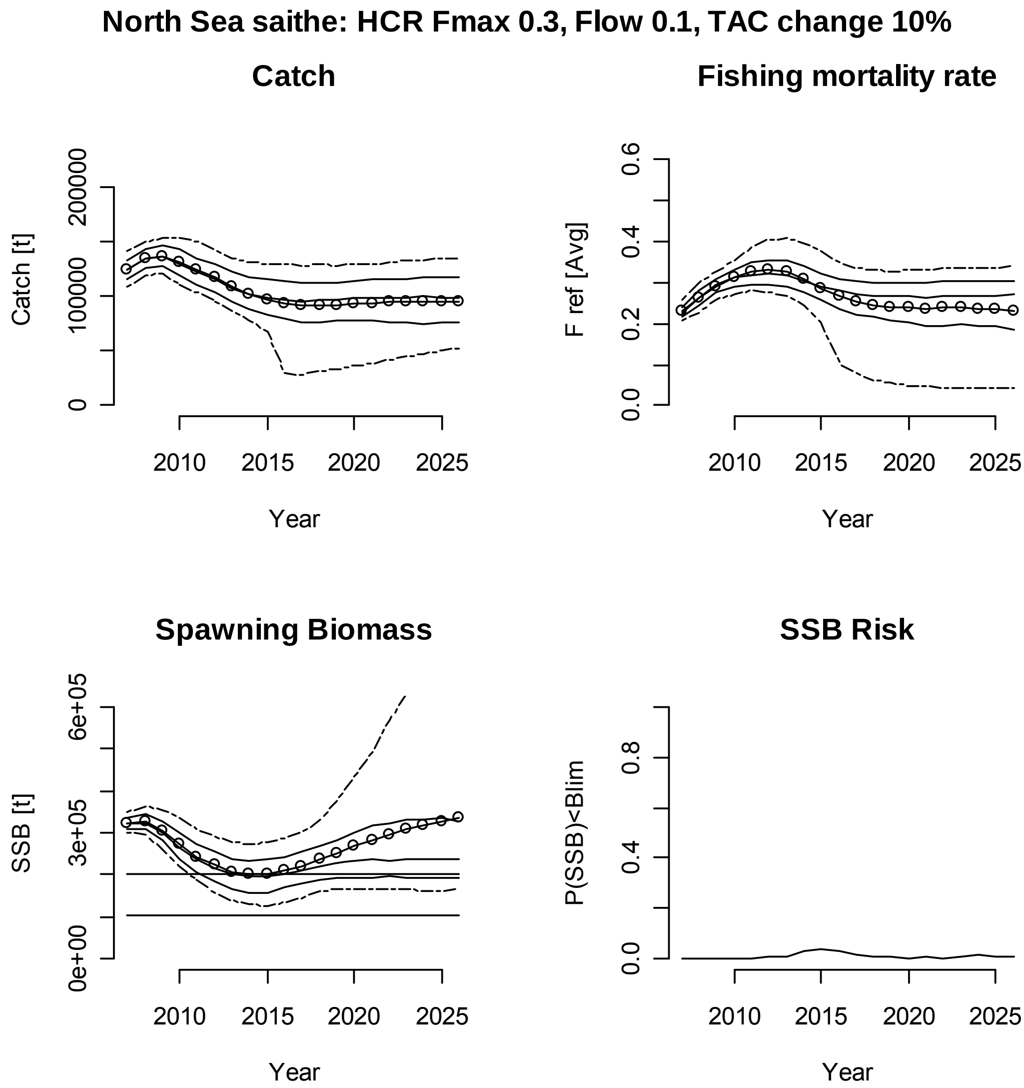


Figure 15.5.9 North Sea, west of Scotland and the Skagerrak saithe projections for yield, fishing mortality and SSB and the risk that SSB < B_{lim}, based on the current management agreement. Fmax = 0.3, Flow = 0.1, Bpa = 200000, Blim = 106000, annual catch constraint 10%

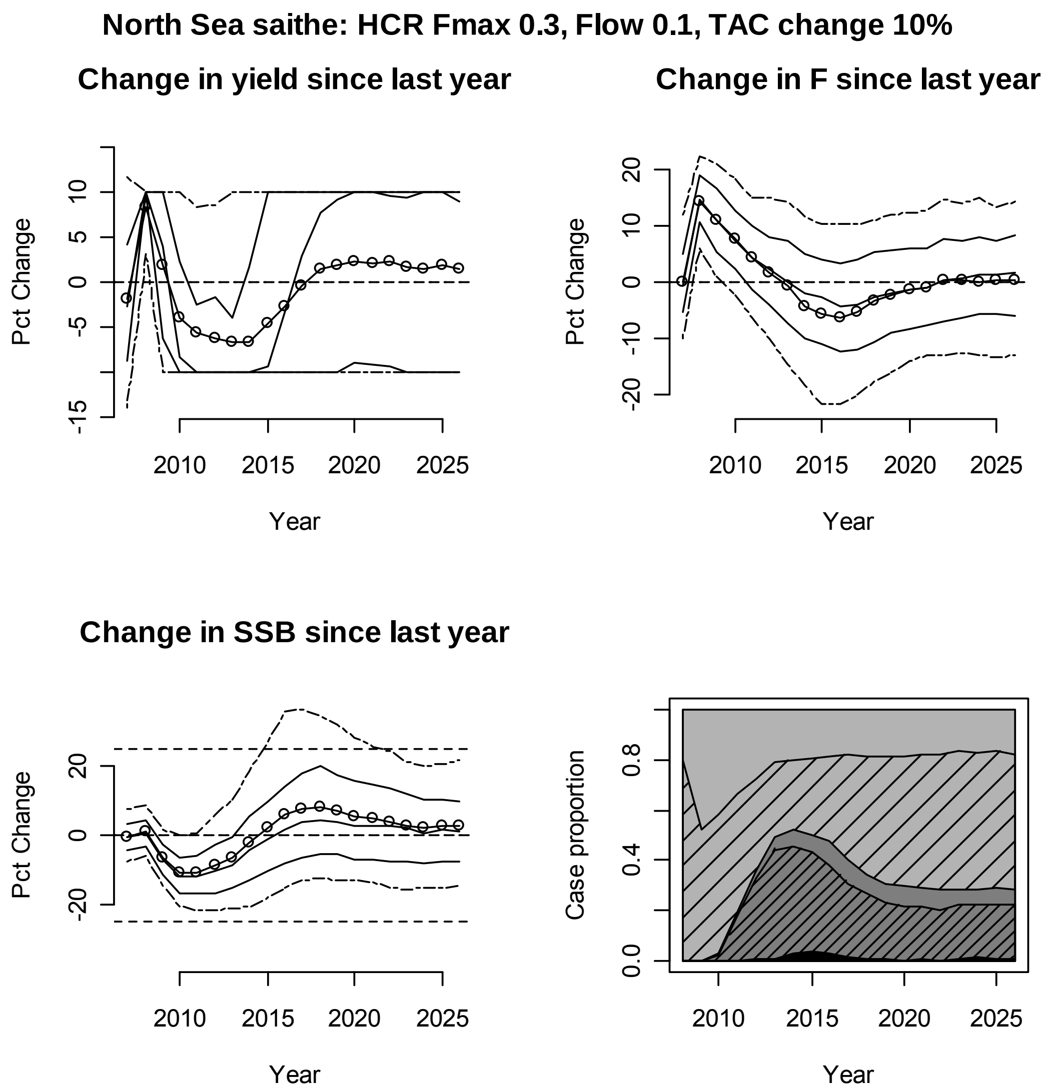


Figure 15.5.10 North Sea, west of Scotland and the Skagerrak saithe projections for Fmax = 0.3, Flow = 0.1, Bpa = 200000, Blim = 106000, annual catch constraint 10%. Illustrating annual change in yield, fishing mortality and SSB and the proportion of cases in which the HCR clauses are invoked, based on the current management agreement (solid black - SSB < Blim F = Flow, dark grey - Blim < SSB < Bpa and no constraint, hatched dark grey Blim < SSB < Bpa but catch constrained, light grey SSB > Bpa F = Fmax and no constraint, hatched light grey SSB > Bpa but catch constrained)

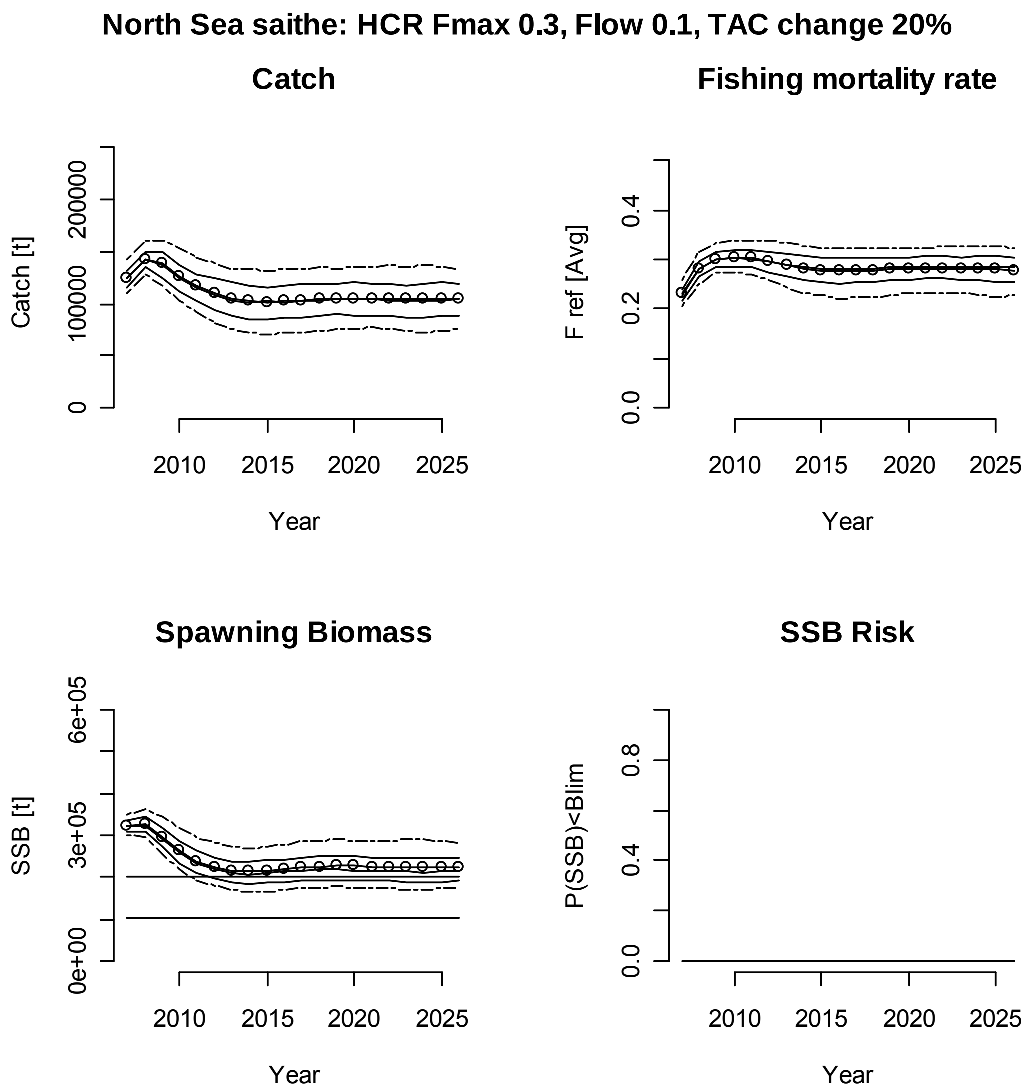


Figure 15.5.11 North Sea, west of Scotland and the Skagerrak saithe projections for yield, fishing mortality and SSB and the risk that SSB < B_{lim}, based on the current management agreement. Fmax = 0.3, Flow = 0.1, Bpa = 200000, Blim = 106000, annual catch constraint 20%

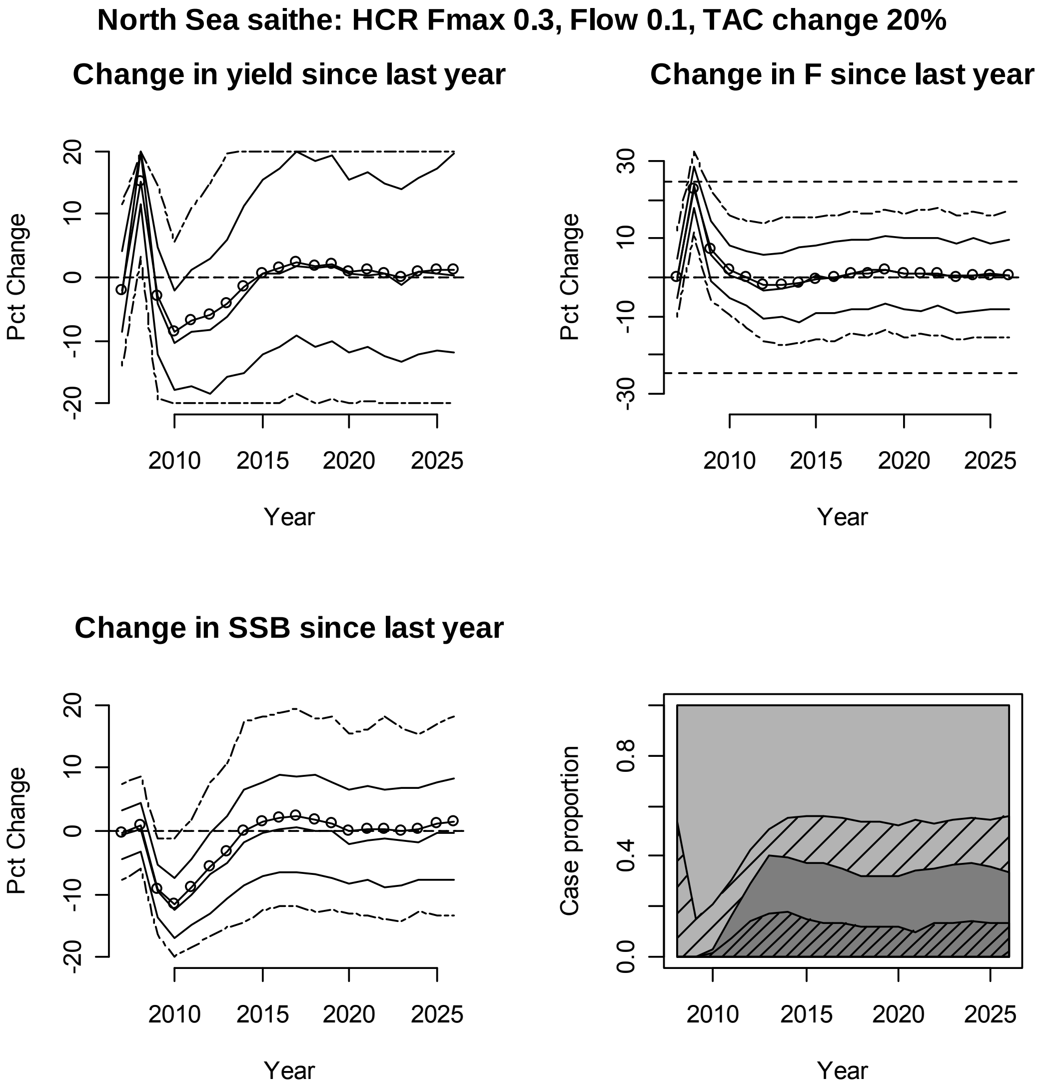


Figure 15.5.12 North Sea, west of Scotland and the Skagerrak saithe projections for Fmax = 0.3, Flow = 0.1, Bpa = 200000, Blim = 106000, annual catch constraint 20%. Illustrating annual change in yield, fishing mortality and SSB and the proportion of cases in which the HCR clauses are invoked, based on the current management agreement (solid black - SSB < Blim F = Flow, dark grey - Blim < SSB < Bpa and no constraint, hatched dark grey Blim < SSB < Bpa but catch constrained, light grey SSB > Bpa F = Fmax and no constraint, hatched light grey SSB > Bpa but catch constrained)

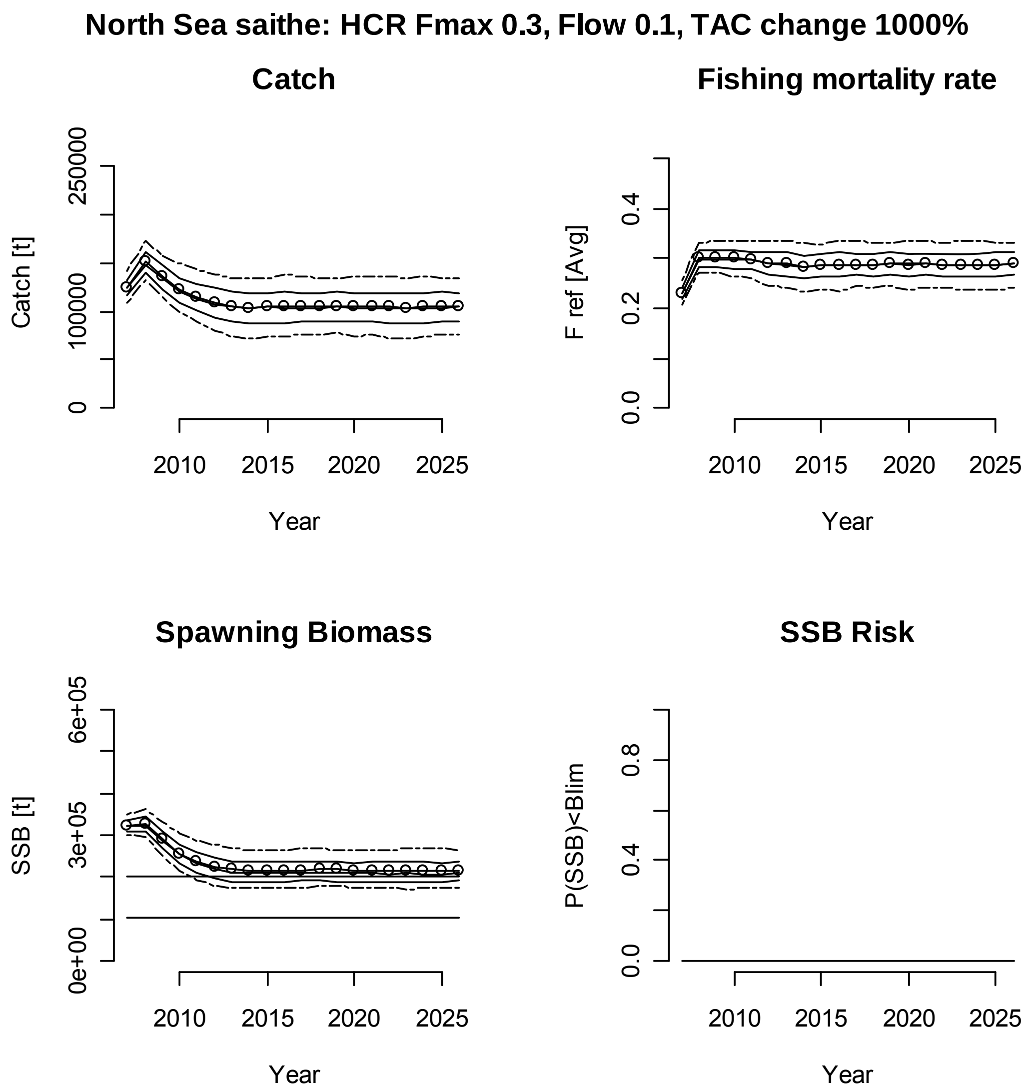


Figure 15.5.13 North Sea, west of Scotland and the Skagerrak saithe projections for yield, fishing mortality and SSB and the risk that SSB < B_{lim}, based on the current management agreement. Fmax = 0.3, Flow = 0.1, Bpa = 200000, Blim = 106000, no annual catch constraint

