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Report on the Assessment of Demersal Stocks in the North Sea and Skagerrak

7 – 16 September 2004
Bergen, Norway

International Council for the Exploration of the Sea

Conseil International pour l’Exploration de la Mer

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0 EXECUTIVE SUMMARY

The ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) met in Bergen, Norway, during 7-16 September 2004. There were 25 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 collate data for mixed fisheries evaluations; and to evaluate stock recovery plans.

0.1 Working procedures

The Working Group (WG) continued and developed the the approach of categorising stocks as being subject to benchmark or update assessments, according to a rolling schedule agreed by ACFM in October 2002. This year, the WG carried out benchmark assessments for cod in Sub-Area IV and Divisions IIIa and VIId, whiting in Sub-Area IV and Division VIId, plaice in Sub-Area IV, Norway pout, and sandeel. For these stocks detailed analyses of data and assessment methods were performed. All other assessments were carried out as updates, which meant that the assessment process was retained unchanged from last year unless there was compelling evidence to do otherwise. The Quality Control Handbook was updated with drafts of stock annexes for all stocks assessed by the WG.

0.2 State of the 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. The trends in landings, spawning-stock biomass (SSB), mean fishing mortality (*F*) and recruitment from the assessments are presented in Figures 2.1.3-2.1.6. Note that the WG were unable to propose a final assessment for North Sea whiting this year (see Section 5).

WG estimates of total catches (reported landings + discards + estimated under-reported landings) for **cod** in 2003 (78,000 t) are the second-lowest in the historical record. The inclusion of estimated under-reported catch and discards in the assessment this year increased the estimates of SSB during 1993–1997, but not in more recent years in which SSB is still very low and well below the current $\boldsymbol{B}_{lim}$ (70,000 tonnes). Fishing mortality has increased slightly after falling for several years, although the absolute level of *F* in 2003 is uncertain. Recruitment has remained at a low level after the strong 1996 year-class.

The strong 1999 year-class again dominated the catches of **haddock** in 2003 (69,000 t). However, the contribution of this year-class to the fishery appears to be drawing to a close. Recruitment following the 1999 year-class has been low, and SSB is likely to decline in the short-term. All sources of information agree that fishing mortality has declined rapidly in this fishery to an historical minimum.

Catches of **whiting in the North Sea and eastern Channel** (43,000 t) have continued to decline in 2003 to the lowest observed level. However, two of the three available survey indices covering the North Sea area indicate that stock abundance is at or near a historic maximum. There are also considerable within-series discrepancies in apparent stock trends between different sub-units of the assessed area. These conflicting signals on population trends have prevented the WG from being able to propose a final assessment. The problem requires a fundemental review of all available data for which the WG had neither the time nor the resources, but which the WG proposes be taken up by a dedicated Study Group (see Section 1.8).

Landings of **whiting in Division IIIa** (for human consumption) were 186 tonnes in 2002. Most of the landings are taken in Skagerrak. No analytical assessment of whiting in IIIa was possible.

While still above $\boldsymbol{B}_{pa}$ and apparently increasing, the estimated SSB for **saithe** has been revised downwards from last year's assessment. Fishing mortality is at or near the historic low, and recruitment remains near the long-term mean. Considerable annual revisions of the saithe assessment are a direct consequence of the lack of survey or fishery information for younger age-groups. Reported landings for 2003 (107,000 t) were near to the recent mean.

Landings of **North Sea sole** in 2003 (18,000 t) were at a similar level as seen for 2001 and 2002. SSB has fluctuated around a moderate level for several years and for 2003 was estimated to be just below $\boldsymbol{B}_{pa}$. *F* is still estimated to be above $\boldsymbol{F}_{pa}$, but has declined fairly steadily since the historical maximum in 1996. After the strong 2001 year-class, recruitment has fallen back down to near the mean of the full time-series.

Sole in the Eastern Channel is considered to be within safe biological limits. The fishing mortality is estimated to be below $\boldsymbol{F}_{pa}$ The SSB is above $\boldsymbol{B}_{pa}$ (8000t) following improved recruitment in recent years particularly of the year classes 1998 to 2000. There is a tendency to underestimate F and overestimate SSB. Reported landings in 2003 (5,000 t) were the highest recorded.

Landings of **sole in Division IIIa** are mostly taken in Kattegat and this stock is assessed by the Baltic Fisheries Assessment Working Group. Landings in 2003 amounted 300 tonnes, and 75% was taken in the Kattegat. Further information may be found in the report of this Working Group.

The assessment for **North Sea plaice** included discards for the first time this year. Although reported landings for 2003 are at the lowest observed level (66,000 t), estimated total catches (141,000 t) are the highest since 1998. SSB is estimated to be stable, but very low and well below $\boldsymbol{B}_{pa}$. Fishing mortality is fluctuating around a very high level. The 2001 year-class is estimated to have been the strongest seen since the mid-1980s, but subsequent year-classes are thought to be weak.

The stock of **plaice in the Eastern Channel** follows the pattern of a general decline in plaice stocks observed in other areas up to 1997. Since then SSB appears to have oscillated between $\boldsymbol{B}_{lim}$ and $\boldsymbol{B}_{pa}$. F has decreased since 1998, and it is currently between $\boldsymbol{F}_{lim}$ and $\boldsymbol{F}_{pa}$. Recruitment is close to mean levels after the confirmed strong 2000 year-class. The state of the plaice stock in VIId is highly dependent on the quality of the recruitment. Reported landings in 2003 (4,500 t) were the second lowest on record.

Landings of **plaice in Division IIIa** amounted to 9,000 t in 2003, which is close to the 2002 landings. Historically, TAC has not been restrictive for this stock. About 75% of the landings were taken in Skagerrak. SSB is estimated to have increased steadily since a low point in 2000, although F remains high and subject to large fluctuations. Recruitment in 2003 was around the long-term mean.

Sandeel landings in 2003 (326,000 t) were very low, and current indications of the total landings in 2004 are at about the same low level. SSB is estimated to be at the historic minimum, well below $\boldsymbol{B}_{lim}$, while F has declined from a peak in 2001. The present assessment estimates the 2003 year-class to be below the average recruitment.

Norway pout landings in 2001 and 2002 were around 66,000 t and 77,000 t, respectively. These were the lowest landings recorded since 1967 and well below average for the previous five years. The 2003 landings decreased further: in this year only about 25,000 t were landed. SSB decreased to 164,000 t in 2002 and decreased further to 120,000 t in 2003, and estimated to be about 90,000 t (near $\boldsymbol{B}_{lim}$) in the 1st quarter of 2004. Fishing mortality has generally been lower than the natural mortality for this stock and has generally decreased in recent years well below the long term average F (0.7). Fishing mortality was historically low in 2003 and in the two first quarters of the year in 2004. Recent year-classes are estimated to have been very weak, and there are no indications of a strong year-class in 2004.

0.3 Mixed-fisheries modelling

The approach taken by ICES to the issue of mixed-fisheries modelling and forecasting changed between the formulation of the ToRs for the WG meeting, and the meeting itself. At the first meeting of the Study Group on Long Term Advice (SGLTA; ICES 2004b) it was decided that the request to the WG to develop the existing mixed-fisheries forecast model and provide fisheries-based catch options (ToR c) was no longer appropriate for two main reasons. Firstly, any evaluation or development of the existing models would have required fisheries definitions and catch data from the Study Group on the Development of Fisheries-Based Forecasts (SGDFF; ICES 2004a) which were not forthcoming. Secondly, the provision of catch options requires decisions to be made on the relative importance of specific fisheries, which the WG were unable to do. Therefore, SGLTA proposed that assessment WGs should provide fisheries definitions, collate fisheries-based catch data in the appropriate format, and provide these data to ACFM. This has been done as requested.

0.4 The Integrated Approach

ICES' proposals for a new integrated approach were considered. These proposals involve a much closer integration of advice from ACFM, ACME and ACE. The view of the WG was that the integrated approach was a valid idea to promote, but that the ability of assessment WGs to address these issues was limited by their current membership. WG practice would have to change considerably for the integrated approach to become a reality, and there are considerable problems to be faced. However, there is also a clear requirement for assessment WGs to evolve to fit the new focus. One possible model is that of the NAFO scientific meeting, at which environmental scientists present information to stock assessors to help them in their deliberations. Such integration would necessarily require a reduction in the time available for the type of population analysis done currently. There would have to be a tradeoff between integration, the ability to carry out in-depth analyses of stocks, and the time available.

1 GENERAL

1.1 Participants

The ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) met in Bergen, Norway, during 7-16 September 2004, with the following participants:

Ewen Bell	England
Jesper Boje	Denmark
Loes Bolle	Netherlands
Max Cardinale (part-time)	Sweden
Liz Clarke	Scotland
Uli Damm	Germany
Chris Darby	England
Maria Hansson (part-time)	Sweden
Steven Holmes	Scotland
Henrik Jensen	Denmark
Espen Johnsen	Norway
Knut Korsbrekke	Norway
Phil Kunzlik	Scotland
Paul Marchal	France
Coby Needle (chair)	Scotland
Rasmus Nielsen	Denmark
Martin Pastoors	Netherlands
Hajo Rätz	Germany
Are Salthaug	Norway
Clara Ulrich-Rescan	Denmark
Olvin van Keeken	Netherlands
Willy Vanhee	Belgium
Sieto Verver	Netherlands
Joël Vigneau	France
Morten Vinther	Denmark

1.2 Terms of reference

The **Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak** [WGNSSK] (Chair: C. L. Needle, UK) met in Bergen, Norway, from 7–16 September 2004 to:

a) assess the status of the following stocks: 1) cod in Subarea IV and Division IIIaN (Skagerrak), and Division VIId, 2) haddock in Subarea IV and Division IIIa, 3) whiting and 4) plaice, both in Subarea IV, Division IIIa, and Division VIId, 5) saithe in Subarea IV, Subarea Via, and Division IIIa, and 6) sole in Subarea IV and Division VIId;

b) assess the status of and provide catch forecasts for 2005 for Norway pout and sandeel stocks in Subarea IV and Divisions IIIa and VIa, and identify any needs for management measures (including TACs) required to safeguard the stocks;

c) consider and implement the proposed methodology for projection of yield by fisheries made by the Study Group on the Development of Fishery-based Forecasts based on the data compiled through this Study Group. The Group should present a limited set of fisheries-based catch options;

d) provide specific information on possible deficiencies in the 2004 assessments including, at least, any major inadequacies in the data on catches, effort or discards, any major inadequacies in research vessel surveys data, and any major difficulties in model formulation, including inadequacies in available software. The consequences of these deficiencies for the assessment of the status of the stocks and for the projection should be clarified;

e) comment on this meeting's assessments compared to the last assessment of the same stock, for stocks for which a full or update assessment is presented;

f) document fully the methods to be applied in subsequent update assessments and list factors that would warrant reconsideration of doing an update, and consider doing a benchmark ahead of schedule, for stocks for which benchmark assessments are done;

g) evaluate the effects of the existing EU-Norway recovery plan for North Sea cod if such a plan will be implemented for 2004;

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

i) provide the data required to carry out multispecies assessments (quarterly catches and mean weights-at-age in the catch and stock for 2003 for all species in the multispecies model that are assessed by this Working Group).

WGNSSK will report by 20 September 2004 for the attention of ACFM.

The terms of reference (ToRs) are addressed in the following sections of the report:

Term of reference	**Section(s)**
a) Assess status of cod, haddock, whiting, saithe, plaice, sole	3–11
b) Assess status of Norway pout and sandeel	12–13
c) Generate fisheries-based forecasts based on data and models from SGDFF	14 (see Note 1 below)
d) Provide information on assessment deficiences	3–13
e) Compare methods and results of this year's assessments with last year's.	3–13
f) Specify procedures for future update assessments	4–8, 10–13, Quality Control Handbook
g) Evaluate the North Sea cod recovery plan	3 (see Note 2 below)
h) Quantify bycatches in Norway pout and sandeel fisheries	1.8.1
i) Provide quarterly data for the multispecies WG	1.8.2

Notes:

1. The approach taken by ICES to the issue of mixed-fisheries modelling and forecasting changed between the formulation of the these ToRs, and the WG meeting. At the first meeting of the Study Group on Long Term Advice (SGLTA; ICES 2004b) it was decided that ToR c) for WGNSSK was no longer appropriate for two main reasons. Firstly, any evaluation or development of the existing models would have required fisheries definitions and catch data from the Study Group on the Development of Fisheries-Based Forecasts (SGDFF; ICES 2004a) that were not forthcoming. Secondly, the provision of catch options requires decisions to be made on the relative importance of specific fisheries, which the WG would be unable to do. Therefore, SGLTA proposed that assessment WGs should provide fisheries definitions, collate fisheries-based catch data in the appropriate format, and provide these data to ACFM. This task is addressed in Section 14 of this report.

2. Prior to the meeting, ICES requested (through the chair) that the cod recovery plan (and any other proposed recovery plans) were not to be evaluated as such. Rather, the issue was to be addressed by including multipliers on the values of fishing mortality proposed in catch options tables. This has be done in this report in Sections 3 (North Sea cod) and 9 (North Sea plaice).

In addition to its agreed ToRs, the WG received two special requests for fast-track advice. The first was a request from the Government of Norway for advice on management measures for sandeel. This is addressed in Section 13. The second request came from the Dutch ICES delegate, and asked for an evaluation of reference points for North Sea plaice along with advice on appropriate levels of fishing mortality. This request is addressed in Section 9.

1.3 Data sources and sampling levels

1.3.1 Roundfish and flatfish 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.

1.3.1.1 Data on landings, age compositions, weights-at-age, and 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 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 Working Group database. The differences introduced by conversion factors, and the difference between sums-of-products (SOP) and nominal catches, are minor in most cases. SOP corrections are usually not applied in the flatfish stocks, but it is a standard procedure for all roundfish stocks: however, these corrections are relatively small.

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 Working Group estimates of the landings include specifi corrections for misreported or unreported landings. These are discussed in the relevant stock annex sections of the Quality Control Handbook. There are signals that misreported or unreported landings occur in other stocks, especially in the stocks of valuable species, but these could not be verified or quantified. Strong reservations were expressed in last year's WG report on the quality of North Sea cod landings data in particular. These have been addressed in this year's report (Section 3) by the use of an alternative assessment method which allows for recent catch data to be downweighted in the overall abundance estimation.

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 sole in Lowestoft (CEFAS), VIId plaice in Port-en-Bessin (IFREMER) and IIIa plaice in Charlottenlund (DIFRES). Any revisions that have been made in 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 never 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. 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 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 resarch-vessel surveys, for example) indicates 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. The WG did not feel that it was in a position to evaluate the consequences of adjusting the maturity ogive during the meeting and recommended that this is examined before revised maturity ogives are implemented. The analyses of maturity ogives are discussed in more detail in Section 1.3.2.1.

1.3.1.2 Discard data used in the assessment

Estimates of discards are used in the assessments for North Sea haddock, North Sea whiting and North Sea plaice. All the discard data available for other species has been presented in the report (see the relevant stock sections), and has been used in exploratory analyses for North Sea cod. For the remaining species, the existing discard time-series are too short to permit their inclusion yet. The use of discard estimates in assessments is thought to reduce bias, give more realistic estimates of fishing mortality, and lead to more representative inputs for mixed fisheries analyses. However, discard estimates can be noisy and increase the variability of the assessment. Furthermore, for many of the stocks it is unclear whether the available discard estimates form a representative sample of discarding practice in the fisheries.

For cod, haddock and whiting, total annual international discard estimates by age group were derived by extrapolation from the Scottish discard sampling programme. Discard estimates for plaice in the North Sea were obtained by a combination of observations from the Dutch fishery for recent years, and reconstructions based on observed growth for earlier years (see Section 9).

Availability of discards data in WGNSSK

Compilation of discards data for North Sea plaice (as for other species) was attemped by SGDBI in 2002 (ICES 2002). The data were mainly from towed-gear fisheries for cod, haddock, whiting, saithe, sole and plaice in Division IIIa and Sub-Area IV as collected by Germany, England, Denmark, and Sweden between 1999 and 2001 under EC project 98/097. Some data from other projects going back to 1997 were also available to SGBDI. WGNSSK noted in its 2002 report (ICES 2003c) that ignoring discards in stock assessments may introduce bias and affect estimates of *F* and stock biomass, particularly when discard patterns vary over time. The collection and collation of data as undertaken by SGDBI was not useful at that time for assessment purposes. Since 2002, the EC data regulation (EC 2001) has introduced the obligation for EU member states to collect discards data for their major fleets. The data collected needs to be submitted to the EC in annual reports: however, there is no official requirement to submit the data in a suitable format to the relevant ICES working groups. Therefore, the discards data that have been collected for the North Sea stocks by the different countries have not yet been made available to this WG. This is clearly an undesirable situation.

The WG recognized that some effort has been made within SGDFF to develop a format for exchanging fishery based information. This format has been used to generate datafiles for the mixed-fisheries forecasts. However, at present there is no standardised procedure for handling the landings and discards data in the exchange files, and therefore *ad-hoc* approaches have been developed to combine the data for the mixed fisheries forecasts. The WG recognized the need to develop software that can be used to compile and aggregate the raw input data for working groups like WGNSSK. This would involve software that could generate a database of the raw input data, and merge and raise the input data to the required level (e.g. landings and discards at age by year). Within ICES, there have been initiatives to develop such an approach, but so far this has not resulted in any software that is directly useable by assessment WGs.

The European Commission is in the process of developing exchange formats and software for the data collected within the data regulation, but the likely development of this software is at too high and aggregation level to be useful for assessment WGs.

The WG recommends that ICES tasks a specific group to develop and test a software approach to compiling and aggregating landings and discards data for working groups. The obvious candidate for such a task would be the SGDFF which involves the chairs of different assessment working groups.

1.3.1.3 Natural mortality

The estimates of natural mortality for cod, haddock and whiting are based on historical estimates of multispecies predation rates (ICES 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. The natural mortality of saithe is assumed to be 0.2 for all age groups. Natural mortality estimates for Norway pout have been changed in this year's assessment (see Section 12). For sandeel, the natural mortalies used are derived from multispecies considerations (ICES 1989), although they are not exactly the same (see the sandeel stock annex in the Quality Control Handbook).

1.3.1.4 Commercial fleet and research vessel data

All available time-series of CPUE and effort data from commercial fleets and research-vessel surveys have been presented in this year's report, and a subset of these data have been used to tune the relevant assessments and refine short-term prognoses (see Section 1.4). 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, ITQ's, 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 the commercial CPUE data has been excluded from the assessments of a number of stocks. Such data has been retained in assessments only in cases where no survey data are available, or where commercial CPUE series provide reliable information that cannot be obtained elsewhere. At the time of year when the meeting took place, survey indices from the Dutch beam trawl survey and the IBTS Q3 surveys were not available. Indices from the English Q3 groundfish survey were made available for some stocks during the second week of the meeting, and were included in forecast estimates where appropriate. Figure 1.3.1 shows the roundfish sampling areas covered by the IBTS Q1 and Q3 surveys.

1.3.2 Data sources for 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.

1.3.2.1 Data on landings, age composition, weights-at-age, and maturity

In some cases management areas do not entirely correspond with areas for which the assessments are carried out. If the management areas are larger, landings cannot always be obtained for the assessment area separately. In these cases landings have to be estimated by the WG from external information.

The sampling of Norway pout and sandeel landings are described in detail in the Quality Control Handbook of the present report (see Appendix 4). The applied sampling systems vary between countries.

In Norway, the sampling system since 1993 is based on catch samples from three market categories: E02 (mainly sandeel), D13 (blue whiting, if not sandeel and catch taken west of 0°E), 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. A paper presented at the WG meeting in 2000 indicated high variability in maturity of 1-group Norway pout.

1.3.2.2 Natural mortality

The currently-used natural mortality estimates are based on historical information (MSVPA, ICES, 1989) and kept constant over the whole time period of the assessment. Natural mortality for Norway pout has been taken as 0.4 per quarter, corresponding to an annual mortality of 1.6. This year the sandeel stock was assessed by using both XSA and SXSA. The annual natural mortality for sandeel estimates by age are:

Age 0: $M = 0.8$
Age 1: $M = 1.2$

Age 2+: $M = 0.6$

As mentioned previously (Section 1.3.1.3), SGMSMS has re-estimated natural mortality of cod, haddock, whiting, sandeel, and Norway pout (Section 1.6.2), and the effects of using these in the assessments of cod and haddock are explored.

1.3.2.3 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 first and third quarter IBTS, third quarter EngGFS and third quarter ScoGFS.

For sandeel, only data from the Danish and Norwegian commercial fleets are available.

1.3.3 Sampling levels and sampling 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 1999a). 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 is required. The national market sampling programmes have been adjusted accordingly.

Table 1.3.1 gives an overview of the sampling levels in 2003 for each stock. Sampling levels in recent years for the Scottish discard observer programme are summarised in Table 1.3.2.

1.4 Methods and software

1.4.1 Update and benchmark assessments

Following guidelines adopted by ACFM in October 2002, the WG performed each assessment as either a benchmark assessment or an update assessment, according to a previously-agreed schedule. The intention of this split is to reduce the high workload implied by the ToRs, while ensuring that the WG performs an in-depth analysis of each stock at least once every three years. Benchmark assessments should include full explorations of input data and analyses of the implications of different model choices and assumptions. Update assessments are intended to be more concise and follow (where appropriate) the estimation procedures outlined in the relevant stock annex. However, there is a degree of flexibility in this approach, so that issues causing concern in update assessments can be addressed in limited exploratory analyses. This year, the WG took this one step further and permitted small modifications in update assessments if there was a clear need. Such alterations are highlighted in the opening paragraph of each stock section if they were found to be necessary.

The issue of which outputs to include in an update assessment report caused considerable discussion during the WG. The template produced by ACFM allowed only for tables of input data and basic outputs, and two summary figures (stock summaries and historical assessment performance). This year the WG has departed from this template by including a limited number of additional figures that are of direct relevance to fisheries managers. The WG took the view that the main benefit of an update assessment is that time is saved by not revisting the estimation *process* every year. However, the *outputs* and implications for managers will change from year to year, even with a consistent model, and therefore key aspects of model outputs still need to be presented in an update assessment. This does not add significantly to the time taken for the update, and increases greatly the usefulness of the report. The required figures and tables for each update assessment are listed below:

Figures

1. Relative commercial effort and CPUE.
2. Stock summaries: catches, mean *F*, recruitment (including intermediate year), SSB (including intermediate year).
3. Historical performance of the assessment.
4. Probability profiles for short-term projection.

Tables

1. Official statistics (including TACs).
2. Catch numbers at age (all available ages and years, with those used in the assessment highlighted in bold).

3. Discard estimates (if available).
4. Catch weights at age (all available ages and years, with those used in the assessment highlighted in bold).
5. Stock weights at age (if different from catch weights-at-age).
6. Commercial effort and CPUE.
7. Tuning data (all available series, ages and years, with those used in assessment highlighted in bold).
8. Model diagnostics.
9. Fishing mortality at age.
10. Stock numbers at the start of the year.
11. Stock summaries, with intermediate-year estimates for recruitment and SSB (there should be a footnote explaining these).
12. Input for RCT3 (if used).
13. Output from RCT3 (if used).
14. Input data for catch forecasts (SEN file data).
15. Catch forecast output (management option table).
16. Detailed forecast table.
17. Relative contributions of year-classes to forecast landings and SSB.

Other figures and tables could be included as required to illustrate any important exploratory analyses that were done.

The schedule of assessments for WGNSSK is as follows, including a provisional proposed schedule for 2005–2007 (modified from that presented in last year's report). Concerns over the modelling of the large 1999 haddock year-class as a plus-group in forecasts have meant that it has been moved forward in the schedule. Due to low stock sizes, North Sea cod and plaice are on an observation list, which means that they are always treated as benchmark assessments.

Stock	**2003**	**2004**	**2005**	**2006**	**2007**
Cod 3a47d	**Benchmark**	**Benchmark**	**Benchmark**	**Benchmark**	**Benchmark**
Haddock 3a4	**Benchmark**	Update	**Benchmark**	Update	Update
Whiting 47d	Update	**Benchmark**	Update	Update	Update
Saithe 3a46	Update	Update	**Benchmark**	Update	Update
Sole 4	**Benchmark**	Update	Update	Update	**Benchmark**
Sole 7d	Update	Update	Update	**Benchmark**	Update
Plaice 4	**Benchmark**	**Benchmark**	**Benchmark**	**Benchmark**	**Benchmark**
Plaice 3a	Update	Update	Update	**Benchmark**	Update
Plaice 7d	Update	Update	Update	**Benchmark**	Update
Sandeel	Update	**Benchmark**	Update	Update	**Benchmark**
Norway pout	Update	**Benchmark**	Update	Update	**Benchmark**
# benchmark	**4**	**5**	**4**	**5**	**5**

The approach of categorizing assessments as updates or benchmarks has caused the WG considerable concern. The system has been in operation for two meetings of this WG, and it has not been a success. For the WG to do justice to a benchmark assessment, a great deal of in-depth analysis needs to be performed. There are two main problems with this. There is not enough time to do all the analyses that are required, and the length of time taken by those analyses that the WG can do means that there is no time left to review and correct the text satisfactorily. The purpose of update assessments is that they should be finished quickly, leaving WG members free to work on benchmark assessments. However, when clear problems are found in the existing data or method, these have to be addressed otherwise a faulty assessment will result. This means that work on update assessments continues into the second week, no matter how stringent time-keeping is. The consequence is that effort on assessments cannot be redistributed as planned.

In the opinion of the WG, the update/benchmark system can only function if the following conditions are met:

- Update assessments need to be fully completed (including stock annexes and ACFM summary sheets) at least one week before the WG meeting. The assessments should be circulated and reviewed by the WG members. One or two days can be allowed at the start of the meeting for modifications, but no more.

- Groups must be identified to work by correspondence on key topics for benchmark assessments. Examples from this year might include discards for cod, plaice and whiting, stock structure in whiting, and tuning indices for Norway pout and sandeel.

- It may be appropriate to limit the number of benchmark assessments to three.

The first two of these points requires commitments by WG members and their institutes to participating. If there can be no guarantee of such intersessional work, then the update/benchmark approach must be replaced by an alternative system. This is particularly true if the Integrated Approach (see Section 15) is to be implemented. One possibility would be to undertake all the necessary analyses for a benchmark assessment intersessionally, and treat all assessments during the meeting itself as updates.

1.4.2 Quality Control Handbook

Stock annexes for all stocks assessed by this WG (except North Sea plaice, see Section 9) have been drafted this year following the outlines proposed by ICES, and are available in the Quality Control Handbook (included this year as an appendix). In some cases these are still in draft form, while for other stocks they are more complete.

1.4.3 Assessment methods

Table 1.4.1 lists the biological basis of the stock assessments undertaken by this Working Group. Table 1.4.2 gives an overview of model settings for these assessments.

XSA

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. Two implementations were used: version 3.1 of the Lowestoft VPA package was used for roundfish and flatfish stocks along with sandeel, while Seasonal XSA (Skagen 1994) was used for 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.

- 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.

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 12 and 13) to estimate fishing mortalities and stock numbers at age by half-year, using data up to and including the first half year of 2004. 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 manual entered 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 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. 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.

TSA

An implementation (Time-Series Analysis or TSA) of the Kalman filter algorithm was used in comparative assessments for cod and whiting. Its main advantage is that it is thought to encapsulate the uncertainty in terminal-year estimates, and it can model industrial bycatch separately from human consumption and discard catch components. Its main disadvantage is that it is still difficult to use, with a nearly-flat parameter solution space in which it can be difficult to obtain maximum-likelihood solutions. Development on TSA has slowed in recent years due to time constraints on the principal developer: a robust and generally-applicable implementation is proving difficult to specify, and the future of the method is unclear.

Technical details of the basic model may be found in Harvey (1989), Jones (1993) and Gudmundsson (1994), while the TSA implementation used here is discussed in the 1998 report of the ICES WG on the Assessment of Northern Shelf Demersal Stocks (WGNSDS; ICES CM 1999/ACFM:1, Appendix 3), the 2001 and 2003 reports of the ICES WG on Methods of Fish Stock Assessment (WGMG; ICES CM 2002/D:01, ICES CM 2003/D:03), Fryer *et al* (1998), Fryer (2001) and the 2003 report of the Working Group on Methods in Fish Stock Assessment. In brief, the Kalman filter TSA algorithm is a recursive procedure that represents the variables of interest (stock numbers and fishing mortalities at age) as unobserved state variables that evolve forward over time. Each year, observed catches-at-age are used to update the estimates of the state variables. Year-class strength is assumed (in this implementation) to be distributed according to a Ricker stock-recruitment model. Model fitting proceeds by examination of standardised catch prediction errors (equivalent to model-fit residuals) and inflation of permitted variance on year-age pairs for which such errors are high. Each estimate of historical mean F and stock numbers is produced with an associated standard error, allowing a statistical evaluation of the uncertainty in the assessment. A number of research-vessel tuning series can be incorporated. The model is also able to roll forward and produce estimates for all parameters for as many years as required following the last historical year. A new version this year assumed a constant CV on catch and survey estimates, and allowed for the separate modelling of industrial bycatch.

SURBA

For several stocks, the WG used SURBA (version 2.20) to summarise the population dyanamics information provided by research-vessel survey indices and commercial CPUE indices. SURBA is a Windows-based survey-analysis programme which fits a separable model of fishing mortality to index data, and which also generates a variety of plots to support exploratory analyses. The method generates relative indices of abundance, which can optionally be raised to pseudo-absolute abundance estimates using externally-derived catchabilities. These estimates can also be bootstrapped to allow for estimation of uncertainty, although the validity of this approach for these data is currently being questioned. The method is based on the model presented in Cook (1997, 2004), while the software implementation is described in detail in ICES (2003a, 2003b, 2004) and Needle (2002, 2003, 2005).

SURBA was used in two different ways by the WG. Firstly, plots were generated to summarise information from indices without any modelling. These included bivariate scatterplots of index values-at-age, catch curves (log index values by cohort), mean-standardised index values at age by cohort, and empirical estimates of relative SSB and Z where, for index values $I_{a,y}$,

$$\mathrm{SSB}_y = \sum_{\mathrm{a=a1}}^{\mathrm{a2}} I_{a,y} W_{a,y} \mathrm{Mat}_{a,y} \ \text{ and } \ Z_{a,y} = \ln\left(\frac{I_{a,y}}{I_{a+1,y+1}}\right).$$

Depending on the stock, these summaries were based on unsmoothed (raw) or smoothed indices. This smoothing was done by fitting a cubic smoothing spline with a user-defined smoothing parameter. While this can be useful in terms of reducing noise and dealing with missing values, it can also lead to a loss of information.

Secondly, for some stocks the separable model in SURBA was applied to generate abundance and Z estimates. Abundances were not raised to pseudo-absolute estimates, but were left as relative values. Point estimates were used in preference to the 50th percentiles from bootstraps, as the latter have been shown to be misleading in simulations (see WP2).

ICA

Integrated Catch-at-age Analysis (ICA; Patterson and Melvin 1996) combines a statistical separable model of fishing mortality for recent years with a conventional VPA for the more distant past. Population estimates are tuned by CPUE indices from commercial fisheries or research-vessel surveys, which may be age-structured or not as required. The model fit can optionally be modified to a greater or lesser degree by the assumption of an underlying Beverton-Holt stock-recruitment relationship.

ADAPT with missing catch data

A new implementation of the ADAPT method (Gavaris, 1988) was developed for the WG, in order to provide estimates of underreporting in the North Sea cod fishery. This method is described in full in Appendix 4.

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 Norway pout (see also Section 12), where the assessment includes ages 0–3+ and quarterly catch data are used:

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

with F-components defined as follows:

$F(a)$:

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

$F(q)$:

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

$F(y)$:

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

The parameters $F(a_a)$, $F(y_y)$ and $F(q_q)$ are estimated in the model. $F(q_q)$ in the last quarter and $F(y_y)$ Fy in the first year are set to constants to obtain a unique solution.

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 quarter. Catchability is assumed age dependent for all ages of Norway pout.

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 ($L = L_C * L_{\mathrm{CPUE}}$,). 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 the Ad-model builder **(**Otter Research Ltd.), which is a software package to develop non-linear statistical models. The SMS model is still under development, but the "single species part" has extensively been tested in the last year on both simulated and real data.

SMS can estimate the variance of parameters and derived values like average F or SSB from the Hessian matrix.

Alternatively, variance can be estimated by using the built-in functionality of the AD-Model builder package to carry out Markov Chain Monte Carlo simulations (Gilks et al. 1996), MCMC, to estimate the posterior distributions of the parameters. For the historical assessment, period uniform priors are used. For prediction, an additional stock/recruitment relation can be used.

1.4.4 Recruit estimation

For several stocks, recruitment estimates have been made using RCT3 (Shepherd 1997). This was the case when recruitment indices from 2004 surveys are available, or when *F*-shrinkage in XSA has 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.

1.4.5 Short-term prognoses and sensitivity analyses

Short-term prognoses (forecasts) were made for all stocks, including sandeel and Norway pout for the first time. Half-year forecasts (to the start of 2005) were produced for the industrial stocks this year in order to give ACFM further information on which to base advice in the current situation of low biomass. These were based on survivors estimates at the end of the second quarter in 2004 from Seasonal XSA, rolled forwards to the start of the first quarter in 2005 using assumed mortality and weights-at-age.

Forecasts for all non-industrial stocks were based on initial stock sizes as estimated by XSA (in a number of cases supplemented with separate recruitment estimates as described above), natural mortalities and maturity ogives as used in the XSA, and mean weights at age averaged over recent years (normally 3). For haddock, the mean weight-at-age of the large 1999 year-class in the forecast was modelled using a fitted growth curve. Fishing mortalities-at-age in forecasts were taken to be either the 2003 values, or a scaled or unscaled mean *F*-pattern over the most recent 3 years. Forecasts and corresponding sensitivity analyses were undertaken using either the Aberdeen suite of forecast programs or the MFDP/MFYPR software.

The WG attempted to incorporate possible effects of management measures implemented during 2004, such as days-at-sea restrictions and the cod protection area, along with perceived effort reductions. For each stock the best estimate of the likely effect was included in the final forecast presented, but the sensitivity of the forecast to the assumptions made was also explored.

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

1.4.6 Stock-recruitment modelling and medium-term projections

The WGMTERMC program (from the Aberdeen suite) was used to generate stochastic medium-term (10-year) projections for those stocks where this was thought to be appropriate. Two programs were available to fit stock-recruitment models for these projections. RECRUIT, also part of the Aberdeen suite, fits Ricker, Beverton-Holt and Shepherd models by nonlinear least-squares regression. RecAn 2.0 is a Windows-based alternative that can fit 24 different stock-recruit models and which produces graphical summaries of the output. The use of non-standard models from RecAn 2.0 is, however, currently limited by WGMTERMC, which only incorporates the three models mentioned above.

1.4.7 Estimation of biological reference points

Established biological reference points ($\boldsymbol{F}_{med}$, $\boldsymbol{F}_{high}$, $\boldsymbol{F}_{0.1}$, $\boldsymbol{F}_{max}$ etc) have been estimated using the REFPOINT software or the PA-software. For stocks where the perception of abundance or fioshing mortality has changed significantly, the PA software has been used to provide a full exploration of the biological reference points.

1.4.8 Mixed fisheries modelling

Last year, the WG was asked to evaluate methods for generating mixed-fisheries forecasts and to run the forecasts themselves. However, producing such forecasts requires decisions on the relative importance of different stocks and fisheries which the WG was unable to make as they are essentially political in nature. Therefore the WG concentrated this year on collating data for mixed-fisheries forecasts, for subsequent use by advisory groups such as ACFM and STECF. The *de facto* standard for producing forecasts based on these data is the MTAC model, which was described in full in last year's WG report (Section 1.4.7).

1.4.9 Software versions

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

Software	**Purpose**	**Version**
VPA95 (Lowestoft VPA suite)	Catch-at-age analysis (separable VPA, Laurec-Shepherd tuning, XSA).	Compiled 08/06/1998.
RETVPA00	Retrospective analysis for XSA.	Compiled 12/06/2002.
TSA (Time Series Analysis)	Catch-at-age analysis (with surveys, constant CV assumption, industrial bycatch modelled separately).	No formal version number: recompiled for each run.
SXSA (Seasonal XSA)	Catch-at-age analysis for seasonal fisheries.	Compiled 01/09/2004.
RCT3	Recruitment estimation.	Compiled 26/08/1996.
SURBA	Survey-based analysis.	2.20 (compiled 13/09/2004).
INSENS	Generation of input files for Aberdeen Suite programmes.	Compiled 20/05/2002.
RECRUIT	Estimation of stock-recruit model parameters.	Compiled 04/02/2002.
RecAn	Estimation of stock-recruit model parameters.	2.20 (compiled 01/07/2004).
WGFRANSW	Short-term prediction and sensitivity analysis.	1.0 (compiled 22/05/2001).
WGMTERMC	Medium-term projections.	Compiled: 03/11/1999.
REFPOINT	Calculation of reference points and yield-per-recruit.	Compiled: 12/06/1997.
MTAC	Fisheries-based forecasts.	R script created 25/02/2004.
SMS	Catch-at-age analysis with a stochastic multi-species model	Unknown.
ICA	Catch-at-age analysis (mixed separable and conventional VPA)	1.4 (compiled 09/09/1999).
BADAPT	Catch-at-age analysis with estimated misreporting	Compiled 01/10/2004.

1.5 Biological reference points

For update assessments, biological reference points ($\boldsymbol{F}_{lim}$, $\boldsymbol{F}_{pa}$, $\boldsymbol{B}_{lim}$, $\boldsymbol{B}_{pa}$) have been retained at the values defined by ICES: these are given in the stock annex for each case (see the Quality Control Handbook in the Appendix). For benchmark assessments, if the method or data used has been substantially altered, then biological reference points have been revised to the technical basis for each stock. In these cases, the revised points are given in both the stock section and the stock annex. For all assessments, the technical basis for estimating reference points is given in the relevant stock annex.

ACFM has stated that future management advice by ICES will be constrained by $\boldsymbol{F}_{pa}$ and $\boldsymbol{B}_{pa}$, the precautionary thresholds which imply a reasonably high probability of remaining below a limit fishing mortality and above a limit spawning stock biomass. $\boldsymbol{F}_{pa}$ and $\boldsymbol{B}_{pa}$ are thus the main devices to be used by ICES in providing management advice.

1.6 Working papers and background documents

WP 1: Robin Cook & Mike Heath. The implications of warming climate for the management of North Sea demersal fisheries.

Abstract: This work applies a modified Ricker stock and recruitment model to data covering a recent thirty to forty year period for North Sea cod, haddock, whiting, saithe, plaice, sole and herring. The modified Ricker function incorporates an additional parameter to permit the influence of variable temperature to be expressed in the relationship between stock and recruitment:

$$R = aSSBe^{(cT - SSB/b)}$$

where *a*, *b* and *c* are parameters. An index of sea-surface temperature was derived from IBTS stations and ICES hydrographic records, and the modified Ricker model was applied to the time-series of stock, recruitment and temperature. The temperature index is assumed to reflect the general variation in the environment over time, and specifically to reflect the impact of climate change as indicated by the recent warming of the North Sea. For cod, plaice and sole the temperature parameter was significant and negative. For saithe it was significant and positive, but insignificant for herring, haddock and whiting.

A positive value for the temperature parameter implies an increase in recruitment per unit SSB with increasing temperature while a negative value indicates a decrease. Consequently, species with a negative relationship between recruitment and temperature may be expected to support smaller fisheries in a future warm period. As the temperature data indicate that the North Sea experienced a warmer period since 1988 relative to the period from 1957-1987, stock projections were made for those species exhibiting a significant temperature parameter. The projections assumed a future temperature regime corresponding to the mean of (i) the earlier, cooler period, and (ii) the latter, warmer period.

The projections were made for fishing mortalities corresponding to $\mathbf{F}_{MSY}$ under each of the temperature regimes and also to $\mathbf{F}_{pa}$. The former indicates the effect of these temperature bounds on MSY and and SS$\mathbf{B}_{MSY}$ whereas the latter predicts outcomes at the upper limit of fishing mortality commensurate with ICES' implementation of the Precautionary Approach.

For cod, plaice and sole (those species with a significant negative temperature parameter), $\mathbf{F}_{MSY}$, MSY and SS$\mathbf{B}_{MSY}$ were all estimated to be lower during warmer periods than cooler ones; for saithe (with a significant positive relationship), these values are higher in the warmer period. Also, during the warmer period, the equilibrium SSB corresponding to exploitation at $\mathbf{F}_{pa}$ is below $\mathbf{B}_{pa}$ for cod, plaice and sole. This implies that at equilibrium for the warmer period, $\mathbf{F}_{pa}$ is inappropriately high for the adopted values of $\mathbf{B}_{pa}$. However, for cod, MSY under the warmer regime is still estimated to be substantially greater than the current low yields. This reflects the fact that fishing mortality on cod has been in excess of $\mathbf{F}_{MSY}$ for a long period and has contributed to the current depleted state of the stock.

Discussion: The WG welcomed this paper as helpful attempt to quantify the effect of warming of the North Sea on commercially important North Sea fish stocks, particularly on the expected future productivity of the stocks during a warmer period.

Concerns were expressed to whether the recruitment model incorporating a temperature parameter was over-parameterised. Parameters from stock-recruit model fits are usually highly correlated, implying over-parameterisation. This is not, however, unique to this analysis and it is true that additional information is used by the model in the form of the sea surface temperatures,.

Comments concerned with specific stocks were firstly that recruitment data for whiting in this model was used since 1960. The working group has for a long time queried the full time-series of stock and recruitment information for this species because of an abrupt shift in apparent productivity around the end of the 1970s. One explanation for this could be the impact of a regime shift at that time; however, a more mundane explanation could be the incorrect attribution of a late-1970s discard ogive to the landings data for whiting prior to that time. This too could present itself as a change in productivity and would have a confounding effect on the sort of analysis presented here.

Haddock tends to be characterised by occasional extreme recruitment events. As these have occurred in both the cooler, (pre-1988), and warmer (post-1988) periods, it was considered unsurprising that the temperature parameter for haddock was found to be insignificant with very wide error bounds.

Concern was also expressed for the cod results. Inspection of the time-series of temperature and spawning stock biomass indicate that the period of low SSB is concurrent with the predominant period of warmer sea surface temperatures. Because of this, it is not clear that the estimation of the temperature parameter in the stock and recruitment model is not confounded in some way. Although the existence of at least some "warmer" years in the high SSB period for cod may recompense this, the extent to which this occurs is not clear.

WP2: Liz Clarke. Scottish fishery definitions.

Abstract: We defined Scottish fisheries using cluster analysis of the landings composition of Scottish demersal reported landings data for the North Sea in 2000-2002. We used the percentage weight landed by species (or species group) i.e. the landings composition for each trip to define the clusters. The final analyses were performed on data grouped by gear. The resulting clusters were aggregated after consultation with the industry and experts, so that they are defined by simple combinations of gear, mesh-size, time of year and fishing area. Landings and discard numbers-at-age were estimated using Scottish data based on the current Scottish fleet definitions.

Discussion: Scottish fishermen have been consulted about this work and the working group was interested about their views. Generally the industry was in favour of the idea of mixed fisheries. When asked about their views on the number of fisheries present in the Scottish fleet, however, skippers tended to prefer a high level of aggregation into few fisheries. If fishermen identified seasonal differences in fishing patterns this tended to centre on differing bycatch. This could be problematic for fisheries definitions based on landings as a large proportion of bycatch can be discarded.

Different statistical tests for determining the optimal number of fisheries were discussed. It was agreed one or more could be applied to this work, although presently human intervention to decide the merits of splitting a fleet into a different number of fisheries is preferred.

The resolution of the data being used to form the fisheries definitions was discussed. It was decided the resolution, both spatially and temporally, was sufficient given the level of aggregation of fisheries being preferred.

The WG considered the fact that the fisheries definitions can only be based on current and past landings. The approach can not take account of any segment of the fleet preparing to target new areas or species. The consistency of the fisheries definitions over time was also considered. It was asked whether use of mesh size would be a sufficient and consistent means of defining fisheries. The existing method, however, does take account of mesh size and gear type as well as landings composition and it is hoped this combination will allow fisheries definitions to remain consistent over time. It was asked whether there were any examples of boats with a single gear being classified into different fisheries on different trips. These tests have not been performed yet but the work has highlighted problems with the available data, in that boats with a single gear are recorded as having different gear on different trips. This problem is being addressed with the help of the industry.

WP3: Coby Needle. Data simulation and testing of XSA, SURBA and TSA.

Abstract: A series of six configurations of a data simulator were set up, involving misreporting, changes in survey catchability, and variable discarding rates in different combinations. Two realisations of each configuration were generated, and corresponding population estimates from three different assessment models (XSA, TSA and SURBA) were compared with the true underlying values from the simulations. In general, XSA performed best with simple simulations, TSA performed best with more complicated simulations, and SURBA was the least successful of the three. However, time constraints and the difficulties inherent in fitting the TSA model meant that the number of possible replications was far too low to enable concrete conclusions to be drawn to assist ACFM in their deliberations on Division VIa gadoid stocks, and the conclusions of this study are limited to qualitative comments only.

Discussion: The WG found the results of this paper interesting, but the number of simulations was too low to make general statements about the different estimation methods. There was general discussion about simulations and the need for careful choice of simulation model to avoid inadvertently favouring a method with similar assumptions. The assumption of changes in survey “catchability” in TSA, which actually reflects changes in mismatch between catch and survey data, was also discussed, and it was noted that one of the purposes of the simulations was to test the effects of making such assumptions. It was commented that, for most models, poor fits could have been made worse by user intervention on the basis of diagnostics.

WP4: Clara Ulrich-Rescan & Maria Hansson. Revision of the IBTS time series for plaice IIIa - can the "scientist-effect" affect stock perception?

Abstract: The IBTS q1 data used for tuning the assessment of Plaice IIIa is traditionally not provided by ICES. They are calculated directly by the DIFRES scientist in charge of the assessment from haul-by-haul Swedish data, usually computed every year for the previous year’s data only. The responsibility for assessing this stock has changed quite often both in DIFRES and IMR, with four different DIFRES scientists and three IMR scientists in the last ten years. There is no existing documentation of the estimation method used and the calculation of indices, but we know that some differences occurred in the methodology. As a matter of quality insurance and data control, we decided to check the whole time series by extracting all haul-by-haul data since 1991, and to compare them with the official numbers shown in the last WG report. Two methods of index estimation are presented, one as average over all hauls, and one as an average over average by rectangle. It was concluded from this exercise that: 1. small differences in basic methodology (raw data extraction, averaging method) give large differences in single-fleet assessment results. 2. Old time series are not reliable anymore and should be replaced by the revised time series. 3. To avoid the “scientist-effect”, and for quality check of the data, documentation on working procedure for preparation of input data is needed. Also, ICES is requested to do the calculation of the indices also for this stock in the future.

Discussion:

- Recommendation to the ICES IBTS WG, asking them for making a guideline how to calculate these indices.
- Generally, hauls with large number of individuals should not be removed as outliers just because of the magnitude.

Hauls with zero catch should be included in the data series.

WP5: Clara Ulrich-Rescan & Else Nielsen. Should western Baltic plaice be included in the plaice IIIa assessment?

Abstract: The assessment of plaice IIIa has repeatedly been criticised because of its large fluctuations in estimations of fishing mortality, and its major retrospective patterns. Concerns have often been expressed by the scientists in charge of the assessment regarding non accounted "natural" mortality, which includes migrations outside the assessment area.

We showed here that there are large catches of plaice being taken outside IIIa, and for which there exists strong belief that they belong to the same biological stock as the one being assessed. These catches are not likely to be only the fact of misreporting, as the same increase of biomass was detected in both areas from survey data.

The stock delimitation will not be changed during this session of the WG, but the matter should be discussed. If the WG considers it important to include these catches in the stock, then extra intersessional work will be performed in order to derive catches at age, and results will be analysed and compared during a forthcoming benchmark assessment.

WP6: Mark Dickey-Collas *et al.* How can differing assumptions about the trend in fishing mortality within a stock assessment affect the management of a fish stock?

Abstract: Simulated populations of sole and plaice are assessed and managed for a period of 13 years into the future. True and perceived populations are compared. The effect of shrinking fishing mortality (F) towards the recent mean F, as part of the solution of a stock assessment is investigated during a period of strong trends in F. By their nature, recovery plans should result in a negative trend in F. Using shrinkage to mean F is a compromise between introducing bias in the assessment and coping with the noise in the data. This amounts to trading off bias against uncertainty in the assessment. It is intuitive that this bias should exist, however this study shows that the bias can affect management. In this scenario the bias results in a cyclical difference developing between the true and perceived populations. The simulation suggests that the management measures are often out sync with that actually required by the stock for sustainable exploitation and to reach stable management targets. It questions whether scientists can really reliably monitor a stock experiencing extreme fluctuations in exploitation. Recruitment is also under- or overestimated by up to 25%. The bias introduced by shrinkage towards the mean F, in this scenario, also in results less stability in the annual catches.

Discussion: The WG reacted that shrinkage of 0.5 was chosen to get rid of the retrospective pattern but in fact did introduce a bias. Due to the high shrinkage it takes a relatively long time to pick up signals in the data.

WP7: Hajo Rätz, Kay Panten & Jens Ulleweit . German Otter Trawl Board Fleet as Tuning Series for the Assessment of Saithe in IV, VI and IIIa, 1995-2003.

Abstract: The working document gives an update of the commercial tuning series used in the saithe assessment, accompanied with information about sampling efforts and biological parameters. During 1995-2003, otter trawl catches were considered of 8 vessels continuously being engaged in the directed saithe fishery. The saithe fleet used for tuning accounted for 64-85 % of the entire annual German saithe landings officially reported.

The German fleet reported only about 9,000 t of saithe landings in 2003 representing a quota utilization of about 50 % only, the lowest figure since 1995. Very poor market conditions for saithe attracted the German vessels to target other resources. No significant discarding occurred during 2 trips covered by scientific observation. The geographical distribution of the quarterly aggregated landings in 1995-2003 reveals a fairly constant fishing pattern in the northern part of the North Sea mainly along the Norwegian trench. However, the northern fishing grounds seem to have been avoided in 2003, probably in order to reduce sailing. The age disaggregated abundance indices derived from CPUE indicated the 1992, 1996 and 1998 year classes as strong, the latter one being the strongest and most important year class for recent catches (47 % in numbers). The 1998 year class remains the only abundant year class exceeding the average abundance at age since 1995. The age group 4 does seem to be a significant estimator of year class strength at age 5 explaining about 60 % of the observed variation.

WP8: Joe Horwood. UK effort 1997–2003 & 2004 North Sea & West of Scotland.

Abstract: No abstract presented.

Discussion: No rapporteur's report available.

WP9: Peter Wright and Henrik Jensen. Potential effects of technical management measures for the sandeel stock in the North Sea.

Abstract: This WP was been produced in response to the Norwegian government's request to ICES for advice on "the uncertain situation for the sandeel stock in the North Sea". The high mortality of sandeel and the few year classes in the fishery make the North Sea stock size and catch opportunities largely dependent on the size of the incoming year classes. Based on the latest ICES assessment of sandeels ACFM reported that the state of the North Sea sandeel stock was uncertain (ICES 2003). The 2001 year-class still appeared to be abundant in 2003 but the 2002 year-class was estimated to be extremely weak. Total landings and effort (days at sea) in 2003 was close to 41% and 66% of the average recorded for the period 1987-2003, respectively. The scarcity of the 2002 year-class means that the strength of the 2003 year-class was particularly important to the state of the stock in 2004. For this reason the Council of the EU adopted a harvest control rule based on the size of the 2003 year-class. From an estimate of 2003 year-class and the uncertainty associated with that estimate STECF considered that continued fishing throughout 2004 with unrestricted effort carried the risk of overexploitation of the North Sea sandeel stock (STECF 2004a). The STECF working group, set up to provide an estimate for the EU harvest control rule, highlighted that the North Sea level approach does not account for the possible effect of the fishery on future spawning stock biomass. Further, this approach does not take into consideration the complex population structure of this stock (STECF 2004b). This WP concludes that there is insufficient data to permit a quantitative reponse to the Norwegian request, but raises some qualitative points that may be of assistance to fisheries managers.

Discussion: see WP14 below.

WP10: C. Millar and R. F. Fryer. Revised estimates of annual discards-at-age for cod, haddock, whiting and saithe in ICES Division IV.

This paper describes recent modifications made to the collation process applied to data from the Scottish discard observer sampling programme. A collapsed-strata method is presented which reduces bias and variability in estimation. The paper illustrates the effect that the new methods will have on discard estimates for cod, haddock, whiting and saithe. Note that this WP was made available to the WG as background information, but was not discussed in plenary because discard estimates from the new method are not yet finalised.

WP11: RIVO. RIVO work overview.

Abstract: The working document highlights major findings of a joint evaluation of biological and commercial data as well as management measures to improve the North Sea flat fish assessments. Productivity parameters (growth rates) were estimated through length back calculation from otoliths. Reconstructed growth patterns for plaice revealed slower growth since mid 1980s, which coincided with poor recruitment. Nutrient Flows (phosphate) in the ecosystem were hypothesised to be environmental drivers of such effects. Female maturity of plaice increased over the whole time series as the proportion of females in the population increased as well. An analysis of spatial distribution of plaice at age 1 showed that juveniles tend to moved offshore after 1995. Thus, the plaice box had recently a decreased effect on the protection of juveniles. Discard reconstructions based on historic and recent samplings showed a variable but increased discard rates in the plaice fisheries, in excess of 80 % over all age groups most recently. The effort of the Dutch fleet decreased in horse power days, since 1995. The fishing effort is recently concentrating in the southern North Sea. Newly developed CPUE trends in the first and second quarters based on landings only have undergone decreases with a minimum at the end of the 1990s, followed by a reversal since 2000. CPUE at age indicate a strong recruiting 2001 year class, which is however estimated to be less abundant than the year class 1996.

WP12: O. van Keeken, M. Pastoors and A. D. Rijnsdorp. Reconstructing the numbers of plaice discarded in the demersal fisheries since 1957.

Abstract: Discard percentages at age are simulated based on mean length at age, selection and availability ogives, leading to discard estimations by means of correction of F at ages 1-6. The model considers 3 different ogives: a gear selection ogive, a availability ogive to account for differences in plaice distribution, and a sorting ogive. From this,

discard percentages at age were calculated and used to correct F at age. From these newly calculated F at age, discard-corrected stock numbers and resulting catch numbers at age were calculated. Estimates of ages 1 and 2 are strongly affected by the inclusion of discard estimates with significant implications for changes in PA management reference points. The inclusion of discards in the plaice assessment was considered necessary during the following discussion of the working group.

WP13: T. Johannessen, E. Johnsen, K. Korsbrekke and D. Skagen. Yield and sustainability in the sandeel fishery in the North Sea.

Abstract: The 2003 and 2004 landings of sandeel in the North Sea were the lowest recorded since the mid-1970s, and in the northern assessment area the fishery has practically collapsed after several years with decreasing landings. The very strong 2001 year-class gave a prediction of a spawning stock well above $\mathbf{B}_{pa}$, but the low 2003 landings indicate that the high SSB prediction was far too high. An increased targeting of 0-group sandeel, a higher general fishing mortality or a combination of these may have caused a higher proportion of 0-group sandeel in the landings in recent years. This work suggests measures should be taken to protect 0-group and to utilize the large weight and oil content increase that the sandeels undergo from early spring until June.

General measures:

- yield of sandeel may be increased by delaying the opening of the fishery until mid-April or until the Fulton condition factor exceeds 0.28.

Measures suggested for northern assessment area:

- closing the fishery from July onwards may protect 0-group as the fishery in the second half of the year is mainly targeting 0-group.

Measures suggested for southern assessment area:

- a minimum landing size of 12 cm from June onwards will protect 0-group sandeel and reduce the effort in the fishery for I-group sandeel.

Discussion: see WP14.

WP14: E. Bell. Response to sandeel request – 2005 Sandeel assessment.

No abstract is available for this WP.

Discussion: (including WDs 9 and 13) These three papers were all submitted in response to the special request on sandeels from Norway, and were therefore discussed together. Wright and Jensen (WP9) wrote about the request in general terms, and concluded that sufficient data were not available to enable the WG to provide a quantitative response. The WG agreed with this conclusion as it stood, but emphasised that there was a need to provide qualitative statements (at the very least) upon which ACFM could build useful advice to attempt to reverse the recent sandeel decline. Johanesson et al (WP13) were only able to list methods by which the points of the special request could in theory be met, without providing data or outlining appropriate data collection programmes. The WG concluded that the focus of its work needed to be on the likely effect of plausible management measures, not just the form that those measures could take. Bell (WP14) presented a hindcast sensitivity test of the in-year monitoring system developed by STECF (see BD9). Overall, the WG decided that there were probably insufficient data to provide a quantitative response to the request, but that a more qualitative response needs to be presented in order for ACFM to deliver advice for the sandeel stock. Furthermore, the poor state of the stock suggested by the current assessment implies that a recovery-plan proposal is a distinct possibility, in which case a stronger focus will fall on the assessment. Given this, the request provides a useful structure around which to plan work for next year's assessment of this stock.

1.7 Data for other Working Groups

1.7.1 WGECO

Data on species composition of bycatches in the industrial fisheries in the North Sea are given in Tables 2.1.1, 2.1.2 and 2.1.3. The allocation of roundfish bycatches (from the Danish industrial fisheries) to human consumption or reduction purposes is summarised in Tables 2.1.4 – 2.1.7. In addition, data on the age composition of commercil roundfish species from these bycatches are provided for the Danish (cod, haddock, whiting: Table 2.1.9) and Norwegian (cod, haddock, saithe, whiting: Table 2.1.10) fisheries.

1.7.2 WGMSVPA

Data for multispecies assessment were not made available to the WG. These will be collated after the meeting.

1.8 Recommendations

The WG appreciated the presentation given by Lena Larsen (ICES) on the DATRAS system and the data-collation process used the generate IBTS indices. The WG **recommends** that IBTS data be made available for review at least two months before the next WG meeting (September 2005), and that these data should be reviewed by the WG Chair and at least two other WG members. The protocol for this checking process should agreed by correspondance. Following this review and associated corrections, the finalised IBTS series should be provided to all WG members at least one month before the WG meeting.

ICES have proposed that, from 2005, assessments of *Nephrops* stocks will be undertaken in the relevant regional assessment WG. For WGNSSK, this means that six extra stocks will need to be assessed during the meeting, as well as being reviewed in plenary, and that several extra WG members will need to participate. The WG suggests that this will cause logistical difficulties that will prove insurmountable. In addition, it is not the *Nephrops* assessments themselves that are necessary to address the concerns of ICES, but just the collated data for mixed-fisheries analyses. Therefore, the WG **recommends** that WGNEPH meet annually before the WGNSSK meeting to carry out *Nephrops* stock assessments. Resultant input data for fisheries-based forecasts should then be presented to WGNSSK during a short visit by appropriate members of WGNEPH.

The WG has encountered serious problems in addressing the split between benchmark and update assessments. In order to make a benchmark assessment worthwhile, a great deal of analysis needs to be done during the meeting itself. It has proved impossible to complete much of this analysis intersessionally, due to constraints in time and data availability. As a result, the text for benchmark assessments is reviewed in haste and may not be of good quality. In addition, it is unclear what should be included in the report for an update assessment to ensure its utility for both ICES and fisheries managers. The WG also encountered difficulty in evaluating whether an assessment scheduled for an update should remain as such, or be changed to a benchmark. The WG **recommends** that ICES review the system of update and benchmark assessments. Suggestions for ways in which this could be done are given in Section 1.4.1 above.

The WG appreciated the provision of official statistics tables in Excel as well as Word format. It would be a further improvement for these updated tables to include the full time-series usually presented in the WG report, rather than just the last 10 or so years. The WG **recommends** that the official statistics tables provided by ICES be expanded to include all available years.

The Scottish North Sea acoustic survey carried out each year in August has the potential to yield important abundance indices for Norway pout (and possibly sandeel, although this is less likely to be representative). The WG **recommends** that the generation of indices for Norway pout (and sandeel) be included in the Terms of Reference for the next meeting of the Planning Group for Herring Surveys (PGHERS), scheduled for January 2005.

The WG **recommends** that ICES tasks a specific group to develop and test a software approach to compiling and aggregating landings and discards data for working groups. The obvious candidate for such a task would be the SGDFF which involves the chairs of different assessment working groups.

The WG **recommends** that a period of at least one week be allowed between the end of the meeting and the final report submission date to ICES. The current requirement that the report be available to reviewers immmediately after the meeting does not allow any time for editing and correction of errors.

The WG **recommends** that its 2005 meeting be held at ICES Headquarters, during dates set in relation to the preceding recommendation.

1.8.1. Proposed Study Group on Stock Identity and Management Units of Whiting

The assessment of the whiting stock in Sub-Area IV and Division VIId in this report is uncertain. Spatially-disaggregated research-vessel survey indices, reported landings data, and perceptions of change in abundance from the North Sea Fishers' Survey, all indicate that stock trends may be different in different areas (possibly with a north-south split). Any such structure is difficult to accommodate in the current assessment and management framework. To address this, the WG makes the following **recommendation**.

A **Study Group on Stock Identity and Management Units of Whiting** [SGSIMUW] (Chair: Phil Kunzlik, UK) should be established and meet in Aberdeen for three days in early 2005 to:

a) review all reported material on the stock identity of whiting in the North Sea and adjacent waters in order to identify the most likely definition of biological stocks of whiting as well as suggest practical management units;

b) agree a data exchange format to provide (i) survey data and (ii) commercial landings and discard data, disaggregated by ICES statistical rectangle and quarter of the year to Study Group members. This will be done to provide spatially-structured catch data to which appropriate biological characteristics are or can attributed (eg age compositions etc) in order to compile assessment datasets nominally derived from the stock definitions determined under ToR (a);

c) define an evaluation protocol under which the consequences of assessing multiple stocks or stock sub-units as a single stock can be determined, and allocate responsibilities, as required, between Study Group members;

SGIMUW will report by (Annual science conference at Aberdeen) for the attention of RMC and ACFM.

Supporting information:

Priority	High
Scientific justification and relation to Action Plan	The assessments of whiting in the North Sea, Irish Sea and West of Scotland have been problematic for many years. Available sources of information include reported landings, estimated discards, and research-vessel surveys. Stock-dynamics trends derived from these different sources are often contradictory, making coherent assessments of these stocks extremely difficult. It is possible that the use of incorrect management units is a contributing factor in this situation: it may be that each whiting management unit covers several distinct substocks, which have different and irreconcilable stock dynamics. However, little is currently known of the stock structure of whiting populations in ICES areas. The aim of the proposed SG would be to analyse extant data from commercial landings records, research-vessel surveys, tagging studies, and fishery-related information such as industry questionnaires, to determine if there is evidence for substocks, as well as to evaluate stock assessments based on any new management units suggested by the analysis. The consequences in more general terms of assessing multiple stocks would also be investigated.
Resource requirements	Coastal states must give an undertaking to provide the necessary disaggregated catch and survey data for at least the last 20 years.
Participants	Experts on stock assessment, structure and biology for the North Sea whiting stock.
Secretariat facilities	None.
Financial	None.
Linkages to Advisory Committees	ACFM
Linkages to other Committees or Groups	RMC, WGNSSK
Linkages to other Organisations	
Cost share	

Table 1.3.1. Biological sampling levels by stock and country: preliminary official landings (t) and number of fish measured and aged to analyse commercial landings in 2003.

	Cod in IIIa, IV, VIId			Whiting in IV, VIId		
	Landings (t)	Lengths (No)	Ages (No)	Landings (t)	Lengths (No)	Ages (No)
Belgium	1536	1980	0	313	0	0
Denmark	9188	3696	3674	89	0	0
France	1744	0	0	8892	0	0
Germany	2097	6026	1505	334	1811	2146
Netherlands	2367	4943	1989	1617	7098	1200
Norway	5326	3536	86	39	165	0
Poland	35	0	0	0	0	0
Sweden	1626	330	330	10	0	0
UK (E/W/NI)	2334	24487	2929	789	8180	1153
UK (Scotland)	7852	35694	9192	5734	51540	3781
Total	34105	80692	19705	17817	68794	8280

	Haddock in IIIa, IV			Saithe in IV, IIIa,VI		
	Landings (t)	Lengths (No)	Ages (No)	Landings (t)	Lengths (No)	Ages (No)
Belgium	375	0	0	44	0	0
Denmark	4776	2902	2879	6954	5547	5522
France	1100	288	645	21500	5596	1933
Germany	1675	2524	1074	9010	4900	8632
Ireland	0	0	0	170	0	0
Netherlands	193	0	0	11	0	0
Norway	2397	7618	258	61712	21415	1588
Poland	16	0	0	734	0	0
Russia	0	0	0	6	0	0
Sweden	642	943	0	1876	0	0
UK (E/W/NI)	1561	8029	1236	1478	0	0
UK (Scotland)	31527	94342	5988	7018	15168	4940
Total	44262	116646	12080	110513	52626	22615

	Sole in IV			Sole in VIId		
	Landings (t)	Lengths (No)	Ages (No)	Landings (t)	Lengths (No)	Ages (No)
Belgium	1622	3400	350	1659	5100	390
Denmark	703	235	233	0	0	0
France	264	0	0	2898	9031	1533
Germany	749	1115	92	0	0	0
Netherlands	12469	3592	3592	0	0	0
Norway	125	0	0	0	0	0
UK (E/W/NI)	521	3082	1112	1114	15534	2385
UK (Scotland)	239	0	0	0	0	0
Total	16692	11424	5379	5671	29665	4308

Table 1.3.1. cont. Biological sampling levels by stock and country: preliminary official landings (t) and number of fish measured and aged to analyse commercial landings in 2003.

	Plaice in IV			Plaice in VIId		
	Landings (t)	Lengths (No)	Ages (No)	Landings (t)	Lengths (No)	Ages (No)
Belgium	4570	5500	350	995	2000	300
Denmark	13742	2953	2894	0	0	0
France	343	0	0	2783	7789	1837
Germany	3800	5476	1100	0	0	0
Netherlands	27372	5689	5689	2	0	0
Norway	1967	1019	0	0	0	0
Sweden	2	0	0	0	0	0
UK (E/W/NI)	7135	0	0	756	15225	2007
UK (Scotland)	6757	8623	0	0	0	0
Total	65688	29260	10033	4536	25014	4144

	Plaice in IIIa			Norway Pout in IV, IIIa		
	Landings (t)	Lengths (No)	Ages (No)	Landings (t)*	Lengths (No)	Ages (No)
Denmark	6884	4180	3947	16649	843	723
Germany	14	0	0	0	0	0
Netherlands	1494	96	96	0	0	0
Norway	74	0	0	11387	2244	412
Sweden	377	427	427	0	0	0
Total	8843	4703	4470	28036	3087	1135

	Sandeel in IV		
	Landings (t)	Lengths (No)	Ages (No)
Denmark	274141	10335	2942
Norway	29616	1292	286
Sweden	21517	0	0
UK (E/W/NI)	0	0	0
UK (Scotland)	301	0	0
Total	325575	11627	3228

Table 1.3.2. Sampling levels (1996–2003) for the Scottish discard observer programme.

Year	Trips	Lengths measured					Ages estimated			
		Cod	Haddock	Whiting	Saithe	Other	Cod	Haddock	Whiting	Saithe
1996	62	5802	91385	27481	4152	45529	1510	4752	3718	813
1997	66	11542	74208	25145	6096	65177	2909	5240	3242	1495
1998	64	11639	65558	25057	4027	49615	2769	4944	3329	1125
1999	54	3635	61489	27792	1498	59552	1140	4087	3043	917
2000	53	4122	73851	29083	8544	42901	1792	4022	2639	1414
2001	77	10394	128510	19228	14486	54630	2344	5615	3222	2341
2002	63	2415	66195	22102	7444	40046	1425	3791	2697	1641
2003	48	1381	36886	15965	12642	42861	852	2723	1994	1421

Table 1.4.1. Overview of the biological basis of stock assessments carried out by the WG.

Stock	Area	Stock numbers	Mean wt catch	Mean wt stock	Natural mort.	Proportion mature	Ages
Cod	3a47d	AC from EW, SC, DK, NL. AC of discards from SC. SOP correction applied.	Based on AC. No smoothing. Calculated separately for different catch components.	Same as mean weight in the catch	**M** = (0.8, 0.35, 0.25, 0.2, …, 0.2)	**Mat** = (0.01, 0.05, 0.23, 0.62, 0.86, 1.0, …, 1.0)	1-7+
Haddock	3a4	AC from SC, EW, DK, NL. AC on ind. bycatch from DK and N. AC of discards from SC. Discard and ind. bycatch included in assessment	Based on AC. No smoothing. Calculated separately for different catch components.	Same as mean weight in the catch	**M** = (2.05, 1.65, 0.4, 0.25, 0.25, 0.2, …, 0.2)	**Mat** = (0.0, 0.01, 0.32, 0.71, 0.87, 0.95, 1.0, …, 1.0)	0–7+
Whiting	47d	AC from SC, EW, FR, NL, GER. AC on ind. bycatch from DK and N. AC of discards from SC, not applied to 7d. Discard and ind. Bycatch included in assessment	Based on AC. No smoothing. Calculated separately for different catch components.	Same as mean weight in the catch	**M** = (0.95, 0.45, 0.35, 0.3, 0.25, 0.25, 0.2, 0.2)	**Mat** = (0.11, 0.92, 1.0, …, 1.0)	1–8+
Saithe	3a46	AC from N, SC, DK, GER, FR for area IV. AC from SC for area VI. No discards included. SOP corrected.	Based on AC. No smoothing.	Same as mean weight in the catch	**M** = **0.2**	**Mat** = (0.0, 0.15, 0.70, 0.90, 1.0, …, 1.0)	1–10+
Sole	4	AC from NL, EW, FR, B. No discards included. SOP corrections applied by EW and B	Based on AC. No smoothing.	2nd quarter catch weights at age	**M** = **0.1, 0.9 in 1963**	**Mat** = (0.0, 0.0, 1.0, …, 1.0)	1–10+
Sole	7d	AC from B, FR and EW (since 1985). AC of discards from NL. No SOP correction.	Based on AC. No smoothing. Calculated separately for different catch components.	2nd quarter catch weights at age	**M** = **0.1**	**Mat** = (0.0, 0.0, 1.0, …, 1.0)	1–11+
Plaice	4	AC from NL, EW, DK, FR, B. No discards included. SOP corrections applied by EW and B	Based on AC. No smoothing.	1st quarter catch weights	**M** = **0.1**	**Mat** = (0.0, 0.5, 0.5, 1.0, …, 1.0)	1–15+
Plaice	3a	AC from DK only. No discards included. SOP corrected ??	Based on AC. No smoothing.	Same as mean weight in the catch	**M** = **0.1**	**Mat** = (0.0, 1.0, …, 1.0)	2–11+
Plaice	7d	AC from FR, B and EW. No discards included. SOP corrected ???	Based on AC. No smoothing.	1st quarter catch weight	**M** = **0.1**	**Mat** = (0.0, 0.15, 0.53, 0.96, 1.0, …, 1.0)	1–10+
Norway pout	4	AC from DK and N. No discards in the fishery.	Based on AC. No smoothing.	Fixed mean weight in the stock by quarter and age used	**M** = **0.4** per quarter	**Mat** = (0.0, 0.10, 1.0, 1.0, 1.0)	0–4+
Sandeel	4	AC from DK and N. No discards in the fishery.	Based on AC. No smoothing.	Same as mean weight in the catch	First half year: $\mathbf{M}_{1-3}$ = (1.0, 0.4, 0.4) Second half year: $\mathbf{M}_{0-3}$ = (0.0, 0.2, …, 0.2)	**Mat** = (0.0, 0.0, 1.0, …, 1.0)	0–4+

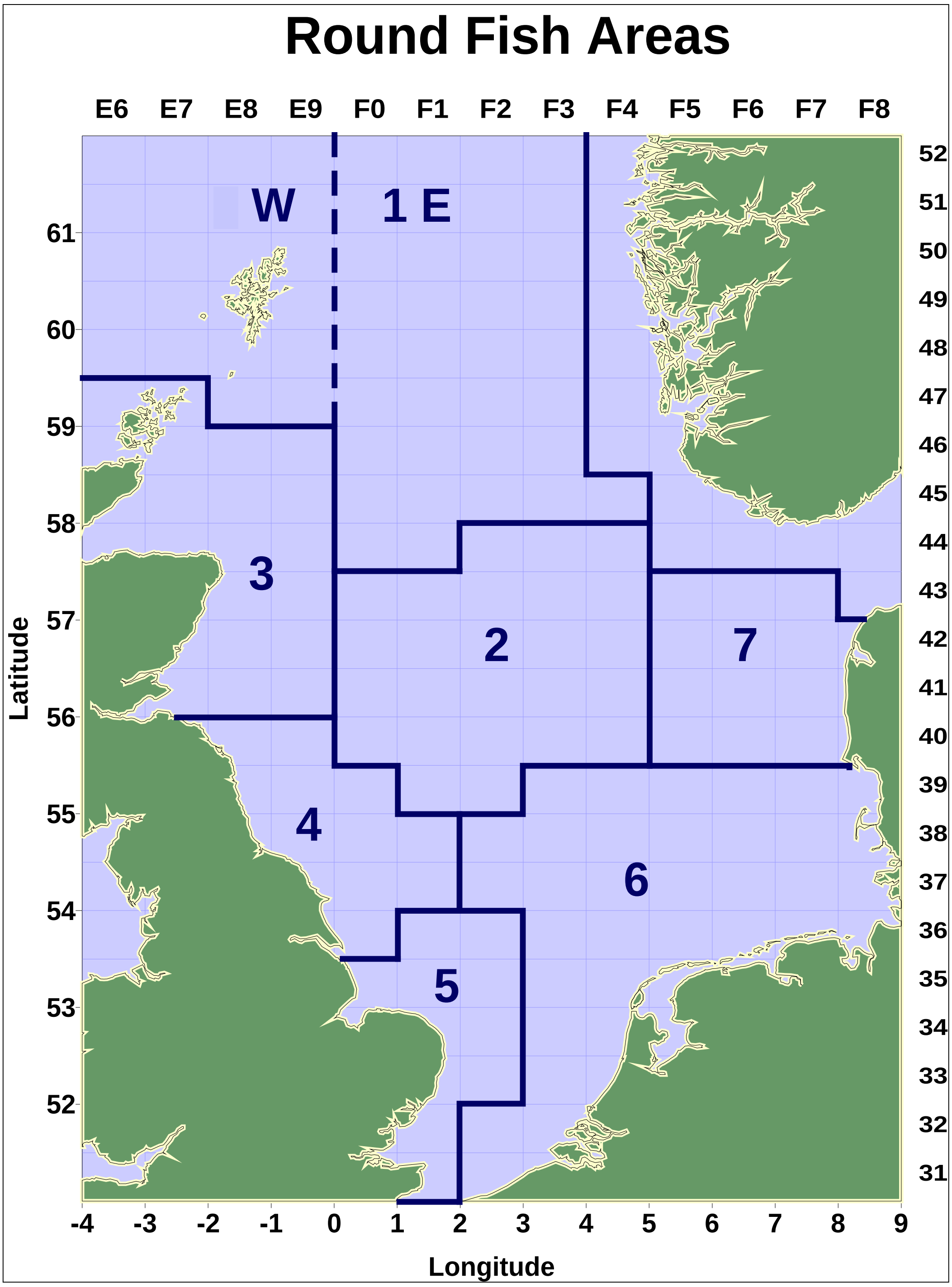
Table 1.4.2. Overview of model settings used for stock assessments by WGNSSK 2004.

Stock	Area	Assessment Method	Assessment Age Range	Assessment year range	Fbar Age Range	Time taper	Catchability dependent on stock size for ages	Catchability independent of age for ages >=	Survivor estimates shrunk towards mean F	S.E of mean F to which estimates shrunk	Min S.E. for pop. Estimates	Prior weighting	Tuning fleet type	Tuning Fleet Name	Tuning Fleet Year Range	Tuning Fleet Age Range	Tuning Fleet alpha-beta
Cod	347d	BADAPT	1-7+	1963-2003	2-4	None	None	5	None	N/a	N/a	N/a	S	ScoGFS	1982-2004	1-6	0.5-0.75
													S	EngGFS	1992-2004	1-6	0.5-0.75
													S	IBTS_Q1	1976-2004	1-5	0-0.25
Haddock	34	XSA	0-7+	1963-2003	2-4	None	0	2	5 years, 3 ages	2.0	0.3	No	S	EngGFS	1992-2004	0-5	0.5-0.75
													S	ScoGFS	1982-2004	0-5	0.5-0.75
													S	IBTS_Q1	1975-2003	0-4	0.99-1
Whiting	47d	None	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a
Saithe	346	XSA	1-10+	1967-2003	3-6	20 yr Tricubic	1-2	7	5 years, 3 ages	1.0	0.3	No	C	FraTRB	1990-2003	3-9	0-1
													C	NorTRL	1980-2003	3-9	0-1
													C	GerOTB	1995-2003	3-9	0-1
													S	NORACU	1995-2003	3-7	0.5-0.75
Sole	4	XSA	1-10+	1957-2003	2-6	None	1	7	5 years, 5 ages	2.0	0.3	No	C	NL beam	1990-2003	2-9	0-1
													S	BTS-Isis	1985-2003	1-9	0.67-0.75
													S	SNS	1970-2003	1-4	0.67-0.75
Sole	7d	XSA	1-11+	1982-2003	3-8	None	None	7	5 years, 5 ages	2.0	0.3	No	C	BEL beam	1986-2003	2-10	0-1
													C	UK beam	1986-2003	2-10	0-1
													S	UK BTS	1988-2003	1-6	0.5-0.75
													S	FR YFS	1987-2003	1-1	0.5-0.75
Plaice	4	XSA	1-10+	1957-2003	2-6	None	None	6	5 years 2 ages	0.5	0.3	No	S	BTS-Isis	1985-2003	1-9	0.66-0.75
													S	BTS-Tri	1996-2003	2-9	0.66-0.75
													S	SNS	1982-2003	1-3	0.66-0.75

Table 1.4.2. cont. Overview of model settings used for stock assessments by WGNSSK 2004.

Stock	Area	Assessment Method	Assessment Age Range	Assessment year range	Fbar Age Range	Time taper	Catchability dependent on stock size for ages	Catchability independent of age for ages >=	Survivor estimates shrunk towards mean F	S.E of mean F to which estimates shrunk	Min S.E. for pop. Estimates	Prior weighting	Tuning fleet type	Tuning Fleet Name	Tuning Fleet Year Range	Tuning Fleet Age Range	Tuning Fleet alpha-beta
Plaice	3a	XSA	2-11+	1978-2003	4-8	20-year tricubic	None	8	5 years 5 ages	0.5	0.3	No	C	DK seine	1987-2003	2-10	0-1
													C	DK trawl	1987-2003	2-10	0-1
													C	DK gillnet	1987-2003	2-10	0-1
													S	IBTS_Q1	1991-2003	1-6	0.99-1.00
													S	IBTS_Q3	1995-2003	1-6	0.83-0.92
													S	Kasu Q1	1995-2003	1-6	0.99-1.00
													S	Kasu Q4	1994-2003	1-6	0.83-0.92
Plaice	7d	XSA	1-10+	1980-2003	2-6	None	None	7	5 years 3 ages	0.5	0.3	No	C	UK Insh.	1988-2003	2-9	0–1
													C	BEL beam	1988-2003	2-9	0–1
													C	FRA TRL	1989-2003	2-9	0–1
													S	UK BTS	1988-2003	1-6	0.5–0.75
													S	YFS	1988-2003	1	0.5-0.75
													S	FRA GFS	1988-2003	1-5	0.75–1
N. pout	4	SXSA	0-4+	1983-2004	1-2	None	N/a	N/a	N/a	N/a	N/a	N/a	C	Comm	1982-2004	1-3	Q1
													C	Comm	1982-2003	1-3	Q3
													C	Comm	1982-2003	0-3	Q4
													S	IBTS Q1	1982-2004	1-3	Q1
													S	EngGFS	1992-2004	0-1	Q2
													S	ScoGFS	1998-2004	0-1	Q2
													S	IBTS Q3	1991-2003	2-3	Q3
Sandeel 1	4	SXSA	0-4+	1983-2004	1-2	None	N/a	N/a	N/a	N/a	N/a	N/a	C	North 1	1983-2004	1-3	0.25-0.5
													C	North 2	1983-2004	1-3	0.5-0.75
													C	South 1	1983-2004	0-3	0.25-0.5
													C	South 2	1983-2004	0-3	0.5-0.75
Sandeel 2	4	XSA	0-4+	1983-2003	1-2	None	None	2	5 year 2 ages	1.5	0.3	No	C	North 1	1983-2004	1-3	0.25-0.5
													C	North 2	1983-2004	1-3	0.5-0.75
													C	South 1	1983-2004	0-3	0.25-0.5
													C	South 2	1983-2004	0-3	0.5-0.75

Figure 1.3.1. Roundfish sampling areas for the IBTS Q1 and Q3 research-vessel survey indices.



2 OVERVIEW

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

2.1.1 Description of the fisheries

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. 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 consumption and reduction by the Danish small-mash fleet are given for 1993-2003 in Tables 2.1.3 and 2.1.4 respectively. Similar data by quarter for 2003 are shown in Tables 2.1.5 and 2.1.6. Sampling intensity of the Danish industrial by-catch is given in Table 2.1.7.

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

Effort

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 below. 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 commensurate with effort. Recent trends in reported effort in UK fisheries are described in WP1 (see Section 1.6.1), which show significant declines. Total effort data by country were made available to the WG for the UK and the Netherlands, while combined Danish-Norwegian effort data were made available for the sandeel and Norway pout fisheries. These are summarised in Table 2.1.11 and Figure 2.1.1 which show considerable declines in effort. Trends in commerical effort and CPUE on each stock is reported in the relevant stock sections.

2.1.1.1.1.1 Landings

The trends in the landings (WG estimates) since 1970 of the species assessed by the WG are shown in Table 2.1.1 and in Figure 2.1.2. The 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 are fluctuating around 1 million t over the years. These landings 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.

The landings by country and fleet segment for the human consumption fisheries are presented in Section 15 of this report (Table 15.2.1.1 and Figure 15.2.1.2). Most of the human consumption landings are from the Dutch beam-trawl fishery harvesting plaice and sole (> 0000 t) and from the Scottish fishery harvesting cod, haddock and whiting (> 100000 t). This Figure shows clearly the great level of technical interactions between the cod, haddock and whiting fisheries and between the sole and plaice fisheries. The flatfish and roundfish landings are generally taking 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 low impact on the others. However, the fisheries non-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.

2.1.1.1.1.2 Assessment areas

For some stocks, the North Sea assessment area may also comprises other regions adjacent to 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. Sandeel stocks at Shetlands and in IIIa are separately dealt with.

2.1.1.1.1.3 Biological interactions

Biological interactions are not 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.

2.1.1. Technical measures

The national management measures with regard to the implementation of the 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). TACs for these fisheries have only recently been introduced.

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) 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).

2.1.1.1. 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

2.1.1.2. 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.

2.1.1.1.1.4 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 70-109 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, and with a codend if a mesh size of 70-79 mm is to be used.