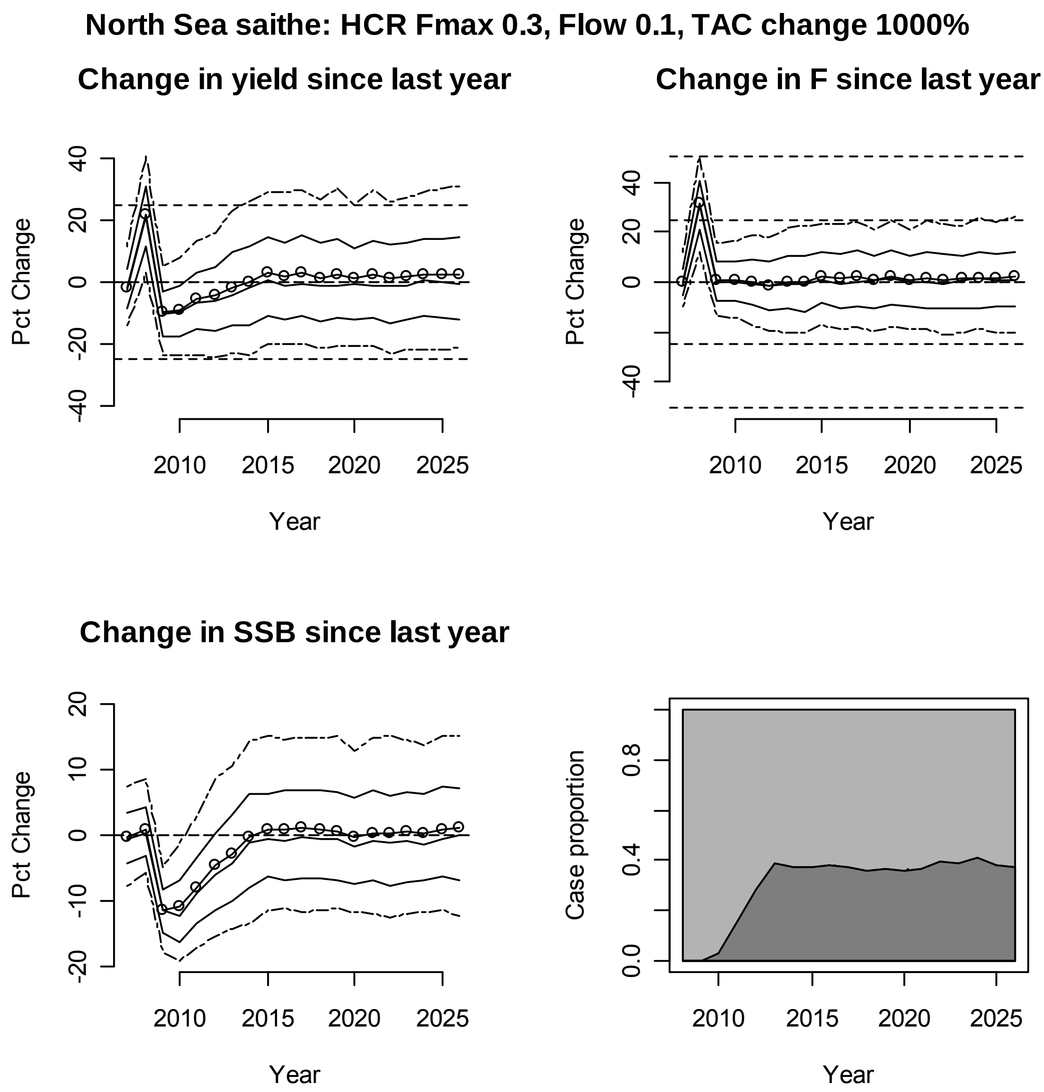


Figure 15.5.14 North Sea, west of Scotland and the Skagerrak saithe projections for Fmax = 0.3, Flow = 0.1, Bpa = 200000, Blim = 106000, no annual catch constraint. Illustrating annual change in yield, fishing mortality and SSB and the proportion of cases in which the HCR clauses are invoked, based on the current management agreement (solid black - SSB < Blim F = Flow, dark grey - Blim < SSB < Bpa and no constraint, hatched dark grey Blim < SSB < Bpa but catch constrained, light grey SSB > Bpa F = Fmax and no constraint, hatched light grey SSB > Bpa but catch constrained)

15.7 Yield

15.7.1 Target reference points based on biological equilibrium growth models

Changes in the growth rate of saithe have altered the productivity of the resource and the consequent potential yield from the fishery at given harvest rates. Figure 15.6.1 presents the yield per recruit calculated using the within year selection pattern and weight at age from the most recent stock assessment. There has been a marked reduction in the yield per recruit with the change in growth. Fishing at the suggested target level of 0.3 does not result in any loss of yield within either of the productivity periods when compared to the values from 0.1 – 0.4. The results of the yield analysis are obviously conditional on the assumption of a stable selection pattern; which was similar for the two periods and weighted towards selection of older (ages 6 –10) fish.

Continued reductions in the growth of the stock will result in further reductions in yield – not as a result of over fishing but through changes in natural productivity. For this reason a harvest control rule that utilises a low fixed exploitation rate would represent a more rational approach to the harvesting of this stock, rather than targeting a fixed yield or an exploitation rate that is based on biological characteristics of the stock such as $F_{0.1}$ and which varies continuously.

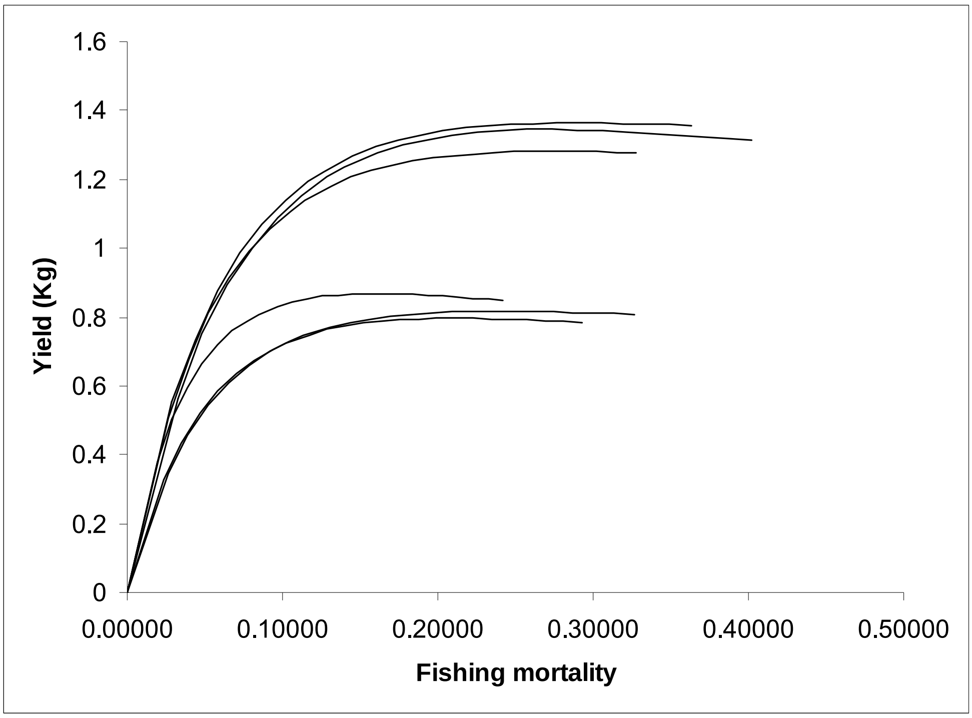


Figure 15.6.1 Individual year yield per recruit curves for the years 2002 – 2005 (lower curves) and 1967 – 1969 (upper curves).

15.7.2 Stochastic medium-term yield

The stochastic simulations for the saithe stock were run for 20 years in order to examine the potential medium-term yields resulting from setting F_{max} at range of levels. For some simulations the forecast yields and spawning stock biomass were still evolving after 20 years with some exhibiting the beginnings of cyclic behaviour. In such cases the runs were still utilised in order to provide an evaluation of the within year variance in yield and SSB to changes in target fishing mortality.

Figure 15.6.2 presents the percentiles of realised fishing mortality, yield and spawning stock biomass from the simulations in which F_{max} is varied from 0.05 – 0.6 for the current harvest control rule ($F_{max} = 0.3$, $F_{low} = 0.1$ $\gamma = 0.15$).

In Figure 15.6.2a it can be seen that the target fishing is achieved in the range 0.05 – 0.25, however at higher levels of fishing mortality than 0.25 the target is achieved in less than 50% of the runs. Figure 15.6.2b illustrates that at fishing mortality levels around 0.3 the spawning stock biomass stabilises at a level around the Bpa threshold and runs in which spawning stock biomass falls below the threshold invoke the sliding scale of fishing mortality reductions and consequently in the majority of simulations the 0.3 target is not achieved. At F_{max} fishing mortality levels above 0.3 the target fishing mortality is rarely achieved and the control and prediction of he level of biomass and fishing mortality become increasingly uncertain as the interaction between the sliding level of fishing mortality and the 15% constraint on the annual change in yield make the dynamics of the system less predictable.

Medium-term yield (Figure 15.6.2c) increases with target fishing mortality up until 0.15 but then remains stable at around 100,000t for all levels of fishing in the range 0.15 – 0.3, at target fishing mortalities above 0.3 yield appears to increase, however, as discussed above the realised fishing mortality at these targets is substantially lower than the target and in most cases is set close to the minimum level in order to allow SSB to rebuild to Bpa after pulses of high mortality.

As noted in section 15.5.3 restrictions on the annual variation in catches reduces the proportion of scenarios in which a target fishing mortality level can be achieved. The variation in the level and interannual change in fishing mortality and spawning stock biomass increase and control over the level of fishing mortality is relaxed in favour of stable catches. The risk that the stock declines below precautionary reference points is increased and the uncertainty in the stock dynamics is magnified.

If catch constraints are tightened reductions in target fishing mortality are required to balance the increased risk to the stock and to achieve targeted F_{max} fishing mortalities. Decreasing restrictions on the annual variation in catches reduces the proportion of scenarios in which the catch constraint is applied and allows more control on the level of fishing mortality. This is illustrated for medium-term yield in Figure 15.6.3 in which a 20% constraint on the change in catch is simulated, uncertainty in the fishing mortality and SSB levels is decreased in the 0.3 – 0.4 target fishing mortality range as greater annual variation in catch is permitted. The level of catch derived from the stock in year 20 is fairly insensitive to the catch constraint.

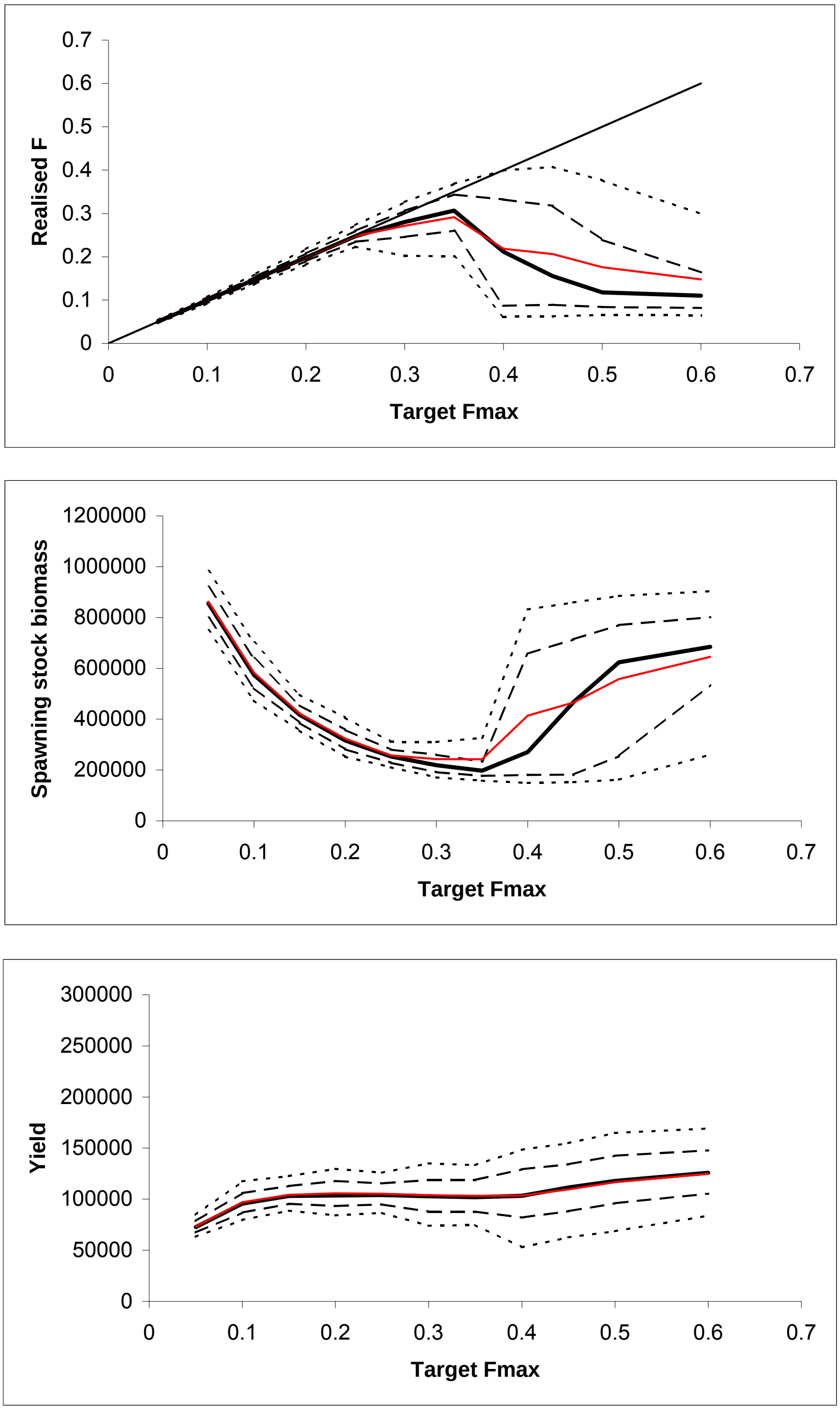


Figure 15.6.2 North Sea, west of Scotland and the Skagerrak saithe HCR projections for realised (a) fishing mortality, (b) spawning stock biomass and (c) yield in year 20 at a range of target (F_{max}) fishing mortalities at $F_{max} = 0.3$, $F_{low} = 0.1$ $\gamma = 0.15$.

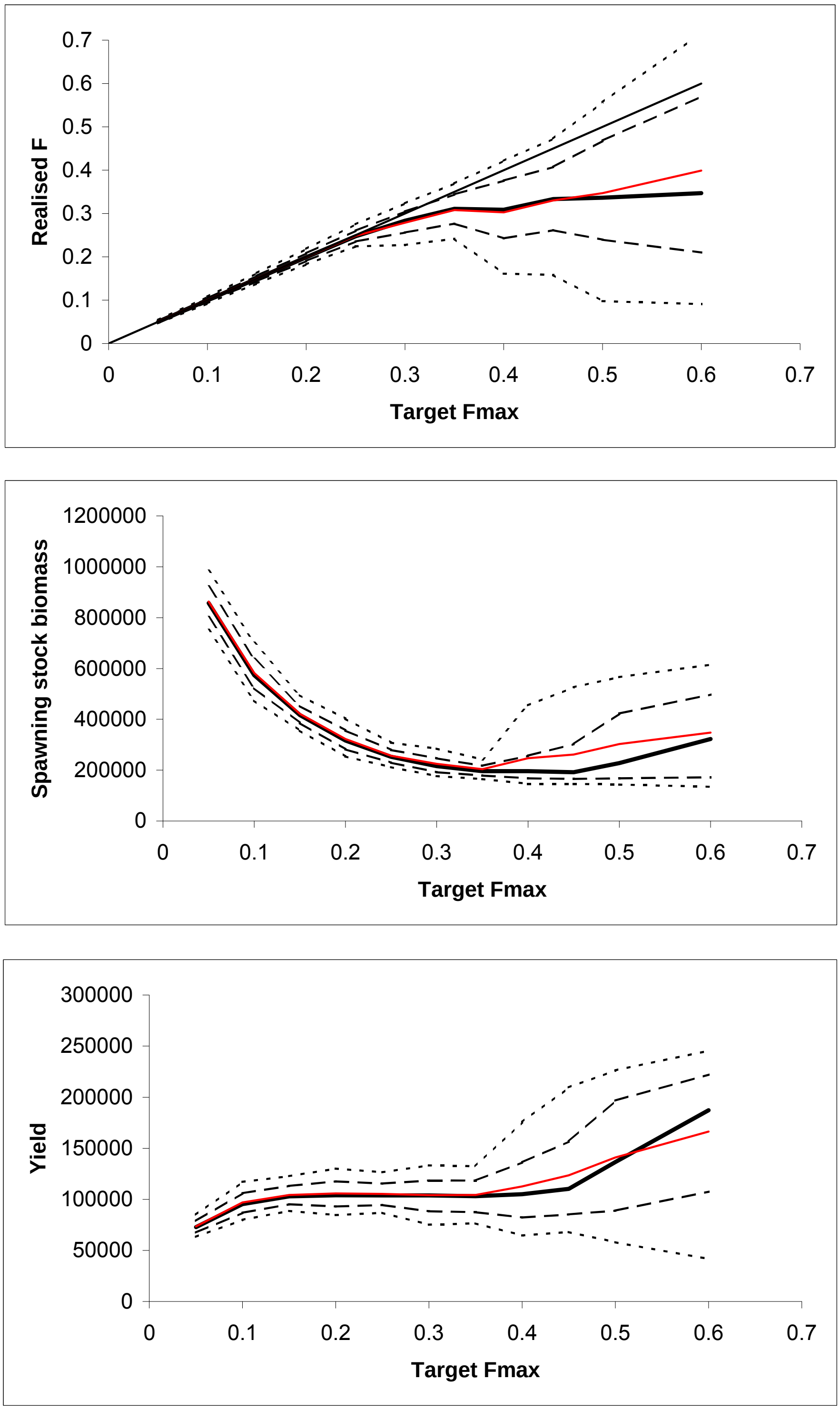


Figure 15.6.3 North Sea, west of Scotland and the Skagerrak saithe HCR projections for realised (a) fishing mortality, (b) spawning stock biomass and (c) yield in year 20 at a range of target (Fmax) fishing mortalities at Fmax = 0.3, Flow = 0.1 g = 0.20.

15.8 Evaluation of saithe management plan using full feedback simulation

An evaluation of the North Sea saithe management plan was undertaken using a full feedback approach. The implementation makes many similar assumptions to CS_HCR, however, it differs from CS_HCR in that it includes an assessment and forecasting procedure that replicates current practice and it models the underlying population and the perceived stock separately.

Due to time constraints it has not been possible to conduct as thorough an analysis as had initially been intended, however, sufficient results have been obtained to allow comparison with the alternative approaches. The management procedure as detailed in section 15.2 has been investigated and compared to an alternative approach that omits the 15% change in TAC restriction.

15.8.1 The Operating Model

The operating model was constructed on the basis of an age structured population of age range m . . . n. In accordance with the population equations given below. M is the instantaneous rate of natural mortality and is assumed to be independent of age and time. $s_{y,a}$ is the selectivity of the gear on fish of age a in year y and Fy is the fishing mortality on the fully selected age groups.

$Ny+1;a =$ $Ny+1;0$ if a=m

$Ny;a¡1:e¡(My;a¡1+sy;a¡1:Fy)$ if m < a < n

$Ny;m¡1:e¡(My;n¡1+sy;n¡1:Fy) + Ny;n:e¡(My;n+sy;n:Fy)$ if a = n

Catch numbers at age a in year y ($C_{a;y}$) are determined from

$$C_{a;y} = (s_aF_y /(s_aF_y + M_{a;y})N_{a;y} \ e\wedge(-s_aF_y - M_{a;y}))$$

Survey based indices of abundance were calculated as

$$U_{a;y} = N.B_{a;y}:s^s{}_a:q^s$$

where $N_{a;y}$ is the population number at age in the operating model and *ssa* is the selection pattern at age of the survey

The operating model has been conditioned using the ICES stock assessment data and the results of the 2007 XSA analysis. As a result, the characteristics of the operating model are almost identical to that on which the population assessments are based. There are, however, some differences. The fishing mortality applied to the operating model is derived from a fixed selection pattern at age *sa* scaled by an F multiplier *Fy*. The selection pattern is calculated as the mean selection over the full time series (1967:2006) from the most recent stock assessment. Because the selection pattern does not change over time a different pattern of fishing mortality is applied to the historic component of the operating model to that determined by the most recent stock assessment. This results in differences in the level of SSB in 2006 between the ICES assessment and this analysis. As a consequence, the simulations start from a higher level of SSB in 2006 than that estimated by the stock assessment. The assessment of North Sea saithe uses four tuning series; two commercial LPUE series, one accoustic survey and an IBTS quarter 3 survey. The present analysis models only one commercial fleet and assumes that the catches of the fleet are sampled without error or bias. A single age structured tuning index *Ua;y* is modelled and again assumed to be an accurate and unbiased index of abundance at age ie. *ssa*=1 for all a and *qs*=1.

Maturity and natural mortality remained fixed throughout the evaluations at the values specified by the working group. Similarly the proportions of fishing mortality and natural mortality prior to spawning were assumed to be zero in all cases.

A Beverton-Holt stock-recruit model was fitted to the estimates of SSB and recruitment derived from the XSA analysis. The stock-recruitment model was used to generate recruitment in both the historic and future components of the analysis. The use of a Beverton Holt stock-recruit model differed from the CS5 analyses in which a hockey stick had been applied. Figure 15.7.2 shows the historic series of SSB and recruitment and both the Beverton Holt and hockey stick models applied.

15.8.1.1 Growth

Length at age was modeled using a von Bertalanffy growth model and converted to weight at age using a fixed length-weight relationship. A fixed weight at age was assumed throughout the time series derived from a standard von Bertalanffy fit (fig 3). The fitted growth model approximates weight at age relatively well between the ages 5 and 9 but underestimates weight at age at the youngest and oldest ages. The simulated population was extended only to age 12 so as to minimise the effect of mis-specified growth through extrapolation of the model to older ages.

$$W_a = \alpha(L\infty.(1- e\hat{}(-k.(a-a0))\beta$$

15.8.2 The Management Procedure

The management procedure is the specific combination of the sampling regime, the stock assessment method, the biological reference points and the management strategies, embodied by a harvest control rule. Here the management procedure is based on the assessment protocol used by ICES and the specific harvest control rule agreed by EU and Norway for saithe in Skagerrak, North Sea and West of Scotland in 2004.

The stock was assessed using VPA, tuned using the XSA methodology. The results of the stock assessment were projected forwards using a short-term forecast to enable calculation of the TAC to be implemented in the management year.

The short term forecast used in the analysis was consistent with the approach typically used by ICES. The fishing selection pattern for future years was taken as the mean of the last three years, as were the values of weight at age, maturity, natural mortality and the proportions of fishing mortality and natural mortality before spawning. Recruitment was taken as the long term geometric mean. The F multiplier (used to scale the selection pattern to the level of fishing mortality) was set so as to achieve catches equal to the TAC in the first forecast year and conditions corresponding to the harvest control rules in the second forecast year.

15.8.2.1 The observation error model

The model simulates, as closely as possible, the data collection processes of the real world but may not incorporate all of the error inherent in the true system. The model simulates a single fish population exploited by a single fishing fleet. The catches of the fleet were sampled to generate the information with which to assess the stock. A separate survey index was also generated to tune the assessment. In the real world the collection of these data will be subject to error through a number of different processes. For the purposes of this study, however, no observation error has been included and it has been assumed that the data available to the Management Procedure are an accurate and unbiased representation of the operating model. Similarly, in the real world the catches of the fleet may not correspond exactly with the TAC but for the initial analyses there was assumed to be perfect implementation of the management controls.

15.8.3 Results

In the time available it was only possible to consider two management procedures; MP1 which comprised the existing management procedure described in section XX and MP2 which was identical to MP1 in all aspects except that the upper fishing mortality target had been increased to 0.4. The simulations begin after 2006 and run for a 20 year period. Since the only source of uncertainty introduced into the system is through recruitment variation, confidence intervals are initially small and increase as the number of cohorts subject to variable recruitment increases. Box plots show the 10th, 25th, 50th, 75th and 90th percentiles. Outliers are shown by individual points but are only shown for the change in TAC.

The number of iterations run for each simulation varied and in some cases had to be reduced due to time constraints. Whilst a large number of iterations is preferable in order to get consistent measures of variability it was found that the general dynamics of the system could be identified from relatively few iterations. As little as 20 iterations were often sufficient to provide a basic impression of the behaviour of the model.

15.8.3.1 The Base Case: MP1

The results of the base case evaluations in terms of trajectories of landings, fishing mortality and SSB, are shown in Figure 15.7.6. It shows SSB and catches reaching relatively stable and high levels and fishing mortality moving progressively towards the target of 0.3. Although the management procedure included a 15% cap on any change in TAC from one year to the next, this was rarely implemented with only relatively small annual adjustments in TAC being made. As a consequence the results of an alternative management procedure in which the 15% bounds were omitted are more or less identical to those in Figure 15.7.6.

Figure 15.7.5 shows the equilibrium yield and SSB curve with points on the curve corresponding to Fmax and F0.1. the points about the curve show the trajectory of yield and SSB for both the historic and future components of the simulation. The results for one iteration are shown. Initially the points are clustered closer to the origin with relatively low yields and SSB. As the simulation progresses the points move further up the curve but do not reach the level of Fmax.

It was found that the simulations were sensitive to the values of in-coming recruitment assumed by the management procedure. If these values were over-estimated then large oscillations could be introduced which, under certain conditions, could lead to the collapse of the stock. The simulations were run using both a long term (all years) geometric mean assumption for recruitment in the forecasts and a short term (5 years). For the base case, where the target fishing mortality was 0.3, this had little effect.

15.8.3.2 Alternative Management Procedure: MP2

An alternative MP was investigated in which the target fishing mortality was increased from 0.3 to 0.4. The results show the system to be less stable with large oscillations apparent in catches and SSB. These results are surprising given the relatively small change in target fishing mortality. It has not been possible to fully explore these results in the time available and it is not yet clear whether they are a consequence of the biological characteristics of the fish population or an artefact of the way that the management procedure has been modelled. It would, however, seem that at target fishing mortalities greater than 0.3 there is less probability of maintaining high levels of yield and SSB.

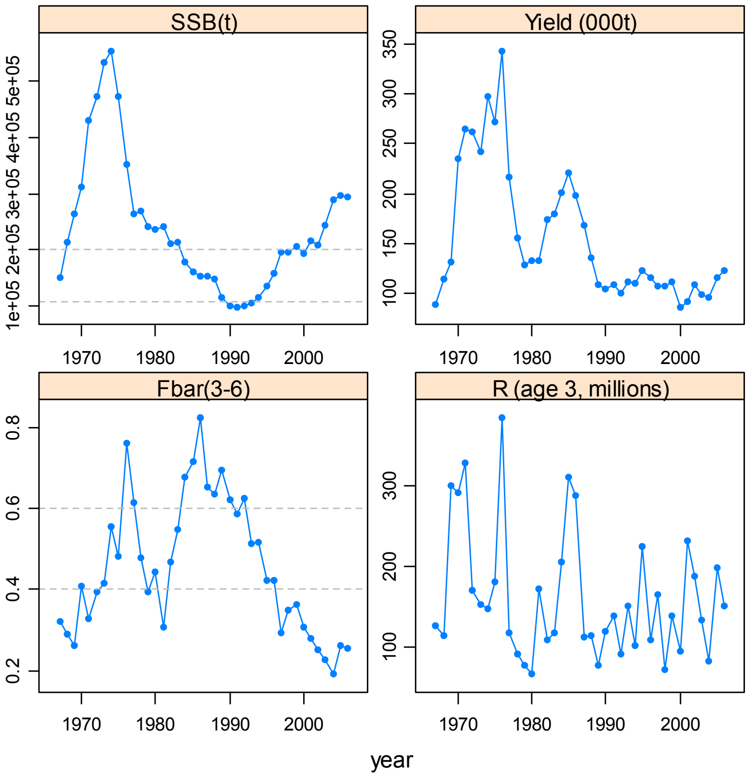


Figure 15.7.1. Summary results of XSA analysis of historic data used as the basis for conditioning the model.

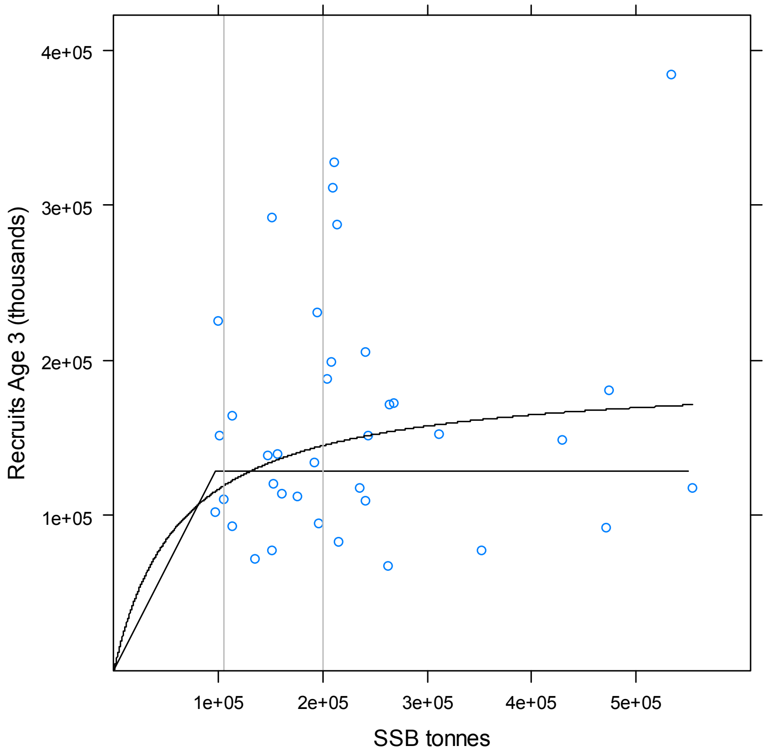


Figure 15.7.2. Beverton Holt and hockey stick stock and recruitment models

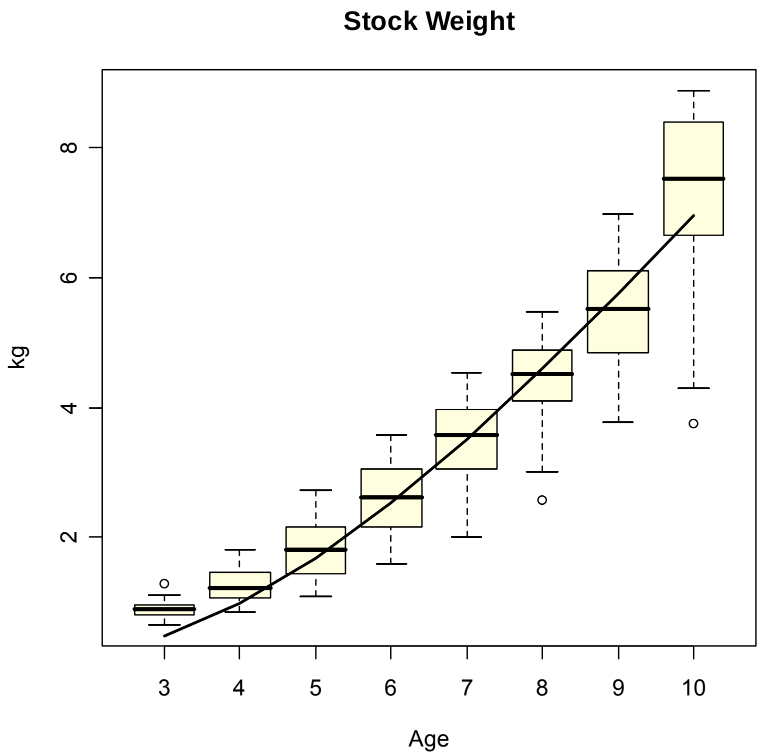


Figure 15.7.3. Time invariant von Bertalanffy fit to weight at age.

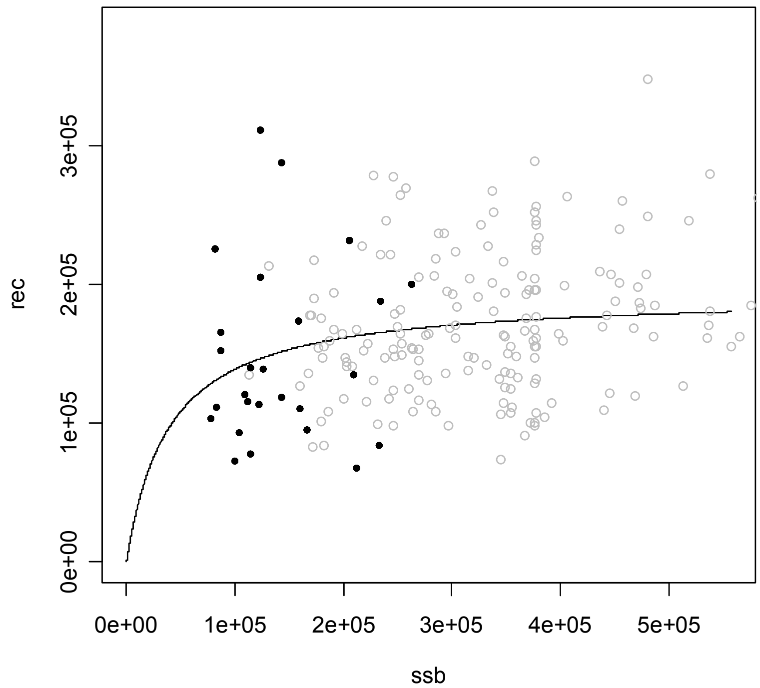


Figure 15.7.4. Stock and recruitment points shown about Beverton Holt SRR curve. Solid points show historic recruitment values, open circles show future generated SRR pairs for 10 iterations of base case simulation.