- **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 exeption 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 consumtion) 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.

2.1.1.3. Closed areas

Twelve-mile zones

Twelve miles 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 another 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 until 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 is aimed to enhance the TAC uptake of haddock in the North Sea while preventing cod by-catches. It regulates fishing of haddock of licensed vessels for a maximum of 3 months under the condition not to fish inside or transit the cod protection area, that cod does not contribute more than 5 % to the total catch retained on board, not to tranship any fish at sea, not to carry on board or deploy trawl gear of less than 100 mm mesh size and to comply with a number of special landing regulations.

2.1.1.1.2 Fishing effort limitation

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

2.1.2. Human consumption fisheries

Data

2.1.1.1.2.1 The volume of biological sampling in 2003 for most of the stocks assessed by this WG is close to that for previous years (Table 1.3.1).

Estimates of discarding rates from the Scottish observer sampling programme were used in the assessments of cod, haddock and whiting in the North Sea, after raising to the level of the international catch. A combination of observed (from the Dutch sampling programme) 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. In general, considerable 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 used a new assessment method for North Sea cod (Section 3 and Appendix 4) which estimates under-reporting on the basis of research-vessel survey data.

Several research-vessel survey indices are available for most species, and were used both to tune 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 historically significant for haddock, whiting and saithe, but these have reduced considerably in recent years.

2.1.1.1.2.2 Stock impressions

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. The trends in landings, spawning-stock biomass (SSB), mean fishing mortality (*F*) and recruitment from the assessments are presented in Figures 2.1.3-2.1.6. Note that the WG were unable to propose a final assessment for North Sea whiting this year (see Section 5).

WG estimates of total catches (reported landings + discards + estimated under-reported landings) for **cod** in 2003 (78,000 t) are the second-lowest in the historical record. The inclusion of estimated under-reported catch and discards in the assessment this year increased the estimates of SSB during 1993–1997, but not in more recent years in which SSB is still very low and well below the current B_{lim} (70,000 tonnes). Fishing mortality has increased slightly after falling for several years, although the absolute level of *F* in 2003 is uncertain. Recruitment has remained at a low level after the strong 1996 year-class.

The strong 1999 year-class again dominated the catches of **haddock** in 2003 (69,000 t). However, the contribution of this year-class to the fishery appears to be drawing to a close. Recruitment following the 1999 year-class has been low, and SSB is likely to decline in the short-term. All sources of information agree that fishing mortality has declined rapidly in this fishery to an historical minimum.

Catches of **whiting** (43,000 t) have continued to decline in 2003 to the lowest observed level. However, two of the three available survey indices covering the North Sea area indicate that stock abundance is at or near a historic maximum. There are also considerable within-series discrepancies in apparent stock trends between different sub-units of the assessed area. These conflicting signals on population trends have prevented the WG from being able to propose a final assessment. The problem requires a fundemental review of all available data for which the WG had neither the time nor the resources, but which the WG proposes be taken up by a dedicated Study Group (see Section 1.8).

While still above B_{pa} and apparently increasing, the estimated SSB for **saithe** has been revised downwards from last year's assessment. Fishing mortality is at or near the historic low, and recruitment remains near the long-term mean. Considerable annual revisions of the saithe assessment are a direct consequence of the lack of survey or fishery information for younger age-groups. Reported landings for 2003 (107,000 t) were near to the recent mean.

Landings of **sole** in 2003 (18,000 t) were at a similar level as seen for 2001 and 2002. SSB has fluctuated around a moderate level for several years and for 2003 was estimated to be just below B_{pa}. F is still estimated to be above F_{pa}, but has declined fairly steadily since the historical maximum in 1996. After the strong 2001 year-class, recruitment has fallen back down to near the mean of the full time-series.

The assessment for **plaice** included discards for the first time this year. Although reported landings for 2003 are at the lowest observed level (66,000 t), estimated total catches (141,000 t) are the highest since 1998. SSB is estimated to be stable, but very low and well below B_{pa}. Fishing mortality is fluctuating around a very high level. The 2001 year-class is estimated to have been the strongest seen since the mid-1980s, but subsequent year-classes are thought to be weak.

2.1.3. Industrial fisheries

2.1.4.1. Description of fisheries

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

2.1.4.2. Data available

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

2.1.4.3. Trends in landings and effort

Sandeel landings in 1974–1985 fluctuated between 428,000 and 787,000 tonnes with a mean of 611,000 tonnes. In the period 1986–2000 the landings increased to a generally higher level between 591,000 and 1,091,000 tonnes and a mean of 819,000 tonnes. 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 804,000 tonnes (Table 2.1.2) which is just above the average of 779,000 tonnes for the period 1980-2002. The landings in 2003 of about 326,000 tonnes were very low, and current indications of the total landings in 2004 are at about the same low level.

Norway pout landings showed a downward trend in the period 1974–1988. Thereafter the landings have fluctuated around a level of 150,000 tonnes. The respective landings in 1998 and 1999 were 80,000 and 92,000 tonnes, which were the lowest landings since 1974. In 2000 Norway pout landings increased to around 184,000 tonnes based on a fishery on the strong 1999 year class. Landings in 2001 and 2002 were around 66,000 and 77,000 tonnes, respectively. These were the lowest landings recorded since 1967 and well below average for the previous five years. The 2003 landings decreased further: in this year only about 25,000 tonnes were landed.

Trends in effort of the Norwegian and Danish small-meshed fisheries for Norway pout and sandeel are shown in Figure 2.1.1. The effort of the sandeel fleet decreased gradually from 1989 to 1994, increased a little from 1994 to 1998, before decreasing from 1998 to 2002. The 2003 effort was a little higher than the effort in 2002. The Danish fishery targeting sandeel mainly determines the total effort of the sandeel fleet.

The effort in the Norway pout fleet decreased gradually from 1993 to 2003, when reported effort reached a historic low (Figure 2.1.1). The effort in 2002 nearly doubled from the 2001 effort being at the same level as in the eight years before 2001. But the 2003 effort decreased considerably and was even below the very low effort in 2001.

2.1.4.4. Landings of Blue Whiting

The following text relates to the 2003 assessment of blue whiting. At the time of writing there was no updated information on blue whiting for 2004.

ACFM states, that the linkage between blue whiting and e.g. Norway pout fisheries should be addressed. Blue whiting is caught by different gears and mesh sizes and can be grouped in two types of fisheries. The first is a directed fishery where by-catches of other species are insignificant. These landings are used for human consumption or for meal and oil production. Secondly there is mixed industrial fishery where varying proportions of juvenile blue whiting are caught together with Norway pout or other species. The majority of these landings are for meal and oil production.

In 2001 ACFM stated that the Blue Whiting stock is considered to be outside safe biological limits. Total catches in 2002 were estimated to be 1 554 995 t compared to 1 780 170 t in 2001.

The Danish blue whiting fishery is conducted by trawlers using a minimum mesh size of 40 mm in the directed fishery and in the fisheries where blue whiting was taken as by-catch, trawls with mesh sizes between 16 and 36 mm were used. The directed fishery in 2002 caught 39 100 t mainly in Divisions IIa (13 600 t), IVa (20 900 t) with small catches from Divisions IIIa, Vb, VIa and VIIb. By-catches of blue whiting (12 100 t) were caught mainly in the Norway pout fishery in the North Sea and in the Skagerrak. Some blue whiting by-catches were also taken during the human consumption herring fishery in the Skagerrak.

Norway set a blue whiting quota of 250 000 tonnes for the Norwegian EEZ, Jan Mayen zone and international waters for 2002. In addition, through international agreements, 120 000 t in the EEZ of EU and 35 000 tonnes in the Faroese zone were made available to the Norwegian fishery. The mixed industrial fishery in the North Sea/southern Norwegian Sea was allowed to take 79 396 tonnes. The total quota for Norwegian vessels in 2002 was 484 396 tonnes. The main Norwegian fishery is a directed pelagic trawl fishery, regulated by vessel quotas, and is carried out on and west of the spawning areas west of the British Isles. The Norwegian fishery in 2002 started at the beginning of February and stopped on 5 May when the quota in the EU zone was taken.

In addition young blue whiting are fished by Norway in the North Sea and in the southern Norwegian Sea (areas south of 64ºN) in the mixed industrial fishery targeting blue whiting and Norway pout. An estimated catch of approximately 98 000 tonnes was taken in this fishery in 2002 in this fishery.

2.1.4.5. Stock impressions

Trends in yield, mean *F*, SSB and recruitment for sandeel and Norway pout are given in Figures 2.1.4–2.1.7.

The SSB of **Norway pout** showed an increasing trend in the period 1974–1984. Over the next two years SSB dropped to a low level which was followed by an increase. SSB peaked in 1996 due to the big 1994 year-class but decreased again in the period up to 1999. SSB in 2001 increased to 238,000 tonnes to reach a similar level as in 1996, due to the strong 1999 year class. The SSB decreased to 164,000 tonnes in 2002 and decreased further to 120,000 tonnes in 2003, and estimated to be about 90,000 tonnes (near B_{lim}) in the 1st quarter of 2004. Fishing mortality has generally been lower than the natural mortality for this stock and has generally decreased in recent years well below the long term average *F* (0.7). Fishing mortality was historically low in 2003 and in the two first quarters of the year in 2004. Fishing effort has in general decreased in recent years reaching a historically minimum in 2001 and in 2003 and in the first part of the year 2004, but increased in 2002 to the level of that in 1999-2000.

Over the years, SSB of **sandeel** has been fluctuating around 1 million tonnes with an increasing trend from 1989 to 1995 and a decreasing trend from 1998 to 2002. Until 2003 the sandeel stock was considered to be within safe biological limits, and the stock was thought to be able to sustain the exisiting fishing mortality. However, in the 2003 ICES assessment SSB was estimated to be below B_{lim} in 2003, and ICES reported that the state of the North Sea sandeel stock is uncertain. The sandeel stock shows large fluctuations over time, mainly due to large variations in the recruitment pattern, and the scarcity of the 2002 year-class means that the strength of the 2003 year-class was particularly important to the state of the stock in 2004. The present assessment estimates the 2003 year-class to be below the average recruitment.

2.2. Overview of the stocks in the Skagerrak and Kattegat (Division IIIa)

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 the fisheries for industrial species and herring, which are landed for reduction purposes.

The roundfish, flatfish, and *Nephrops* stocks are mainly exploited 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. Effort measures available from the major Danish fleets (Figure 2.2.1) fishing plaice and cod have been stable for nearly a decade. These fleets do not comprise the entire fishery, but are however considered representative for 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 is given in Table 2.2.1.

There are important technical interactions between the fleets. This issue has been discussed by the WG since its 2003 meeting. Last year the analysis was restricted to the North Sea, but in 2004 data were also available for the Skagerrak Danish, Norwegian, Swedish and German fisheries. The methodology used is presented in Section 14. 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 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 hydrology, 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.

Several of the stocks in the Skagerrak may not be separate stocks but are assumed to intermingle with the stocks in the North Sea. This is the case for cod, haddock, whiting, and Norway pout. Plaice in IIIa in considered as being a mix of several sub-populations, which would intermingle both with the North Sea and the Baltic Sea.

The official landings of **cod** in Division IIIa were 6.7 thousand tonnes in 2003 in the human consumption fishery, which is a historic low and 30% less than last year. 70 % was taken in Skagerrak, and the majority of catches were taken by Denmark and Sweden. 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. ICES has since 2002 advised that no fishery should take place on this stock. 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}. ICES considers the agreement to be inconsistent with the precautionary approach.

By-catches of cod in the Danish small-meshed fishery have been decreasing steadily in the latest decade (Table 2.2.2.).

Landings of **haddock** in Division IIIa, in the human consumption fishery, amounted to 2.2 thousand tonnes. 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. By-catches of haddock in the Danish small-meshed fishery have been decreasing steadily in the latest decade (Table 2.2.2.).

Landings of **whiting** (for human consumption) were 186 tonnes in 2002. Most of the landings are taken in Skagerrak. No analytical assessment of whiting in IIIa was possible. By-catches of whiting in the Danish small-meshed fishery have been slightly increasing in the recent 6 years (Table 2.2.2.).

Landings of **saithe** in Divisions IV and IIIa were about 105 thousand tonnes in 2003, which is close to the landings last year. The saithe assessment comprises Divisions IV, IIIa, and VI. Almost no by-catches of saithe have occured in the Danish small-meshed fishery since 1999 (Table 2.2.2.).

The **plaice** landings in Division IIIa amounted to 8.9 thousand tonnes in 2003, which is close to the 2002 landings. Historically, TAC has not been restrictive for this stock. About 75% of the landings were taken in Skagerrak. Plaice in IIIa is assessed as a separate stock. By-catches of plaice in the Danish small-meshed fishery have been decreasing steadily in the latest decade (Table 2.2.2.).

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 2003 amounted 300 tonnes, and 75% was taken in the Kattegat. Further information may be found in the report of this Working Group.

The **Norway lobster** stock in Division IIIa is assessed by the *Nephrops* Assessment Working Group. Landings data may be found in the report of this Working Group.

Most of the landings from the **industrial** fisheries in 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 1999-2002. All other years refer to data provided by Denmark only. The Norway pout assessment comprises Divisions IIIa and IV. Sandeel in Division IIIa was not possible to assess.

Table 2.2.1 Catches of the most important species in the industrial fisheres in Division IIIa (' 000 t), 1989-2002.

Year	Sandeel	Sprat[1]	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	49	26	32	3	12	122
Mean 1989-2002	33	18	33	21	12	117

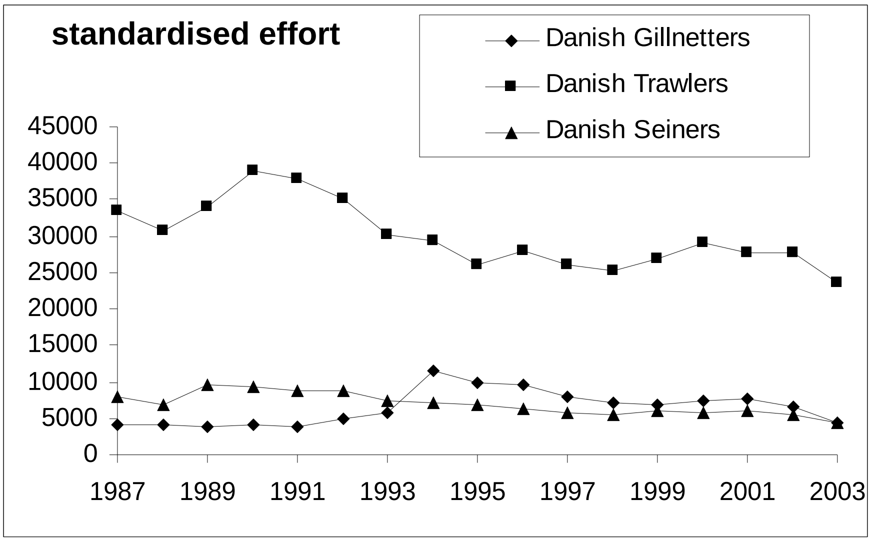
* 1999-2001 data provided from Denmark and Sweden. Other years, only data from Denmark is presented

[1] Data provided by Working Group members

Table 2.2.2 By catches of the most important consumption species in the Danish small meshed fisheries in Division IIIa (t), 1989´-2003

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
Mean 1989-2003	1965	191	56	4	166

Figure 2.2.1. Standardised effort in the Danish demersal mixed fisheries for plaice in Division IIIa.



2.3. Overview of stocks in the Eastern Channel (Division VIId)

2.3.1. Description of the fisheries

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. The contribution of Dutch beam-trawlers to the flatfish fishery in Division VIId has increased in recent years as a result of the application of more restrictive management measures in Sub-Area IV. These vessels switch effort to other areas and onto scallops leading to periodic large changes in effort in Division VIId.

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 who 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 increased consistently since the mid-1970s. The fishing effort of both English beam trawlers and netters has increased between 1980s and 1990s, but has shown a decline in recent years (Figure 2.3.1). 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 only available since 2001, and it has not been presented here.

2.3.2. 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 effort of the UK fleet 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 (CGFS) provides tuning indices for cod, whiting and plaice. A research vessel survey using beam trawl which covers most of VIId in August (BTS) is used in tuning 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.

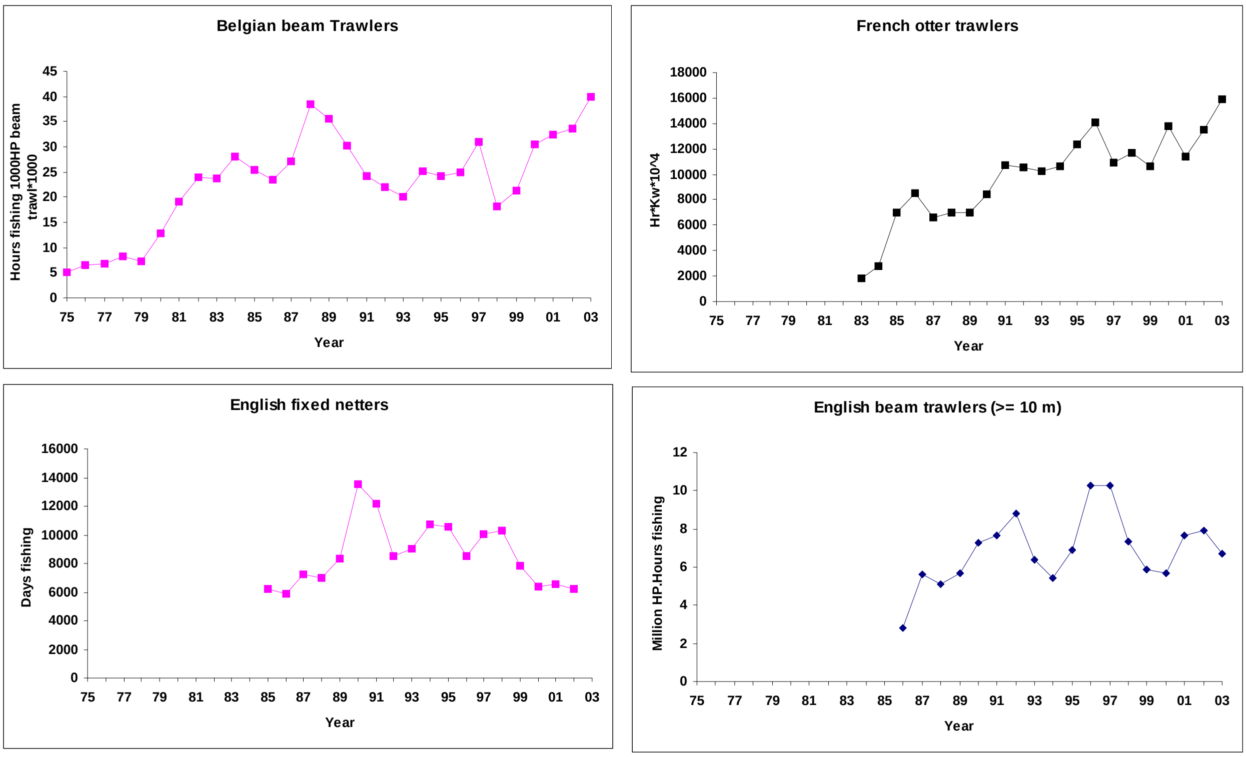
2.3.3. State of the stocks

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).

Sole: The stock is considered to be within safe biological limits. The fishing mortality is estimated to be below F_{pa} The SSB is above B_{pa} (8000t) following improved recruitment in recent years particularly of the year classes 1998 to 2000. There is a tendency to underestimate F and overestimate SSB.

Plaice: The stock follows the pattern of a general decline in plaice stocks observed in other areas up to 1997. Since then SSB appears to have oscillated between B_{lim} and B_{pa}. F has decreased since 1998, and it is currently between F_{lim} and F_{pa}. Recruitment is close to mean levels after the confirmed strong 2000 year class. The state of the plaice stock in VIId is highly dependent on the quality of the recruitment.

Figure 2.3.1. Reported fishing effort of demersal fleets in Division VIId.



2.4. Overview of 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 indicates that in excess of 97% of the catch consisted of *Ammodytes marinus*, with the by-catch consisting mostly of other species of sandeel. Landings from both fisheries are small compared to the fisheries in the North Sea. Landings of sandeel from VIa were very low in 2003, reflecting the continued reduced effort in the fishery.

Table 2.1.1 Working Group estimates of landings ('000 t) from the management areas of species assessed by WGNSSK.
hc = landings for human consumption; ib = by-catch of human consumption species landed from the small mesh fisheries and sent for reduction.
ic = landings from the small mesh fisheries sent for reduction

	cod		haddock		whiting		saithe	sole (1)	plaice (2)	Norway pout	sandeel	h cons	industrial
Year	hc	ib	hc	ib	hc	ib	hc	hc	hc	ic	ic	total	total
1970	226	n/a	525	180	83	115	237	20	130	238	191	1221	724
1971	328	n/a	235	32	61	72	272	24	114	305	382	1034	791
1972	354	n/a	193	30	64	61	275	21	123	445	359	1030	895
1973	239	n/a	179	11	71	90	260	19	130	346	297	898	744
1974	214	n/a	150	48	81	130	309	18	113	736	524	885	1438
1975	205	n/a	147	41	84	86	309	21	109	560	428	874	1115
1976	234	n/a	166	48	83	150	362	17	114	437	488	976	1123
1977	209	n/a	137	35	78	106	223	18	119	390	786	785	1317
1978	297	n/a	86	11	97	55	166	20	141	270	787	807	1123
1979	270	n/a	83	16	107	59	136	23	167	329	578	786	982
1980	294	n/a	99	22	101	46	142	16	159	483	729	811	1280
1981	335	n/a	130	17	90	67	146	15	157	239	569	874	892
1982	303	n/a	166	19	81	33	190	25	170	395	611	935	1058
1983	259	n/a	159	13	88	24	198	28	160	451	537	892	1025
1984	228	n/a	128	10	86	19	220	30	173	393	669	865	1091
1985	215	n/a	159	6	62	15	226	28	179	205	622	870	848
1986	204	n/a	166	3	64	18	203	22	186	178	848	845	1047
1987	216	n/a	108	4	68	16	181	22	178	149	825	773	994
1988	184	n/a	105	4	56	49	141	25	178	110	893	689	1056
1989	140	n/a	76	2	45	36	118	26	186	168	1039	591	1245
1990	125	n/a	51	3	47	50	108	39	177	152	591	547	796
1991	102	n/a	45	5	53	38	116	38	165	193	843	518	1079
1992	114	n/a	70	11	52	27	104	33	143	300	855	517	1193
1993	122	0.66	80	11	53	20	119	36	134	184	579	544	795
1994	111	0.78	80	5	49	10	115	37	128	182	786	520	984
1995	136	0.96	75	8	46	27	125	35	114	241	918	531	1195
1996	126	0.34	76	5	41	5	120	27	98	166	777	488	953
1997	124	0.79	79	7	36	7	113	20	100	170	1137	471	1322
1998	146	0.40	77	5	28	3	109	24	86	80	1004	470	1092
1999	96	0.10	66	4	30	5	115	28	96	92	735	430	836
2000	71	0.06	47	9	28	8	94	26	96	184	699	362	900
2001	50	0.10	41	8	25	7	96	24	99	66	862	335	943
2002	54	0.03	58	4	22	8	122	22	85	77	811	362	899
2003	31	n/a	44	1	16	3	107	23	80	25	325	301	354

(1) 1970-1980: IV only. 1980-2003: IV and VIId. (2) 1970-1978: IV only. 1978-1979: IV and IIIa. 1980-2003: IV, IIIa and VIId.

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
Avg 74-03	718	200	61	238	63	13	38	9	33	1359

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

0 denotes < 500 tonnes

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

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

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

[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 1993–2003 from small-meshed fisheries in the North Sea. Landings (tonnes) used for human consumption purposes. Note: these landings have been counted against the Danish human consumption quotas and have been included in the estimated catch in numbers reported to ICES.

Cod	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Sandeel fishery	89	80	167	208	223	134	16	5	7	11	3
Sprat fishery	124	172	222	87	12	15	6	4	7	3	+
Norway pout fishery	435	413	537	419	497	216	89	147	77	40	1
Blue whiting fishery	4	+	0	77	38	94	92	39	31	37	10
"Others" fishery	34	17	38	25	41	69	24	10	3	13	5
Total	686	682	964	816	811	528	227	205	125	104	19

Haddock	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Sandeel fishery	86	16	19	51	32	5	4	1	3	11	4
Sprat fishery	20	26	62	2	2	4	2	+	5	1	+
Norway pout fishery	547	567	280	128	175	53	84	63	20	15	2
Blue whiting fishery	3	+	0	16	8	23	24	8	8	15	9
"Others" fishery	70	15	19	8	9	8	10	3	3	17	2
Total	726	624	380	205	226	93	124	75	39	59	17

Whiting	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Sandeel fishery	19	3	3	+	+	+	+	+	+	+	0
Sprat fishery	10	4	3	2	+	+	+	+	+	+	0
Norway pout fishery	932	307	201	92	33	11	9	19	9	9	2
Blue whiting fishery	6	+	0	9	3	4	1	1	2	2	1
"Others" fishery	60	5	2	4	2	1	1	+	+	+	+
Total	1,027	319	209	107	38	16	11	20	11	11	3

Saithe	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Sandeel fishery	52	52	111	88	73	23	44	6	5	5	3
Sprat fishery	37	48	123	9	1	3	6	1	13	13	0
Norway pout fishery	589	514	1,057	359	599	264	205	267	245	245	27
Blue whiting fishery	2	4	0	155	167	356	476	214	186	186	143
"Others" fishery	21	43	73	43	117	137	108	21	11	11	46
Total	701	661	1,364	654	957	783	839	509	460	460	219

Table 2.1.5. Danish by-catch landings of cod, haddock and saithe in 1993–2003 from small-meshed fisheries in the North Sea. Landings (tonnes) used for reduction purposes.

Cod	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Sandeel fishery	185	70	79	288	375	202	51	56	7	12	5
Sprat fishery	116	493	174	23	40	11	7	4	4	0	11
Norway pout fishery	232	201	680	4	242	161	11	0	81	3	3
Blue whiting fishery	0	0		24	37	20	28	0	0	14	0
"Others" fishery	126	14	23	2	94	6	4	1	4	1	2
Total	659	778	956	341	789	400	101	61	97	30	21

Haddock	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Sandeel fishery	2,879	528	534	1,600	524	202	364	1,226	1,557	220	103
Sprat fishery	113	685	1,097	18	11	6	62	66	223	27	15
Norway pout fishery	3,028	1,399	4,766	1,774	1,454	251	318	1,734	1,252	1,545	16
Blue whiting fishery	0	10		153	205	66	195	258	218	133	59
"Others" fishery	1,193	71	349	77	137	218	117	40	42	183	96
Total	7,214	2,693	6,745	3,622	2,331	744	1,055	3,324	3,292	2,108	289

Whiting	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Sandeel fishery	4,493	1,392	3,322	1,909	2,143	902	2,121	1,539	2,761	1,397	444
Sprat fishery	4,122	4,352	10,386	784	107	673	1,088	2,107	1,700	2,238	1,105
Norway pout fishery	7,071	3,121	7,291	1,373	2,235	178	331	2,935	1,559	1,675	265
Blue whiting fishery	0	0		126	113	83	169	71	217	123	30
"Others" fishery	2,448	187	4,422	22	173	112	116	89	184	127	63
Total	18,134	9,053	25,422	4,214	4,771	1,948	3,825	6,740	6,420	5,560	1,907

Saithe	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Sandeel fishery	21	0	0	40	0		28		1	0	30
Sprat fishery	0	11	297	0	0				3	0	0
Norway pout fishery	9	135	490	84	209			116	22	246	0
Blue whiting fishery	0	0		20	80	11	8	2	84	72	17
"Others" fishery	41	0	542	0	40	1	4	2	7	109	69
Total	71	146	1,329	144	329	12	40	120	117	427	116

All species	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Sandeel fishery	482,832	611,554	644,473	622,211	761,963	624,925	514,047	551,008	637,518	628,205	274,854
Sprat fishery	246,980	314,970	344,309	107,243	103,523	145,978	171,757	208,641	170,862	167,472	194,210
Norway pout fishery	115,595	111,208	140,550	76,390	104,499	33,515	29,361	135,196	47,788	54,980	9,020
Blue whiting fishery	1,615	419		34,857	13,181	46,052	51,060	34,129	26,038	27,052	21,320
"Others" fishery	40,283	19,480	48,936	8,882	14,554	17,893	26,945	7,433	10,554	8,503	6,184
Total	887,304	1,057,632	1,178,268	849,584	997,719	868,363	793,169	936,408	892,760	886,212	505,588

Table 2.1.6. Quarterly Danish by-catch landings of cod, haddock and saithe in 2003 from small-meshed fisheries in the North Sea. Landings (tonnes) used for human consumption purposes. Note: these landings have been counted against the Danish human consumption quotas and have been included in the estimated catch in numbers reported to ICES.

Cod	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total**
Sandeel fishery		0.6	1.9		2.5
Sprat fishery			0.1		0.1
Norway pout fishery			0.5	0.8	1.3
Blue whiting fishery	7.3	0.7	1.7		9.7
"Others" fishery	5.3				5.3
Total	12.6	1.3	4.2	0.8	18.9

Haddock	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total**
Sandeel fishery		2.7	0.8		3.5
Sprat fishery					0.0
Norway pout fishery			0.1	1.8	1.9
Blue whiting fishery	5.2	1.6	2.3		9.1
"Others" fishery	1.7				1.7
Total	6.9	4.3	3.2	1.8	16.2

Whiting	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total**
Sandeel fishery					0.0
Sprat fishery					0.0
Norway pout fishery			0.3	2.0	2.3
Blue whiting fishery	0.6	0.1	0.1		0.8
"Others" fishery	0.2				0.2
Total	0.8	0.1	0.4	2.0	3.3

Saithe	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total**
Sandeel fishery	0.6	0.1	2.0		2.7
Sprat fishery					0.0
Norway pout fishery		0.4	4.0	22.8	27.2
Blue whiting fishery	95.2	12.2	35.8		143.2
"Others" fishery	45.7				45.7
Total	141.5	12.7	41.8	22.8	218.8

All other human consumtion species	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total**
Sandeel fishery	0.3	2.0	1.8	0.2	4.3
Sprat fishery			1.2	1.0	2.2
Norway pout fishery		0.6	2.2	6.2	9.0
Blue whiting fishery	52.9	15.0	21.4		89.3
"Others" fishery	19.5		0.1		19.6
Total	72.7	17.6	26.7	7.4	124.4

Table 2.1.7. Quarterly Danish by-catch landings of cod, haddock and saithe in 2003 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	4		5
Sprat fishery			11		11
Norway pout fishery				3	3
Blue whiting fishery					0
"Others" fishery	2				2
Total	2	1	15	3	21

Haddock	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery	22	45	35	1	103
Sprat fishery			15		15
Norway pout fishery				16	16
Blue whiting fishery	56	3			59
"Others" fishery	96				96
Total	174	48	50	17	289

Whiting	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		380	56	8	444
Sprat fishery	2		798	305	1,105
Norway pout fishery			51	214	265
Blue whiting fishery	2	26	2		30
"Others" fishery	56		7		63
Total	60	406	914	527	1,907

Saithe	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery			30		30
Sprat fishery					0
Norway pout fishery					0
Blue whiting fishery	17				17
"Others" fishery	69				69
Total	86	0	30	0	116

All species	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery	2,834	221,895	46,155	3,970	274,854
Sprat fishery	17,982		64,129	112,099	194,210
Norway pout fishery		66	2,025	6,929	9,020
Blue whiting fishery	6,877	7,847	6,596		21,320
"Others" fishery	5,153		1,031		6,184
Total	32,846	229,808	119,936	122,998	505,588

Table 2.1.8. Numbers of fish aged and measured from the Danish industrial by-catch sent for reduction from 1998–2003.

	Cod		Haddock		Whiting
Quarter	N measured	N aged	N measured	N aged	
					Not specified
1	0	0	2	2	
2	3	3	214	4	
3	136	102	33	31	
4	36	23	2	1	
Total	175	128	251	38	

Table 2.1.9. Numbers and mean weight at age of commercial roundfishes from the Danish small-meshed fishery sent for reduction, 2003

Cod

Not specified

Haddock

	Quarter 1		Quarter 2		Quarter 3		Quarter 4		N Total	SoP Total
Age	Number ('000)	Weight (g)	Number ('000)	Weight (g)	Number ('000)	Weight (g)	Number ('000)	Weight (g)		
0	0	0	0	0	3390	11	760	15	4150	48.69
1	4780	22	430	43	170	53	160	29	5540	137.3
2	1480	44	410	50	20	120	5	67	1915	88.355
3	50	158	80	68	4	109	3	171	137	14.289
Total	6310		920		3584		928		11742	
SoP (t)		178.18		44.43		49.136		16.888		288.634

Whiting

	Quarter 1		Quarter 2		Quarter 3		Quarter 4		N Total	SoP Total
Age	Number ('000)	Weight (g)	Number ('000)	Weight (g)	Number ('000)	Weight (g)	Number ('000)	Weight (g)		
0	0	0	0	0	53560	9	3580	21	57140	557.22
1	110	65	5870	27	8790	33	2570	61	17340	612.48
2	130	151	2810	68	630	116	810	180	4380	429.59
3	90	251	510	111	190	194	460	196	1250	206.22
4	50	204	0	0	60	304	180	270	290	77.04
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	20	380	20	7.6
Total	330		9190		63170		7420		80110	
SoP (t)		49.37		406.18		882.05		467.91		1805.51

Table 2.1.10. Numbers ('000) and mean weight (g) at age of commercial roundfish species in 2003 in the bycatch of the Norwegian industrial fishery.

Saithe	2003									
	1. Quarter		2. Quarter		3. Quarter		4. Quarter		Year	
AGE	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	2.0	452.0	5.7	452.0	0.0	0.0	13.2	452.0	20.9	1355.9
3	24.3	551.3	68.3	547.1	847.6	697.7	844.8	628.8	1785.1	2424.8
4	304.3	611.7	295.5	721.0	2301.9	806.0	1494.2	731.1	4395.9	2869.9
5	548.3	758.1	658.1	766.6	1730.0	894.1	788.9	836.1	3725.3	3254.9
6	56.0	838.7	47.8	912.4	18.9	1135.3	0.0	0.0	122.6	2886.5
7	3.9	863.2	10.6	946.0	9.4	1135.3	0.0	0.0	23.9	2944.5
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cod	2003									
	1. Quarter		2. Quarter		3. Quarter		4. Quarter		Year	
AGE	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
0	0.0	0.0	0.0	0.0	669.8	23.0	0.0	0.0	669.8	23.0
1	0.0	0.0	30.5	60.2	0.0	0.0	0.0	0.0	30.5	60.2
2	10.4	218.9	6.9	352.8	0.0	0.0	0.0	0.0	17.3	571.6
3	0.0	0.0	4.9	1043.2	0.0	0.0	0.0	0.0	4.9	1043.2
4	0.0	0.0	2.0	1043.2	0.0	0.0	0.0	0.0	2.0	1043.2
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Whiting	2003									
	1. Quarter		2. Quarter		3. Quarter		4. Quarter		Year	
AGE	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	46.1	55.0	60.4	90.4	0.0	0.0	1.4	90.4	107.9	235.7
2	154.8	136.2	480.5	117.6	10.7	267.0	8.2	114.1	654.3	634.8
3	512.6	215.2	699.4	197.0	101.3	279.5	11.5	291.2	1324.7	982.9
4	302.0	302.3	251.8	270.9	316.7	348.0	52.1	371.0	922.5	1292.2
5	124.5	392.4	62.0	380.9	170.2	446.3	33.8	434.5	390.5	1654.1
6	0.0	0.0	0.0	0.0	24.6	521.8	4.1	501.1	28.7	1023.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haddock	2003									
	1. Quarter		2. Quarter		3. Quarter		4. Quarter		Year	
AGE	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
0	0.0	0.0	18.4	4.6	0.0	0.0	0.0	0.0	18.4	4.6
1	98.2	101.6	155.5	65.0	219.9	123.7	0.0	0.0	473.7	290.4
2	95.8	122.5	42.3	119.8	57.4	220.0	1.0	287.4	196.6	749.6
3	600.0	239.3	329.0	266.5	209.0	224.6	9.7	398.7	1147.6	1129.0
4	457.7	290.4	466.6	389.3	500.5	277.7	97.9	447.3	1522.6	1404.7
5	0.0	0.0	0.0	0.0	7.2	287.4	4.6	420.1	11.8	707.5
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 2.1.11. Reported international effort data made available to the WG.

Year	UK (all gears)	Netherlands (beam trawl)	Demark/Norway (Norway pout)	Denmark/Norway (sandeel)
	Millions kW-days	Million HP days	– Units not known –	
1978		44.3		
1979		44.9		
1980		45.0		
1981		46.3		
1982		57.3		12.7015
1983		65.6		11.63582
1984		70.8		12.22938
1985		70.3		14.84857
1986		68.2		16.30781
1987		68.5	5529.247	14.87949
1988		76.3	4356.924	21.70644
1989		61.6	8428.324	27.62465
1990		71.4	7948.764	22.00438
1991		68.5	7113.295	20.02274
1992		71.1	8305.812	17.72369
1993		76.9	7695.403	16.04519
1994		81.4	6205.364	15.24447
1995		81.2	4557.385	19.45047
1996		72.1	4093.32	16.20835
1997	58.777	72.0	3952.925	17.41714
1998	55.019	70.2	2764.317	18.37847
1999	55.090	67.3	3898.407	17.59725
2000	52.560	67.7	4327.099	15.0605
2001	51.085	61.4	1807.445	15.0451
2002	43.954	56.6	3257.887	12.01759
2003	35.898	51.6	1592.550	12.50286

Figure 2.1.1. Reported total effort data by country made available to the WG, along with combined reported Danish/Norwegian effort in the sandeeland Norway pout fisheries. Data are mean-standardised to a common period (1997–2003).

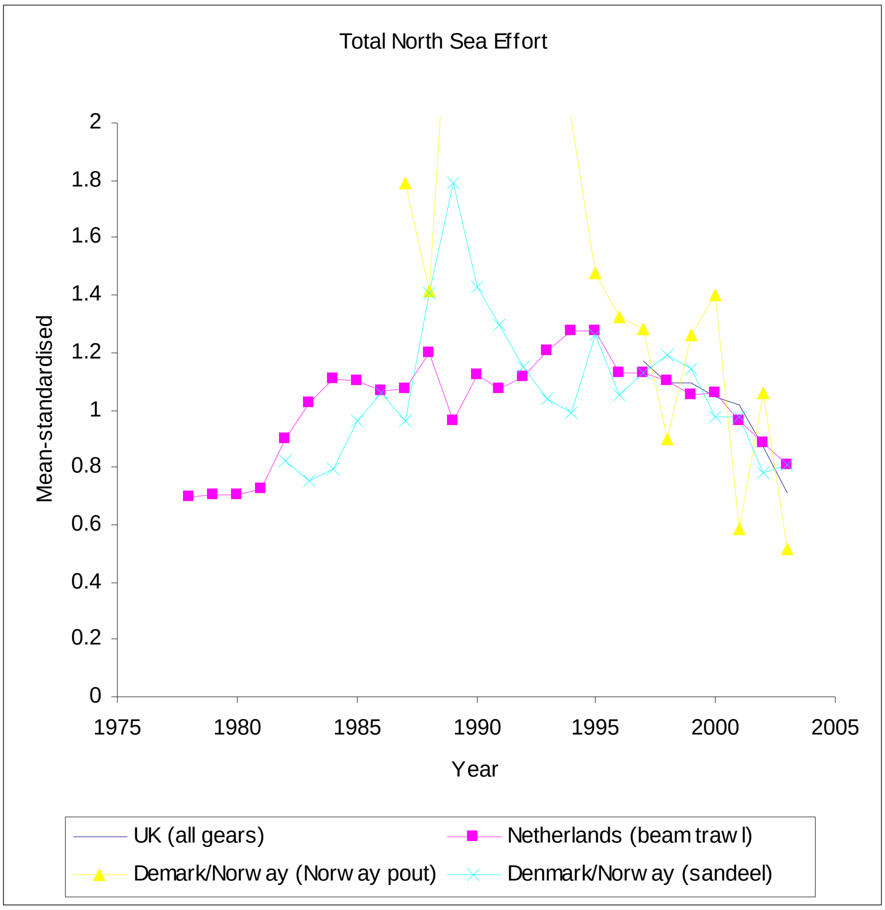


Figure 2.1.2. Total demersal landings from the North Sea management area.

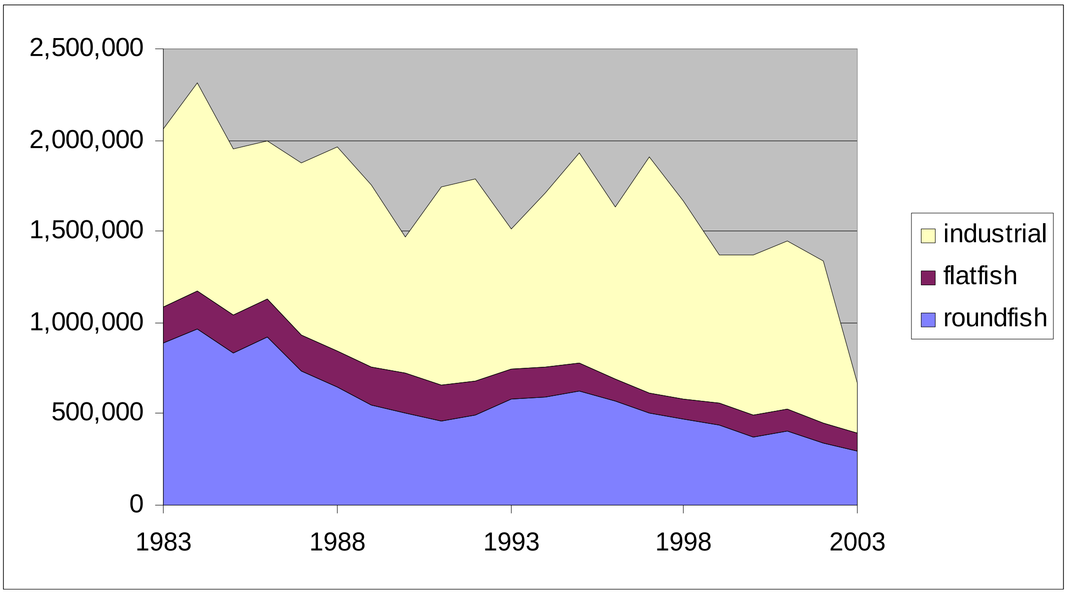


Figure 2.1.3. Yield by species for the main stocks considered by this WG. For cod, yield refers to reported landings, discards and estimated under-reported landings; for haddock, whiting and plaice in Sub-Area IV, yield refers to total catches (reported landings and discards); for all other species, yield refers to reported landings.

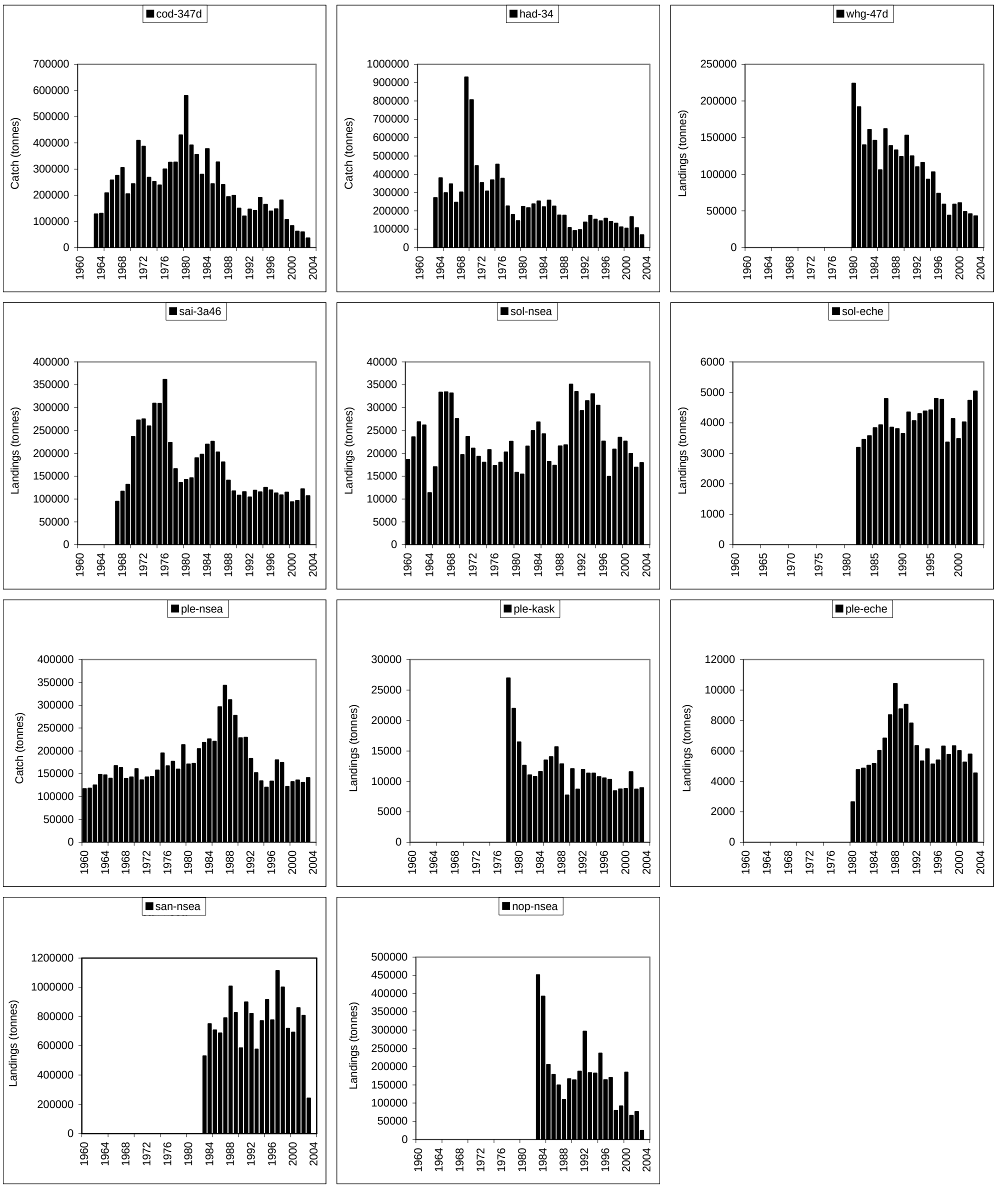


Figure 2.1.4. Trends in SSB for the stocks assessed by this WG. Dotted lines show levels of B_{pa}. The 2004 estimate (based on survivors from 2003) is included. There was no final whiting assessment at this year's WG meeting.

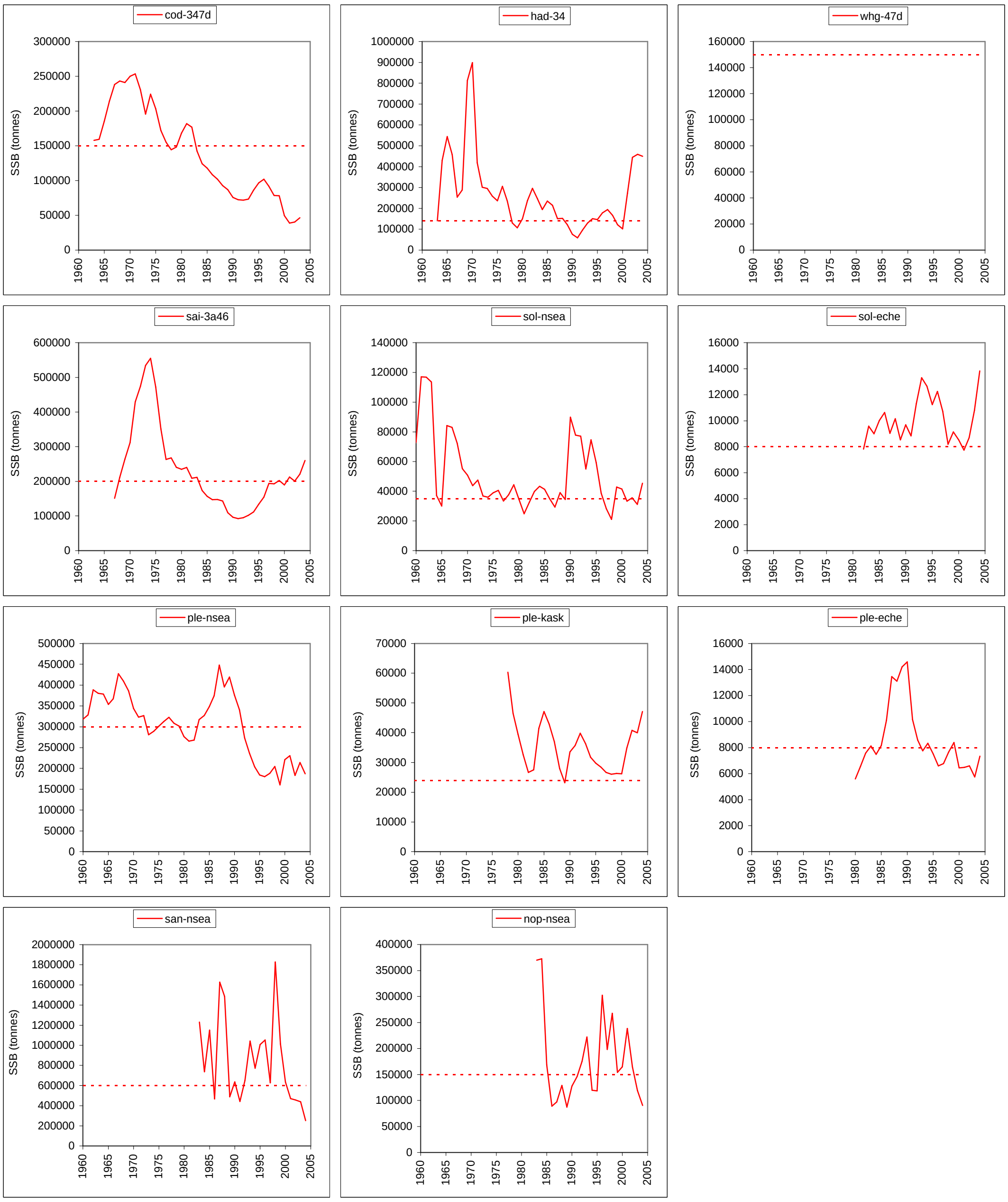


Figure 2.1.5. Trends in mean fishing mortality for the stocks assessed by this WG. Dotted lines show levels of F_{pa}. There was no final whiting assessment at this year's WG meeting.

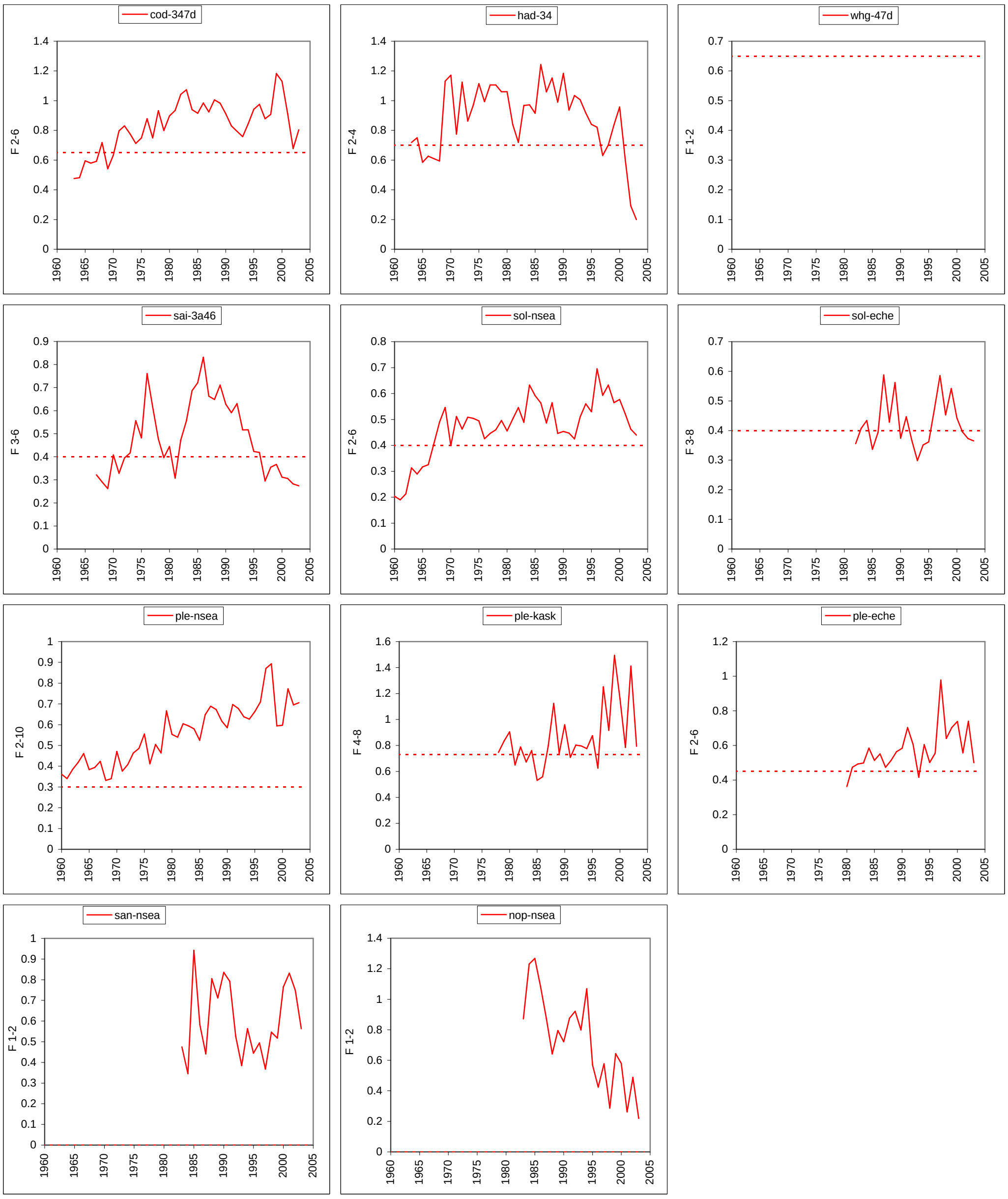
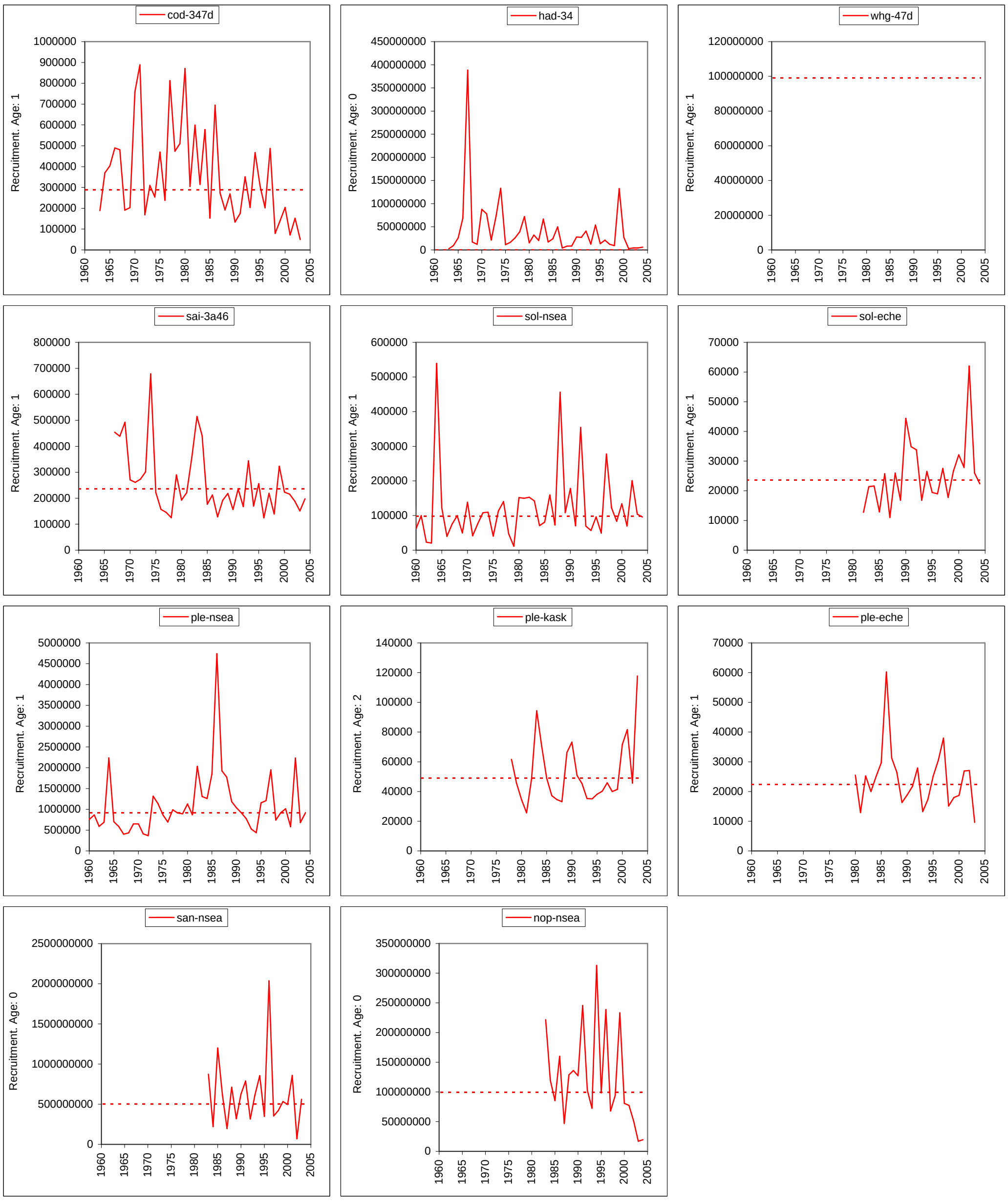


Figure 2.1.6. Trends in recruitment for the stocks assessed by this WG. Dotted lines show the geometric mean (GM) for the whole time period for each stock. There was no final whiting assessment at this year's WG meeting.



3 COD IN SUB-AREA IV, DIVISIONS IIIA (SKAGERRAK) AND VIID

Since 1996, this assessment has covered the cod stock in the North Sea (Sub-area IV), the Skagerrak (Division IIIa) and the eastern Channel (Division VIIa). Prior to 1996 cod in these areas were assessed separately.

Due to its very poor state, this stock is classified as an “observation” stock by ICES with the consequence that an update assessment is not considered to be appropriate for it. The assessment of this stock has also been under continuous external review by the North Sea Commission Fisheries Partnership (NSCFP). Note that there is no Stock Annex as yet for this stock.

3.1 Stock definition and the fishery

Cod occur throughout the North Sea. Available information[1] 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 possible to quantify long-term changes in the use of spawning grounds because of a lack of comprehensive survey series on eggs or spawning adults. However, the limited data available 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. Information on changes for more southerly spawning sites is lacking.

A recent genetic survey of cod in European continental shelf waters using micro-satellite DNA detected significant fine scale differentiation, which suggests 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 historical tagging studies (Anon 1971).

Young fish have historically been found in large numbers in the southern part of the North Sea. In the 1980s an attempt was made to afford the juveniles some protection through the so-called cod box in the German Bight, in which the minimum mesh size of towed demersal fishing gears was greater than in other parts of the North Sea. Between 1987 and 1992 the minimum mesh size in the major North Sea otter trawl and seine net fisheries for roundfish increased in several steps from 80mm to 100mm, implicitly revoking the special regulation of the cod box.

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, while in others the fisheries are directed mainly towards cod, for example some of the fixed gear fisheries. The spatial distribution of reported international landings for 2000-2002 was shown in last year’s WG report. The landings in those years generally coincided with the areas of highest density of cod aged 2 and older seen in the IBTS Q1 survey. This was especially apparent for the northern North Sea; however, a significant proportion of the landings in 2000-2002 were reported from the Southern Bight, the eastern central North Sea and entrance to the Skagerrak, where observed IBTS densities of cod aged 2 and older were relatively low. This was intepreted as a reflection of the large amount of effort deployed in areas of low cod density. It has not been possible to update the spatial distribution of landings to include 2003 values.

In recent years much has been discussed about the possibility of large scale shift of cod distributions northwards within the North Sea caused by climate change. The arguments state that cod, preferring cooler temperatures, are moving north away from a warming North Sea. A working paper presented to WGNSSK at its 2003 meeting (Bannister & Turrell, 2003) analysed the oceanographic evidence for this hypothesis and found that it to be lacking. Briefly, the paper concluded that owing to the effect of the Atlantic water Flowing past the northern boundary of the North Sea, the North Sea has rather a unique internal ocean climate. In the winter, temperatures get warmer further north, not cooler. Hence if fish move according to some temperature preference, seeking cooler water, they are more likely to move south in the winter in the North Sea.

[1] Information on spawning cod and population structuring is taken from a summary prepared for the 2003 meeting of this WG, and presented at that meeting as a working paper by Wright *et al.* (2003).

3.1.1 ACFM advice applicable to 2003 and 2004

The advice from ICES for 2003 was as follows:

> **Given the very low stock size, the recent poor recruitments, and continued high fishing mortality despite management efforts to promote stock recovery, ICES recommends a closure of all fisheries for cod as a targeted species or by-catch. In fisheries where cod comprises solely an incidental catch there should be stringent restrictions on the catch and discard rates of cod, with effective monitoring of compliance with those restrictions.**
>
> These and other measures that may be implemented to promote stock recovery should be kept in place until there is clear evidence of the recovery of the stock to a size associated with a reasonable probability of good recruitment and there is evidence that productivity has improved. The current SSB is so far below historic stock sizes that both the biological dynamics of the stock and the behaviour of fleets are unknown, and therefore historic experience and data are not considered a reliable basis for medium-term forecasts of stock dynamics under various rebuilding scenarios.

For 2004, the ICES advice was presented in a modified format to provide mixed-fishery advice. For cod the single species exploitation boundary was:

> **Given the very low stock size, the recent poor recruitments and the continued substantial catch [54 000 t in 2002], ICES recommends the implementation of a recovery plan to ensure a safe and rapid rebuilding of SSB to levels above $\mathbf{B_{pa}}$. Such a recovery plan must include a provision for zero catch until the estimate of SSB is above $\mathbf{B_{lim}}$ or other strong evidence of rebuilding is observed. In accordance with such a recovery plan ICES recommends a zero catch in 2004.**

The mixed-fisheries advice was as follows:

> Cod, plaice and sole (with the exception of sole in the Eastern Channel) are outside safe biological limits. These stocks are the overriding concerns in the management advice of all demersal fisheries:
>
> - for cod in Division IIIa, North Sea and Eastern Channel ICES recommends a zero catch;
> - for plaice in the North Sea ICES recommends a recovery plan that will ensure a safe and rapid recovery of SSB to a level in excess of $\mathbf{B}_{pa}$;
> - for other plaice stocks than the North Sea plaice and for sole stocks fishing should be restricted within $\mathbf{F}_{pa}$.
>
> Demersal fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2004 be managed according to the following rules, which should be applied simultaneously:
>
> They should fish:
>
> - **without bycatch or discards of cod;**
> - **within a recovery plan for North Sea plaice. Until a recovery plan has been implemented that ensures rapid and sure recovery of SSB above $\mathbf{B_{pa}}$, fishing mortality should be restricted to the lowest possible level and well below $\mathbf{F_{pa}}$. Management must include measures that ensure that discards of plaice be significantly reduced and quantified;**
> - **within the biological exploitation limits for all other stocks.**
>
> Furthermore, unless ways can be found to harvest species caught in a mixed fisheries within precautionary limits for all those species individually then fishing should not be permitted.

The single species fishing mortality and biomass reference points agreed by the EU and Norway are as follows:

$\mathbf{B}_{lim}$ = 70,000t; $\mathbf{B}_{pa}$ = 150,000t, $\mathbf{F}_{lim}$ = 0.86; $\mathbf{F}_{pa}$ = 0.65

3.1.2 Management applicable in 2003 and 2004

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:

	2002 Agreed TAC (000 t)	2003 Agreed TAC (000 t)
IIIa (Skagerrak)	3.9	3.9
IIa + IV	27.3	27.3

There is no TAC for cod set for Division VIId alone. Landings from Division VIId count against the overall TAC agreed for ICES Divisions VII b-k.

In 1999 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 constrain harvesting within safe biological limits and designed to provide for sustainable fisheries and greater potential yield. The plan shall consist of the following elements:*

1 *Every effort shall be made to maintain a minimum level of SSB greater than 70 000 t (B_{lim}).*

2 *For 2000 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of 0.65 for appropriate age groups as defined by ICES.*

3 *Should the SSB fall below a reference point of 150 000 t (B_{pa}), the fishing mortality referred to under paragraph 2 shall be adapted in the light of scientific estimates of the conditions then prevailing. Such adaptation shall ensure a safe and rapid recovery of SSB to a level in excess of 150 000 t.*

4 *In order to reduce discarding and to enhance the spawning biomass of cod, 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.*

The Parties shall, as appropriate, review and revise these management measures and strategies on the basis of any new advice provided by ICES."

This agreement has been re-established annually since 1999.

EU technical regulations in force in 2003 and 2004 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, cod 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. Details are given in Council regulation (EC) 2056/2001. The basic minimum mesh size for towed gears for cod from 2002 was 120 mm, although a transitional arrangement until 31 December 2002, vessels were allowed to exploit cod with 110 mm codends provided that the trawl is fitted with a 90 mm square mesh panel and the catch composition of cod retained on board is 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. In addition effort restrictions were introduced in 2003. The details for 2003 are given in Annex XVII of Council Regulation (EC) 2341/2002 and amended in Council Regulation (EC) 671/2003. The minimum mesh size for vessels targeting cod in Norwegian waters is also 120 mm. Effort restriction measures were revised for 2004 and the details are given in Annex V of Council Regulation (EC) 2287/2003.

In 2004 agreement was reached within the EU on a formal recovery plan that will operational during the TAC and management decision processes of 2004, effectively rendering the plan operational in 2005. Details of it are given in Council Regulation (EC) 423/2004.

The emergency measure (Council Regulation (EC) 259/2001) involving the closure of a large area of the North Sea from 14 February to 30 April 2001 to all fishing vessels using gears likely to catch cod, has not been adopted since. The minimum landing size for cod in Sub-area IV and Divisions IIIa and VIId is 35 cm, although for Danish vessels it is 40 cm.

3.1.3 The fishery in 2003

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** 3.1.1. The WG estimate for landings from the three areas combined in 2003 is 30.9 thousand tonnes, split as follows for the separate areas.

2003 Landings ('000 t)

Division IIIa(Skagerrak)	3.8
Sub-Area IV	25.8
Division VIId	1.2
Total	30.9

Minor revisions for 2002 were also reported for landings from some countries.

WG estimates of landings indicate that the TACs for Subarea IV was not fully taken in 2003. This is in keeping with previous years.

For cod in IIIa, IV and VIId, ICES first raised concerns about the mis-reporting and non-reporting of landings in the early 1990s, particularly when TACs became intentionally restrictive for management purposes. Some WG members have since provided estimates of under-reporting of landings to the WG, but by their very nature these are difficult to quantify. In terms of events since the mid-1990s, the WG suspects that under-reporting of landings may have been significant in 1998 because of the abundance in the population of the relatively strong 1996 year-class as 2-year-olds. The landed weight and input numbers at age data for 1998 were adjusted to include an estimated 3000 t of under-reported catch. The 1998 catch estimates remain unchanged in the present assessment.

For 1999 and 2000, the WG has no *a priori* reason to suspect that there was significant under-reporting of landings. However, the substantial reduction in fishing effort implied by the 2001, 2002 and 2003 TACs is likely to have resulted in an increase in unreported catch in those years. Anecdotal information from the fisheries in some countries indicates 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** 3.1.1 nevertheless comprise the basic input values to the assessment.

Estimates of the proportion of cod discarded by age group for the period 1994-2003 from observations aboard English vessels in the North Sea are given in **Table** 3.1.2. International discard estimates for the period 1997-2001 are given in the 2002 report of the SGDBI (www.ices.dk - reports/ACFM/2002/SGDBI/datafiles/northseaandskagerrak). The by-catch of cod from the Danish and Norwegian industrial fisheries that was sent for reduction to fishmeal and oil in 2002 was 29 tonnes (**Table** 2.1.3). An additional 19 tonnes of cod from the Danish industrial catch was landed for human consumption (**Table** 2.1.4) and was declared against the cod quota for Denmark. The WG has no information on any by-catch of cod in the Norwegian industrial catch that was landed for human consumption.

3.2 Natural Mortality, Maturity, Age Compositions, and Mean Weight at Age

Values for natural mortality and maturity are given in **Table** 3.2.1, 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 areas (IV, IIIa and VIId). The WG notes that although natural mortality is treated as constant in the assessment, the results of multi-species VPA indicate that this is probably not the case.

Landings in numbers at age for age groups 1-11+ and years 1963-2003 are given in **Table** 3.2.2. SOP corrections have been applied. These data form the basis for the catch-at-age analysis but do not include industrial fishery by-catches landed for reduction purposes, or discards. By-catch estimates are available for the total Danish and Norwegian small-meshed fishery in Sub-area IV (**Table** 2.1.3) and separately for the Skagerrak (**Table** 3.1.1.), but as in previous years, these data were not included in the assessment.

In 2002, the landings were dominated by the 1999 year-class as 3-year olds, which accounted for 42% of the total international landings in number. Approximately 90% of the international landings in number were accounted for by juveniles aged 1-3, with 1-year-old cod from the 2001 year-class accounting for almost 25%.

In contrast, in the corresponding values for 2003, the landings were dominated by the 2001 year-class as 2-year olds, which accounted for 57% of the total international landings in number. Approximately 80% of the international landings in number were accounted for by juveniles aged 1-3, in 2003 1-year-old cod accounted for less than 3%. Mean weight at age data for landings are given in **Table** 3.2.3. These values were also used as stock mean weights. Values of discard numbers-at-age and discard mean weights-at-age are shown in **Tables** 3.2.4 and 3.2.5. These values arise from the application of Scottish discard ogives to the international landings-at-age. 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.

Age compositions were provided by Denmark, Germany, England, France, the Netherlands, Norway and Scotland (**Table** 1.3.1).

Long-term trends in mean weight at age for ages 1-9 are plotted in **Figure** 3.2.1. It 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 over time. Ages 1 and 2 show little absolute variation over the long-term.

3.3 Catch, Effort, and Research Vessel Data

Historically, the effort and CPUE series of Scottish fleets was presented using hours fished as the measure of fishing effort. This consisted of aggregated hours fished by fleet and year and aggregated catch or landings divided by this value. Individual, disaggregated trip data were not available for the analysis of CPUE. Since the mid-to-late 1990s, changes to the central database and 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 and proportionately fewer entries have been made since the late 1990s. Consequently, the effort data, as hours fished, are not considered to be representative of the actual deployed fishing effort. These effort data for selected commercial fleets exploiting cod are shown in **Figure** 3.3.1.1. Section 2.1.1 presents a discussion of UK fishing effort data expressed in terms of kW-days that is considered to be a more reliable reflection of recent effort trends, recent changes in which are attributable to the joint effects of vessel decommissioning, days-at-sea limitations and the transference of activity between fleet segments.

The report of the 2001 meeting of this WG (ICES CM 2002/ACFM:01), and the ICES advice for 2002 (ICES Co-op. Res. Rep 2001/246) provides arguments for the exclusion of commercial CPUE tuning series from calibration of the catch-at-age analysis. Such arguments remain valid and only survey data have been considered for calibration purposes.

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 1992-2004. Only ages 1–6 are used for calibration, as catch rates for older ages are very low. The age-composition data for 2004 from this survey were not available at the start of the WG meeting, but were ultimately included in the assessment. At its 2003 meeting, the WG split this survey into 2 periods based on the timing of the change from the Granton to the GOV trawl (ICES CM2004/ACFM:07). This was due to a step change in total mortality (Z) that was implied by the survey. This was coincident with the change in gear despite the inclusion of a GOV-to-Granton conversion factor being applied, and interpreted as a change in catchability at age 1 with the change in gear. Consequently, the WG split the survey series into two for calibrating catch data, and this has been maintained this year. This survey covers the whole of the North Sea in August-September each year to about 200m depth, using a fixed station design of 75 standard tows and the GOV trawl.

- Scottish third-quarter groundfish survey (ScoGFS): ages 1–8. This survey covers the period 1982–2004. Only ages 1–6 are used for calibration, as catch rates for older ages are very low. This survey is undertaken during August each year using a fixed station design and the GOV trawl. Coverage was restricted to the northern part of the North Sea until 1988, corresponding to only the northernmost distribution of cod in the North Sea. Since 1998 it has been extended into the central North Sea. For the purpose of this assessment, the indices used correspond to the area of the pre-1988 change, ie., the indices since 1987 are calculated by excluding the "new" central North sea stations in the survey. The ScoGFS has also used a new gear and vessel since 1999. The catch rates as presented are corrected for the change in vessel and gear, on the basis of comparative trawl haul data (Zuur *et al* 2001).

- Quarter 1 international bottom-trawl survey (IBTSQ1): ages 1–6+, covering the period 1976–2004. 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 French VIId survey has taken place in October in the eastern Channel since 1988. A GOV trawl is used with half-hour tows and indices standardised to one hour. Cod is one of the species to which this survey is targeted. Indices are available for ages 1-3.

A third quarter international bottom-trawl survey series is also available (IBTS Q3) from 1991-2003. This was not used for calibrating the catch-at-age analysis because data from the Scottish and English third quarter surveys contribute to this index.

Maps showing the distribution of cod are shown in **Figures** 3.3.1.2 (IBTS ages 1-3) and 3.3.1.3 (EngGFS ages 1-4). The recent dominant effect of the size and distribution of the 1996 and, to a lesser extent, the 1999 year-classes are clearly apparent from these charts.

The complete data available for calibrating the catch-at-age analysis are shown in **Table** 3.3.1. These tables do not include the addition of discard estimates to the fleet landings-at-age.

3.4 Exploratory analyses

As part of the benchmark review process a series of analyses have been used to examine each of the sources of information available for the assessment of the North Sea cod stock. Within the following Sections, the recorded landings data and survey series are screened for sampling errors and the time series of survey and commercial CPUE are examined for correlation between series. Survey CPUE is then used independently of the catch data to provide indices of the stock dynamics before a catch-at-age model is fitted to the catch and survey series in order to derive time series of stock and exploitation estimates. The review process was used to guide the WG in its conclusions with regard to the current state of the stock and its projected dynamics.

3.4.1 A Separable VPA of the North Sea cod catch-at-age data.

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 VPA based models.

Figure 3.4.1.1 illustrates the log catch ratio residuals at age for the final 5 years. The residuals in the most recent years indicate no strong patterns or large values for ages less than age 10. The fitted model indicates that the age structure of the recorded landings has been relatively consistent in recent years and that the landings 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.

3.4.2 The assessment age range

In the previous years' benchmark review of this stock the age range of the assessment was reduced from and 11+ group to a 7+ group due to the scarcity of survey calibration data older than age 6. The revision to the assessment age range required a revision to the reference ages used for calculating average fishing mortality, previously ages 2 - 8. In recent years, average fishing mortality at ages 2–4 has been used to highlight exploitation rates on the juvenile ages. The age range represents ages that are predominant in the landings and was therefore adopted as the new benchmark for measuring fishing mortality.

3.4.3 Survey and commercial catch per unit effort concurrence

All the available calibration series are presented as log-transformed catch curves of the available cohort data. **Figure** 3.4.3.1 shows the data for the commercial series and **Figure** 3.4.3.2 for the survey series. The commercial series are presented for both human consumption landings data and for a series that incorporates discard quantities that have been attributed on the basis of the long-term Scottish discard ogives. The effect of the inclusion of discard information is to lessen, and in some cases remove, the appearance of partial recruitment at the youngest age (age 1) represented in the data. For the commercial series, there is little evidence of substantial distortion in the cohort curves from year to year. The survey series (**Figure** 3.4.3.2) also demonstrate partial recruitment to the survey gear at the youngest age, and there is also some evidence that older fish are not well sampled by the surveys. Nevertheless, with the exception of the FraGFS series that provides indices of fish aged 1 to 3 only, there is little evidence of substantial distortion in the cohort curves from year to year.

Within each series, the CPUE values were mean-standardised at each age, with the year range over which the means were taken constant across all series. The mean-standardised catch rates from all the available survey series are presented in **Figure** 3.4.3.3 for the commercial series (excluding the discard data) and in **Figure** 3.4.3.4 for the survey series. These figures show the data plotted by year-class across series, indicating the consistency with which the different series track the relative abundance of yearclasses at different ages. These figures indicate an inconsistency between some of the commercial series and the survey series when considering the stronger yearclasses of recent times. Past catch-at-age analyses have indicated the 1996 yearclass to be the only above average yearclass since the mid-1980s, although its magnitude has generally been reduced in successive assessments. **Figure** 3.4.3.3 indicates across several ages of the commercial CPUE data, that the 1999 yearclass was of at least a corresponding magnitude for the Scottish fleets with their more northerly activity (however, these are also the fleets for which the hours-fished effort data are considered to be the least consistent in terms of reporting). For the more southerly-orientated English fleets, the relative abundance of the 1999 yearclass is very much lower. For the survey series, the 1996 yearclass is clearly more abundant than the 1999 yearclass, not only for the IBTS and EngGFS series that cover the entire North Sea, but also for the ScoGFS in the northern North Sea.

All of the CPUE series are also presented as unsmoothed, non-standardised values in two additional ways. **Figure** 3.4.3.5 shows the pairwise bivariate scatterplots plotted by age within series for log-transformed series. This demonstrates the internal consistency of the indices within each series. **Figure** 3.4.3.6 shows similar plots by series within ages. This demonstrates the consistency between indices for the different ages. No attempt is made to quantify this because in many cases individual points with high leverage or potential outliers are likely to corrupt the validity of simple R^2 goodness-of-fit values. Nevertheless, linear trends are plotted in the **Figures** to indicate where overall positive or negative associations exist. From **Figure** 3.4.3.5 it can be seen that all the series demonstrate positive relationships between the log-abundance of neighbouring age groups. The FraGFS series is highly sensitive to a single point with high leverage and excluding that value would leave little evidence of a clear relationship between indices. The other surveys indicate consistency between adjacent age groups and also between non-adjacent age groups up to the age of 5 although for the EngGFS and ScoGFS, the observed relationship becomes noisier as the difference between ages increases. The IBTS comparisions are clearly sensitive to a single influential point at age 1. The commercial series also demonstrate consistency between adjacent age groups values, with occasional points of high leverage for example in the EngTrl series at ages 1 and 2. These series also demonstrate consistency between non-adjacent age groups, particularly where the difference between ages is of the order of 2-3 years. The EngSei series appears to be very consistent across all ages.

Figure 3.4.3.6 shows the same data plotted by age across the different series. Excluding the VIId FraGFS, the survey series demonstrate the strongest agreement at ages 1-3. There is a positive but noisier association at ages 4 and 5 with occasional outlying points. The surveys and commercial series are mostly concordant at ages 2 and 3; thereafter the relationships between survey and commercial series become noisier, but there is still a reasonable degree of concordance between the ScoGFS and the two English commercial series up to age 6. Between the commercial series alone, the agreement within English fleets and within Scottish fleets is generally more consistent than between the English and Scottish fleets.

3.4.4 Survey-based analyses

Survey-based evaluations of stock trends are presented for the IBTSQ1, EngGFS and ScoGFS series. For the IBTSQ1, EngGFS and ScoGFS, data were avalailable up to and including 2004. The indices are presented as smoothed empirical estimates of SSB, as unsmoothed empirical estimates of Z, and as SURBA estimates based on unsmoothed indices (see Section 1.4.3 for a description of methods).

Although all the surveys indicate that the cod stock is at a low level, the smoothed empirical esimates of SSB indicate differences in the detailed interpretation of the most recent years of the survey series (**Figure** 3.4.4.1). The IBTSQ1 and ScoGFS both indicate a substantial decline in SSB since the early- to mid- 1980s, and the EngGFS also shows a decline from an earlier peak. They differ in that the ScoGFS indicates a short-term arrest of the decline in the mid-1990s before falling further to a historical low in the series followed by a slight recovery in 2003 and 2004, whereas the decline in SSB suggested by the IBTSQ1 is almost continuous to a new historic low. The EngGFS series only covers the more recent period, and generally reflects the pattern shown by the ScoGFS over that period other than for a decrease rather than an increase in 2004. The estimates of unsmoothed empirical Z (**Figure** 3.4.4.2) also differ in their interpretation of the most recent data; the IBTS and EngGFS indicate a fluctuating value around a stable trend; the ScoGFS indicates a sharp decrease in 2002, 2003 and 2004.

SURBA estimates were calculated using raw rather than smoothed indices, and made use of mean-standardised estimates of the ADAPT catchabilities at age from the catch-at-age analysis (Section 3.4.7) to provide relative catchabilities at age in the SURBA analysis. Results from the IBTSQ1, ScoGFS and EngGFS surveys are presented in **Figure** 3.4.4.3 from which it can be seen the development of SSB and mean F are similar in each case to the empirical estimates of the survey series. The residuals of the SURBA fits are shown in **Figure** 3.4.4.4, and the results of retrospective SURBA analyses are given in **Figure** 3.4.4.5 from which it is seen that the IBTSQ1 estimate of fishing mortality is extremely sensitive to the index value for 2004.

3.4.5 A Laurec-Shepherd based analysis of the North Sea cod tuning data

The Laurec-Shepherd VPA calibration model was used to screen the survey calibration data before fitting within assessment models. The Laurec-Shepherd model makes the assumption that the selection pattern at the oldest ages is constant, which reduces the number of parameters to be estimated.

Figures 3.4.5.1–3.4.5.4 present the time series of the log catchability residuals from single fleet Laurec-Shepherd tuning models fitted to the English (EGFS), Scottish (ScoGFS), and International Bottom Trawl Survey (IBTS) surveys in the North Sea, and the French groundfish survey in Division VIId (FraGFS). The figures illustrate that for the majority of survey ages, catchability has been increasing over time and shows cohort effects related to population abundance. The increase is more pronounced at the youngest ages of the ScoGFS, IBTS and the FraGFS surveys.

Catchability is derived as the ratio of the survey catch-at-age to the population calculated from a VPA transformation of the catch data. The changes in level in recent catchability could result from bias in the VPA populations induced by underreporting, increased levels of discarding and/or natural mortality, or changes in survey catchability. There have been frequent reports from the fishing industry that the recent reductions in TAC have not been observed. It is therefore considered that the most likely cause of the trends in residuals, which are consistent across surveys, is underreporting bias in the catch-at-age data.

Apart from the trends and cohort effects noted in the residuals there are no strong outliers in the surveys previously used for tuning (IBTS, ScoGFS and EGFS). These series were therefore accepted as being suitable for inclusion in an assessment analysis of the stock.