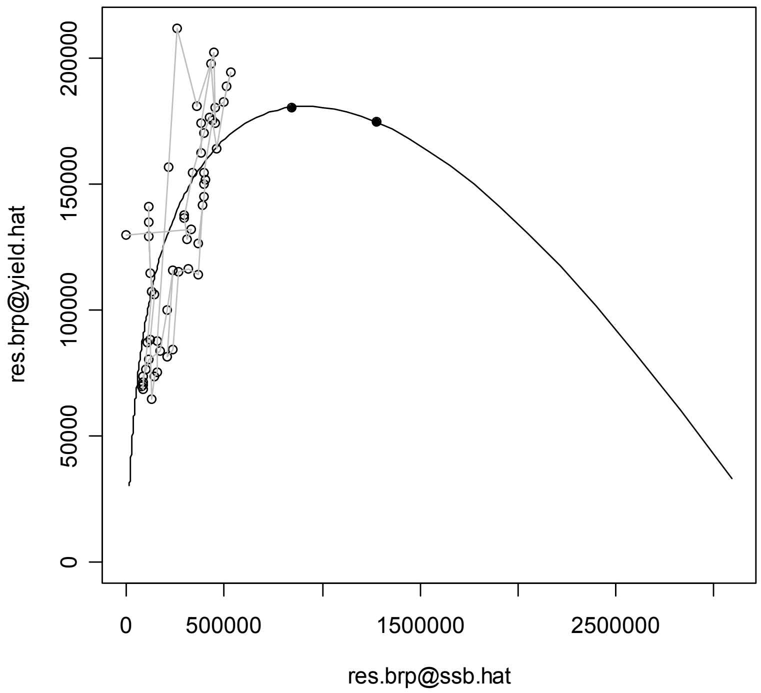


Figure 15.7.5. Equilibrium SSB and yield curve with points on the curve showing the positions corresponding to Fmax and F0.1. Open circles show the trajectories of yield and SSB for one iteration of the base case simulation.

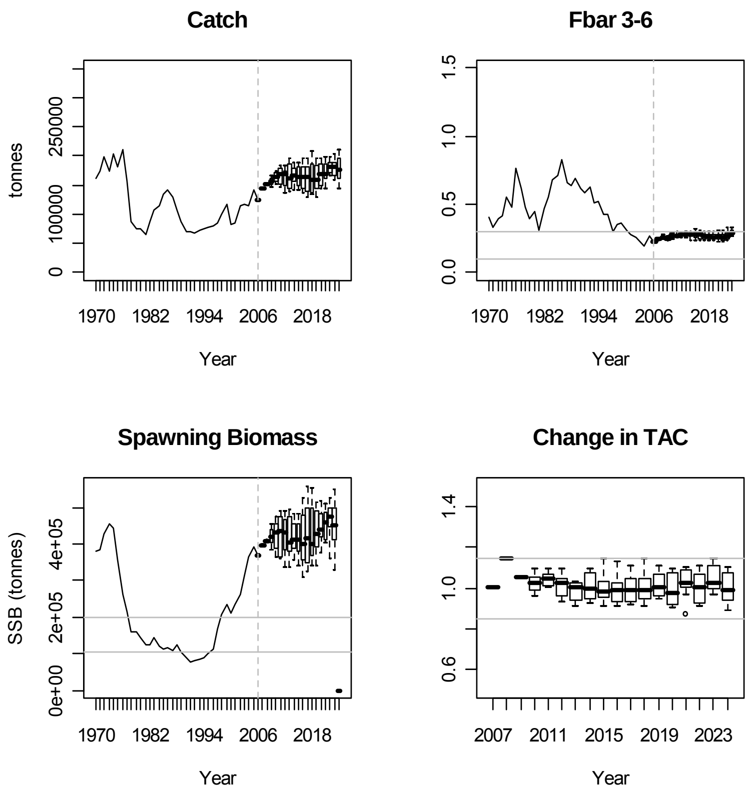


Figure 15.7.6. Results of base case simulations (MP1). Box and whisker plots show 10th, 25th, 50th, 75th and 90th percentiles. Outliers are shown by circles for TAC change only.

15.9 Summary

1) The analyses presented address issues pertinent to the current management plan as agreed between the EU Commission and Norway in 2004 for North Sea saithe.

2) This paper examines the likely effects of variation in the structure of the saithe harvest control rule using a stochastic simulation approach as currently applied by a variety of scientific working groups.

3) Stochastic simulations using the CS_HCR model indicate that under the current recruitment regime and exploitation pattern, the current HCR will result in:

   a) levels of spawning stock biomass that are stable at levels just above B_{pa} and that remain above the B_{lim} with a very high probability.

   b) catches that will stabilise at around 100,000t and that are relatively insensitive to changes in the harvest control rule target fishing mortality in the range 0.1 – 0.3

   c) invocation of the 15% constraint in ~ 50% of years in which the rule is applied.

4) Evaluations using the full feedback model and simulated data result in higher levels of catch but were based on the full time series of weights at age and a more optimistic stock and recruitment model. The ratio of the differences in forecast catch is consistent with the differences in the assumptions about weight at age.

5) Both sets of simulations indicate that the proposed HCR will maintain SSB above B_{pa} and fishing mortality below F_{lim} and the HCR is therefore considered appropriate to maintain the stock within precautionary levels.

6) In recent years growth and recruitment to the stock have been at a lower level than recorded in the past, the reasons for this are unknown, they could relate to an environmental or biological change in stock production. Yields and spawning stock biomass calculated are greater for the same level of exploitation using the historic data. If conditions return to the more favourable production state higher yields and levels of spawning stock biomass would be achieved using the same harvest control rule structure. If the productivity deteriorates further a revision of the parameters would be required.

7) For this reason a harvest control rule that utilises a fixed exploitation rate (as the current plan does) would represent a more rational approach to the harvesting of this stock, rather than a fixed yield strategy or one that is based on biological characteristics of the stock, such as targeting $F_{0.1}$.

8) Any inference from using levels of probability less than 10% or greater than 90% would be ill-advised. This approach predicates the forecasts on simple assumptions based on recent experience. Real uncertainties are much larger than those represented here. The model should not be used to estimate absolute probabilities but to compare strategies. It would be more appropriate to categorise the risk as high medium and low.

Annex 1: Participants Lists for Spring and Autumn

Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak

ICES, Headquarters, 1–8 May 2007

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Annex 2: Stock Annexes

Quality handbook: Plaice in Division VIId

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GENERAL

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.

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).

Ecosystem Aspects

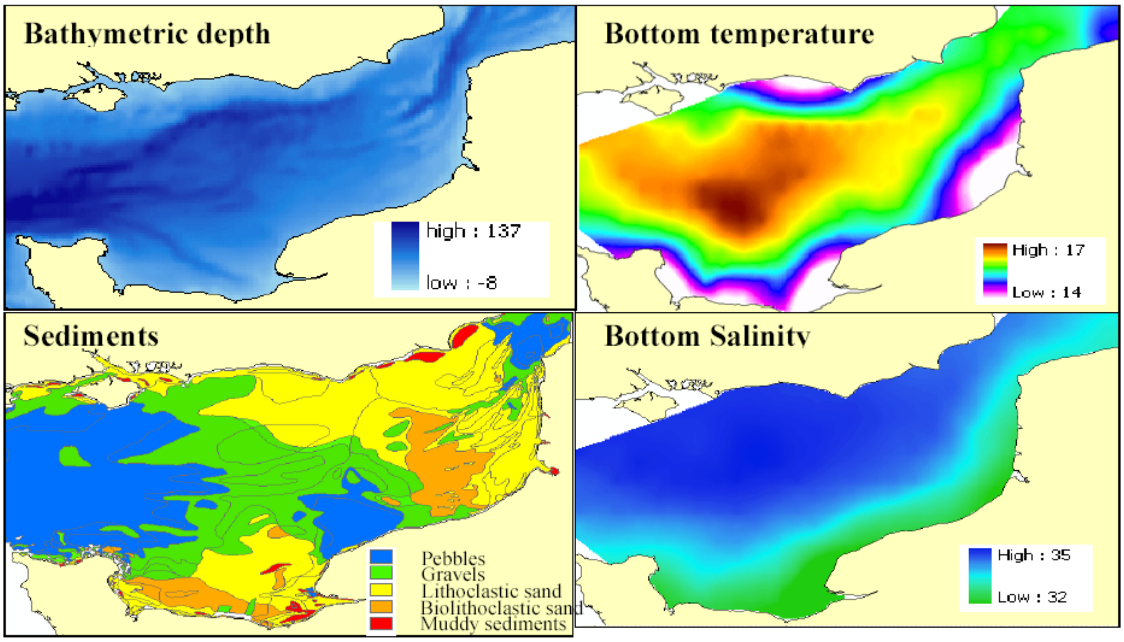

Figure 1 Eastern English Channel physical and hydrological features: Bathymetric depth and simplified sediment types representation. Survey bottom temperature and bottom salinity (averaged for 1997 to 2003) obtained by kriging. (in Vaz *et al.* 2004)

Biology : Adult plaice feed essentially on annelid polychaetes, bivalve molluscs, coelenterates, crustaceans, echinoderms, and small fish. In the English Channel, spawning occurs from December to March between 20 and 40 m. depth. At the beginning, pelagic eggs float at the surface and then progressively sink into deeper waters during development. Hatching occurs 20 (5-6°C) to 30 (2-2.5°C) days after fertilization. Larvae spend about 40 days in the plankton before migrating to the bottom and moving to coastal waters when metamorphosing (10-17 mm). The fry undergo relatively fast growth during the first year (*Carpentier et al., 2005*).

Environment: This bentho-demersal species prefers living on sand but also gravel or mud bottoms, from the coast to 200 m depth. The sepcies is found from marine to brackish waters in temperate climate (*Carpentier et al., 2005*)..

Geographical distribution : Northeast Atlantic, from northern Norway and Greenland to Morocco, including the White Sea; Mediterranean and Black Seas (*Carpentier et al., 2005*)..

Vaz et al. (2007) used a multivariate and spatial analyses to identify and locate sh, cephalopod, and macrocrustacean species assemblages in the eastern English Channel from 1988 to 2004. Four sub-communities with varying diversity levels were identi ed in relation to depth, salinity, temperature, seabed shear stress, sediment type, and benthic community nature. One Group (class 4 in Fig.2 below) was a coastal heterogeneous community represented by pouting, poor cod, and sole and was classified as preferential for many flatfish and gadoids. It displayed the greatest diversity and was characterized by heterogeneous sediment type (from muds to coarse sands) and various associated benthic community types, as well as by coastal hydrology and bathymetry. It was mostly near the coast, close to large river estuaries, and in areas subject to big salinity and temperature variations. Possibly resulting from this potentially heterogeneous environment (both in space and in time), this sub-community type was the most diverse.

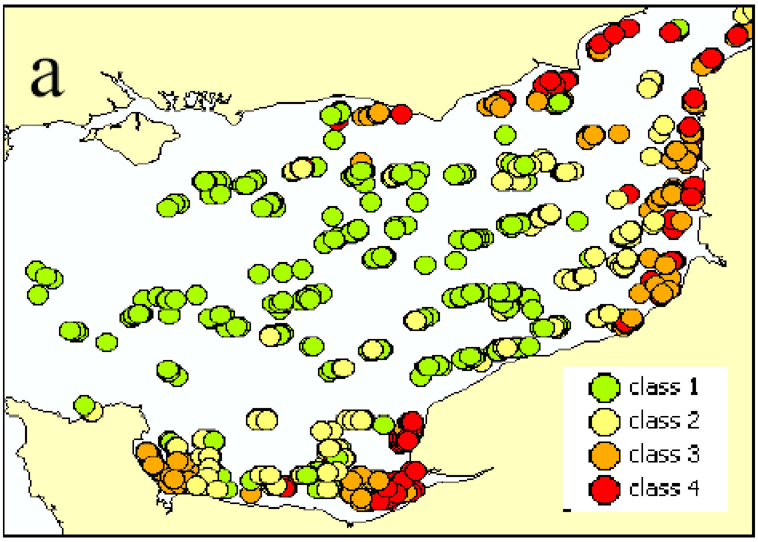

Figure 2 : Spatial distribution of Fish Subcommunities in the Eastern Channel from 1988 to 2003. Observed assemblage type at each station, These illustrate the gradation from open sea community to coastal and estuarine communities. (In Vaz *et al.*, 2004)

Community evolution over time : (From Vaz *et al*., 2007). The community relationship with its environment was remarkably stable over the 17 y of observation. However, community structure changed significantly over time without any detectable trend, as did temperature and salinity. The community is so strongly structured by its environment that it may reflect interannual climate variations, although no patterns could be distinguished over the study period. The absence of any trend in the structure of the eastern English Channel fish community suggests that fishing pressure and selectivity have not altered greatly over the study period at least. However, the period considered here (1988–2004) may be insufficient to detect such a trend.

Data

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.

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.

Surveys

A dedicated 4m beam trawl survey for plaice and sole has been carried out by England using the RV Corystes since 1988. The survey covers the whole of VIId and is a depth stratified survey with most samples allocated to the shallower inshore stations where the abundance of sole is highest. In addition, inshore small boat surveys using 2m beam trawls are undertaken along the English coast and in a restricted area of the Baie de Somme on the French coast. In 2002, The English and French Young Fish Surveys were combined into an International Young Fish Survey. The dataset was revised for the period back to 1987. The two surveys operate with the same gear (beam trawl) during the same period (September) in two different nursery areas. Previous analysis (Riou et al, 2001) has shown that asynchronous spawning occurs for flatfish in Division VIId. Therefore both surveys were combined based on weighting of the individual index with the area nursery surface sampled (Cf. Annex 1). Taking into account the low, medium, and high potential area of recruitment, the French YFS got a weight index of 55% and the English YFS of 45%.

A third survey consists of the French otter trawl groundfish survey (FR GFS) in October (Annex 2). Prior to 2002, the abundance indices were calculated by splitting the survey area into five zones, calculating a separate index for each zone each zone, and then averaging to obtain the final GFS index. This procedure was not thought to be entirely satisfactory, as the level of sampling was inconsistent across geographical strata. A new procedure was developed based on raising abundance indices to the level of ICES rectangles, and then by averaging those to calculate the final abundance index. Although there are only minor differences between the two indices, the revised method was used in 2002 and subsequently.

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.

Other Relevant Data

None.

Historical Stock Development

Deterministic Modelling

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

Survivor estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages

S.E. of the mean to which the estimate are shrunk = 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

Uncertainty Analysis

Retrospective Analysis

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

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.

Long-term projections, yield per recruit

Biological Reference Points

Blim = 5400 t.

Bpa = 8000 t.

Flim = 0.54

Fpa = 0.45

Other Issues

None.

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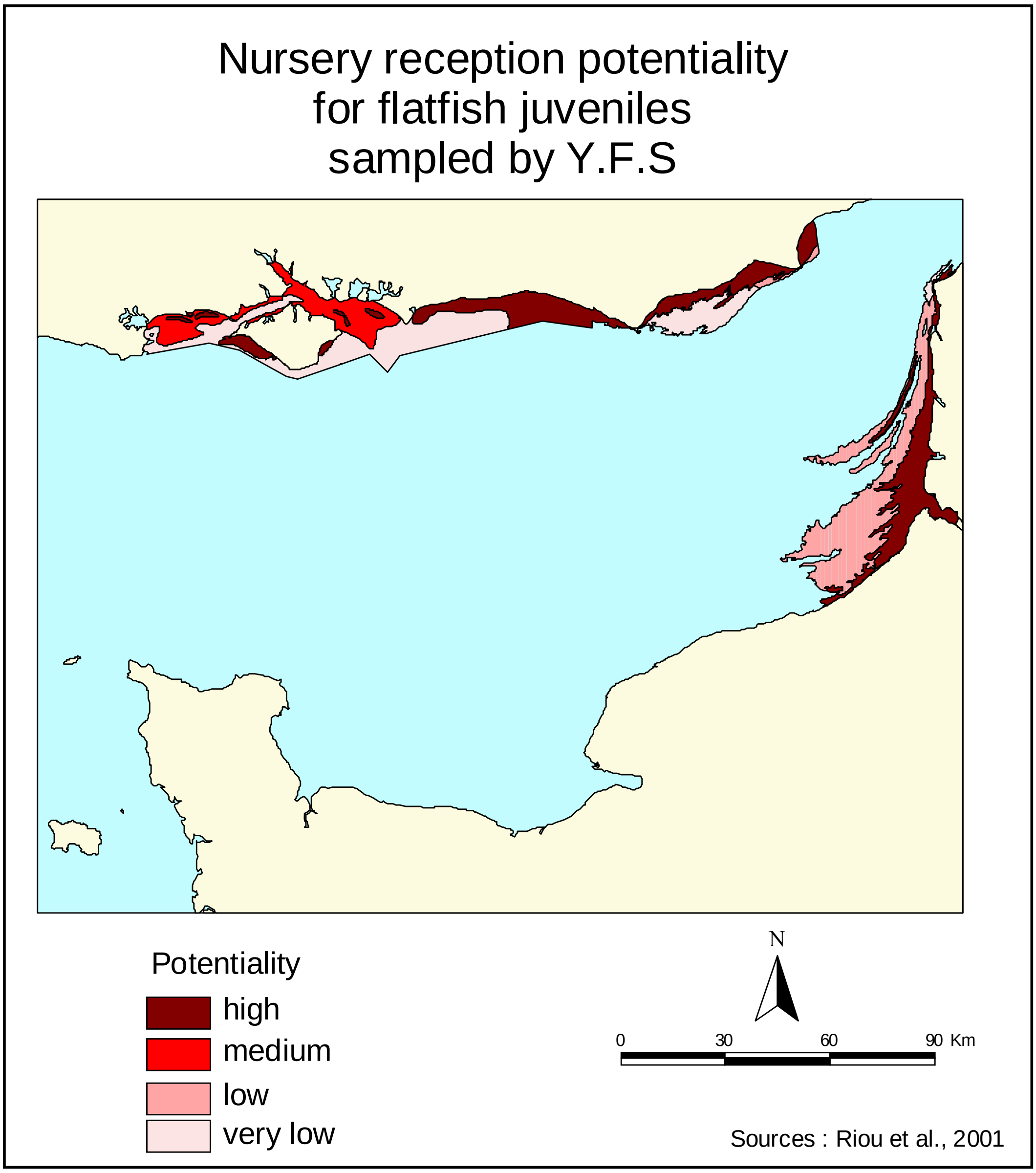
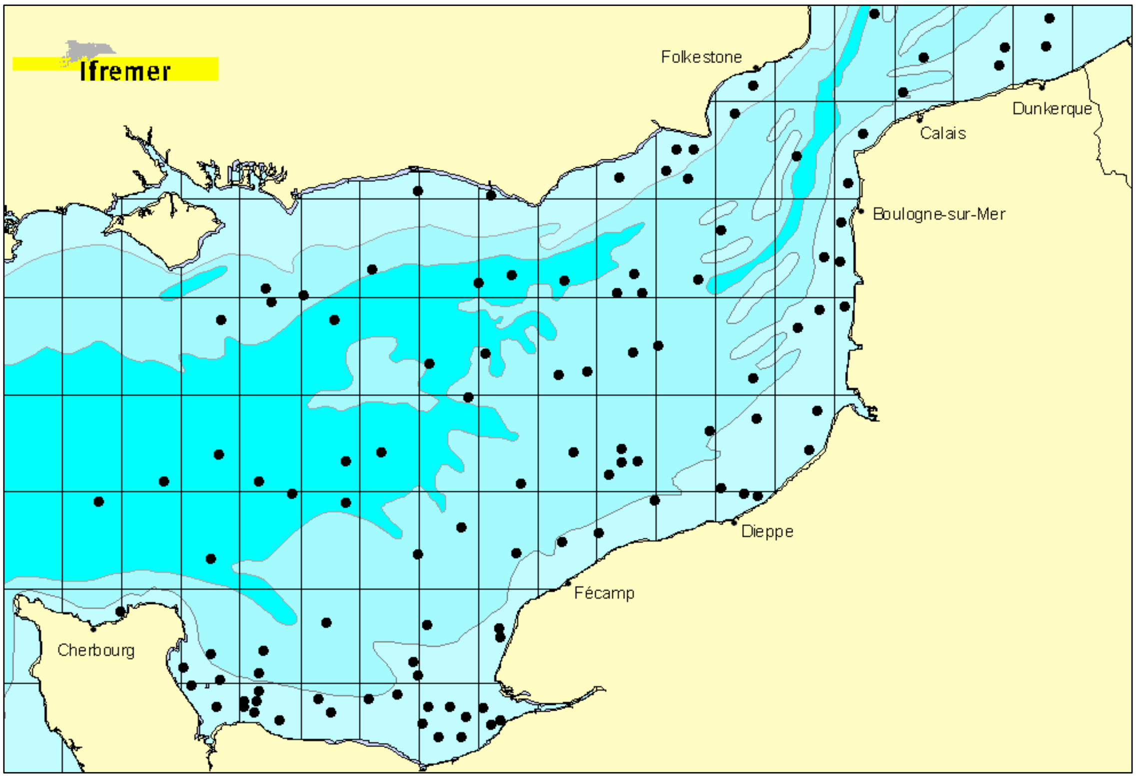
Riou et al. 2001. Relative contributions of different sole and plaice nurseries to the adult population in the Eastern Channel : application of a combined method using generalized linear models and a geographic information system. Aquatic Living Resources. 14 (2001) 125-135

Appendix 1 – Nursery reception potentiality for flatfish used as a basis for the combination of FR and UK YFS

Potentiality surface (Km^2)	South England	Bay of Somme
High	756	575.1
Medium	484.7	0
Low	30.5	953.1
Very low	993.3	21.3
Total	2264.5	1549.5
Total (Low – Medium – High)	1271.2	1528.2



Appendix 2 – FR GFS. Sampling tows location grid



Quality Handbook ANNEX:__SAN-NSEA

Stock specific documentation of standard assessment procedures used by ICES.

Working group: North Sea Demersal Working Group

Updated: 8/5//2006 by: Henrik Jensen (hj@dfu.min.dk)

1 Sandeel in IV

1.1.1 General

1.1.2 Stock definition

For assessment purposes, the European continental shelf was divided into four regions for sandeel assessment purposes up to 1995: Division IIIa (Skagerrak), northern North Sea, southern North Sea, and Shetland Islands and Division VIa. These divisions were based on regional differences in growth rate and evidence for a limited movement of adults between divisions (e.g. ICES CM 1977/F:7, ICES CM 1991/Assess:14.). The two North Sea divisions were revised in 1995, and it was decided to amalgamate the two stocks into a single stock unit with two fleets, one fleet in the northern North Sea and one in the southern North Sea. The Shetland sandeel stock is assessed separately. ICES assessments have used these stock definitions since 1995.

Sandeels are largely stationary after settlement and the North Sea sandeel fishery must be considered as exploiting a complex of local populations (Proctor et al. 1998, Wright et al. 1998). Recruitment to local areas may not only be related to the local stock, as some interchange between areas situated close to each other seems to take place during the early phases of life before settlement.

Based on the distribution and simulated dispersal of larval stages, Wright et al. (1998) suggest that the North Sea stock could be split into six areas, including the Shetland as a separate population. Assessments have tentatively been made for some of these areas (Pedersen et al. 1999) and there was high correlation between the results from the study and the assessment made by the WG for the whole North Sea. Presently there are insufficient information about sandeel biology, especially about the intermixing of the early life stages between spawning aggregations, to allow for and alternative separation of the North Sea into separate population units to be assessed.

Recent studies indicate a low interchange of pre-settled sandeels between the spawning grounds identified (Christensen et al. Accepted, Christensen et al. Submitted). These results also indicate that the population structure suggested by Wright et al. (1998) need to be revised. Work is currently conducted to do this.

1.1.3 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.

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. Danish and Norwegian landings in 2003 were only 44% and 17% of those in 2002.

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). Up to 2002 and particularly prior to 1998, most landings of sandeels in March were taken from the eastern North Sea banks whilst sandeel landings in April-June were mainly from the west Dogger Bank. In some years a relatively large part of the sandeel landings are taken from the central and eastern North Sea along the Danish west coast. From 1991, grounds off the Scottish east coast have been targeted particularly in June. However, since 2000 the banks in the Firth of Forth area have been closed to fishing.

Large variations in the fishing pattern occurred concurrent with the decline in the total fishery and CPUE in 2003. The distribution of landings in the southern North Sea in 2003 to 2005 seemed more extensive than the typical long-term pattern in the same area. Further, grounds usually less exploited became more important for the total fishery during the same period. In 2006 there was another large change in the fishing pattern, when the fishery showed a strong concentration at the fishing grounds in the Dogger Bank area. Although this overall large variation in fishing pattern there is a general high importance for most years of the Dogger Bank area.

In the Northern North Sea, mainly NEEZ, the change in the spatial pattern was significantly different from southern part. The highest landings from a single statistical square were taken in 1995 on the Vikingbank, the most northerly fishing ground for sandeel in the North Sea. However, in 1996 landings from the Vikingbank dropped substantially, and since 1997 have been close to null. The marked reduction in landings around 2000 in NEEZ was accompanied by a marked contraction of the fishery to a small area in the southern part of NEEZ, the Vestbank area. In this area landings remained high in 2001 and 2002 due to the strong 2001 year-class. However, the 2001 year-class was only abundant in the Vestbank area, which resulted in a highly concentrated fishery and the decimation of the year-class before it reached maturity in 2003. This may have led to the collapse of the sandeel fishery in NEEZ. In the EU EEZ any contraction of the fishery has been less apparent.

The sandeel fishing season was unusual short in both 2005 and 2006, starting later and ending earlier than in previous years. The late start of the fishery was partly because the Danish fishery first opened the 1st April, in accordance with a national regulation introduced in 2005. Further, weekly data on the oil content of sandeels in the commercial landings, provided by Danish fish meal factories, indicated a late onset of sandeels feeding season in both 2005 and 2006 and that sandeels therefore became available to the fishery later than usual. Landings in the second half year of both 2005 and 2006 were on a low level compared to previous years. Only 14.000 tones were recorded in 2005 and 17.000 tones in 2006.

Regulation of the fishery is no explanation to the small fishery observed from 2003 and on-wards. The TAC in force has never been restrictive in the sandeel fishery, and in 2005 (the only year when additional regulation was introduced) the fishery was first regulated in July after the main fishing season.

There was a 50% decline in the number of Danish vessels (from 200 to 98 vessels) fishing sandeels from 2004 to 2005. 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.

Technical measures for the sandeel fishery include a minimum percentage of the target species at 95% for meshes < 16 mm, or a minimum of 90% target species and maximum 5% of the mixture of cod, haddock, and saithe for 16 to 31 mm meshes.

Most of the sandeel catch consists of the lesser sandeel *Ammodytes marinus*, although small quantities of other Ammodytoidei spp. are caught as well. There is little by-catch of protected species (ICES WGNSSK 2004).

1.1.4 Ecosystem aspects

Due to the stationary habit of post-settled sandeels (DIFRES unpublished information, Gauld 1990), a patchy distribution of the sandeel habitat (Jensen et al. 2001, Jensen and Rolev 2004), and a limited interchange of the planktonic stages between the spawning areas (Christensen et al. Accpeted, Christensen et al. Submitted, Gauld et al. 1998) the sandeel stock in IV consist of a number of sub-populations (Wright et al. 1998). 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. The ICES Ad Hoc Group on Sandeels (ICES AGSAN 2007) outlined some feasible management strategies in the context of management aims and recent understanding of population biology. It will require modelling and simulation work well beyond what has been common practise for other stocks.

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.

ACFM consider that there is a need to ensure that the sandeel stock remains high enough to provide food for a variety of predator species.

The decline in the sandeel population concurrent with a markedly change in distribution (ICES WGNSSK 2007) has increased the possibility of local depletion, of which there now is some evidence (ICES WGNSSK 2007). This may be of consequence for marine predators that are dependent on sandeels as a food source. It is presently not possible to make an assessment that takes account of the sub-population structure of sandeels (ICES AGSAN 2007).

Sandeels are important prey species for many marine predators, but the effects of variation in the size of this stock on predators are poorly known. Although the direct effects of sandeel fishing that have been identified on other species fished for human consumption, e.g. haddock and whiting are relatively small in comparison to the effects of directed fisheries for human consumption species there is still relatively scant information on the indirect effects of the sandeel fishery.

In 1999 the U.K called for a moratorium on sandeel fishing adjacent to seabird colonies along the U.K. coast and in response the EU requested advice from ICES. An ICES Study Group, was convened in 1999 to assess whether removal of sandeel by fisheries has a measurable effect on sandeel, whether establishment of closed areas and seasons for sandeel fisheries could ameliorate any effects, and to identify possible spatial and/or temporal restrictions of the fishery as specifically as possible. The ICES Advisory committees (ACFM and ACE) accepted the advice from the study group. STECF (1999) agreed with this ICES advice and the EU advised to close the fishery whilst maintaining a commercial monitoring. A 3-year closure, from 2000 to 2002, was decided. All commercial fishing was excluded, except for a maximum of 10 boat days in each of May and June for stock monitoring purposes. The closure was maintained for three years (see e.g. Wright et *al.* 2002) and has been extended until 2007, with a small increase in the effort of the monitoring fishery. There is presently no decision on weather a full commercial sandeel fishery will be reopened in the Firth of Forth area.

In general, fishing on sandeel aggregations at a distance less than 100 km from seabird colonies has been found to affect some surface feeding bird species, especially black-legged kittiwake and sandwich tern (Frederiksen et al. 2004, 2005). Recent research of effects on seabird predators due to changes in sandeel availability showed that black-legged kittiwake Rissa tridactyla in the Firth of Forth area off the Scottish east coast was related to abundance of both 1+ group, the age class targeted by the fishery, and 0 group sandeels. The same relationship was not found for six other sandeel dependent seabird species. Controlling for environmental variation (sea surface temperature, abundance of larval sandeels and size of adult sandeels), Frederiksen et al. (submitted) found that breeding productivity in the seabird colony on the Isle of May was significantly depressed by the fishery during periods of unregulated fishery for one surface-feeding seabird species (black-legged kittiwake), but not for four diving species. The mechanism by which the fishery affects the seabird however remains unclear as the fishery is not always in direct competition with the birds. The strong impact on these surface-feeding species, while no effects are documented found for diving species, could result from its inherently high sensitivity to reduced prey availability, from changes in the vertical distribution of sand lance at lower densities, or from sand lance showing avoidance behaviour to fishery vessels.

The ecosystem effects of industrial fisheries are discussed in the Report of the ICES Advisory Committee on Ecosystems, June 2003, Section 11 (ICES Cooperative Research Report No. 262).

Other ecosystem effects of the sandeel fishery are discussed in section 16.5 and in the ICES Report of the Advisory Committee on Ecosystems, June 2003, Section 11.

1.2 Data

1.2.1 Commercial catch

In the last 20 years the landings of sandeels in IV have been taken mainly by Denmark and Norway with UK/Scotland, Sweden and Faroes Isl. taken a much smaller part of total landings. 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.

1.2.1.1 **Denmark** More details to be included in this section

Industrial species are not sorted by species before processing and it is assumed that the landings consist of one species only in the calculation of the official landings. The WG estimate of landings is based on samples for species composition taken by the Fishery Inspectors 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).

1.2.1.2 **Norway** Text to be inserted by Norway

For Norway and Sweden, the official landings and the WG estimated landings are the same.

1.2.1.3 **UK/Scotland** Text to be inserted by UK/Scotland

1.2.1.4 **Sweden** Text to be inserted by Sweden

The text table below shows which country supplies which kind of data:

	Data				
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Denmark	x	x	x		x
Norway	x	x	x		x
UK/Scotland	x				
Sweeden	x				
Farao Islands	x				

All input files are Excel spreadsheet files.

The national data sets have been imported in a database aggregated to international data by DIFRES.

The combined Danish and Norwegian age composition data and weight at age data are applied on the landings of UK, Sweeden and Farao Isl., assuming catches from these countries have the same age composition and weight at age as the Danish and Norwegian landings.

1.2.2 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). During the WGNSSK 2005 meeting an exploratory assessment was carried out, using the natural mortality for sandeels estimated by ICES-SGMSNS (2005). The time series of natural mortality only include up to 2003, so 2003 estimates were copied to 2004 and 2005. In contras to the fixed values of natural mortality used in previous sandeel assessments, the natural mortalities estimated by ICES-SGMSNS (2005) show large variability over years. The most significant differences between the natural mortalities of sandeels used in previous sandeel assessments and those estimated by ICES-SGMSNS (2005) are those for age-0 sandeels. The natural mortalities of age-0 sandeels estimated by ICES-SGMSNS (2005) are about twice as high than those used in previous sandeel assessments.

The proportion mature is assumed constant over the whole period with 100% mature from age 2 and 0% of age 0 and 1. Recent research indicates however, that there are large regional variations in age at maturity of *Ammodytes marinus* in the North Sea (Boulcott et al. 2006). Whilst sandeels in some areas seem to spawn at age 2 or older, sandeels in other regions seem to mature and spawn at age 1. As the decision to spawn at age 1 or 2 is an annual event, it is likely that there are large regional and annual variations in the fraction of the populations of the sandeels that contribute to the spawning. The age at maturity keys used in the assessment might thus considerably underestimate the spawning biomass of sandeels in the North Sea.

The fishing fleet catches sandeels in different parts of the North Sea during the year, and the fishing pattern changes from year to year. Because sandeels, *Ammodytes marinus*, in the North Sea consist of a number of sub populations (section 1.1.1) the industrial fishery target different part of the sandeel populations during the year and between years. There seem to be significant spatial and temporal variations in emergence behaviour (e.g. Rindorf *et al*. 2000) and growth (e.g. Boulcott et al. 2006, Pedersen et al. 1999; Wright et al. 1998) of sandeels in the North Sea. Further, there are age/length dependent variations in the burrowing behaviour of sandeels (Kvist et al. 2001). The information about age compositions in the catches and the age and weight relationships thus represent average values over time and space and reflect the variability in emergence behaviour and growth. For example, weight at age of sandeels seems to vary both between years and between Danish and Norwegian catches.

1.2.3 Surveys

As no recruitment estimates (abundance of age-0 sandeels second half year) from surveys are available, recruitment estimated in the assessments are based exclusively on commercial catch-at-age data. The tuning diagnostics indicate that the 0-group CPUE is a poor predictor of recruitment.

The need for fishery independent information on sandeel distribution and abundance has been highlighted by ICES-WGNSSK (2006 and 2007). The demand for such information has increased due to the recent years decline in the North Sea sandeel stock concurrent with large changes in distribution and in the fishing pattern.

Different survey approaches are presently investigated by European research institutes, to establish a time series of fishery independent abundance estimates for sandeels in the North Sea. This is not a trivial job, because of the unpredictable emergence behaviour of sandeels, i.e. any sampling approach must take account of that part of the population can be in the water column as well as in the sea bed (Greenstreet et al. 2006). Further, more in total 238 individual sandeel fishing grounds are identified (Jensen and Rolev 2004). The total area of the sandeel fishing constitutes 15831 km2.

Descriptions of the survey methods that are presently explored and preliminary information from these surveys are given by ICES WGNSSK (2006 and 2006) and ICES_AGSAN (2007).

1.2.4 Commercial CPUE

There is no survey time-series available for this stock. As in previous assessments effort data from the commercial fishery in the northern and southern North Sea are treated as two independent tuning fleets, separated into first and second half year.