The FraGFS series has similar trends and cohort effects to the longer time series but exhibits stronger variation. This could result from noise in the series as discussed in Section 3.4.3 or coverage of a small part of the stock distribution, which may have differing dynamics. It was therefore agreed that the survey would not be included in the assessment tuning model this year. Its contribution and CPUE dynamics will be reviewed each year as the series develops.

3.4.6 Time Series Analysis (TSA)

TSA could not be fitted to the cod data sets due to an inability to achieve a stable minimisation. The minimisation was found to be highly sensitive to the initial starting conditions.

3.4.7 ADAPT Analysis

Last year's WG noted that there have been frequent reports from the fishing industry that the recent reductions in TAC have not been observed. The WG concluded that as a direct consequence of the uncertainty in the reported landings of North Sea cod, estimates of stock abundance and exploitation rates for recent years could not be reliably determined by assessment models, such as XSA, that treat the catch data as unbiased. Stock and exploitation rate trends were considered to be representative only of the historic stock and fishery development.

A development of the ADAPT (Gavaris 1988) model structure is described in Appendix 4. The model uses survey information to estimate under-reporting bias in recent landings data. The model is able to "correct" simulated biased catch data and was therefore applied to the North Sea cod data in order to examine its potential for estimating the stock and fishery times series required for the provision of advice.

The model was applied to the WG numbers at age and landings weight at age data sets listed in **Tables** 3.2.2–3.2.3 and the English (ages 1–6), Scottish (ages 1–6) and IBTS (ages 1–5) groundfish survey series (**Table** 3.3.1). Fishing mortality at the oldest assessment age was estimated as the average of ages 3–5 (an assumption of a flat topped selection pattern). Catchability of each survey was assumed to be constant in time and independent at all ages except for ages 5 and 6 of the EngGFS and ScoGFS surveys for which a single survey catchability parameter was estimated. Equal weight was assumed for the estimates from the three survey series in the estimation of parameters.

In order to estimate the uncertainty in the derived stock parameters, the model was bootstrapped by age-structured re-sampling of the log catchability residuals to derive new CPUE values.

Based on anecdotal information provided by the commercial fishing industry, bias parameters were estimated for the years 1993–2003. Two model fits are presented:

1) A fit with no smoothing of catches during the underreporting period; catches are allowed to exhibit strong variation from year to year.
2) A fit with a smoothing constraint (set to 1.0) applied to year to year variation in catch during the period in which bias is estimated; permitted variation in catches from year to year is reduced.

Run(1) No smoothing of catches

Figures 3.4.7.1–3.4.7.4 present the bootstrap percentiles for the time series of estimated catches, fishing mortality, SSB and the bias parameter estimates. The SSB, F and the landings estimated without fitting the bias parameter are also plotted.

Year effects in the survey CPUE series result in a variable time series of estimated landings. Landings are estimated to have been under-reported in 1995, 1996, 1999, 2001 and 2003. The pattern of increasing under reporting from 1995–1996 with a drop in 1997/8, when the 1996 year class arrived in the fishery and the high rate of underreporting in 2001 and 2003, are consistent with reports from the industry.

The estimates of annual fishing mortality in 2003 are double the value estimated without fitting the bias parameters. SSB estimates are higher from 1994 onwards. The model estimates that since 1994, the stock has followed a similar trajectory to that estimated using the reported landings but at a higher level. This pattern of under estimation of the stock size is consistent with the known retrospective pattern, noted previously for this stock, in which survey estimates are revised downwards in successive years when populations that were initially estimated from survey information are later calculated from biased landings. The trends in the estimates of SSB are also consistent with the analyses carried out by the WG last year, in which survey estimates of SSB were consistently higher than those estimated from an XSA assessment of recorded landings.

Run(2) smoothing of catches

The second run examined the effect of introducing a smoothing factor that penalises large-scale changes in catch from year to year, to the model objective function.

Figures 3.4.7.5–3.4.7.8 present the estimates of catch, SSB, F and bias in the landings. A weak smoothing was applied to the time series of total catches (a weight of 1.0 for each residual between years). The model estimates showed less variability between years and reduced uncertainty in the time series estimates. Smoothing the time series of estimated catch results in similar, but less variable, trends in fishing mortality and spawning stock biomass to those estimated without the constraint.

Figure 3.4.7.9 illustrates the sensitivity of the time series of estimates of spawning stock biomass, average fishing mortality at ages 2–4 and estimated landings to the weight applied to the constraint in the year to year variation in landings within the smoothed objective function. The first row of figures illustrates the estimated values when no smoothing is applied, the second a smoothing weight of 1.0 and the final row a weight of 10.0. The smoothing parameter has the desired effect of reducing variation in the estimates between years with only a minor effect on the overall trends in the time series.

The final ADAPT model structure

The smoothed time series of estimated fishing mortality and landings were considered to be more consistent with the reports from the commercial fishery and the effort series submitted to the WG. 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. In order to reduce the potential for over-smoothing and introducing model-imposed bias to the estimates, the smoothing weight was set to 1.0.

The diagnostics and stock estimates from the fitted model are presented in **Tables** 3.4.1–3.4.6, fishing mortality estimates in **Table** 3.4.7, stock numbers in **Table** 3.4.8, the assessment summary in **Table** 3.4.9. **Figure** 3.4.7.10 presents the time series of log catchability residuals from the fitted smoothed ADAPT model. **Figure** 3.4.7.11 presents the time series of ADAPT derived assessment estimates of the stock, exploitation trends and the stock and recruitment plot.

Retrospective analysis

Figures 3.4.7.12–3.4.7.14 present the retrospective analysis estimates of landings, SSB and average fishing mortality from retrospective runs back to the year 2000. There is no retrospective bias in the model results. Fishing mortality is more variable than the other estimated series.

3.4.8 An assessment of the North Sea cod: ADAPT including discards

The data sets used for the North Sea cod stock assessment do not contain information on historic discards and this has raised concerns as to the reliability and quality of the estimated population trends and consequent advice to managers.

At last year's WG meeting, the sensitivity of the assessment models to discarding was examined. Discard data sampling of the North Sea fleets has been undertaken in Scotland since 1978; data are available from other countries since 2001. Discarding, as measured within the available data sets, occurs on predominantly small juvenile North Sea cod which make up the first ages of the assessment age range. The dominant effect of the inclusion of discards in the cod assessment is therefore to increase the level of recruitment and age-1 mortality.

At an EU meeting of experts that took place in May 2003 (EC 2003), comparisons were made between the discard ogives recorded in the EU study with those from the Scottish sampling program. The discard ogives were very similar for the available range of overlapping years. Therefore, Scottish discard observations for the years 1978–2003 have been used to raise the complete time series of North Sea cod catch-at-age data and the effect on the assessment time series of estimates examined. The raising process makes the gross assumption that the Scottish observations of discards from, predominantly, trawl gear can be applied to all gear types used by the fleets fishing in the North Sea.

The ADAPT model was applied to the discard-corrected landings data, **Table** 3.2.2 lists the landings numbers at age, **Table** 3.2.3 the discard numbers at age, **Table** 3.2.4 landings weight at age and **Table** 3.2.5 discard weights at age. Discard numbers are estimated from the landings data therefore parameters fitted to estimate the bias in landings numbers at age should also be applied to the discard numbers. There was therefore no need to modify the model structure described previously.

When discards were included, the fit of the model (partial sum of squares) improved at the youngest ages resulting in a 4% reduction in the overall sum of squares. **Figure** 3.4.8.1 presents the time series of ADAPT-derived assessment estimates of the spawning stock biomass, exploitation trends and the stock and recruitment plot.

The largest change in the assessment estimates, when discards were included, was in the abundance and mortality rates at the youngest ages. Historic year class strength was estimated to be considerably higher, especially during the relatively stronger recruitment recorded during the 1970's and 80's. There was no major change in the structure of the time series, only in the level of the recruitment.

Figure 3.4.8.2 presents the average fishing mortality at age estimated with and without discards, F at age 1 is increased by a factor of 4 and at age 2 by a factor of 1.5. Reference fishing mortality calculated as the average of ages 2 - 4 is increased with the inclusion of discards, but the trends in the rate of exploitation are unchanged.

The time series of spawning stock biomass which consists of ages that were largely unaffected by historic discarding is unchanged.

Given the requirement for fishing mortality vectors that are consistent with the mixed fisheries forecasts described in Section 14 the Group considered that the fit of the ADAPT model to the data set that includes discards should be presented as the most appropriate assessment of the dynamics of cod in 347d.

3.4.9 Conclusions drawn from the exploratory analysis

All of the models used to examine the dynamics of the North Sea cod stock indicate that the spawning stock biomass of the stock is close to its lowest level within the recorded time series. This conclusion is robust to the source of information used for the analysis.

Survey indices of SSB have remained stable since 2001 (Figures 3.4.4.1 and 3.4.9.1). The trends in SSB estimated by survey only methods are consistent with the fitted assessment model, apart from the early years of the Scottish groundfish survey, which indicates higher historic biomasses.

The results of the catch-at-age analyses indicate that fishing mortality rates have been too high to maintain a spawning stock biomass above current Precautionary Approach reference levels. Fishing mortality is estimated to have declined in recent years but not to the extent estimated by models that assume reported landings to be unbiased. Survey analyses that are independent of the changes in recorded landings support the conclusion of a high mortality rate with a reduction in recent years (Figure 3.4.9.2). However, the extent of the reduction is unclear from the survey analyses.

For many years recorded landings have followed the TAC, which in 2001, 2002 and 2003 implied severe reductions in fishing mortality. Based on the reported landings the fitted models indicate that the fishing mortality rate has declined. While the WG agrees that recent decommissioning and reductions in the TAC may have reduced exploitation rates, there are frequent anecdotal reports from the fishing industry that the reductions in TAC during 2001-2003 were not complied with. Therefore the WG considers that fishing mortality has not been reduced to the extent estimated by models that are fitted to reported catch-at-age data.

This year the WG has developed a model that estimates bias in the landings data. The results indicate that the level of non-compliance was high during 1995, 1996, 1999, 2001 and 2003. The pattern of increasing bias from 1995–1996 with a drop in 1997/8, when the 1996 year class arrived in the fishery and the high levels of bias in 2001 and 2003 are consistent with reports from the industry. The model estimates of stock abundance and fishing mortality rate are both higher than those estimated using the reported landings.

In the absence of any quantitative information provided by the industry on the actual bias in the reported landings, the WG cannot validate the model estimates. The WG can only determine the capability of the model to recover the unbiased time series, required by fisheries management, using simulated data. Such a simulation test is described in Appendix 4. The method was able to provide estimates of SSB and fishing mortality rate that are consistent with the series with simulated bias and a significant improvement on the estimates obtained from biased landings data.

If the industry cannot or will not provide the WG with the information it requires to correct for the level of bias, and if anecdotal evidence suggests that this bias is considerable, then the WG must use models that attempt to estimate additional parameters and which are therefore associated with increased uncertainty and risk to the stock. Given the lack of choice the WG accepted the ADAPT model fitted to landings and discards data and with estimation of under-reporting bias in landings, as the most appropriate model on which to base its catch forecasts and management advice.

3.4.10 Final Assessment

The final ADAPT model structure was fitted to landings data for the years 1963–2003 and ages 1-7+, adjusted for discarding using estimates from the Scottish discard sampling program. Survey data was used from the English groundfish survey (1992–2004, ages 1–6), the International Bottom Trawl Survey (1976–2004, ages 1–5) and the Scottish groundfish survey (1982–2004, ages 1–6).

Surviving population numbers at ages 1–5 were estimated in 2004 with fishing mortality at age 6 in all years calculated as the average of ages 3–5. Bias parameters were estimated in the years 1993–2003.

A smoothing weight of 1.0 was applied to interannual residuals of the log of total landings in tonnes: that is, interannual variability in landings was penalised. No time series weighting was applied and survey residuals were given equal eight in the analysis. Catchability was assumed to be constant in time and independent of age for ages 1–5. Catchability at age 6 constrained to be equal to that at age 5.

The fitted model diagnostics are presented in **Tables** 3.4.10–3.4.15, fishing mortality estimates in **Table** 3.4.16, stock numbers in **Table** 3.4.17, and the assessment summary in **Table** 3.4.18. The estimated time series trends are plotted in **Figure** 3.4.8.1.

3.5 Historic Stock Trends

The historic stock and fishery trends are presented in **Figure** 3.4.8.1.

Recruitment has fluctuated at a relatively low level since 1997. The 1996 year-class was the last large year class that contributed to the fishery. 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 and remained high until 2000, after which it has decreased. Average fishing mortality (human consumption and discard mortality) at ages 2–4 in 2003 is estimated to be 0.91.

SSB declined steadily during the 1970’s and 80’s. There was a small increase in SSB following the recruitment of the 1995 and 1996 year classes but with low recruitment abundance since 1997 and continued high mortality rates, SSB reached a historic low in 2001. In the last two years SSB is estimated to have increased to 43,000t: however, given the uncertainties in the assessment data and reported landings, this rise cannot be considered to be significant.

3.6 The North Sea Stock Survey 2004

The North Sea Stock Survey 2004 (Marrs 2004) was submitted to the WG in preliminary form in order that the fishers’ perception of the state of the stock be considered as part of the assessment process. The spatial distribution of the change in the abundance since 2001 is recorded by survey area in **Figure** 3.6.1. **Figure** 3.6.2 presents the IBTS survey results by area for the 1+ group abundance.

The North Sea Survey responses indicate that (apart from areas 1, 7 and 8) the abundance of cod has remained relatively stable since 2001. In area 1 there has been a steady year on year increase, in areas 7 and 8 there has been an increase in the most recent year. Areas 4 and 5 have recorded a decrease in abundance compared to last year.

The IBTS survey data are broadly in agreement in recording a stable overall stock abundance, although the survey has more variability due to the inherent variation in survey results. The increase in area 1 is not recorded in the surveys if all age classes are considered the survey records a decrease in abundance. However, if only the older (4+) fish caught by the survey are considered there has been an increase in abundance since 2001. The North Sea Survey responses on the size of fish being taken from area 1 indicate that there are more mostly large fish in area 1 than adjacent areas and this may provide the linkage between the North Sea survey and IBTS results.

In areas 7 and 8 the IBTS survey has recorded a locally high level of recruits (**Figure** 3.3.1.2). This is consistent with the North Sea survey recording high abundance, relatively high recruitment and more discards in those areas. The IBTS survey has also recorded less fish in area 4 and 5 in 2004 compared with 2003.

3.7 Recruitment estimates

Figures 3.7.1 and 3.7.2 present the 1991–2004 indices of abundance at ages 1 and 2 for the three surveys, each scaled to the mean. The surveys show consistent agreement at both ages. The 2004 indices are concurrent in indicating that the 2003 year-class is at the average of the values recorded in recent years.

Inputs to RCT3 are listed in **Table** 3.7.1. The output from the RCT3 run is presented in **Table** 3.7.2. **Figure** 3.7.3 plots the RCT3 estimates and the VPA estimates in the same years and the geometric mean of the VPA estimates for the 1997–2002 year classes. The RCT3 model consistently overestimates the VPA populations. Given this consistent over-estimation bias in recent years, the WG adopted the geometric mean of the 1997–2002 year classes for recruitment at age 1 in 2004.

3.8 Short term Forecast

Table 3.8.1 presents the inputs to the short term forecast. Population numbers are taken from the ADAPT model apart from the recruitment, which is the geometric mean of the 1997–2002 year classes at age 1. Estimates of fishing mortality for the human consumption and discard components are derived from the partial fishing mortalities at each age in 2001–2003 and scaled to the final year. Mean landings and discard weights at age for each fishery component are derived as the mean of the data for 2001–2003. Stock weights at age are the average of the overall catch weight at age during 2001–2003.

Short-term forecasts were run using the input data shown in **Table** 3.8.1 Two forecasts were run initially, one corresponding to status quo fishing mortality during 2004 (the “middle year”) and a second assuming a TAC constraint in 2004 of 27.3kt. Results from these forecasts are presented in **Tables** 3.8.2 and 3.8.3.

Under the assumption of status quo fishing mortality (0.91), the landings in 2004 are predicted to be 59.3kt compared to the TAC of 27.3kt. The TAC-constrained forecast implies a fishing mortality in 2004 of 0.32, substantially below the status quo value.

When interpreting these values, it is important to recall that the status quo forecast implicitly includes a component in the predicted catch that can be considered to be a “mis-reported” component, as the status quo assumptions of fishing mortality and population size are derived from an assessment that includes a statistical estimation of the mis-reported catch. Assuming the other inputs to the forecasts to be adequately specified, then the TAC-constrained forecast essentially implies no mis-reporting of landings in 2004.

Whereas these two forecasts are considered likely to bound the upper and lower limits of the expected catch in 2004, there is other information available to inform the appropriate choice of middle-year assumption. Anecdotal information from UK fishermen and from UK enforcement agencies strongly suggests control and enforcement in 2004 to be more robust than in previous years. Consequently, it is unlikely that a status quo “mis-reporting” component is appropriate in for 2004, the middle year of the forecast. Whether this is sufficient to reduce mis-reporting to zero is unlikely; however, an additional factor is also relevant.

During 2001-2002 the UK decommissioned a total of 13.3% of its >100mm mesh demersal whitefish effort (expressed as the percentage reduction in Kw days of decommissioned vessels relative to a 2001 baseline value). Then during 2003-2004 the UK decommissioned a further 16.5% relative to 2001 (Horwood, 2004 WP 8). (These values related to effort within the EU cod protection zone of the North Sea, ie the areas from which the predominant cod landings have been reported in recent years). These schemes have liberated the quota attached to the decommissioned vessels, and that quota is now available for lease or purchase by the remaining vessel owners. Hence there is a reduced incentive to misreport compared to the status quo assumption in the short-term forecast, particularly in consideration of the 2003-2004 round of decommissioning which is not acknowledged in the calculation of status quo F. It should be noted that this is not an argument based on effort reduction, but reflects the decommissioning of fishing vessels and the subsequent redistribution of quota to reduce the incentive to misreport landings.

In addition to this, there is also the consequence of the EU days at sea regulation to consider. Relative to the baseline year of 2001, this implies a reduction in Kw days of 34% for the UK demersal fleet (>100mm minimum mesh size), notwithstanding the decommissioning of vessels –a total reduction of approximately 65% is found if combined with the decommissioning data. Although there is no clear evidence of a decline in fishing mortality in the catch-at-age analysis attributable to such a large-scale reduction in effort, it is highly questionable whether a status quo assumption is appropriate in this case. Allowing for some transfer of fishing effort from the >100mm whitefish demersal fleet to the

<100mm Nephrops fleet, Horwood (2004, WP 8) considers the actual reduction in UK fishing effort (relative to the 2001 baseline) to lie between 25% and 60%, and probably nearer to the upper value.

As most of the non-UK demersal whitefish sector has also undergone some form of days at sea regulation since 2002, an additional short-term forecast has been made that assumes a reduction in fishing mortality of 50% relative to F in the baseline year of 2001. (EU Member States adopted a TAC for 2003 that assumed a greater, 65%, reduction in fishing mortality relative to 2001, and this was simply rolled-over into 2004 due to the absence of catch options other than zero in the ICES advice).

The WG was unable to recommend this as the most likely middle year forecast scenario, but notes that it is consistent with the implied (if not observed) reduction in fishing mortality contingent on the effort regulation scheme, the increased control and enforcement measures during 2004 within the UK and the reduced incentive to mis-report through the lease or purchase of quota formerly available to the now decommissioned UK vessels.

The results of this forecast are presented in **Table** 3.8.4 and imply a fishing mortality during 2004 of 0.53 with corresponding landings of 41kt and an SSB at the start of 2005 of 60kt. **Figures** 3.8.1–3.8.3 presents the sensitivity analysis, probability profiles and short term forecast plots for this stock projection scenario.

3.9 Medium-Term Projections

No medium-term predictions have been undertaken for cod at the present meeting.

3.10 Biological Reference Points

The PA reference points for cod in IIIa (Skagerrak), IV and VIId have been unchanged since 1999. They are:

Reference point:

$\mathbf{B}_{lim}$ 70 000 t. $\mathbf{B}_{pa}$ 150 000 t.
$\mathbf{F}_{lim}$: 0.86 $\mathbf{F}_{pa}$ 0.65

Technical basis:

$\mathbf{B}_{lim}$ Rounded $\mathbf{B}_{loss}$. The lowest observed spawning stock biomass.
$\mathbf{B}_{pa}$ The previously agreed MBAL and affords a high probability of maintaining SSB above $\mathbf{B}_{lim}$, taking into account the uncertainty of assessments. Below this value the probability of below average recruitment increases. Previous MBAL and signs of impaired recruitment below: 150 000 t.
$\mathbf{F}_{lim}$ $\mathbf{F}_{loss}$
$\mathbf{F}_{pa}$ Approx. 5th percentile of $\mathbf{F}_{loss}$

Changes to the range of ages used for the assessment of this stock resulting from the lack of reliable tuning information at the oldest ages and the addition of discard data necessitate a recalculation of the PA reference points for this stock. The PA soft program was therefore applied to the stock and exploitation estimates derived from the ADAPT model based on the fit to landings and discards. The stock and recruit time series used for the estimation of reference points was 1963–2002, that is the 1962–2001 year classes.

The PAsoft diagnostic program was used to examine the appropriate settings for the span of the calculation for Gloss. There is a minimum value in the Akaike information index at spans lower than 0.8 (**Figure** 3.10.1) therefore this value was used in the estimation of the reference point.

Figure 3.10.2 and **Table** 3.10.1 present the PAsoft output from the reference point estimation procedure.

The revised assessment model and inclusion of discards set has not significantly altered the structure in the scatter plot of the estimates of SSB and recruitment. This implies that the position of the break point in the stock and recruitment plot is unchanged at about 150,000t. There remains a high probability of poor recruitment at SSB below this value. ACFM has previously recommended that this value should be used as $\mathbf{B}_{pa}$ but this is currently under review.

Using the previously applied criteria for the selection of fishing mortality reference points (ACFM report 2002) $\mathbf{F}_{lim} = \mathbf{F}_{loss}$, the new deterministic estimate of $\mathbf{F}_{loss}$ for the assessment including discards is 0.94 and the median of the bootstrapped values 1.01. Using the previous ACFM formulation $\mathbf{F}_{pa}$ is therefore taken from the 5th percentile of $\mathbf{F}_{loss}$ and is estimated to be 0.80. This compares with the previous value of 0.65 when the assessment data does not include discards.

The WG notes that the $\mathbf{F}_{loss}$ estimate may be an over-estimate. The PAsoft diagnostic plots indicate that the non-parametric smoother is over estimating the majority of the recent low recruitment, near to the origin of the stock and recruitment relationship. Given that the region around the origin of the stock and recruitment curve is currently being explored, and that there is a well defined curvature in the pairs of estimates, the WG consider that a parametric model estimate of the slope at the origin may be more robust to random variation in recent recruitment. This should be examined in detail before the $\mathbf{F}_{lim}$ and $\mathbf{F}_{pa}$ values are revised.

The results of long-term equilibrium yield and SSB-per-recruit analyses are given in **Figure** 3.10.2.

The estimates of biological reference points and management reference points for the cod assessment including discards are given in the text **Tables** below.

Biological reference point	2004 estimate
$\mathbf{F}_{max}$	0.20
$\mathbf{F}_{0.1}$	0.13
$\mathbf{F}_{med}$	0.80

3.11 State of the stock

The general perception of the cod stock remains unchanged from recent assessments. All sources of information indicate that the mortality rate has remained high since the late 1970s. There has been an apparent reduction in fishing mortality in 2001 and 2002. However, the magnitude of the reduction is uncertain.

The proportion of mature individuals in the stock and the catches remains very low. Only about 5% of individuals at age 1 survive to age 5.

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.

Recruitment of 1 year old cod has varied considerably since the 1960s but since 1997 average recruitment has been lower than any other time. There are no indications of a strong year-class of cod since 1996, a year class that was a prominent feature in all surveys and was heavily exploited by the fishery at ages 1-5. The incoming 2003 year class is estimated to be close to the average of the recent low values.

3.12 Management considerations

There is a need to maintain a low 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). 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.

Cod is a specific target for some fleets, but the majority of cod in the North Sea are caught (landings and discards) in mixed demersal fisheries. This means it is important to take into account the impact of the management of cod on other stocks, especially haddock and whiting, although fishing opportunities for other commercially important stocks will also be affected. The reverse is also true. Comparisons between the extent of the reduction in fishing mortality on haddock in 2003 compared to that on cod indicate that some degree of de-coupling may have occurred in 2003.

Recent measures to protect North Sea cod, such as the 2001 closed area, and proposals to increase mesh size, will most likely have a greater beneficial effect to stocks other than cod. Any benefits for cod by such measures are likely to be through reduced discarding of fish below the minimum landing size. The discard data available to the WG do not indicate a substantial decline in discards at the youngest ages in recent years.

It is considered that conclusions drawn from the trends in the historic stock dynamics and exploitation rates are robust to the uncertainty in the level of recent recorded catches. A sensitivity analysis has shown that the recent stock trends are largely unaffected by the measured rate of discarding but are highly sensitive, especially estimates of fishing mortality, to bias in the reported landings.

Table 3.1.1. Nominal landings (in tonnes) of COD in IIIa (Skagerrak), IV and VIId, 1984–2003 as officially reported to ICES and as used by the Working Group.

Sub-area IV

Country	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Belgium	5,804	4,815	6,604	6,693	5,508	3,398	2,934	2,331	3,356	3,374
Denmark	46,751	42,547	32,892	36,948	34,905	25,782	21,601	18,998	18,479	19,547
Faroe Islands	-	71	45	57	46	35	96	23	109	46
France	8,129	4,834	8,402	8,199	8,323	2,578	1,641	975	2,146	1,868
Germany	13,453	7,675	7,667	8,230	7,707	11,430	11,725	7,278	8,446	6,800
Netherlands	25,460	30,844	25,082	21,347	16,968	12,028	8,445	6,831	11,133	10,220
Norway	7,005	5,766	4,864	5,000	3,585	4,813	5,168	6,022	10,476	8,742
Poland	7	-	10	13	19	24	53	15	-	-
Sweden	575	748	839	688	367	501	620	784	823	646
UK (E/W/NI)	35,605	29,692	25,361	29,960	23,496	18,375	15,622	14,249	14,462	14,940
UK (Scotland)	54,359	60,931	45,748	49,671	41,382	31,480	31,120	29,060	28,677	28,197
United Kindom										
Total Nominal Catch	197,148	187,923	157,514	166,806	142,306	110,444	99,025	86,566	98,107	94,380
Unallocated landings	7,723	6,773	11,292	15,288	14,253	5,256	5,726	1,967	-758	10,200
WG estimate of total landings	**204,871**	**194,696**	**168,806**	**182,094**	**156,559**	**115,700**	**104,751**	**88,533**	**97,349**	**104,580**
Agreed TAC	**215,000**	**250,000**	**170,000**	**175,000**	**160,000**	**124,000**	**105,000**	**100,000**	**100,000**	**101,000**

Division VIId

Country	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Belgium	331	501	650	815	486	173	237	182	187	157
Denmark	-	-	4	-	+	+	-	-	1	1
France	2,492	2,589	9,938	7,541	8,795	n/a	n/a	n/a	2,079	1,771
Netherlands	-	-	-	-	1	1	-	-	2	-
UK (E/W/NI)	282	326	830	1,044	867	562	420	341	443	530
UK (Scotland)	-	-	-	-	-	-	7	2	22	2
United Kingdom										
Total Nominal Catch	3,105	3,416	11,422	9,400	10,149	n/a	n/a	n/a	2,734	2,461
Unallocated landings	419	-111	3,722	4,819	580	-	-	-	-65	-29
WG estimate of total landings	**3,524**	**3,305**	**15,144**	**14,219**	**10,729**	**5,538**	**2,763**	**1,886**	**2,669**	**2,432**

Division IIIa (Skagerrak) (not official statistics as these are only reported for the entire Division IIIa. The numbers below are as used by the WG)

Country	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Denmark	17,443	14,521	18,424	17,824	14,806	16,634	15,788	10,396	11,194	11,997
Sweden	1,981	1,914	1,505	1,924	1,648	1,902	1,694	1,579	2,436	2,574
Norway	311	193	174	152	392	256	143	72	270	75
Germany	-	-	-	-	-	12	110	12	-	-
Others	156	-	-	-	106	34	65	12	102	91
Norwegian coast *	1,187	990	917	838	769	888	846	854	923	909
Danish industrial by-catch *	1,084	1,751	997	491	1,103	428	687	953	1,360	511
Total Nominal Catch	19,891	16,628	20,103	19,900	16,952	18,838	17,800	12,071	14,002	14,737
WG estimate of total landings	**19,891**	**16,628**	**20,103**	**19,900**	**16,952**	**18,697**	**17,800**	**12,059**	**14,002**	**14,737**
Agreed TAC	**28,000**	**29,000**	**29,000**	**22,500**	**21,500**	**20,500**	**21,000**	**15,000**	**15,000**	**15,000**

Table 3.1.1. cont'd

Sub-area IV, Divisions VIId and IIIa (Skagerrak) combined

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Total Nominal Catch	220,144	207,967	189,039	196,106	169,407	n/a	n/a	n/a	114,843	111,578
Unallocated landings	8,142	6,662	15,014	20,106	14,833	-	-	-	-823	10,171
WG estimate of total landings	**228,286**	**214,629**	**204,053**	**216,212**	**184,240**	**139,936**	**125,314**	**102,478**	**114,020**	**121,749**

Table 3.1.1. cont'd. **Nominal landings (in tonnes) of COD in IIIa (Skagerrak), IV and VIId, 1984–2003 as officially reported to ICES and as used by the Working Group.**

Sub-area IV

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Belgium	2,648	4,827	3,458	4,642	5,799	3,882	3,304	2,470	2,616	1,482*
Denmark	19,243	24,067	23,573	21,870	23,002	19,697	14,000	8,358	9,022	4,676
Faroe Islands	80	219	44	40	102	96				
France	1,868	3,040	1,934	3,451	2,934*	1,750[1]*	1,222	717	1,777	617
Germany	5,974	9,457	8,344	5,179	8,045	3,386	1,740	1,810	2,018	2,048
Netherlands	6,512	11,199	9,271	11,807	14,676	9,068	5,995	3,574	4,707	2,305*
Norway	7,707	7,111	5,869	5,814	5,823	7,432	6,410	4,383*	4,994*	4,518*
Poland	-	-	18	31	25	19	18	18	39	35*
Sweden	630	709	617	832	540	625	640	661	463	252
UK (E/W/NI)	13,941	14,991	15,930	13,413	17,745	10,344	6,543	4,087	3,112	2,213
UK (Scotland)	28,854	35,848	35,349	32,344	35,633	23,017	21,009	15,640	15,416	7,852
United Kindom										
Total Nominal Catch	87,457	111,468	104,407	99,423	114,324	79,316	60,881	41,718	44,164	25,998
Unallocated landings	7,066	8,555	2,161	2,746	7,779	-924	-1,114	-745	136	-151
WG estimate of total landings	**94,523**	**120,023**	**106,568**	**102,169**	**122,103**	**78,392**	**59,767**	**40,973**	**44,300**	**25,847**
Agreed TAC	**102,000**	**120,000**	**130,000**	**115,000**	**140,000**	**132,400**	**81,000**	**48,600**	**49,300**	**27,300**

Division VIId

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Belgium	228	377	321	310	239	172	110	93	51	54*
Denmark	9	-	-	-	-	-	-	-	-	
France	2,338	3,261	2,808	6,387	7,788*		3,084	1,677	1,361	1,127
Netherlands	-	-	+	-	19	3	4	17	6	36*
UK (E/W/NI)	312	336	414	478	618	454	385	249	145	121
UK (Scotland)	+	+	4	3	1	-	-	-	-	
United Kingdom										
Total Nominal Catch	2,887	3,974	3,547	7,178	8,665	629	3,583	2,036	1,563	1,338
Unallocated landings	-37	-10	-44	-135	-85	6,229	-1,258	-463	1,534	-104
WG estimate of total landings	**2,850**	**3,964**	**3,503**	**7,043**	**8,580**	**6,858**	**2,325**	**1,573**	**3,097**	**1,234**

Division IIIa (Skagerrak) (not official statistics as these are only reported for the entire Division IIIa. The numbers below are as used by the WG)

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Denmark	11,953	8,948	13,573	12,164	12,340	8,734	7,683	5,901	5,524	3,070
Sweden	1,821	2,658	2,208	2,303	1608	1,909	1,350	1,035	1,716	509
Norway	60	169	265	348	303	345	301	134	146	193
Germany	301	200	203	81	16	54	9	32	83	-
Others	25	134	-	-	-	-	-	-	-	-
Norwegian coast *	760	846	748	911	976	788	624	846	n/a	n/a
Danish industrial by-catch *	666	749	676	205	97	62	99	687	n/a	n/a
Total Nominal Catch	14160	12109	16249	14896	14267	11042	9343	7102	7469	3772
Unallocated landings	-899	0	0	50	1,064	-68	-66	-16	-1	19
WG estimate of total landings	**13,261**	**12,109**	**16,249**	**14,946**	**15,331**	**10,974**	**9,277**	**7,086**	**7,468**	**3,791**
Agreed TAC	**15,500**	**20,000**	**23,000**	**16,100**	**20,000**	**19,000**	**11,600**	**7,000**	**7,100**	**3,900**

Table 3.1.1. cont'd

Sub-area IV, Divisions VIId and IIIa (Skagerrak) combined

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Total Nominal Catch	104,504	127,551	124,203	121,497	137,256	90,987	73,807	50,856	53,196	31,108
Unallocated landings	6,130	8,545	2,117	2,661	8,758	5,238	-2,438	-1,224	1,669	-236
WG estimate of total landings	**110,634**	**136,096**	**126,320**	**124,158**	**146,014**	**96,225**	**71,369**	**49,632**	**54,865**	**30,872**

* Preliminary
[1] includes IIa(EC)

Table 3.1.2. Percentage cod discards at age recorded during 1994 – 2003 from English vessels fishing in ICES Sub-area IV.

		Percentage discards at age								
Year	Quarter	0	1	2	3	4	5	6	7	7+
1994	1		100	25	1	0	0	0	0	0
	2		100	30	0	0	0	0	0	0
	3		92	12	0	0	0	0	0	0
	4	100	40	0	0	0	0	0		
1995	1		100	30	0	0	0	0	0	0
	2		91	8	0	0	0	0	0	0
	3		74	7	0	0	0	0		
	4	100	36	0	0	0	0	0	0	0
1996	1		100	9	0	0	0	0	0	
	2		100	5	0	0	0	0	0	0
	3		58	5	0	0	0	0	0	0
	4	100	73	0	0	0	0		0	0
1997	1		100	42	0	0	0	0	0	
	2		100	17	0	0	0	0	0	0
	3		79	22	0	0	0	0	0	0
	4	100	68	14	0	0	0	0	0	0
1998	1		100	49	0	0	0	0	0	0
	2		65	34	0	0	0	0	0	0
	3		90	21	0	0	0	0	0	
	4		55	1	0	0	0	0	0	
1999	1		100	65	20	5	0	0	0	0
	2		0	0	0	0				
	3		78	2	1	0	0	0	0	0
	4	100	74	0	0	0	0	0	0	0
2000	1		100	16	0	0	0	0		0
	2		97	3	0	0	0	0		
	3	100	88	5	0	0	0	0		0
	4		61	16	0	0	0			
2001	1		100	48	0	0	0	0	0	
	2		97	19	0	0	0	0	0	
	3		89	14	0	0	0	0		
	4	100	59	4	15	0	0		0	
2002	1		100	44	7	0	0	0	0	
	2		94	64	4	0	0	0	0	100
	3		33	25	0	0	0	0	0	
	4		63	23	0	0	0	0		
2003	1		100	31	0	11	0	0	0	
	2			33	9	0	0	0	0	
	3		96	7	0	0	0			
	4	100	63	2	0	0	0			

Table 3.2.1 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 3.2.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Landings numbers at age (Thousands)

Run title : Cod North Sea/Skaggerak/Eastern Channel 20/08/2004
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Table 1 Catch numbers at age Numbers*10**-3

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	3214	5030	15813	18224	10803	5829	2947	54493	44824	3832	25966
2	42591	22493	51888	62516	70895	83836	22674	33917	155345	187686	31755
3	7030	20113	17645	29845	32693	42586	31578	18488	17219	48126	54931
4	3536	4308	9182	6184	11261	12392	13710	13339	6754	5682	14072
5	2788	1918	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	13	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	56505	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
1	4938	23769	1255	5941	8294	2217	7192	410
2	36805	29194	81737	9731	23033	20804	7870	9815
3	23364	18646	16958	32224	6472	6192	13252	3584
4	3169	6499	5967	4034	6697	1141	2519	2724
5	1860	1238	2402	1445	1021	1078	366	460
6	399	700	509	626	385	144	349	68
7	162	153	236	223	139	84	51	50
8	88	47	41	91	40	27	31	13
9	43	14	16	14	18	14	13	7
10	4	15	4	10	5	6	5	3
+gp	8	10	12	2	1	1	0	1
TOTALNUM	70837	80285	109137	54341	46105	31710	31649	17134
TONSLAND	126320	124158	146014	96225	71371	49632	54865	30872
SOPCOF %	100	100	100	100	100	100	100	100

Table 3.2.3 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Landings mean weight at age

Run title : Cod North Sea/Skaggerak/Eastern Channel 20/08/2004
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Table 2 Catch weights at age (kg)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.538	0.496	0.581	0.579	0.59	0.64	0.544	0.626	0.579	0.616	0.559
2	1.004	0.863	0.965	0.994	1.035	0.973	0.921	0.961	0.941	0.836	0.869
3	2.657	2.377	2.304	2.442	2.404	2.223	2.133	2.041	2.193	2.086	1.919
4	4.491	4.528	4.512	4.169	3.153	4.094	3.852	4.001	4.258	3.968	3.776
5	6.794	6.447	7.274	7.027	6.803	5.341	5.715	6.131	6.528	6.011	5.488
6	9.409	8.52	9.498	9.599	9.61	8.02	6.722	7.945	8.646	8.246	7.453
7	11.562	10.606	11.898	11.766	12.033	8.581	9.262	9.953	10.356	9.766	9.019
8	11.942	10.758	12.041	11.968	12.481	10.162	9.749	10.131	11.219	10.228	9.81
9	13.383	12.34	13.053	14.059	13.589	10.72	10.384	11.919	12.881	11.875	11.077
10	13.756	12.54	14.441	14.746	14.271	12.497	12.743	12.554	13.147	12.53	12.359
+gp	0	14.998	15.6669	15.6718	19.0163	11.5951	11.5675	14.3667	15.5441	14.3504	12.886
SOPCOFAC	0.9998	0.9999	1	1.0001	1.0001	0.9999	0.9999	1	0.9999	1.0001	0.9999

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.594	0.619	0.568	0.542	0.572	0.55	0.55	0.723	0.589	0.632	0.594
2	1.039	0.899	1.029	0.948	0.937	0.936	1.003	0.837	0.962	0.919	1.007
3	2.217	2.348	2.47	2.16	2.001	2.411	1.948	2.189	1.858	1.835	2.156
4	4.156	4.226	4.577	4.607	4.146	4.423	4.401	4.615	4.13	3.88	3.972
5	6.174	6.404	6.494	6.713	6.531	6.58	6.109	7.045	6.784	6.491	6.19
6	8.333	8.691	8.62	8.828	8.667	8.475	9.12	8.884	8.903	8.423	8.362
7	9.889	10.107	10.132	10.071	9.686	10.637	9.55	9.934	10.399	9.848	10.317
8	10.79	10.91	11.341	11.052	11.099	11.55	11.867	11.519	12.5	11.837	11.352
9	12.175	12.339	12.888	11.824	12.427	13.057	12.782	13.338	13.469	12.797	13.505
10	12.425	12.976	14.14	13.134	12.778	14.148	14.081	14.897	12.89	12.562	13.408
+gp	13.7308	14.4309	14.5568	14.3616	13.9808	15.478	15.3918	16.6291	14.6081	14.4263	13.4716
SOPCOFAC	0.9999	0.9998	1	0.9999	1.0035	1.0087	0.9963	0.9985	0.9946	0.9968	0.9993

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.59	0.583	0.635	0.586	0.673	0.737	0.67	0.699	0.699	0.678	0.721
2	0.933	0.856	0.976	0.881	1.052	0.976	1.078	1.146	1.065	1.075	1.02
3	2.14	1.834	1.955	1.982	1.846	2.176	2.037	2.546	2.479	2.201	2.21
4	4.164	3.504	3.65	3.187	3.585	3.791	3.971	4.223	4.55	4.471	4.292
5	6.324	6.23	6.052	5.992	5.273	5.932	6.083	6.248	6.54	7.167	7.22
6	8.43	8.14	8.307	7.914	7.921	7.889	8.034	8.483	8.094	8.436	8.98
7	10.362	9.896	10.242	9.764	9.725	10.235	9.545	10.102	9.641	9.536	10.283
8	12.073	11.939	11.461	12.127	11.211	10.924	10.949	10.481	10.735	10.323	11.743
9	13.072	12.951	12.447	14.242	12.586	12.802	13.481	11.85	12.329	12.224	13.107
10	14.443	13.859	18.691	17.787	15.557	15.525	13.17	13.905	13.443	14.247	12.052
+gp	16.5876	14.7073	16.6043	16.4767	14.6939	23.2341	14.9889	15.7944	13.9612	12.5231	13.9541
SOPCOFAC	0.9952	1.0098	0.9968	1	0.995	0.9945	0.997	0.9928	0.9948	0.9941	0.9836

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003
1	0.699	0.656	0.542	0.64	0.621	0.725	0.758	0.608
2	1.117	0.96	0.922	0.935	1.03	1.004	1.082	1.173
3	2.147	2.12	1.724	1.663	1.737	2.303	1.916	1.848
4	4.034	3.821	3.495	3.305	3.196	3.663	3.857	3.255
5	6.637	6.228	5.387	5.726	4.83	5.871	5.372	5.185
6	8.494	8.394	7.563	7.403	7.411	7.332	7.991	7.409
7	9.729	9.979	9.628	8.582	9.532	9.264	9.627	8.704
8	11.08	11.424	10.643	10.365	10.952	10.081	10.403	12.178
9	12.264	12.3	11.499	11.6	11.914	12.062	10.963	12.851
10	12.756	12.761	13.085	12.33	12.437	12.009	12.816	10.772
+gp	11.3036	13.4162	14.9208	11.9259	15.0776	10.1952	11.8422	17.5069
SOPCOFAC	0.999	1.0002	0.9998	1.0034	1.0002	1.0001	1.0001	0.9999

Table 3.2.4 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Discard numbers at age

Run title : Cod North Sea/Skaggerak/Eastern Channel 20/08/2004
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Discard numbers at age Numbers*10**-3

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	15043	7432	93840	104296	48299	30045	2425	51493	249475	37039	82279
2	18539	5695	6324	21292	23793	22168	9963	8417	35866	57463	16651
3	30	106	86	68	154	190	109	148	45	172	236
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	33613	13233	100249	125656	72245	52404	12498	60057	285387	94674	99166

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	117784	123776	206340	394689	24353	572445	1156680	153431	178144	51390	533311
2	15064	14687	75277	39853	70934	4963	16294	32166	7755	10560	10953
3	67	0	168	417	0	0	0	63	87	20	4
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	132915	138463	281785	434959	95287	577409	1172975	185660	185986	61970	544268

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	56953	501956	22405	14026	170046	31498	46369	90602	30155	260406	38594
2	34916	3937	53130	15876	6938	43623	7390	8439	25704	14225	39087
3	96	260	0	182	392	55	401	2	9	144	24
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	91965	506153	75535	30084	177376	75176	54160	99043	55868	274775	77704

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003
1	13410	57334	13606	21523	33629	4472	10812	7973
2	19873	11570	80433	4202	4790	29983	2046	8084
3	656	33	1107	7294	0	609	1625	912
4	0	0	0	0	0	0	0	65
5	0	0	0	0	0	0	0	11
6	0	0	0	0	0	0	0	1
7	0	0	0	0	0	0	0	1
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0
TOTALNUM	33939	68938	95146	33019	38418	35064	14483	17046

Table 3.2.5 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Dicard weights at age

Run title : Cod North Sea/Skaggerak/Eastern Channel 20/08/2004
At 13/09/2004 21:31

Discard weights at age (kg)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.27	0.27	0.269	0.269	0.269	0.269	0.268	0.268	0.268	0.268	0.268
2	0.393	0.393	0.392	0.392	0.392	0.392	0.392	0.392	0.392	0.392	0.392
3	0.505	0.508	0.506	0.509	0.506	0.505	0.504	0.505	0.508	0.507	0.507
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.268	0.227	0.189	0.255	0.287	0.276	0.242	0.279	0.274	0.297	0.27
2	0.392	0.359	0.354	0.382	0.309	0.361	0.411	0.396	0.489	0.458	0.469
3	0.508	0	0.412	0.376	0	0	0	0.517	0.593	0.534	0.509
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.276	0.242	0.237	0.3	0.326	0.26	0.315	0.314	0.274	0.287	0.316
2	0.376	0.365	0.353	0.339	0.431	0.371	0.366	0.408	0.429	0.362	0.404
3	0.652	0.437	0	0.463	0.484	0.526	0.395	2.309	0.705	0.483	0.553
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003
1	0.342	0.313	0.358	0.257	0.298	0.232	0.294	0.259
2	0.38	0.453	0.375	0.389	0.422	0.361	0.42	0.344
3	0.515	0.616	0.481	0.422	0	0.406	0.34	0.54
4	0	0	0	0	0	0	0	0.675
5	0	0	0	0	0	0	0	2.272
6	0	0	0	0	0	0	0	2.849
7	0	0	0	0	0	0	0	3.585
8	0	0	0	0	0	0	0	5.033
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	5.771

Table 3.3.1 COD in IIIa (Skagerrak), IV and VIId: Scottish Trawl. Ages 1-10. Effort in column one is hours fished (Including discards)

SCOTRL_IV

1978	2003									
1	1	0	1							
1	10									
135220	409.35	1474.496	285.8833	181.9258	63.9739	15.99347	11.99511	6.997144	2.998776	0.999592
87467	279.8442	925.261	447.2435	73.87503	46.92063	22.96116	11.97974	3.993245	2.994933	0.998311
55475	247.8763	921.5746	379.3265	127.3929	19.96455	19.96455	7.605545	6.654851	0.950693	1.901386
51553	109.3078	992.8969	387.6827	113.6954	51.25613	13.97894	5.591578	1.863859	0.93193	0.93193
47889	708.2266	310.4488	392.9126	73.23587	17.39352	6.408139	2.746345	0.915448	0.915448	0
48339	358.3487	1471.041	208.3826	112.4297	23.26131	9.692212	1.938442	0	0	0.969221
34574	459.2087	787.6639	346.0258	32.72631	16.83067	7.480299	0.935037	0.935037	0	0
33103	177.5764	1003.979	196.0045	79.31344	9.116488	4.558244	2.734946	0.911649	0.911649	0
27839	619.7301	194.4787	256.0416	19.91435	10.43132	0.948302	0.948302	0	0	0
27208	294.4729	891.5172	38.46321	39.40134	8.443145	1.876254	0	0.938127	0	0
21559	32.12963	374.3775	159.5134	8.07663	8.07663	4.038315	1.009579	1.009579	0	0
16657	398.0894	62.98812	136.7382	40.92921	2.974049	2.233094	1.19371	0.186866	0.725151	0.079953
14325	70.0218	427.7629	18.79561	22.48633	5.118328	1.214538	1.003704	0.225413	0	0
13495	135.025	109.5013	103.953	7.730703	6.99791	1.717706	0.482721	0	0.027672	0
10887	797.19	103.8477	30.2392	33.29115	1.15342	1.210886	0.120062	0.029759	0.053361	0
11657	66.56156	197.3851	31.23236	4.272787	6.325061	0.634283	0.055382	0.001045	0	0
15671	157.2719	41.89827	124.9601	9.460851	1.712914	1.656455	0.520226	0.37303	0	0
17728	71.63212	482.127	93.74244	49.03211	1.500962	0.465057	0.538377	0.034565	0.019901	0.199011
13471	6.349531	142.4422	108.3843	23.9094	15.04451	1.5798	0.200256	0.356011	0.002023	0.017194
12651	305.5104	88.36956	91.36169	26.78548	4.987823	2.978304	0.730642	0.104377	0.00912	0
25744	242.2595	1475.276	161.5658	91.32574	20.54947	6.612289	3.318138	0.714599	1.10E-02	0.169905
23859	106.704	127.215	819.216	45.336	23.229	5.972	4.037	2.009	0.417	0.358
21320	649.464	581.585	76.825	164.579	25.919	14.448	7.8	1.014	0.292	0.109
11897	183.86	977.54	107.302	12.17	20.422	3.53	1.518	0.874	0.327	0.092
10480	238.473	231.259	412.183	32.258	2.906	10.843	3.297	2.036	1.035	0
7186	88.585	202.61	121.085	87.317	7.419	0.606	1.367	0.427	0.345	0

Table 3.3.1 Cont'd. COD in IIIa (Skagerrak), IV and VIId: Scottish Seine. Ages 1-12. Effort in column one is hours fished (Including discards)

SCOSEI_IV												
1978	2003											
1	1	0	1									
1	12											
325246	3651.878	24305.32	1385.952	850.9705	201.993	47.99834	22.99921	20.99928	7.999723	2.999897	1.999931	0.999966
316419	11805.66	8634.839	3257.039	382.887	344.8983	66.98024	43.98702	18.9944	11.99646	3.99882	0	1.99941
297227	44564.51	8048.976	2341.237	828.8259	144.3705	89.57929	33.04867	14.78493	8.697019	4.348509	0.869702	0
289672	4649.446	17426.21	2365.833	698.6884	204.8165	18.1692	10.73635	12.38809	3.303491	0	0	0
297730	17237.39	5730.45	6034.887	822.2935	291.1069	151.4091	25.09542	20.91286	11.7112	0.836514	1.673028	0.836514
333168	5816.789	15348.75	1817.754	1289.703	227.4941	98.35269	39.34108	18.8153	15.39433	2.565722	4.276204	0
388085	32443.86	11777.36	3784.819	453.7518	381.2589	108.2919	46.53865	25.95425	6.264818	7.159792	3.579896	1.789948
382910	5076.408	22569.68	2515.926	835.2875	127.1874	107.3426	26.15911	24.35504	9.922422	3.608154	3.608154	0
425017	63834.96	3301.307	6910.345	824.8633	285.8161	42.82586	38.17088	13.96496	7.447976	2.792991	2.792991	0
418536	4526.886	25093.95	680.2406	1423.568	283.4336	186.5176	24.68615	35.65777	15.54313	4.571509	1.828604	0.914302
377132	3832.935	9997.084	4672.046	201.9924	471.9823	131.9951	55.9979	15.9994	9.999625	2.999887	2.999887	3.99985
355735	13456.02	4646.699	3251.37	1092.297	91.15594	185.0664	44.65026	18.69781	2.391308	7.743597	2.613733	0.591258
270869	5255.092	21460.95	1112.953	671.5308	291.6038	38.80657	50.40748	11.53376	3.699487	1.792674	0.099593	0.27528
336675	8860.262	6493.976	3088.675	241.3702	173.9244	113.1636	32.98114	25.22875	7.592064	0.570267	0.390664	0.14206
300217	10044.17	5956.925	942.4573	618.2141	97.90319	59.25222	31.80537	8.852039	8.416391	3.234635	0.997082	1.476704
268413	2947.92	9677.088	778.997	208.9325	142.3878	26.4007	19.57215	9.164559	2.347157	0.806043	0.543446	0.077056
264738	10803.36	5124.046	2416.562	301.2221	60.53988	37.71629	13.2818	5.076709	2.266693	0.872732	0.537298	1.071582
204545	7584.973	13810.35	916.6366	496.5739	84.51649	21.55696	16.61581	0.91366	0.96664	0.902664	1.266528	0.219918
177092	733.4724	5540.032	2728.724	239.2006	165.1076	19.69878	8.662095	5.687598	1.848795	1.187796	0.487737	0.14522
166817	6484.63	4257.157	1586.048	687.7692	118.7261	71.21364	17.32534	6.006303	2.108448	0.850117	0.730229	0
150361	454.3057	15319.53	1250.237	423.2973	287.2965	46.10329	29.68486	4.187283	0.993094	0.802718	0.25318	0
93796	2589.308	748.768	3354.515	140.141	88.419	37.97	10.232	7.249	2.031	0.067	0.056	0.05
69505	2057.803	2319.915	115.111	401.656	55.626	24.218	9.986	5.275	1.823	0.163	0.124	0
36135	173.939	5090.058	307.77	24.817	64.284	10.45	5.353	2.017	1.587	0.86	0.12	0.022
21831	307.716	443.255	1315.383	93.789	14.339	23.177	2.671	1.919	0.617	0.284	0.184	0
15373	282.6332	924.427	154.135	180.353	18.167	2.082	3.263	0.444	0.657	0.037	0.015	0.005

Table 3.3.1 Cont'd. COD in IIIa (Skagerrak), IV and VIId: Scottish Light trawl. Ages 1-11. Effort in colimn 1 is hours fished (Including discards)

SCOLTR_IV											
1978	2003										
1	1	0	1								
1	11										
236929	3563.496	6140.808	670.8813	269.9522	50.99097	27.99505	6.998762	7.998584	4.999115	0	0.999823
207494	59063.64	5976.786	1808.121	178.0119	61.00409	15.001	3.000201	4.000268	2.000134	0	0
333197	116771.3	5763.403	2100.709	549.1993	71.40472	15.86772	4.407699	3.526159	0.88154	0	0
251504	8520.899	5931.566	1475.438	293.6062	81.83851	10.96805	5.905871	0	0	0	0.843696
250870	10234.89	3302.19	2303.319	377.3817	109.9951	39.34785	8.048424	6.259885	3.577077	5.365616	0
244349	4298.235	6519.319	1020.723	459.821	111.1458	31.37181	14.3414	5.378024	2.689012	0.896337	0.896337
240725	24925.01	3487.897	1544.073	180.3689	85.67522	36.07378	9.920289	7.214756	2.705533	0	0
268136	973.9859	6897.385	865.994	293.6529	39.33668	21.04055	3.659226	2.74442	0.914807	0.914807	0
279767	6008.823	1198.853	1849.553	250.9651	95.65086	12.3115	8.523344	4.735191	1.894076	0.947038	0
351131	3343.454	7206.319	530.2775	468.273	45.34659	31.46498	10.17985	5.552644	0.925441	0.925441	0
391988	718.7831	3936.688	1919.598	133.3749	148.4171	33.09301	14.03946	2.005637	1.002819	0	1.002819
405883	8549.296	1550.909	1616.046	565.7122	48.60529	45.2361	13.34317	3.38168	0.893709	0.256581	1.048427
398153	1367.276	9253.556	525.4563	456.8287	179.5233	25.74575	11.32401	3.712067	0.999011	0.127846	0.015839
408056	5550.412	2470.334	2152.873	138.0389	94.18764	48.09913	8.198981	8.481565	1.205553	0.028462	0
473955	14015.88	3034.779	748.3596	646.7289	44.07698	36.368	11.91228	2.053066	2.020331	0.219935	0.122754
447064	3493.383	6959.532	1262.558	163.9833	80.12223	9.88541	5.160946	3.794121	0.415991	0.211069	0.210045
480400	4978.661	2325.239	2367.073	370.5925	47.31199	42.37136	5.791775	2.345689	0.299924	0.22393	0.144896
442010	2420.854	9246.369	1579.927	797.1688	73.98882	8.576699	6.861158	0.636685	0.882335	0.554467	0.114303
445995	1436.903	5317.354	3114.515	424.1476	296.4993	31.73013	9.558771	5.477213	1.110849	0.797662	0.113517
479449	8339.782	3709.375	2809.411	808.3259	112.982	114.5114	10.293	0.946728	1.937183	3.067969	1.068756
427868	2486.337	17511.68	1694.537	675.569	193.1438	36.46541	31.4808	2.837979	0.226756	0.233811	0.101
329750	3712.019	1757.858	3913.763	299.8275	160.4792	45.76834	13.62074	7.653232	1.843825	0.630385	4.13E-02
280938	5732.985	3236.786	378.5365	905.9968	70.23299	36.84406	8.206451	6.20034	3.166538	9.25E-02	5.43E-02
245489	318.0813	6565.431	535.7789	83.25088	131.8429	11.16488	9.613866	1.375123	1.362131	1.76E-01	2.48E-01
184103	1545.652	701.137	2072.433	171.2748	38.53872	34.31218	9.563167	8.874635	3.944505	8.60E-01	1.41E-02
98722	425.6158	1290.52	317.5353	433.8435	25.27571	5.618623	6.893836	0.698788	0.752386	2.83E-02	7.89E-02

Table 3.3.1 Cont'd. COD in IIIa (Skagerrak), IV and VIId: English Trawl. Ages 1-12. Effort in column 1 is hours fished (Including discards based on Scottish ogive)

ENGTRL_IV

1978	2003											
1	1	0	1									
1	12											
559930	4286.281	17150.92	1093	987	338	117	57	60	22	4	1	5
553020	53526.49	8150.569	3341	393	403	99	54	15	30	7	0	0
442036	77510.33	4851.411	2106	865	122	114	38	16	6	8	3	0
423658	12210.64	15133.98	1890.779	535	250	38	48	8	6	4	2	0
424272	17618.05	3652.63	3808.614	587	298	179	35	24	11	2	0	0
392364	5143.314	15130.79	1186.742	907	127	87	49	16	4	2	1	0
358387	36713.86	4141.779	2656.27	267	217	42	32	16	3	3	0	0
342844	3952.108	10221.1	1052.532	533	72	54	16	10	4	1	1	0
288867	38689.89	2339.106	2403.338	209	161	15	12	4	2	2	0	0
275899	1705.453	13419.24	682	596	36	26	3	4	2	1	1	0
296092	1806.404	2818.93	2436.241	90	126	17	10	0	2	0	0	0
310444	9209.517	2293.573	736.9495	501	25	34	5	4	0	0	0	0
255314	2153.731	5290.257	515.7698	134	101	11	13	4	1	0	0	0
258037	3416.509	1963.237	1113.923	88	25	17	2	2	0	0	0	0
223702	6218.854	2613.981	481.0823	234	19	5	5	0	0	0	0	0
209869	2179.172	5417.093	442.4967	96	55	5	3	2	0	1	0	0
184764	15928.13	3255.314	1154.464	78.19	14.284	7.036	1.762	0.673	0.847	0.023	0.063	0.002
173463	2737.632	5740.289	873.0717	158.03	11.028	2.992	1.896	0.662	0.132	0.247	0.048	0
159155	1502.486	4428.232	1688.046	189.238	43.97	6.812	1.649	1.464	0.552	0.155	0.003	0.008
152030	3897.965	3372.261	892.0419	334.563	41.12	14.836	2.063	0.781	0.286	0.084	0.173	0.002
161478	1842.657	22614.77	1858.418	243.07	77.418	12.373	4.033	0.807	0.326	0.086	0	0
137699	1781.07	878.0279	2302.694	97.058	11.516	3.962	0.446	0.319	0.043	0.015	0	0
129140	2078.156	1845.977	154.424	143.879	10.037	1.254	0.256	0.166	0.072	0.029	0	0.025
111826	331.8458	2258.866	270.9495	7.983	5.018	0.538	0.213	0.056	0.001	0	0	0
69953	752.0542	540.0665	264.5585	32.047	1.364	1.079	0.117	0.009	0.01	0.004	0	0
53661	217.27	582.1016	69.02214	25.00927	2.914894	0.191703	0.202812	0.021884	0.022	0.005	0.000199	0

Table 3.3.1 Cont'd. COD in IIIa (Skagerrak), IV and VIId: English Seine. Ages 1-12. Column 1 is Effort hours fished (Including discards based on Scottish ogive)

ENGSEI_IV

1978	2001											
1	1	0	1									
1	12											
203382	2605.229	17803.75	746	547	131	78	21	37	9	1	1	2
187180	39918.48	7335.21	2438	162	280	76	35	14	18	4	1	0
201169	80642.77	8866.299	1370	611	146	210	54	29	9	12	4	0
185423	9402.239	14588.24	1056.733	398	359	61	74	12	8	6	3	0
183209	10494.28	3583.168	2477.399	330	294	189	38	31	9	3	2	0
177004	3155.493	5273.114	574.0176	557	207	150	104	18	17	8	3	2
167699	21674.56	1932.847	1215.166	147	290	72	50	32	6	5	1	0
157815	1915.811	4339.895	329.0231	241	72	117	40	27	13	4	2	0
136358	11817.84	397.7102	577.664	65	139	34	52	13	7	7	2	1
123281	753.4219	3560.337	82	184	44	77	10	22	8	2	1	0
91178	519.8114	1131.193	596.8989	19	80	19	12	3	3	1	0	0
88782	3614.582	881.4858	223.5378	138	9	46	7	8	1	2	0	1
80537	731.6764	1778.592	116.9737	45	58	4	15	3	1	1	0	0
84346	971.7097	396.3006	214.2835	33	26	38	6	16	1	1	1	0
67810	1586.26	572.7483	57.02038	42	10	8	8	2	3	0	0	0
54574	288.5182	705.421	41.07595	19	22	4	3	2	0	1	0	0
39667	2478.6	391.5565	139.77	11.373	17.04	14.114	3.077	0.889	0.519	0.07	0.278	0.071
28406	356.6505	713.6282	83.35091	21	5.216	3.742	5.623	3.043	0.608	0.162	0.755	0.085
14991	95.13878	310.3846	170.7331	19.592	16.881	4.434	1.542	1.136	0.148	0.24	0	0
11823	207.0991	113.4073	35.41122	27.906	6.115	5.284	1.7	0.333	0.357	0.26	0.024	0.001
10664	50.75842	578.1492	38.14429	9.665999	11.58	3.732	2.002	0.382	0.126	0.105	0	0
9720	113.2627	41.63449	107.0153	2.902	1.297	0.928	0.329	7.30E-02	0.013	0.014	0	0
10230	88.74635	69.33748	2.275	7.197	0.765	0.853	0.438	1.15E-01	0.166	0.001	0	0.008
8885	4.437132	38.41618	3.399988	0.246	1.045	0.062	0.115	2.00E-02	0.006	0.002	0.003	0.002

Table 3.3.1 Cont'd. COD in IIIa (Skagerrak), IV and VIId: ScoGFS. Ages 1-8

SCOGFS_IV

1982	2004							
1	1	0.5	0.75					
1	8							
100	61.4	35.1	57.2	18.3	9.2	5.9	1.4	0.5
100	32.5	78	18.1	19.7	7.5	2.3	1.5	0
100	81.9	39.1	25.3	5	5.7	1.6	0.5	0.2
100	6.6	114.3	19.7	11.2	3	2.4	0.6	1
100	80.1	10.4	39.6	5.7	3.9	1.9	0.6	0
100	21.9	69.5	3.4	9.2	2.9	0.7	0.2	0
100	16.2	28.8	16.5	2.5	3.3	1.2	0.4	0
100	56.1	13.5	16.8	9.5	2	0.8	0.5	0
100	11.4	49	5.9	7.4	2.6	0.9	0.8	0
100	30.3	15.4	13.3	1.3	0.6	0.4	0.2	0
100	64.2	19.3	7.2	6.7	2.9	1.8	1.2	0.2
100	34.7	74.9	10.1	2.5	1.2	0.3	0	0.1
100	115.8	33.4	28.8	3.1	1.2	0.7	0.2	0
100	47.5	144.3	13	8.5	1.1	0.7	0.4	0
100	31.8	35.6	54.2	7.4	3.4	0.4	0	0
100	99.9	27.8	22.4	10.2	2.2	1	0.2	0
100	10.4	213.4	11.6	5.7	3.7	0.8	0.2	0
100	44	10.3	61.6	2.7	1	0.6	0.3	0
100	70	23.7	2.8	4.4	0	0.8	0.3	0
100	6.9	40.9	6.8	0.3	1.8	0	0	0
100	27.4	12	21.5	1.1	0.6	0.5	0	0
100	11.9	29.4	3.5	5.1	0.5	0	0	0
100	21.5	21.2	27.8	3.4	2.1	0	0	0

Table 3.3.1 Cont'd. COD in IIIa (Skagerrak), IV and VIId:

EngGFS. 1977-1991, Granton trawl

ENGGFS_IV_GRT

1977	1991					
1	1	0.5	0.75			
1	5					
100	6269.55	447.37	323.77	57.3	10.9	0.63
100	2283.89	1249.86	98.52	98.87	13.28	6.62
100	2422.7	579.97	200.13	27.22	35.51	5.59
100	5084.39	670.06	153.25	72.93	10.93	5.32
100	1135.94	1386.46	127.5	38.33	40.04	23.04
100	3237.01	290.46	328.71	52.54	36.96	22.97
100	1539.78	1095.61	120.18	110.36	28.58	22.21
100	6122.1	474.79	177.69	40.54	20.81	7.8
100	429.55	1189.3	107.48	55.66	20.23	21.17
100	3437.94	115.13	202.01	29.3	10.88	1.09
100	1421.91	1065.49	27.86	60.83	14.67	0.57
100	835.52	406.73	198.22	1.31	42.25	3.78
100	2284.99	248.08	118.49	60.89	5.86	5.73
100	608.46	503.78	60.69	13.73	12.09	0
100	751.71	155.24	72.94	12.75	3.63	5.41

1992-2004, GOV trawl. Ages 1-5

ENGGFS_GOV

1992	2004					
1	1	0.5	0.75			
1	6					
100	3708.6	240.98	70.66	54.31	11.97	2.36
100	1128.36	988.6	124.95	24.03	24.81	3.02
100	4008.2	448.86	233.85	28.41	7.58	9.4
100	1561.81	1940.76	181.19	84.49	2.47	2.47
100	1023.15	1102.44	260.28	29.12	30.35	0
100	6147.36	431.9	82.5	38.34	2.26	9.04
100	178.75	2122.3	125.01	12.65	10.28	7.45
100	557.26	84	359.35	19.74	9.46	0
100	1448.25	299.61	22.94	48.34	0	4.52
100	264.39	803	49.11	2.83	6.99	2.36
100	1199.47	222.01	193.28	25.42	0	0
100	205.96	270.408	67.184	49.248	5.32	5.472
100	428.74	147.23	49.73	9.03	12.43	0.0

Table 3.3.1 Cont'd. COD in IIIa (Skagerrak), IV and VIId: IBTS Q1, Ages 1-5.

IBTS_Q1_IV

1976	2004					
1	1	0	0.25			
1	5					
1	7.9	19.9	-1	-1	-1	-1
1	36.7	3.2	-1	-1	-1	-1
1	12.9	29.3	-1	-1	-1	-1
1	9.9	9.3	-1	-1	-1	-1
1	16.9	14.8	-1	-1	-1	-1
1	2.9	25.5	-1	-1	-1	-1
1	9.2	6.7	-1	-1	-1	-1
1	3.9	16.6	2.7	1.8	0.8	1.5
1	15.2	8	3.9	0.9	1	0.9
1	0.9	17.6	3.5	1.7	0.5	1
1	17	3.6	6.8	2.3	1.3	1.1
1	8.8	28.8	1.4	1.7	0.6	0.9
1	3.6	6.1	5.8	0.6	0.9	1.1
1	13.1	6.3	5	2.3	0.4	1
1	3.4	15.2	2	1	1	0.8
1	2.4	4.1	3.4	0.8	0.4	0.8
1	13	4.5	1.2	1	0.3	0.5
1	12.7	19.9	2	0.7	0.6	0.4
1	14.8	4.4	3	0.8	0.5	0.5
1	9.7	22.1	2.8	1.1	0.3	0.3
1	3.5	8	6	0.7	0.6	0.4
1	40	6.9	2.3	1.1	0.4	0.4
1	2.7	26.4	2	0.9	0.5	0.4
1	2.1	1.6	8.1	0.8	0.5	0.5
1	6.6	3.8	0.7	2	0.4	0.5
1	2.8	8.7	1.7	0.2	0.4	0.3
1	7.8	3.4	4.3	0.5	0.1	0.2
1	0.6	3	1	1.4	0.4	0.3
1	7.537	1.328	1.225	0.299	0.407	0.012

Table 3.3.1 Cont'd. COD in IIIa (Skagerrak), IV and VIId: FraGFS. Ages 1-3

FRAgfs

1991	2003		
1	1	0.75	0.85
1	3		
1	0	0.117	0.057
1	1.598	0.082	0.137
1	0.1	0	0.308
1	2.592	0	0.219
1	2.652	0.31	0.093
1	0.154	0.969	0.259
1	32.85	0.158	0.149
1	0.214	6.311	0.385
1	6.253	0.18	0.63
1	2.194	0.687	0.125
1	0.402	0.495	0.33
1	6.088	0.17	0.025
1	0.059	1.019	0.033

Table 3.4.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Tuning diagnostics for the modified ADAPT fitted to the data without discards.

Lowestoft VPA Program

14/09/2004 8:23

Adapt Analysis

Cod North Sea/Skaggerak/Eastern Channel 20/08/2004

CPUE data from file CODIVEF.TUN

Catch data for 41 years : 1963 to 2003. Ages 1 to 7+

Fleet	First year	Last year	First age	Last age	Alpha	Beta
IBTS_Q1_IV	1976	2004	1	5	0	0.25
SCOGFS_IV	1982	2004	1	6	0.5	0.75
ENGGFS_IV_GOV	1992	2004	1	6	0.5	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Fleet	PowerQ ages<x	QPlateau ages>x
IBTS_Q1_IV	1	5
SCOGFS_IV	1	5
ENGGFS_IV_GOV	1	5

Catchability independent of stock size for all ages

Individual fleet weighting not applied

INITIAL SSQ =	167.1807
PARAMETERS =	16
OBSERVATIONS =	339
FINAL SSQ =	77.29828
IFAIL =	0

Table 3.4.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Tuning diagnostics for the modified ADAPT fitted to the data without discards.

Fleet : IBTS_Q1_IV

Log index residuals

Age	1976	1977	1978	1979	1980	1981	1982	1983
1	0.28	0.6	0.08	-0.25	-0.25	-0.97	-0.48	-0.7
2	0.35	-0.88	0.23	-0.45	-0.04	-0.01	-0.31	0.01
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.07
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.21
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.11
6	No data for this fleet at this age							

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0.06	-1.45	-0.01	0.25	-0.28	0.67	0.02	-0.6	0.4	0.9
2	-0.14	0.09	-0.27	0.45	-0.27	0.15	0.65	0.03	-0.16	0.62
3	-0.19	0.17	0.31	-0.12	-0.03	0.65	0.07	0.23	-0.28	-0.02
4	0.05	0.02	0.78	0.04	0.01	0.26	0.16	0.17	-0.02	0.02
5	-0.11	0.06	0.31	0.15	0.08	0.29	0.14	-0.13	-0.24	0.05
6	No data for this fleet at this age									

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.23	0.23	-0.37	1.19	0.29	-0.52	0.25	0.44	0.72	-0.74
2	-0.43	0.41	-0.14	0.05	0.55	-0.52	-0.12	0.28	0.36	-0.49
3	-0.41	-0.02	0.19	-0.39	-0.31	0.35	-0.42	0.14	0.37	-0.19
4	-0.05	-0.37	-0.28	-0.3	-0.23	-0.1	0.47	-0.39	-0.03	-0.01
5	0.26	-0.39	-0.32	-0.14	-0.38	-0.03	0.34	-0.1	-0.23	0.51
6	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5
Mean Log	-10.4859	-9.3541	-9.1986	-9.0177	-8.5681
S.E(Log q)	0.596	0.3796	0.2887	0.2759	0.251

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	0.89	0.787	10.71	0.66	28	0.53376	-10.49
2	0.85	1.521	9.69	0.81	28	0.31685	-9.35
3	0.87	1.229	9.35	0.82	21	0.24776	-9.2
4	0.95	0.441	9.03	0.77	21	0.26621	-9.02
5	1.08	-0.677	8.61	0.79	21	0.2748	-8.57

Table 3.4.3 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Tuning diagnostics for the modified ADAPT fitted to the data without discards.

Fleet : ENGGFS_IV_GOV

Log index residuals

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.64	-0.06
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.51	0.14
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.16	0.18
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.52	0.09
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.47	0.8
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.29	0.06

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.4	-0.09	-0.13	0.8	-0.97	-0.35	0.22	-0.44	0.33	-0.36
2	-0.2	0.61	0.47	-0.19	0.58	-0.92	-0.03	0.4	0.04	-0.41
3	0.11	0.35	0.21	-0.63	-0.01	0.54	-0.65	-0.34	0.17	0.23
4	0.1	0.54	0.04	-0.15	-0.97	-0.09	0.43	-1.05	0.5	0.05
5	0.06	-1.27	0.77	-1.31	-0.21	0.24	99.99	-0.03	99.99	0.46
6	0.88	0.02	99.99	0.73	1.05	99.99	1.01	0.87	99.99	2.07

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	-9.2257	-9.08	-9.3399	-9.6423	-9.7334	-9.7334
S.E(Log q)	0.5035	0.4738	0.3744	0.5297	0.7522	1.0344

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	0.65	4.222	10.25	0.93	12	0.20423	-9.23
2	0.64	3.259	9.89	0.89	12	0.22083	-9.08
3	0.75	1.804	9.57	0.84	12	0.25703	-9.34
4	0.7	1.304	9.47	0.66	12	0.36175	-9.64
5	0.82	0.29	9.41	0.24	10	0.64791	-9.73
6	3.39	-1.811	14.71	0.08	9	2.11338	-9.02

Table 3.4.4 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Tuning diagnostics for the modified ADAPT fitted to the data without discards.

Fleet : SCOGFS_IV

Log index residuals

Age	1976	1977	1978	1979	1980	1981	1982	1983
1	99.99	99.99	99.99	99.99	99.99	99.99	-0.3	-0.33
2	99.99	99.99	99.99	99.99	99.99	99.99	-0.16	0.12
3	99.99	99.99	99.99	99.99	99.99	99.99	0.44	0.27
4	99.99	99.99	99.99	99.99	99.99	99.99	0.79	0.64
5	99.99	99.99	99.99	99.99	99.99	99.99	0.75	0.7
6	99.99	99.99	99.99	99.99	99.99	99.99	1	0.52

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0.02	-1.22	-0.15	-0.57	-0.5	0.38	-0.51	0.19	0.24	0.12
2	-0.05	0.48	-0.72	-0.18	-0.23	-0.62	0.3	-0.25	-0.29	0.29
3	0.03	0.22	0.45	-0.93	-0.55	0.24	-0.52	-0.1	-0.26	-0.15
4	0.18	0.3	0.17	0.19	-0.1	0.16	0.59	-0.94	0.29	-0.31
5	0.19	0.39	-0.01	0.27	-0.05	0.52	-0.37	-1.16	0.55	-0.73
6	0.24	0.36	1.02	-0.66	0.5	-0.34	0.81	-1.23	0.93	-0.75

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.52	0.07	0.05	0.34	-0.16	0.77	0.84	-0.43	0.2	0.45
2	-0.06	0.75	-0.22	-0.2	1.02	-0.28	0.17	0.16	-0.14	0.11
3	0.2	-0.1	0.82	0.25	-0.2	0.96	-0.57	-0.13	0.16	-0.54
4	-0.25	0.11	0.54	0.39	0.1	-0.21	-0.1	-1.43	-0.77	-0.35
5	-0.29	-0.58	0.07	0.16	0.26	-0.52	99.99	0.11	0.15	-0.41
6	-0.22	0.26	-0.48	0.03	0.31	-0.12	0.77	99.99	-0.03	99.99

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6
Mean Log	-12.8809	-11.816	-11.5244	-11.5106	-11.2267	-11.2267
S.E(Log q)	0.4854	0.4055	0.465	0.5354	0.4962	0.6469

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	0.96	0.236	12.86	0.69	22	0.47914	-12.88
2	0.73	2.805	11.73	0.85	22	0.25763	-11.82
3	0.64	4.241	11.12	0.87	22	0.21966	-11.52
4	0.55	5.062	10.46	0.86	22	0.19841	-11.51
5	0.88	0.649	10.85	0.6	21	0.4428	-11.23
6	1.23	-0.605	11.99	0.27	20	0.78849	-11.08

Table 3.4.5 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Tuning diagnostics for the modified ADAPT fitted to the data without discards.

	Landings(Tonnes)		
Year	Estimated	Recorded	Factor
1963	116457	116457	1.00
1964	126041	126041	1.00
1965	181036	181036	1.00
1966	221336	221336	1.00
1967	252977	252977	1.00
1968	288368	288368	1.00
1969	200760	200760	1.00
1970	226124	226124	1.00
1971	328098	328098	1.00
1972	353976	353976	1.00
1973	239051	239051	1.00
1974	214279	214279	1.00
1975	205245	205245	1.00
1976	234169	234169	1.00
1977	209154	209154	1.00
1978	297022	297022	1.00
1979	269973	269973	1.00
1980	293644	293644	1.00
1981	335497	335497	1.00
1982	303251	303251	1.00
1983	259287	259287	1.00
1984	228286	228286	1.00
1985	214629	214629	1.00
1986	204053	204053	1.00
1987	216212	216212	1.00
1988	184240	184240	1.00
1989	139936	139936	1.00
1990	125314	125314	1.00
1991	102478	102478	1.00
1992	114020	114020	1.00
1993	124607	121749	1.02
1994	155297	110634	1.40
1995	208287	136096	1.53
1996	198686	126320	1.57
1997	151237	124158	1.22
1998	155324	146014	1.06
1999	147007	96225	1.53
2000	88591	71371	1.24
2001	78162	49632	1.57
2002	59986	54865	1.09
2003	72741	30872	2.36

Table 3.4.6 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Tuning diagnostics for the modified ADAPT fitted to the data without discards.