Because of the trends in the residuals for 1-group sandeels in the first half year, the two tuning fleets in the first half year were in the final assessment from 2005 split into two time periods, i.e. before and after 1999. This change in the tuning series removed the trends in the residuals of log stock numbers, and the tendency to underestimate F and overestimate SSB was reduced. Information about the size of the trawls used by Danish vessels fishing sandeels show an increase in trawl size from 1988 to 1994 and a larger increase from 1997 to 1998. This is a clear indication of an increase in catchability of the Danish vessels fishing sandeels, due to gear technology. However based only on this information it is not possible to quantify the likely change in catchability over the years.

The definition of tuning fleets used in 2005 was also used in 2006. The following tuning series were from 2005 are:

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 is analysed in this year's assessment. The reason for including the Norwegian effort data for first half year for the southern North Sea into the tuning fleet is that in recent years Norwegian catches in the southern North Sea in first half year constitute a significant part of Norwegian landings in the North Sea. The tuning fleet used for the northern North Sea is a mixture of Danish and Norwegian vessels. A separation of the Danish and Norwegian fleets is presently not possible, due to the lack of Norwegian age-length keys for the period before 1996. Separate national fleets would have been preferable because this would have made procedure for the generation of the tuning series more transparent. This issue should be addressed at the next benchmark assessment.

The size distribution of the fleet has changed through time. Therefore effort standardisation is required. The assumption underlying the standardisation procedure is that CPUE is a function of sandeel abundance and vessel size. Standardised effort is calculated from standardised CPUE and total catch. CPUE is standardized to a vessel size of 200 Gross Tonnes (GR) using the relationship:

$CPUE = a * GR^{b}$ (1)

where a and b are constants and GR is vessel size in GR

The constants a and b were prior to 2003 estimated for each year by performing the regression analysis:

Ln(C/e)=ln(a)+b*ln(GR)   (2)

where C=catch in ton, e=effort in days spend fishing, and the rest of the parameters are as in (1).

Since 2003 the parameters in (2) have estimated using catch and effort data on single trip level, instead of average values of catch and effort for each vessel size category (see ICES 2004). The data used for the regression is logbook data for the Danish industrial fleet for the years 1984 to 2003 and first half year of 2004. General linear models were used to estimate the parameters in:

$\ln(CPUE) = d_y + f_y * \ln(GR)$ (3)

where y=year, GR=vessel size in GR as defined in Table 1, and the remaining factors are constants. Log transformation was required to stabilise the variance in CPUE to fit the model although it does result in a more skewed distribution of GT leading to the smaller vessels receiving a higher weight in the subsequent regression. The GLM was carried out by half year (first and second half year) and area (northern and southern North Sea) to generate estimates of effort for the fleets presently used in the assessment of sandeels in IV. Type III analysis was used to test for significance of parameters. All analyses were weighted by the number of days spend fishing, as the variation on the average catch per day fishing decreases with the number of days fished. The results of the analysis and the parameter estimates are given in Table 13.1.3.2.

The parameters estimated in (3) were used to estimate CPUE for a vessel size of 200 GR from:

$CPUE = e^{dy} * 200^{fy}$ (4)

Mean CPUE of Danish and Norwegian fleets, after the Norwegian CPUE had been standardised to a vessel size of 200 GR, was estimated as a weighted mean weighted by the catches sampled used to estimate CPUE. Total standardised effort was afterwards estimated from the combined Danish and Norwegian CPUE and total international catches.

As no recruitment estimates from surveys are available, recruitment estimates are based exclusively on commercial catch-at-age data. The tuning diagnostics indicate that the 0-group CPUE is a poor predictor of recruitment.

There is a relatively poor correlation between the tuning indices and the stock, which may be due to the fact that several sub-stocks are assessed as a single unit.

1.2.5 Other relevant data

None.

1.3 Estimation of Historical Stock Development

The Seasonal XSA (SXSA) developed by Skagen (1993) was up to 2001 used for stock assessment of sandeel in IV. Annual XSA was tried in 2002 WG where it was concluded that the two approaches gave similar results. For a standardization of methodology, it was decided to shift to XSA in 2003. In 2004 SXSA was used again for the final assessment, the reason being that data were available for the first half year of 2004 for the assessment. SXSA has been used or the final assessment since 2004. The XSA are used for comparison using the following settings:

Time series weights	none
Power model	no
Catchability independent of age	>=2
F-shrinkage S.E.	1.5 (5 years and 2 ages)
Min. standard error for pop. estimate	0.3
Prior weighting	none
Number of iterations	20
Convergence	Yes

In the SXSA weighting of estimated catchabilities (rhat) is set manually, where last years data is down weighted compared to previous years. Estimated survivors are weighted from manually entered data, where estimates of survivors are given a lower weighting in the second half of the year. This setting was chosen because the fishery inflicts the majority of the fishing mortality in the 1st half of the year and thus the signal from the fishery is considered less reliable in the second half.

During the benchmark assessment in 2004 (ICES-WGNSSK 2005) the effect of changing some of the default settings was explored. The assumption in the assessment of constant catchability for the tuning fleets over years, was analysed. Further, the effect of weighting the survivors with the inverse variance of the estimated log catchability, instead of the manual weighting, was explored. At last, the effect of down weighting last half years data in the estimation of the inverse catchability was analysed. There were no major effects on the assessment results of changing these settings, i.e. the same trends were seen in SSB, R and F. It was therefore decided to keep the default settings.

During the 2005 WG meeting the SMS model was used as a comparison to the SXSA. The SXSA and SMS explorative runs gave quite similar results for the time trend of SSB, but the absolute levels differ between model configurations. The main difference in the explorative runs is in the estimate of fishing mortality. Fs for the most recent years were estimated higher and more variable by the SMS model. All SXSA runs showed a decrease in F since 2001, while SMS estimated a step decrease in F in 2003 followed by a seep increase in 2003 and subsequently decreases in 2004 and 2005. Both SXSA and SMS assume constant catchability in the CPUE time series. In addition, SMS assumes constant catchability (or more correctly, constant exploitation pattern) for the F-model and catch data. CPUE time series are however, subset of the total international catch data and changes in the exploitation pattern will violate the assumption of constant catchability for the CPUE time series. Said in another way; if exploitation pattern changes, the assumptions for both models are violated. It is difficult to judge whether the SXSA assumption that catch data are exact, or the SMS assumption that exploitation pattern are constant, violates the assumptions most. The F values from SXSA shows a very variable exploitation pattern from year to year, and extreme F values for age 4. This indicates that there might be a considerable sampling uncertainty in the international catch at age data, which SMS might be better to handle. However, SXSA was chosen for the final assessment, because the model is the default model for this stock and SXSA does not rely on the assumption of constant exploitation pattern in catch at age data.

During the WGNSSK 2005 meeting an exploratory assessment was carried out, using the natural mortality for sandeels estimated by ICES-SGMSNS (2005, see section 1.1.2). The assessment using the natural mortalities estimated by ICES-SGMSNS (2005) showed similar trends in SSB as the assessment using the fixed natural mortalities, whereas the estimates of recruitment and F, were generally higher in assessment using the natural mortalities estimated by ICES-SGMSNS (2005). This difference was mainly due to the larger natural mortality for the 0-group sandeels used in the assessment using the natural mortalities estimated by ICES-

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.

1.4 Short-Term Projection

The high natural mortality of sandeel and the few year classes in the fishery make the stock size and catch opportunities largely dependent on the size of the incoming year classes. Quantitative estimates of recruits (age 0) in the year of the assessment are not available at the time of the WG. Traditional deterministic forecasts are therefore not considered appropriate.

The high natural mortality of sandeel and the few year classes in the fishery make the stock size and catch opportunities largely dependent on the size of the incoming year classes.

0-group CPUE is a poor predictor of recruitment (ICES-WGNSSK 2003) why traditional deterministic forecasts are not considered appropriate. However, because of the low sandeel stock WGNSSK provided indicative short term prognoses during the meetings from 2004 and on, using a range of scenarios for the recruitment and exploitation pattern.

The short term forecasts from 2004 and 2005 overestimated the SSB in 2005 and 2006 by a factor 2-3 when compared to the SSB estimated by the SXSA in 2006. This overestimation bias was addressed during the 2006 WG meeting, carrying out a short term forecast, where the start population and the F-s-at-age in the first half year of 2006 was corrected according to the bias identified in the assessment. In order to estimate potential bias in the terminal population sizes and F's, an analysis was made from the retrospective SXSA runs. A bias factor was determined for each year by dividing the terminal estimate of each retrospective run with the "true" value as estimated by this year's final assessment. The bias factor taken forwards to the short term forecast was the mean ratio over the period 2000-2005. As retrospective corrections continue to be made for several years, the bias correction factors for the most recent 1-2 years may be underestimates. Additional analyses were made to investigate the change in bias correction when comparing terminal values with "converged" values taken from retrospective runs 1 or 2 years later. This demonstrated that the bulk of the correction is made in the first year with much smaller corrections in the second year.

1.5 Medium-Term Projections

Not done

1.6 Long-Term Projections

Not done

1.7 Biological Reference Points

There is no management objective set for this stock. There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. Management of fisheries should try to prevent local depletion of sandeel aggregations, particularly in areas where predators congregate.

In 1998 ACFM proposed that $\mathbf{B}_{lim}$ be set at 430,000 t, the lowest observed SSB. The $\mathbf{B}_{pa}$ was estimated at 600,000 t, approximately $\mathbf{B}_{lim}$ * 1.4. This corresponds to that if SSB is estimated to be at $\mathbf{B}_{pa}$ then the probability that the true SSB is less than $\mathbf{B}_{lim}$ will be less than 5% (assuming that estimated SSB is log normal distributed with a CV of 0.2). No fishing mortality reference points are given. These reference points are based on an assessment using another tuning method than used from 2002 (see section 1.2.4).

1.8 Other Issues

Recent investigations (Greenstreet et al. 2006) showed the biomass of age 1+ sandeels increased sharply in the Firth of Forth area in the first year of the closure and remained higher in all four of the closure years analysed, than in any of the preceding three years, when the fishery was operating. Further, the biomass of 0-group sandeels in three of the four closure years exceeded the biomass present in the three years of commercial fishing. The closure appears to have coincided with a period of enhanced recruit production.

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Quality handbook: Stock Annex- 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) 04/05/07: Willy Vanhee (willy.vanhee@ilvo.vlaanderen.be)

GENERAL

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).

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.

Ecosystem Aspects

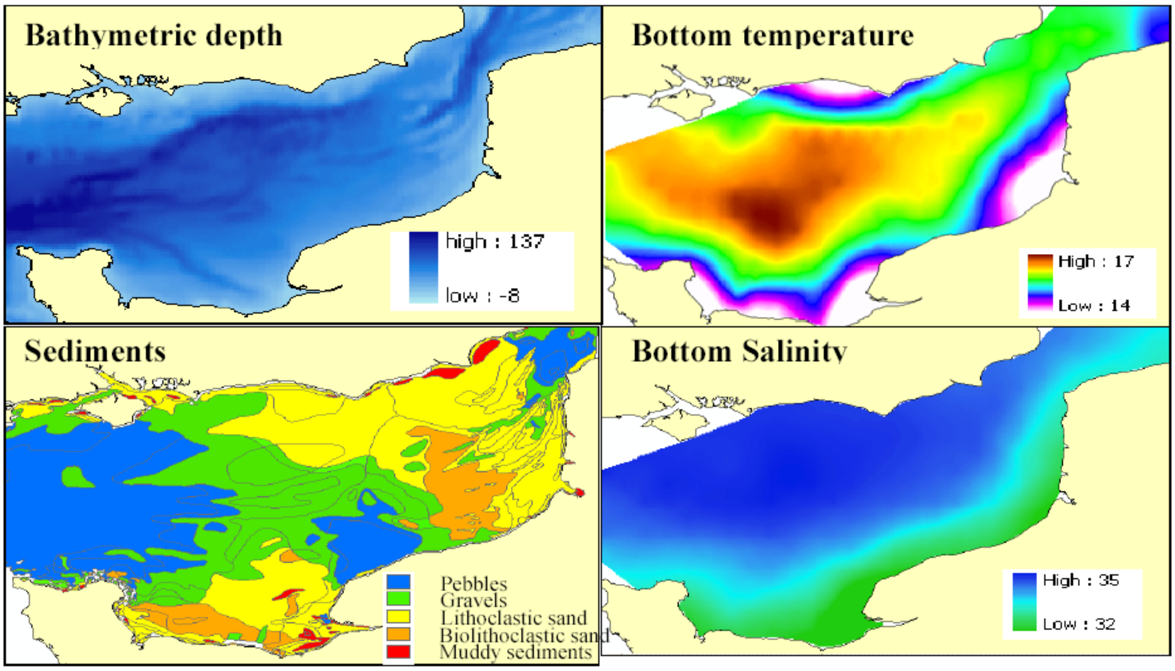

Figure 1 Eastern English Channel physical and hydrological features: Bathymetric depth and simplified sediment types representation. Survey bottom temperature and bottom salinity (averaged for 1997 to 2003) obtained by kriging. (in Vaz *et al.* 2004)

Biology: Adult sole feeds on worms, small molluscs and crustaceans. In the English Channel, reproduction occurs between February and April, mainly in the coastal areas of the Dover Strait and in large bays (Somme, Seine, Solent, Mont-Saint-Michel, Start et Lyme Bay). Pelagic eggs hatch after 5 to 11 days leading to larvae that are also pelagic and that will metamorphose into benthic fry after 1 or 2 weeks. Juveniles spend the first 2 or 3 years in coastal nurseries (bays and estuaries) where fast growth occurs (11 cm at 1 year old) before moving to deeper waters.

The spatial distribution of life stages of common sole shows a particular pattern: larvae distribution (on spanning grounds) and juvenile distributions (in nursery grounds) overlap. If larvae are found everywhere during spring, the potential habitat for stage 2 larvae is along the Flanders coast and near the Pays de Caux, to the central zone of the English Channel. Older larvae have a more coastal preference habitat, which can be explained by a retention phenomenon linked to estuaries.

Environment: A benthic species that lives on fine sand and muddy seabeds between 0 and 150 meters depth. Ranges from marine to brackish waters with temperatures between 8 and 24°C.

Geographical distribution: Eastern Atlantic, from southern Norway to Senegal, Mediterranean Sea including Sea of Marmara and Black Sea.

Vaz et al. (2007) used a multivariate and spatial analyses to identify and locate sh, cephalopod, and macrocrustacean species assemblages in the eastern English Channel from 1988 to 2004. Four sub-communities with varying diversity levels were identi ed in relation to depth, salinity, temperature, seabed shear stress, sediment type, and benthic community nature. One Group (class 4 in Fig.2 below) was a coastal heterogeneous community represented by pouting, poor cod, and sole and was classified as preferential for many flatfish and gadoids. It displayed the greatest diversity and was characterized by heterogeneous sediment type (from muds to coarse sands) and various associated benthic community types, as well as by coastal hydrology and bathymetry. It was mostly near the coast, close to large river estuaries, and in areas subject to big salinity and temperature variations. Possibly resulting from this potentially heterogeneous environment (both in space and in time), this sub-community type was the most diverse.

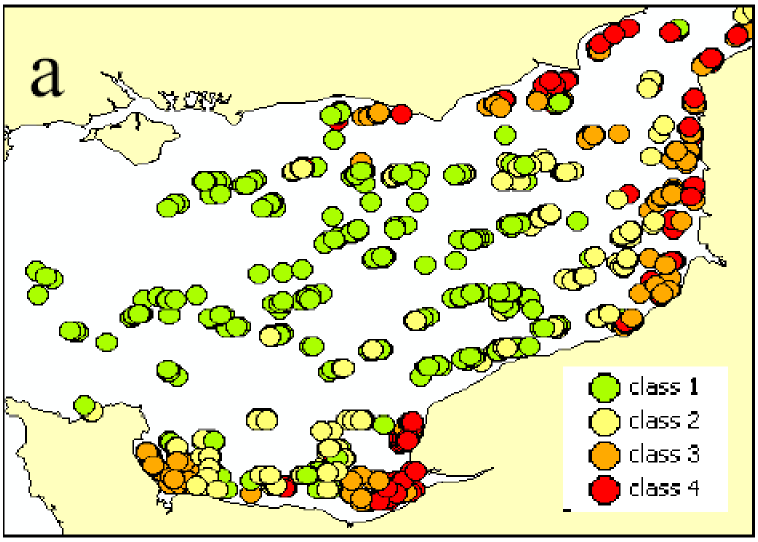

Figure 2 : Spatial distribution of Fish Subcommunities in the Eastern Channel from 1988 to 2003. Observed assemblage type at each station, These illustrate the gradation from open sea community to coastal and estuarine communities. (In Vaz *et al.*, 2004)

Community evolution over time : (From Vaz *et al*., 2007). The community relationship with its environment was remarkably stable over the 17 y of observation. However, community structure changed significantly over time without any detectable trend, as did temperature and salinity. The community is so strongly structured by its environment that it may reflect interannual climate variations, although no patterns could be distinguished over the study period. The absence of any trend in the structure of the eastern English Channel fish community suggests that fishing pressure and selectivity have not altered greatly over the study period at least. However, the period considered here (1988–2004) may be insufficient to detect such a trend.

Data

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

Belgian commercial landings and effort information by quarter, area and gear are derived from log-books.

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. Since 2004 it is part of the DCR.

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.

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.

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%. (see Annex 1)

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.

Other Relevant Data

None.

Historical Stock Development

Deterministic Modelling

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

Survivor estimates shrunk towards the mean F of the final 5 years or the 5 oldest ages

S.E. of the mean to which the estimate are shrunk = 0.500

Since 2004 - S.E. of the mean to which the estimate are shrunk = 2.000

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Catch data available for 1982-present year. However, there 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

Uncertainty Analysis

Retrospective Analysis

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.

Since 2004 initial stock size for age 2 was taken from XSA.

Natural mortality: Set to 0.1 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Average weight over the last three years

Weight at age in the catch: Average weight over the three last years

Exploitation pattern: Average of the three last years, scaled to the level of Fbar (3-8) in the last year

Intermediate year assumptions: F status quo

Stock recruitment model used: None, the long term geometric mean recruitment at age 1 is used

Procedures used for splitting projected catches: Not relevant

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

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

Biological Reference Points

Biological reference points

Bpa	Fpa	Flim
8000 t	0.4	0.55

Other Issues

None.