Parameters

Age	Survivors	s.e log est
1	21854.381	0.21017
2	25430.519	0.21274
3	3659.7109	0.22945
4	5027.7193	0.23454
5	305.94507	0.41993

Year	Multiplier	s.e log est
31	1.02348	0.21608
32	1.4037	0.20436
33	1.53045	0.20257
34	1.57288	0.19695
35	1.21811	0.2087
36	1.06376	0.20306
37	1.52774	0.18397
38	1.24128	0.18982
39	1.57482	0.209
40	1.09334	0.22751
41	2.3562	0.19198

Variance covariance matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
2	0.00	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
3	0.00	0.00	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.06	-0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
5	0.00	0.00	0.01	-0.03	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
6	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
7	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
8	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
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.03	-0.01	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.05	-0.01
16	0.01	0.00	0.00	0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04

Table 3.4.7 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Fishing mortality at age as estimated by ADAPT without discards

Run title : Cod North Sea/Skaggerak/Eastern Channel 20/08/2004

At 14/09/2004 8:24

Table 8 Fishing mortality (F) at age

AGE\YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.025	0.0199	0.0584	0.0554	0.0331	0.0452	0.0213	0.1092	0.0757	0.0335	0.1287
2	0.5328	0.3834	0.4649	0.556	0.5076	0.6293	0.3917	0.5853	0.8832	0.8815	0.6993
3	0.3934	0.5997	0.6822	0.6181	0.7479	0.7699	0.5966	0.7487	0.7915	0.9128	0.832
4	0.5005	0.4627	0.6368	0.5653	0.5213	0.7554	0.6356	0.5678	0.7175	0.6961	0.7977
5	0.4227	0.5618	0.5074	0.5126	0.6735	0.5985	0.7095	0.6888	0.6854	0.7283	0.6489
6	0.4389	0.5414	0.6088	0.5653	0.6476	0.7079	0.6472	0.6684	0.7314	0.7791	0.7595
+gp	0.4389	0.5414	0.6088	0.5653	0.6476	0.7079	0.6472	0.6684	0.7314	0.7791	0.7595
FBAR 2- 4	0.4756	0.4819	0.5947	0.5798	0.5923	0.7182	0.5413	0.6339	0.7974	0.8302	0.7763

AGE\YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	0.0925	0.108	0.0355	0.1433	0.095	0.1037	0.1094	0.1008	0.1743	0.1253
2	0.8151	0.7444	0.9423	0.852	1.0197	0.7963	0.8813	0.9705	0.9365	1.0741
3	0.6831	0.8023	0.8941	0.7922	0.96	0.9553	0.9978	1.0193	1.2409	1.1976
4	0.6381	0.7002	0.8003	0.6047	0.82	0.6474	0.8127	0.8121	0.95	0.9491
5	0.6748	0.7349	0.6218	0.7142	1.0656	0.8167	0.7772	0.7193	0.889	0.853
6	0.6653	0.7458	0.772	0.7037	0.9485	0.8064	0.8626	0.8503	1.0266	0.9999
+gp	0.6653	0.7458	0.772	0.7037	0.9485	0.8064	0.8626	0.8503	1.0266	0.9999
FBAR 2- 4	0.7121	0.749	0.8789	0.7496	0.9332	0.7996	0.8973	0.934	1.0425	1.0736

AGE\YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0.1754	0.0871	0.2311	0.1402	0.1754	0.1267	0.135	0.1176	0.1207	0.0354
2	0.9517	0.9794	0.9008	0.9104	0.9081	0.8707	0.8884	0.73	0.7588	0.6372
3	1.0092	0.9671	1.062	0.9205	1.1719	1.0816	0.9638	0.9223	0.779	0.8212
4	0.8585	0.8	0.9882	0.9426	0.9355	0.9983	0.8848	0.8405	0.8433	0.8148
5	0.8198	0.77	0.8491	0.788	0.8256	0.9282	0.7458	0.8148	0.7264	0.7387
6	0.8959	0.8457	0.9664	0.8837	0.9776	1.0027	0.8648	0.8592	0.7829	0.7916
+gp	0.8959	0.8457	0.9664	0.8837	0.9776	1.0027	0.8648	0.8592	0.7829	0.7916
FBAR 2- 4	0.9398	0.9155	0.9837	0.9245	1.0052	0.9836	0.9123	0.8309	0.7937	0.7577

AGE\YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	FBAR
1	0.07	0.1197	0.0572	0.0897	0.0245	0.0978	0.0757	0.0729	0.0779	0.0284	0.0597
2	0.6293	0.8562	0.7927	0.6571	0.7026	0.6786	0.8611	0.5959	0.4095	0.5581	0.5212
3	0.9982	1.0775	1.179	1.0307	1.0126	1.4845	1.2257	1.0026	0.6717	1.0941	0.9228
4	0.9045	0.8926	0.954	0.949	1.0064	1.3839	1.304	1.1368	0.9512	0.7603	0.9494
5	0.8548	0.7156	1.0041	0.8931	0.9776	1.3242	1.3906	1.1137	0.8632	1.4171	1.1314
6	0.9192	0.8952	1.0457	0.9576	0.9988	1.3975	1.3068	1.0844	0.8287	1.0905	1.0012
+gp	0.9192	0.8952	1.0457	0.9576	0.9988	1.3975	1.3068	1.0844	0.8287	1.0905	
FBAR 2- 4	0.844	0.9421	0.9752	0.8789	0.9072	1.1823	1.1303	0.9118	0.6775	0.8042	

Table 3.4.8 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Population numbers at age as estimated by ADAPT without discards

Run title : Cod North Sea/Skaggerak/Eastern Channel 20/08/2004

At 14/09/2004 8:24

Table 10 Stock number at age (start of year) Numbers*10**-3

AGE\YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	188927	370476	403369	489332	480629	190887	202829	759828	888836	168750	309796
2	120348	82796	163187	170963	208018	208924	81977	89216	306096	370266	73328
3	24231	49779	39767	72237	69093	88238	78463	39044	35016	89188	108061
4	9827	12733	21282	15655	30321	25471	31823	33652	14383	12358	27881
5	8862	4877	6563	9217	7283	14740	9798	13799	15615	5746	5044
6	3740	4755	2277	3235	4520	3040	6633	3946	5673	6442	2271
+gp	1825	2160	2612	2815	3293	3150	2935	3345	3676	5659	3786
TOTAL	357761	527576	639056	763454	803157	534450	414459	942830	1269296	658409	530167

AGE\YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	254341	470113	237777	812870	473562	510065	871115	305092	599697	314870
2	122393	104186	189602	103112	316481	193499	206601	350844	123937	226367
3	25679	38174	34876	52071	30995	80441	61497	60309	93675	34234
4	36624	10101	13327	11109	18365	9243	24101	17658	16948	21093
5	10280	15841	4106	4902	4968	6623	3961	8754	6417	5366
6	2158	4286	6219	1805	1965	1401	2396	1491	3491	2160
+gp	3221	2140	2487	4103	1858	1484	1595	1634	1327	1574
TOTAL	454697	644841	488394	989973	848193	802756	1171266	745782	845492	605664

AGE\YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	577933	153224	695127	274195	191763	269205	133849	175018	350779	203899
2	124820	217899	63107	247892	107089	72304	106565	52548	69918	139697
3	54493	33961	57665	18067	70291	30434	21331	30887	17846	23070
4	8050	15469	10056	15527	5605	16959	8036	6337	9564	6378
5	6685	2793	5691	3065	4953	1801	5117	2716	2239	3369
6	1872	2411	1059	1993	1141	1776	583	1987	984	886
+gp	1478	1279	1513	1047	810	787	837	766	898	703
TOTAL	775331	427036	834218	561787	381652	393265	276317	270258	452227	378002

AGE\YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	467053	307363	202349	487175	79991	140554	204101	71799	151705	50037	0
2	88429	195672	122528	85870	200114	35072	57268	85021	29993	63059	21854
3	52054	33211	58573	39080	31367	69848	12538	17058	33015	14034	25431
4	7904	14941	8806	14032	10858	8875	12327	2867	4874	13134	3660
5	2312	2619	5010	2777	4447	3250	1821	2740	753	1542	5028
6	1318	805	1048	1503	931	1370	708	371	736	260	306
+gp	460	414	509	423	531	487	301	217	196	122	105
TOTAL	619530	555025	398824	630861	328240	259455	289064	180072	221273	142188	56383

Table 3.4.9 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Stock summary as estimated by ADAPT without discards

Run title : Cod North Sea/Skaggerak/Eastern Channel 20/08/2004

At 14/09/2004 8:24

Table 16 Summary (without SOP correction)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2- 4
1963	188927	448184	157994	116457	0.7371	0.4756
1964	370476	526631	159411	126041	0.7907	0.4819
1965	403369	680691	185353	181036	0.9767	0.5947
1966	489332	826035	214406	221336	1.0323	0.5798
1967	480629	894510	238079	252977	1.0626	0.5923
1968	190887	758858	243107	288368	1.1862	0.7182
1969	202829	605181	240930	200760	0.8333	0.5413
1970	759828	926829	250115	226124	0.9041	0.6339
1971	888836	1133276	253481	328098	1.2944	0.7974
1972	168750	794520	230820	353976	1.5336	0.8302
1973	309796	631103	195567	239051	1.2224	0.7763
1974	254341	605281	224343	214279	0.9551	0.7121
1975	470113	679826	203316	205245	1.0095	0.749
1976	237777	584356	172061	234169	1.361	0.8789
1977	812870	794988	155295	209154	1.3468	0.7496
1978	473562	775337	144221	297022	2.0595	0.9332
1979	510065	769170	148410	269973	1.8191	0.7996
1980	871115	975542	168424	293644	1.7435	0.8973
1981	305092	820334	181732	335497	1.8461	0.934
1982	599697	806381	176717	303251	1.716	1.0425
1983	314870	621598	142613	259287	1.8181	1.0736
1984	577933	691915	124238	228286	1.8375	0.9398
1985	153224	483492	117948	214629	1.8197	0.9155
1986	695127	660799	108488	204053	1.8809	0.9837
1987	274195	555493	101945	216212	2.1209	0.9245
1988	191763	411811	92717	184240	1.9871	1.0052
1989	269205	406318	87003	139936	1.6084	0.9836
1990	133849	323754	75721	125314	1.6549	0.9123
1991	175018	302487	72263	102478	1.4181	0.8309
1992	350779	442967	71814	114020	1.5877	0.7937
1993	203899	414019	73431	121749	1.658	0.7577
1994	467053	594082	86309	110634	1.2818	0.844
1995	307363	589380	96851	136096	1.4052	0.9421
1996	202349	487115	102080	126320	1.2375	0.9752
1997	487175	572933	91638	124158	1.3549	0.8789
1998	79991	356261	78645	146014	1.8566	0.9072
1999	140554	301519	78119	96225	1.2318	1.1823
2000	204101	263995	49507	71371	1.4416	1.1303
2001	71799	208139	39021	49632	1.2719	0.9118
2002	151705	241430	40339	54865	1.3601	0.6775
2003	50037	184204	46481	30872	0.6642	0.8042
Arith. Mean	353422	589043	139535	189094	1.4128	0.8315
0 Units	(Thousand	(Tonnes)	(Tonnes)	(Tonnes)		

Table 3.4.10 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Diagnostic of the ADAPT model fitted to the cod347d data including discards

Lowestoft VPA Program

14/09/2004 9:48

Adapt Analysis

North Sea/Skagerrak/Eastern Channel Cod INCLUDES DISCARDS

CPUE data from file cod347ef.tun

Catch data for 41 years : 1963 to 2003. Ages 1 to 7+

Fleet	First year	Last year	First age	Last age	Alpha	Beta
IBTS_Q1_IV	1976	2004	1	5	0	0.25
SCOGFS_IV	1982	2004	1	6	0.5	0.75
ENGGFS_IV_GOV	1992	2004	1	6	0.5	0.75

Time series weights : Tapered time weighting not applied

Catchability analysis :

Fleet	PowerQ ages<x	QPlateau ages>x
IBTS_Q1_IV	1	5
SCOGFS_IV	1	5
ENGGFS_IV_GOV	1	5

Catchability independent of stock size for all ages

Terminal population estimation :

Individual fleet weighting not applied survey estimates at age given equal weight

INITIAL SSQ =	87.75677
PARAMETERS =	16
OBSERVATIONS =	339
FINAL SSQ =	74.55961
IFAIL =	0

Regression weights

	1	1	1	1	1	1	1	1	1	1

Table 3.4.11 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Diagnostic of the ADAPT model fitted to the cod347d data including discards

Fleet : IBTS_Q1_IV

Log index residuals

Age		1976	1977	1978	1979	1980	1981	1982	1983
	1	-0.14	0.49	0.48	-0.63	-0.72	-1	-0.34	-0.47
	2	0.2	-1.02	0.21	-0.3	0.06	0.08	-0.2	0.14
	3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.06
	4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.22
	5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.12
	6	No data for this fleet at this age							

Age		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	1	-0.26	-1.38	-0.24	0.51	0.03	0.37	0.13	-0.51	0.42	1.06
	2	-0.05	0.12	-0.15	0.43	-0.23	0.24	0.48	0.06	-0.13	0.58
	3	-0.18	0.18	0.32	-0.11	-0.02	0.65	0.08	0.22	-0.3	-0.05
	4	0.04	0.02	0.77	0.03	0.01	0.25	0.15	0.15	-0.05	-0.03
	5	-0.12	0.05	0.31	0.14	0.07	0.29	0.13	-0.15	-0.28	0.01
	6	No data for this fleet at this age									

Age		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	1	-0.04	0.32	-0.18	1.15	0.44	-0.38	0.13	0.68	0.87	-0.79
	2	-0.38	0.32	-0.18	0.05	0.34	-0.48	-0.08	0.04	0.4	-0.55
	3	-0.31	-0.01	0.19	-0.38	-0.3	0.26	-0.42	0.13	0.36	-0.26
	4	0.03	-0.37	-0.28	-0.31	-0.21	-0.08	0.45	-0.36	-0.03	0.05
	5	0.33	-0.4	-0.32	-0.15	-0.35	0	0.31	-0.07	-0.21	0.53
	6	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5
Mean Log q	-10.9663	-9.5322	-9.2146	-9.011	-8.5614
S.E(Log q)	0.6208	0.3498	0.2806	0.2697	0.2539

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	-0.577	10.79	0.63	28	0.68283	-10.97
2	0.85	1.713	9.87	0.84	28	0.28878	-9.53
3	0.85	1.512	9.39	0.84	21	0.23052	-9.21
4	0.94	0.465	9.02	0.78	21	0.25972	-9.01
5	1.09	-0.777	8.61	0.79	21	0.28018	-8.56

Table 3.4.12 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Diagnostic of the ADAPT model fitted to the cod347d data including discards

Fleet : ENGGFS_IV_GOV

Log index residuals

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.62	0.05
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.49	0.21
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.21	0.22
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.45	0.1
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.41	0.83
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.35	0.09

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.23	-0.08	-0.04	0.66	-0.88	-0.26	0.01	-0.3	0.37	-0.39
2	-0.14	0.6	0.48	-0.17	0.46	-0.89	0.01	0.31	0.04	-0.42
3	0.14	0.36	0.2	-0.62	0.02	0.49	-0.64	-0.35	0.2	0.19
4	0.12	0.53	0.02	-0.15	-0.95	-0.1	0.43	-1.05	0.5	0.1
5	0.09	-1.27	0.76	-1.3	-0.17	0.22	99.99	-0.01	99.99	0.43
6	0.91	0.02	99.99	0.74	1.09	99.99	1.02	0.9	99.99	2.13

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	-9.5526	-9.1909	-9.3423	-9.6245	-9.7221	-9.7221
S.E(Log q)	0.4381	0.4477	0.3686	0.5211	0.7452	1.0647

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	0.71	3.71	10.42	0.94	12	0.21177	-9.55
2	0.67	3.52	9.98	0.92	12	0.20971	-9.19
3	0.74	2.016	9.59	0.86	12	0.24046	-9.34
4	0.69	1.424	9.45	0.68	12	0.3458	-9.62
5	0.79	0.356	9.35	0.27	10	0.61968	-9.72
6	4.18	-2.016	16.54	0.05	9	2.61374	-9

3.4.10.13 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Diagnostic of the ADAPT model fitted to the cod347d data including discards

Fleet : SCOGFS_IV

Log index residuals

Age		1976	1977	1978	1979	1980	1981	1982	1983
	1	99.99	99.99	99.99	99.99	99.99	99.99	-0.17	-0.19
	2	99.99	99.99	99.99	99.99	99.99	99.99	-0.1	0.19
	3	99.99	99.99	99.99	99.99	99.99	99.99	0.45	0.28
	4	99.99	99.99	99.99	99.99	99.99	99.99	0.78	0.64
	5	99.99	99.99	99.99	99.99	99.99	99.99	0.75	0.7
	6	99.99	99.99	99.99	99.99	99.99	99.99	1	0.52

Age		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	1	-0.11	-1.14	-0.28	-0.46	-0.32	0.13	-0.46	0.23	0.2	0.2
	2	0	0.51	-0.66	-0.18	-0.21	-0.57	0.22	-0.24	-0.31	0.34
	3	0.03	0.23	0.45	-0.93	-0.55	0.24	-0.53	-0.12	-0.3	-0.11
	4	0.17	0.29	0.16	0.18	-0.11	0.15	0.57	-0.97	0.24	-0.29
	5	0.18	0.38	-0.02	0.27	-0.06	0.51	-0.39	-1.19	0.49	-0.7
	6	0.23	0.36	1.02	-0.66	0.49	-0.34	0.8	-1.25	0.87	-0.73

Age		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	1	0.32	0.07	0.12	0.18	-0.09	0.83	0.62	-0.31	0.22	0.39
	2	-0.03	0.72	-0.24	-0.19	0.88	-0.27	0.19	0.05	-0.17	0.07
	3	0.23	-0.09	0.82	0.26	-0.17	0.91	-0.55	-0.14	0.19	-0.58
	4	-0.22	0.11	0.53	0.4	0.13	-0.22	-0.09	-1.41	-0.76	-0.29
	5	-0.26	-0.58	0.07	0.17	0.31	-0.52	99.99	0.14	0.19	-0.43
	6	-0.19	0.26	-0.48	0.04	0.36	-0.07	0.78	99.99	0.03	99.99

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6
Mean Log q	-13.1875	-11.9049	-11.528	-11.5026	-11.2203	-11.2203
S.E(Log q)	0.4178	0.3773	0.4634	0.5287	0.496	0.6426

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	0.99	0.059	13.18	0.79	22	0.4252	-13.19
	2	0.72	3.709	11.84	0.9	22	0.21439	-11.9
	3	0.63	4.473	11.12	0.88	22	0.21016	-11.53
	4	0.55	5.298	10.45	0.87	22	0.19086	-11.5
	5	0.89	0.612	10.86	0.6	21	0.44669	-11.22
	6	1.25	-0.644	12.04	0.27	20	0.79063	-11.07

Table 3.4.14 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Diagnostic of the ADAPT model fitted to the cod347d data including discards

Parameters

Age	Survivors	s.e log est
1	27874	0.221
2	26393	0.220
3	3710	0.228
4	4694	0.231
5	322.39	0.408

Year	Multiplier	s.e log est
1993	1.220	0.194
1994	1.196	0.210
1995	1.540	0.199
1996	1.541	0.194
1997	1.263	0.201
1998	1.049	0.194
1999	1.424	0.184
2000	1.306	0.185
2001	1.498	0.198
2002	1.122	0.220
2003	2.147	0.185

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	0.01
0.00	0.05	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	-0.01	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.05	-0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
0.00	0.00	0.01	-0.03	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
0.00	0.00	0.00	0.00	0.00	0.04	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	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	0.00	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	0.00	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	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.03	-0.01	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-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	0.00	0.00	0.00	0.00	0.00	0.04	-0.01	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.05	-0.01
0.01	0.00	0.00	0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.03

Table 3.4.15 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Diagnostic of the ADAPT model fitted to the cod347d data including discards

	Landings(Tonnes)		
Year	Estimated	Recorded	Factor
1963	127808	127808	1.00
1964	130391	130391	1.00
1965	208931	208931	1.00
1966	257829	257829	1.00
1967	275410	275410	1.00
1968	305254	305254	1.00
1969	205406	205406	1.00
1970	243475	243475	1.00
1971	409005	409005	1.00
1972	386591	386591	1.00
1973	267823	267823	1.00
1974	251858	251858	1.00
1975	238645	238645	1.00
1976	299956	299956	1.00
1977	325415	325415	1.00
1978	325928	325928	1.00
1979	429774	429774	1.00
1980	580500	580500	1.00
1981	391478	391478	1.00
1982	355945	355945	1.00
1983	279862	279862	1.00
1984	377421	377421	1.00
1985	243567	243567	1.00
1986	327012	327012	1.00
1987	240297	240297	1.00
1988	194066	194066	1.00
1989	198546	198546	1.00
1990	149740	149740	1.00
1991	120057	120057	1.00
1992	145961	145961	1.00
1993	172156	141057	1.22
1994	228129	190712	1.20
1995	252658	164104	1.54
1996	213901	138827	1.54
1997	186096	147345	1.26
1998	190420	181568	1.05
1999	152023	106754	1.42
2000	108917	83423	1.31
2001	92576	61808	1.50
2002	66699	59459	1.12
2003	77997	36336	2.15

Table 3.4.16 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Fishing mortality at age as estimated by the ADAPT model fitted to the cod347d data including discards

Run title : Cod with discards North Sea/Skaggerak/Eastern Channel 20/08/2004

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Table 8 Fishing mortality (F) at age

AGE\YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.124	0.0464	0.3064	0.2874	0.1509	0.2201	0.0347	0.1798	0.3581	0.25	0.401
2	0.6949	0.4592	0.5084	0.6886	0.6303	0.7434	0.5217	0.6875	1.0067	1.0422	0.928
3	0.395	0.6021	0.6848	0.6193	0.7506	0.7723	0.5982	0.7529	0.7931	0.915	0.8347
4	0.5009	0.4628	0.6372	0.5655	0.5215	0.7558	0.6358	0.568	0.7178	0.6965	0.7979
5	0.4232	0.5623	0.5077	0.5131	0.6741	0.5989	0.7104	0.6892	0.6858	0.7288	0.6495
6	0.4397	0.5424	0.6099	0.566	0.6487	0.709	0.6481	0.67	0.7322	0.7801	0.7607
+gp	0.4397	0.5424	0.6099	0.566	0.6487	0.709	0.6481	0.67	0.7322	0.7801	0.7607
FBAR 2- 4	0.5302	0.508	0.6101	0.6245	0.6341	0.7572	0.5852	0.6695	0.8392	0.8846	0.8535

AGE\YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	0.5271	0.3114	0.6399	0.5576	0.1616	0.9761	1.0714	0.5997	0.5004	0.3069
2	0.9461	0.8903	1.3059	1.2146	1.245	0.8251	0.9664	1.0686	1.0047	1.1253
3	0.6863	0.8023	0.8993	0.801	0.96	0.9553	0.9978	1.0205	1.242	1.1983
4	0.6386	0.701	0.8003	0.6047	0.82	0.6474	0.8128	0.8122	0.95	0.9493
5	0.6751	0.7359	0.6231	0.7142	1.0656	0.8167	0.7774	0.7194	0.8891	0.8531
6	0.6667	0.7464	0.7742	0.7066	0.9485	0.8065	0.8627	0.8507	1.0271	1.0003
+gp	0.6667	0.7464	0.7742	0.7066	0.9485	0.8065	0.8627	0.8507	1.0271	1.0003
FBAR 2- 4	0.757	0.7979	1.0018	0.8734	1.0083	0.8093	0.9257	0.9671	1.0656	1.091

AGE\YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0.8882	0.4799	0.7936	0.2168	0.2496	0.5714	0.3687	0.3824	0.3482	0.238
2	1.0444	1.1425	0.969	1.1253	1.0532	0.9692	1.2516	0.8609	0.8505	0.9902
3	1.0093	0.9702	1.0671	0.9201	1.1736	1.0921	0.9584	0.922	0.7443	0.9791
4	0.8588	0.8	0.9882	0.9429	0.9345	0.9958	0.8774	0.8233	0.8129	0.9692
5	0.8204	0.7706	0.8491	0.7882	0.8262	0.9256	0.7414	0.7992	0.6951	0.8875
6	0.8962	0.847	0.9681	0.8837	0.9781	1.0045	0.8591	0.8482	0.7508	0.9453
+gp	0.8962	0.847	0.9681	0.8837	0.9781	1.0045	0.8591	0.8482	0.7508	0.9453
FBAR 2- 4	0.9709	0.9709	1.0081	0.9961	1.0538	1.019	1.0291	0.8687	0.8026	0.9795

AGE\YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	FBAR
1	0.5782	0.2937	0.1607	0.1951	0.2178	0.3181	0.2297	0.1702	0.1478	0.345	0.221
2	0.7703	1.1521	1.0242	0.8407	1.0194	0.8153	0.9861	1.0296	0.4666	0.7834	0.7599
3	0.9054	1.0889	1.1772	1.071	1.0723	1.5678	1.288	1.0301	0.7792	1.1744	0.9945
4	0.8152	0.9013	0.9372	0.9915	1.0246	1.3132	1.3706	1.1139	0.9905	0.7598	0.9547
5	0.7673	0.7255	0.9847	0.9356	1.0085	1.2555	1.4639	1.098	0.9203	1.3266	1.115
6	0.8293	0.9053	1.033	0.9994	1.0351	1.3788	1.3741	1.0807	0.8966	1.0869	1.0214
+gp	0.8293	0.9053	1.033	0.9994	1.0351	1.3788	1.3741	1.0807	0.8966	1.0869	
FBAR 2- 4	0.8303	1.0474	1.0462	0.9677	1.0388	1.2321	1.2149	1.0579	0.7454	0.9058	

Table 3.4.17 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Population numbers at age as estimated by the ADAPT model fitted to the cod347d data including discards

Run title : Cod with discards North Sea/Skaggerak/Eastern Channel 20/08/2004

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Table 10 Stock number at age (start of year) Numbers*10**-3

AGE\YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	225530	397692	591568	699253	606874	259979	227993	924561	1387482	264063	463714
2	141797	89516	170585	195652	235708	234487	93734	98945	347060	435771	92405
3	24258	49876	39855	72300	69249	88439	78573	39202	35060	89371	108297
4	9822	12727	21273	15650	30311	25461	31817	33643	14379	12354	27877
5	8854	4873	6560	9210	7279	14732	9790	13794	15608	5743	5040
6	3735	4748	2274	3233	4514	3037	6627	3939	5669	6437	2269
+gp	1823	2157	2608	2812	3289	3146	2932	3339	3673	5654	3782
TOTAL	415817	561589	834723	998109	957224	629282	451465	1117423	1808932	819392	703384

AGE\YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	456923	836041	625361	1540962	520974	1330214	2517050	538197	874746	415554
2	139526	121196	275141	148179	396440	199157	225204	387378	132757	238293
3	25743	38174	35060	52530	30994	80439	61496	60377	93765	34254
4	36606	10093	13327	11109	18365	9242	24100	17657	16947	21089
5	10277	15826	4099	4901	4968	6622	3960	8753	6417	5366
6	2155	4284	6207	1800	1965	1401	2396	1490	3490	2159
+gp	3216	2139	2482	4092	1858	1484	1595	1634	1327	1573
TOTAL	674447	1027752	961678	1763572	975563	1628560	2835801	1015486	1129450	718289

AGE\YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	1394484	243058	1517590	347718	229758	618422	198851	266802	571202	287983
2	137378	257766	67583	308358	125787	80436	156925	61798	81786	181192
3	54498	34066	57946	18072	70523	30918	21504	31632	18412	24622
4	8048	15469	10055	15525	5608	16984	8079	6423	9798	6812
5	6682	2792	5691	3064	4951	1804	5137	2751	2308	3558
6	1872	2409	1058	1993	1141	1774	585	2004	1013	943
+gp	1478	1278	1511	1047	809	786	841	772	924	627
TOTAL	1604440	556837	1661434	695777	438578	751125	391922	372181	685443	505737

AGE\YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	1051982	468262	273808	828759	114034	204246	381625	92026	211507	87592	0
2	101995	265135	156860	104770	306371	41209	66770	136281	34880	81980	27874
3	47433	33269	59035	39691	31851	77900	12850	17552	34298	15414	26393
4	7203	14938	8721	14167	10592	8489	12649	2760	4880	12255	3710
5	2116	2610	4966	2797	4304	3113	1869	2630	742	1484	4694
6	1199	804	1034	1519	899	1285	726	354	718	242	322
+gp	491	411	512	412	520	490	294	217	186	123	101
TOTAL	1212420	785429	504937	992114	468570	336732	476784	251820	287211	199091	63093

Table 3.4.18 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Stock summary as estimated by the ADAPT model fitted to the cod347d data including discards

Run title : Cod with discards North Sea/Skaggerak/Eastern Channel 20/08/2004

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Table 16 Summary (without SOP correction)

	RECRUITS	TOTALBIO	TOTSPBIO	CATCHES	LANDINGS	YIELD/SSE	FBAR 2- 4
	Age 1			Estimated	+DISCARDS		
1963	225530	412859	157266	127808	127808	0.8127	0.5302
1964	397692	483405	158724	130391	130391	0.8215	0.508
1965	591568	628360	184545	208931	208931	1.1321	0.6101
1966	699253	757246	213346	257829	257829	1.2085	0.6245
1967	606874	800288	236561	275410	275410	1.1642	0.6341
1968	259979	718342	242373	305254	305254	1.2594	0.7572
1969	227993	585640	240329	205406	205406	0.8547	0.5852
1970	924561	866919	249249	243475	243475	0.9768	0.6695
1971	1387482	1058291	252712	409005	409005	1.6185	0.8392
1972	264063	779206	230886	386591	386591	1.6744	0.8846
1973	463714	615797	195346	267823	267823	1.371	0.8535
1974	456923	593120	224034	251858	251858	1.1242	0.757
1975	836041	647494	202845	238645	238645	1.1765	0.7979
1976	625361	582243	172158	299956	299956	1.7423	1.0018
1977	1540962	823554	155538	325415	325415	2.0922	0.8734
1978	520974	739325	143996	325928	325928	2.2635	1.0083
1979	1330214	876560	149452	429774	429774	2.8757	0.8093
1980	2517050	1146456	170149	580500	580500	3.4117	0.9257
1981	538197	783175	181649	391478	391478	2.1551	0.9671
1982	874746	769883	176409	355945	355945	2.0177	1.0656
1983	415554	595158	142435	279862	279862	1.9648	1.091
1984	1394484	776124	125145	377421	377421	3.0159	0.9709
1985	243058	474786	117996	243567	243567	2.0642	0.9709
1986	1517590	709398	108929	327012	327012	3.0021	1.0081
1987	347718	539699	101897	240297	240297	2.3582	0.9961
1988	229758	409167	92740	194066	194066	2.0926	1.0538
1989	618422	452079	87527	198546	198546	2.2684	1.019
1990	198851	309987	76159	149740	149740	1.9662	1.0291
1991	266802	291145	72782	120057	120057	1.6495	0.8687
1992	571202	433472	73551	145961	145961	1.9845	0.8026
1993	287983	381408	76186	172156	141057	1.8515	0.9795
1994	1051982	574899	79516	228129	190712	2.3984	0.8303
1995	468262	579264	97013	252658	164104	1.6916	1.0474
1996	273808	461153	100841	213901	138827	1.3767	1.0462
1997	828759	600511	92731	186096	147345	1.589	0.9677
1998	114034	366508	77396	190420	181568	2.346	1.0388
1999	204246	272840	74775	152023	106754	1.4277	1.2321
2000	381625	279353	51084	108917	83423	1.633	1.2149
2001	92026	189135	37517	92576	61808	1.6475	1.0579
2002	211507	224534	39153	66699	59459	1.5186	0.7454
2003	87592	163816	42924	77997	36336	0.8465	0.9058
Arith. Mean	612060	579332	139167	244768.85	234277	1.767	0.8922
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)			

Table 3.7.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Input to the RCT3 program

4 Cod (1year olds)
3 19 2

1985	1517590	80.1	17	-1
1986	347718	21.9	8.8	-1
1987	229758	16.2	3.6	-1
1988	618422	56.1	13.1	-1
1989	198851	11.4	3.4	-1
1990	266802	30.3	2.4	-1
1991	571202	64.2	13	3708.6
1992	287983	34.7	12.7	1128.36
1993	1051982	115.8	14.8	4008.2
1994	468262	47.5	9.7	1561.81
1995	273808	31.8	3.5	1023.15
1996	828759	99.9	40	6147.36
1997	114034	10.4	2.7	178.75
1998	204246	44	2.1	557.26
1999	381625	70	6.6	1448.25
2000	92026	6.9	2.8	264.39
2001	211507	27.4	7.8	1199.47
2002	87592	11.9	0.6	205.96
2003	-1	21.5	7.537	428.74

ScoGfs
IBTS
EngGFS

Table 3.7.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Ouptput from RCT3

Analysis by RCT3 ver3.1 of data from file :

cod4 inp.txt 4 Cod (1year olds)

```
Data for    3 surveys over   19 years :  1985 - 2003
Regression type = C
Tapered time weighting not applied
Survey weighting not applied
Final estimates not shrunk towards mean
Estimates with S.E.'S greater than that of mean included
Minimum S.E. for any survey taken as    .20
Minimum of   3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass =   1999
         I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series           cept   Error          Pts  Value   Value    Error   Weights

ScoGfs    1.13   8.76    .41   .772     14   4.26   13.55     .470     .204
IBTS      1.11  10.48    .50   .691     14   2.03   12.73     .564     .141
EngGFS     .66   8.04    .21   .934      8   7.28   12.86     .262     .655

                                       VPA Mean =   12.87     .725     .000

Yearclass =   2000

         I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series           cept   Error          Pts  Value   Value    Error   Weights

ScoGfs    1.13   8.71    .44   .733     15   2.07   11.03     .561     .155
IBTS      1.11  10.49    .49   .691     15   1.34   11.97     .558     .157
EngGFS     .66   8.04    .20   .934      9   5.58   11.73     .267     .688

                                       VPA Mean =   12.87     .698     .000

Yearclass =   2001

         I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series           cept   Error          Pts  Value   Value    Error   Weights

ScoGfs    1.06   8.96    .41   .791     16   3.35   12.52     .449     .214
IBTS      1.21  10.24    .53   .693     16   2.17   12.88     .581     .128
EngGFS     .71   7.66    .22   .937     10   7.09   12.70     .256     .658

                                       VPA Mean =   12.78     .764     .000
```

Table 3.7.2 (cont) Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Ouptput from RCT3

Yearclass = 2002

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction		---------I	
ScoGfs	1.08	8.89	.40	.787	17	2.56	11.65	.463	.290
IBTS	1.25	10.12	.55	.665	17	.47	10.71	.684	.133
EngGFS	.73	7.47	.26	.909	11	5.33	11.37	.328	.577
					VPA Mean =		12.75	.750	.000

Yearclass = 2003

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction		---------I	
ScoGfs	1.11	8.75	.41	.802	18	3.11	12.22	.447	.241
IBTS	1.16	10.34	.51	.720	18	2.14	12.83	.558	.155
EngGFS	.73	7.47	.24	.926	12	6.06	11.91	.283	.603
					VPA Mean =		12.67	.796	.000

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1999	434962	12.98	.21	.21	.95	381626	12.85
2000	116129	11.66	.22	.20	.81	92026	11.43
2001	323031	12.69	.21	.07	.13	211508	12.26
2002	86281	11.37	.25	.20	.65	87592	11.38
2003	184985	12.13	.22	.23	1.11		

Table 3.8.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
Input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	157309	0.58	WS1	0.38	0.27
N2	27874	0.22	WS2	0.79	0.20
N3	26393	0.22	WS3	1.82	0.16
N4	3710	0.23	WS4	3.57	0.10
N5	4694	0.23	WS5	5.45	0.07
N6	322	0.41	WS6	7.55	0.05
N7	101	0.41	WS7	9.96	0.02
H.cons selectivity			Weight in the HC catch		
sH1	0.04	0.54	WH1	0.70	0.11
sH2	0.39	0.08	WH2	1.09	0.08
sH3	0.82	0.16	WH3	2.02	0.12
sH4	0.90	0.20	WH4	3.59	0.09
sH5	1.05	0.17	WH5	5.48	0.06
sH6	0.97	0.10	WH6	7.58	0.05
sH7	0.97	0.10	WH7	9.99	0.02
Discard selectivity			Weight in the discards		
sD1	0.22	0.74	WD1	0.26	0.12
sD2	0.43	0.73	WD2	0.38	0.11
sD3	0.17	0.62	WD3	0.43	0.24
sD4	0.01	1.73	WD4	0.23	1.73
sD5	0.01	1.73	WD5	0.76	1.73
sD6	0.01	1.73	WD6	0.95	1.73
sD7	0.01	1.73	WD7	1.32	1.73
Natural mortality			Proportion mature		
M1	0.80	0.10	MT1	0.01	0.10
M2	0.35	0.10	MT2	0.05	0.10
M3	0.25	0.10	MT3	0.23	0.10
M4	0.20	0.10	MT4	0.62	0.10
M5	0.20	0.10	MT5	0.86	0.10
M6	0.20	0.10	MT6	1.00	0.10
M7	0.20	0.10	MT7	1.00	0.10
Relative effort in HC fishery			Year effect for natural mortality		
HF04	1.00	0.10	K03	1.00	0.10
HF05	1.00	0.10	K04	1.00	0.10
HF06	1.00	0.10	K05	1.00	0.10
Recruitment in 2005 and 2006					
R04	157309	0.58			
R05	157309	0.58			

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

Recruitment in 2004 is the 1997 - 2002 GM; other stock numbers in 2004 are VPA survivors
All catch component Fs are obtained from mean 2001-2003 exploitation pattern , scaled to estimated F(2003)
CVs for weights and Fs are from 3-year ranges
Effort multiplier 1.0

Data from file:C:\emas2\adapt\cod4\2004wg\data\prediction\discards\short term\co

Table 3.8.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:

Status quo F in 2004 catch forecast with effort multipliers of 0.0 – 0.6 in 2005

	Year 2004	2005						
Mean F Ages Total 2 to 4	0.91	0.00	0.09	0.18	0.27	0.36	0.45	0.54
Effort relative to 2003 Total	1.00	0.00	0.10	0.20	0.30	0.40	0.50	0.60
Biomass								
Total 1 January	172.6	164.4	164.4	164.4	164.4	164.4	164.4	164.4
SSB at spawning time	46.4	40.4	40.4	40.4	40.4	40.4	40.4	40.4
Catch weight (,000t)								
H.cons	59.3	0.0	7.1	13.6	19.6	25.1	30.2	34.8
Discards	9.3	0.0	1.4	2.7	3.9	5.1	6.2	7.3
Total Catch	68.7	0.0	8.5	16.3	23.6	30.2	36.4	42.2
Biomass in year.... 2006								
Total 1 January		263.7	249.6	236.7	224.8	213.9	203.8	194.5
SSB at spawning time		83.2	76.1	69.5	63.6	58.2	53.2	48.7

Status quo F in 2004 catch forecast with effort multipliers of 0.7 – 1.3 in 2005

	Year 2004	2005						
Mean F Ages Total 2 to 4	0.91	0.63	0.72	0.82	0.91	1.00	1.09	1.18
Effort relative to 2003 Total	1.00	0.70	0.80	0.90	1.00	1.10	1.20	1.30
Biomass								
Total 1 January	172.6	164.4	164.4	164.4	164.4	164.4	164.4	164.4
SSB at spawning time	46.4	40.4	40.4	40.4	40.4	40.4	40.4	40.4
Catch weight (,000t)								
H.cons	59.3	39.1	43.1	46.7	50.1	53.1	56.0	58.6
Discards	9.3	8.3	9.3	10.2	11.1	12.0	12.8	13.5
Total Catch	68.7	47.5	52.4	56.9	61.2	65.1	68.8	72.2
Biomass in year.... 2006								
Total 1 January		185.9	178.0	170.7	163.9	157.6	151.9	146.5
SSB at spawning time		44.6	40.9	37.4	34.3	31.5	28.9	26.5

Table 3.8.3 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:

TAC constraint in 2004 catch forecast with effort multipliers of 0.0 – 0.6 in 2005

	Year 2004	2005						
Mean F Ages								
Total 2 to 4	0.32	0.00	0.03	0.06	0.10	0.13	0.16	0.19
Effort relative to 2003								
Total	1.00	0.00	0.10	0.20	0.30	0.40	0.50	0.60
Biomass								
Total 1 January	172.6	224.1	224.1	224.1	224.1	224.1	224.1	224.1
SSB at spawning time	46.4	74.1	74.1	74.1	74.1	74.1	74.1	74.1
Catch weight (,000t)								
H.cons	27.2	0.0	4.2	8.3	12.3	16.1	19.9	23.5
Discards	3.8	0.0	0.6	1.1	1.6	2.2	2.7	3.2
Total Catch	31.0	0.0	4.8	9.4	13.9	18.3	22.6	26.7
Biomass in year.... 2006								
Total 1 January		341.5	333.9	326.5	319.4	312.4	305.7	299.1
SSB at spawning time		140.6	136.1	131.8	127.6	123.5	119.6	115.7

TAC constraint in 2004 catch forecast with effort multipliers of 0.7 – 1.3 in 2005

	Year 2004	2005						
Mean F Ages								
Total 2 to 4	0.32	0.22	0.26	0.29	0.32	0.35	0.38	0.42
Effort relative to 2003								
Total	1.00	0.70	0.80	0.90	1.00	1.10	1.20	1.30
Biomass								
Total 1 January	172.6	224.1	224.1	224.1	224.1	224.1	224.1	224.1
SSB at spawning time	46.4	74.1	74.1	74.1	74.1	74.1	74.1	74.1
Catch weight (,000t)								
H.cons	27.2	27.0	30.4	33.7	36.9	40.0	43.0	45.9
Discards	3.8	3.7	4.2	4.7	5.1	5.6	6.0	6.5
Total Catch	31.0	30.7	34.6	38.4	42.0	45.6	49.1	52.4
Biomass in year.... 2006								
Total 1 January		292.8	286.6	280.7	274.9	269.3	263.8	258.5
SSB at spawning time		112.1	108.5	105.0	101.7	98.5	95.4	92.3

Table 3.8.4 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:

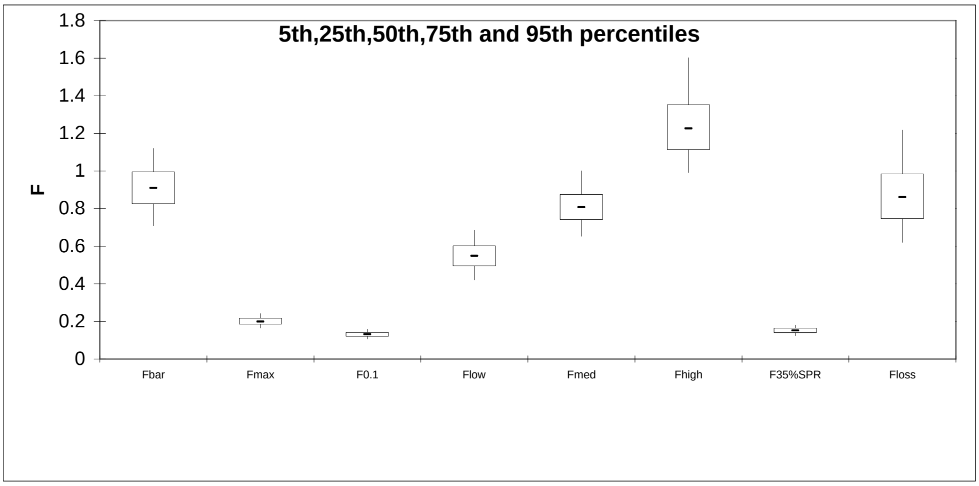
F 50% 2001 in 2004 catch forecast with effort multipliers of 0.0 – 0.6 in 2005

	Year 2004	2005	2005	2005	2005	2005	2005	2005
Mean F Ages								
Total 2 to 4	0.53	0.00	0.05	0.11	0.16	0.21	0.26	0.32
Effort relative to 2003								
Total	1.00	0.00	0.10	0.20	0.30	0.40	0.50	0.60
Biomass								
Total 1 January	172.6	198.8	198.8	198.8	198.8	198.8	198.8	198.8
SSB at spawning time	46.4	59.5	59.5	59.5	59.5	59.5	59.5	59.5
Catch weight (,000t)								
H.cons	40.9	0.0	5.8	11.3	16.5	21.4	26.2	30.6
Discards	6.0	0.0	0.9	1.7	2.6	3.4	4.1	4.9
Total Catch	46.9	0.0	6.7	13.0	19.0	24.8	30.3	35.5
Biomass in year.... 2006								
Total 1 January		308.7	298.0	287.7	278.0	268.8	260.0	251.6
SSB at spawning time		116.0	110.0	104.3	98.9	93.7	88.9	84.3

F 50% 2001 in 2004 catch forecast with effort multipliers of 0.7 – 1.3 in 2005

	Year 2004	2005	2005	2005	2005	2005	2005	2005
Mean F Ages								
Total 2 to 4	0.53	0.37	0.42	0.48	0.53	0.58	0.64	0.69
Effort relative to 2003								
Total	1.00	0.70	0.80	0.90	1.00	1.10	1.20	1.30
Biomass								
Total 1 January	172.6	198.8	198.8	198.8	198.8	198.8	198.8	198.8
SSB at spawning time	46.4	59.5	59.5	59.5	59.5	59.5	59.5	59.5
Catch weight (,000t)								
H.cons	40.9	34.9	39.0	42.8	46.5	50.0	53.3	56.5
Discards	6.0	5.6	6.3	7.0	7.7	8.3	8.9	9.5
Total Catch	46.9	40.5	45.3	49.8	54.2	58.3	62.3	66.0
Biomass in year.... 2006								
Total 1 January		243.6	236.0	228.8	221.9	215.4	209.1	203.2
SSB at spawning time		79.9	75.8	71.9	68.2	64.7	61.4	58.3

Table 3.10.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId
Precautionary approach reference points as estimated by PAplot:



Reference point	Deterministic	Median	75th percentile	95th percentile	Hist SSB < ref pt %
MedianRecruits	463710	463710	520970	591570	
MBAL	150000				56.10
Bloss	37520				
SSB90%R90%Surv	149428	136422	151979	172588	53.66
SPR%ofVirgin	2.08	2.08	2.67	3.63	
VirginSPR	10.33	10.35	12.82	17.03	
SPRloss	0.26	0.24	0.32	0.44	

	Deterministic	Median	25th percentile	5th percentile	Hist F > ref pt %
FBar	0.91	0.91	0.83	0.71	78.05
Fmax	0.20	0.20	0.19	0.17	100.00
F0.1	0.13	0.13	0.12	0.11	100.00
Flow	0.57	0.55	0.49	0.42	97.56
Fmed	0.79	0.81	0.74	0.65	80.49
Fhigh	1.21	1.23	1.11	0.99	31.71
F35%SPR	0.15	0.15	0.14	0.12	100.00
Floss	0.84	0.86	0.75	0.62	80.49

For estimation of Gloss and Floss:
A LOWESS smoother with a span of 0.5 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.
For estimation of the stock recruitment relationship used in equilibrium calculations:
A LOWESS smoother with a span of 0.5 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.

347d Cod

Steady state selection provided as input
FBar averaged from age 2 to 4

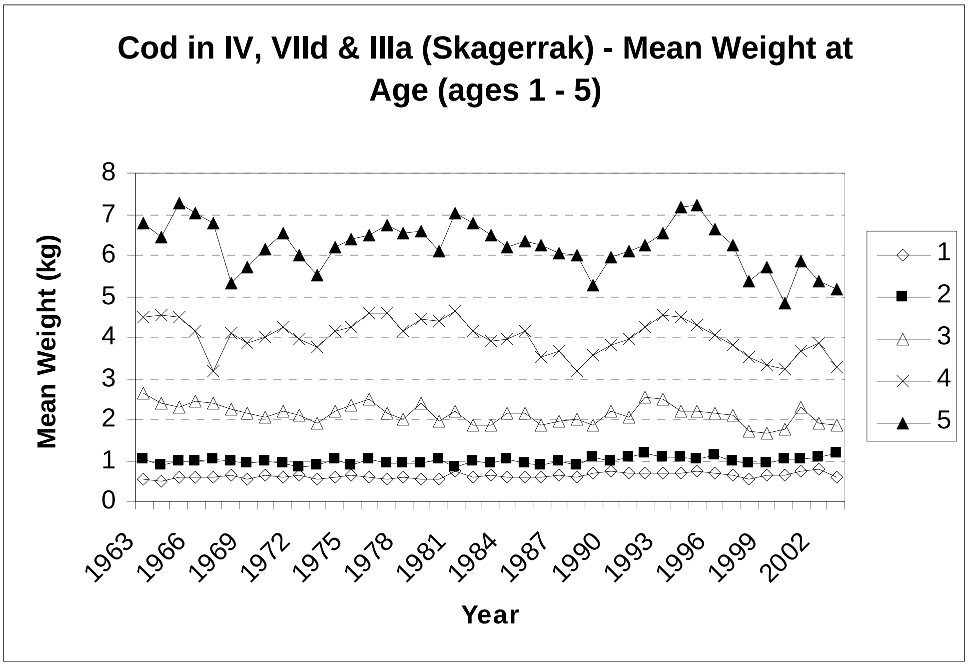
Number of iterations = 1000
Random number seed = -99
Stock recruitment data Monte Carloed using residuals from the equilibrium LOWESS fit

Data source:
C:\emas2\adapt\cod4\2004wg\adapt\Adapt with discards\PAplot\cod discards.sen
C:\emas2\adapt\cod4\2004wg\adapt\Adapt with discards\PAplot\cod discards.SUM

FishLab DLL used
FLVB32.DLL built on Jun 14 1999 at 11:53:37
PASoft 4 October 1999

16/09/04 05:50:50

Figure 3.2.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Mean weight at age in the landings.



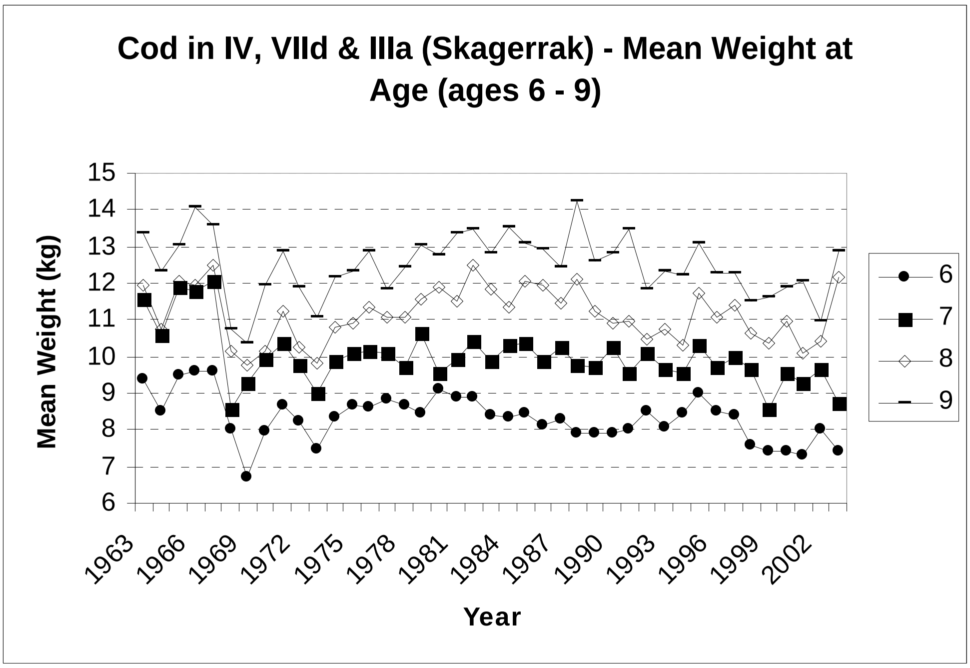


Figure 3.3.1.1 Nominal hours fished by UK fleets. The values plotted are those from Table 3.3.1, indicating the catch-at-age calibration fleets that were available to the working group. Recording of hours fished is not mandatory in logbooks and is not considered to be representative of deployed fishing effort

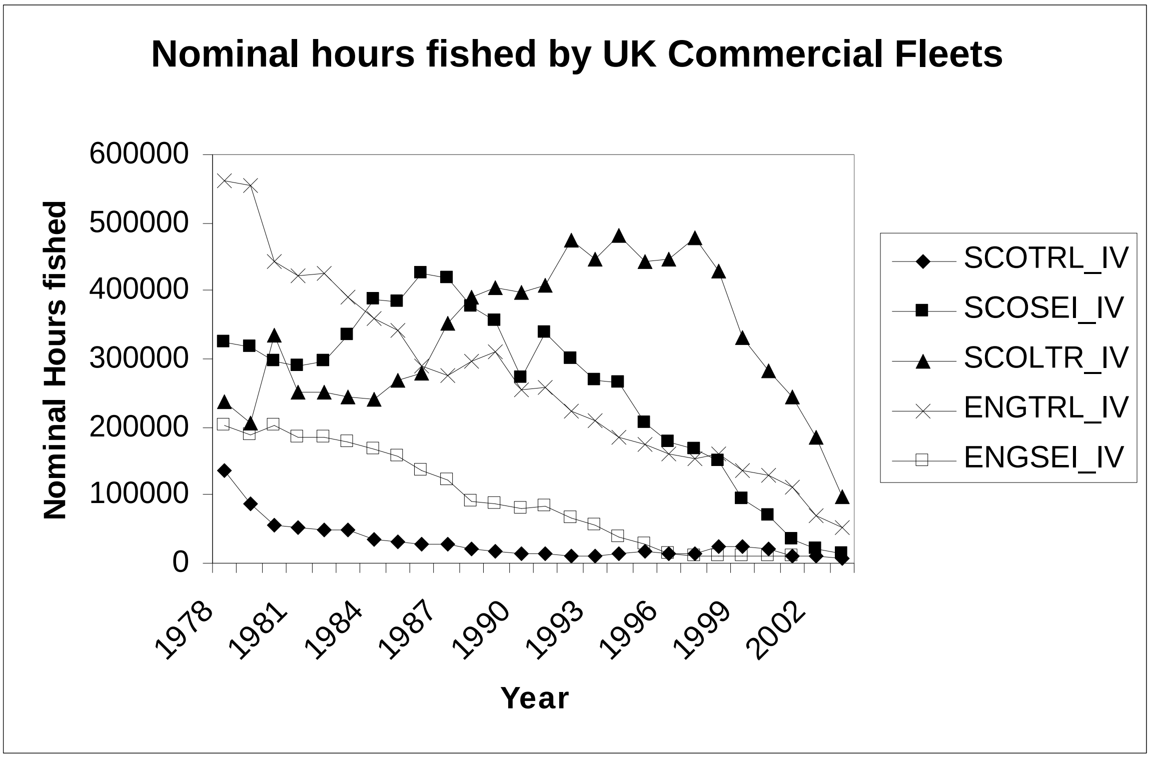


Figure 3.3.1.2. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3 caught in the IBTS Q1 survey 1998-2004 for ages 1-3.

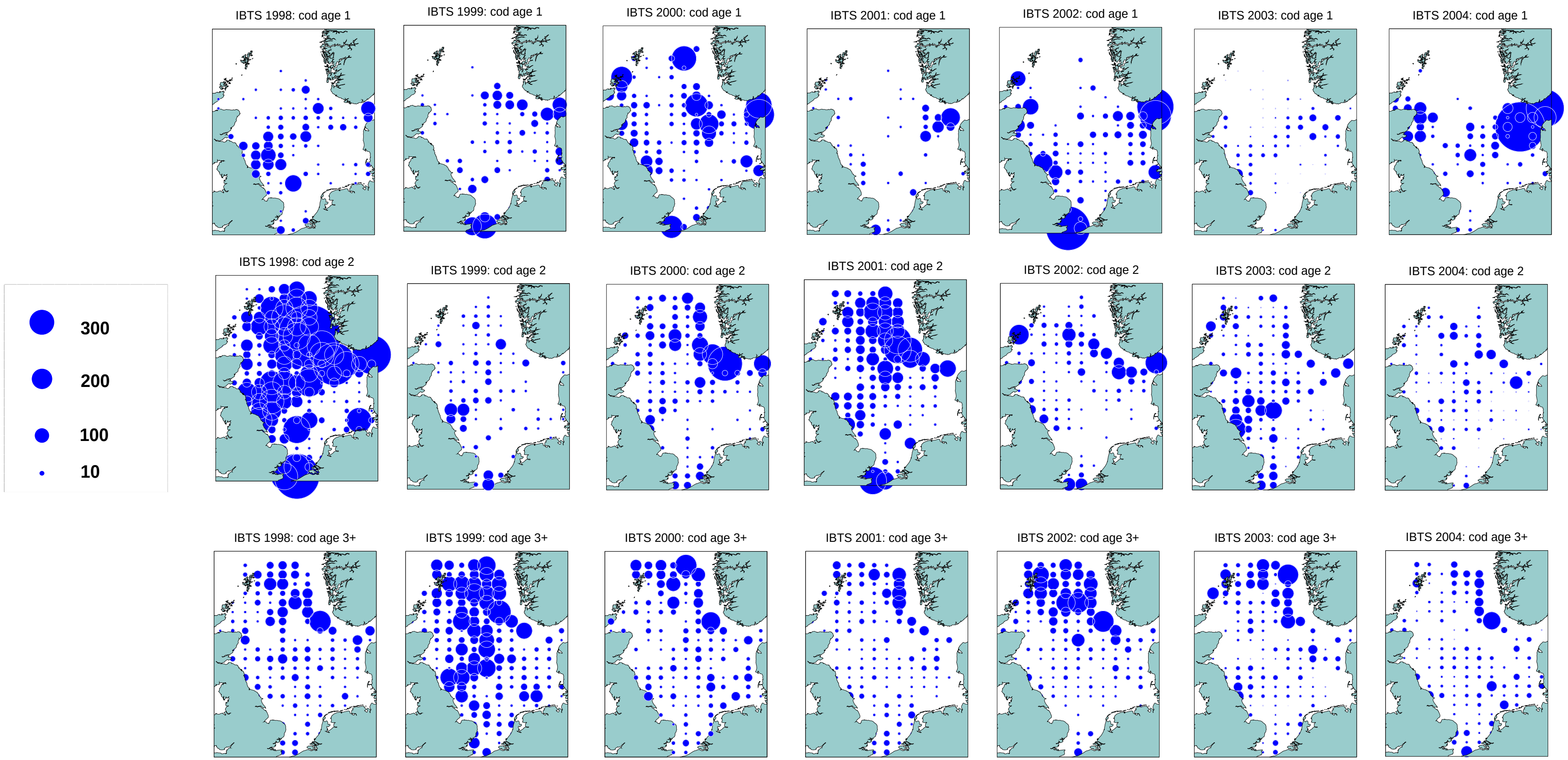


Figure 3.3.1.3 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3 caught in the EngGFS Q3 survey 1996-2004 for ages 1-4.

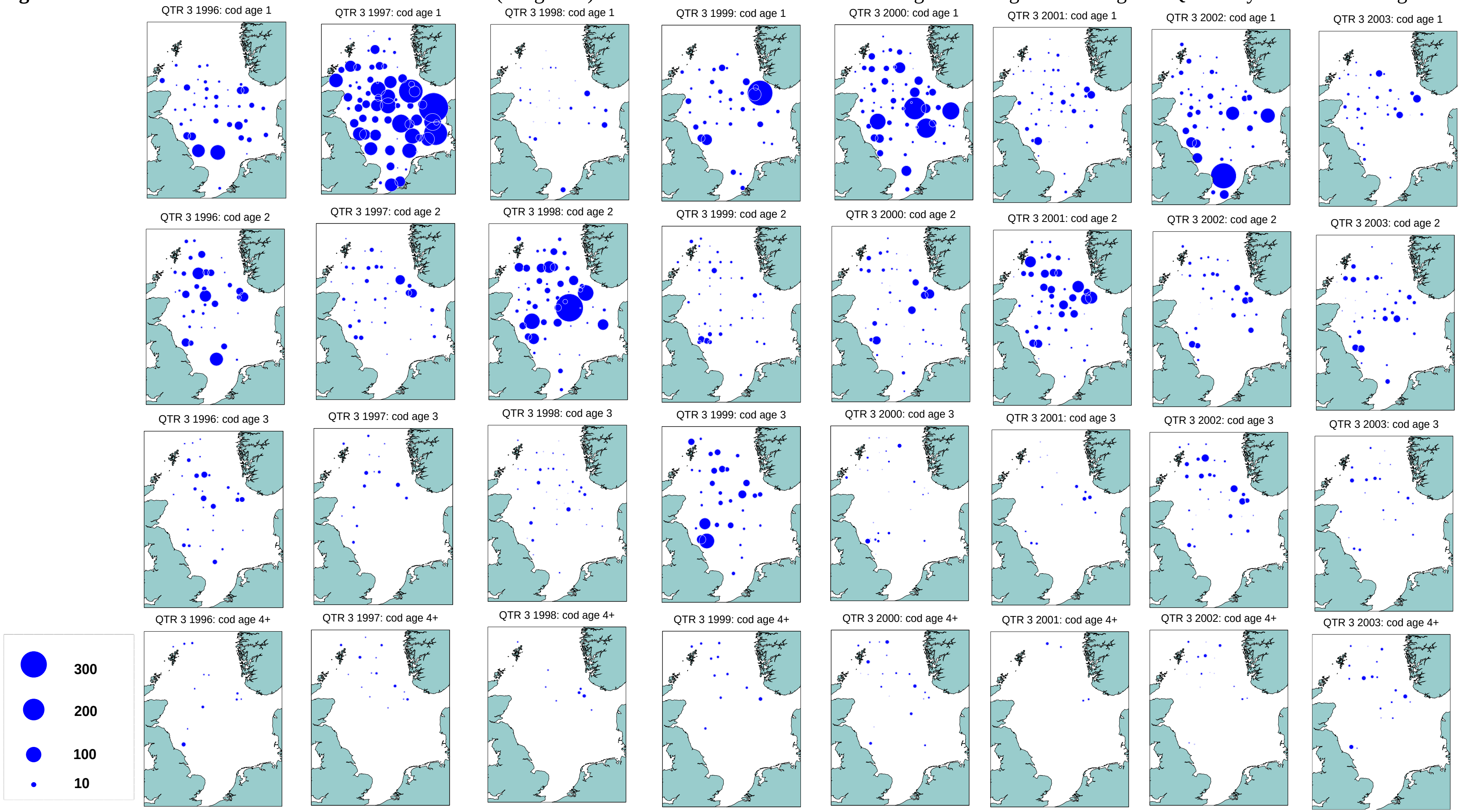


Figure 3.4.1.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Separable VPA residuals for the years 1999- 2003

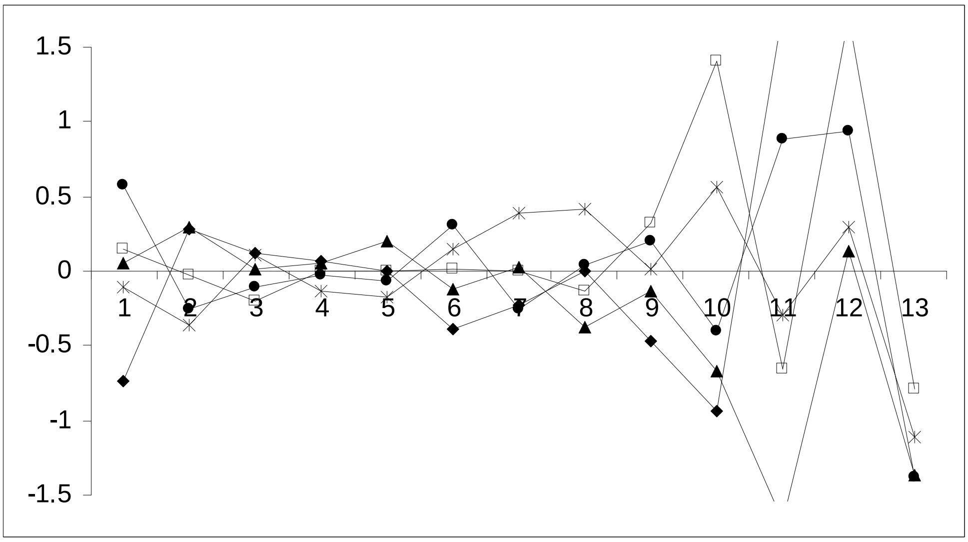
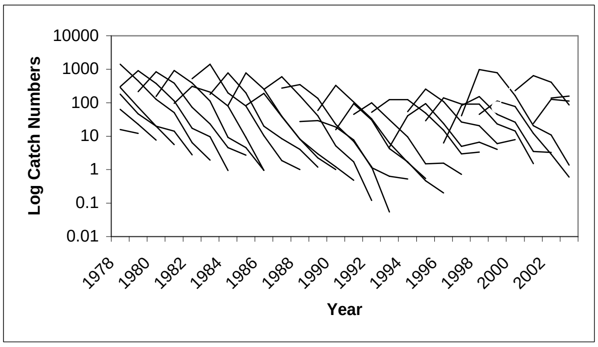


Figure 3.4.3.1 Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Cohort (catch) curves for Scottish commercial series both including and excluding discard estimates (based on Scottish discard ogives).

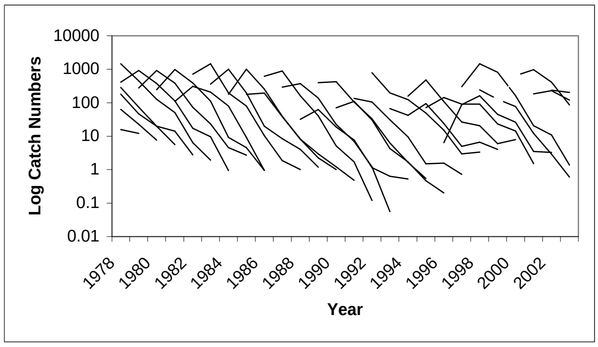
Excluding discards

ScoTrl

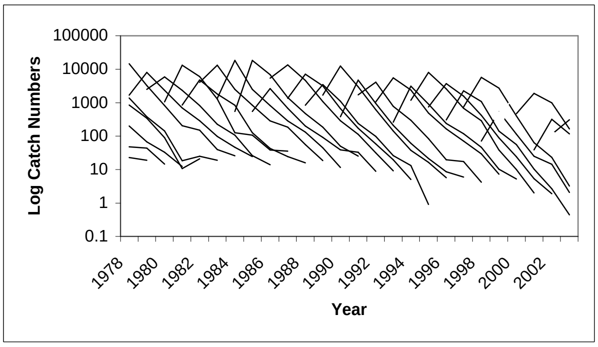


Including discards

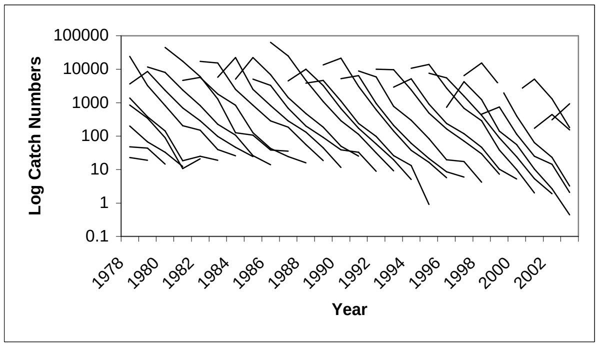
ScoTrl



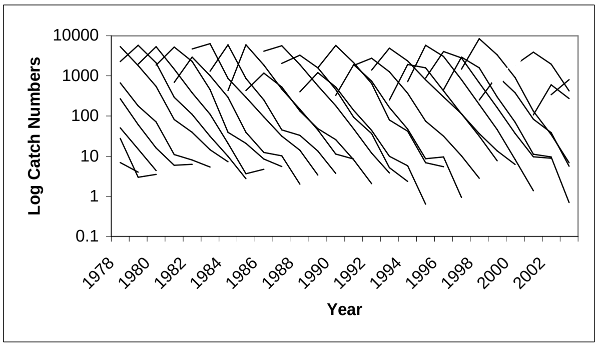
ScoSei



ScoSei



ScoLtr



ScoLtr

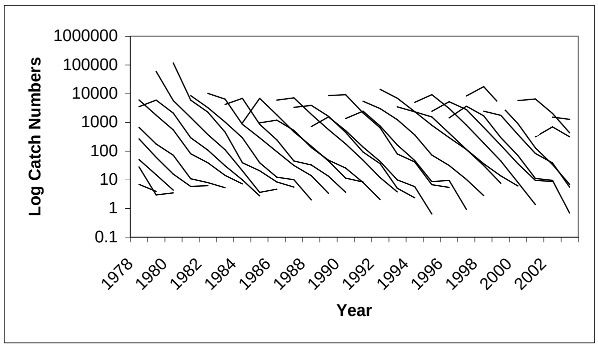
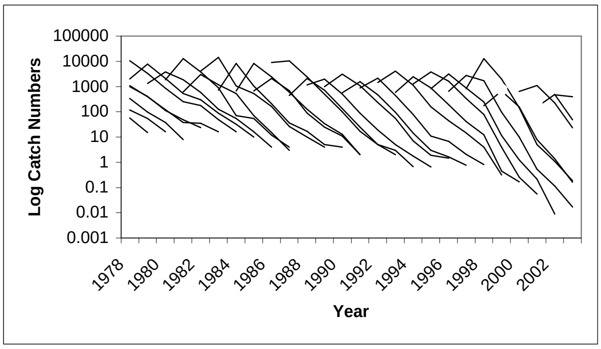


Figure 3.4.3.1(cont'd). Cohort (catch) curves for English commercial series both including and excluding discard estimates (NB. based on Scottish discard ogives).

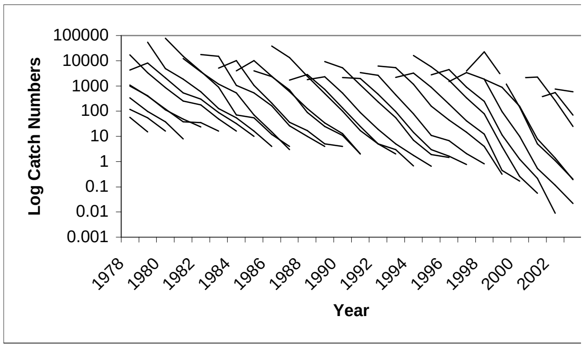
Excluding discards

EngTrl

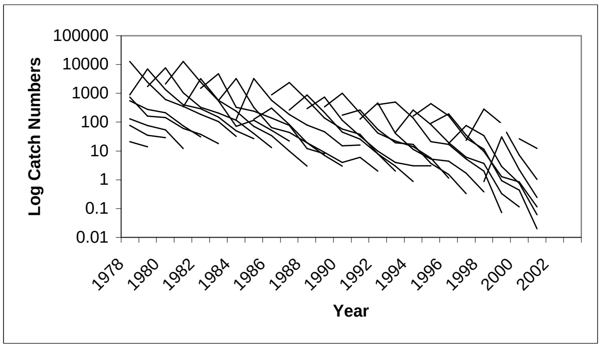


Including discards

EngTrl



EngSei



EngSei

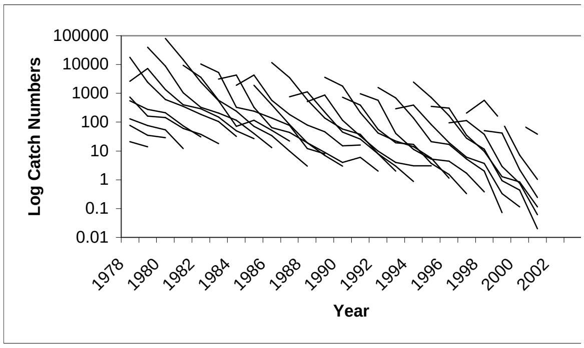


Figure 3.4.3.2 Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Cohort (catch) curves for surveys (IBTSQ1, EngGFS, ScoGFS & FraGFS).

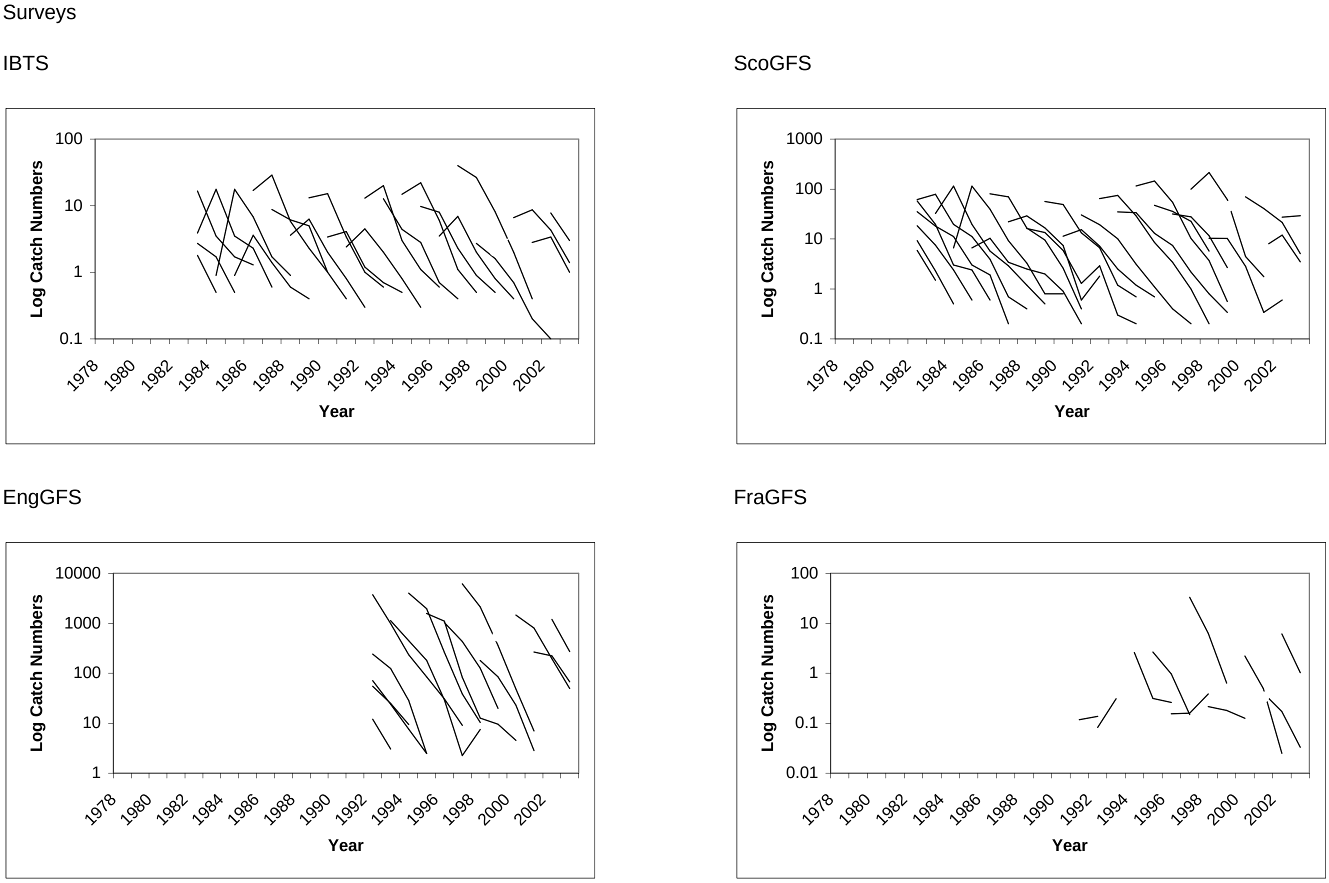
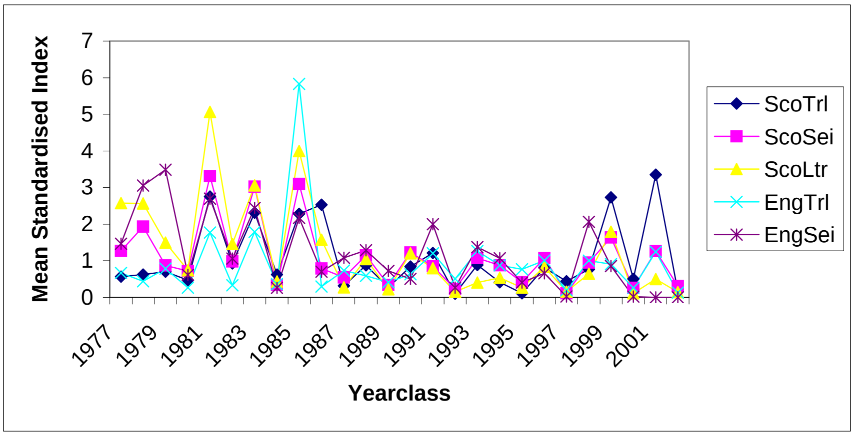
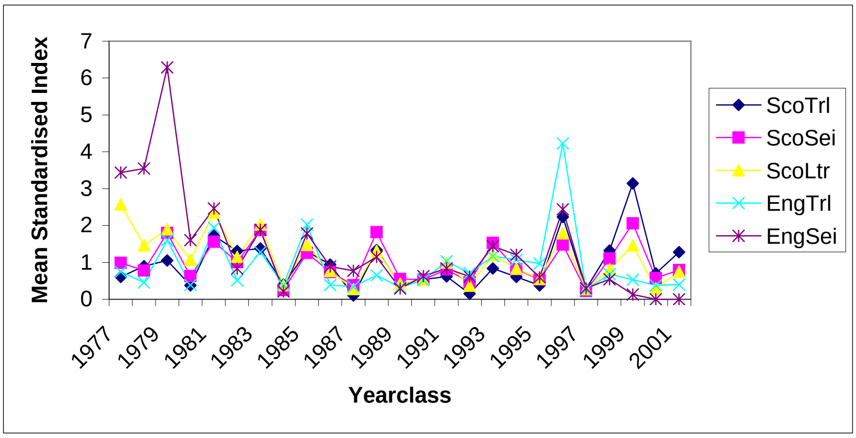


Figure 3.4.3.3 Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Mean-standardised CPUE indices by age for commercial fleets (excluding discards).

Age 1



Age 2



Age 3

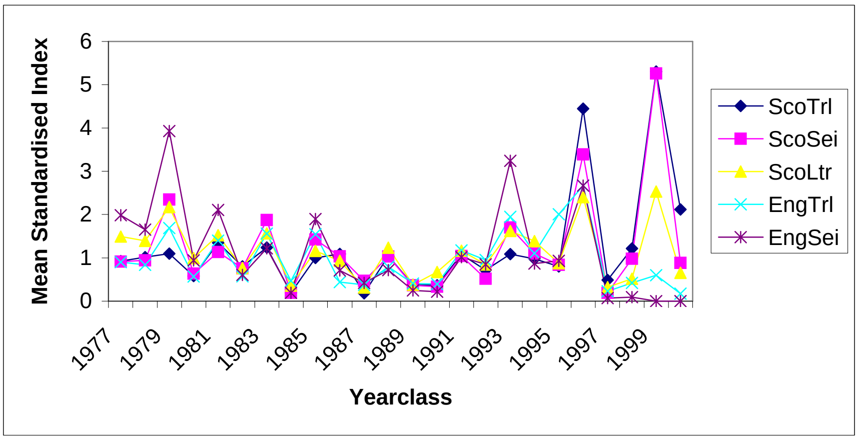
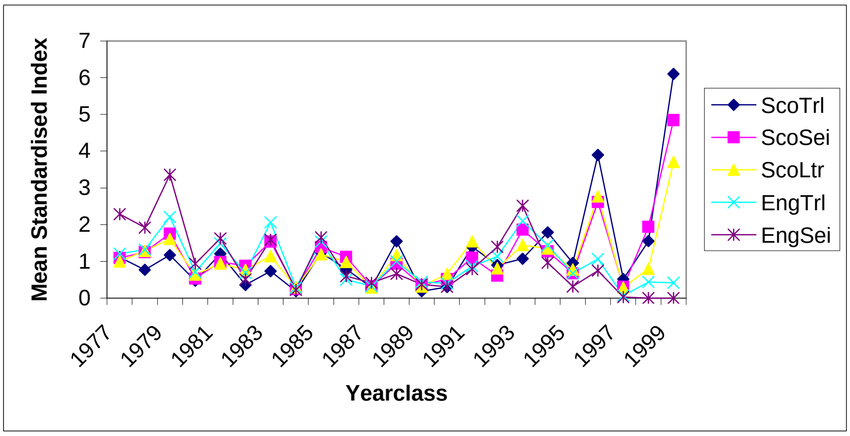
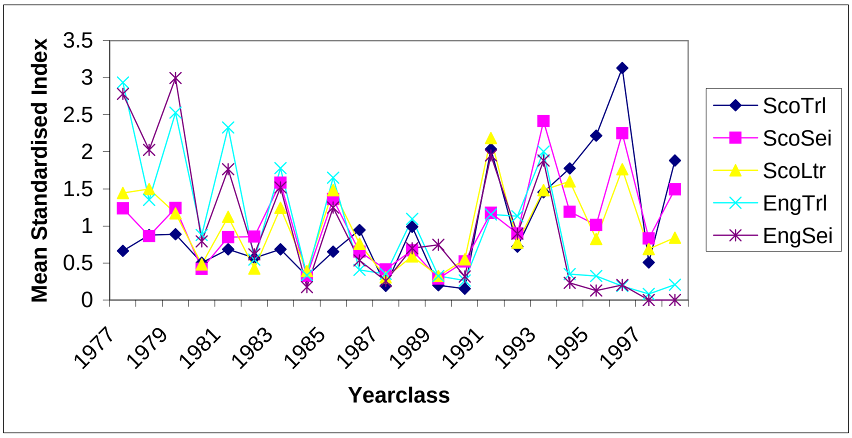


Figure 3.4.3.3 (Cont'd). Mean-standardised CPUE indices by age for commercial fleets.

Age 4



Age 5



Age 6

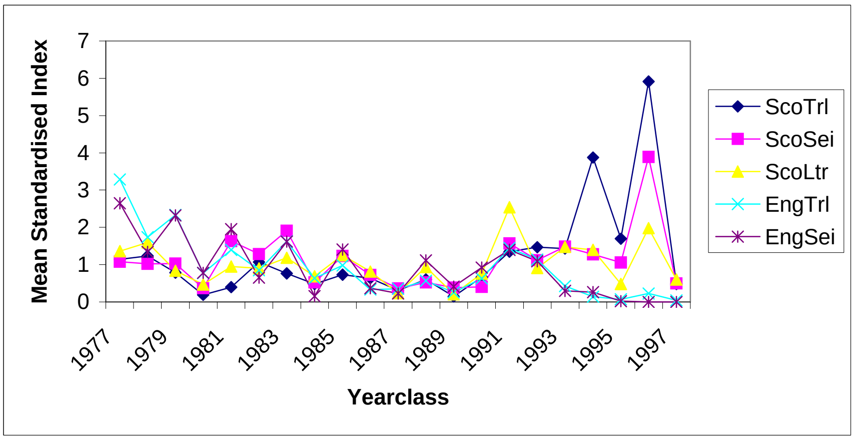
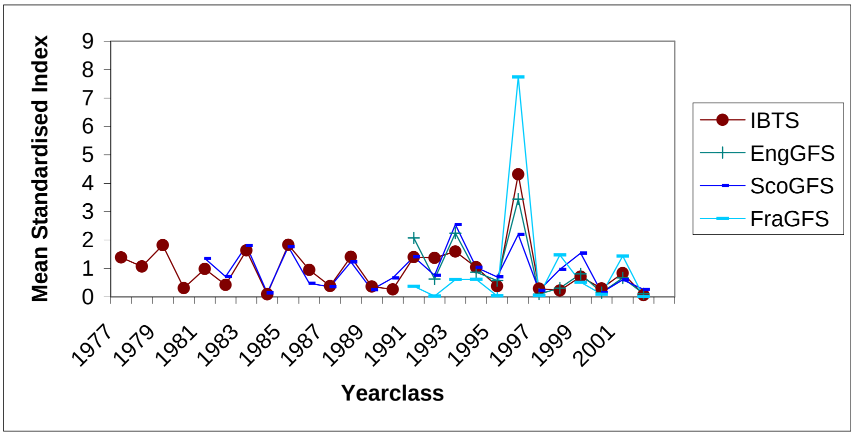
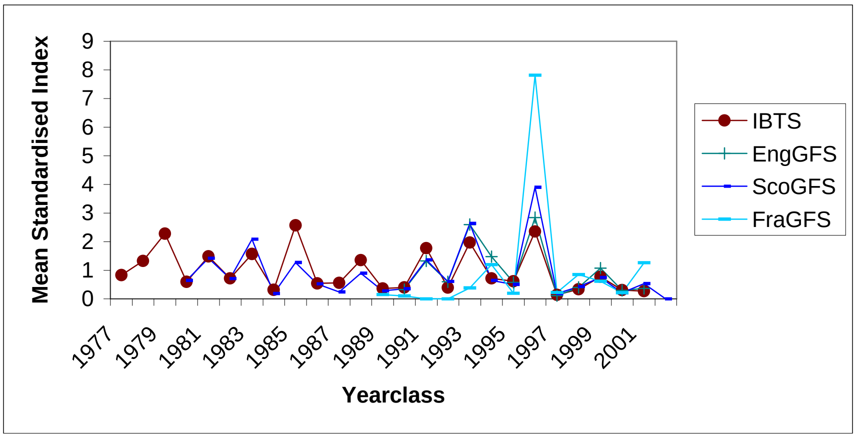


Figure 3.4.3.4 Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Mean-standardised CPUE indices by age for survey fleets.

Age 1



Age 2



Age 3

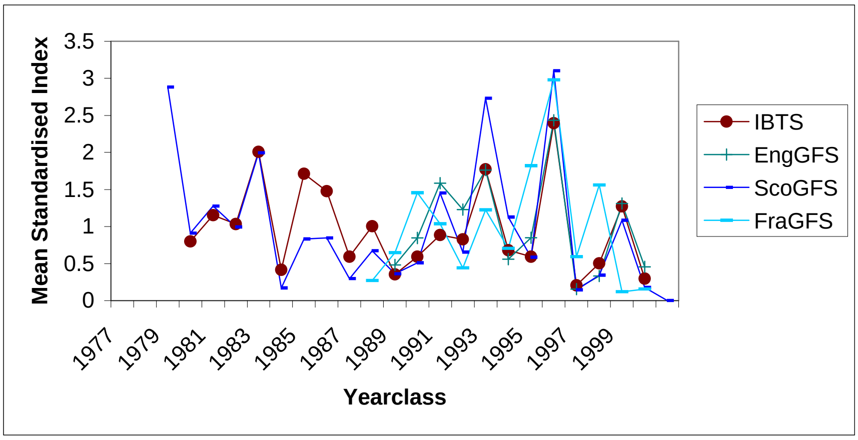
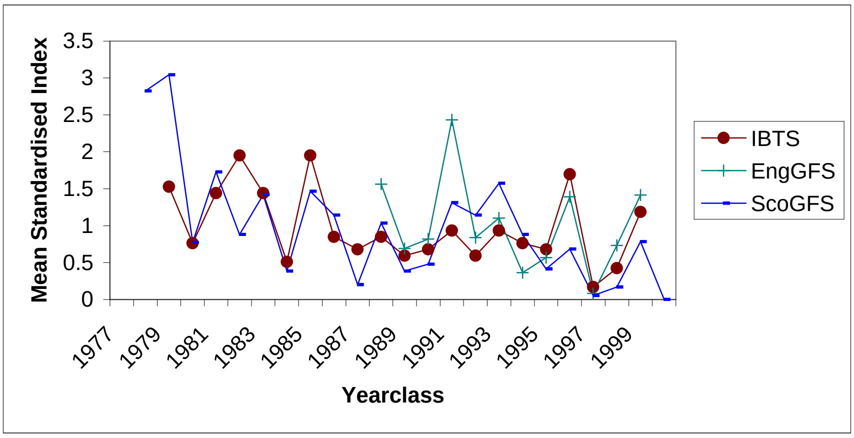
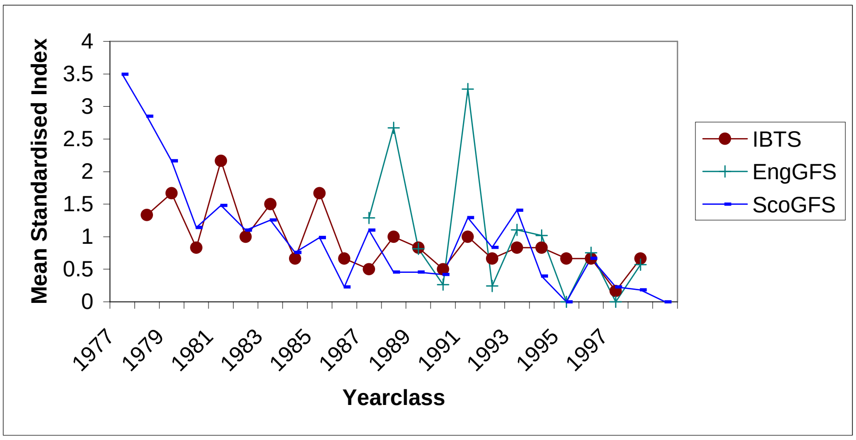


Figure 3.4.3.4 (Cont'd). Mean-standardised CPUE indices by age for survey fleets.