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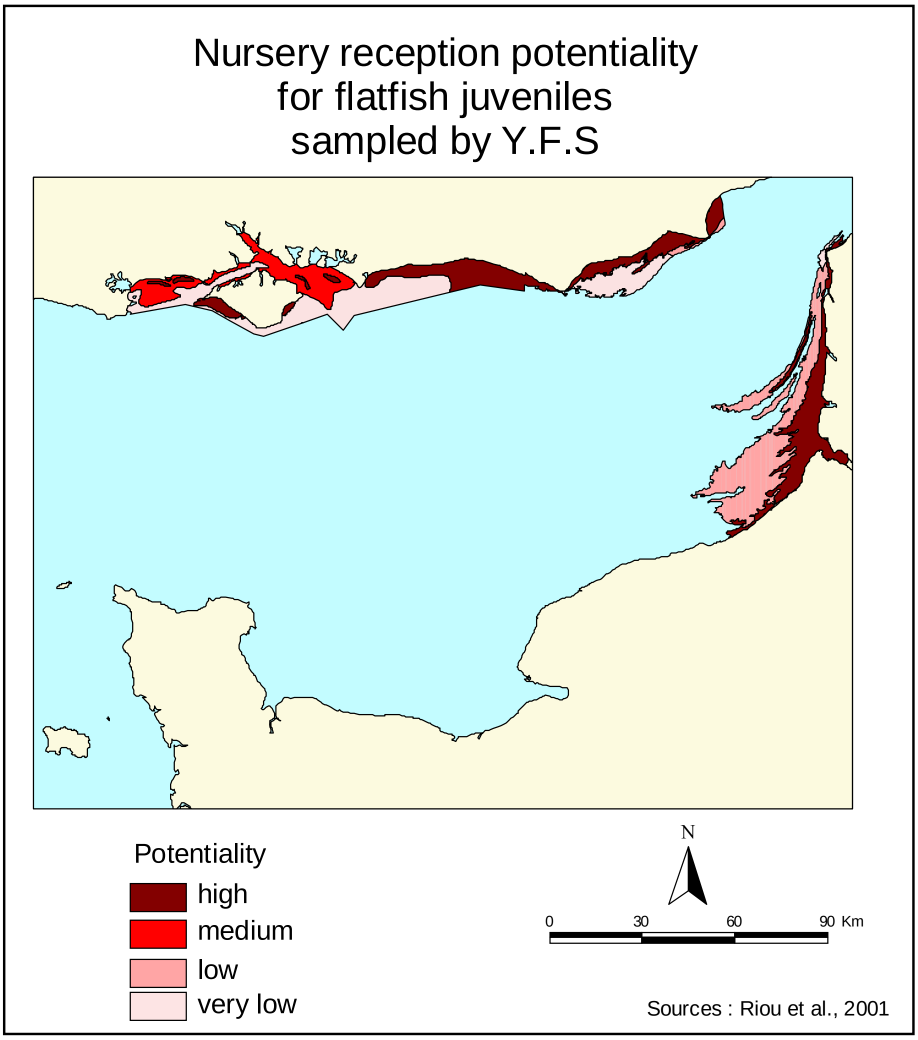
Appendix 1 – Nursery reception potentiality for flatfish used as a basis for the combination of FR and UK YFS

Potentiality surface (Km2)	South England	Bay of Somme
High	756	575.1
Medium	484.7	0
Low	30.5	953.1
Very low	993.3	21.3
Total	2264.5	1549.5
Total (Low – Medium – High)	1271.2	1528.2



Quality Handbook Annex: WGNSSK: IV & VIId Whiting

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Whiting in Division IV
Working Group:	Assessment of Demersal Stocks in the North Sea and Skagerrak
Date:	16 September 2004
Last updated:	08 May 2007

A. General

A.1. Stock definition

Whiting is known to occur exclusively in some localised areas, but for the most part it is caught as part of a mixed fishery operating throughout the entire year. Adult whiting are widespread in the North Sea, while high numbers of immature fish occur off the Scottish coast, in the German Bight and along the coast of the Netherlands.

Tagging experiments, and the use of a number of fish parasites as markers, have shown that the whiting found to the north and south of the Dogger Bank form two virtually separate populations (Hislop & MacKenzie, 1976). It is also possible that the whiting in the northern North Sea may contain 'inshore' and 'offshore' populations.

A.2. Fishery

A.3. Ecosystem aspects

Results from key runs of the North Sea MSVPA in 2002 and 2003 indicate three major sources of mortality. For ages two and above, the primary source of mortality is the fishery, followed by predation by seals, which increases with fish age. For ages 0–1, though more notable on 0–group, there is evidence for cannibalism. This is corroborated by Bromley *et al.* (1997), who postulate that multiple 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.

B. Data

B.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 a small industrial fishery in this area.

B.2. Biological

Weight at age in the stock is assumed to be the same as weight at age in the catch.

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

The maturity ogive is based on North Sea IBTS quarter 1 data, averaged over the period 1981-1985. The maturity ogive used in both the assessment and forecast is:

AGE	1	2	3	4	5	6	7	8+
Maturity Ogive	0.11	0.92	1.00	1.00	1.00	1.00	1.00	1.00

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to zero.

B.3. Surveys

The Scottish Groundfish Survey (SCOGFS) is carried out in August each year, and covers depths of roughly 35m to 200m 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.

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.*, 1999). 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.

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.

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.

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 35m to 200m 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.

B.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.

B.5. Other relevant data

None.

C. Historical Stock Development

N/A for the time being.

D. Short-term Projection

N/A for the time being.

E. Medium-Term Projections

N/A for the time being.

F. Yield and Biomass per Recruit / Long-Term Projections

N/A for the time being.

G. 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 000t; Bpa=315 000t; Flim=0.90; Fpa=0.65.

H. Other Issues

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.

Table 12.2.13 Whiting in IV and VIId. Complete available tuning series.

SCOSEI_IV units = individuals

year	effort	1	2	3	4	5	6	7	8	9
1978	325246	14994	29308	43711	15390	1058	1409	201	36	0
1979	316419	90750	41092	28124	14745	6084	677	156	3	0
1980	297227	27032	73704	37658	11915	9368	2556	260	229	27
1981	289672	8727	22244	25048	10552	2402	2084	374	41	4
1982	297730	3721	7032	26194	13117	2713	539	277	81	5
1983	333168	11565	14957	21690	34199	9831	2155	407	158	16
1984	388035	4923	24016	20670	14986	21269	4715	960	87	50
1985	381647	20068	20263	19696	8956	4796	8013	1363	334	18
1986	425017	139498	48705	34509	11341	2624	1098	1771	216	7
1987	418536	13793	52715	38939	18440	3638	1097	298	348	16
1988	377132	2502	28446	44869	12631	4072	679	64	21	17
1989	355735	6879	15704	41407	23710	4769	1323	112	43	11
1990	252732	14230	124636	27694	29921	14768	721	207	23	0
1991	336675	11952	44964	63414	10436	8730	1743	195	94	0
1992	300217	16614	19452	21217	27962	2805	1958	565	32	3
1993	268413	9564	31623	26013	12458	14446	899	332	153	8
1994	264738	9236	21452	22571	11778	5531	5612	204	116	15
1995	204545	8288	22153	30007	9019	3875	1373	1270	86	15
1996	177092	5732	26021	21430	10506	3483	1031	296	289	28
1997	166817	6628	8974	16231	9922	4445	575	110	62	37
1998	150361	3711	4695	6806	6840	3670	1417	244	13	2
1999	93796	13384	13750	7009	6068	3462	1684	409	77	3
2000	69505	5176	11208	6458	2112	1972	836	298	90	7
2001	36135	607	6352	5592	1715	486	353	146	66	11
2002	21830	1017	3349	7716	2182	363	140	79	23	6
2003	15371	388	1089	2514	2980	1046	256	30	17	5
2004	15663	282	689	1912	2003	1711	456	108	16	4
2005	16149	1131	1889	994	1638	1852	1035	362	41	1
2006	13539	25	435	874	695	966	960	433	99	18

SCOLTR_IV units = individuals

year	effort	1	2	3	4	5	6	7	8	9
1978	236944	8785	19910	30722	14473	956	1612	635	72	6
1979	287494	171147	42910	23155	17996	4058	377	286	57	5
1980	333197	20806	58382	38436	9525	9430	1864	144	145	3
1981	251504	6576	19069	21550	9706	1777	1455	310	9	1
1982	250870	5214	8197	26681	12945	3334	647	339	74	16
1983	244349	37496	17926	12535	19234	6124	1217	183	141	26
1984	240775	38267	16048	10784	6307	9019	2371	479	13	30
1985	267393	28761	9368	7617	3086	1333	2901	443	173	14
1986	279727	8138	8572	9578	4109	767	425	609	52	2
1987	351131	18761	25933	16161	5954	1183	388	116	129	4
1988	391988	2398	15779	22526	5128	1641	207	31	15	6
1989	405883	20319	10052	21390	10837	2394	448	33	54	2
1990	371493	3677	35322	7665	8960	3423	160	40	5	0
1991	408056	8727	11908	22146	3192	2906	629	50	41	0
1992	473955	17581	14551	11823	15418	1500	1160	304	13	0
1993	447064	16439	20513	14386	6591	10105	574	204	97	24
1994	480400	4133	15771	13005	6454	2710	2997	172	84	14
1995	442010	9248	15887	19322	6262	2983	1092	1132	89	3
1996	445995	6662	12461	13523	9223	3012	861	282	243	9
1997	479449	2557	6768	15603	9464	4535	628	181	52	31
1998	427868	5096	5350	8058	9507	4312	1729	276	58	12
1999	329750	26519	20672	9295	6706	4080	2051	487	41	7
2000	280938	8385	16220	9287	3788	2621	1470	602	79	7
2001	245489	1303	11409	10419	3287	745	431	247	66	27
2002	184099	980	4653	11067	3686	818	221	180	60	13
2003	98721	871	1639	3986	5136	2080	286	73	59	7
2004	63953	224	1088	2225	2463	2168	669	123	18	15
2005	54905	954	2414	1236	1448	1901	831	251	26	2
2006	51456	66	495	1487	990	1055	1067	604	105	6

Table 12.2.13 (cont'd) Whiting in IV and VIId. Complete available tuning series.

FRATRO_IV units = individuals

year	effort	0	1	2	3	4	5	6	7	8
1986	56099	19	1542	1892	7146	3783	600	158	39	2
1987	71765	12	2508	4985	1271	5713	413	258	92	70
1988	84052	0	2537	8982	3223	704	1321	123	55	1
1989	88397	27	2958	3740	5629	1654	209	280	47	11
1990	71750	38	3210	6170	3781	2456	365	29	44	2
1991	67836	323	4465	6084	2864	1412	777	85	6	3
1992	51340	355	3427	6498	1940	635	358	96	5	0
1993	62553	938	3950	4586	4307	877	290	68	40	6
1994	51241	87	7006	3298	1191	612	108	11	8	1
1995	57823	263	6331	6125	2674	544	99	19	0	2
1996	50163	577	5523	4743	3214	890	156	8	12	0
1997	48904	267	1961	4677	3929	1020	221	18	3	0
1998	38103	567	4893	1959	533	161	68	36	0	2
1999	-9	51	7652	2886	1453	960	500	133	46	31
2000	30082	129	7367	8191	2453	1056	737	455	345	95
2001	50846	3357	10767	15476	6923	3227	1701	638	345	128
2002	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9
2003	52609	625	9277	16880	7857	5528	1701	188	19	23
2004	21074	0	938	367	919	946	743	256	36	4
2005	23683	0	1037	1665	386	178	149	103	52	14
2006	19100	4.918	4402.199	2229.464	373.059	37.178	183.608	226.409	0.27	-9

FRATRB_IV units = individuals

year	effort	1	2	3	4	5	6	7	8	9
1978	69739	1153	10312	14789	8544	807	1091	227	34	4
1979	89974	698	12272	14379	10884	3789	394	315	45	14
1980	63577	90	5388	11298	4605	4051	1004	78	71	10
1981	76517	144	6591	13139	8196	2090	1644	314	16	10
1982	78523	173	1643	16561	11241	3948	1035	539	119	14
1983	69720	500	4407	8188	16698	5541	1061	228	126	19
1984	76149	317	4281	7465	4576	5999	1596	308	32	26
1985	25915	315	3653	2942	1225	566	599	117	12	4
1986	28611	891	3830	3991	1202	369	94	160	22	1
1987	28692	431	4823	3667	2152	497	166	48	46	3
1988	25208	150	2718	4815	1125	530	100	31	3	4
1989	25184	448	2064	4351	1877	314	106	10	4	1
1990	21758	164	3794	2124	2010	620	55	13	1	0
1991	19840	292	2224	3829	819	657	138	15	3	0
1992	15656	365	1598	1686	2204	248	195	44	3	0
1993	19076	173	1225	2633	1141	1233	97	37	14	4
1994	17315	108	1806	1721	1466	413	430	29	8	1
1995	17794	114	1023	3304	1537	1163	240	212	14	7
1996	18883	21	655	1594	1438	482	199	38	30	10
1997	15574	40	357	1407	1139	606	86	16	10	2
1998	14949	32	126	317	326	192	63	8	2	1
1999	-9	96	490	489	684	452	239	59	14	1
2000	11747	47	1148	2968	1205	320	298	124	54	5
2001	6771	298	649	528	150	36	36	14	6	2

FRATRO_7D units = individuals

year	effort	1	2	3	4	5	6	7
1986	257794	2587	2250	7741	4463	804	198	19
1987	188236	1955	5050	907	4606	331	218	54
1988	215422	2233	7957	2552	537	1193	127	61
1989	320383	2578	3916	6006	1490	216	343	50
1990	257120	2492	5240	3363	2168	251	30	51
1991	294594	4009	8177	3985	2625	1474	155	11
1992	285718	5733	10924	3241	882	587	171	3
1993	283999	3158	6543	8607	1677	442	124	79
1994	286019	13932	7980	3269	1776	444	40	21
1995	268151	6301	8450	5261	1217	264	63	8
1996	274495	6140	6466	5465	1623	324	47	14
1997	282216	3320	8144	6608	1974	451	59	8
1998	291360	9921	6863	2385	781	265	105	15
1999	-9	-9	-9	-9	-9	-9	-9	-9
2000	215553	7096	7026	1734	1724	1375	877	675
2001	163848	89	6101	10124	3976	2563	2303	1040
2002	192589	985	1922	6247	6476	2270	461	463
2003	296717	155	6896	5489	5551	2397	312	65
2004	89127	1831	706	2312	2945	2611	902	109
2005	108369	5813	3730	793	813	720	510	262
2006	78600	2864	1912	457	133	800	1013	0

Annex 3: Assessment Methods and Software

Assessment methods

XSA and SXSA

Extended Survivors' Analysis (XSA; Darby and Flatman 1994) has been used for catch-at-age analysis for most stocks, although it has not been selected as the final assessment in all cases. Three implementations were used. Some older analysts used version 3.1 of the Lowestoft VPA DOS based package. For an increasing number of stocks, younger members of the group used the version (FLXSA version) incorporated in the FLR package (FLR Team 2006) following validation against the DOS based version and further development which have resulted in the ability to produce tuning diagnostics output. Seasonal XSA (Skagen 1993, 1994) was used for analyses of Norway pout and sandeel to allow for seasonal data.

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

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

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

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

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

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

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

B-ADAPT

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

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

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

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

and for the years with bias

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

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

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

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

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:

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

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

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

$$SSQ = SSQ_{vpa} + SSQ_{catches}$$

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

SMS

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

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

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

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

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

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

with F-components defined as follows:

$F(a)$:

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

$F(q)$:

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

F(*y*):

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

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

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

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

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

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

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

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

SURBA

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

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

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

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

ASPIC

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

Methods

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

At present, assessments are evaluated largely through qualitative visual inspection of results such as catchability residuals. It could be argued that this is not sufficient, and should be supplemented by a more quantitative approach. One way of potentially improving assessment methodology is summarised below.

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

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

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

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

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

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

where COV refers to the covariance function and VAR to the variance function. Values of ACR close to -1 characterise oscillations around a stable mean; values between -1 and 0 are associated to low trends; 0 value identify a pure random process; 0 to 1 values mean that there is a persistence phenomena within the time series (if one year show positive residual it is likely that the next year residual will be positive too) and value around 1 characterise trends in the residuals time series. One way to interpret this criterion is to compare its value with a confidence interval $\left[-2N^{-1/2}, 2N^{1/2}\right]$ 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 :

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

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

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

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.

FLR

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

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

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

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

Recruitment estimation

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

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

1.1.1 Short-term prognoses and sensitivity analyses

Short-term prognoses (forecasts) are made for all stocks for which a final assessment is presented. Half-year forecasts are produced for the industrial stocks in order to give ACFM further information on which to base advice in the current situation of low biomass. These are based on survivors' estimates at the end of the second quarter in the year of the meeting (final assessment year + 1) from Seasonal XSA or SMS, rolled forwards to the start of the first quarter in the next using assumed mortality and weights-at-age.

Forecasts in all other cases were based on initial stock sizes as estimated by XSA or B-ADAPT (in a number of cases supplemented with separate recruitment estimates as described above), natural mortalities and maturity ogives as used in the age based assessment model, and mean weights at age averaged over recent years (normally 3). For haddock, the mean weight-at-age of the large 1999 and moderate 2000 year-classes in the forecast has been modelled using a fitted growth curve. Fishing mortalities-at-age in forecasts are taken to be either the final year values, or a scaled or unscaled mean *F*-pattern over the most recent 3 years (depending on whether or not mean *F* showed a recent trend).

Forecasts and corresponding sensitivity analyses were undertaken using either the Aberdeen suite of forecast programs, the MFDP/MFYPR software, or more recent implementations in the FLR suite. Where the latter have been used, they have been cross-checked with the equivalent standard software.