Age 4



Age 5



Age 6

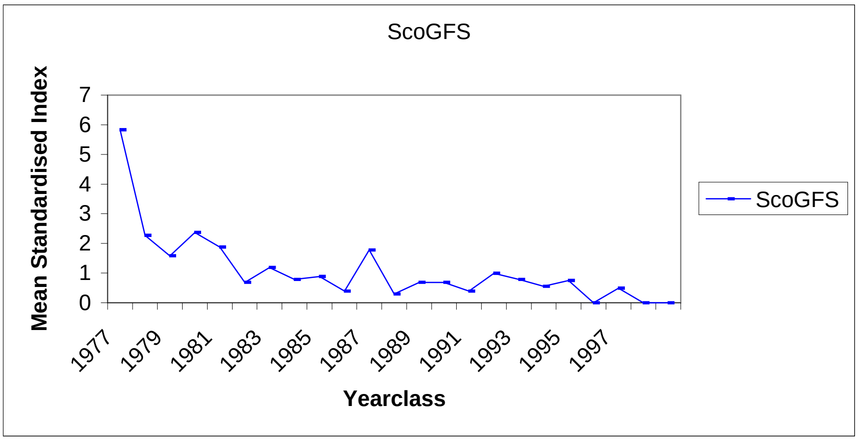


Figure 3.4.3.5 Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Bivariate scatterplots indicating within-survey consistency of IBTSQ1 indices.

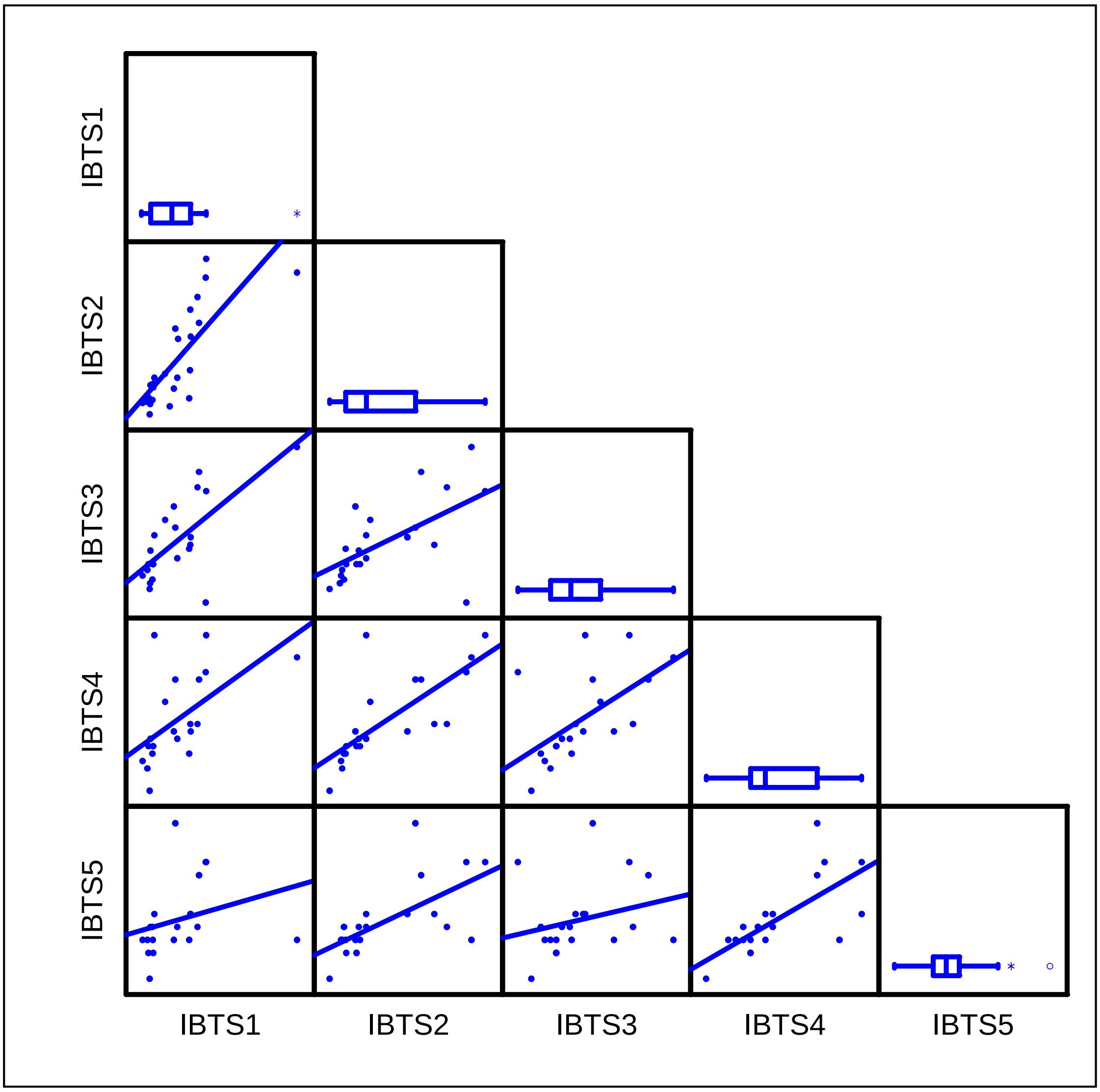


Figure 3.4.3.5 (Cont'd). Bivariate scatterplots indicating within-survey consistency of EngGFS indices.

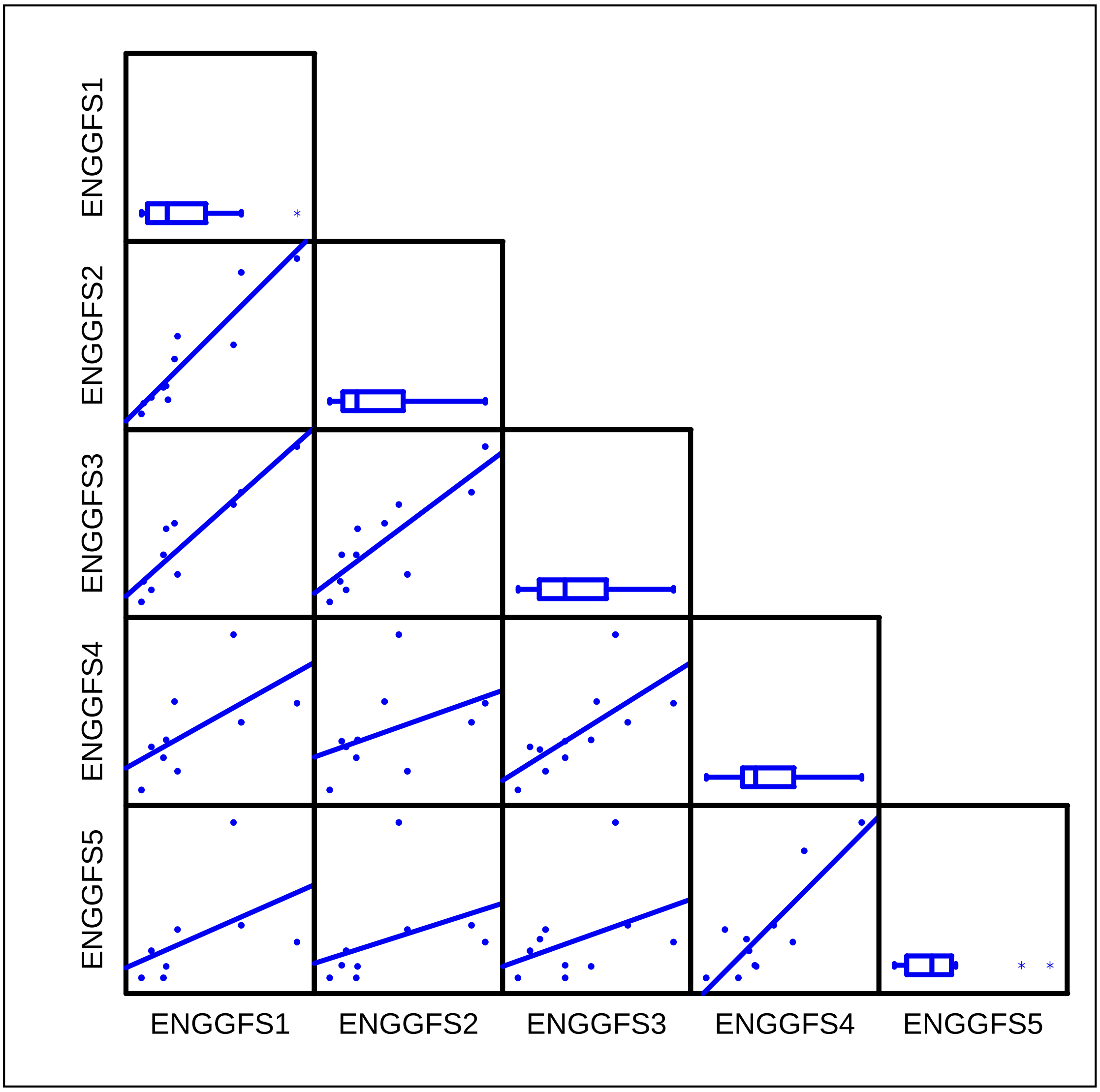


Figure 3.4.3.5 (Cont'd). Bivariate scatterplots indicating within-survey consistency of ScoGFS indices.

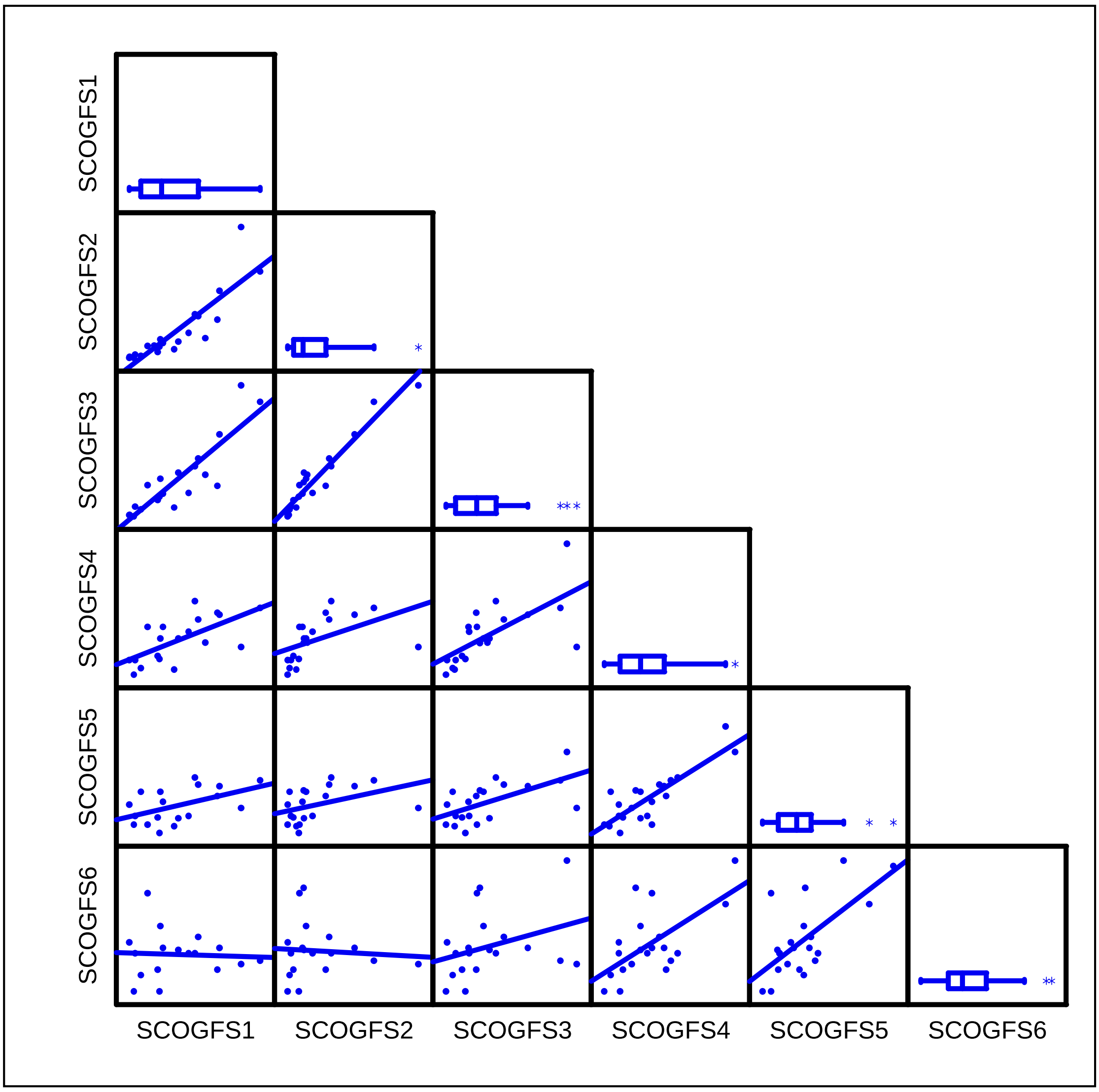


Figure 3.4.3.5 (Cont'd). Bivariate scatterplots indicating within-survey consistency of FraGFS indices.

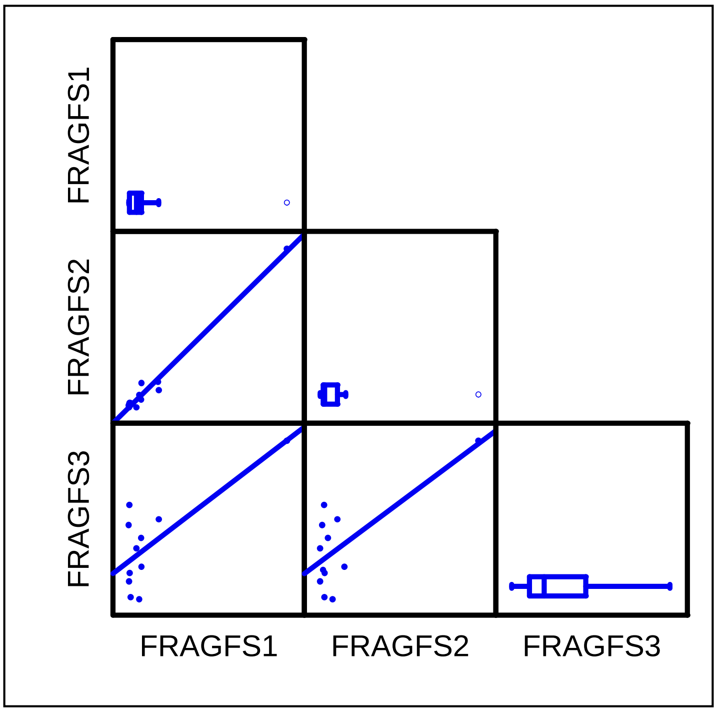


Figure 3.4.3.5 Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Bivariate scatterplots indicating within-series consistency of commercial ScoTrl indices.

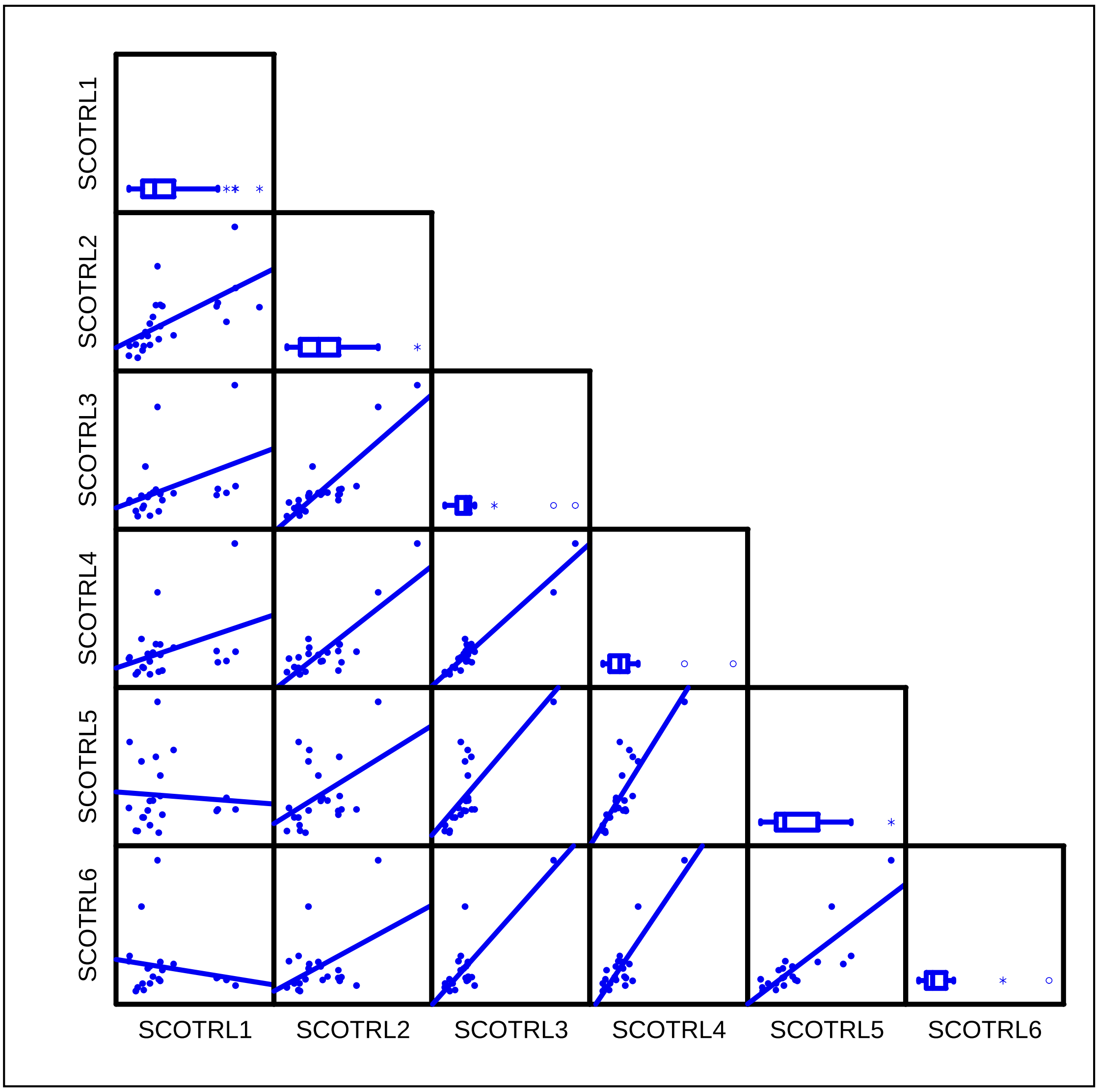


Figure 3.4.3.5 (Cont'd). Bivariate scatterplots indicating within-series consistency of commercial ScoSei indices.

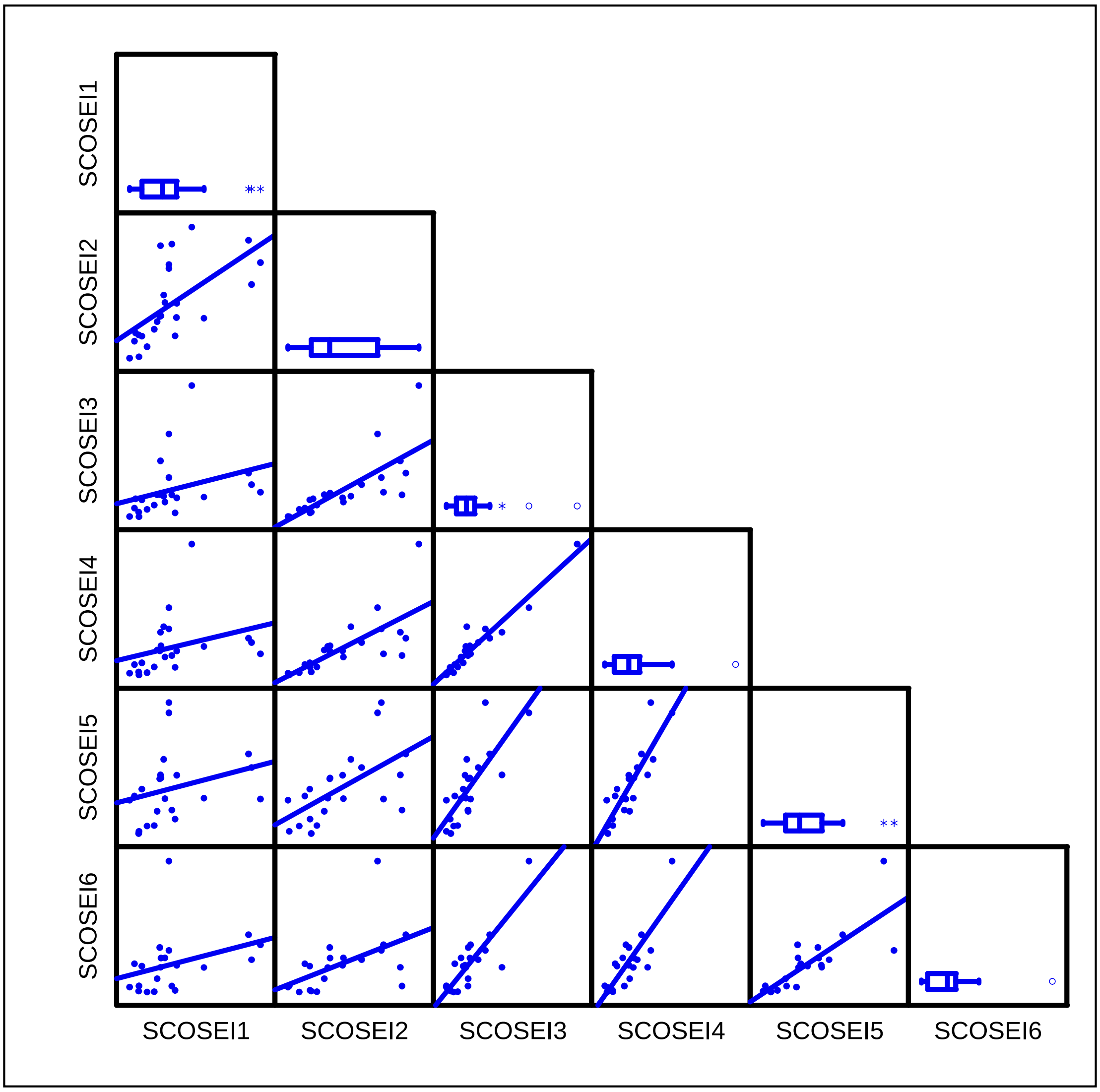


Figure 3.4.3.5 (Cont'd). Bivariate scatterplots indicating within-series consistency of commercial ScoLtr indices.

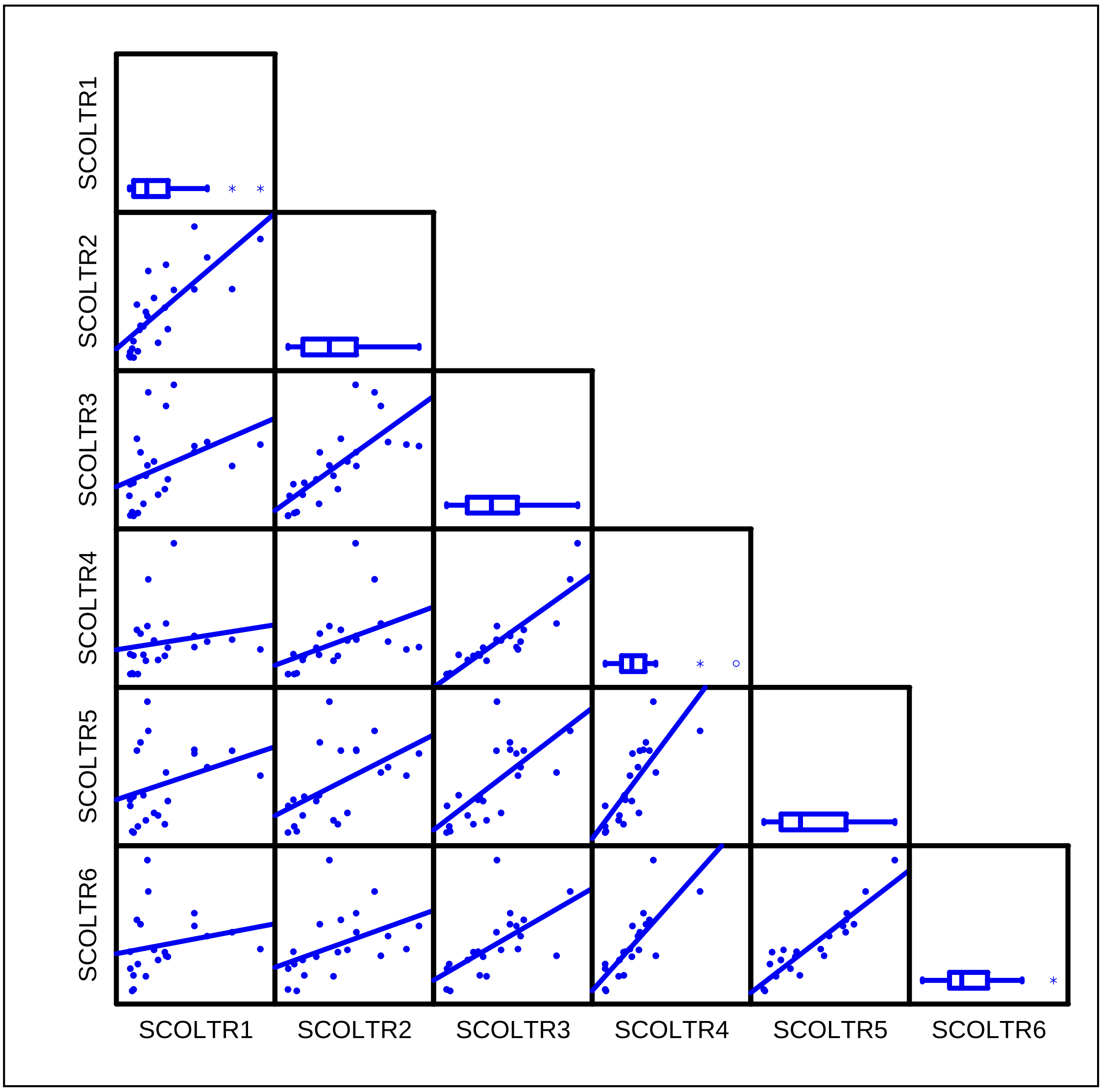


Figure 3.4.3.5 (Cont'd). Bivariate scatterplots indicating within-series consistency of commercial EngTrl indices.

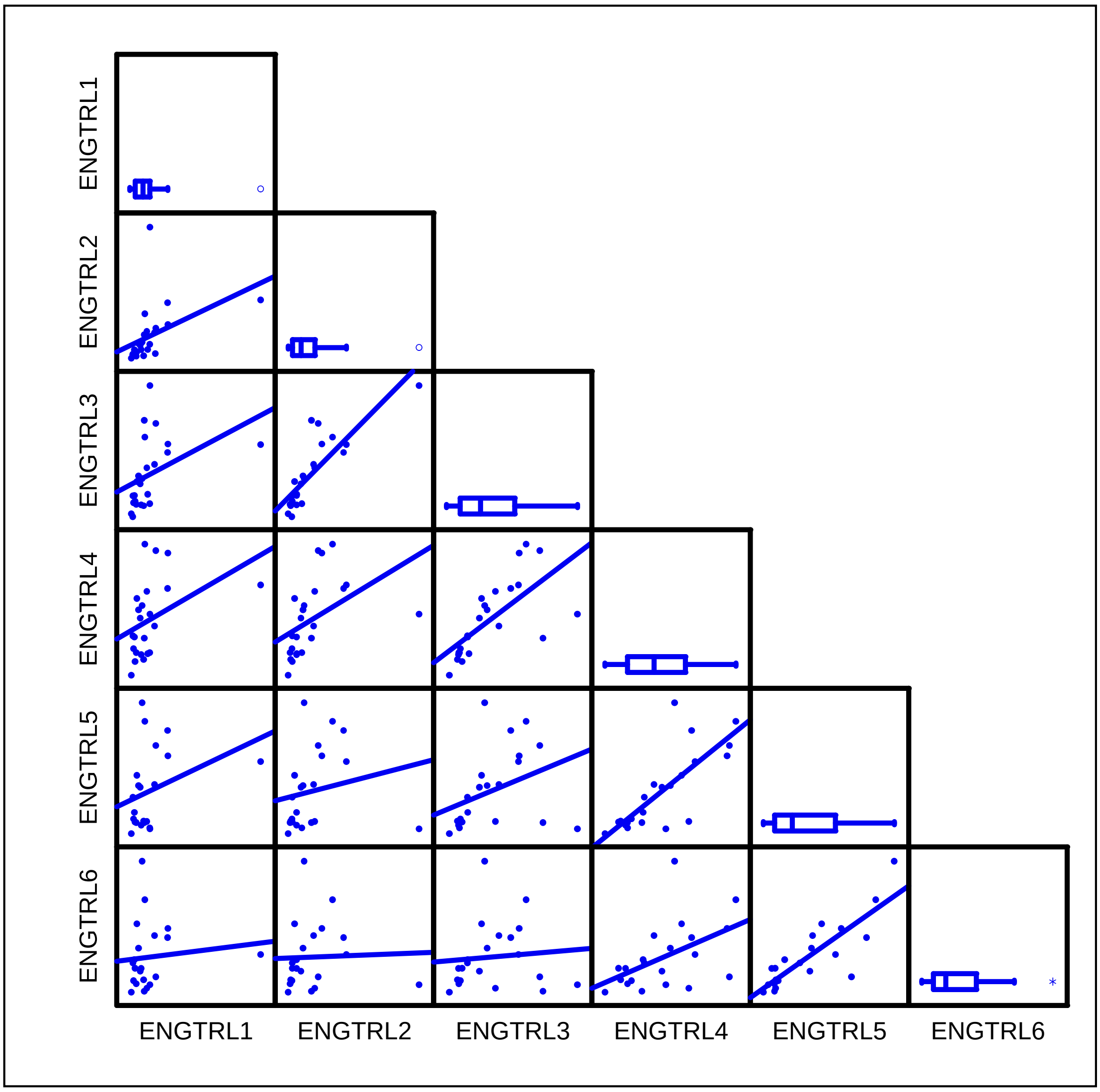


Figure 3.4.3.5 (Cont'd). Bivariate scatterplots indicating within-series consistency of commercial EngSei indices.

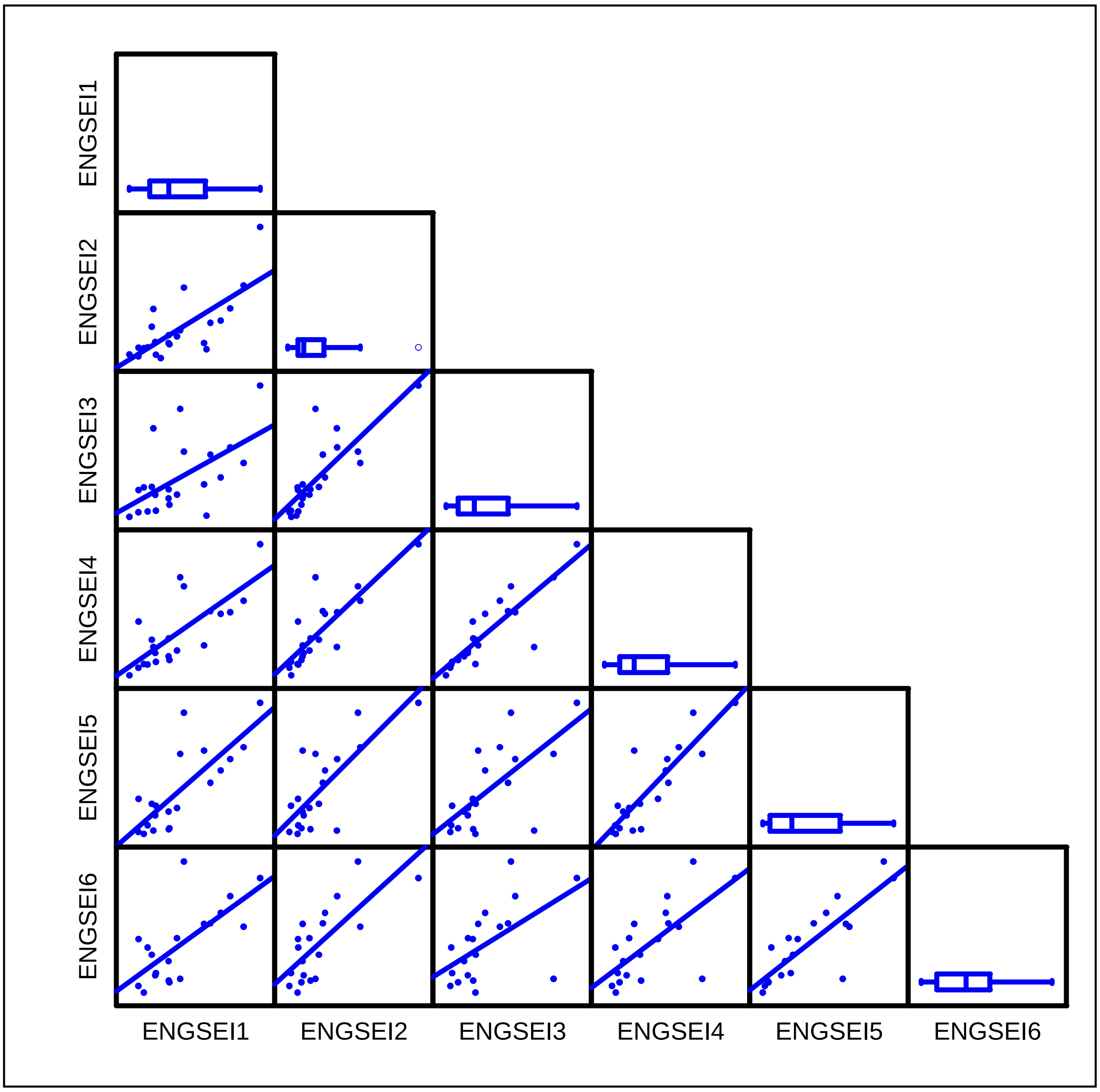


Figure 3.4.3.6 Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Bivariate scatterplots indicating between-series consistency of indices by age: Age 1.

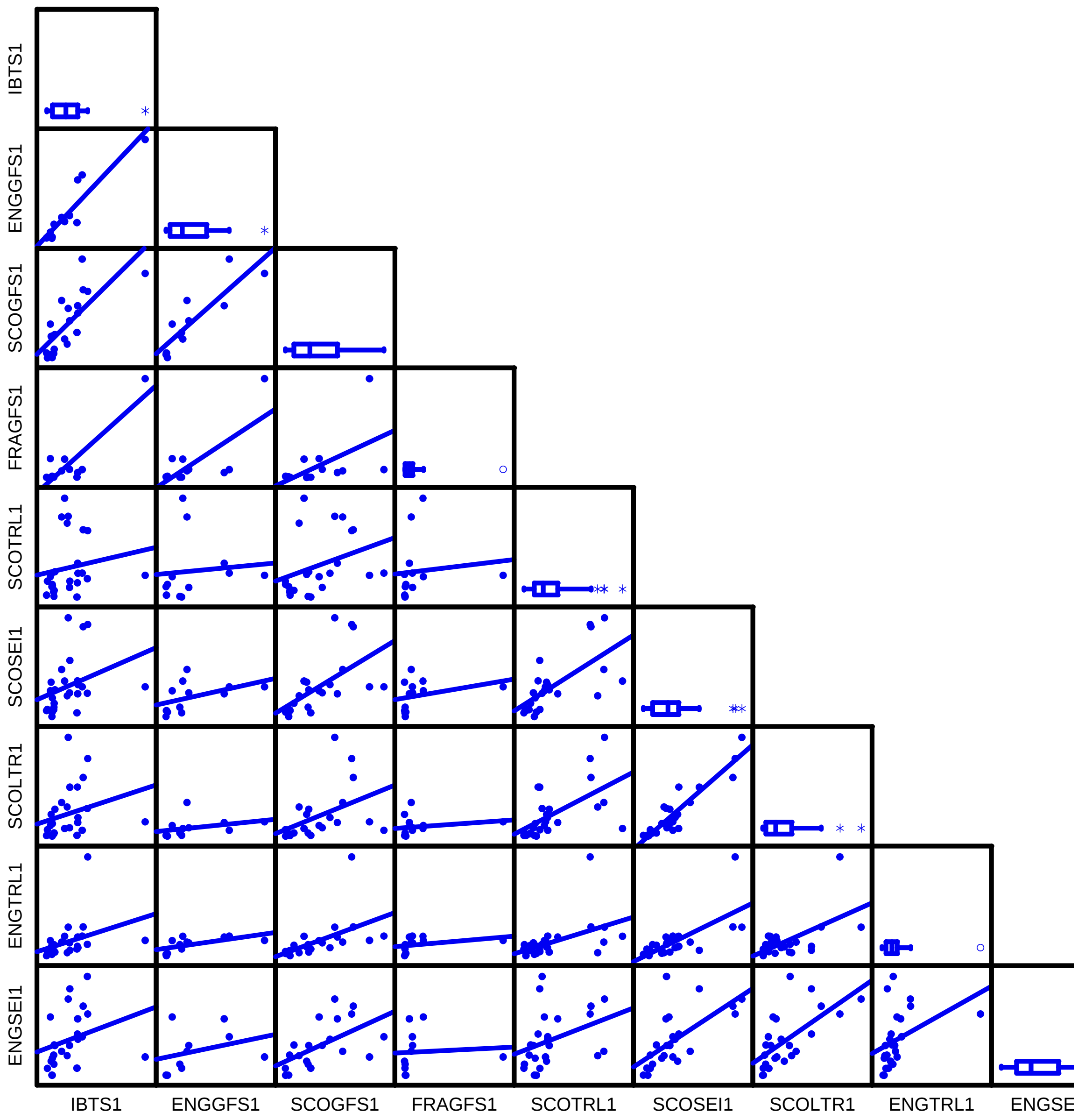


Figure 3.4.3.6 (Cont'd). Bivariate scatterplots indicating between-series consistency of indices by age: Age 2.

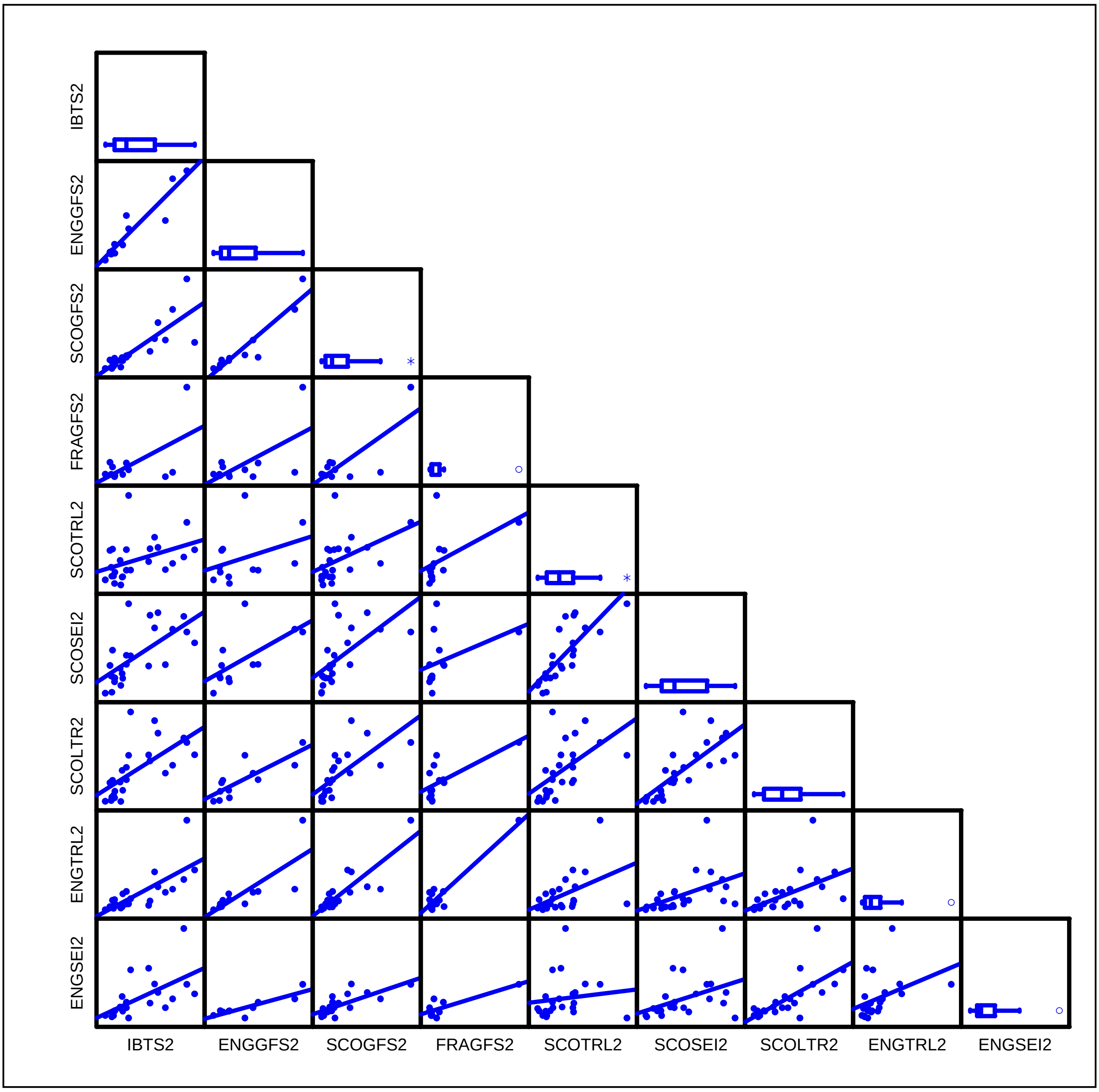


Figure 3.4.3.6 (Cont'd). Bivariate scatterplots indicating between-series consistency of indices by age: Age 3.

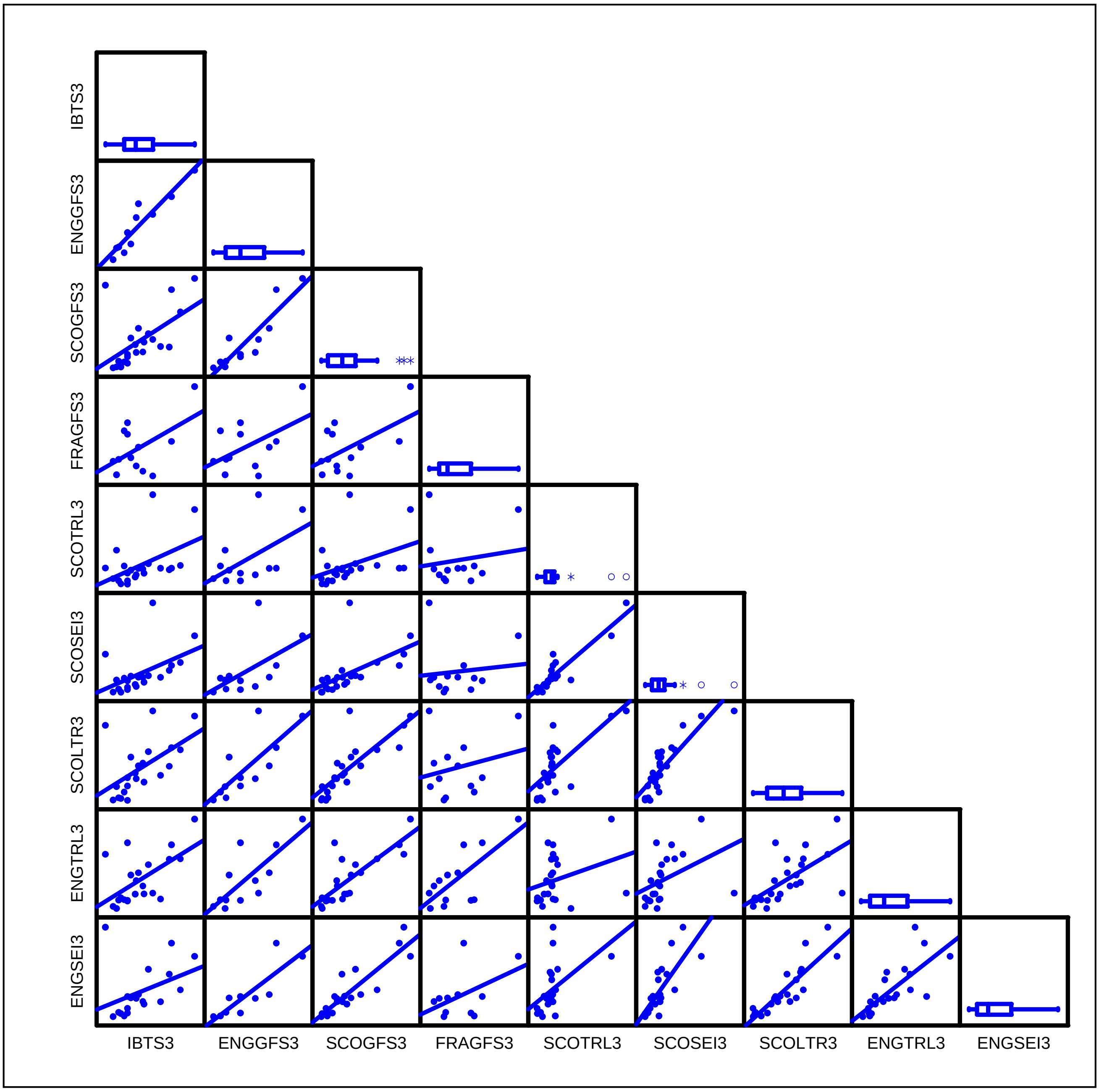


Figure 3.4.3.6 (Cont'd). Bivariate scatterplots indicating between-series consistency of indices by age: Age 4.

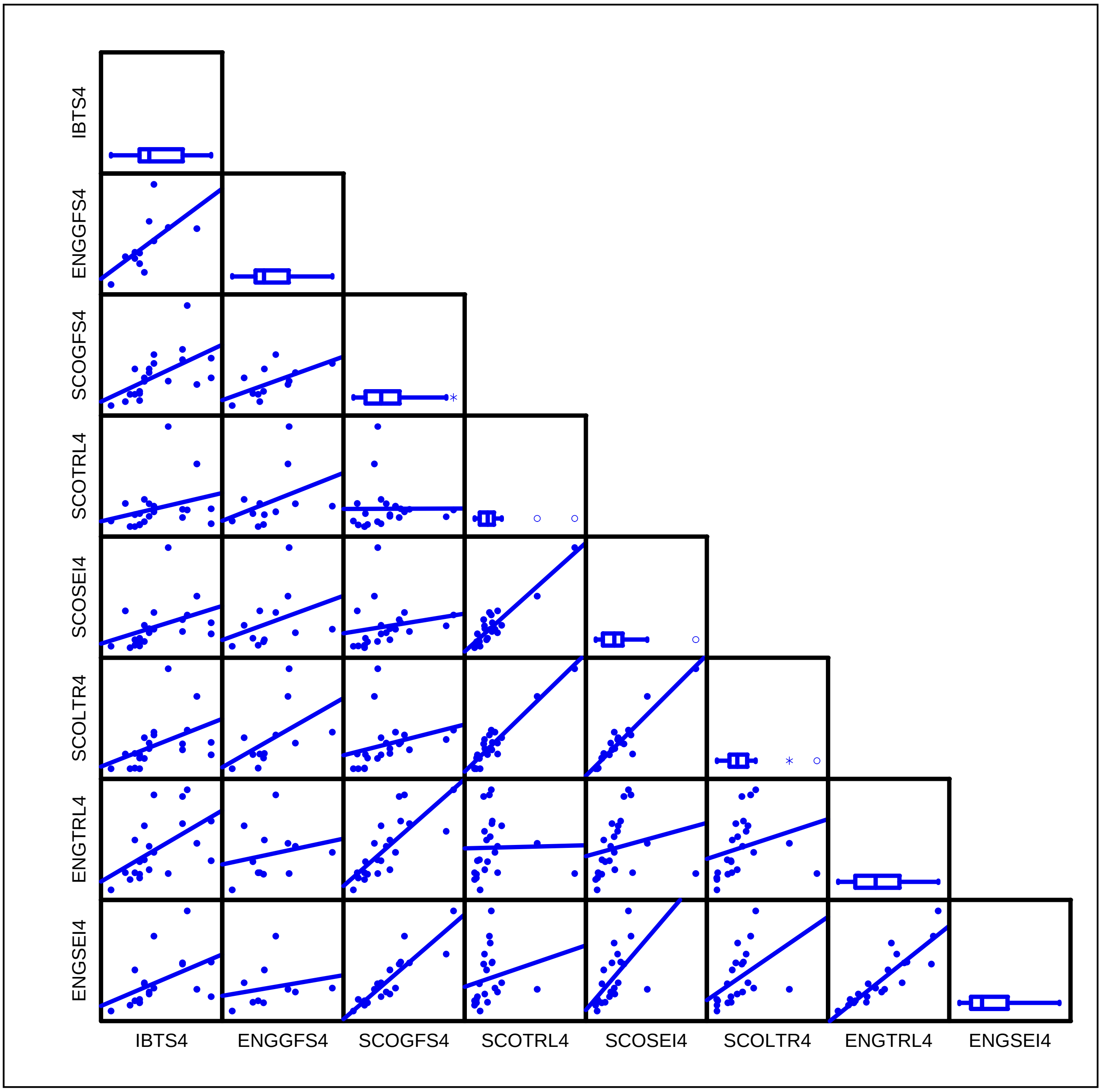


Figure 3.4.3.6 (Cont'd). Bivariate scatterplots indicating between-series consistency of indices by age: Age 5.

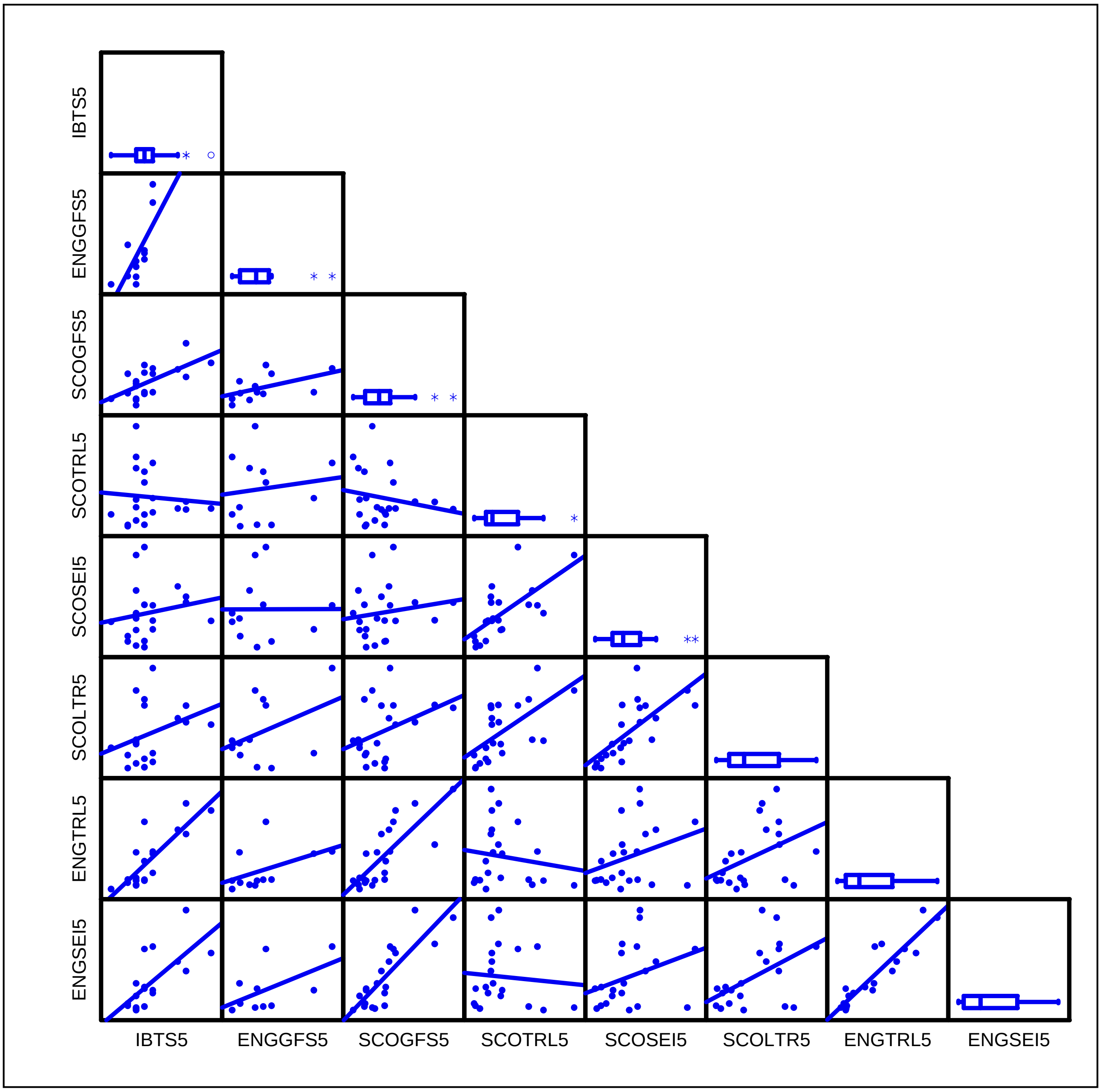


Figure 3.4.3.6 (Cont'd). Bivariate scatterplots indicating between-series consistency of indices by age: Age 6.

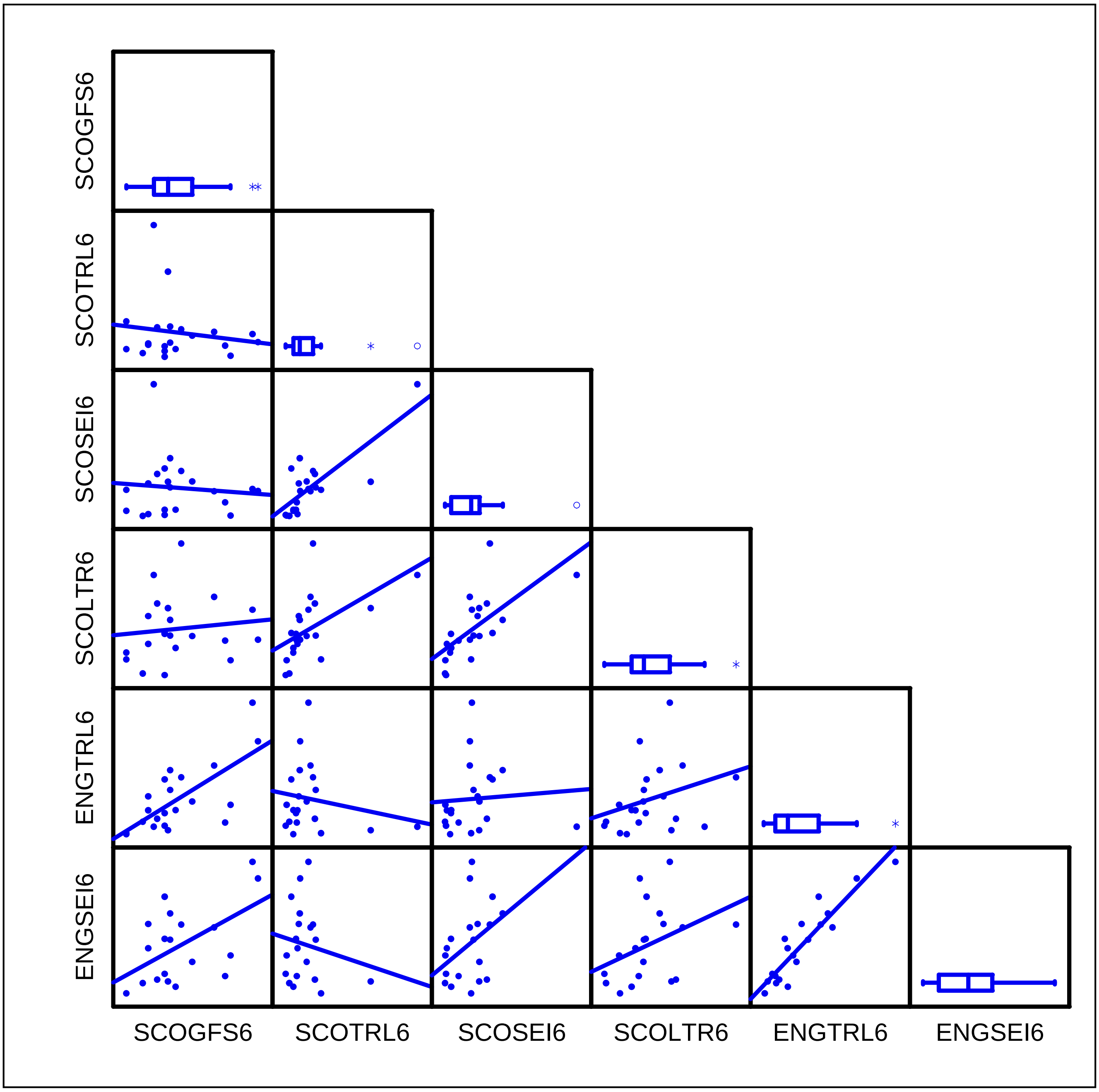
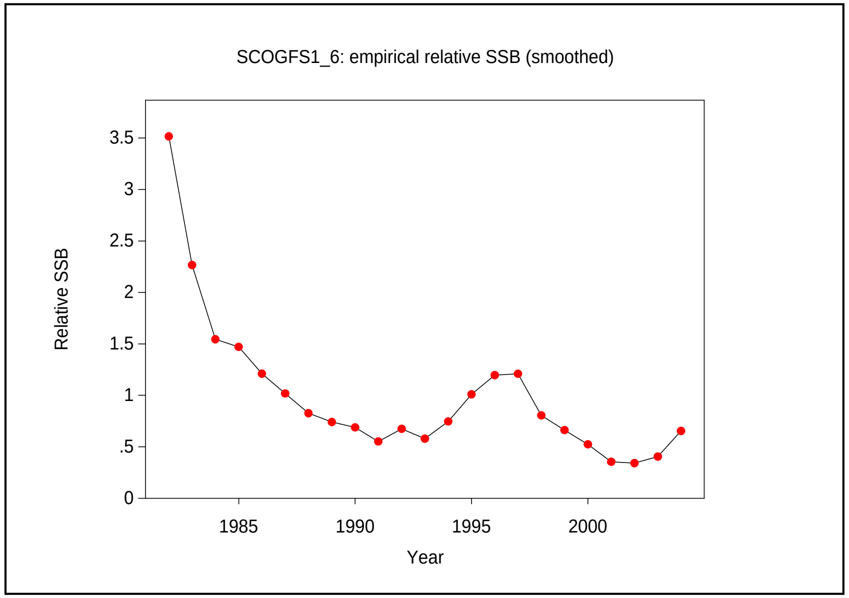
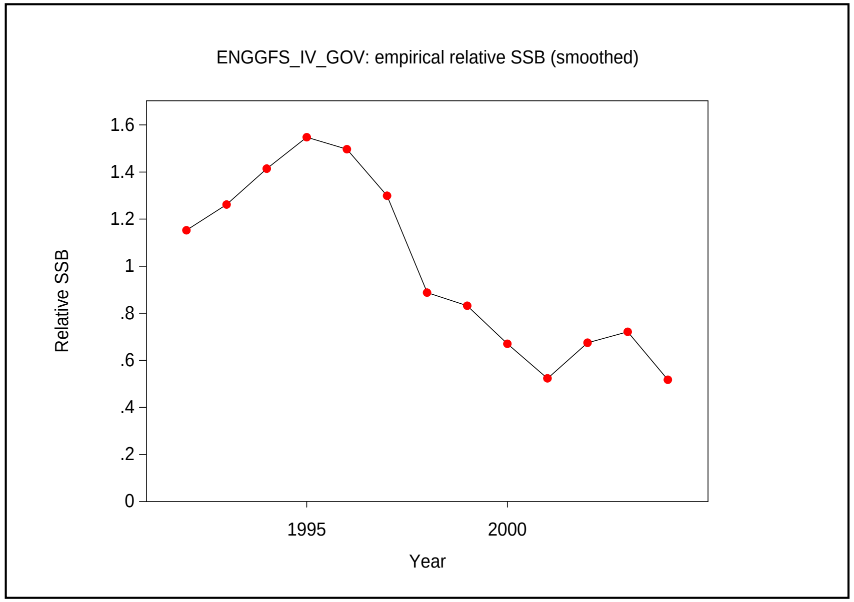
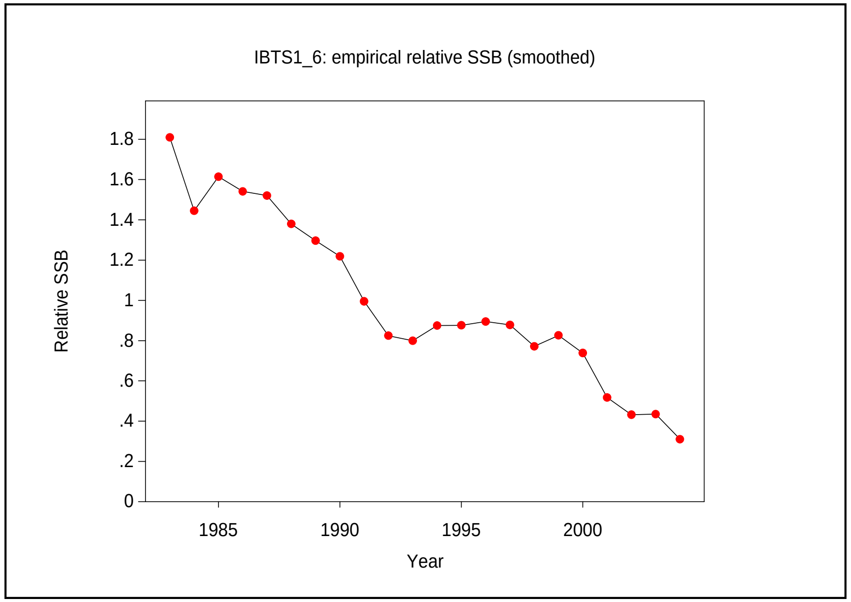


Figure 3.4.4.1 Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Smoothed empirical SSB by survey.







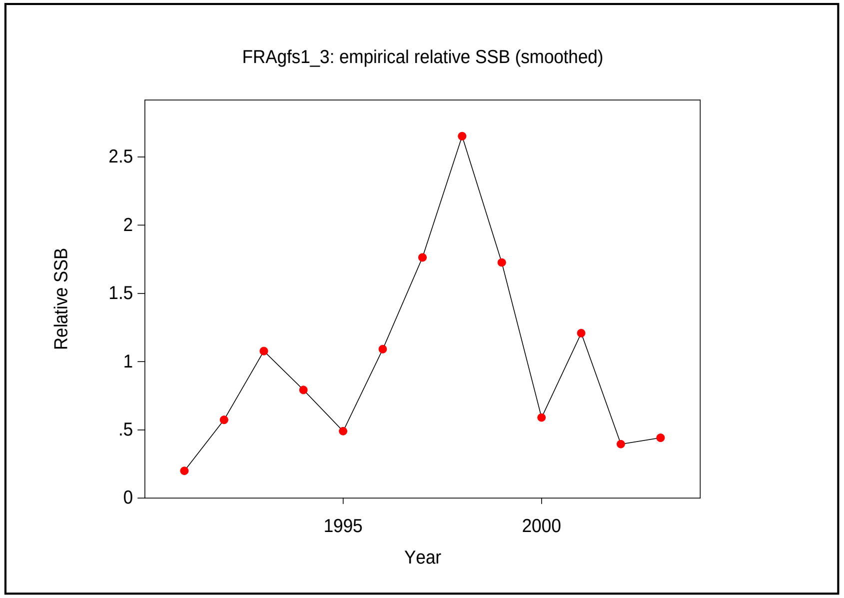


Figure 3.4.4.2 Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Raw empirical Z by survey.

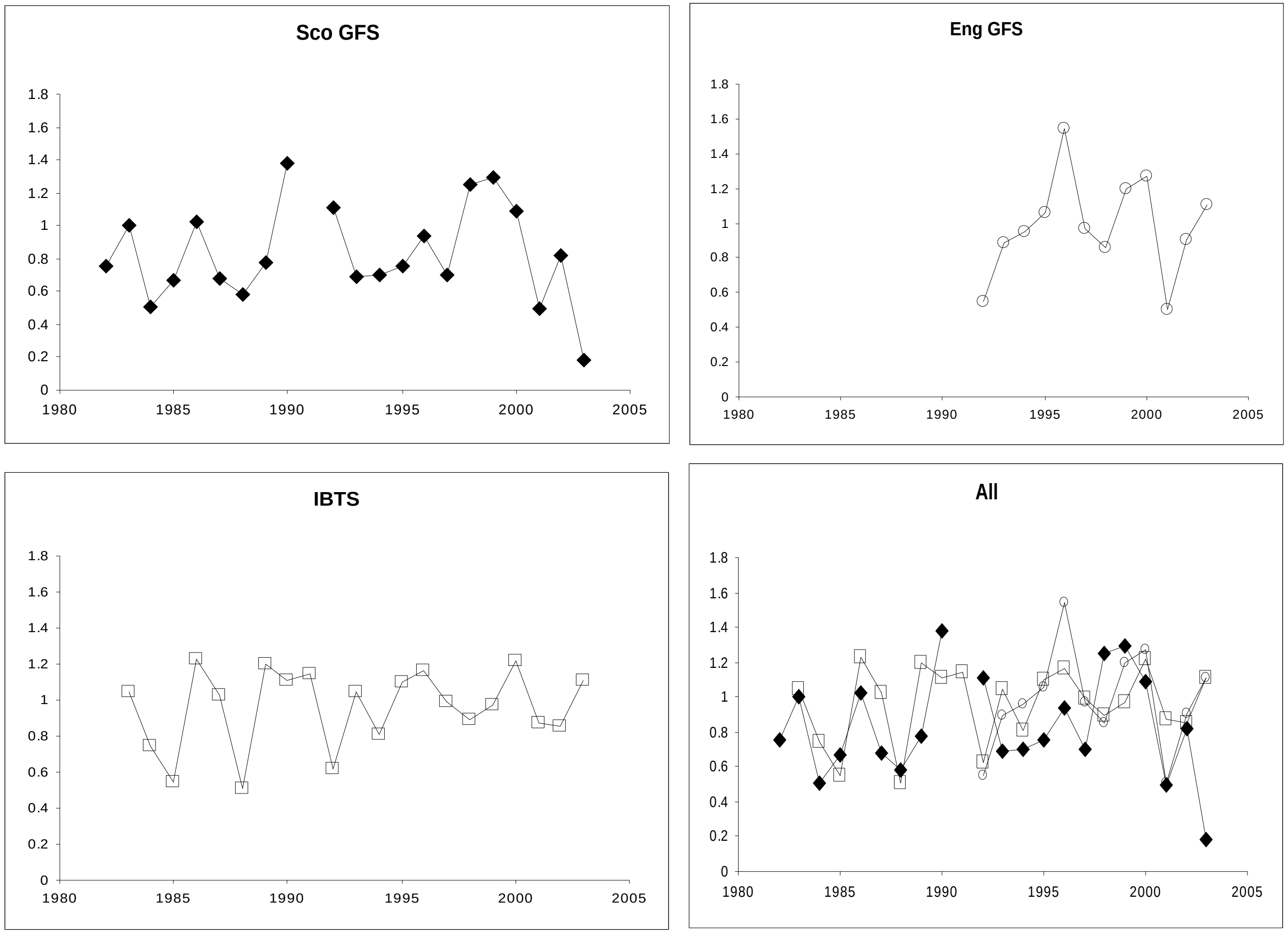


Figure 3.4.4.3 Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Summary results from SURBA, by survey.

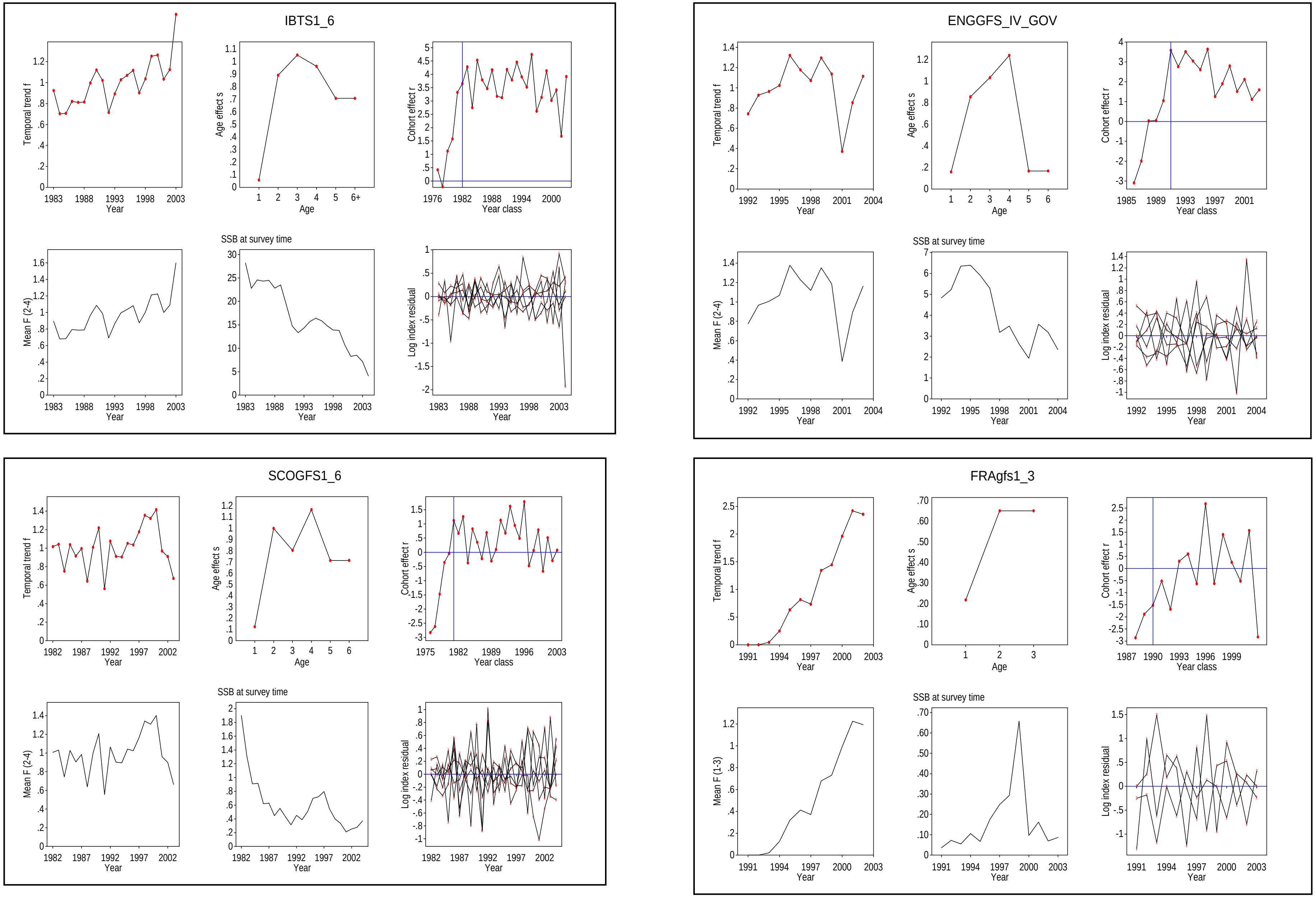


Figure 3.4.4.4 Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Residual plots from SURBA model fits, by survey.

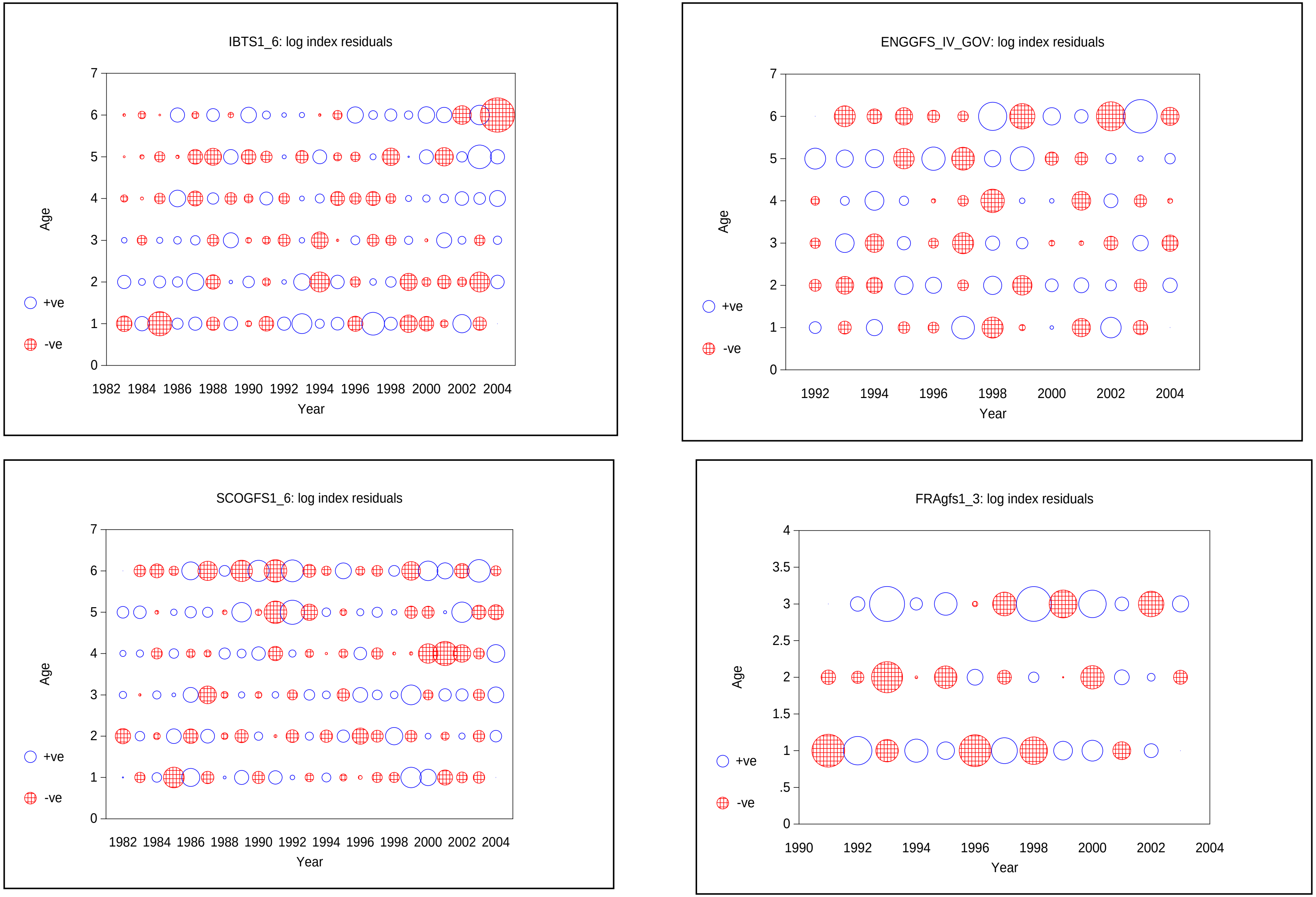


Figure 3.4.4.5 Cod in Sub-area IV and Divisions IIIa (Skagerrak) and VIId. Retrospective analysis of SURBA model fits, by survey.

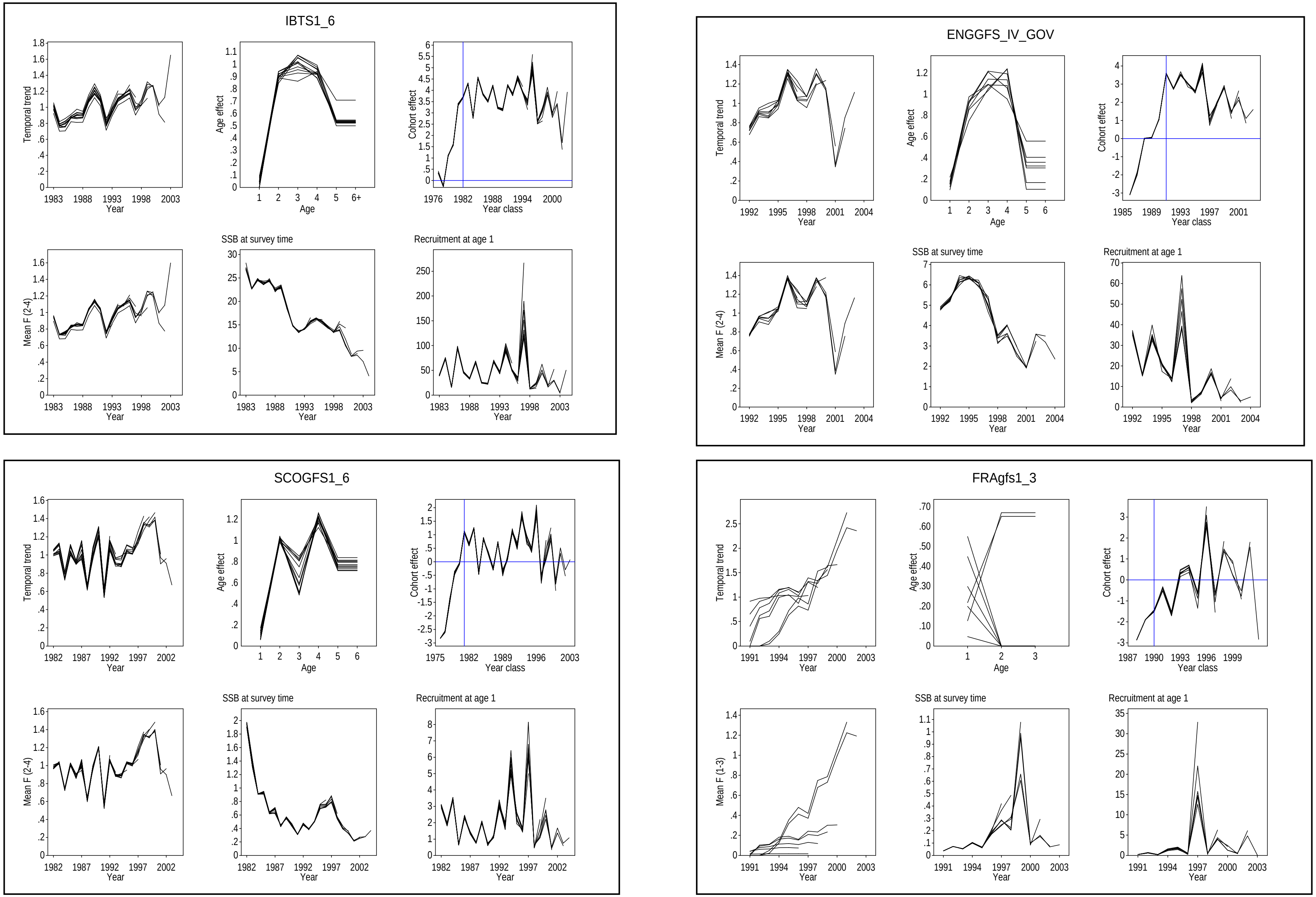


Figure 3.4.5.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId:
The log catchability residuals resulting from a fit of the Laurec-Shepherd VPA calibration model to the North Sea cod reported landings at age data set and the English groundfish survey data for 1992 – 2003.

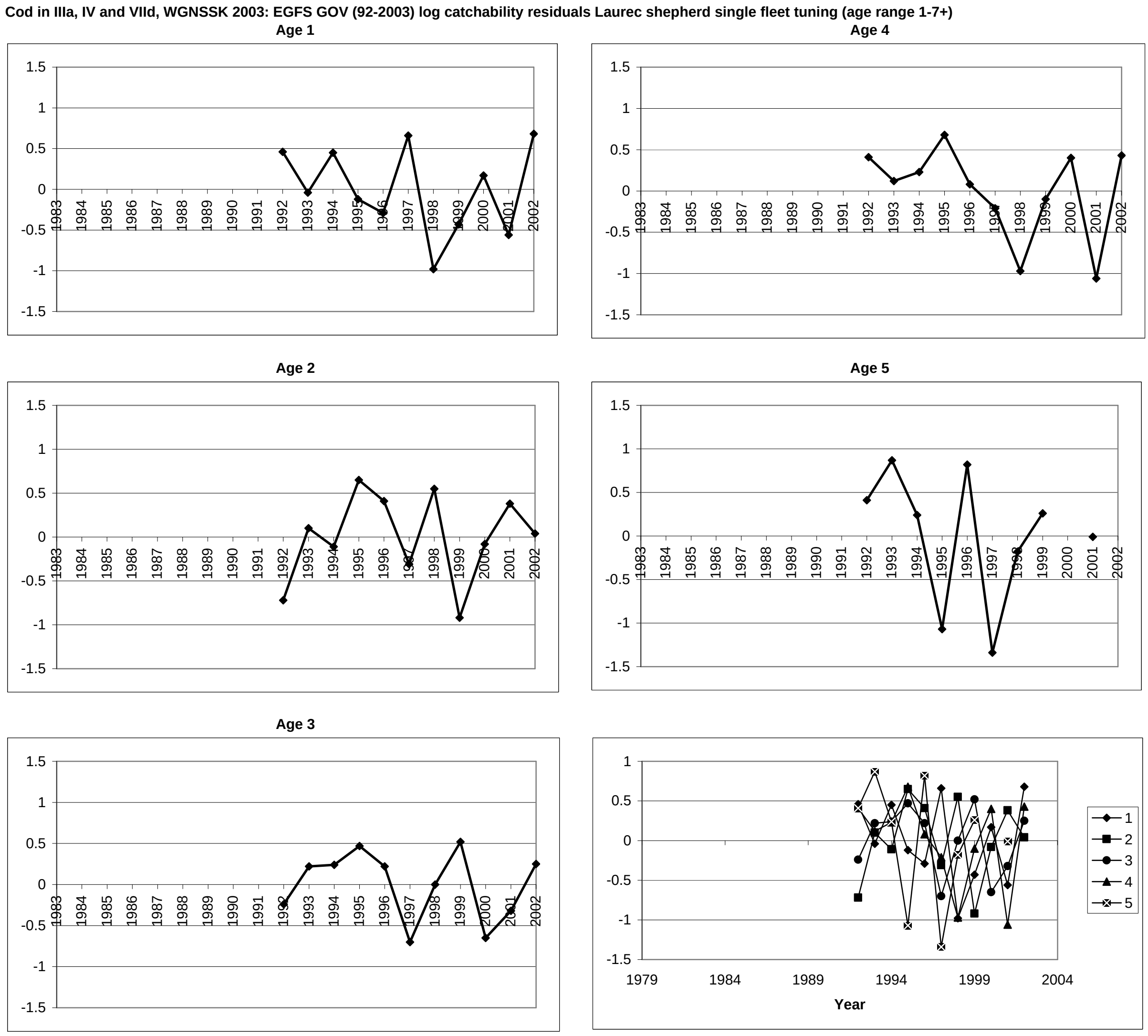


Figure 3.4.5.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The log catchability residuals resulting from a fit of the Laurec-Shepherd VPA calibration model to the North Sea cod reported landings at age data set and the Scottish groundfish survey data for 1983 – 2003.

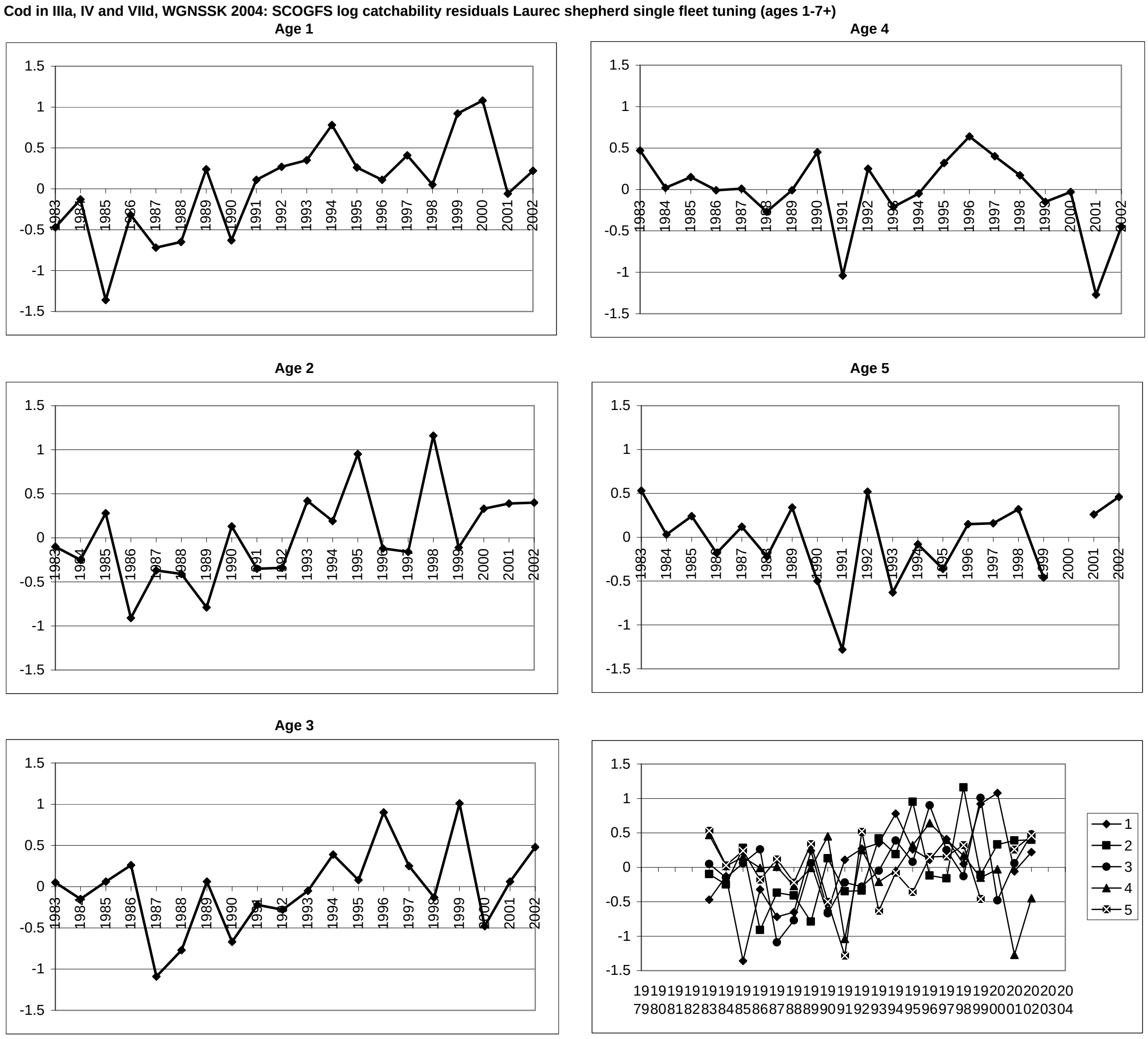


Figure 3.4.5.3 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The log catchability residuals resulting from a fit of the Laurec-Shepherd VPA calibration model to the North Sea cod reported landings at age data set and the IBTS groundfish survey data for 1993 – 2003.

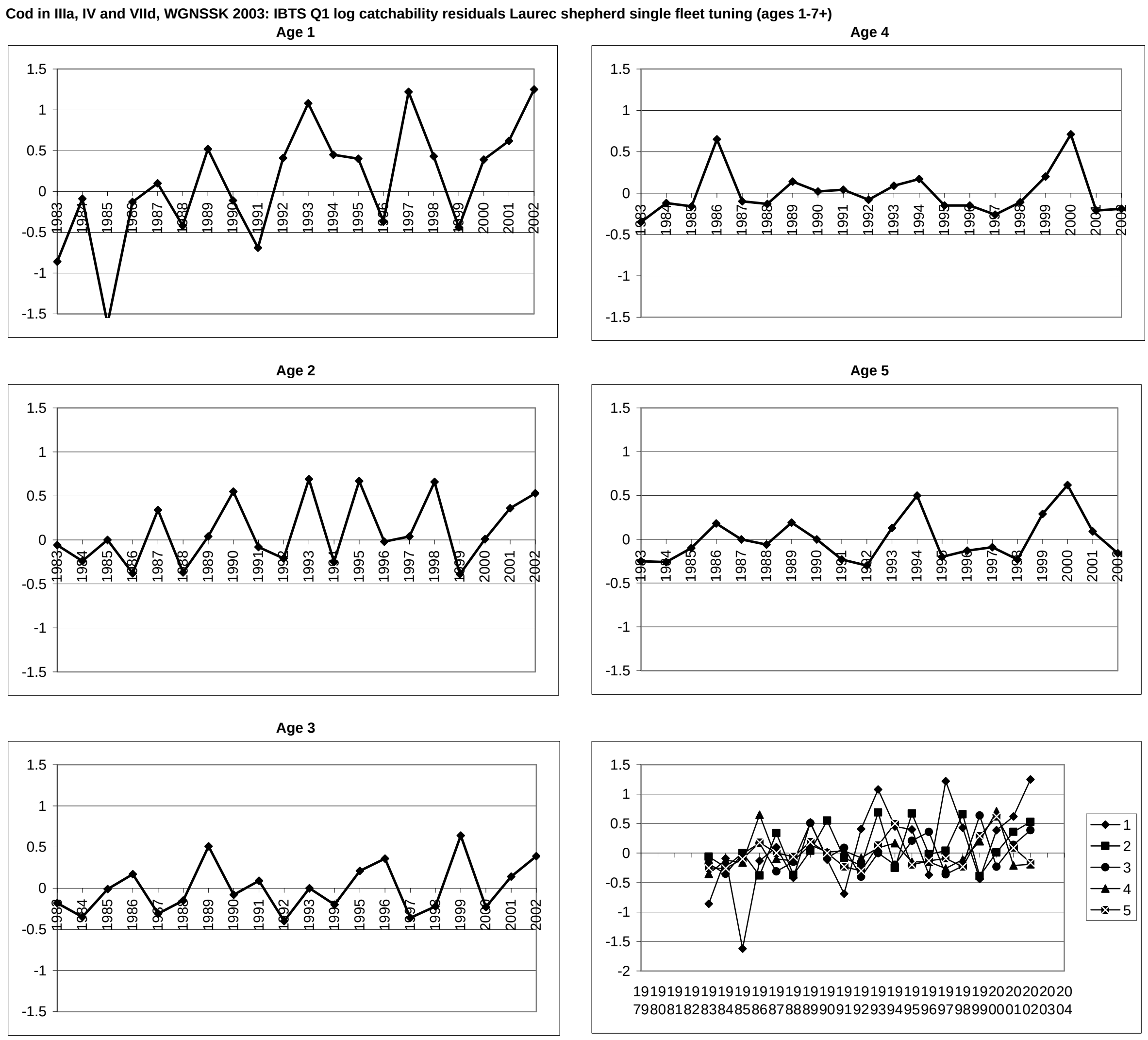


Figure 3.4.5.4 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The log catchability residuals resulting from a fit of the Laurec-Shepherd VPA calibration model to the North Sea cod reported landings at age data set and the French groundfish surveyin 7d for 1991 – 2003.

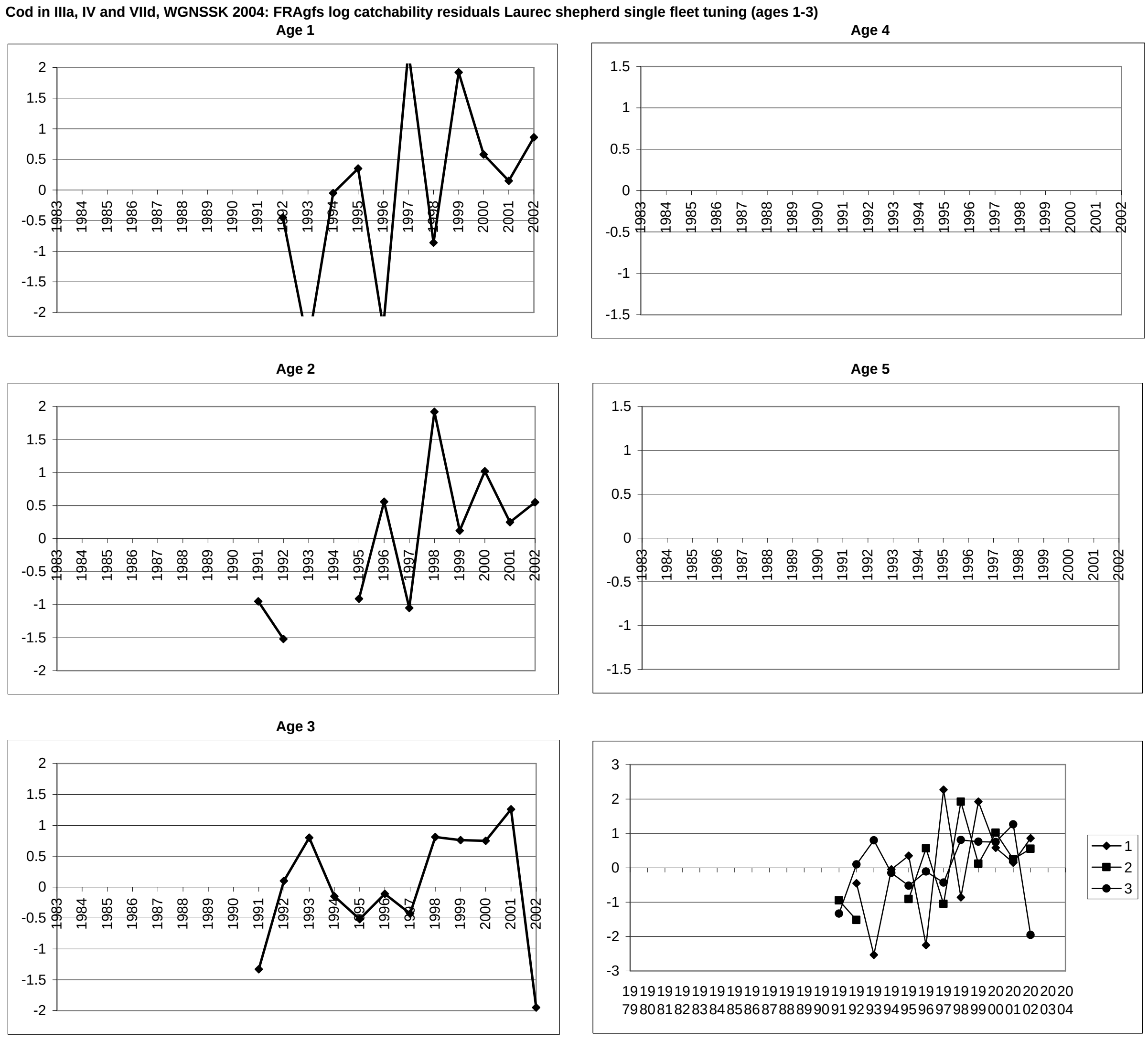


Figure 3.4.7.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The percentiles (5,25,50,75,95) of cod in 347d total landings as estimated by the ADAPT model applied without catch smoothing. The solid line represents the reported catch.

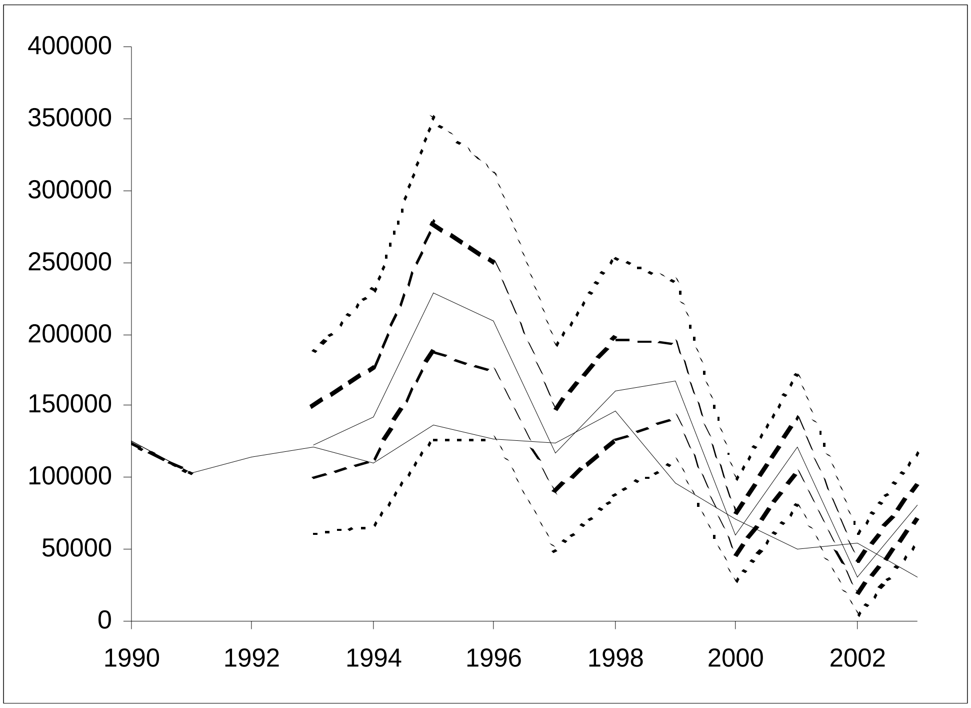


Figure 3.4.7.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The percentiles (5,25,50,75,95) of the cod in 347d average fishing mortality estimates from the ADAPT model applied without catch smoothing. The solid horizontal line represents the estimate of average mortality without assuming bias in the catch data.

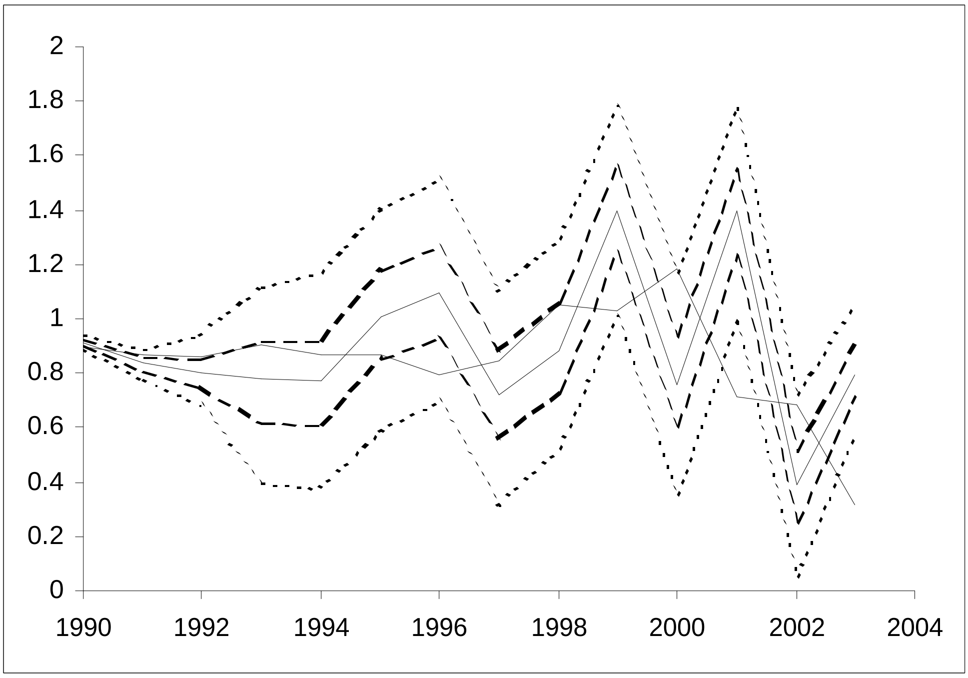


Figure 3.4.7.3 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The percentiles (5,25,50,75,95) of the cod in 347d SSB estimates as estimated by the ADAPT model applied without catch smoothing. The solid line represents the estimate SSB without assuming bias in the catch data.

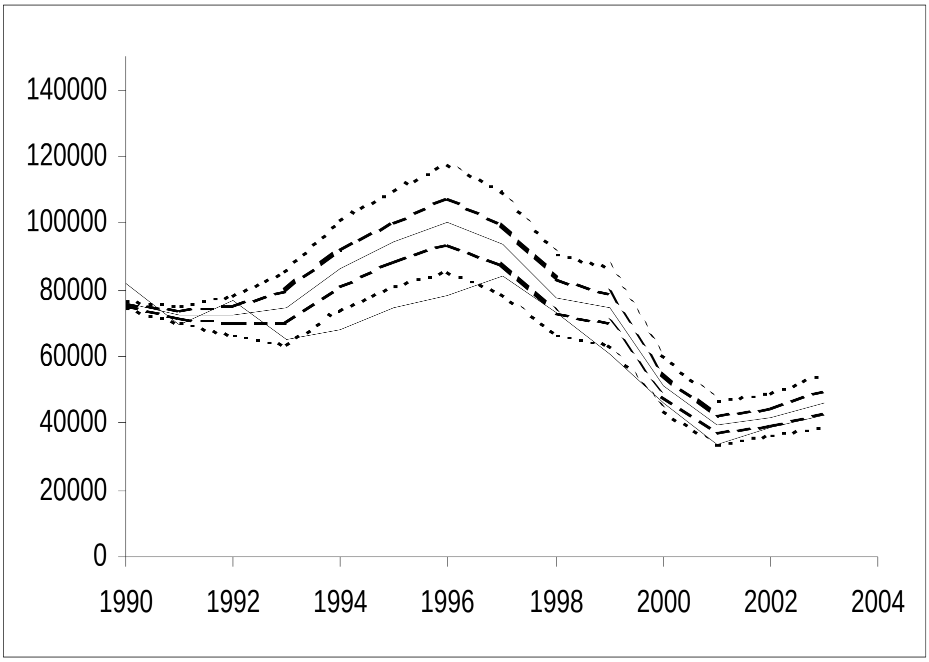


Figure 3.4.7.4 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The percentiles (5,25,50,75,95) of the cod in 347d catch raising factor estimates from the ADAPT model applied without catch smoothing. The solid line represents no bias.

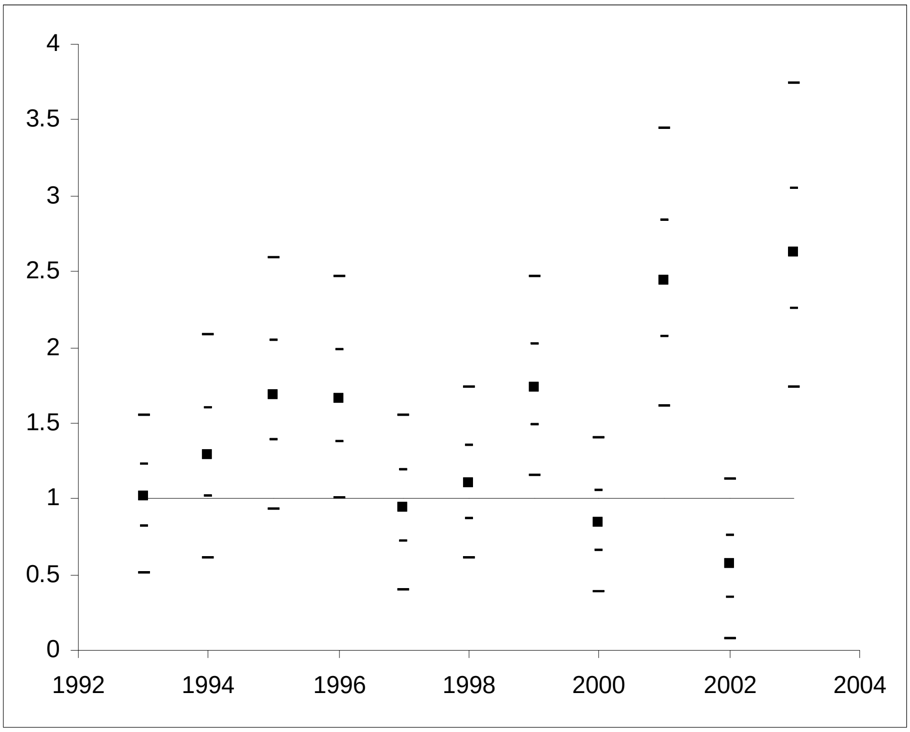


Figure 3.4.7.5 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The percentiles (5,25,50,75,95) of estimated cod in 347d total catch from the ADAPT model applied with catch smoothing. The solid line represents the reported catch.

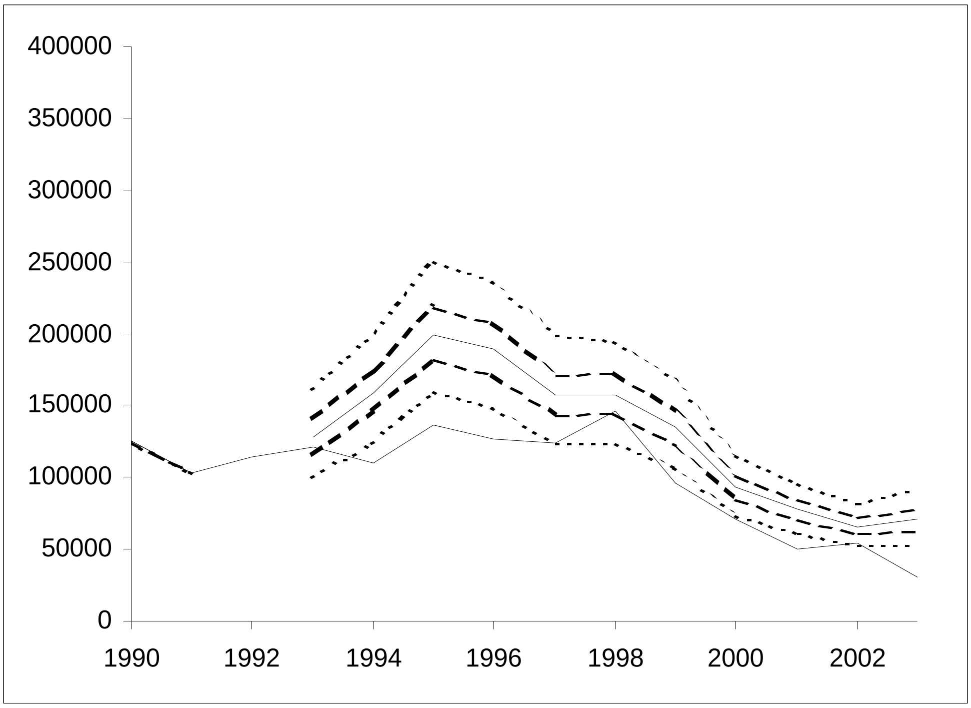


Figure 3.4.7.6 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The percentiles (5,25,50,75,95) of the cod in 347d average fishing mortality estimates from the ADAPT model applied with catch smoothing. The solid horizontal line represents the estimate of average mortality without assuming bias in the catch data.

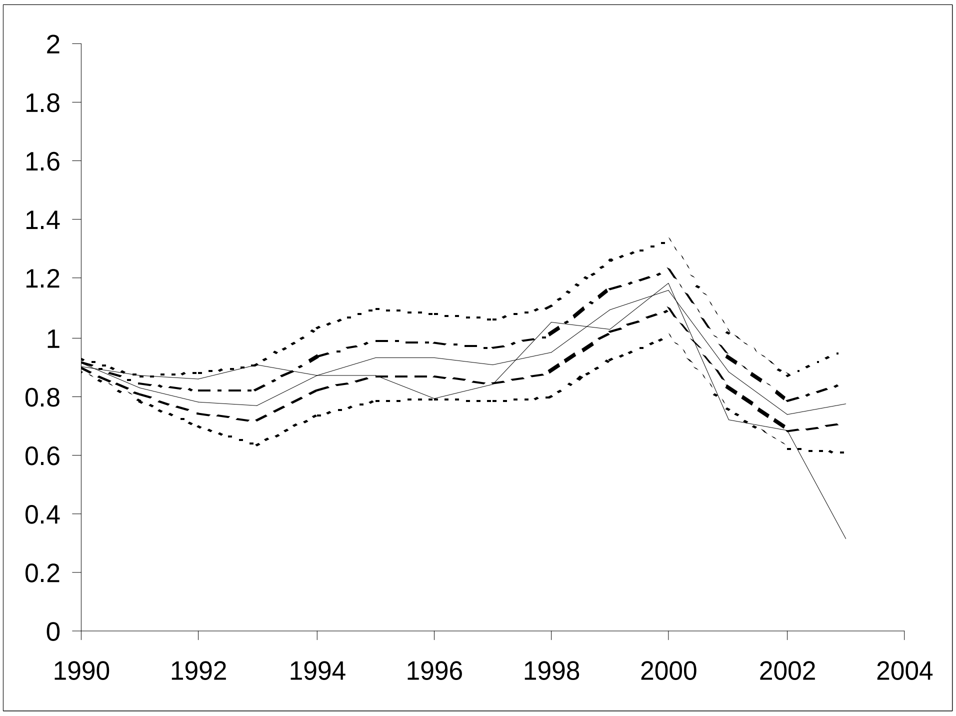


Figure 3.4.7.7 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The percentiles (5,25,50,75,95) of the cod347d SSB estimates from the ADAPT model applied with catch smoothing. The solid line represents the estimate SSB without assuming bias in the catch data.

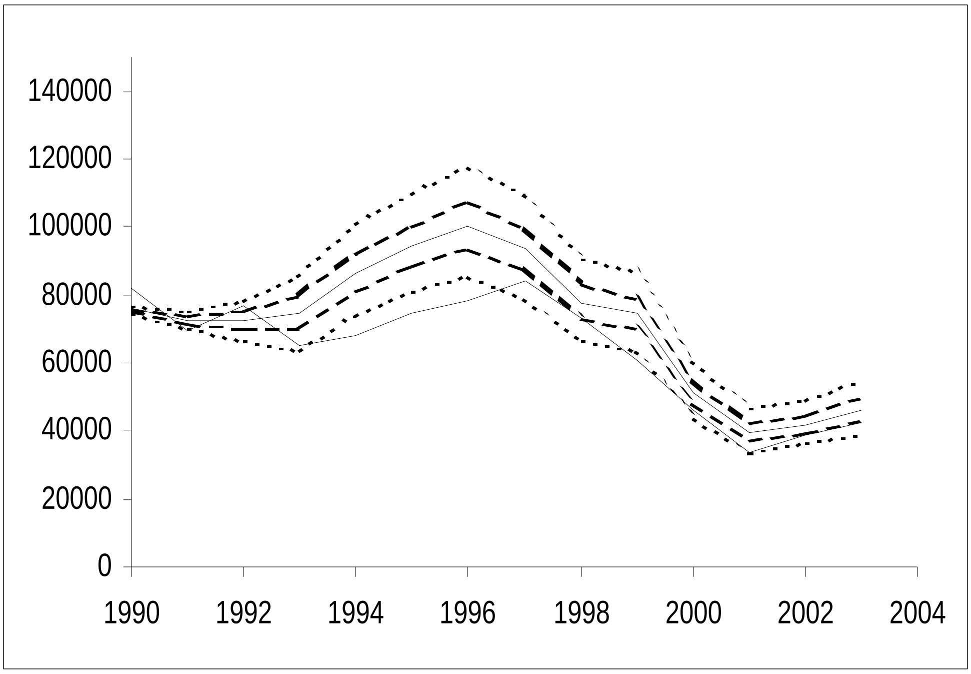


Figure 3.4.7.8 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The percentiles (5,25,50,75,95) of the cod 347d catch raising factor estimates from the ADAPT model applied with catch smoothing. The solid line represents no bias.

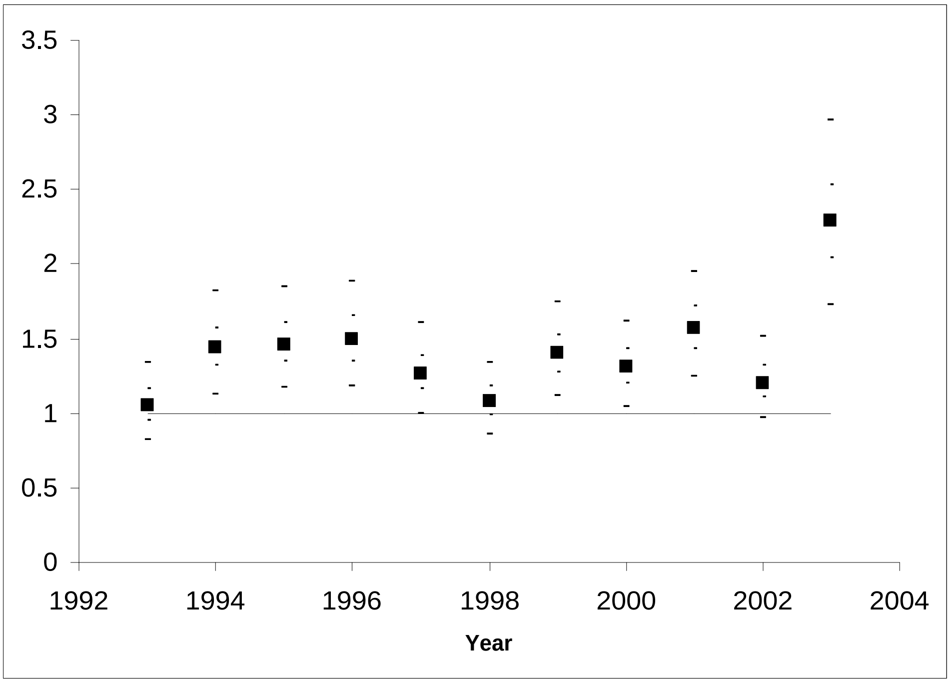


Figure 3.4.7.9 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The sensitivity of the estimates of landings, SSB and average fishing mortality (ages 2 – 4) to the weight given to the smoothing constraint on year to year variation on total landings. Solid line – estimates with estimation of missing landings, fine line - estimates without estimation of missing landings.

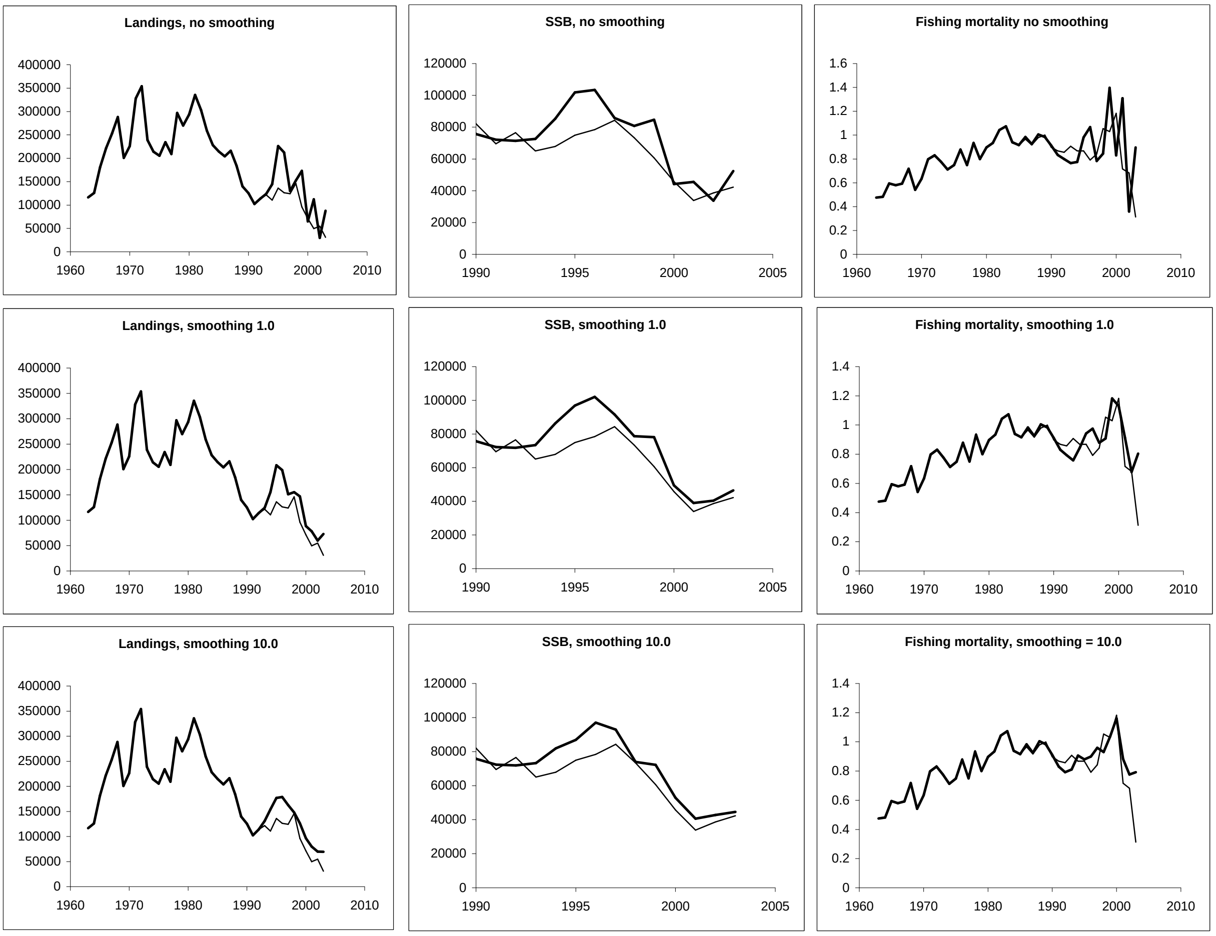


Figure 3.4.7.10 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: ScoGFS log catchability residuals resulting from a fit of the modified ADAPT model without estimation of missing catch data (open diamonds) and with estimation of missing catch (solid squares)

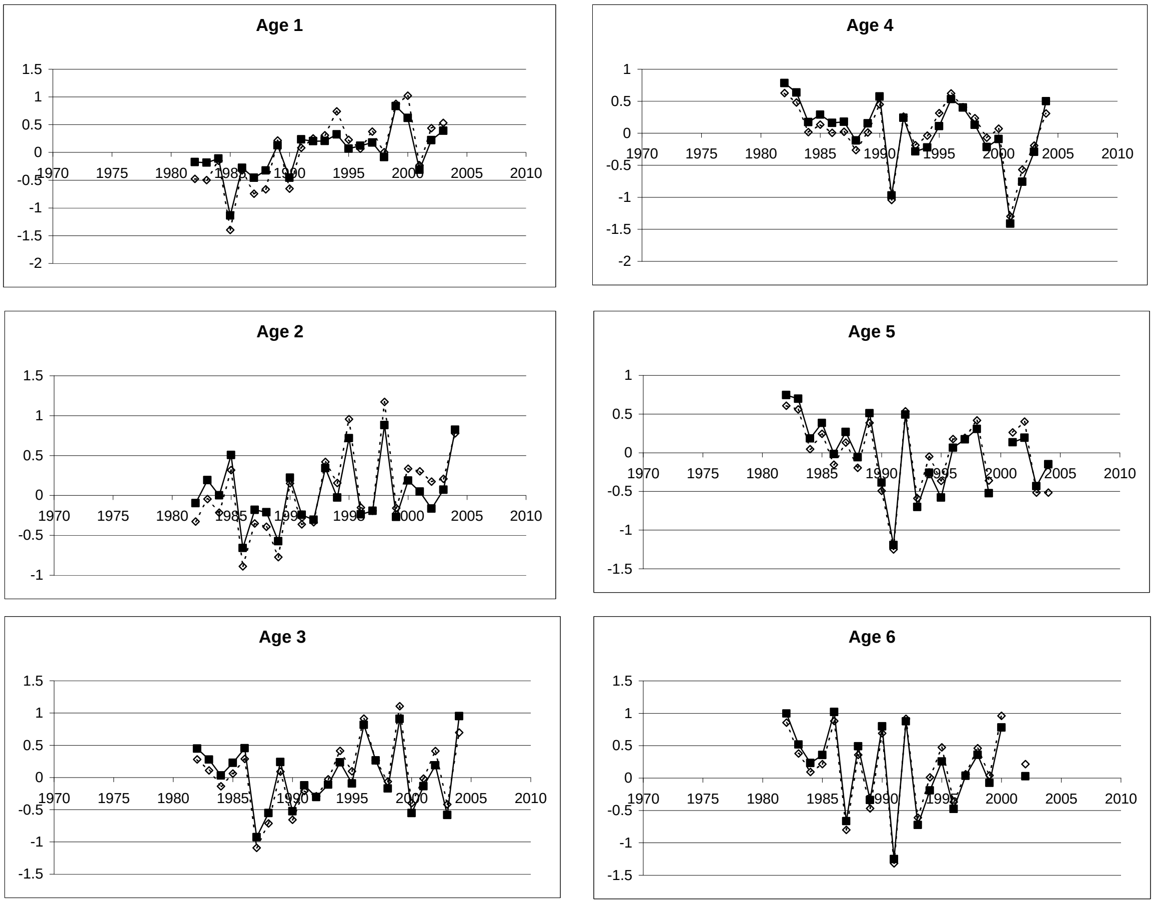


Figure 3.4.7.10 (cont) EGFS log catchability residuals resulting from a fit of the modified ADAPT model without estimation of missing catch data (open diamonds) and with estimation of missing catch (solid squares)

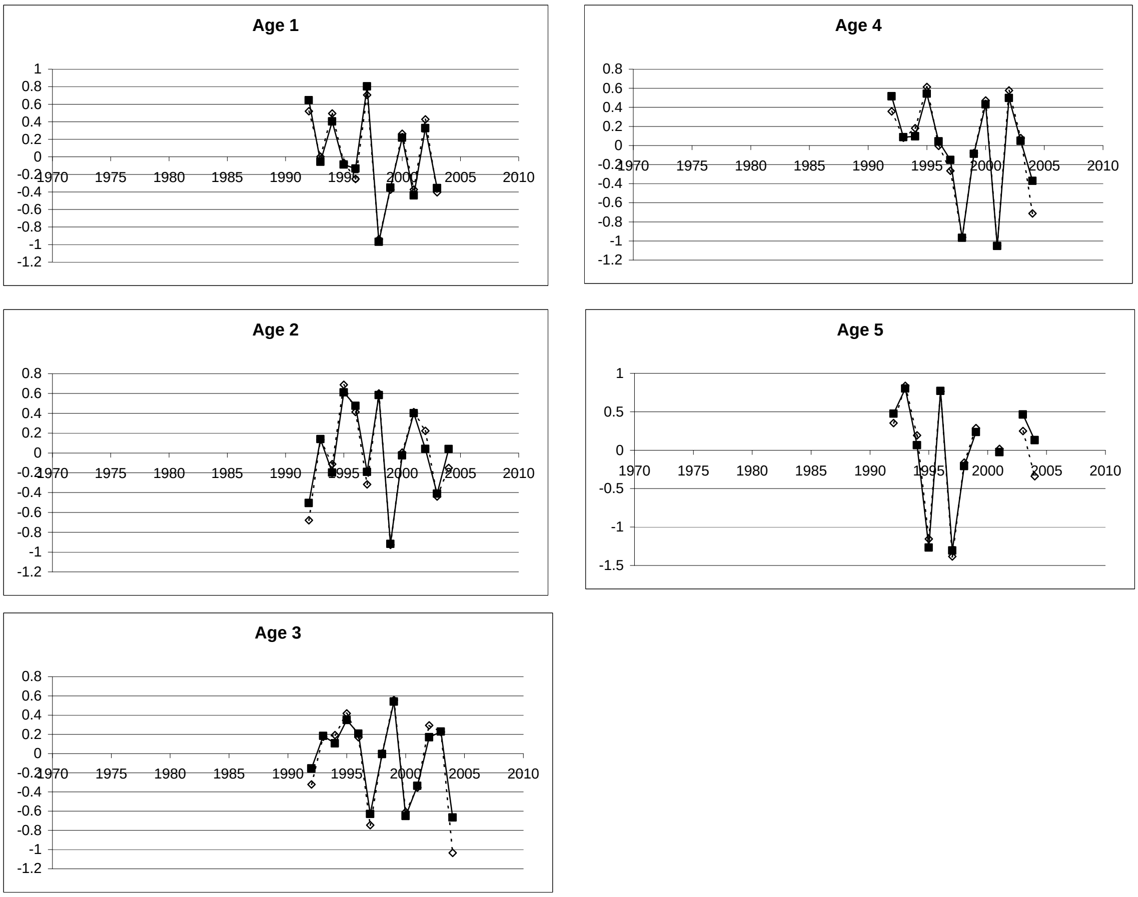


Figure 3.4.7.10 (cont) IBTS log catchability residuals resulting from a fit of the modified ADAPT model without estimation of missing catch data (open diamonds) and with estimation of missing catch (solid squares)

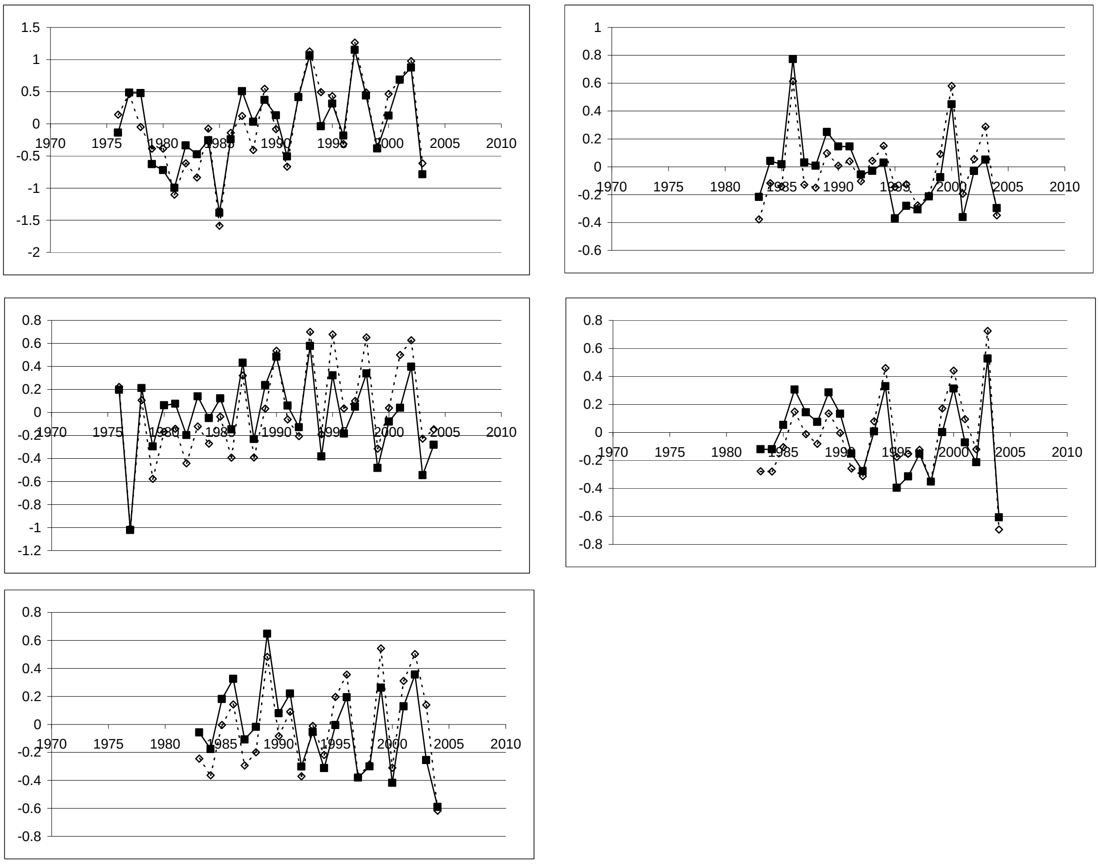


Figure 3.4.7.11 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: historic trends estimated by the modified ADAPT model when fitted to landings data without discards.

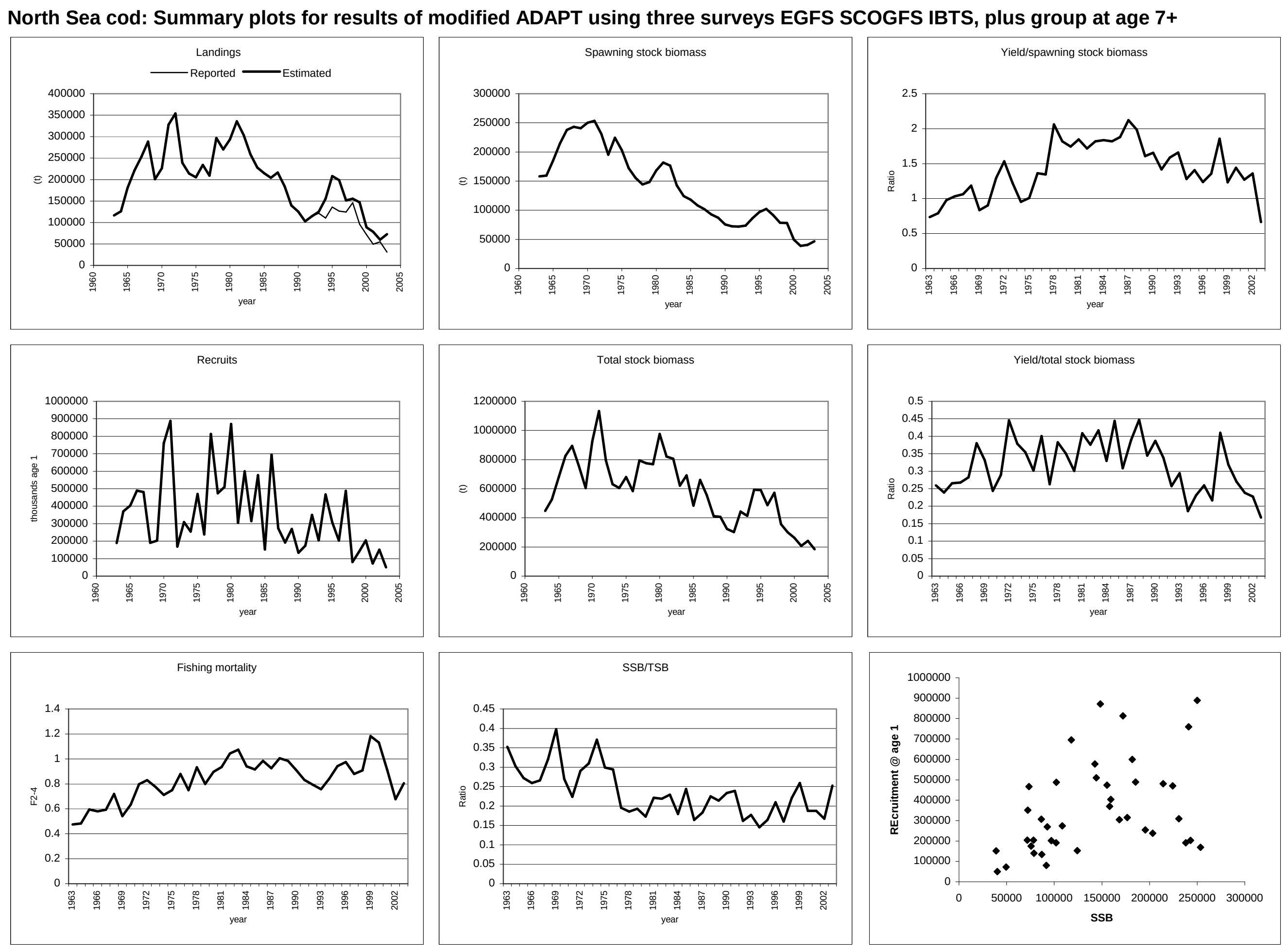


Figure 3.4.7.12 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Retrospective series of the total landings as estimated using the modified ADAPT model for assessment years finishing in 1998 – 2003 (without discards).

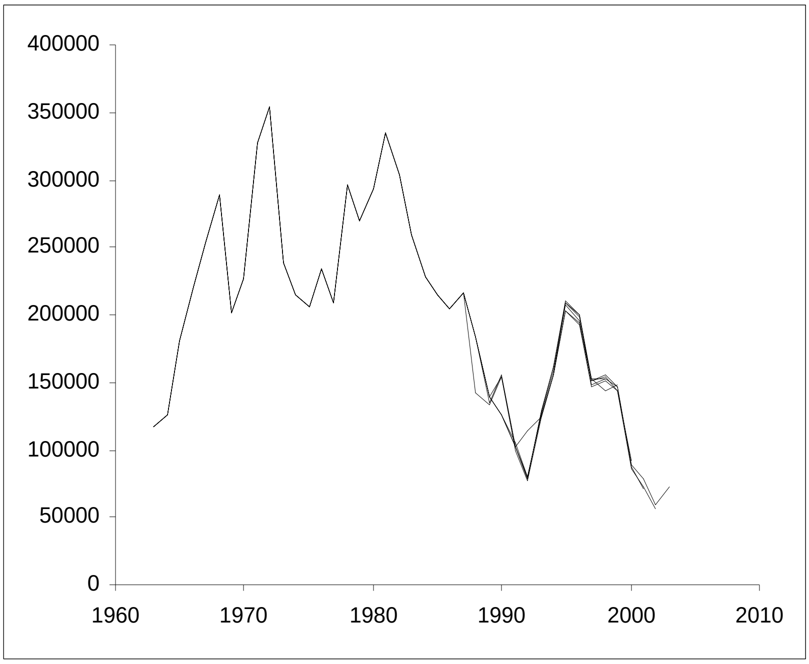


Figure 3.4.7.13 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Retrospective series of average fishing mortality as estimated using the modified ADAPT model for assessment years finising in 1998 - 2003 (without discards).

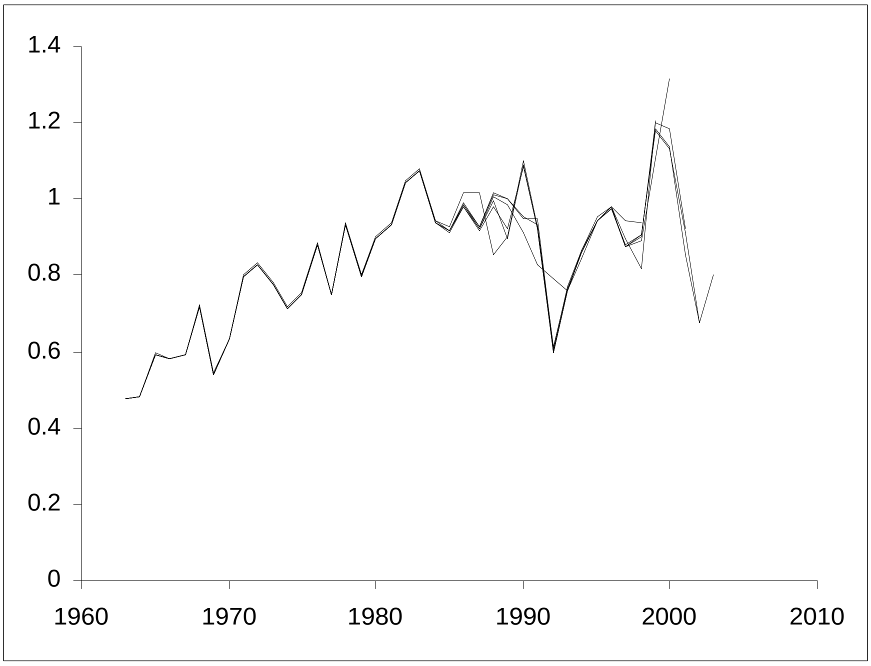


Figure 3.4.7.14 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Retrospective series of spawning stock biomass as estimated using the modified ADAPT model for assessment years finising in 1998 - 2003 (without discards).

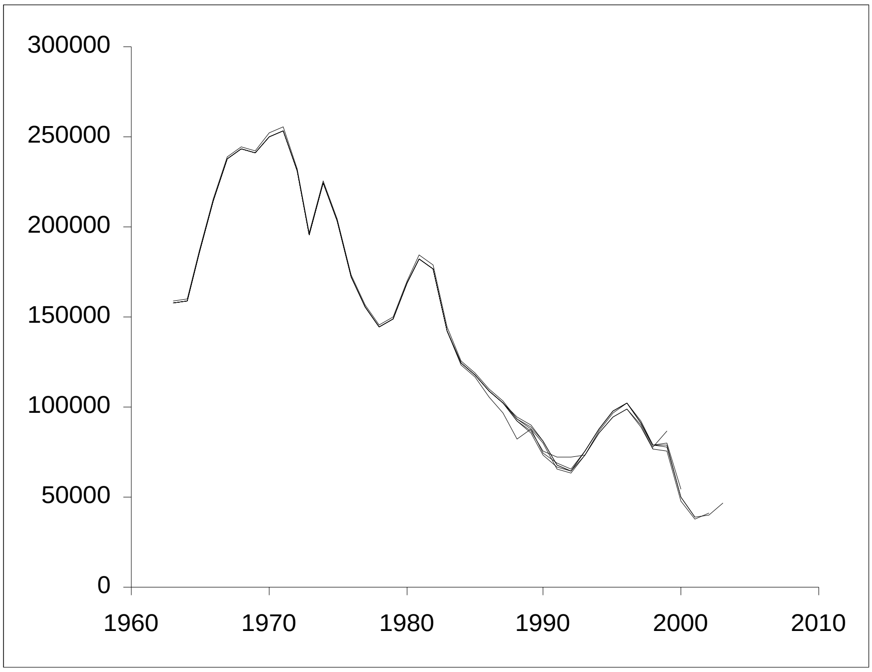


Figure 3.4.8.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: historic trends estimated by the modified ADAPT model when fitted to data including discards. The solid line illustrates the with discards estimates the fine lines estimates from the run without discards.

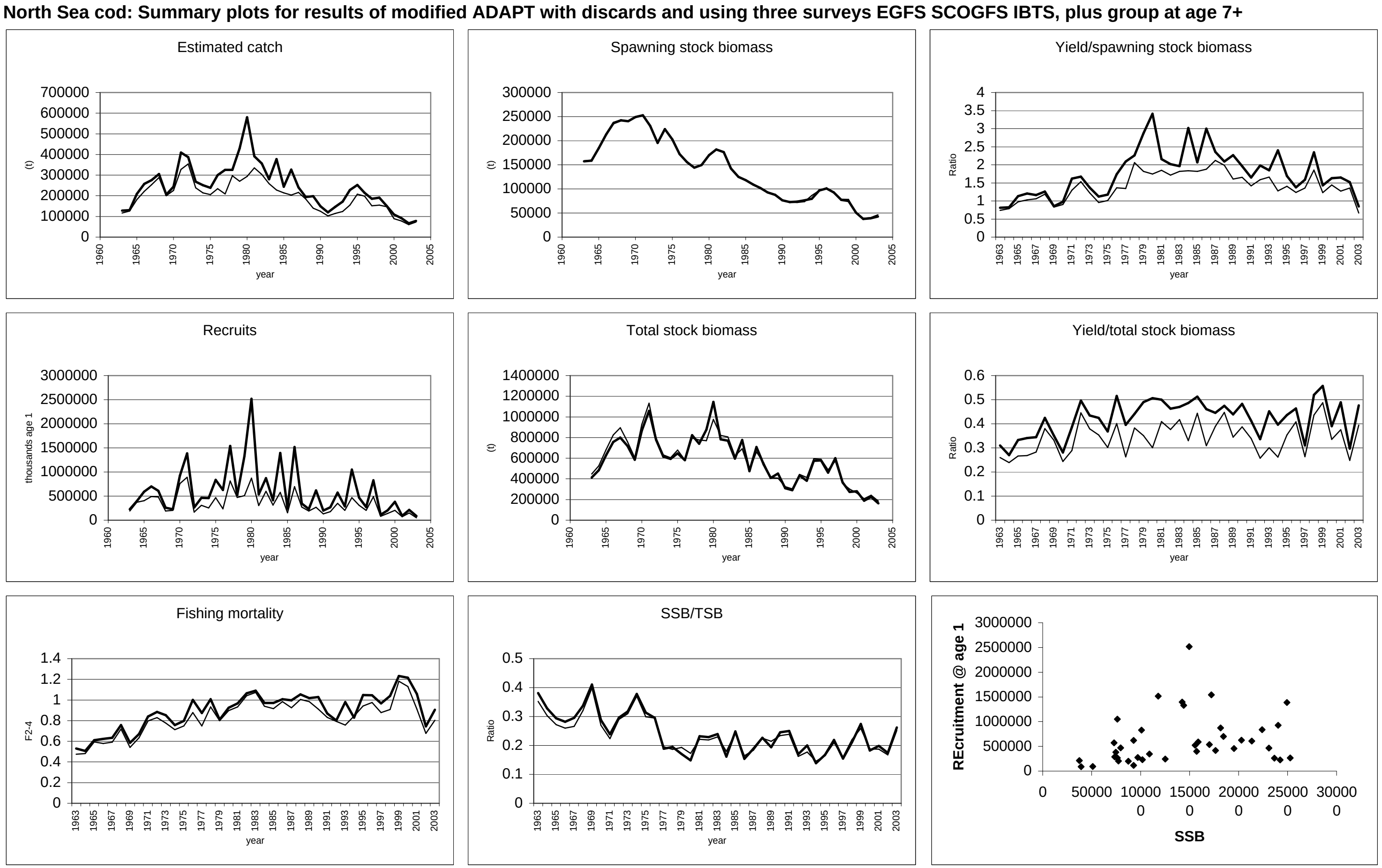


Figure 3.4.8.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Average (2001 – 3002) fishing mortality at age estimated the modified ADAPT when applied to catch

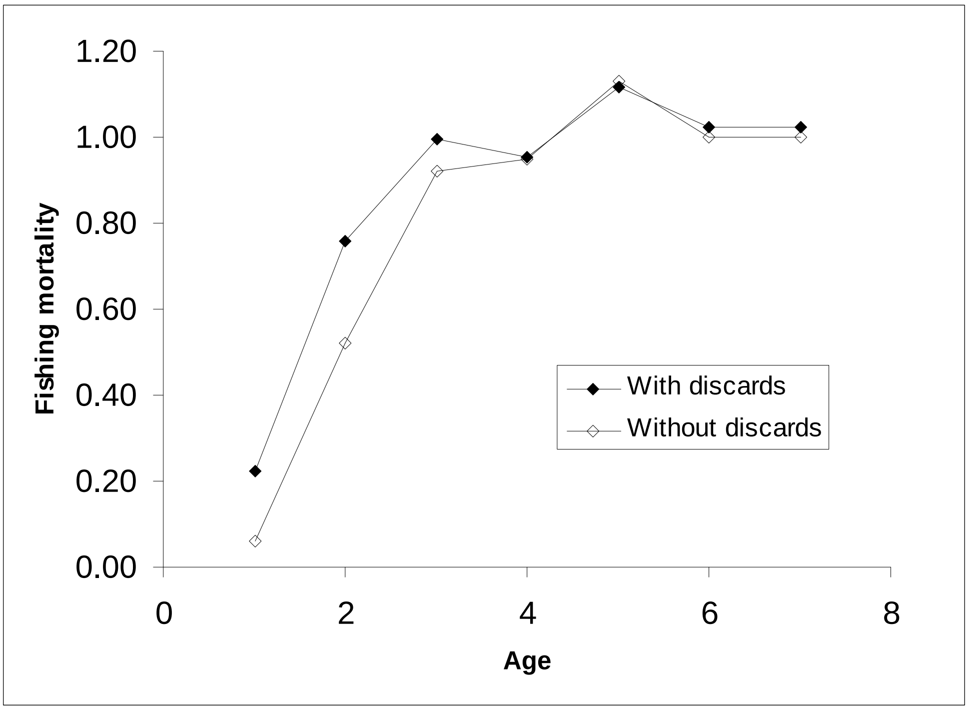


Figure 3.4.9.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: A comparison between SURBA estimates of relative SSB (fine lines) and the estimates from the modified ADAPT (solid line).

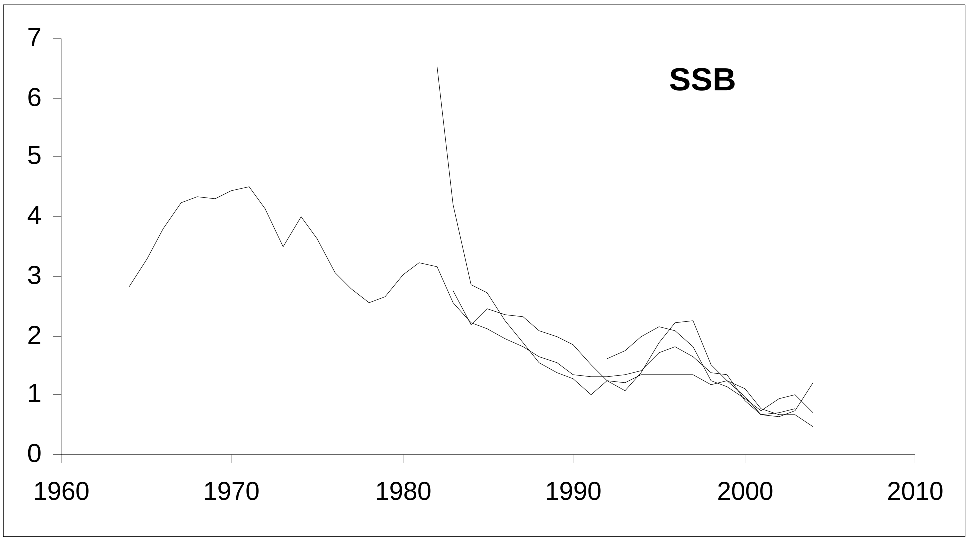


Figure 3.4.9.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: A comparison between SURBA estimates of relative average fishing mortality (fine lines) and the estimates from the modified ADAPT (solid line).

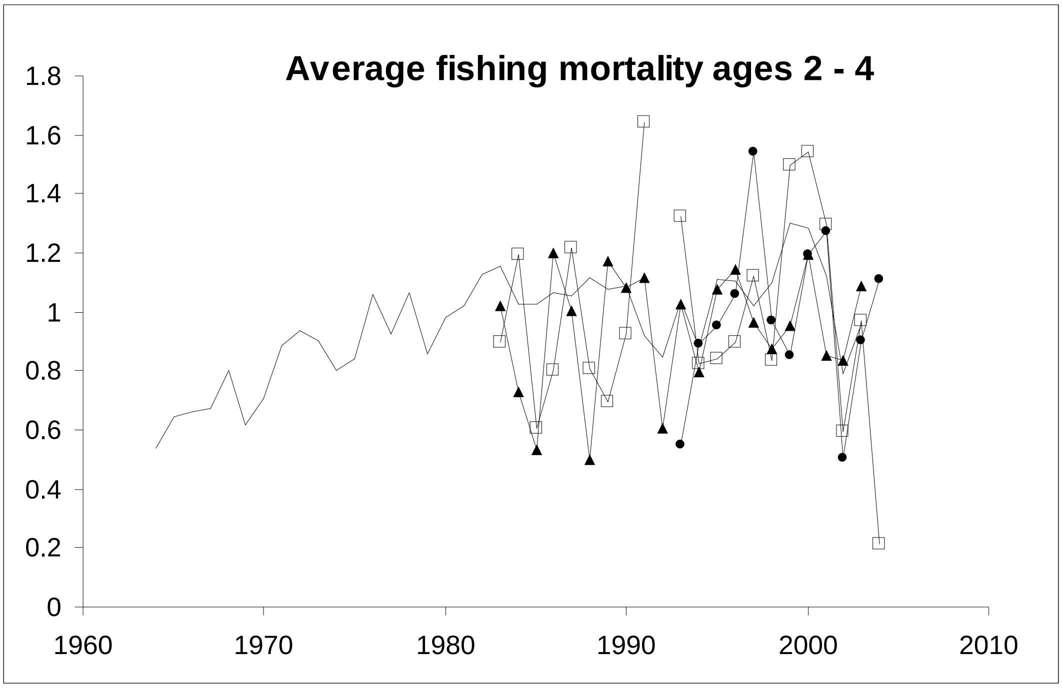


Figure 3.6.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The time trends in the responses on cod abundance as presented in the North Sea Survey

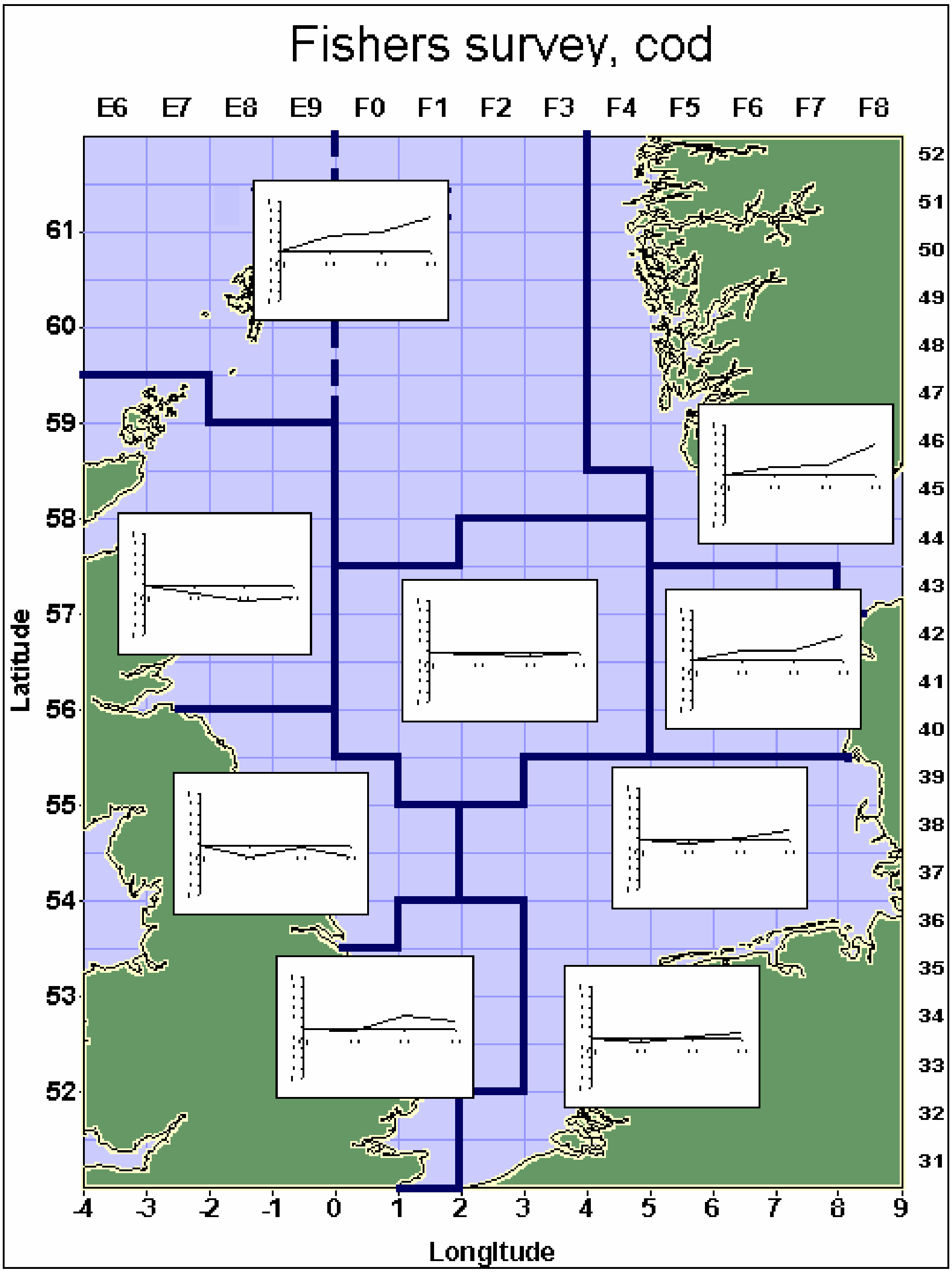


Figure 3.6.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The indices of 1+ cod caught in the IBTS first quarter ground fish survey during the years 2002 – 2004 scaled to the index values for 2001 for comparison with the North Sea survey respones

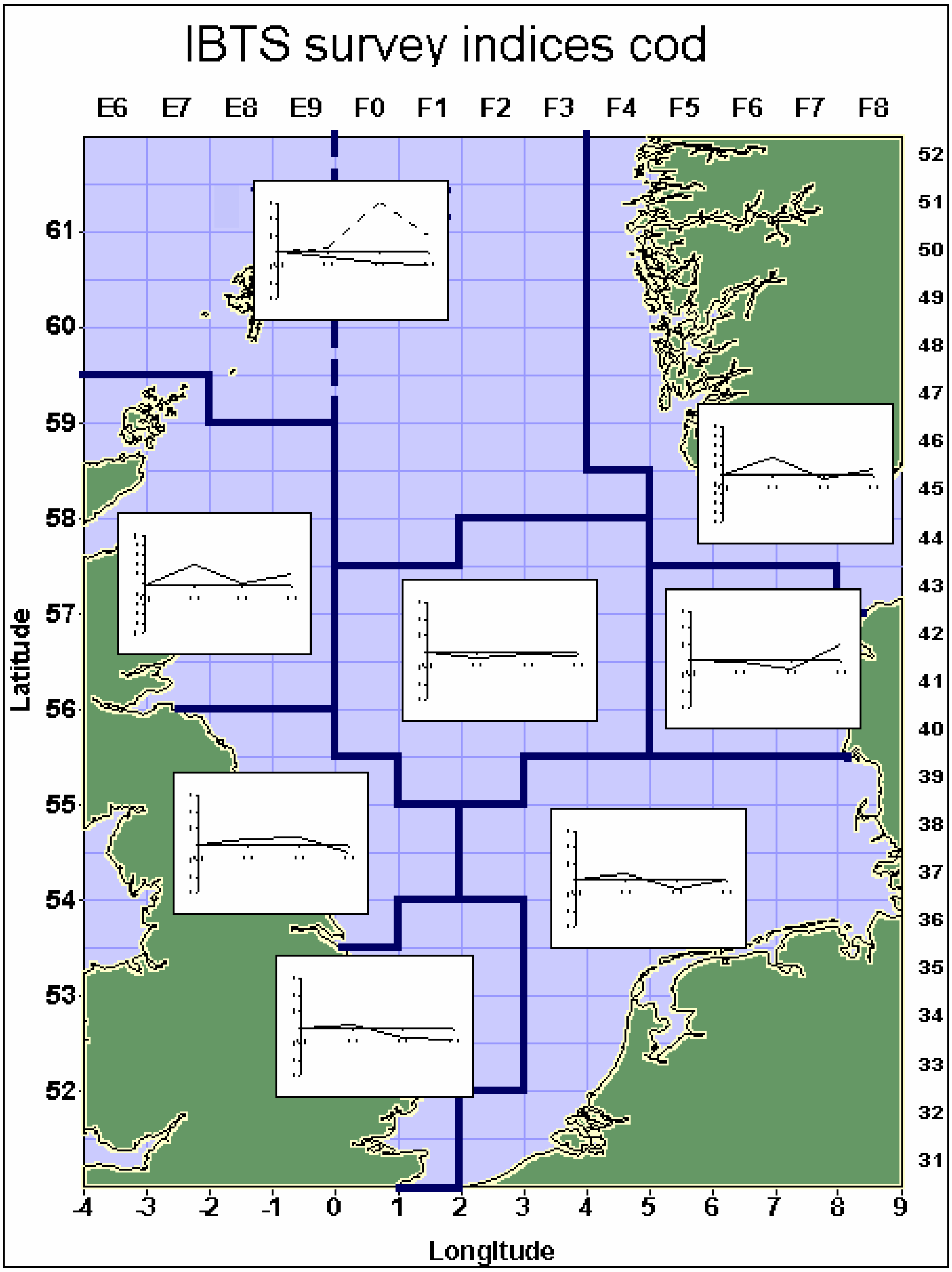


Figure 3.7.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: standardised survey indices of year class abundance recorded at age 1 during 1992 - 2004

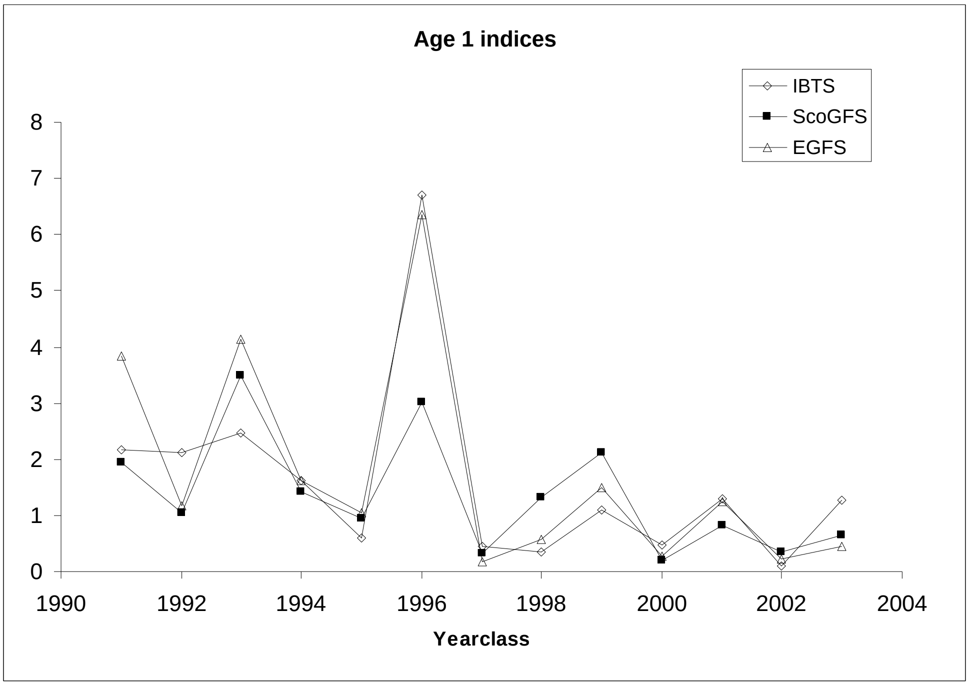


Figure 3.7.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: standardised survey indices of year class abundance recorded at age 2 during 1992 - 2004

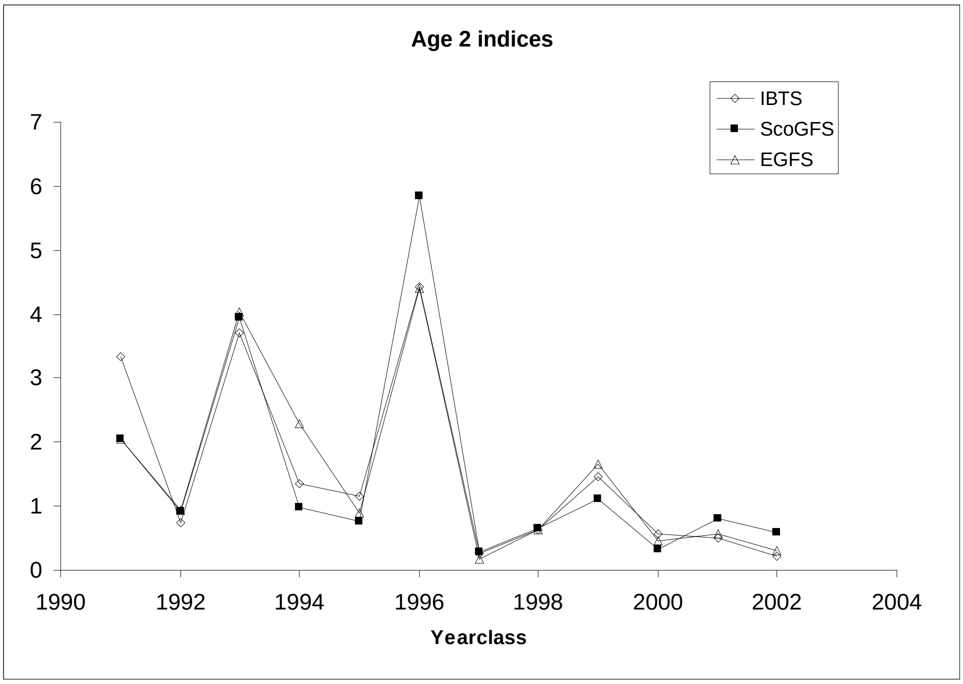


Figure 3.7.3 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Comparison of the VPA estimates of recruitment for 2001 and 2002 (solid squares) with the RCT3 esimates (open squares). The horizontal line plots the geometric mean of the 1997 – 2002 year classes which was used for the recruitment at age 1 in 2004

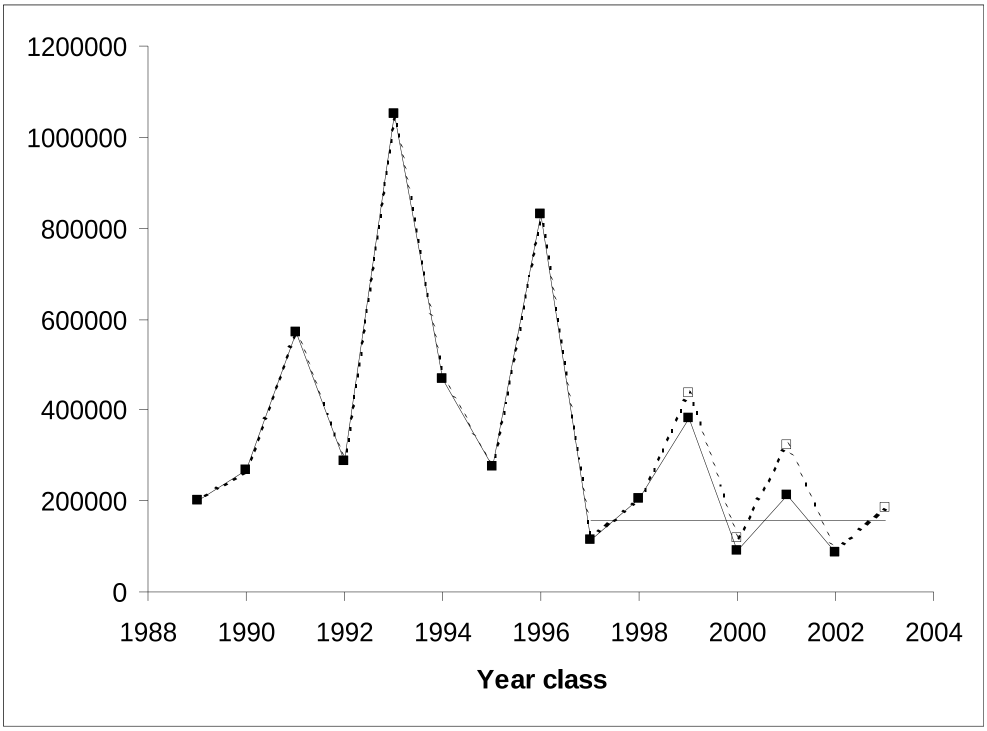


Figure 3.8.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: A sensitivity analysis of the stock projection with fishing mortality in 2004 set to 50% of that estimated for 2001.

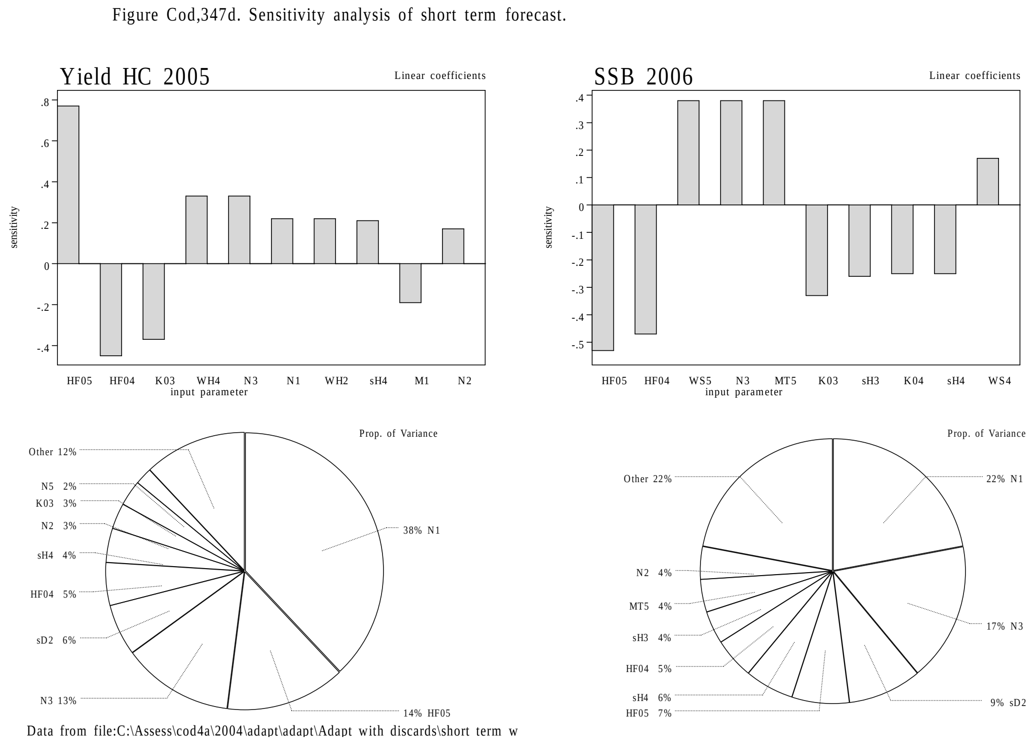


Figure 3.8.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The probability profiles for the stock projection with fishing mortality in 2004 set to 50% of that estimated for 2001.