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

Stock-recruit modelling and medium-term projections

To be done

Estimation of biological reference points

Yield and spawning stock biomass per recruit are undertaken using either the Aberdeen suite of forecast programs, the MFDP/MFYPR software, or more recent implementations in the FLR suite. Where the latter have been used, they have been cross-checked with the equivalent standard software.

Precautionary approach reference points

Precautionary approach reference points are intended to remain unchanged from year to year, **unless** substantial changes occur in the data used (e.g. if discards are included for the first time) or the method employed. When reviewed the change point models developed by Obrien and Maxwell (2003) and PASOFT (Smith et al. xxxx) are used to provide values.

Software versions

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

SOFTWARE	PURPOSE	VERSION
ASPIC	Surplus-production modelling.	Unknown (most recent available version is 5.15).
B-ADAPT	Catch-at-age analysis with estimated misreporting	Compiled 13/09/2006.
FLR	Fisheries toolbox in R: assessments, forecasts, management-plan evaluations.	Core versions 1.3.1 and 2.0 plus *ad hoc* additions.
INSENS	Generation of input files for Aberdeen Suite programmes.	Compiled 20/05/2002.
MFDP	Short-term forecast.	Unknown.
MFYPR	Yield-per-recruit analysis.	Unknown.
RCT3	Recruitment estimation.	Compiled 26/08/1996.
REFPOINT	Calculation of reference points and yield-per-recruit.	Compiled: 12/06/1997.
RETVPA00	Retrospective analysis for XSA.	Compiled 12/06/2002.
SMS	Catch-at-age analysis with a stochastic multi-species model	September 2006.
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).

Annex 4: Review group for fish stocks in the North Sea, 21–23 May 2007

Participants: **Reidar Toresen (chair)**
Eero Aro
Steve Cadrin
Andre Forest
Morten Vinther

Wg chairs: Mark Dickey-Collas (HAWG), Chris Darby (WGNSSK)

The review group reviewed the fish stocks assessed by the Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak, and the herring and sprat stocks in the North Sea and Skagerrak assessed by the Herring Assessment Working Group for the area south of 62°N. Both working groups do impressive efforts to make assessments of high quality, and the reports are impressive with a huge amount of information. Although the working group reports are of considerable size, they are well structured and relevant information for reviewing the quality of the assessments is for most stocks easy to find.

WGNSSK

Technical minutes

Some comments from the WGNSSK chair:

The working group meeting was shortened to 8 days, which created problems for the wg. It was not time enough during the meeting for plenary discussions on important issues, such as quality of assessments and mixed fisheries problems. The working group functioned as many small groups dealing with stocks in parallel settings.

Rescheduling the meeting from September to May created some challenges in the assessments data. Many concurrent wg meetings made it difficult to get help from the ICES staff. The time between the wg meeting and the ACFM spring meeting was not adequate for proper reporting and the review process.

The wg meeting was also too soon after the IBTS-Q1 survey which made the final data preparation from this survey and data checking difficult to complete before the wg meeting.

TORs were unchanged from last year.

The new database, INTERCATCH, didn't work for this working group and led to problems. The group chose to apply FISH BASE for flatfish and used their own program for roundfish.

FLR QC - The new software system for assessing fish stocks speeds things up for some stocks but in general several things concerning the assessments are difficult to check and the system is not very transparent. The application raises quality control issues.

Review, - general comments

Late delivery of the assessment report was a challenge for the review group. The quality of the review would probably have been better with more time available.

It would help if ACFM could be moved to late June. This would help for the processing of WG reports, assessments and reviews before the meeting.

General comments on the WGNSSK report

The overall review of the report was positive. The report was easy to read. The organization, content and format were well standardized. The WG explicitly addressed comments by the RG in the technical minutes from last year, and response by the WG was found to be appropriate.

For some stocks, the figures for demonstrating the quality of the input data (internal and external consistency in both catch and survey data) are not complete or missing. This information is important for reviewers and should be presented in a better way.

The RG made a general suggestion for the WG to attempt alternative models, particularly those that allow for error in the catch. The WG is encouraged to explore other methods for at least for a few stocks as case studies.

Nephrops

General comments:

The nephrops stocks were not assessed during this years meeting. Assessments will be done in 2008.

Technical comments to the update of the data:

There seems to be a better reliability of the UK landings data, because of recent regulations for buyers and sellers. However, the change in statistics may preclude applications that treat the data as a single time series, because effort statistics before and after the change may not be comparable.

STECF is referring to an increase in lpue for small meshed fishery boats. This does not appear to be present for the nephrops fleets. This should be explored before the assessments next year.

Sandeel

General comments:

Advice based on Real Time Monitoring was given in May 2007. There will be a new assessment in September 2007.

Norway pout

General comments:

During this year’s wg meeting, an update assessment was completed. The assessment was consistent with last year and appears to be stable.

Technical comments:

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

The RG recommends a benchmark assessment in 2008.

Conclusions:

The stock is above B_{pa} (1 jan 2007) and it will increase to B_{pa} in 2008 with no fishing in 2007. SSB decreased and has been at low levels in recent years. Fishing mortality decreased and was close to zero in 2005.

Recruitment is below average. The 2005 year class is at the long term average.

The advice should relate to the hcr, which is currently not yet been evaluated by ICES.

ACFM should make options on the basis of the testing of the hcr.

Plaice in IIIa

General comments:

A benchmark assessment was completed.

Lack of stock definitions for plaice in IIIa is creating problems in the assessment, producing different perceptions in the survey area in the Kattegat and fishing grounds near the border of IV.

Technical comments:

The surveys cover the Skagerrak and Kattegat area, but most of the catches are taken in the western parts of Skagerrak, at the border between IV and IIIa. Some of the plaice that are caught in the area where most of the fishery takes place are probably of North Sea origin. The RG recommends an exploration of separate stock assessments in the two areas, perhaps adding the plaice observed in the northwestern part in the North Sea plaice assessment.

The RG noted the curious pattern in retrospectives in which F(4-8) was inconsistent, but no pattern; whereas there is a strong pattern of overestimating SSB (ages 3+). The RG recommended retrospective plots of abundance by age to diagnose source of problem. The IBTS surveys in the Skagerrak area (the westernmost part of Skagerrak) should be intensified to comply with the area where most of the catches are taken.

Conclusions:

The assessment tends to overestimate SSB . SSB appears to have declined for many years with a positive trend in recent years, but is currently estimated to be below B_{pa}. B_{lim} is not defined. In recent years, there is a more positive trend in SSB. Fishing mortality has varied, but appears to be substantially above F_{pa}. F_{lim} is not defined.

The RG rejected the assessment for the determination of stock status, but suggests using the results as illustrative of some trends of fishery in the IIIA. Present fig 7.3.5 and 7.3.6. + the map over the cathes and the surveys 7.2.14 and 7.2.2 in the ACFM summary sheet.

Saithe

General comments:

A modified update assessment was completed.

Technical comments:

There have been long term changes in weight at age, and a substantial decrease in length at age over time. There are also indications of density dependence, as observed in other saithe stocks. The RG requested information on observed condition factor (i.e., weight at length). The fixed proportion of maturity at age in the assessment should be explored in association with the changing weights at age. The hcr evaluation should include density dependent mean weights.

The RG noted that there was no a priori justification for removal of the first year of survey data from the stock assessment model and recommends that the observations be included to represent the measurement error in the assessment.

Conclusions:

The assessment was accepted as reliable and consistent. The stock is in a very good condition and harvested sustainably.

SSB has been above B_{pa} since 2001

F is well below F_{pa}, and has been since 1997

Advice should be given according to the management plan.

Cod in NS

General comments:

A benchmark assessment was completed, because the stock is on the observation list. The assessment is consistent, despite problems with discards.

Technical comments:

The IBTS data are important for the assessment of this stock, but the historical time series of IBTS has been changed. For the assessment people applying these data, there is no description of what has been changed in the IBTS data by ICES since last assessment. There is also no information on the quality of the IBTS data (last update etc by ICES), and there is no information on when the index is complete. The RG recommends that information on the status of the IBTS data is made available to the WG.

The RG recommends that the WG try to improve estimation of total catch to get beyond the need to estimate a catch multiplier. The catch multiplier estimate can hide a lot of problems in the assessment. The WG is challenged to try to get better estimates of the catches and discards.

The RG noted a decrease in weight at age over the time series (but to a lesser degree than for saithe).

The RG suggested that variability in maturity at age and individual weights should be investigated.

Conclusions:

The assessment was accepted and is quite consistent. The stock is in a very poor condition. Recruitment is impaired. The 2005 year class is somewhat better, but is still smaller than long term mean.

SSB is below B_{lim} and declining, with no signs of recovery.

F is above F_{lim} and shows signs of decline in recent years

Recruitment is still poor.

Whiting

General comments:

A benchmark assessment was completed, because the assessment was rejected last year. The contradiction between survey and fishery signals was a problem before 1995. However, the RG concluded that the assessment was consistent since 1995 and offers a reliable basis for determining stock status, including estimation of current stock size and fishing mortality.

Technical comments:

The RG recommends that the potential for different mortality rates among areas should be studied by re-establishing the study group on stock identity and management units of whiting (SGSIMUW). SGSIMUW should continue their work on whiting (the group was dissolved in 2006). The RG also noted the regional problems with discards. The RG considers the sampling of discards to be important, but questioned if sampling was good enough in all fishing areas. The RG recommends exploring variable maturity at age, in association with changes in mean weights.

The RG also recommends that the inclusion of age zero in the XSA be explored.

Conclusions:

The assessment was accepted as a basis of stock status, because the assessment is consistent for the recent 12 years.

The RG noted an odd selectivity pattern in the last year and the forecast. A revised forecast was based on the 2003-2005 selection pattern, scaled to the 2006 average F for ages 4-6.

Relative to 1999, the stock is low and declining. SSB is far below B_{lim}.

Incoming recruitment is weak.

Fishing mortality is below F_{pa}, but increased since 2004

Haddock

General comments:

An update assessment was completed. However, the assessment was revised to expand the catch-at-age matrix, because the abundant 1999 year class would otherwise have been in the plus-group this year.

Technical comments:

The issue of the 1999 cohort in the plus group needs to be reconciled, perhaps by tuning the plus-group. Another problem is weight at age of the 1999 year class. The weight at age is important for accurate assessments and forecasts.

The retrospective pattern is still good.

The RG recommends that maturity at age be re-estimated, perhaps separately for each year-class. This may be important for the 1999 year-classes, which has exhibited slower growth. The RG noted a problem with the average F with respect to the 1999 year-class. The average F should represent the fishery on that year-classes, but on the other hand, changing the ages included in the average will affect the reference points and the harvest control rules.

The RG suggests a benchmark assessment in 2008, to study how to deal with the 1999 year class becoming a plus group, and how exploitation will affect the younger weaker age groups.

Conclusions:

The final assessment should be used for advice on this stock.

The perception of the stock is same as last year.

F is below F_{pa}, but increasing (1999-year-class not within the range of Fbars)

SSB is above B_{pa}, but declining

Recruitment is relatively low, except for the 2005 year-class which is believed to be of moderate size.

Sole VIId

General comment:

An update assessment was completed.

Technical comments:

Similar pattern of trends in residuals for Sole and Plaice in this area. The WG should look into this feature in VIId.

Conclusions:

The assessment was accepted. There are positive signals in the stock.

SSB is above B_{pa}.

F stabilized below F_{pa} .

There has been good recruitment in recent years.

Plaice in IV

General comments:

A benchmark assessment was completed. Stock definition problems were discussed.

Technical comments:

There seems to be a stock definition problem for plaice, both in relation to IIIa, and VIId. Discard estimates are of marginal quality. The discards data should be further developed. The method of estimating historic discards by raising is not transparent. The RG recommends that it would be better to use the historic data.

There appear to be strong cohort effects on weights at age. In addition to the cohort effects, there is a long term negative decline in weight at age. Weight at age should be investigated by sex and by area.

In the input table for the forecast, split the input F in discards and HC.

There is a need for bringing the surveys together, because they show different signals. A combined survey should be carried out. The age samples from 1997 should be re-processed and included in the assessment in order to include the 1997 SNS survey in the assessment.

The diagnostic figures are too small.

Conclusions:

The RG accepted the assessment.

SSB is declining and between B_{lim} and B_{pa} since late 1990s

F is below F_{pa}

Plaice VIId

General comments:

A benchmark assessment was completed. There appear to be stock definition problems for this stock. Tagging studies show that there are migrations of plaice from the North Sea to VIId and plaice also migrate from VIId to North Sea to feed.

Technical comments:

Discards are not included, but are substantial for younger ages. The RG recommends including discard data in the assessment.

Surveys are noisy. The UK beam trawl survey is more positive than some of the commercial fleets. There is a need for more information in central parts of the VIId area. The French survey covers this area but is very noisy for older ages.

Figures showing consistency in the data are missing in the report. Catch curve analyses (for consistency) would be nice to see.

Conclusions:

The assessment is indicative for trends only.

F seems to have decreased and is estimated at F_{pa}

SSB is estimated to increase somewhat in recent years after a long period of decreasing trend.

Sole IV

General comments:

A benchmark assessment was completed. Retrospective patterns indicate problems in the assessment. Discards are not included, even though data exists for recent years.

Technical comments:

The RG recommends that the effects of including discards be explored.

When fit to surveys only, there is a different conclusion than when fitted to commercial series. F estimates are higher when only surveys are used than for the combined assessment including all fleets. The RG questions if this indicates substantial misreporting. The RG recommends that these differences be investigated in a benchmark assessment next year.

Evaluating the consistency in the data may be necessary. It would have been nice to see figures showing catch curve consistency.

If the assessment are run with only survey data , there is a more pessimistic view of the fishing mortality. Therefore, the assessment may be too optimistic.

The log catchability residual plots should be of higher quality.

Conclusions:

The assessment was accepted.

SSB is between B_{pa} and B_{lim}. SSB fluctuated between the reference points in the last 10 years.

F is below F_{pa} and is estimated to have a decreasing trend.

For the forecast, F in the intermediate year should be the average unscaled, which is more consistent with the retrospective pattern.

Stocks assessed by the HAWG

Herring in IV

General comments:

An update assessment was completed. The stock is declining because of poor recruitment in recent 5 years.

There is some misreporting of catches by area and overshoot of landings. Some of the catch data has been revised. Some input data was adjusted.

Technical comments:

The RG questioned why the 3, 4 and 5 year old estimates of the IBTS surveys were used in the assessments.

The best estimate of the older ages is in the catch, but the RG questioned the quality of the catch data and sampling of catches.

The RG also had several questions about the surveys: Why does the IBTS survey perform badly, for age group 2? Why doesn't the acoustic survey pick up older ages? Why are there old fish in the catch and not in the surveys?

The RG also noted the inconsistent accounting of small-mesh herring fisheries, because the Norwegian catches of small herring are included in the A-fleet.

A minor statistical note is that Q-Q plots may not be optimal for such low sample sizes. When sample size is small (n<50), q-q plots are sensitive to the number of samples, particularly in the tails of the distribution. A more appropriate evaluation of normality for low sample sizes is ranked normal deviates, rather than quantiles (Sokal & Rohlf 1995). R code for the procedure:

```
rankit<- qnorm(ppoints(n))[order(b=variable)]
            qqplot (variable, rankit)#  makes quantile -quantile plot
xy1 <-qqplot (variable, rankit, plot=FALSE)# makes files with scores, normal quantiles
            r1<- lsfit (xy1$x, xy1$y)      #  makes linear fit
            abline (r1, lty=2, col="blue") # plots line based on intercept, slope
```

Conclusions:

The assessment was accepted.

SSB is under B_{trig} but is declining.

F is greater than target F (0.35). The management rule is not robust to implementation error. Last year managers agreed on a TAC that was greater than that indicated by the management rule.

A mistake in input data file was found this year. This only had a small impact on the assessment (less than 1%). The RG decided to use the present assessment, but the mistake needs to be addressed and corrected as basis for next year's assessment of the stock.

The large overshoot of F is explained with the fact that managers have agreed on too high TACs in recent years. This should be interpreted as implementation error of the Management Plan.

SSB is below B_{trig} of 1,3 million tones and decreasing.

F is above target F of 0,25, and increasing.

Recruitment is very low and has been low for 5 successive years.

Sprat in IV

General comments:

An experimental assessment was completed. Data from IBTS and a short time series of acoustic data is available. The assessment has never been used for advice. A regression between IBTS index and catch the following year has been used as catch forecast.

Technical comments:

The RG recommends that the WG try to develop the acoustic abundance estimates, and see if these could be used in assessments.

The RG proposes that a data transformation of the IBTS survey data should be explored to reduce the effect of a few large tows in the IBTS surveys.

Conclusions:

There is no evidence that the catch levels have created problems for the stock. An in-year recommendation should be made on the same basis as the recommendation made last year. However, the RG noted that if three points in the regression are removed (1989, 1994 and 1995) associated with a large-tow effect and years when there is a lot of herring in the catches (1994-1995), the regression may be more reliable?

Western Baltic spring spawners. Herring in IIIa

General comment:

An update assessment was completed. The assessment is noisy, with large residuals, and huge year-effects. Each source of input data covers only a portion of the stock.

Technical comments:

The RG noted that input data are all weighed 1, and recommended using the same weighing process for the data for this stock as for North Sea herring.

The RG concluded that the assessment is not reliable for status determination, because it lumps together information on different parts of the stock. Retrospective pattern for recruits are very bad. Residuals are large, and there are year-effects on the residuals of the assessment. The RG felt that the quality of the assessment is poor. The estimate of 0- group the most recent year is particularly bad.

The RG recommends that there should be a survey which covers all components of the stock.

Conclusions:

The assessment was accepted, with a recommendation that there should be a benchmark assessment next year.

SSB cannot be evaluated in relation to reference values because they are not defined, but SSB seems to have stabilized.

Fishing mortality seems to have stabilized at levels around 0,5, which is rather high for a herring stock.

There are signs of a declining trend in recruitment

SPRAT in IIIa

Landings since 1974.