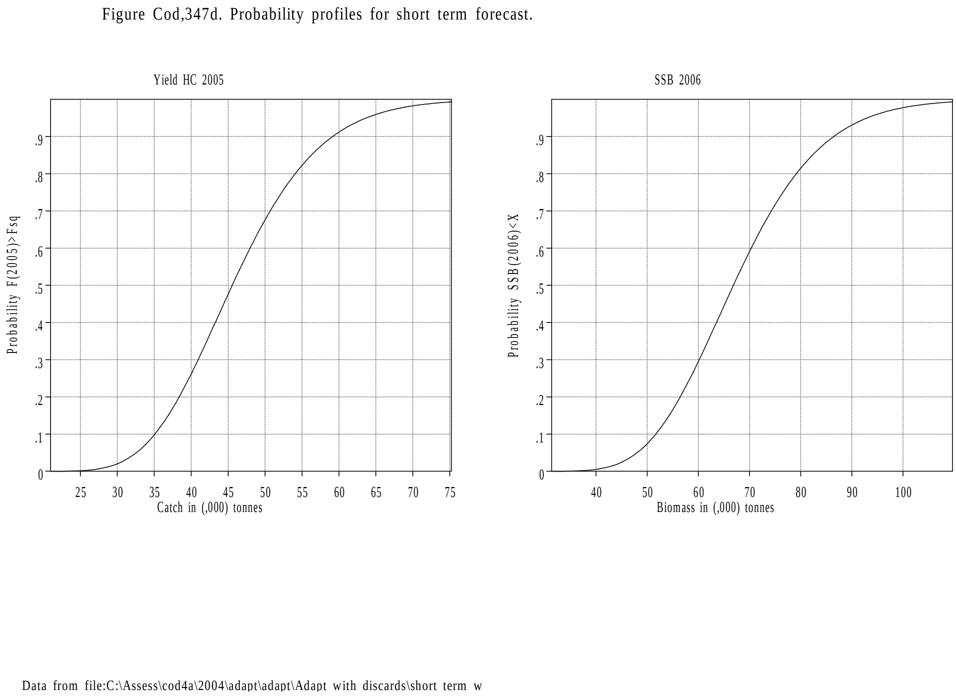


Figure 3.8.3 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The short term forecast plot of the stock projection with fishing mortality in 2004 set to 50% of that estimated for 2001.

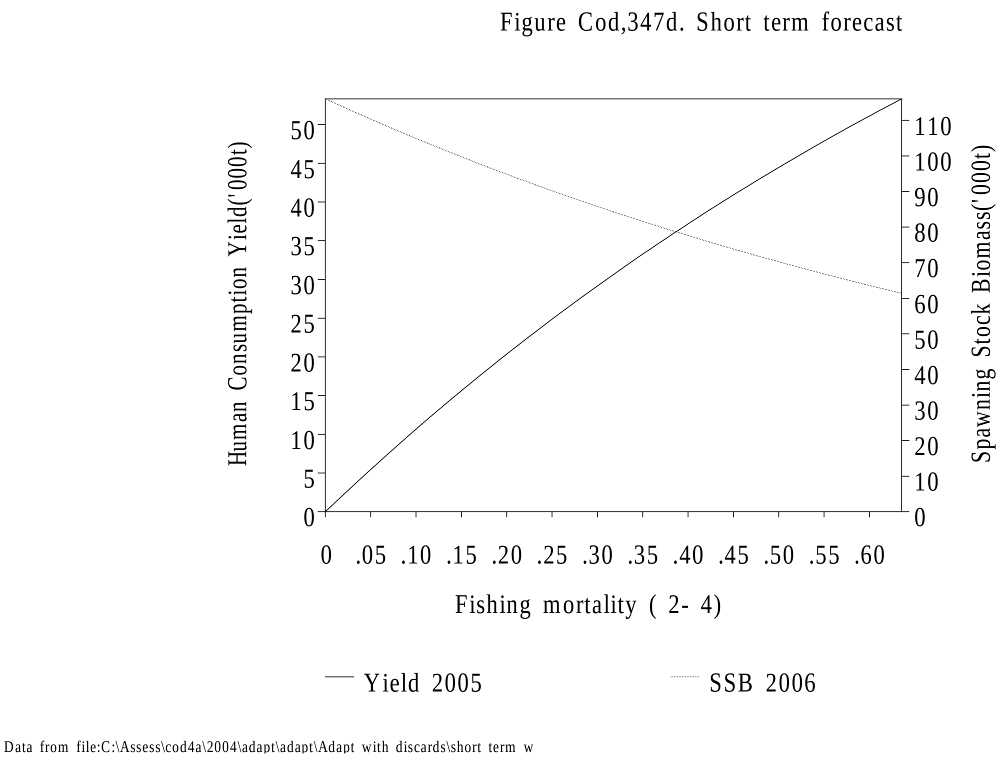
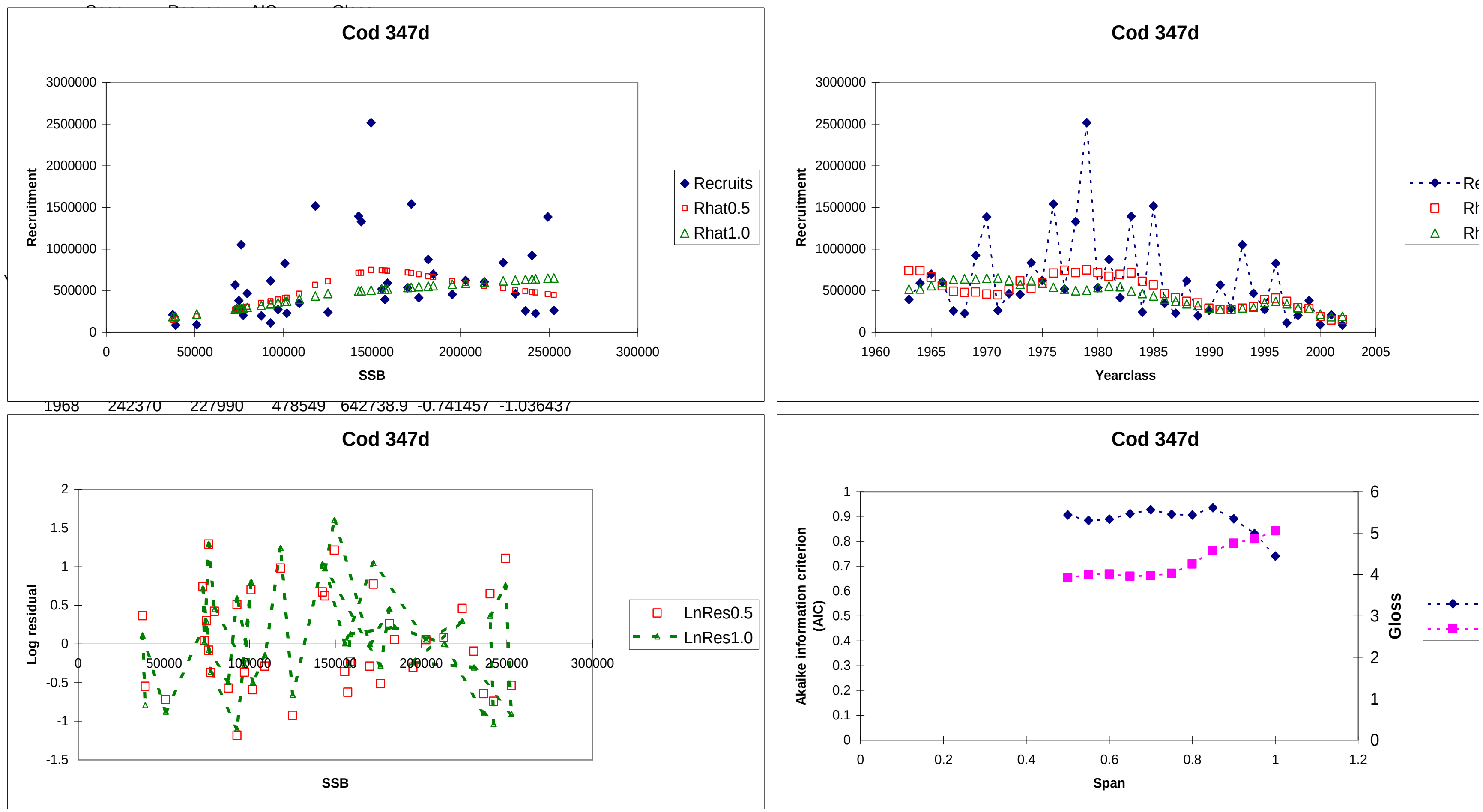


Figure 3.10.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The PAsoft reference point estimation diagnostic output

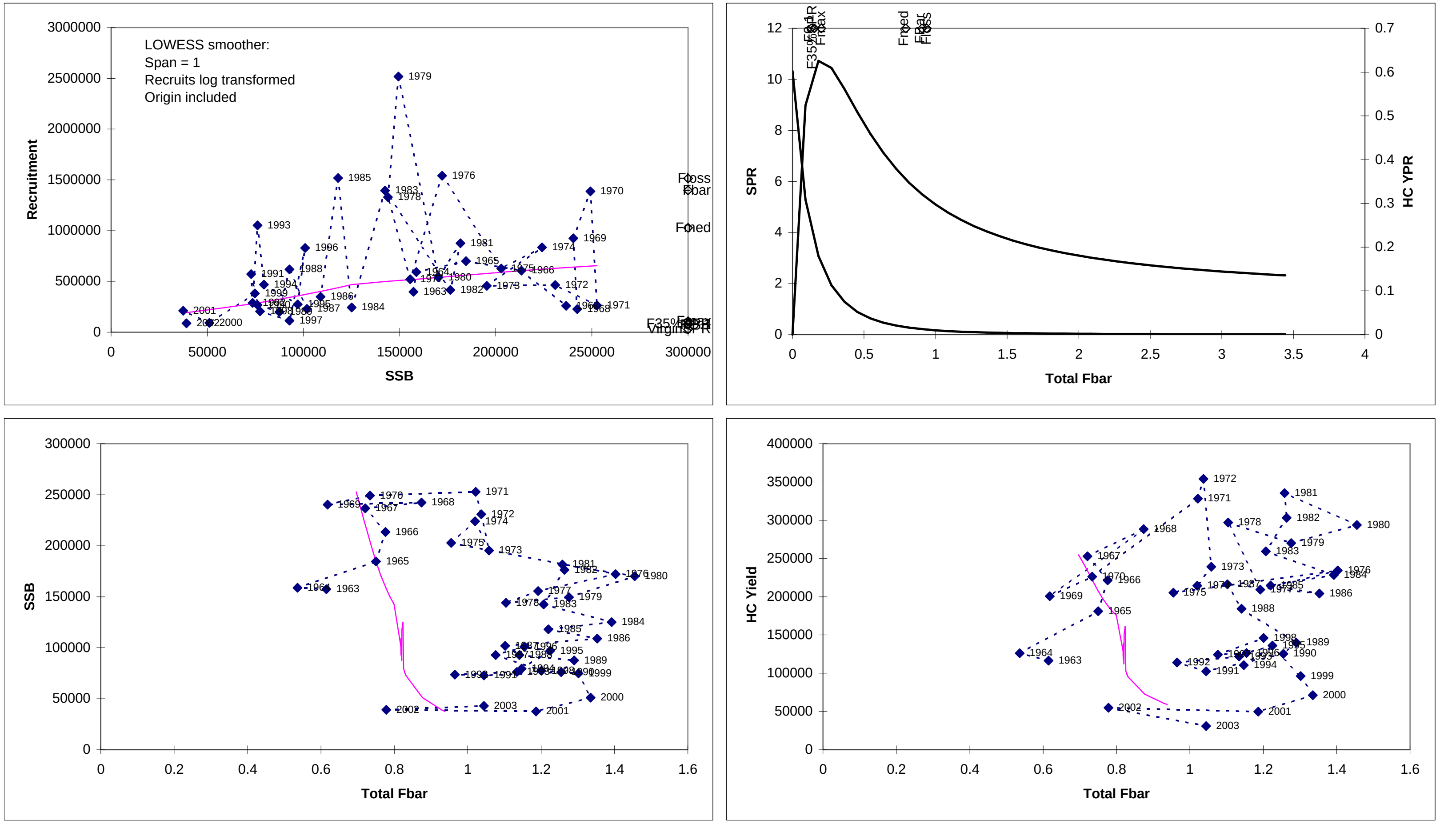


1968 242370 227990 478549 642738.9 -0.741457 -1.036437

1988 92740 618420 371854.8 342442.4 0.508664 0.591064

 O:\Advisory Process\ACFM\WGREPS\WGNSSK\REPORTS\2005\Sec3.Doc 01/12/04 15:06

Figure 3.10.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The PAsoft reference point charts



4 HADDOCK IN IV AND IIIA

The assessment of haddock in sub-area IV and IIIa is presented as an update assessment, with the exception of small modifications to the survey series used. Some exploratory analyses were carried out to confirm the outcome of the standard assessment for this stock. All the relevant biological and methodological information can be found in the stock annex dealing with this stock. In this section, the basic input and output from the assessment model will be presented along with the results of the additional analysis.

4.1 The Fishery

A description of the fishery is presented in the stock annex.

4.1.1 ICES advice applicable to 2003 and 2004

Following the October 2002 ACFM meeting, and in response to continued high fishing mortality (above F_{pa} = 0.7) and low spawning-stock biomass (below B_{pa} = 140 000 t) during 2001, ICES recommended that fishing for haddock should not be permitted unless ways to harvest haddock without by-catch or discards of cod could be demonstrated. The main principle behind this advice was the strong perceived linkage between the North Sea cod and haddock fisheries, and the requirement for a recovery of the cod stock. If this linkage were not considered in management, then the advice for haddock alone would indicate a reduction of fishing mortality of at least 40% to below 0.52, to ensure that the stock remained above B_{pa}.

In October 2003, ICES classified the stock as being inside safe biological limits, but noted that the estimate of the fishing mortality was uncertain. ICES recommended that fishing mortality in 2004 should be less than F_{pa} but furthermore that the mixed fishery aspects should be taken into account. ICES recommended that demersal fisheries in Division IIIa (Skagerrak-Kattegat), in Sub-Area IV (North Sea) and in Division VIId (Eastern Channel) should in 2004 be managed according to the following rules, which should be applied simultaneously. They should fish:

- without bycatch or discards of cod;
- within a recovery plan for North Sea plaice. Until a recovery plan has been implemented that ensures rapid and sure recovery of SSB above B_{pa}, fishing mortality should be restricted to the lowest possible level and well below F_{pa}. Management must include measures that ensure that discards of plaice be significantly reduced and quantified;
- within the biological exploitation limits for all other stocks.

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

4.1.2 Management applicable to 2003 and 2004

Annual management of the fishery operates through TACs. The 2003 and 2004 TACs for haddock in Sub-Area IV and Division IIa (EC waters) were 51,735 and 77,000[1] t respectively, while the TACs for Divisions IIIa, IIIb and IIIc were 3,150 t and 4,940 t respectively.

[Check these quotas.]

The agreed 2004 TAC for haddock recognised that it was possible to exploit haddock in areas of the North Sea in which cod by-catches were low compared to other areas. "Additional" haddock could be available to EU Member States if caught outside a defined cod protection area. Council Regulation (EC) 2287/2003 defined the conditions under which certain stocks, including haddock, could be caught in Community waters. Council Regulation (EC) 867/2004 subsequently amended Regulation 2287/2004 to redefine the cod protection area (Figure 4.1.1) and set a maximum of

[1] The TAC was set at 80,000 t. (COUNCIL REGULATION (EC) No 2287/2003 of 19 December 2003) but was later revised to 77,000 tonnes.

35% of the haddock TAC that could be taken from within the cod protection area, and a minimum of 65% to be taken outside the cod protection zone.

For UK vessels a complex quota scheme was developed for 2004. The overall UK quota was 46,100t. A minimum of 29,500t was available to those vessels that took a special permit that forbade the capture of haddock in the cod protection zone. For vessels that did not take the special permit, a maximum of 16,600t could be taken, but these could be taken from within the cod protection zone. Although this management scheme was proposed to permit additional haddock to be caught in 2004 at the cost of reducing fishing effort in the cod protection zone, the proportion of the overall UK quota that was accessible outside the cod protection zone became a matter of dispute with fishermen and uptake of the special permit has been relatively low. By the end of June 2004, just over one-third of the overall quota and one-third of the special permit quota had been taken.

Vessel decommissioning in several fleets has been underway since 2002. Effort reductions for much of the international fleet to 15 days at sea per month have been imposed since February 2003 (EU 2003/0090).

4.2 Data available

4.2.1 Landings

Official catch data for each country participating in the fishery are presented in Table 4.2.1, together with the corresponding WG estimates. The full time series of landings, discards and industrial bycatch (in tonnes) is presented in Table 4.2.2.

4.2.2 Age compositions

Total catch-at-age data are given in Table 4.2.3. while catch-at-age data for each catch component are given in Tables 4.2.4–4.2.6.

4.2.3 Weight at age

Weight-at-age data from the total catch (that is, human consumption, discards and industrial bycatch) in the North Sea, which are also used as stock weights-at-age, are given in Table 4.2.7. The mean weights-at-age for the separate catch components are given for in Tables 4.2.8– 4.2.10.

4.2.4 Maturity and natural mortality

Maturity and natural mortality are assumed at fixed values and are described in the stock annex.

4.2.5 Catch, effort and research vessel data

Auxiliary data available for calibration of the assessment are presented in Table 4.2.11. Trends in CPUE are shown in Figure 4.2.1. During preparations for the 2000 round of assessment WG meetings it became apparent that the 1999 effort data for the Scottish commercial fleets were not in accord with the historical series and specific concerns were outlined in the 2000 report of WGNSSK (ICES CM 2001/ACFM:07). Effort recording is still not mandatory for these fleets, and concerns remain about the validity of the historical and current estimates.

4.3 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 EGFS survey was truncated to 1992 because of the change in gear that took place in that year. Furthermore, the SGFS survey was used with the consistent area definition in contrast to the assessment presented last year that erroneously mixed the old and new area definitions within one tuning series. The differences are minor, however.

Results of the analysis are presented in Tables 4.3.1 (diagnostics), 4.3.2 (fishing mortality at age), 4.3.3 (population numbers at age), and 4.3.4 (stock summary). The stock summary is also shown in Figure 4.3.1.

Exploratory analyses of the survey-based auxiliary data were carried out using SURBA in order to investigate whether the signals from the XSA assessment were confirmed from the individual CPUE series. The indices were smoothed, and based on these smoothed indices, the total Z from the CPUE data and the relative SSB were estimated. The separable model implemented within SURBA was not used. Results are shown in Figure 4.3.2 and indicate that the trends observed in the XSA assessment are close to the individual survey estimates.

The historical performance of the assessment is shown in Figure 4.3.3.

4.4 Recruitment estimates

Recruitment estimation was carried out according to the specifications in the stock annex, which means for this stock that the short term geometric mean is used for the 2004 year-class at age 0. Average recruitment in the period 1963-2003 was 22.6 billion (geometric mean) 0-group fish. The short term GM (2000-2003) was 6.1billion. Year class strength estimates used for short term prognosis are summarised in the text table below.

Year Class	Age in 2004	XSA Millions	GM (1963-2003) Millions	GM (2000-2003) Millions
2002	2	**96**	498	395
2003	1	**532**	3137	1859
2004	0		22655	**6139**

4.5 Short term prognosis

The relatively slow growth of the large 1999 year-class continues to present a problem to the short term forecast. Given the dominance of this year-class in the stock, accurate estimation of future stock and catch weight is critical. Reduced weight at age appears to have remained an issue only in the human consumption landings. Catch weights for the 1999 year-class in the discard and industrial by-catch components remain within the bounds of previously observed weights.

The model used to project human consumption catch weight was the same exponential function used in last year's WG report. The formulation is as follows:

$$y = \frac{1}{1 + \exp(a - bx)}$$

where y is weight in kg at age x for the 1999 year-class.

Given that there are only four data points with which to fit two parameters (and only three points in last year's estimation), the model appears to perform well. The following text table gives modelled and real weights with parameter estimates. Weights in italics are estimates and the values for the 1967 year-class are given for comparison (as the largest year-class on record). The 1999 year-class at age 4 is slower growing than even the 1967 year-class. The sensitivity to the weight of the 1999 year-class was explored below.

	Actual CW	2003 model	2004 model	1967
1	0.298	0.299	0.301	0.256
2	0.348	0.345	0.345	0.302
3	0.393	0.394	0.392	0.403
4	0.450	*0.445*	0.441	0.524
5		*0.498*	*0.491*	0.609
6		*0.550*	*0.541*	0.726
7			*0.591*	0.963
a		1.060	1.046	
b		0.210	0.202	

Stock weight at age is calculated as an average of the three catch weight components, weighted by their catch numbers. As the ratio of F between human consumption and industrial fisheries changes with each forecast scenario, the stock weights for 2005 and 2006 are unique to each scenario.

The requirement for different catch weights and dynamic calculation of stock weights prevented the use of the standard short-term prediction software. Short-term forecasts were therefore carried out on a spreadsheet.

With the numerous management measures in place for 2004, the standard usage of $\boldsymbol{F_{sq}}$ in the intermediate year was investigated. A working paper (WP8) was presented to the WG in which UK fishing effort (KW days absent) was reported to have declined by about 10% in 2004 compared to the first half year of 2003. There also appears to be some evidence of a relationship between F and effort for this stock.

Four scenarios have been explored with two options for the F multiplier (0.9 and 1.0), and modelled or 1967-year-class weights-at-age for the 1999 year-class. The following text table gives SSB and landings estimates for 2004 and SSB for 2005 for each of the scenarios. SBB in 2005 varies within each scenario depending upon the F multiplier in 2005.

1999 YC basis	*F* mult 2004	SSB 2004	Landings 2004	SSB 2005
Modelled weight	0.90	450	88	383-385
Modelled weight	1.00	450	96	374-376
1967 weight	0.90	525	106	460-462
1967 weight	1.00	525	116	448-450

The decision between 1.0 and 0.9 multipliers for F_{sq} makes relatively little difference in the scenarios compared to the use of modelled or 1967 weights. Information from some member states regarding quota uptake in 2004 indicates that total landings for the year will be below quota (80,000t), mainly due to the permit system.

The forecast put forward by the WG as the most appropriate was therefore 0.9*F_{sq}, using modelled weights for the 1999 year-class out to age 7 in 2006. The inputs are given in Table 4.5.1, and outputs in Table 4.5.2.

[Need basis for F_{sq}*]*

4.6 Biological reference points

Biological reference points for this stock are presented in the Stock Annex.

4.7 Comments

Fishing mortality on haddock has shown a strong decrease which is likely to be due to the combination of a reduction in fishing effort and the presence of the strong 1999 year-class. Reductions of fishing mortality are also observed for whiting and cod which are caught in mixed fisheries with haddock.

There is some, albeit limited, evidence for effects of mesh size regulations and effort regulation. Since 2002 and the mandatory use of 120mm mesh in the main whitefish fishery, there has been a sudden increase in weight at age in the human consumption component for age 2 haddock (Figure 4.7.1). No similar increase is seen in age 1 fish, nor does there appear to have been a major shift in exploitation pattern at the early ages. UK data on effort (KW days absent) indicates significant declines since 2001, partially as a result of decommissioning. This appears to coincide with the sudden decline in *F* from the haddock fishery although a similar linkage in the other whitefish fisheries is less apparent.

The modelling of the growth of 1999 year-class is crucial and problematic for the forecast of this stock. This year-class is the main driver for both the size of the stock and of the catches, and has so far shown even lower growth than the strong 1967 year-class. The short-term forecast is very sensitive to effects of management measures and to biological characteristics.

Preliminary results of the fishermen survey are shown in Figure 4.7.2. This indicates that the fishermen perceive there to have been more haddock over the recent years, notably in the northern part of the North Sea and around the time of the recruitment of the 1999 year-class to the fishery. The fishermen indicate that in 2004 they still perceive more haddock than the year before, but the increase is smaller than in the years before. This is broadly consistent with the results of the assessment presented above.

The WG proposes that the next benchmark assessment for this stock be rescheduled for 2005 (see Section 1.4.1). This is because the strong 1999 year-class will enter the 7+ group in 2006 and additional forecast tools will be needed accordingly.

Table 4.2.1. Nominal catch (‘000 t) of Haddock from Sub-Area IV and Division IIIa 1998–2003, as officially reported to ICES and estimated by ACFM.

Division IIIa

Country	1998	1999	2000	2001	2002	2003	2004
Belgium	-	-	-				
Denmark	3,168	1,012	1,033	1,590	3,791	1741	
Germany	11	3	1	128	239	113	
Netherlands						6 *	
Norway	188	168	126*	148 *	146* *	184 *	
Sweden	529	26	377	285	393	165	
UK (Scotland)	-	-	-	7	-	-	
Total reported	3,896	1,209	1,537	2,158	4,569	2,209	
Unallocated	-137	151	-52	-255	-432	-401	
WG estimate of H.cons. landings	3,759	1,360	1,485	1,903	4,137	1,808	
WG estimate of industrial by-catch	275	334	617	218	57	na	
WG estimate of total catch	**4,034**	**1,694**	**2,102**	**2,121**	**4,194**	**1,808**	
TAC	*7,000*	*5,400*	*4,500*	*4,000*	*6,300*	*3,150*	*4,940*

* Preliminary

Subarea IV

Country	1998	1999	2000	2001	2002	2003	2004
Belgium	724	462	399	606	559	375 *	
Denmark	2,608	2,104	1,670	2,407	5,123	3,035	
Faroe Islands	43	55	-				
France	427 *	742 *1	724	485	903	1,100	
Germany	1,314	565	342	681	852	1,562	
Netherlands	275	110	119	274 2	359	187 *	
Norway	3,262	3,830	3,118	1,901 *	2,245 *	2,213 *	
Poland	7	17	13	12	17	16 *	
Sweden	472	686	596	804	572	477	
UK (E&W&NI)	3,280	2,398	1,876	3,334	3,647	1,561	
UK (Scotland)	60,324	53,628	37,772	29,263	39,624	31,527	
Total reported	72,736	64,597	46,629	39,767	53,901	42,053	
Unallocated landings	4,575	-388	-545	-809	-1,290	226	
WG estimate of H.cons. landings	77,311	64,209	46,084	38,958	52,611	42,279	
WG estimate of discards	45,175	42,562	48,841	118,320	44,730	23,499	
WG estimate of industrial by-catch	5,100	3,834	8,134	7,879	3,717	1,149	
WG estimate of total catch	127,586	110,605	103,059	165,157	101,058	66,927	
TAC	*115,000*	*88,600*	*73,000*	*61,000*	*104,000*	*51,735*	*80,000*

* Preliminary. 1 Includes IIa(EC). 2 Note: Not included here 21t of haddock reported in area unknown.

Division IIIa and Subarea IV

	1998	1999	2000	2001	2002	2003	2004
WG estimate of total catch	131,620	112,299	105,161	167,278	105,252	68,735	
TAC	*122,000*	*94,000*	*77,500*	*65,000*	*110,300*	*54,885*	*84,940*

Table 4.2.2. Haddock in Sub-Area IV and Division IIIa. WG estimates of catch components by weight ('000 tonnes) and the proportion of IIIa HC landings to the total HC landings.

	North Sea				Division IIIa			Total	IIIa HC as proportion of tot total 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%
Min	39.0	23.5	1.1	66.9	0.4	0.0	0.4	92.7	0.1%
Mean	127.9	88.9	30.5	247.4	3.6	1.3	4.8	267.3	3.4%
Max	524.6	260.4	338.4	929.5	10.8	7.2	15.2	930.5	8.4%

Table 4.2.3. Haddock in Sub-Area IV and Division IIIa. Catch-at-age data (thousands). Data used in the assessment are highlighted in **bold**.

HC+Disc+IB	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**7+**
1963	**1367**	**1307178**	**335092**	**20963**	**13026**	**5781**	**502**	653	566	59	18	0	0	0	0	0	**1295**
1964	**140235**	**7436**	**1296771**	**135227**	**9069**	**5350**	**2405**	287	236	231	25	0	0	0	0	0	**779**
1965	**652537**	**368593**	**15184**	**649840**	**29496**	**4662**	**1972**	452	107	90	41	0	0	0	0	0	**690**
1966	**1671205**	**1007322**	**25674**	**6425**	**412551**	**9980**	**1045**	601	165	90	23	2	0	0	0	0	**880**
1967	**306037**	**838189**	**89083**	**4863**	**3585**	**177857**	**2443**	215	216	57	34	0	0	0	0	0	**521**
1968	**11146**	**1098748**	**439511**	**19600**	**1947**	**2529**	**45973**	325	40	13	5	0	0	0	0	0	**383**
1969	**72670**	**20493**	**3578611**	**303489**	**7596**	**2411**	**2515**	19129	200	24	7	0	0	0	0	0	**19360**
1970	**925768**	**266379**	**218480**	**1908736**	**57435**	**1178**	**1197**	256	5954	67	11	19	0	0	0	0	**6308**
1971	**333396**	**1815054**	**71035**	**47546**	**400469**	**10374**	**462**	195	147	1592	160	3	5	0	0	0	**2102**
1972	**244075**	**679205**	**587590**	**40604**	**21213**	**158000**	**3563**	190	34	27	408	11	0	0	0	0	**670**
1973	**60545**	**366830**	**570630**	**240604**	**6192**	**4470**	**39459**	1257	108	29	109	49	5	0	0	0	**1556**
1974	**614903**	**1220855**	**176342**	**332967**	**54314**	**1875**	**1351**	10922	242	23	32	4	5	0	0	0	**11228**
1975	**46388**	**2116937**	**641755**	**58991**	**109062**	**15813**	**983**	620	2714	266	63	11	0	8	0	0	**3682**
1976	**174161**	**170529**	**1062943**	**211544**	**9952**	**31311**	**4996**	206	76	759	60	3	0	0	0	0	**1106**
1977	**120798**	**258923**	**107675**	**394175**	**40185**	**4318**	**6275**	1300	135	29	200	3	0	1	0	0	**1668**
1978	**305115**	**463554**	**146957**	**30377**	**113703**	**8708**	**1264**	2076	402	116	15	64	13	2	0	0	**2688**
1979	**881823**	**351451**	**204046**	**41297**	**7406**	**28024**	**2237**	262	483	152	54	12	11	1	0	0	**976**
1980	**399372**	**678499**	**333261**	**73043**	**10476**	**1901**	**8067**	598	121	162	75	31	9	3	1	0	**1002**
1981	**646419**	**134470**	**423059**	**143151**	**15228**	**2034**	**458**	2498	125	64	23	30	4	1	3	0	**2749**
1982	**278705**	**275686**	**86126**	**299895**	**41435**	**3407**	**713**	279	784	30	15	7	2	2	0	0	**1119**
1983	**639814**	**157259**	**252258**	**73920**	**127250**	**16480**	**1708**	297	61	191	53	6	4	4	0	0	**616**
1984	**95502**	**432193**	**168273**	**122984**	**22079**	**32658**	**3789**	596	84	41	112	16	5	1	1	0	**857**
1985	**139579**	**178878**	**534269**	**78726**	**37445**	**5306**	**7355**	965	212	52	21	88	4	0	0	0	**1343**
1986	**56503**	**160398**	**178824**	**323650**	**27685**	**9691**	**1237**	1810	237	117	49	32	36	13	4	1	**2298**
1987	**13384**	**314017**	**250496**	**47432**	**67864**	**4761**	**2877**	545	778	135	36	50	27	29	5	8	**1613**
1988	**16535**	**30044**	**490706**	**89940**	**13431**	**18579**	**1602**	639	166	141	50	18	11	10	15	1	**1051**
1989	**12042**	**47648**	**35358**	**182748**	**18106**	**2636**	**4058**	510	200	83	30	13	6	2	2	1	**848**
1990	**57702**	**86819**	**103021**	**18947**	**57830**	**3905**	**896**	1380	210	78	41	11	11	1	4	2	**1738**
1991	**123910**	**228553**	**78258**	**23197**	**3888**	**12526**	**976**	401	614	148	54	6	5	1	2	1	**1231**
1992	**270758**	**209879**	**253286**	**32494**	**6552**	**1250**	**4861**	454	301	293	124	22	6	2	0	0	**1203**
1993	**141209**	**359995**	**262765**	**108421**	**7107**	**1698**	**450**	1138	146	103	144	59	3	2	0	0	**1595**
1994	**85966**	**99260**	**296776**	**100476**	**29609**	**1920**	**573**	191	509	115	32	27	25	5	0	0	**905**
1995	**273689**	**301733**	**85925**	**167801**	**25875**	**7645**	**511**	127	45	62	19	8	6	2	1	0	**269**
1996	**347568**	**53415**	**357942**	**56894**	**55147**	**7503**	**3052**	756	52	31	25	5	8	3	1	0	**882**
1997	**40082**	**134642**	**86231**	**213293**	**15272**	**15406**	**1892**	679	62	15	12	4	4	4	2	0	**782**
1998	**23902**	**83557**	**167359**	**49648**	**108066**	**5743**	**3562**	472	140	14	6	5	2	2	1	1	**643**
1999	**108254**	**81423**	**121249**	**87242**	**24739**	**39860**	**2338**	1595	342	41	6	2	1	1	0	0	**1988**
2000	**52181**	**350998**	**88624**	**43351**	**26356**	**6026**	**8707**	560	234	32	12	2	1	1	0	0	**842**
2001	**3510**	**86744**	**632880**	**32343**	**8886**	**4122**	**1561**	1305	195	64	17	3	1	0	0	0	**1585**
2002	**50754**	**18400**	**66343**	**242196**	**6547**	**2038**	**1066**	549	458	265	15	8	5	0	0	0	**1301**
2003	**6132**	**18616**	**14122**	**44745**	**109063**	**1970**	**602**	271	110	89	38	5	1	0	0	0	**515**

Table 4.2.4. Haddock in Sub-Area IV and Division IIIa. HC catch-at-age data (thousands). Data used in the assessment are highlighted in **bold**.

HC landings	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	7+
1963	**0**	**27353**	**118185**	**16692**	**12212**	**5644**	**498**	653	566	59	18	0	0	0	0	0	**1295**
1964	**0**	**48**	**250523**	**86368**	**8166**	**4689**	**2283**	286	236	231	25	0	0	0	0	0	**777**
1965	**0**	**2636**	**3445**	**335396**	**23479**	**4063**	**1852**	446	107	90	41	0	0	0	0	0	**684**
1966	**0**	**12976**	**6724**	**4250**	**372535**	**9188**	**1018**	599	165	90	23	2	0	0	0	0	**878**
1967	**0**	**54953**	**33894**	**3845**	**3345**	**174011**	**2421**	215	216	57	34	0	0	0	0	0	**521**
1968	**0**	**18443**	**139035**	**14557**	**1806**	**2495**	**45047**	324	40	13	5	0	0	0	0	0	**382**
1969	**0**	**139**	**713860**	**166997**	**6542**	**2014**	**2381**	18876	200	24	7	0	0	0	0	0	**19107**
1970	**0**	**2259**	**51861**	**1133133**	**50823**	**1012**	**1131**	254	5954	67	11	19	0	0	0	0	**6305**
1971	**0**	**34019**	**25862**	**35168**	**369443**	**10006**	**455**	195	147	1592	160	3	5	0	0	0	**2102**
1972	**0**	**12778**	**207267**	**33215**	**19853**	**156344**	**3550**	190	34	27	408	11	0	0	0	0	**670**
1973	**0**	**6024**	**205717**	**193852**	**5829**	**4238**	**39336**	1257	108	29	109	49	5	0	0	0	**1556**
1974	**0**	**23993**	**52416**	**227998**	**46793**	**1785**	**1232**	10693	242	23	32	4	5	0	0	0	**10999**
1975	**0**	**24144**	**200961**	**38295**	**90302**	**15524**	**978**	620	2709	266	63	11	0	8	0	0	**3677**
1976	**0**	**2301**	**223465**	**142803**	**9721**	**28103**	**4978**	206	76	759	60	3	0	0	0	0	**1106**
1977	**0**	**8484**	**31741**	**249285**	**37092**	**4057**	**6021**	1300	135	29	200	3	0	1	0	0	**1668**
1978	**0**	**12883**	**54630**	**25305**	**100036**	**8568**	**1152**	2070	402	116	15	64	13	2	0	0	**2682**
1979	**0**	**14009**	**110008**	**36486**	**7284**	**27543**	**2219**	262	483	152	54	12	11	1	0	0	**976**
1980	**0**	**8982**	**141895**	**61901**	**9063**	**1843**	**7975**	591	121	161	75	31	9	3	1	0	**994**
1981	**0**	**1759**	**153466**	**112407**	**14679**	**2025**	**455**	2498	125	64	23	30	4	1	3	0	**2748**
1982	**0**	**7373**	**38819**	**236209**	**37728**	**2913**	**713**	279	784	30	15	7	2	2	0	0	**1119**
1983	**0**	**7101**	**109201**	**52566**	**117819**	**15760**	**1603**	297	61	190	53	6	4	4	0	0	**616**
1984	**0**	**19501**	**75963**	**104651**	**21372**	**31874**	**3788**	596	84	41	112	16	5	1	1	0	**857**
1985	**0**	**2120**	**248125**	**70806**	**36734**	**5076**	**7329**	965	212	52	21	88	4	0	0	0	**1343**
1986	**0**	**12132**	**62362**	**261225**	**27548**	**9671**	**1237**	1810	237	117	49	32	36	13	4	1	**2298**
1987	**0**	**6896**	**113196**	**37763**	**66221**	**4760**	**2877**	545	778	135	36	50	27	29	5	8	**1613**
1988	**0**	**1524**	**146403**	**76925**	**12024**	**18310**	**1602**	639	166	141	50	18	11	10	15	1	**1051**
1989	**0**	**4519**	**16387**	**128051**	**16762**	**2574**	**3916**	498	199	83	30	13	6	2	2	1	**835**
1990	**0**	**5493**	**43168**	**14338**	**45015**	**3269**	**775**	1242	202	78	41	11	11	1	4	2	**1592**
1991	**0**	**19482**	**46902**	**21841**	**3812**	**12337**	**976**	401	614	148	54	6	5	1	2	1	**1231**
1992	**0**	**2853**	**117953**	**28828**	**6485**	**1247**	**4779**	454	300	293	124	22	6	2	0	0	**1203**
1993	**0**	**2488**	**77820**	**86806**	**6976**	**1686**	**450**	1119	146	103	144	59	3	2	0	0	**1575**
1994	**0**	**467**	**69457**	**70354**	**27587**	**1860**	**524**	191	509	115	32	27	25	5	0	0	**905**
1995	**0**	**1870**	**29177**	**101663**	**24715**	**7565**	**511**	127	45	62	19	8	6	2	1	0	**269**
1996	**0**	**742**	**74892**	**36685**	**47168**	**7501**	**3052**	756	52	31	25	5	8	3	1	0	**882**
1997	**0**	**1409**	**23943**	**123178**	**14028**	**15208**	**1892**	679	62	15	12	4	4	4	2	0	**782**
1998	**0**	**822**	**38321**	**36736**	**92738**	**5607**	**3543**	472	140	14	6	5	2	2	1	1	**643**
1999	**0**	**994**	**25856**	**53192**	**23301**	**37630**	**2155**	1595	342	41	6	2	1	1	0	0	**1988**
2000	**0**	**4750**	**30316**	**28653**	**23407**	**5873**	**8644**	560	234	32	12	2	1	1	0	0	**842**
2001	**0**	**611**	**67196**	**16117**	**7406**	**3929**	**1561**	1295	191	64	17	3	1	0	0	0	**1571**
2002	**0**	**639**	**13666**	**111346**	**5640**	**2004**	**1066**	419	458	265	15	8	5	0	0	0	**1171**
2003	**0**	**32**	**1091**	**13925**	**73059**	**1920**	**571**	270	109	89	38	5	1	0	0	0	**513**

Table 4.2.5. Haddock in Sub-Area IV and Division IIIa. Discards catch-at-age data (North Sea only). Data used in the assessment are highlighted in **bold**.

Disc	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**7+**
1963	**42**	**1047925**	**193718**	**3476**	**708**	**51**	**2**	0	0	0	0	0	0	0	0	0	**0**
1964	**2395**	**4182**	**623111**	**13597**	**262**	**21**	**10**	0	0	0	0	0	0	0	0	0	**0**
1965	**5307**	**110628**	**4020**	**130369**	**3641**	**4**	**1**	0	0	0	0	0	0	0	0	0	**0**
1966	**7880**	**444111**	**12388**	**1166**	**24114**	**35**	**2**	0	0	0	0	0	0	0	0	0	**0**
1967	**6250**	**389691**	**49635**	**863**	**216**	**1576**	**9**	0	0	0	0	0	0	0	0	0	**0**
1968	**39**	**615649**	**219022**	**3006**	**94**	**15**	**186**	0	0	0	0	0	0	0	0	0	**0**
1969	**1732**	**5152**	**1158445**	**37686**	**420**	**16**	**8**	0	0	0	0	0	0	0	0	0	**0**
1970	**51717**	**92978**	**77992**	**289679**	**2640**	**13**	**4**	0	0	0	0	0	0	0	0	0	**0**
1971	**7586**	**1205838**	**35117**	**8960**	**24590**	**66**	**2**	0	0	0	0	0	0	0	0	0	**0**
1972	**4231**	**424657**	**322547**	**6353**	**1212**	**1212**	**13**	0	0	0	0	0	0	0	0	0	**0**
1973	**18540**	**241423**	**352310**	**46740**	**352**	**33**	**123**	0	0	0	0	0	0	0	0	0	**0**
1974	**24758**	**915157**	**90904**	**57011**	**2814**	**6**	**4**	0	0	0	0	0	0	0	0	0	**0**
1975	**630**	**1478590**	**353422**	**15781**	**13388**	**143**	**0**	0	0	0	0	0	0	0	0	0	**0**
1976	**2191**	**98420**	**648662**	**38317**	**183**	**137**	**0**	0	0	0	0	0	0	0	0	0	**0**
1977	**11812**	**95090**	**44918**	**73431**	**605**	**9**	**0**	0	0	0	0	0	0	0	0	0	**0**
1978	**5250**	**316339**	**80219**	**4207**	**12085**	**72**	**106**	0	0	0	0	0	0	0	0	0	**0**
1979	**1824**	**205555**	**75517**	**3232**	**34**	**84**	**0**	0	0	0	0	0	0	0	0	0	**0**
1980	**644**	**369727**	**168124**	**2346**	**39**	**0**	**0**	0	0	0	0	0	0	0	0	0	**0**
1981	**1509**	**33434**	**237524**	**25928**	**86**	**3**	**0**	0	0	0	0	0	0	0	0	0	**0**
1982	**3703**	**93865**	**31915**	**49462**	**1845**	**0**	**0**	0	0	0	0	0	0	0	0	0	**0**
1983	**151108**	**85338**	**128171**	**15966**	**7112**	**717**	**105**	0	0	0	0	0	0	0	0	0	**0**
1984	**2915**	**314421**	**80803**	**13430**	**327**	**240**	**0**	0	0	0	0	0	0	0	0	0	**0**
1985	**17501**	**165086**	**267747**	**6088**	**149**	**4**	**8**	0	0	0	0	0	0	0	0	0	**0**
1986	**23807**	**108204**	**114606**	**61612**	**31**	**12**	**0**	0	0	0	0	0	0	0	0	0	**0**
1987	**1166**	**188582**	**133010**	**9320**	**1506**	**0**	**0**	0	0	0	0	0	0	0	0	0	**0**
1988	**1528**	**24588**	**325259**	**9684**	**788**	**67**	**0**	0	0	0	0	0	0	0	0	0	**0**
1989	**1790**	**40211**	**16959**	**51491**	**814**	**20**	**42**	0	0	0	0	0	0	0	0	0	**1**
1990	**52477**	**68625**	**56359**	**3977**	**10190**	**235**	**77**	0	0	0	0	0	0	0	0	0	**0**
1991	**7001**	**182162**	**27942**	**725**	**27**	**145**	**0**	0	0	0	0	0	0	0	0	0	**0**
1992	**29056**	**110995**	**123961**	**3298**	**38**	**0**	**65**	0	0	0	0	0	0	0	0	0	**0**
1993	**16715**	**235123**	**170794**	**18375**	**48**	**3**	**0**	1	0	0	0	0	0	0	0	0	**1**
1994	**16059**	**82033**	**217538**	**29100**	**1862**	**53**	**48**	0	0	0	0	0	0	0	0	0	**0**
1995	**3228**	**191807**	**54448**	**65250**	**1095**	**79**	**0**	0	0	0	0	0	0	0	0	0	**0**
1996	**3968**	**35340**	**275597**	**16870**	**7872**	**2**	**0**	0	0	0	0	0	0	0	0	0	**0**
1997	**7162**	**85588**	**50976**	**85664**	**1061**	**182**	**0**	0	0	0	0	0	0	0	0	0	**0**
1998	**3132**	**72793**	**112075**	**10165**	**13766**	**71**	**18**	0	0	0	0	0	0	0	0	0	**0**
1999	**14588**	**69196**	**90861**	**31119**	**1094**	**2064**	**180**	0	0	0	0	0	0	0	0	0	**0**
2000	**2474**	**272894**	**36568**	**12614**	**2764**	**148**	**64**	0	0	0	0	0	0	0	0	0	**0**
2001	**545**	**61878**	**529908**	**6100**	**1446**	**186**	**0**	10	4	0	0	0	0	0	0	0	**14**
2002	**946**	**3872**	**48189**	**127212**	**403**	**8**	**0**	130	0	0	0	0	0	0	0	0	**130**
2003	**1987**	**12601**	**10930**	**29535**	**34480**	**37**	**31**	1	0	0	0	0	0	0	0	0	**2**

Table 4.2.6. Haddock in Sub-Area IV and Division IIIa. Industrial bycatch catch-at-age data (North Sea only). Data used in the assessment are highlighted in **bold**.

Ind BC	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	7+
1963	1325	231900	23190	795	106	85	3	0	0	0	0	0	0	0	0	0	0
1964	137840	3205	423136	35262	641	641	112	1	0	0	0	0	0	0	0	0	1
1965	647230	255329	7719	184075	2375	594	119	6	0	0	0	0	0	0	0	0	6
1966	1663325	550235	6562	1009	15901	757	25	2	0	0	0	0	0	0	0	0	2
1967	299787	393545	5554	156	24	2269	12	0	0	0	0	0	0	0	0	0	0
1968	11107	464656	81454	2036	46	19	740	1	0	0	0	0	0	0	0	0	1
1969	70938	15201	1706305	98806	633	380	126	253	0	0	0	0	0	0	0	0	253
1970	874052	171142	88628	485924	3972	153	61	2	0	0	0	0	0	0	0	0	2
1971	325810	575197	10056	3419	6435	302	6	0	0	0	0	0	0	0	0	0	0
1972	239844	241771	57776	1037	148	444	0	0	0	0	0	0	0	0	0	0	0
1973	42005	119383	12604	11	11	199	0	0	0	0	0	0	0	0	0	0	0
1974	590144	281705	33021	47958	4707	84	115	229	0	0	0	0	0	0	0	0	229
1975	45758	614202	87373	4916	5372	146	5	0	5	0	0	0	0	0	0	0	5
1976	171970	69809	190817	30424	48	3071	18	0	0	0	0	0	0	0	0	0	0
1977	108986	155349	31016	71460	2488	251	254	0	0	0	0	0	0	0	0	0	0
1978	299865	134332	12109	864	1582	68	7	6	0	0	0	0	0	0	0	0	6
1979	879999	131887	18520	1579	88	397	17	0	0	0	0	0	0	0	0	0	0
1980	398727	299790	23243	8796	1375	58	92	7	0	1	0	0	0	0	0	0	8
1981	644910	99277	32070	4817	463	6	3	0	0	0	0	0	0	0	0	0	0
1982	275003	174449	15392	14225	1862	494	0	0	0	0	0	0	0	0	0	0	0
1983	488707	64821	14885	5387	2320	3	0	0	0	0	0	0	0	0	0	0	0
1984	92587	98272	11507	4903	380	543	0	0	0	0	0	0	0	0	0	0	0
1985	122079	11672	18397	1832	563	226	18	0	0	0	0	0	0	0	0	0	0
1986	32696	40062	1857	813	106	8	0	0	0	0	0	0	0	0	0	0	0
1987	12217	118539	4290	348	138	0	0	0	0	0	0	0	0	0	0	0	0
1988	15007	3933	19044	3332	620	202	0	0	0	0	0	0	0	0	0	0	0
1989	10251	2918	2013	3206	530	42	99	12	0	0	0	0	0	0	0	0	12
1990	5225	12702	3494	632	2625	401	44	138	8	0	0	0	0	0	0	0	146
1991	116909	26909	3415	631	49	44	0	0	0	0	0	0	0	0	0	0	0
1992	241702	96031	11373	367	29	3	17	0	0	0	0	0	0	0	0	0	0
1993	124495	122384	14151	3240	83	9	0	18	0	0	0	0	0	0	0	0	18
1994	69907	16759	9782	1022	160	7	1	0	0	0	0	0	0	0	0	0	0
1995	270461	108056	2300	888	65	0	0	0	0	0	0	0	0	0	0	0	0
1996	343600	17333	7453	3338	107	0	0	0	0	0	0	0	0	0	0	0	0
1997	32920	47645	11312	4451	184	17	0	0	0	0	0	0	0	0	0	0	0
1998	20771	9942	16963	2748	1562	65	0	0	0	0	0	0	0	0	0	0	0
1999	93667	11232	4531	2932	344	166	3	0	0	0	0	0	0	0	0	0	0
2000	49707	73355	21740	2085	186	5	0	0	0	0	0	0	0	0	0	0	0
2001	2965	24255	35776	10127	35	8	0	0	0	0	0	0	0	0	0	0	0
2002	49807	13889	4489	3638	504	27	0	0	0	0	0	0	0	0	0	0	0
2003	4145	5983	2101	1285	1524	12	0	0	0	0	0	0	0	0	0	0	0

Table 4.2.7. Haddock in Sub-Area IV and Division IIIa. Weight-at-age data from the total catch in the North Sea, which are also used as stock weights-at-age. Data used in the assessment are highlighted in **bold**.

CWt catch	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	7+
1963	**0.012**	**0.123**	**0.253**	**0.473**	**0.695**	**0.807**	**1.004**	1.131	1.173	1.576	1.825	0.000	0.000	0.000	0.000	0.000	**1.179**
1964	**0.011**	**0.118**	**0.239**	**0.403**	**0.664**	**0.814**	**0.908**	1.382	1.148	1.470	1.781	0.000	0.000	0.000	0.000	0.000	**1.350**
1965	**0.010**	**0.069**	**0.225**	**0.366**	**0.648**	**0.844**	**1.193**	1.173	1.482	1.707	2.239	0.000	0.000	0.000	0.000	0.000	**1.353**
1966	**0.010**	**0.088**	**0.247**	**0.367**	**0.533**	**0.949**	**1.266**	1.525	1.938	1.727	2.963	2.040	0.000	0.000	0.000	0.000	**1.662**
1967	**0.011**	**0.115**	**0.281**	**0.461**	**0.594**	**0.639**	**1.057**	1.501	1.922	2.069	2.348	0.000	0.000	0.000	0.000	0.000	**1.792**
1968	**0.010**	**0.125**	**0.253**	**0.510**	**0.731**	**0.857**	**0.837**	1.606	2.260	2.702	2.073	0.000	0.000	0.000	0.000	0.000	**1.719**
1969	**0.011**	**0.063**	**0.216**	**0.406**	**0.799**	**0.891**	**1.031**	1.094	2.040	3.034	3.264	0.000	0.000	0.000	0.000	0.000	**1.107**
1970	**0.013**	**0.073**	**0.222**	**0.352**	**0.735**	**0.873**	**1.191**	1.362	1.437	2.571	3.950	3.869	0.000	0.000	0.000	0.000	**1.458**
1971	**0.011**	**0.106**	**0.247**	**0.362**	**0.506**	**0.887**	**1.267**	1.534	1.337	1.275	1.969	4.306	3.543	0.000	0.000	0.000	**1.366**
1972	**0.024**	**0.115**	**0.243**	**0.388**	**0.506**	**0.606**	**1.000**	1.366	2.241	2.006	1.651	2.899	0.000	0.000	0.000	0.000	**1.635**
1973	**0.044**	**0.112**	**0.241**	**0.373**	**0.586**	**0.649**	**0.725**	1.044	1.302	2.796	1.726	2.020	2.158	0.000	0.000	0.000	**1.176**
1974	**0.024**	**0.127**	**0.226**	**0.344**	**0.549**	**0.891**	**0.895**	0.952	1.513	2.315	2.508	4.152	2.264	0.000	0.000	0.000	**0.973**
1975	**0.020**	**0.100**	**0.242**	**0.357**	**0.450**	**0.680**	**1.245**	1.124	1.093	1.720	2.217	2.854	0.000	3.426	0.000	0.000	**1.173**
1976	**0.013**	**0.124**	**0.225**	**0.402**	**0.512**	**0.588**	**0.922**	1.933	1.784	1.306	2.425	2.528	0.000	0.000	0.000	0.000	**1.521**
1977	**0.019**	**0.107**	**0.242**	**0.346**	**0.602**	**0.613**	**0.802**	1.181	1.943	2.322	1.780	3.189	0.000	4.119	0.000	0.000	**1.340**
1978	**0.011**	**0.142**	**0.255**	**0.420**	**0.442**	**0.719**	**0.745**	0.955	1.398	2.124	2.867	1.849	2.454	4.782	0.000	0.000	**1.114**
1979	**0.009**	**0.095**	**0.292**	**0.443**	**0.637**	**0.664**	**0.933**	1.187	1.187	1.468	2.679	1.624	1.760	1.643	0.000	0.000	**1.326**
1980	**0.012**	**0.102**	**0.285**	**0.487**	**0.732**	**1.046**	**0.936**	1.394	1.599	1.593	1.726	3.328	1.119	3.071	3.111	0.000	**1.542**
1981	**0.009**	**0.074**	**0.264**	**0.477**	**0.745**	**1.147**	**1.479**	1.180	1.634	1.764	1.554	1.492	3.389	4.273	1.981	0.000	**1.226**
1982	**0.011**	**0.100**	**0.293**	**0.462**	**0.785**	**1.166**	**1.441**	1.672	1.456	2.634	2.164	1.924	1.886	3.179	0.000	0.000	**1.558**
1983	**0.022**	**0.135**	**0.298**	**0.449**	**0.651**	**0.916**	**1.215**	1.162	1.920	1.376	1.395	1.907	2.853	4.689	0.000	0.000	**1.366**
1984	**0.010**	**0.141**	**0.302**	**0.489**	**0.671**	**0.805**	**1.097**	1.100	1.868	2.425	1.972	2.247	2.422	2.822	4.995	0.000	**1.389**
1985	**0.013**	**0.149**	**0.280**	**0.481**	**0.668**	**0.857**	**1.049**	1.459	1.833	2.124	2.145	2.003	2.387	2.471	2.721	3.970	**1.594**
1986	**0.025**	**0.124**	**0.242**	**0.397**	**0.613**	**0.863**	**1.257**	1.195	1.715	1.525	2.484	2.653	2.538	3.075	2.778	2.894	**1.348**
1987	**0.007**	**0.116**	**0.267**	**0.407**	**0.615**	**1.029**	**1.276**	1.433	1.529	1.877	2.054	1.940	2.471	2.411	2.996	2.638	**1.592**
1988	**0.022**	**0.164**	**0.217**	**0.416**	**0.590**	**0.748**	**1.284**	1.424	1.551	1.627	1.680	3.068	2.468	2.885	3.337	2.863	**1.565**
1989	**0.025**	**0.197**	**0.304**	**0.372**	**0.606**	**0.811**	**0.983**	1.364	1.655	1.684	2.248	2.166	2.364	2.389	2.307	1.146	**1.520**
1990	**0.042**	**0.190**	**0.292**	**0.435**	**0.476**	**0.775**	**0.968**	1.152	1.521	2.037	2.653	2.530	2.392	3.444	1.852	4.731	**1.296**
1991	**0.029**	**0.177**	**0.322**	**0.472**	**0.640**	**0.651**	**1.042**	1.232	1.481	1.776	1.996	2.253	2.404	1.070	3.509	2.936	**1.468**
1992	**0.018**	**0.104**	**0.307**	**0.486**	**0.748**	**1.016**	**0.896**	1.395	1.537	1.912	1.997	2.067	2.441	1.781	0.000	0.000	**1.637**
1993	**0.010**	**0.113**	**0.282**	**0.447**	**0.680**	**0.894**	**1.173**	1.102	1.592	1.737	1.920	1.718	2.274	2.516	0.000	0.000	**1.288**
1994	**0.017**	**0.115**	**0.251**	**0.420**	**0.597**	**0.943**	**1.209**	1.570	1.469	1.620	2.418	2.108	2.849	2.403	2.580	0.000	**1.606**
1995	**0.013**	**0.101**	**0.299**	**0.364**	**0.592**	**0.763**	**1.099**	1.423	1.685	1.873	1.881	2.508	1.674	1.699	2.243	0.000	**1.644**
1996	**0.018**	**0.121**	**0.247**	**0.390**	**0.483**	**0.780**	**0.870**	0.846	1.833	2.025	1.623	2.393	2.369	2.598	3.439	0.000	**0.999**
1997	**0.017**	**0.133**	**0.280**	**0.359**	**0.579**	**0.615**	**0.909**	0.966	1.647	2.247	2.146	2.634	2.757	2.262	2.867	2.782	**1.092**
1998	**0.023**	**0.153**	**0.254**	**0.394**	**0.440**	**0.651**	**0.760**	1.103	1.153	1.825	2.357	2.150	2.824	2.423	2.085	2.509	**1.163**
1999	**0.022**	**0.168**	**0.243**	**0.361**	**0.473**	**0.498**	**0.680**	0.782	0.749	1.247	1.559	1.913	2.232	2.392	2.912	2.225	**0.791**
2000	**0.057**	**0.119**	**0.254**	**0.367**	**0.498**	**0.615**	**0.650**	1.100	1.091	1.760	1.959	2.331	2.385	2.315	3.810	1.843	**1.142**
2001	**0.019**	**0.109**	**0.216**	**0.311**	**0.467**	**0.697**	**0.754**	0.971	1.892	1.198	2.114	2.706	3.237	2.534	1.239	3.425	**1.111**
2002	**0.016**	**0.096**	**0.264**	**0.326**	**0.530**	**0.736**	**0.924**	0.846	1.423	1.941	2.368	1.840	2.349	2.762	0.000	0.000	**1.302**
2003	**0.030**	**0.097**	**0.213**	**0.321**	**0.404**	**0.674**	**0.770**	1.155	1.380	1.646	2.181	2.209	2.506	2.606	1.981	3.092	**1.380**

Table 4.2.8. Weight-at-age data 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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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

Table 4.2.9. Haddock in Sub-Area IV and Division IIIa. Weight-at-age data 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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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

Table 4.2.10. Haddock in Sub-Area IV and Division IIIa. Weight-at-age data 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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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

Table 4.2.11. Haddock in Sub-Area IV and Division IIIa. Auxiliary data available for calibration of the assessment. Data used in the assessment are highlighted in **bold**.

English Groundfish Survey, age 0 – 7+. Survey period: 0.5-0.75

ENG_GFS	effort	0	1	2	3	4	5	6	7
1977	100	53.480	6.681	3.206	6.163	0.925	0.072	0.091	0.013
1978	100	35.827	13.688	2.617	0.239	2.220	0.214	0.005	0.074
1979	100	87.551	29.554	5.461	0.872	0.109	0.437	0.035	0.004
1980	100	37.402	62.331	16.731	2.570	0.273	0.043	0.142	0.022
1981	100	153.746	17.319	43.910	7.557	0.742	0.064	0.003	0.060
1982	100	28.134	31.547	7.979	11.800	1.026	0.236	0.098	0.014
1983	100	83.193	21.821	10.952	2.143	2.174	0.266	0.041	0.014
1984	100	22.846	59.933	6.159	3.078	0.417	0.478	0.103	0.013
1985	100	24.587	18.656	23.819	2.111	0.698	0.196	0.128	0.041
1986	100	26.600	14.973	4.472	3.383	0.278	0.175	0.038	0.036
1987	100	2.241	28.193	4.310	0.533	0.687	0.048	0.033	0.003
1988	100	6.074	2.856	18.353	1.549	0.160	0.279	0.040	0.012
1989	100	9.429	8.168	1.446	3.968	0.252	0.030	0.060	0.014
1990	100	28.188	6.645	1.983	0.286	0.878	0.048	0.027	0.013
1991	100	26.333	11.505	0.961	0.231	0.048	0.219	0.005	0.006
1992	**100**	**82.774**	**19.688**	**9.774**	**0.584**	**0.049**	**0.012**	0.084	0.004
1993	**100**	**13.578**	**24.609**	**5.859**	**1.665**	**0.059**	**0.017**	0.000	0.009
1994	**100**	**94.297**	**8.066**	**9.020**	**0.839**	**0.283**	**0.020**	0.001	0.001
1995	**100**	**17.993**	**38.310**	**4.452**	**3.403**	**0.278**	**0.092**	0.007	0.000
1996	**100**	**19.917**	**8.310**	**14.570**	**1.217**	**0.830**	**0.071**	0.054	0.000
1997	**100**	**13.032**	**14.863**	**4.334**	**6.607**	**0.227**	**0.216**	0.027	0.006
1998	**100**	**5.302**	**8.891**	**5.681**	**1.347**	**1.418**	**0.083**	0.046	0.003
1999	**100**	**210.984**	**5.572**	**2.830**	**1.233**	**0.423**	**0.405**	0.014	0.012
2000	**100**	**31.023**	**84.112**	**1.525**	**0.550**	**0.247**	**0.113**	0.118	0.000
2001	**100**	**0.372**	**9.635**	**32.493**	**1.023**	**0.279**	**0.118**	0.045	0.019
2002	**100**	**0.919**	**1.329**	**7.596**	**20.400**	**0.183**	**0.033**	0.051	0.032
2003	**100**	**1.078**	**2.021**	**0.042**	**4.705**	**15.177**	**0.242**	0.009	0.074

Scottish Groundfish Survey. Ages 0-5+. Survey period: 0.5-0.75

SCO_GFS	effort	0	1	2	3	4	5
1982	**10**	**1235**	**2488**	**996**	**1336**	**115**	**7**
1983	**10**	**2203**	**1813**	**1611**	**372**	**455**	**53**
1984	**10**	**873**	**4367**	**788**	**336**	**55**	**65**
1985	**10**	**818**	**1976**	**2981**	**232**	**103**	**14**
1986	**10**	**1747**	**2329**	**574**	**598**	**36**	**27**
1987	**10**	**277**	**2393**	**704**	**106**	**128**	**8**
1988	**10**	**406**	**467**	**1982**	**170**	**27**	**23**
1989	**10**	**432**	**886**	**214**	**574**	**31**	**4**
1990	**10**	**3163**	**1002**	**240**	**32**	**103**	**7**
1991	**10**	**3471**	**1705**	**178**	**21**	**5**	**16**
1992	**10**	**8270**	**3832**	**963**	**48**	**8**	**3**
1993	**10**	**859**	**5836**	**1380**	**269**	**6**	**4**
1994	**10**	**13762**	**1265**	**2080**	**210**	**53**	**2**
1995	**10**	**1566**	**8153**	**734**	**926**	**74**	**28**
1996	**10**	**1980**	**2231**	**4705**	**231**	**206**	**22**
1997	**10**	**972**	**2779**	**849**	**1397**	**66**	**56**
1998	**10**	**3280**	**6349**	**1924**	**490**	**511**	**24**
1999	**10**	**66067**	**1907**	**1141**	**688**	**197**	**164**
2000	**10**	**11902**	**30611**	**460**	**221**	**130**	**73**
2001	**10**	**79**	**3790**	**11352**	**179**	**65**	**40**
2002	**10**	**2149**	**675**	**2632**	**6931**	**70**	**37**
2003	**10**	**2159**	**1172**	**307**	**2092**	**4344**	**22**

Table 4.2.11 cont. Haddock in Sub-Area IV and Division IIIa. Auxiliary data available for calibration of the assessment. Data used in the assessment are highlighted in **bold**.

IBTS Q1 survey, backshifted. Ages 0-5+. Survey period: 0.99-1.00

IBTS_Q1-	effort	0	1	2	3	4	5
1966	1	42.00	3.94	2.85	6.01	0.21	0.26
1967	1	4877.59	29.18	13.11	4.97	1.76	7.41
1968	1	3555.63	1600.88	159.08	46.54	21.70	24.98
1969	1	52.58	148.78	145.93	60.28	7.23	1.24
1970	1	528.51	30.02	31.80	64.81	1.10	0.23
1971	1	395.09	258.09	32.94	4.74	9.70	0.82
1972	1	327.80	876.33	200.08	12.08	2.24	0.96
1973	1	1136.06	136.13	198.45	18.66	0.87	7.44
1974	1	1146.29	355.76	18.62	34.47	6.22	0.88
1975	1	105.00	556.39	182.89	16.47	13.72	3.23
1976	1	139.44	66.46	134.55	16.45	1.17	1.80
1977	1	352.82	105.85	27.92	66.53	10.43	2.92
1978	1	468.16	212.41	52.46	6.70	15.32	2.61
1979	1	863.66	388.56	86.65	10.66	2.37	5.76
1980	1	267.74	637.56	159.70	25.73	4.38	3.06
1981	**1**	**537.59**	**253.00**	**421.86**	**60.26**	**8.05**	2.16
1982	**1**	**308.22**	**402.61**	**89.79**	**115.26**	**12.71**	1.92
1983	**1**	**1067.67**	**221.34**	**130.95**	**20.93**	**21.20**	4.65
1984	**1**	**228.46**	**828.35**	**105.12**	**33.77**	**4.29**	7.16
1985	**1**	**584.54**	**251.14**	**285.87**	**17.22**	**6.03**	2.06
1986	**1**	**917.32**	**328.81**	**47.18**	**61.09**	**4.73**	2.58
1987	**1**	**100.66**	**670.95**	**96.97**	**12.70**	**13.56**	2.02
1988	**1**	**217.62**	**97.39**	**273.66**	**16.79**	**2.14**	4.70
1989	**1**	**217.45**	**139.11**	**33.00**	**50.37**	**3.16**	1.80
1990	**1**	**677.98**	**132.96**	**24.83**	**4.24**	**8.43**	2.41
1991	**1**	**1162.98**	**344.58**	**18.08**	**3.00**	**0.61**	2.04
1992	**1**	**1254.31**	**540.80**	**154.47**	**8.87**	**1.08**	0.95
1993	**1**	**228.73**	**503.86**	**98.30**	**23.29**	**1.56**	0.79
1994	**1**	**1355.49**	**201.07**	**176.17**	**24.34**	**5.31**	0.80
1995	**1**	**267.41**	**813.27**	**65.87**	**46.69**	**7.73**	3.07
1996	**1**	**860.15**	**366.45**	**470.59**	**24.83**	**15.14**	3.39
1997	**1**	**373.58**	**432.33**	**105.51**	**113.69**	**8.65**	5.36
1998	**1**	**211.76**	**232.93**	**129.71**	**48.10**	**36.62**	4.26
1999	**1**	**3702.06**	**107.83**	**49.88**	**25.37**	**15.56**	10.28
2000	**1**	**887.61**	**2279.02**	**47.76**	**10.93**	**7.18**	5.71
2001	**1**	**58.17**	**491.76**	**1392.57**	**9.97**	**7.45**	4.34
2002	**1**	**89.62**	**40.30**	**237.85**	**537.85**	**2.45**	2.40
2003	**1**	**75.68**	**81.96**	**36.88**	**172.92**	**357.71**	1.98

Scottisch Seiners CPUE. Ages 0-13.

SCO_SEI	fishing hours	0	1	2	3	4	5	6	7	8	9	10	11	12	13
1978	325246	1665	160843	69033	14340	44152	2366	482	673	86	29	3	16	6	0
1979	316419	543	83631	78815	17215	3040	8073	648	70	113	24	4	1	1	0
1980	297227	210	131314	128306	26205	3393	501	2415	123	20	56	23	13	1	1
1981	289672	345	10367	134260	55726	5181	702	102	579	15	22	1	10	2	0
1982	297730	1445	31143	30969	118898	14297	682	145	39	230	1	9	1	0	0
1983	333168	18101	29021	77289	30414	50115	6394	583	119	15	69	26	1	2	0
1984	388085	422	120868	63391	49286	9426	14977	1594	254	18	8	38	3	2	0
1985	382910	2052	29239	164839	33203	15993	2293	2846	308	47	19	9	28	2	0
1986	425017	8265	33999	72604	155836	12895	4169	490	620	58	11	20	15	11	3
1987	418734	138	43646	97731	19731	28883	1989	1174	199	285	31	16	15	12	7
1988	377132	499	11576	201533	37421	4736	7415	718	290	80	70	27	6	6	7
1989	355735	123	19004	19274	91070	8389	1091	1611	223	89	40	13	6	4	1
1990	300076	712	35844	46489	9055	26705	1434	302	408	67	29	5	3	0	0
1991	336675	2226	66144	30755	9531	1485	5028	308	122	183	42	11	1	1	0
1992	300217	1232	30384	64733	8588	1512	290	1180	79	57	53	18	4	0	1
1993	268413	2913	74523	88375	34997	2349	446	100	314	29	15	14	3	0	1
1994	264738	3231	26626	125357	34127	10522	415	138	42	95	9	7	7	2	1
1995	204545	236	67772	32301	70290	8734	2181	117	39	13	9	4	2	3	1
1996	177092	1333	9192	123829	18532	17077	2161	707	84	12	8	11	3	2	1
1997	166817	3109	30046	19165	59309	3918	4083	495	195	10	7	2	0	0	2
1998	150361	38	12692	36813	12003	26564	1659	856	69	22	4	2	2	0	0
1999	93796	3466	23253	35102	21991	6628	11164	690	456	56	12	0	1	0	0
2000	69505	110	46422	13650	8497	5610	1761	2357	110	41	4	1	0	0	0
2001	36135	60	3973	91165	4469	1720	799	273	263	27	18	1	1	0	0
2002	21817	14	653	9269	42086	1126	377	187	55	42	15	2	1	0	0
2003	15374	29	395	1312	8571	23778	346	80	32	11	4	5	2	0	0

Table 4.2.11 cont. Haddock in Sub-Area IV and Division IIIa. Auxiliary data available for calibration of the assessment. Data used in the assessment are highlighted in **bold**.

Scottish light trawlers, ages 0-13.

SCO_LTR	fishing hours	0	1	2	3	4	5	6	7	8	9	10	11	12	13
1978	236929	1692	45733	11471	2914	12279	774	110	167	24	4	0	5	1	0
1979	287494	464	44562	23135	4109	714	3644	203	20	57	20	0	0	1	0
1980	333197	180	92519	46282	8062	755	197	1015	61	18	8	5	0	0	0
1981	251504	436	7979	58146	13653	1518	161	20	320	12	6	7	6	0	0
1982	250870	352	24575	10170	33463	3937	133	67	7	58	0	0	2	0	0
1983	244349	63676	19635	48680	6955	11807	1258	124	27	4	25	7	0	0	2
1984	240725	514	56769	22191	13375	2074	3392	402	98	15	7	14	1	0	0
1985	268136	3548	38850	57422	4913	2787	414	872	128	27	2	0	18	0	0
1986	279767	4371	26322	26549	32339	2797	1014	124	307	43	37	2	2	2	3
1987	351128	97	26220	33648	6464	7197	496	377	72	119	27	2	4	3	4
1988	391988	209	2931	57589	14075	2367	2924	167	84	28	21	6	0	0	0
1989	405883	1077	10415	2919	24895	2754	541	627	109	30	21	7	4	1	1
1990	441084	201	11886	19205	2665	10237	669	168	264	45	14	5	2	1	0
1991	408056	1041	44141	12394	3356	564	2213	226	80	146	38	16	2	1	0
1992	473955	1838	20443	31073	3889	757	144	766	98	52	58	17	3	1	0
1993	447064	231	39863	39176	20213	1527	362	84	274	29	27	26	8	2	1
1994	480400	1482	8267	49047	23557	6304	474	128	42	64	13	7	7	2	2
1995	442010	144	22874	13762	32063	5821	1658	97	15	13	17	3	2	1	1
1996	445995	353	14281	72692	9860	13959	2041	955	304	10	14	7	1	2	1
1997	479449	460	15907	13451	49548	3537	4511	553	163	13	2	2	1	1	1
1998	427868	157	27498	33166	9597	29614	1666	1228	173	46	4	1	1	0	1
1999	329750	2101	24475	36849	24426	5531	11752	841	579	94	9	2	0	0	0
2000	280938	5	64710	15038	11707	7061	1300	2593	174	83	8	2	1	0	0
2001	245489	87	15567	173376	6323	2897	1253	365	444	62	17	9	0	0	0
2002	184096	8	982	11514	53313	1738	664	395	165	218	94	5	4	2	0
2003	98723	71	2804	3186	10931	30249	601	235	123	56	35	15	2	1	0

Table 4.3.1 Haddock in Sub-Area IV and Division IIIa. Tuning diagnostics

Lowestoft VPA Version 3.1

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Extended Survivors Analysis

Haddock in the North Sea and Skagerrak, ages 0-7+

CPUE data from file hadivef.txt

Catch data for 41 years. 1963 to 2003. Ages 0 to 7.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
ENGGFS ,	1992,	2003,	0,	5,	.500,	.750
SCOGFS ,	1982,	2003,	0,	5,	.500,	.750
IBTS_Q1(backshift; 5,	1981,	2003,	0,	4,	.990,	1.000

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability dependent on stock size for ages < 1

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 1

Catchability independent of age for ages >= 2

Terminal population estimation :

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

S.E. of the mean to which the estimates are shrunk = 2.000

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 24 iterations

Regression weights
, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000

Fishing mortalities

Age,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003
0,	.004,	.057,	.047,	.009,	.007,	.002,	.005,	.003,	.033,	.004
1,	.154,	.105,	.076,	.126,	.130,	.167,	.048,	.058,	.121,	.081
2,	.574,	.514,	.456,	.439,	.628,	.819,	.800,	.285,	.136,	.322
3,	1.096,	.932,	.958,	.648,	.579,	.995,	.988,	.964,	.192,	.147
4,	1.083,	1.075,	1.049,	.807,	.899,	.696,	1.084,	.586,	.547,	.131
5,	1.286,	1.000,	1.205,	1.045,	.879,	1.118,	.367,	.483,	.260,	.321
6,	2.042,	1.901,	1.819,	1.273,	.736,	1.204,	.798,	.151,	.218,	.113

XSA population numbers (Thousands)

	AGE						
YEAR ,	0,	1,	2,	3,	4,	5,	6,
1994 ,	5.39E+07,	1.59E+06,	8.30E+05,	1.71E+05,	5.07E+04,	2.93E+03,	7.28E+02,
1995 ,	1.37E+07,	6.90E+06,	2.61E+05,	3.14E+05,	4.45E+04,	1.34E+04,	6.64E+02,
1996 ,	2.11E+07,	1.66E+06,	1.19E+06,	1.05E+05,	9.62E+04,	1.18E+04,	4.03E+03,
1997 ,	1.23E+07,	2.59E+06,	2.96E+05,	5.07E+05,	3.12E+04,	2.63E+04,	2.90E+03,
1998 ,	9.46E+06,	1.57E+06,	4.38E+05,	1.28E+05,	2.06E+05,	1.09E+04,	7.56E+03,
1999 ,	1.33E+08,	1.21E+06,	2.65E+05,	1.57E+05,	5.59E+04,	6.54E+04,	3.69E+03,
2000 ,	2.74E+07,	1.70E+07,	1.97E+05,	7.83E+04,	4.51E+04,	2.17E+04,	1.75E+04,
2001 ,	2.87E+06,	3.51E+06,	3.12E+06,	5.93E+04,	2.27E+04,	1.19E+04,	1.23E+04,
2002 ,	4.36E+06,	3.68E+05,	6.35E+05,	1.57E+06,	1.76E+04,	9.83E+03,	6.00E+03,
2003 ,	4.15E+06,	5.43E+05,	6.26E+04,	3.72E+05,	1.01E+06,	7.94E+03,	6.21E+03,

Estimated population abundance at 1st Jan 2004

, 0.00E+00, 5.31E+05, 9.62E+04, 3.04E+04, 2.50E+05, 6.90E+05, 4.71E+03,

Taper weighted geometric mean of the VPA populations:

, 2.27E+07, 3.14E+06, 4.98E+05, 1.67E+05, 4.70E+04, 1.25E+04, 3.73E+03,

Standard error of the weighted Log(VPA populations) :

, 1.1022, 1.1205, 1.1418, 1.1930, 1.2316, 1.1272, 1.1376,
1

Log catchability residuals.

Fleet : ENGGFS

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.18	.29
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.21	.06
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.69	.24
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.50	.16
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.46	-.34
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	1.55	-.02

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	-.03	.39	.01	.29	.02	-.45	-.01	-.35	-.23	-.10
1	.11	.17	.04	.22	.20	.02	.02	-.56	-.25	-.25
2	.16	.57	.20	.37	.37	.29	-.04	-.06	-.02	-2.78
3	-.40	.29	.38	.29	.04	.00	-.11	.77	.01	-.05
4	-.30	-.17	.13	-.19	-.19	-.22	-.30	.20	.00	.12
5	.01	-.18	-.18	.05	-.13	-.19	-.83	-.11	-1.33	.91

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5
Mean Log q	-15.7867	-15.5880	-15.5880	-15.5880	-15.5880
S.E(Log q)	.2379	.9060	.3513	.2571	.7277

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.59	5.669	17.06	.95	12	.27	-17.42

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	.94	.967	15.72	.96	12	.22	-15.79
2	.67	2.031	14.74	.79	12	.53	-15.59
3	1.13	-1.178	15.85	.90	12	.34	-15.43
4	.93	1.515	15.41	.98	12	.18	-15.73
5	1.50	-1.622	18.86	.51	12	1.02	-15.63

Fleet : SCOGFS

Age	1981	1982	1983
0	99.99	-.53	-1.18
1	99.99	-.45	-.34
2	99.99	.17	.03
3	99.99	-.10	.30
4	99.99	-.47	.13
5	99.99	-.84	.11

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	-.69	-1.09	-1.12	-.35	-.70	-.66	.01	.12	.54	-.40
1	-.67	-.07	-.29	-1.01	-.15	-.23	-.07	-.75	.09	.13
2	-.26	-.18	-.14	-.43	-.21	-.02	-.36	-.78	-.36	.07
3	-.35	-.30	-.46	-.44	-.37	-.21	-.61	-1.40	-.72	-.39
4	-.20	-.20	-.66	-.55	-.32	-.50	-.55	-1.17	-1.02	-1.37
5	-.31	-.07	-.16	-.70	-.73	-.82	-.49	-1.08	-.46	-.36

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	.72	.10	-.12	-.26	1.13	1.28	1.26	-1.15	1.52	1.56
1	-.23	.13	.24	.05	1.37	.46	.51	.01	.58	.72
2	-.04	.04	.35	.02	.56	.66	.04	.16	.20	.48
3	-.52	.26	-.02	.01	.30	.69	.25	.30	.20	.42
4	-.69	-.23	.01	-.15	.06	.29	.33	.01	.32	.14
5	-1.02	-.07	-.07	-.03	-.10	.18	.01	.08	.05	-.22

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5
Mean Log q	-10.3860	-9.9532	-9.9532	-9.9532	-9.9532
S.E(Log q)	.5296	.3390	.4971	.5715	.5093

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.93	.340	12.76	.55	22	.93	-12.47

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	1.24	-1.680	9.34	.70	22	.63	-10.39
2	1.01	-.076	9.93	.88	22	.35	-9.95
3	.84	1.832	10.40	.87	22	.38	-10.10
4	.82	2.689	10.36	.92	22	.34	-10.26
5	.85	2.054	10.13	.90	22	.31	-10.28

Fleet : IBTS_Q1(backshift; 5

Age	1981	1982	1983
0	-.30	-.39	-.39
1	.14	-.16	-.33
2	-.02	-.02	-.17
3	.07	-.24	-.18
4	.55	-.34	-.49
5	No data for this fleet at this age		

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	-.52	.04	-.27	.10	.13	.11	.02	.57	.25	-.21
1	-.23	.00	-.14	-.18	.39	.01	.04	-.24	.24	-.20
2	.04	-.23	-.19	-.01	.17	.42	-.14	-.71	.15	-.21
3	-.27	-.53	-.26	-.15	-.18	-.27	-.18	-.95	.06	-.43
4	-.29	-.60	-.15	-.35	-.36	-.30	-.59	-.92	-.60	-.29
5	No data for this fleet at this age									

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	.03	-.11	.57	.27	-.01	.09	.30	-.06	-.04	-.18
1	.04	-.08	.51	.29	.17	-.30	-.01	.05	-.14	.14
2	-.23	-.12	.27	.15	.16	-.11	.13	.23	-.10	.54
3	-.26	-.38	.11	-.25	.20	-.23	-.39	-.22	-.28	-.02
4	-.58	-.08	-.21	.12	-.24	.01	-.16	.07	-.83	-.31
5	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4
Mean Log q	-7.2176	-7.2583	-7.2583	-7.2583
S.E(Log q)	.2221	.2601	.3327	.4449

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.96	.651	8.95	.92	23	.29	-8.62

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	-1.612	6.58	.94	23	.23	-7.22
2	1.03	-.537	7.06	.92	23	.27	-7.26
3	.98	.351	7.57	.94	23	.24	-7.49
4	.97	.410	7.64	.93	23	.32	-7.56

1

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 2003

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
ENGGFS ,	483049.,	.300,	.000,	.00,	1,	.470,	.000
SCOGFS ,	2537466.,	.952,	.000,	.00,	1,	.047,	.000
IBTS_Q1(backshift; 5,	446069.,	.311,	.000,	.00,	1,	.438,	.000
P shrinkage mean ,	3137117.,	1.12,,,,				.034,	.001
F shrinkage mean ,	180662.,	2.00,,,,				.011,	.012

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
531493.,	.21,	.25,	5,	1.224,	.004

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 2002

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
ENGGFS ,	75800.,	.213,	.008,	.04,	2,	.454,	.102
SCOGFS ,	238714.,	.471,	.345,	.73,	2,	.094,	.034
IBTS_Q1(backshift; 5,	101728.,	.215,	.089,	.41,	2,	.446,	.077
F shrinkage mean ,	65222.,	2.00,,,,				.006,	.118

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
96163.,	.14,	.14,	7,	.985,	.081

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2001

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
ENGGFS ,	19563.,	.213,	.409,	1.92,	3,	.318,	.464
SCOGFS ,	45231.,	.282,	.292,	1.04,	3,	.196,	.228
IBTS_Q1(backshift; 5,	34886.,	.176,	.221,	1.25,	3,	.480,	.286
F shrinkage mean ,	16006.,	2.00,,,,				.006,	.544

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
30406.,	.12,	.18,	10,	1.471,	.322

Age 3 Catchability constant w.r.t. time and age (fixed at the value for age) 2

Year class = 2000

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
ENGGFS ,	202921.,	.181,	.148,	.82,	4,	.341,	.178
SCOGFS ,	330418.,	.246,	.160,	.65,	4,	.189,	.113
IBTS_Q1(backshift; 5,	264049.,	.155,	.086,	.56,	4,	.467,	.139
F shrinkage mean ,	35151.,	2.00,,,,				.004,	.753

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
249948.,	.11,	.09,	13,	.829,	.147

Age 4 Catchability constant w.r.t. time and age (fixed at the value for age) 2

Year class = 1999

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
ENGGFS	,	658348.,	.160,	.106,	.66,	5,	.405,	.136
SCOGFS	,	892561.,	.232,	.118,	.51,	5,	.182,	.102
IBTS_Q1(backshift;	5,	657386.,	.151,	.104,	.69,	5,	.410,	.137
F shrinkage mean	,	82621.,	2.00,,,,				.004,	.772

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
689973.,	.10,	.07,	16,	.720,	.131

Age 5 Catchability constant w.r.t. time and age (fixed at the value for age) 2

Year class = 1998

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
ENGGFS	,	6039.,	.208,	.170,	.82,	6,	.433,	.259
SCOGFS	,	4884.,	.300,	.125,	.42,	6,	.273,	.311
IBTS_Q1(backshift;	5,	3233.,	.198,	.183,	.92,	5,	.282,	.439
F shrinkage mean	,	2044.,	2.00,,,,				.013,	.627

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
4714.,	.14,	.11,	18,	.792,	.321

1

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 2

Year class = 1997

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
ENGGFS	,	4221.,	.209,	.246,	1.17,	6,	.433,	.121
SCOGFS	,	5405.,	.304,	.138,	.45,	6,	.276,	.096
IBTS_Q1(backshift;	5,	4401.,	.199,	.114,	.57,	5,	.277,	.117
F shrinkage mean	,	2457.,	2.00,,,,				.014,	.200

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
4538.,	.14,	.11,	18,	.760,	.113

Table 4.3.2. Haddock in Sub-Area IV and Division IIIa. *F* at age

Run title : Haddock in the North Sea and Skagerrak, ages 0-7+

At 13/09/2004 13:50

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1963,
0,	.0016,
1,	.1219,
2,	.7914,
3,	.6391,
4,	.7267,
5,	.7653,
6,	.7172,
+gp,	.7172,
0 FBAR 2- 4,	.7190,

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
0,	.0434,	.0716,	.0701,	.0022,	.0018,	.0168,	.0299,	.0120,	.0321,	.0023,
1,	.0564,	1.3531,	1.3051,	.2633,	.0515,	.0215,	.5027,	.4747,	.1694,	.3739,
2,	.4438,	.4010,	.8142,	1.0863,	.5803,	.6543,	1.0391,	.6645,	.7944,	.5661,
3,	1.1202,	.4901,	.3409,	.3999,	.9110,	1.3932,	1.1454,	.7989,	1.3721,	1.1633,
4,	.6872,	.8640,	.7247,	.3440,	.2914,	1.3465,	1.3308,	.8615,	1.2063,	.8589,
5,	.7973,	1.0111,	.8713,	.8545,	.4505,	.7436,	.8037,	.9935,	1.1248,	.9619,
6,	.8775,	.7964,	.6515,	.5371,	.5555,	1.1752,	1.1062,	.8942,	1.2498,	1.0060,
+gp,	.8775,	.7964,	.6515,	.5371,	.5555,	1.1752,	1.1062,	.8942,	1.2498,	1.0060,
0 FBAR 2- 4,	.7504,	.5850,	.6266,	.6101,	.5942,	1.1313,	1.1717,	.7750,	1.1243,	.8628,

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
0,	.0129,	.0113,	.0299,	.0132,	.0218,	.0348,	.0743,	.0572,	.0387,	.0271,
1,	.3531,	.3357,	.3088,	.3385,	.3930,	.1759,	.1901,	.1805,	.1740,	.1527,
2,	.9352,	.9689,	.8170,	1.0127,	1.0141,	.8933,	.7100,	.4524,	.4356,	.6632,
3,	.9543,	1.2610,	1.3701,	1.0458,	1.1536,	1.1499,	1.2551,	.9537,	.8238,	1.0456,
4,	1.0156,	1.1136,	.7936,	1.2592,	1.1509,	1.1368,	1.2136,	1.1130,	.8986,	1.1939,
5,	.7256,	1.0275,	1.3293,	1.0736,	1.1538,	1.0996,	1.1409,	.8560,	.8500,	1.2923,
6,	.9083,	1.1477,	1.1785,	1.1397,	1.1667,	1.1423,	1.2180,	.9852,	.8666,	1.7166,
+gp,	.9083,	1.1477,	1.1785,	1.1397,	1.1667,	1.1423,	1.2180,	.9852,	.8666,	1.7166,
0 FBAR 2- 4,	.9684,	1.1145,	.9936,	1.1059,	1.1062,	1.0600,	1.0595,	.8397,	.7194,	.9676,

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
0,	.0157,	.0164,	.0032,	.0090,	.0055,	.0039,	.0057,	.0127,	.0187,	.0315,
1,	.1257,	.2083,	.1286,	.1193,	.1380,	.1064,	.1986,	.1569,	.1481,	.1739,
2,	.6771,	.6191,	1.0368,	.9101,	.8022,	.6647,	1.1278,	.8030,	.7435,	.8145,
3,	1.0077,	.9859,	1.2685,	1.1033,	1.3386,	1.0057,	1.2039,	1.0527,	1.2315,	1.0601,
4,	1.2296,	1.1393,	1.4217,	1.1648,	1.3178,	1.2993,	1.2192,	.9539,	1.1285,	1.1437,
5,	1.3440,	1.3029,	1.1666,	1.1306,	1.4110,	1.1154,	1.2739,	1.0408,	1.0288,	1.1351,
6,	1.3535,	1.5128,	1.4403,	1.6179,	1.9807,	1.7549,	1.9068,	1.5419,	2.0260,	1.5626,
+gp,	1.3535,	1.5128,	1.4403,	1.6179,	1.9807,	1.7549,	1.9068,	1.5419,	2.0260,	1.5626,
0 FBAR 2- 4,	.9715,	.9148,	1.2423,	1.0594,	1.1528,	.9899,	1.1837,	.9365,	1.0345,	1.0061,

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	FBAR 01-03
0,	.0045,	.0573,	.0470,	.0091,	.0071,	.0023,	.0053,	.0034,	.0330,	.0041,	.0135,
1,	.1542,	.1051,	.0760,	.1263,	.1295,	.1667,	.0482,	.0581,	.1212,	.0814,	.0869,
2,	.5736,	.5144,	.4563,	.4392,	.6280,	.8191,	.7995,	.2851,	.1364,	.3223,	.2479,
3,	1.0958,	.9319,	.9582,	.6480,	.5789,	.9955,	.9880,	.9636,	.1920,	.1467,	.4341,
4,	1.0835,	1.0746,	1.0486,	.8071,	.8991,	.6965,	1.0840,	.5865,	.5470,	.1306,	.4214,
5,	1.2856,	1.0000,	1.2054,	1.0455,	.8786,	1.1185,	.3668,	.4832,	.2602,	.3207,	.3547,
6,	2.0425,	1.9013,	1.8193,	1.2734,	.7360,	1.2036,	.7978,	.1511,	.2185,	.1134,	.1610,
+gp,	2.0425,	1.9013,	1.8193,	1.2734,	.7360,	1.2036,	.7978,	.1511,	.2185,	.1134,	
0 FBAR 2- 4,	.9176,	.8403,	.8210,	.6314,	.7020,	.8370,	.9572,	.6117,	.2918,	.1999,	

Table 4.3.3. Haddock in Sub-Area IV and Division IIIa. Stock numbers at age

Run title : Haddock in the North Sea and Skagerrak, ages 0-7+

At 13/09/2004 13:50

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR	1963
0	24064
1	259948
2	7485
3	503
4	286
5	119
6	11
+gp	28
0 TOTAL	292445

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
0	92014	263163	688326	3885141	170966	121530	877086	781820	215227	729040
1	3093	11342	31537	82615	499055	21969	15384	109590	99451	26831
2	44195	561	563	1642	12193	91028	4129	1787	13093	16123
3	2274	19007	252	167	371	4575	31719	979	616	3965
4	207	578	9068	140	87	116	885	7858	343	122
5	108	81	190	3422	77	51	24	182	2586	80
6	45	40	24	65	1192	40	20	9	55	687
+gp	15	14	20	14	10	303	102	39	10	27
0 TOTAL	141950	294786	729980	3973205	683951	239613	929349	902264	331381	776876

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	1333030	115058	164672	256192	394676	719190	155452	323943	204638	666273
1	93636	169401	14646	20574	32547	49714	89421	18579	39383	25344
2	3545	12633	23256	2065	2817	4219	8007	14200	2979	6355
3	6136	933	3214	6887	503	685	1158	2639	6055	1292
4	965	1840	206	636	1885	124	169	257	792	2069
5	40	272	471	72	141	464	31	39	66	251
6	25	16	80	102	20	36	127	8	14	23
+gp	205	58	17	27	42	16	15	48	21	8
0 TOTAL	1437581	300211	206561	286554	432630	774448	254379	359713	253948	701615

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	171247	239426	496672	41673	84166	85761	280674	273662	407241	127088
1	83477	21703	30322	63736	5317	10776	10997	35926	34785	51455
2	4178	14138	3384	5120	10864	889	1861	1732	5898	5761
3	2195	1423	5103	804	1381	3265	307	404	520	1880
4	354	624	413	1118	208	282	930	72	110	118
5	488	81	156	78	272	43	60	214	21	28
6	56	104	18	40	21	54	12	14	62	6
+gp	12	19	32	22	13	11	22	17	15	22
0 TOTAL	262007	277516	536100	112591	102241	101082	294862	312039	448652	186357

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	GMST 63-03	AMST 63-03
0	538523	136939	210850	123052	94638	1325620	273846	28682	43609	41456	0	246847	439007
1	15854	69018	16647	25897	15697	12097	170265	35066	3680	5432	5315	34668	62131
2	8304	2610	11933	2963	4383	2648	1966	31161	6354	626	962	5218	10068
3	1710	3137	1046	5068	1280	1568	783	593	15706	3716	304	1544	3241
4	507	445	962	312	2065	559	451	227	176	10095	2499	446	984
5	29	134	118	263	109	654	217	119	98	79	6900	127	304
6	7	7	40	29	76	37	175	123	60	62	47	36	90
+gp	11	3	11	12	13	31	17	124	73	53	84		
0 TOTAL	564946	212293	241607	157595	118261	1343215	447720	96095	69756	61519	16111		

Table 4.3.4. Haddock in Sub-Area IV and Division IIIa. Stock summary table

```
Run title : Haddock in the North Sea and Skagerrak, ages 0-7+            ,

At 13/09/2004  13:50

Table 16    Summary     (without SOP correction)

   Terminal Fs derived using XSA (With F shrinkage)
```

	Recruitment Age 0	Total Biomass	SSB	Total catch	HC	Disc	IB	Yield/SSB	F 2- 4	F HC 2- 4	F Disc 2-4	F IB 2-4
1963	2406440	3473263	140251	271531	68779	188969	13783	1.94	0.72	0.49	0.20	0.03
1964	9201402	1314189	429790	380158	130944	160318	88896	0.88	0.75	0.47	0.12	0.16
1965	26316326	1100591	544405	299464	162307	62236	74921	0.55	0.59	0.34	0.10	0.14
1966	68832632	1496730	457782	346726	226335	73572	46819	0.76	0.63	0.36	0.17	0.10
1967	388514080	5513842	253987	246589	147778	78056	20755	0.97	0.61	0.35	0.23	0.03
1968	17096554	6900896	288304	302043	105830	161886	34327	1.05	0.59	0.38	0.15	0.07
1969	12152958	2475569	812540	930538	331419	260232	338887	1.15	1.13	0.69	0.15	0.29
1970	87708592	2545017	898942	806674	525325	101380	179969	0.90	1.17	0.70	0.20	0.27
1971	78182032	2532359	418674	446634	237340	177482	31812	1.07	0.78	0.54	0.18	0.06
1972	21522668	2192177	301055	353606	195494	128130	29983	1.17	1.12	0.84	0.24	0.04
1973	72904016	4108057	295678	307688	181518	114719	11451	1.04	0.86	0.65	0.21	0.00
1974	133302984	4766987	258593	368797	153116	166786	48895	1.43	0.97	0.60	0.23	0.13
1975	11505774	2388681	236404	454536	151386	260424	42726	1.92	1.11	0.68	0.34	0.10
1976	16467185	1095137	305461	377118	172607	154265	50246	1.23	0.99	0.62	0.25	0.12
1977	25619152	1050722	236043	226411	145083	44347	36982	0.96	1.11	0.71	0.21	0.19
1978	39467552	1094539	130538	180144	91674	76878	11592	1.38	1.11	0.78	0.28	0.04
1979	71919000	1316396	107000	146001	87094	41732	17175	1.36	1.06	0.87	0.14	0.05
1980	15545177	1429199	149801	223610	105071	94743	23796	1.49	1.06	0.81	0.13	0.12
1981	32394300	957347	237561	217151	138731	60115	18306	0.91	0.84	0.66	0.14	0.03
1982	20463828	1059421	296051	237842	176635	40549	20658	0.80	0.72	0.55	0.11	0.05
1983	66627320	2216120	247802	253594	167353	65925	20316	1.02	0.97	0.71	0.21	0.05
1984	17124650	1651865	193958	222563	134505	75294	12764	1.15	0.97	0.78	0.15	0.04
1985	23942562	1159846	234662	258117	165672	85444	7001	1.10	0.91	0.76	0.13	0.02
1986	49667240	1947539	215228	225697	169157	52209	4331	1.05	1.24	0.93	0.30	0.01
1987	4167343	1090001	150540	176880	111779	59212	5889	1.18	1.06	0.81	0.24	0.01
1988	8416576	620320	151845	175516	107978	62062	5475	1.16	1.15	0.85	0.25	0.05
1989	8576092	619557	122081	108772	80288	25713	2770	0.89	0.99	0.74	0.22	0.03
1990	28067428	1568431	75532	92720	55558	32603	4559	1.23	1.18	0.78	0.36	0.04
1991	27366224	1526371	58731	97021	48731	40276	8014	1.65	0.94	0.80	0.11	0.03
1992	40724084	1329344	96601	138001	74614	47967	15420	1.43	1.03	0.85	0.17	0.02
1993	12708826	978188	130068	174296	81539	79601	13156	1.34	1.01	0.74	0.24	0.03
1994	53852304	1414363	150779	153864	82730	65392	5741	1.02	0.92	0.64	0.27	0.01
1995	13693884	1111223	146593	144773	77503	57360	9909	0.99	0.84	0.59	0.24	0.01
1996	21084962	1006482	178687	159671	79176	72522	7973	0.89	0.82	0.54	0.26	0.02
1997	12305150	905011	193889	141900	82496	52105	7299	0.73	0.63	0.41	0.19	0.03
1998	9463799	723700	166437	131621	81070	45175	5376	0.79	0.70	0.45	0.22	0.04
1999	132562000	3437088	121712	112299	65569	42562	4168	0.92	0.84	0.48	0.33	0.02
2000	27384620	3468187	102082	105161	47569	48841	8751	1.03	0.96	0.63	0.24	0.08
2001	2868186	1175802	272374	167278	40861	118320	8097	0.61	0.61	0.33	0.17	0.11
2002	4360863	806212	444592	107917	58308	45892	3717	0.24	0.29	0.20	0.08	0.02
2003	4145552	732225	459438	68735	44087	23499	1149	0.15	0.20	0.05	0.13	0.02
2004			450000									
Arith. Mean	41966639	1909732	261280									
0 Units	(Thousands)	(Tonnes	(Tonnes	(Tonnes	(Tonnes	(Tonnes	(Tonnes)					

** XSA survivors multiplied by the weight as in the short term forecast.*

Table 4.5.1. Haddock in Sub-Area IV and Division IIIa. Short term forecast input.

N	2004	2005	2006
0	6138.607	6138.607	6138.607
1	531.500		
2	96.166		
3	30.401		
4	249.914		
5	689.942		
6	4.693		
7+	8.406		

	Modeled '99YC			Constant catch weights	
	Catch weight (H. cons)				
	2004	2005	2006	DIS	IBC
0	0.000	0.000	0.000	0.014	0.051
1	0.348	0.348	0.348	0.060	0.137
2	0.400	0.400	0.400	0.122	0.218
3	0.427	0.427	0.427	0.208	0.280
4	0.498	0.498	0.498	0.351	0.331
5	**0.491**	0.712	0.712	0.400	0.426
6	0.818	**0.541**	0.818	0.000	0.218
7+	1.301	1.301	**0.800**	0.000	0.583

	Substituted '67 YC		
	Catch weight (H. cons)		
	2004	2005	2006
0	0.000	0.000	0.000
1	0.348	0.348	0.348
2	0.400	0.400	0.400
3	0.427	0.427	0.427
4	0.498	0.498	0.498
5	**0.609**	0.712	0.712
6	0.818	**0.726**	0.818
7+	1.301	1.301	**0.984**

F	Hcons	DIS	IBC
0	0.000	0.001	0.000
1	0.001	0.039	0.037
2	0.038	0.226	0.029
3	0.056	0.060	0.017
4	0.093	0.021	0.004
5	0.280	0.007	0.002
6	0.100	0.002	0.000
7+	0.098	0.004	0.000

	M	Mat
0	2.050	0.000
1	1.650	0.010
2	0.400	0.320
3	0.250	0.710
4	0.250	0.870
5	0.200	0.950
6	0.200	1.000
7+	0.200	1.000

Table 4.5.2. Haddock in Sub-Area IV and Division IIIa. Short term forecast output.

		2004	2005					
Mean F							**F**$_{pa}$	
	H.cons	0.16	0.13	0.15	0.16	0.20	0.24	0.64
	Ind BC	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Relative to 2003								
	H.cons	0.9	0.7	0.81	0.9	1.1	1.3	3.5
	Ind BC	1	1	1	1	1	1	1
Biomass								
	Total	870	800	803	805	808	811	825
	SSB	450	382	382	382	382	383	383
Catch weights								
	HCONS	88	41	46	51	61	71	155
	DIS	8	5	6	7	8	9	22
	IBC	2	1	1	1	1	1	1
	Total	98	47	54	59	71	82	178
Biomass in 2006								
	Total		818	811	809	800	791	697
	SSB		397	390	384	372	361	259

Figure 4.1.1. Haddock in Sub-Area IV and Division IIIa. The EU cod protection zone as defined in Council Regulation (EC) 867/2004 for the haddock fishery in 2004.

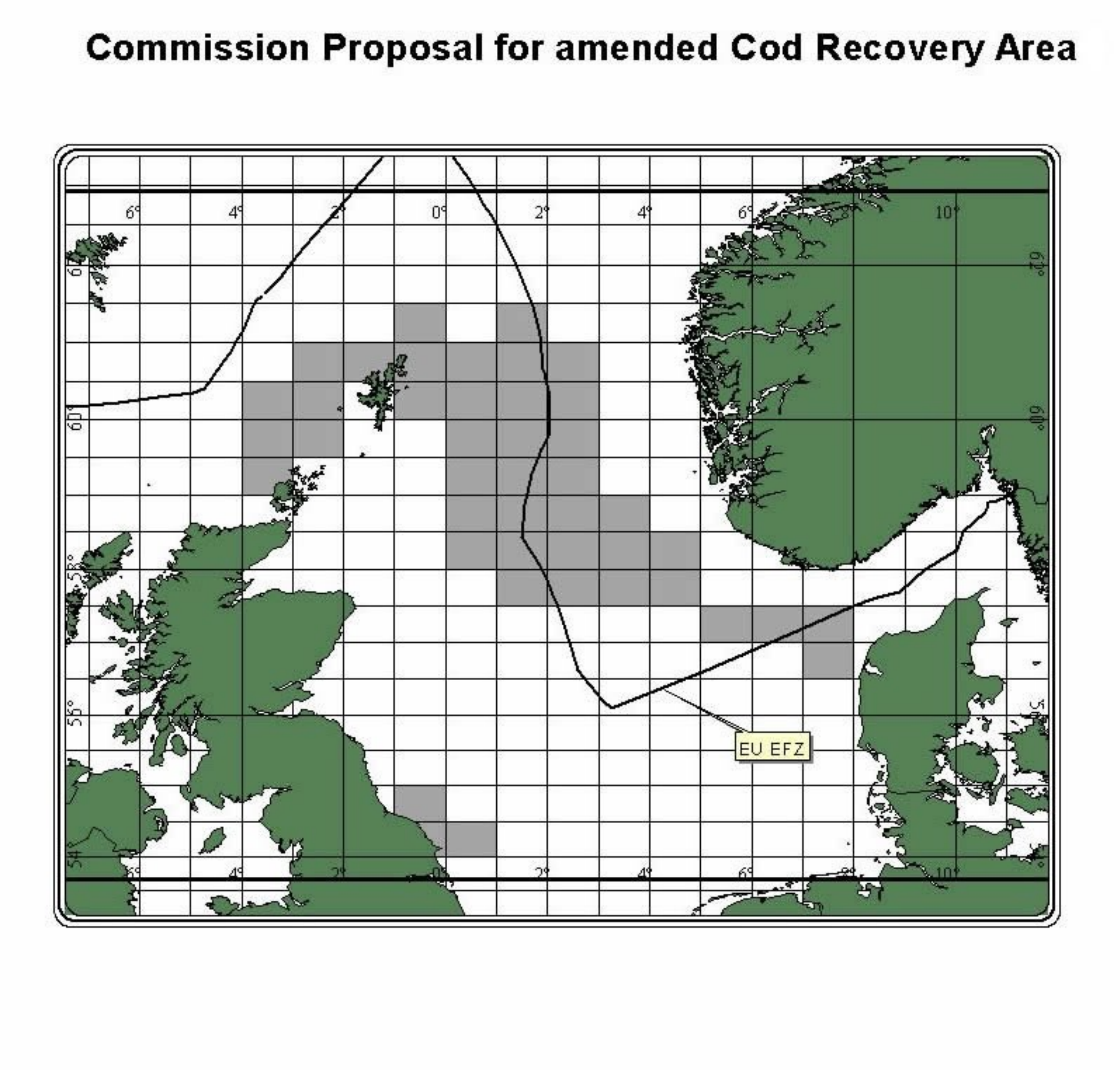


Figure 4.2.1.a. Haddock in Sub-Area IV and Division IIIa. CPUE data at age from surveys.

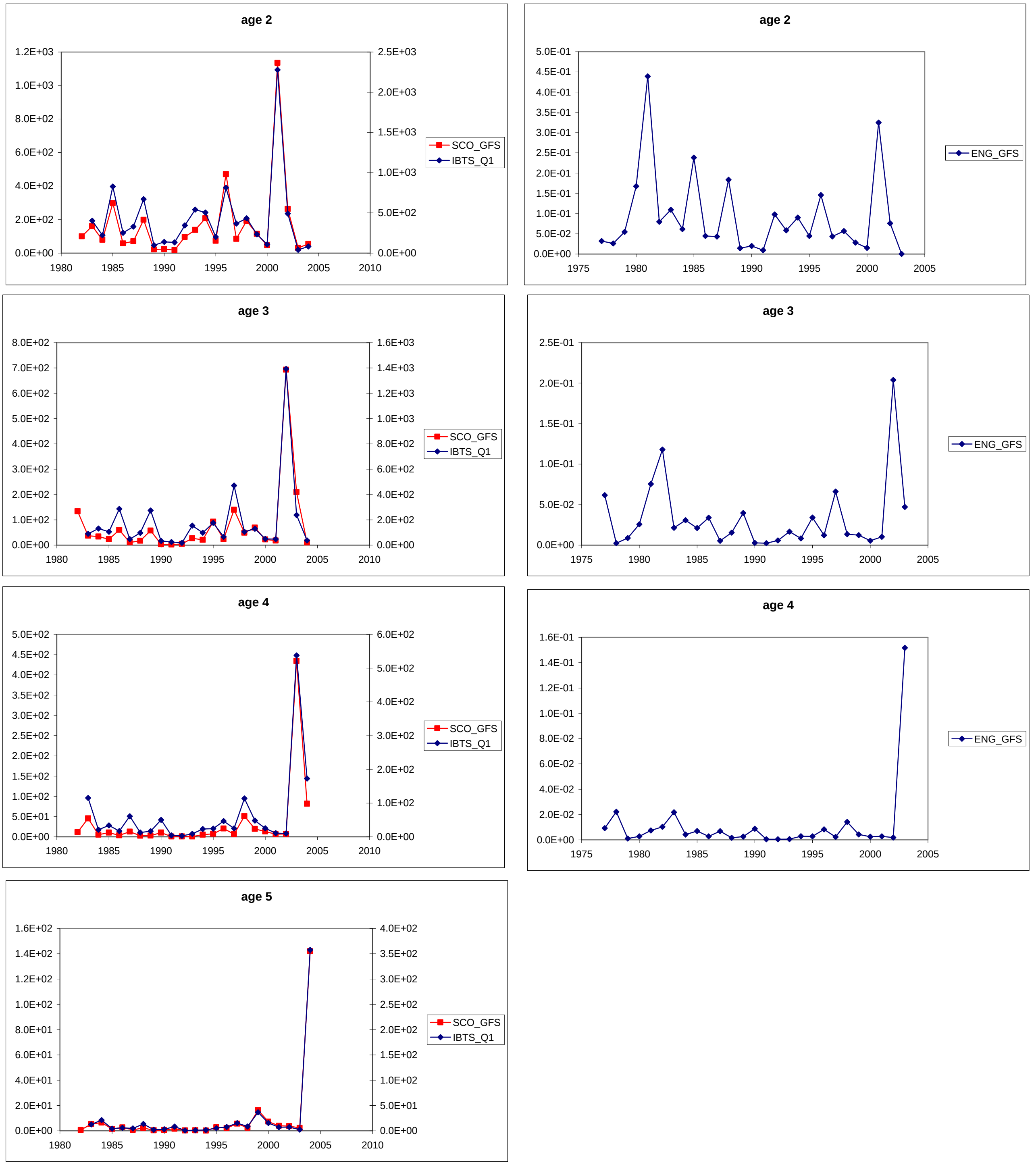
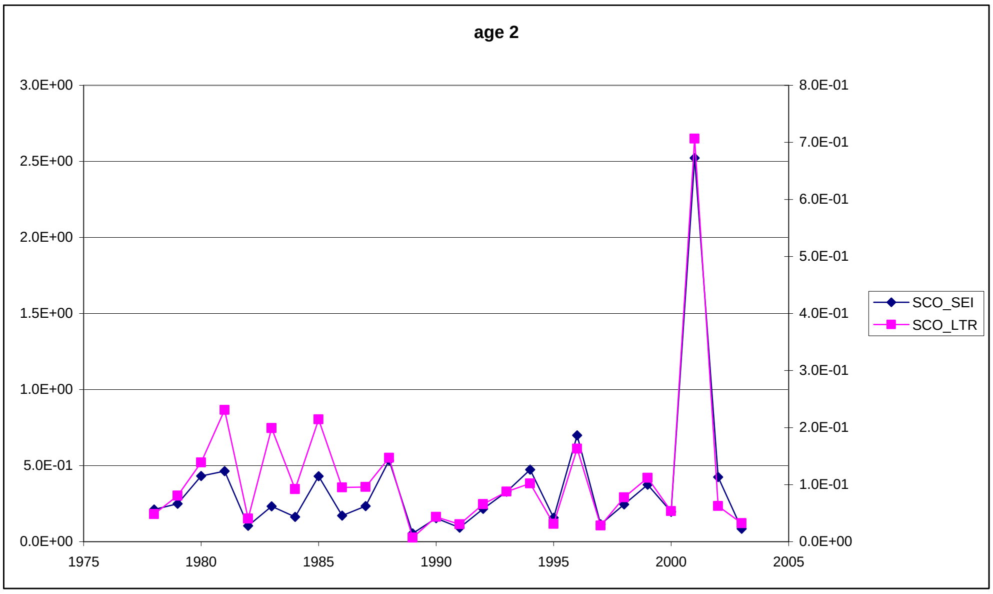
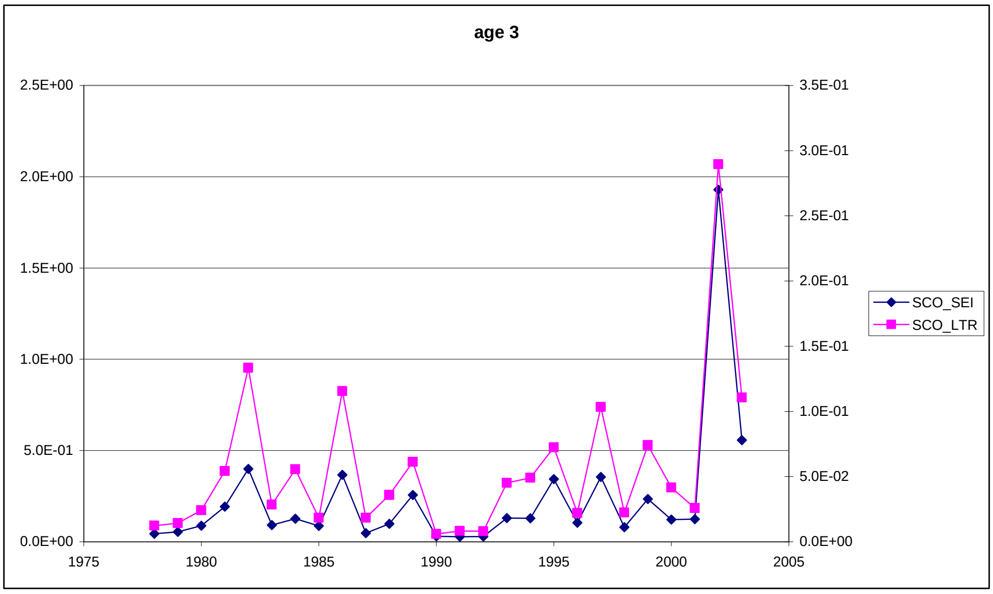


Figure 4.2.1.b. Haddock in Sub-Area IV and Division IIIa. Commercial CPUE data at age.





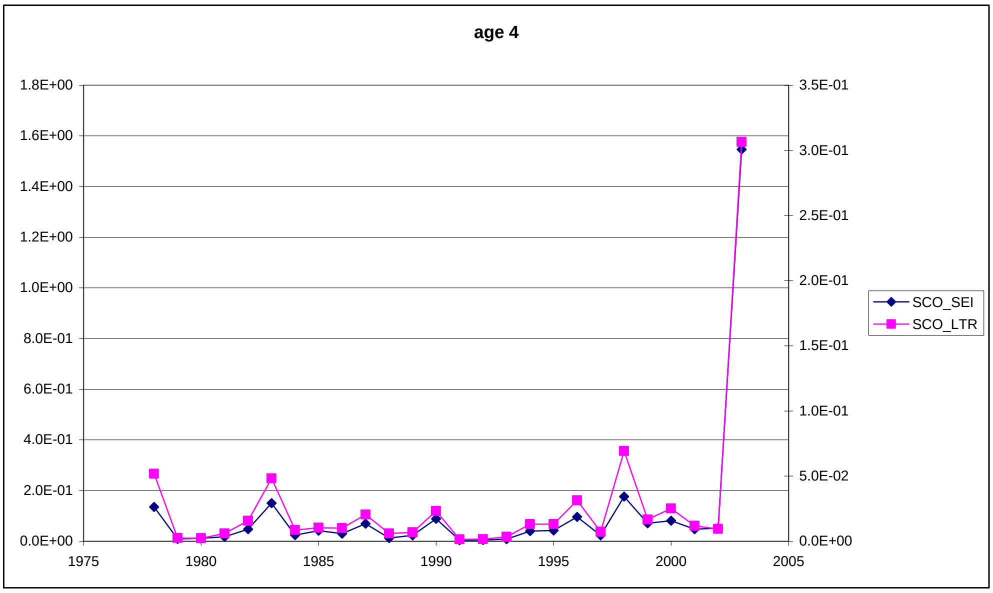
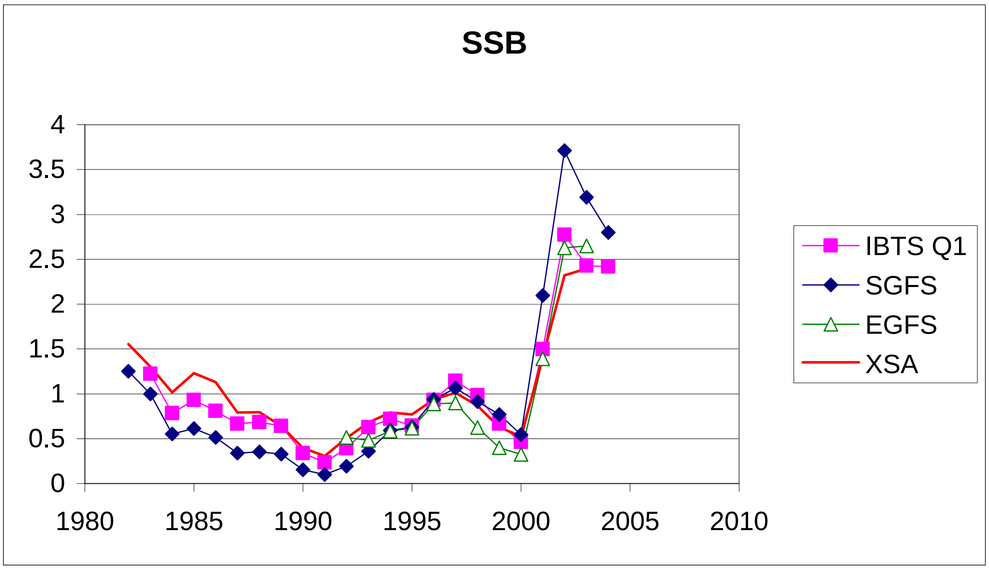


Figure 4.3.1. Haddock in Sub-Area IV and Division IIIa. Stock summary. Dotted horizontal lines indicate $\boldsymbol{F_{pa}}$ and $\boldsymbol{B_{pa}}$, while solid horizontal lines indicate $\boldsymbol{F_{lim}}$ and $\boldsymbol{B_{lim}}$.

Figure 4.3.2. Haddock in Sub-Area IV and Division IIIa. Relative SSB and Z-estimates from SURBA.



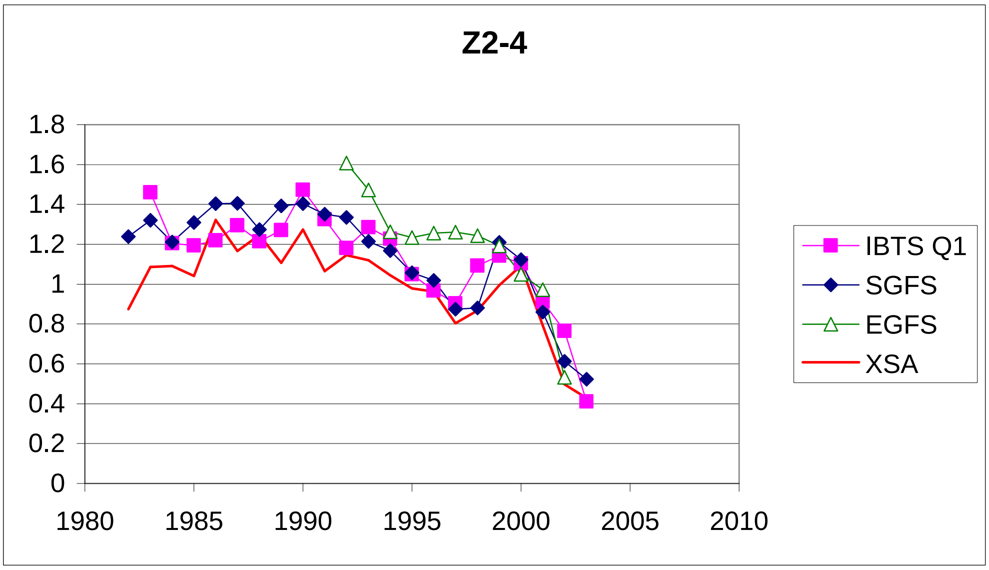
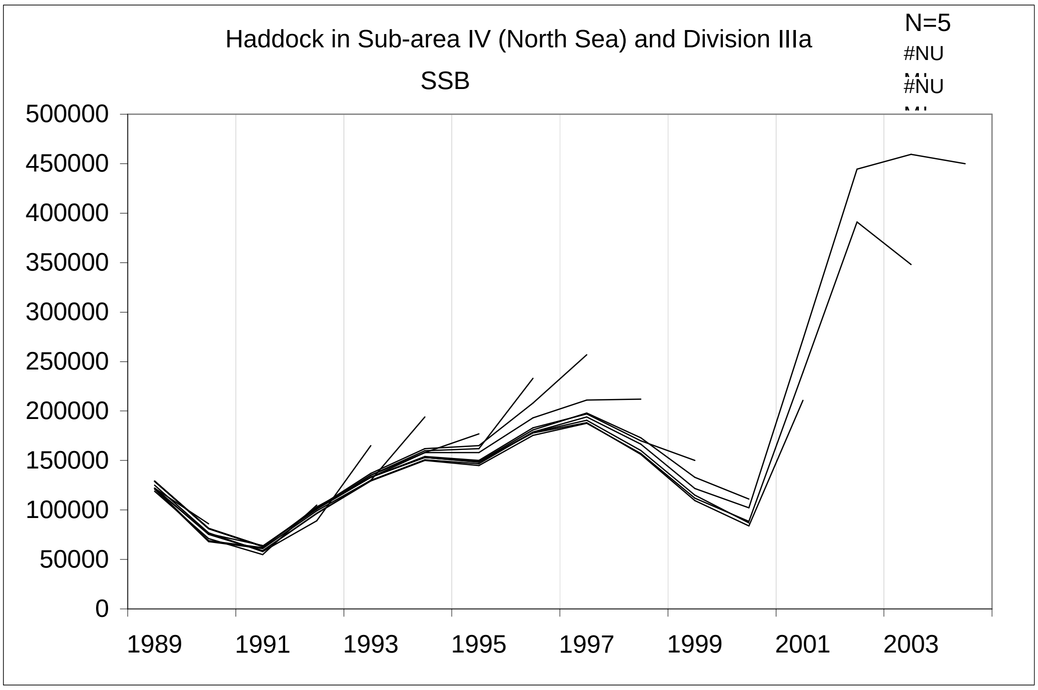
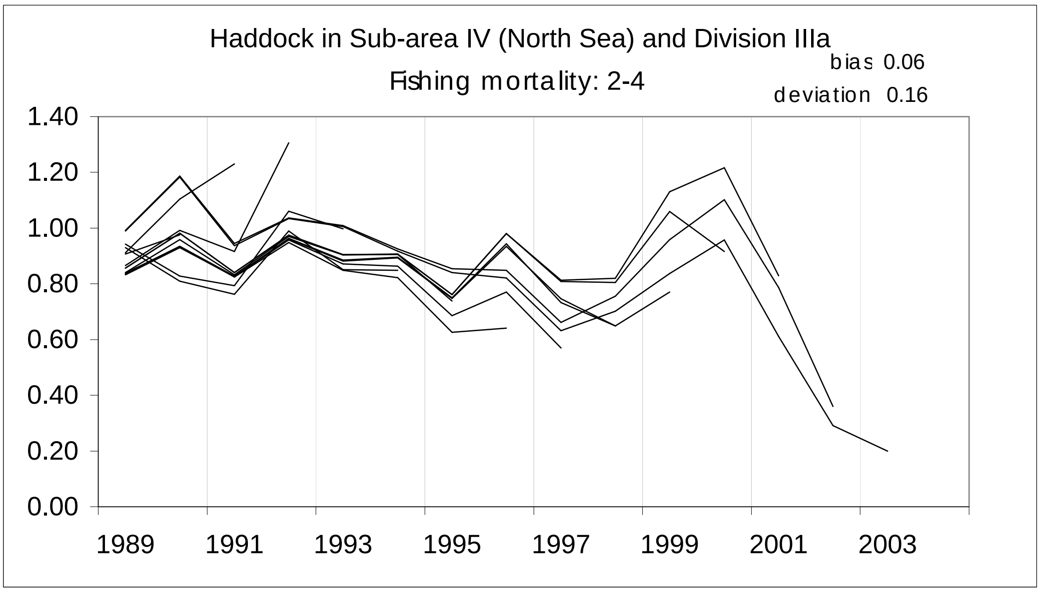


Figure 4.3.3. Haddock in Sub-Area IV and Division IIIa. Quality control graph.





Note: reference age for fishing mortality was changed from 2-6 to 2-4 at the WGNSSK 2003 and onwards.

Figure 4.7.1. Haddock in Sub-Area IV and Division IIIa. Catch weights at age from the human consumption fishery by age.

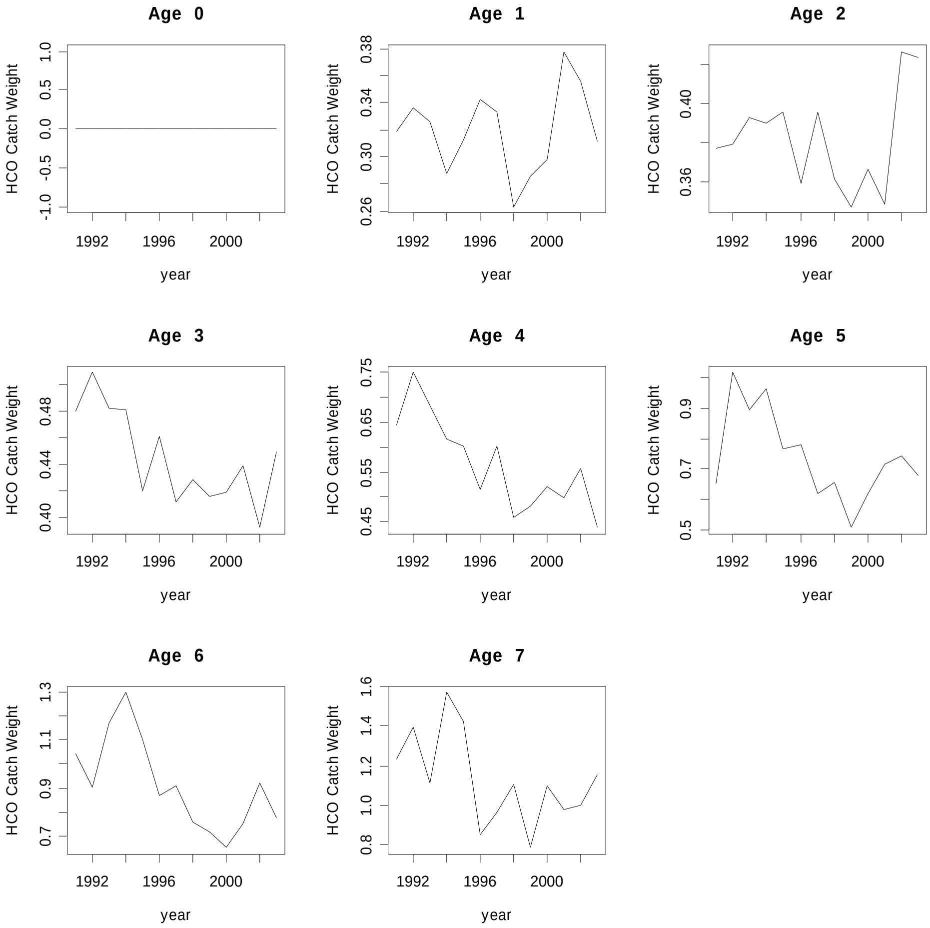
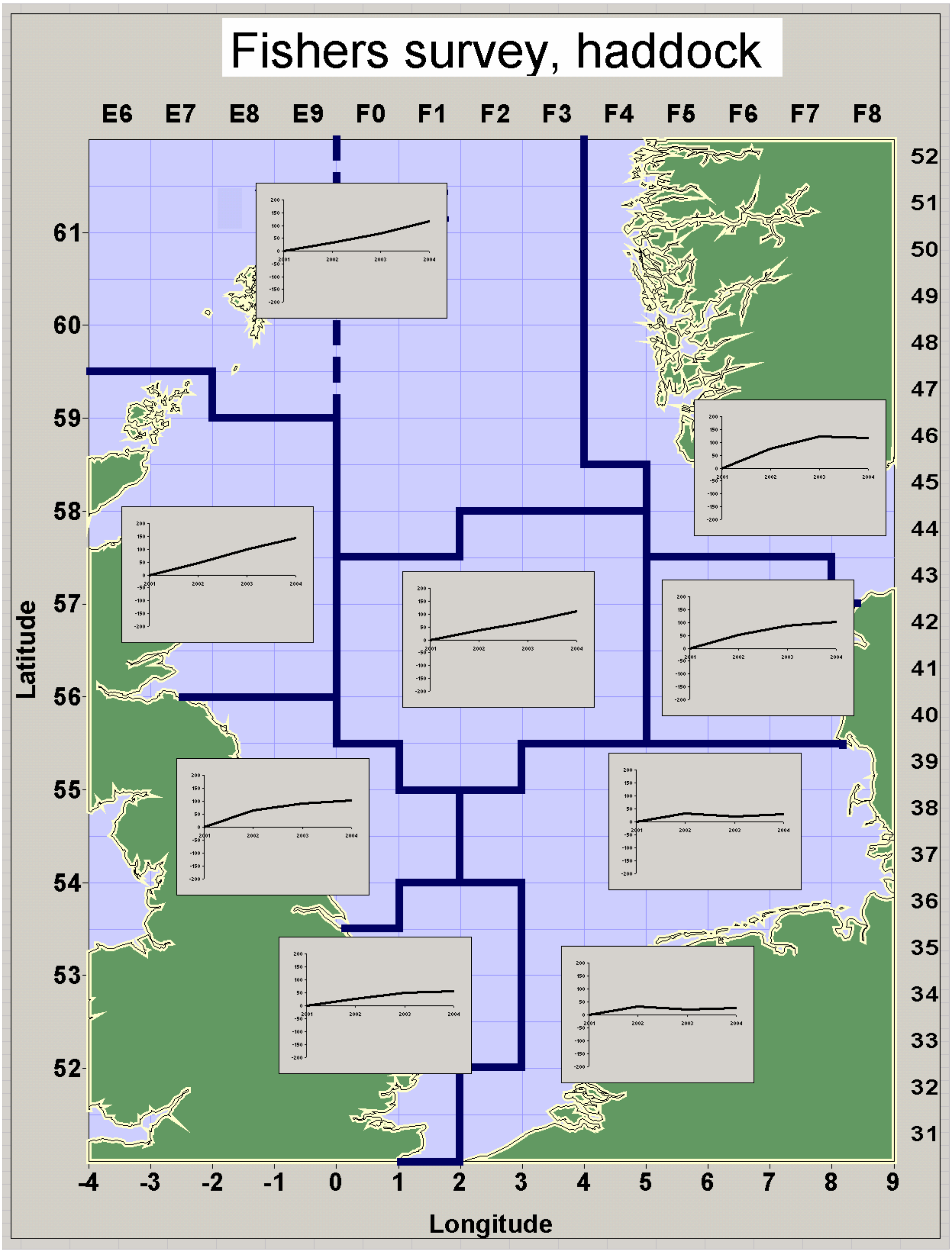


Figure 4.7.2. Haddock in Sub-Area IV and Division IIIa. Results of the North Sea fishermen survey.



5 Whiting in Sub-area IV and Divisions VIId AND IIIA

5.1 Whiting in Sub-area IV and Divisions VIId

The present assessment is classified as a benchmark assessment. All the relevant biological and methodological information can be found in the stock annex dealing with this stock. The assessment of the stock will be subject to review this year by the North Sea Commission Fisheries Partnership (NSCFP).

5.1.1 The Fishery

Total nominal landings are given in Table 5.1.1.1 for the North Sea (Sub-area IV) and Eastern Channel (Division VIId). A brief description of the fishery is given in the stock annex.

5.1.1.1 ICES advice applicable to 2003 and 2004

The advice in 2002 for the fishery in 2003 was:

> "*Since whiting is mostly taken in demersal fisheries with cod and haddock, the advice for cod determines the advice for whiting. Except where it can be demonstrated that whiting can be harvested without by-catch or discards of cod, fishing for whiting should not be permitted.*
>
> *On the status of whiting alone, in order to bring SSB above $\boldsymbol{B}_{pa}$ in 2004, ICES would recommend that fishing mortality in 2002 should be below 0.27, corresponding to human consumption landings of less than 26,000 t. This implies a reduction in fishing mortality of at least 40%. If fishing on whiting is permitted consistent with the advice on cod then total catches should not exceed these values."*

For 2004, the ICES advice was presented in a modified format to provide mixed-fishery advice. For whiting the single species exploitation boundaries were:

> "*Fishing mortality in 2004 should be less than $\boldsymbol{F}_{pa}$. Catch should not increase in 2004 compared to recent years.*"

This coexists with advice that all demersal fisheries in Sub-Area IV and Division VIId should fish

> "*Without bycatch or discards of cod; and*
>
> *Within a recovery plan for North Sea plaice*."

Biological reference points for this stock are given in the relevant Stock Annex.

5.1.1.2 Management applicable in 2003 and 2004

Annual management of the fishery operates through TACs. The 2003 and 2004 TACs for whiting in Sub-area IV and Division IIIa (EC waters) were 16,000 t for both years. The minimum mesh size for vessels fishing for cod in the mixed demersal fishery in EC Zones 1 and 2 (West of Scotland and North Sea excluding Skagerrak) was changed from 100 mm to 120 mm from the start of 2002 under EU regulations regarding the cod recovery plan (Commission Regulation EC 2056/2001), with a one-year derogation of 110 mm for vessels targeting other species such as whiting. This derogation was not extended beyond the end of 2002. Whiting are a by-catch in some Nephrops fisheries that use a smaller mesh size, although landings are restricted through by-catch regulations. Industrial fishing with small-meshed gear is permitted, subject to by-catch limits of protected species including whiting. The minimum landing size of whiting in the human consumption fishery from this area is 27 cm. Regulations applying to the Norway pout box prevent industrial fishing with small meshes in an area where the by-catch limits are likely to be exceeded.

The UK implemented a national regulation in mid 2000, requiring the mandatory fitting of a 90 mm square mesh panel (SSI 227/2000), predominantly to reduce discarding of the large 1999 year class of haddock. Further unilateral legislation in 2001 (SSI 250/2001) banned the use of lifting bags in the Scottish fleet. These measures are likely to have affected the selectivity of whiting.

Vessel decommissioning in several fleets has been underway since 2002. Effort reductions for much of the international fleet to 15 days at sea per month have been imposed since February 2003 (EU 2003/0090).

There is no separate TAC for Division VIId, landings from this Division are counted against the TAC for Divisions VIIb-k combined (31,700 t in 2003 and 27,000 t in 2004). Minimum mesh size for whiting in Division VIId is 80mm, with a 27 cm minimum landing size.

5.1.1.3 The fishery in 2003

For the North Sea, the total international catches were 37,500 t in 2003, of which 10,700 t were human consumption landings, 24,100 t discards and 2,700 t industrial by-catch. The human consumption landings were the lowest ever recorded, as was industrial bycatch. Discards in the North Sea went from near parity with human consumption landings in 2002 to well over double human consumption landings in 2003. For the eastern Channel, the total catch in 2003 (6,800 t) was 1,000 t greater than the previous year, and the highest since 1994.

The total North Sea and eastern Channel human consumption landings of 17,800 t in 2003 were 26% of the status quo forecast of 69,000 t from the 2002 assessment. No short-term forecasts were made during last year's WG.

5.1.2 Data available

5.1.2.1 Landings and Discards

Total international catches as estimated by the Working Group for the combined North Sea and Eastern Channel are shown in Table 5.1.2.1. Eastern Channel catches as used by the Working Group are also shown separately in Table 5.1.2.2.

In 2002, the WG decided to truncate the catch data to start from 1980. This was because discard data for years prior to 1978 were estimated, and furthermore there was evidence of a regime shift in recruitment around 1980. There is no new evidence to suggest this decision should be reversed.

5.1.2.2 Age compositions

Total international catch numbers at age (IV and VIId combined) are presented in Table 5.1.2.3. Total international human consumption landings, discards and industrial by-catch numbers at age (Sub-Area IV and Division VIId combined) are presented in Tables 5.1.2.4 - 5.1.2.6. The Scottish discard estimates are used to estimate discarding in all other fleets. This may not be appropriate because of different spatial distributions in fleet effort and different discarding practices.

Proportion of catch at age is given in Figure 5.1.2.1. Ages 0-4 comprise approximately 95% of the catch on average.

5.1.2.3 Weight at age

Mean weights at age (Sub-Area IV and Division VIId combined) in the catch are presented in Table 5.1.2.7. Mean weights at age (both areas combined) in human consumption landings, discards and industrial by-catch are presented in Tables 5.1.2.8 – 5.1.2.10 and Figure 5.1.2.2. There appears to be an increase in mean weight at age across ages in the most recent years for the human consumption fishery. This may reflect the increase in minimum mesh size from the beginning of 2002 associated with the cod recovery plan (see Section 5.1.1.2).

5.1.2.4 Maturity and natural mortality

Maturity and natural mortality are assumed at fixed values, and are given in the Stock Annex.

5.1.2.5 Catch, effort and research vessel data

A summary of available tuning series is presented in Table 5.1.2.11. The full commercial CPUE and survey tuning indices are presented in Table 5.1.2.12. Due to non-mandatory reporting of effort (in terms of hours fished), commercial CPUE series are not considered reliable and are therefore not included in the assessment.

The IBTS surveys for whiting treat age 6 as a plus group. Therefore only ages 1 to 5 of the IBTS survey data were used in analyses. IBTS data prior to 1983 is not used because not all participating countries used the same GOV trawl gear before that year, and fewer ages were included in the series. The English ground fish survey (EngGFS), changed gears from 1992. Although a correction factor was applied to the data from earlier years this was regarded by the WG as unreliable and so English ground fish survey data was split into two series, one containing data up to 1991 and the second data from 1992 onwards. Catch rates for ages 7 and 8 in the Scottish ground fish survey (ScoGFS) are very low, and have been excluded when the Scottish series is used as a tuning fleet.

5.1.3 Exploration of Survey data

Survey data were examined to evaluate the internal and external consistency of the survey data, and to estimate stock trends independently of catch-at-age data.

5.1.3.1 Mean-standardised indices and log CPUE curves

Previous WGs have noted different trends in the signals from the IBTS Q1, ScoGFS, EngGFS and French ground fish survey (FraGFS) survey indices.

Catch-at-age indices from these surveys, mean-standardised over the years 1992 to 2003, are shown in Figure 5.1.3.1. Trends in survey indices agree relatively well for ages 1 and above from 1995 onwards, although the FraGFS is more variable and less consistent than the other series. The high 1988 year class is picked up by the surveys at ages 1 to 5.

FraGFS is conducted in Division VIId whereas the ScoGFS, EngGFS and IBTS Q1 surveys cover Sub-area IV. The WG was concerned that the lack of consistency between FraGFS and the other surveys was evidence of stock sub-structure in the assessment area. This was investigated further using IBTS Q1 indices and international landings data for ICES round fish areas, together with maps of the numbers and locations of fish caught in recent years for both the IBTS Q1 and Q3 surveys (see Section 5.1.6).

Mean standardised catch-at-age indices by cohort are shown in Figure 5.1.3.2. The EngGFS, ScoGFS and IBTS Q1 surveys demonstrate good self-consistency, for ages 1-5, picking up strong year-classes in 1986, 1988 and 1999. The FraGFS appears less internally consistent, although the shorter time series allows for fewer comparisons by cohort.

Plots of log CPUE by cohort (catch curves) are shown in Figure 5.1.3.3. Scottish, English and French data include age-0 fish. It is believed that age 0 fish are only partially selected, even in survey trawls using a small mesh size. This accounts for the positive slopes found at the beginning of cohort lines. Considering only cohorts from age 1, all surveys show good internal consistency and age 0 fish are therefore removed from subsequent analyses.

5.1.3.2 Empirical SSB and *Z* estimates

SURBA (see section 1.4) was used to calculate empirical Z and SSB time series for ScoGFS, EngGFS and IBTS Q1 surveys. A comparison of Z estimates is shown in Figure 5.1.3.4. The time series are noisy but there is indication that mortality has fallen in recent years. A loess smoother was fitted to each series and the resultant curves reinforce the idea of falling Z values, possibly from the beginning of the 1990s. A comparison of these SSB estimates, mean standardised over 1992 to 2003, show different trends (Figure 5.1.3.4). The ScoGFS and EngGFS surveys indicate that the spawning stock has generally increased since the 1980s, and is now at a relatively high level compared to historical values, whereas the IBTS Q1 survey indicates a highly variable but relatively stable stock. However, relative trends in SSB agree well from 1995, indicating a decrease to 1998, followed by an increase to a peak around 2001 and a subsequent decrease in the last three years.

5.1.4 Exploration of catch data

Figure 5.1.4.1 shows total catch in tonnes, disaggregated into human consumption landings, discards and industrial bycatch. Each component of the catch has reduced since 1980. Industrial bycatch has been low since 1996. However, there is no marked trend in the proportions of each component in the catch. Figure 5.1.4.2 shows landings for Sub-Area IV, disaggregated into landings by Scotland and landings from all other countries combined, and landings for Division VIId. Landings by Scotland have decreased 5 fold since 1985. Landings from all other countries combined have decreased to a lesser extent, so they are now at a similar level to those of Scotland. Landings from VIId have remained relatively constant and now form about one third of the total landings from Sub-Area IV and Division VIId.

5.1.4.1 Mean-standardised index

Figure 5.1.4.3 shows the total international catch numbers at age of whiting, mean-standardised over 1992-2003. These are quite variable, particularly for older ages, but have general decreasing trends over the whole time series. Catches at age decreased sharply between 1983-1985. The 1988 year-class is well represented in the catch data, the 1998 year-class to a lesser extent. Catches generally dropped to their lowest levels in about 1997, increasing thereafter until about 2001, but remain at historically low levels. This is in contrast to the survey time series (Figure 5.1.3.1), which are generally at historically high levels for ages 3+ in particular.

5.1.4.2 Discards

International discards are currently estimated by applying Scottish discard rates to the landings, due to lack of appropriate discard data for other countries. Table 5.1.4.1 gives the approximate discard rate by Scottish fleets, estimated as the ratio of international discards to international human consumption catch. Table 5.1.4.2 shows the actual discarding rate of the English fleet. Figure 5.1.4.4 compares these time series of discard rates at age. It can be seen that the rate of discarding in the English fleet is generally greater than that in the Scottish based series up to and including age 4. As stated in Section 5.1.2.2, ages 0-4 comprise approximately 95% of the whiting catch. The current practice of applying Scottish discard rates to English landings could lead to underestimation of English discards.

Landings and discards numbers-at-length of whiting by the French Otter Trawl and Gillnet fleets are shown in Figures 5.1.4.5 and 5.1.4.6. Discarding rates for the French Otter Trawl are relatively low. There was insufficient time at the Working Group to appropriately convert this data to discard proportions at age. The data is valuable, however, and should be investigated intersessionally, for example, at the proposed whiting Study Group (see Section 1.8.1).

5.1.5 Catch-at-age analysis

A number of exploratory runs were performed. Separable VPA runs were carried out to determine the plus-group and minimum age for inclusion of catch data. Laurec-Shepherd runs were performed to investigate the relationship between absolute population abundance as indicated by catch data, and relative population abundance as indicated by the surveys. Time series of the residuals were also used to characterise any trend in catchability mismatch between the catch and survey data. XSA and TSA runs were carried out to determine the population dynamics indicated by both the catch data alone and catch and survey data combined.

5.1.5.1 Separable VPA

A separable VPA (Lowestoft assessment suite) was run on the full catch at age dataset (years 1980-2003, ages 0-12+). This run used equal weighting of 1.0 on ages, and equal weighting of 1.0 on all years. Based on last year’s assessment terminal F (on age 4) was set to 0.35, and terminal S to 1.0. Log catch residuals were large for age ratio 9:10 upwards, (Figure 5.1.5.1), but increasing from ratio 8:9. This supported the use of a plus-group at age 8+, as in previous assessments. Residuals were also larger for the ratio 0:1 than for intermediate ages. Whiting at age zero are only partially recruited and subject to discarding in the human consumption fishery. Fish at this age are also a significant component of the industrial fisheries bycatch. Therefore, age 0 catch data were excluded from assessment runs.

5.1.5.2 Single-fleet Laurec-Shepherd

Single-fleet Laurec-Shepherd runs were carried out using each of IBTS Q1, ScoGFS, EngGFS (pre 1992), EngGFS (1992 and later) and FraGFS tuning fleets in turn. Time series of residuals were plotted to characterise any trend in catchability mismatch between the catch and survey data (Figure 5.1.5.2). The residuals show very definite trends from the ScoGFS, EngGFS (pre 1992) and especially from the FraGFS, and a trend is still evident in the IBTS Q1 plot. The only survey series not to show any trend in residuals is the EngGFS (1992 and later). Scatter plots of log survey index against log estimated numbers at age are shown in Figures 5.1.5.3 to 5.1.5.7. Good agreement would result in a regression line with high R^2 and positive slope.

With the exception of age 6, results for the EngGFS (1992 and later) were much better than those for EngGFS (pre 1992). Given the low R^2 values for the latter series it was decided not to include it in the assessment. Correlation between survey index and estimated catch numbers were also poor for the FraGFS, with the slope being negative for some ages. This was seen as further evidence that stock trends might be different in different parts of the North Sea. The results for the ScoGFS and IBTS Q1 surveys were considered reasonable and there is nothing within them to suggest these surveys should not be used as tuning surveys.

5.1.5.3 Extended Survivors Analysis (XSA)

Settings for the XSA runs performed are listed below:

Run	Surveys included	Plus group	shrinkage	mean F
run 1	3 surveys	Age 6	0.5	(2-4)
run 2	3 surveys	Age 6	2	(2-4)
run 3	3 surveys	Age 8	0.5	(2-4)
run 4	3 surveys	Age 8	0.5	(2-6)
run 5	3 surveys	Age 8	2	(2-6)
run 6	EngGFS	Age 8	2	(2-6)
run 7	ScoGFS	Age 8	2	(2-6)
run 8	IBTS Q1	Age 8	2	(2-6)

Run 1 uses the same settings as final XSA run from last year’s WG report. In this run, the plus group is ages 6 and above. This plus-group was chosen because the survey indices are truncated at age 6. However, this also meant reducing the mean F range from F (2-6) to F (2-4). Therefore runs using an 8 plus-group were performed for comparison with TSA analyses, and further runs were performed with weak shrinkage to allow the model to follow the trends in the data more closely. Single fleet runs for each of the survey indices, with an 8 plus-group, F (2-6) and weak shrinkage were also carried out.

These runs show very similar overall trends in SSB, mean F and recruitment (Figure 5.1.5.8), with the main differences occuring from 1998-2001, but generally converging again for 2003. Estimated SSB for 2003 is around or slightly below $\mathbf{B}_{lim}$, with an estimated mean F for 2003 of around 0.3. F (2-6) has decreased more rapidly in recent years than F (2-4), indicating that F on older ages is decreasing. Log catchability residuals for XSA run 5 (with 8 plus group and low shrinkage) indicate the models fit relatively well but show a trend for ScoGFS before 1995 (Figure 5.1.5.9). The retrospective plots for this run show large retrospective bias in mean F (Figure 5.1.5.10). Input settings, the tuning file, and relevant output for run 5 are given in Tables 5.1.5.1-5.1.5.5.

5.1.5.4 Time series Analysis (TSA)

A new version of the TSA was available for this year's assessment, in which catch data can be modelled with separate human consumption (landings and discards) and industrial bycatch components, and fishing mortality attributed to each component. Hereafter, we refer to this as the HCI model. The TSA runs performed are given below.

Run	Catch model	Surveys included
TSA run 1	total catch	no surveys
TSA run 2	total catch	EngGFS
TSA run 3	total catch	ScoGFS
TSA run 4	total catch	IBTS Q1
TSA run 4	total catch	EngGFS & ScoGFS & IBTS Q1
TSA run 6	HCI: separate industrial bycatch	no surveys
TSA run 7	HCI: separate industrial bycatch	EngGFS
TSA run 8	HCI: separate industrial bycatch	ScoGFS
TSA run 9	HCI: separate industrial bycatch	IBTS Q1
TSA run 10	HCI: separate industrial bycatch	EngGFS & ScoGFS
TSA run 11	HCI: separate industrial bycatch	EngGFS & IBTS Q1
TSA run 12	HCI: separate industrial bycatch	ScoGFS & IBTS Q1
TSA run 13	HCI: separate industrial bycatch	EngGFS & ScoGFS & IBTS Q1

Runs modelling total catch gave very similar results to the equivalent HCI runs (e.g. run 1 and run 4), and so, since the HCI model gives potential for greater insight into the individual fishing mortality components, this model was used for further analyses (i.e. runs 6-10). The results for these runs had generally similar trends, with the main differences between 1998 to 2003. The greatest difference in trend occurred between the run excluding survey data (run 6) and that including the EngGFS, ScoGFS and IBTS Q1 surveys (run 13). The stock summaries for these two runs are shown in Figure 5.1.5.11, with the 95% confidence intervals for run 13. They do not follow the catch data exactly, particularly in 1986 and 1990, where estimated discards are unusually high. Although the run using no surveys falls outside the confidence intervals of the three surveys run for the last few years, the general trend is of a declining stock with large fluctuations in mean F over the last few years.

The retrospective plots for TSA run 13 show high retrospective variance and positive bias (Figure 5.1.5.12). For SSB and recruitment, however, the bias seems that much less severe over the last three years. The settings and output files for this TSA run are given in Tables 5.1.5.6 – 5.1.5.11.

5.1.5.5 Comparison of analyses

SSB estimates from the catch-at-age analyses (XSA runs 4-8, and TSA runs 6-9 and 13), mean-standardised over 1992 to 2003, with empirical SSB estimate from the surveys superimposed, are shown in Figure 5.1.5.13. Although the trend of the estimates between 1998 to 2003 is similar, predicting a recent peak in SSB in about 2000, the discrepancy in overall trends between the catch-at-age analyses and the survey estimates is clear.

5.1.6 Indications of stock sub-structure

Whiting are known to aggregate in some localised areas, but for the most part have traditionally been caught as part of a mixed fishery operating throughout the entire year. Historically, adult whiting have been 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, suggest 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.

IBTS Q1 and Q3 survey data were used to investigate the possibility of using survey indices to identify stock structure within the North Sea. These spatial data were only available from 1996, so long-term changes in distribution could not be assessed. The ICES roundfish sampling areas within area IV are shown in Figure 1.3.1.

Figures 5.1.6.1 and 5.1.6.2 show maps of location and numbers caught at different ages for whiting from the IBTS Q1 and Q3 surveys respectively. These maps show relatively large numbers of age 1 fish caught between 1999 and 2002. The high catch rates occurred mainly off the UK coast, and remained high for ages 2 and 3+ in subsequent years. These high catch rates were not present in roundfish area 1 (northern North Sea), historically the most important area for landings.

IBTS Q1 indices for age 1 and approximate SSB indices for 1998-2004 were constructed for each of the ICES roundfish areas within the assessment region (Figures 5.1.6.3 and 5.1.6.4 respectively). These show that the majority of age 1 fish can be found off the UK coast in roundfish areas 3, 4 and 5. The general trends for age 1 fish are similar for all the roundfish areas, indicating a peak around 1999-2001, followed by a subsequent decrease. These are consistent with the empirical SSBs estimated for the whole area. The approximate SSB index shows that the main concentration of mature fish has contracted from areas 3 and 4 to area 4 only in recent years, so that the SSB in area 4 shows a large increase over these years. Elsewhere SSB indices show a peak around 2000-2001, and relatively low abundance since then.

Spatial distribution of landings

Total international landings by quarter for each roundfish area (tonnage and percentage) for 2000-2003 have been calculated using the database compiled by the EU-Norway Expert Group on Cod Assessment and Technical Measures, Brussels, 2003 (Table 5.1.6.1). It is clear that roundfish area 1 is the most important area, although it has become less important over these years, whilst area 6 is becoming more important. Strong seasonal trends in landings are also apparent in roundfish areas 4, 5 and 6.

Total landings by ICES rectangle for most of the countries involved in the whiting fishery (UK, Netherlands and Denmark but not France) were also available for 1996-2002. Figure 5.1.6.5 shows the distribution of landings in 2002 from all these countries combined. The majority of the catches are caught in the eastern North Sea, in three distinct areas, in the northern North Sea (area 1), off the northern English coast, and in the south (across the boundary between Sub-area IV and Division VIId). Figure 5.1.6.6 shows the landings aggregated over roundfish area for 1996-2002. These show that roundfish area 1 is still the most important area, despite decreasing landings from this area, but area 6, where landings are increasing slightly, is increasing in overall importance. Landings from VIId have remained relatively constant since 1980, so this area is also increasing in importance because overall landings are declining (Figure 5.1.4.2).

Comparison

In summary, surveys indicate roundfish areas 3, 4 and 5 are currently the most important areas for the North Sea whiting stock, although historically this may not have been the case. The important area for the fishery is still roundfish area 1.

The Working Group has proposed that a Study Group should be set up to investigate the issue of North Sea stock sub-structure for whiting, including data on Division VIId (see Section 1.8.1).

5.1.7 Conclusion

The trends in the research survey indices for the whole of the North Sea (IBTS Q1, ENGGFS and SCOGFS) are consistent over the last 10 years, indicating a peak around 2000 with a possible subsequent decline. The spatial distributions obtained from IBTS Q1 and Q3 surveys indicate that whiting ages 1 and 2 mainly occur in roundfish areas 3, 4 and 5, and ages 3-5 are concentrated in area 4. There is evidence of different trends in these areas, with substantial increasing trends in area 4 for older fish since 1998. The FRAGFS survey index for Division VIId has different trends to the North Sea surveys. Thus there is evidence of different stock trends and age-structure in different areas of the North Sea.

The FraGFS index and the status of the stock in Division VIId should be investigated further in the proposed Study Group on whiting stock sub-structure (see Section 1.8.1).

The catch at age analyses are driven mainly by the catch data, and whilst the changes in SSB apparent in recent survey indices are reflected in the recent catch, the overall pattern is of a declining stock. This is because total catch in area IV has been steadily decreasing since 1980, the small increase in the late 1990s being mainly due to discarding and industrial bycatch of the 1998 year class. The decrease is mainly due to a large decline in Scottish (and also English) landings – landings from other countries have remained relatively constant. The Scottish landings are mainly taken from the northern North Sea, in roundfish areas 1 and 3, whilst landings from other countries are mainly taken from the south, in areas 4-6.

At least some of this decline in catch could be due to changes in fishing patterns or demand rather than reduced availability. Furthermore, Scottish discard ogives have been applied to the total international landings. Whilst this may have been appropriate when Scottish landings accounted for a large proportion of the international landings, it is much less appropriate for recent years. Discarding patterns in Divisions IVb, IVc and VIId, which now account for a large proportion of the total landings, are likely to be very different to those in area IVa, due to different fishing methods and different stock structure.

Thus the WG concludes that the catch data, as currently aggregated, does not reflect the stock structure of whiting in the North Sea, and therefore catch at age analyses are inappropriate. Survey data are subject to these same aggregation problems and therefore a survey-based assessment is also inappropriate. Hence the WG cannot propose a final assessment for this stock.

5.1.8 Final Assessment

There is no final assessment.

5.1.9 Recruitment estimates

There are no recruitment estimates for 2004 to 2006.

5.1.10 Short term forecasts

There are no short-term forecasts.

5.1.11 Comments

Quality of assessment

Previous meetings of this WG have concluded that the survey data and commercial catch data contain varying signals concerning the stock. Analyses at this WG suggest the differences could be due to spatial structure within the stock. Until this is addressed, an adequate assessment is unlikely. These problems were noted in the ACFM Technical Minutes last year.

An appropriate time series of discard data suitable for use in catch-at-age analysis was available only for Scottish catches. For assessment purposes, discards for other human consumption fleets are estimated by extrapolation from Scottish data. However the Scottish fleets now account for only about 50% of human consumption landings, and other fleets are likely to have different discarding patterns. Data are also collected by other countries, but were not made available to data collators in time for the Working Group.

Fisher's North Sea Stock Survey

The fishermen's surveys (Figure 5.1.11.1) indicate a decrease in stock in the northwest North Sea (roundfish areas 1 and 3), with little change in the northeast, roundfish areas 2, 7, 8 and 9, but increases in stock in the south (roundfish areas 4 and 6). These results are in accordance with the general trends in SSB in these areas from the IBTS Q1 survey (Figure 5.1.5.4).

Management considerations

Surveys indicate increasing or relatively stable stock from the mid 1980s, with a peak around 2000 followed by a subsequent decline in SSB. In contrast, catch-at-age analyses imply a longer-term decline. There are indications that this conflict may be caused by the changing spatial distribution of the stock.

5.2 Whiting in Division IIIa

Total landings are shown in Table 5.2.1.

No analytical assessment of this stock was possible.

Table 5.1.1.1 Nominal landings (in tonnes) of Whiting in Sub-area IV and Division VIId, as officially reported to ICES.

Sub-area IV

Country	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Belgium	1,030	944	1,042	880	843	391	268	529	536	454	270	246*
Denmark	1,377	1,418	549	368	189	103	46	58	105	105	96	89
Faroe Islands	16	7	2	21	-	6	1	1	-	-	-	
France	5,071	5,502	4,735	5,963	4,704	3,526	1,908*	4,292*[1]	2,527	3,455	3,314	2,414
Germany, Fed.Rep.	511	441	239	124	187	196	103	176	424	402	354	334
Netherlands	5,390	4,799	3,864	3,640	3,388	2,539	1,941	1,795	1,884	2,478[2]	2,425	1,442*
Norway	232	130	79	115	66	75	65	68	33	44	41*	39*
Poland	-	-	-	-	-	-	1	-	-	-	-	-*
Sweden	22	18	10	1	1	1	+	9	4	6	7	10
UK (E.&W)[3]	2,528	2,774	2,722	2,477	2,329	2,638	2,909	2,268	1,782	1,301	1,322	680
UK (Scotland)	30,821	31,268	28,974	27,811	23,409	22,098	16,696	17,206	17,158	10,589	7,756	5,734
United Kingdom												
Total	46,998	47,301	42,216	41,400	35,116	31,573	23,938	26,402	24,453	18,834	15,585	10,988
Unallocated landings	-554	680	401	-348	1,006	-276	-72	-421	-412	592	331	-329
WG estimate of H.Cons. landings	46,444	47,981	42,617	41,052	36,122	31,297	23,866	25,981	24,041	19,412	15,916	10,659
WG estimate of discards	30,615	42,871	33,010	30,264	28,181	17,217	12,708	23,584	23,214	16,488	17,509	24,093
WG estimate of Ind. By-catch	26,901	20,099	10,354	26,561	4,702	5,965	3,141	5,183	8,886	7,357	7,327	2,743
WG estimate of total catch	103,960	110,951	85,981	97,877	69,005	54,479	39,715	54,748	56,609	43,258	40,752	37,496

*Preliminary: year 2001, France 1998–1999.
[1]Includes Division IIa (EC).
[2]Not included here are 68 t reported into an unknown area.
[3]1989-1994 revised. N. Ireland included with England and Wales.

Division VIId

Country	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Belgium	66	74	61	68	84	98	53	48	65	75	58	67*
France	5,414	5,032	6,734	5,202	4,771	4,532	4,495*	-	5,875	6,338	5,172	6,478
Netherlands	-	-	-	-	1	1	32	6	14	67	19	175*
UK (E.&W)	419	321	293	280	199	147	185	135	118	134	112	109
UK (Scotland)	24	2	-	1	1	1	+	-	-	-	-	-
United Kingdom												
Total	5,923	5,429	7,088	5,551	5,056	4,779	4,765	189	6,072	6,614	5,361	6,829
Unallocated	-178	-214	-463	-161	-104	-156	-167	4,242	-1,775	-810	439	-1,117
W.G. estimate	5,745	5,215	6,625	5,390	4,952	4,623	4,598	4,431	4,297	5,804	5,800	5,712

*Preliminary.

Sub-area IV and Division VIId

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
W.G. estimate	109,705	116,166	92,606	103,267	73,957	59,102	44,313	59,179	59,587	49,062	46,552	43,208

Annual TAC for Subarea IV and Division IIa

	2000	2001	2002	2003
TAC	29,700	32,358	16,000	16,000

Table 5.1.2.1 Whiting in IV and VIId. Annual weight and numbers caught, years 1980–2003, ages 0–12+.

Year	Weight (thousand tonnes)				Numbers (millions)			
	Total	**H. cons.**	**Disc.**	**Ind. BC**	**Total**	**H. cons.**	**Disc.**	**Ind. BC**
1980	224	101	77	46	1456	340	471	645
1981	192	90	36	67	1439	296	214	929
1982	140	81	27	33	778	271	173	333
1983	161	88	50	24	1358	290	370	697
1984	146	86	41	19	909	285	327	297
1985	106	62	29	15	688	176	231	280
1986	162	64	80	18	1207	225	583	399
1987	139	68	54	16	946	245	416	285
1988	133	56	28	49	1395	212	231	952
1989	124	45	36	43	883	172	280	431
1990	153	47	56	51	1294	177	539	578
1991	125	53	34	38	1611	199	242	1170
1992	110	52	31	27	863	182	216	465
1993	116	53	43	20	1231	174	343	714
1994	93	49	33	10	702	162	235	304
1995	103	46	30	27	2020	147	214	1659
1996	74	41	28	5	448	143	177	128
1997	59	36	17	6	293	131	101	61
1998	44	28	13	3	290	110	83	97
1999	59	30	24	5	456	117	179	160
2000	61	29	23	9	311	114	142	55
2001	49	25	16	7	498	102	114	282
2002	46	22	17	7	377	77	96	205
2003	43	16	24	3	351	57	210	84
Min	43	16	13	3	290	57	83	55
GM	100	48	32	16	775	168	226	326
AM	111	53	35	23	908	184	258	467
Max	224	101	80	67	2020	340	583	1659

Table 5.1.2.2 Whiting in VIId. Annual weight and numbers caught, year 1980–2003, ages 0–12+.

Year	**Weight (tonnes)**	**Numbers (thousands)**
1980	9167	35509
1981	8932	34279
1982	7911	32952
1983	6936	29470
1984	7373	33413
1985	7390	19561
1986	5498	21143
1987	4671	18208
1988	4428	17922
1989	4156	16869
1990	3483	13648
1991	5718	17884
1992	5745	19398
1993	5215	17842
1994	6625	24049
1995	5390	18492
1996	4952	22360
1997	4623	22556
1998	4598	23047
1999	4431	18867
2000	4297	22087
2001	5804	28560
2002	5800	19697
2003	5712	22821
Min	3483	13648
GM	5611	22221
AM	5786	22943
Max	9167	35509

Table 5.1.2.3 Whiting in IV and VIId. Total catch numbers at age (thousands).

Age	1980	1981	1982	1983	1984	1985	1986	1987
1	265359	162899	192640	205646	323408	203321	576731	267051
2	416008	346343	114444	184746	175965	141716	167077	368229
3	286077	266517	245246	118412	124886	82037	169577	122748
4	90718	102295	88137	131508	49505	37847	46517	85240
5	52969	27776	26796	37231	59817	14420	13367	11392
6	10751	12297	6909	8688	13860	17445	3487	4556
7	1152	3540	2082	1780	2964	3328	3975	928
8+	767	326	484	930	613	904	569	1035

Age	1988	1989	1990	1991	1992	1993	1994	1995
1	430344	331672	253745	128507	239792	217539	163609	137481
2	307429	173676	505010	191193	165354	167577	147177	139010
3	179502	191942	129126	187195	89563	124287	90611	111489
4	39635	78464	86324	36830	93636	46543	47533	35728
5	17901	14367	32270	26209	11967	46136	17384	15161
6	2175	5050	2003	5519	6878	3946	17264	5159
7	544	516	735	542	2609	1519	998	4515
8+	168	334	112	273	117	771	460	474

Age	1996	1997	1998	1999	2000	2001	2002	2003
1	72645	53408	71430	178079	66789	84121	49857	72709
2	113956	74200	44697	91355	124365	86178	61239	104040
3	98476	82944	42771	45627	63526	58908	82940	53560
4	48575	42154	36459	34175	23888	20559	34006	42048
5	14235	18492	17756	18528	16232	9177	8007	14305
6	4695	3358	6392	7547	8791	4814	2043	2372
7	1294	1020	1426	2049	4322	2232	1457	474
8+	1113	460	407	676	1265	1268		

Table 5.1.2.4 Whiting in IV and VIId. Human consumption landings numbers at age (thousands).

Age	1980	1981	1982	1983	1984	1985	1986	1987
1	3656	4240	10890	10568	14388	2288	12879	11074
2	62405	69211	46703	68640	62693	51194	44500	72372
3	152570	104348	124656	67312	99204	57049	111527	70504
4	68422	78253	59393	101342	41277	32340	37287	73742
5	41430	23698	21376	31266	51745	12974	11285	10808
6	9911	12036	5664	8330	12735	16361	3379	4506
7	1135	3530	2058	1730	2813	3238	3912	928
8+	767	326	484	921	613	904	557	1004

Age	1988	1989	1990	1991	1992	1993	1994	1995
1	7462	8636	6949	11610	9603	5980	17126	8832
2	61360	28406	54361	43110	45154	29305	31660	28132
3	94163	77009	45423	91129	48838	64353	46217	58538
4	29147	44307	50603	26169	60806	33514	36814	28013
5	16556	9249	17747	21697	9956	34651	14169	13767
6	2158	3888	1407	4687	6223	2989	14706	4953
7	544	420	622	405	1496	1361	928	4401
8+	164	249	110	273	110	771	446	467

Age	1996	1997	1998	1999	2000	2001	2002	2003
1	12516	6522	17081	16689	15406	12257	2606	403
2	26768	23543	19894	26966	31989	28499	10343	11610
3	47593	48237	25016	25863	28500	27332	30858	13991
4	36288	31904	24713	23792	14327	17518	22328	18981
5	12023	15824	14717	14708	11841	8640	6703	9515
6	4453	2957	5446	6660	6657	4506	1710	1862
7	1116	1017	1213	1882	3774	2092	1329	444
8+	1113	443	301	591	1159	1249		

Table 5.1.2.5 Whiting in IV and VIId. Discard numbers at age (thousands).

Age	1980	1981	1982	1983	1984	1985	1986	1987
1	103203	50407	53753	152488	200589	154232	404604	158531
2	250735	96509	26922	85318	82563	48791	120492	202154
3	88399	57403	52349	33325	16815	15117	43479	34824
4	14135	7313	18230	23442	4437	2985	5242	9776
5	10795	1285	2972	4309	4495	761	627	582
6	786	149	343	295	1034	801	108	49
7	0	10	22	25	151	65	63	0
8+	0	0	0	9	0	0	12	31

Age	1988	1989	1990	1991	1992	1993	1994	1995
1	65021	150598	79488	76938	98967	124426	77783	46209
2	87197	36712	245129	77383	57629	101119	97847	77320
3	51135	61442	33194	74005	26527	49064	36762	48601
4	5877	21267	23488	4900	22976	8992	9528	6943
5	846	3276	12012	1828	1199	10709	2856	1318
6	17	103	253	89	350	519	2337	205
7	0	8	87	60	1064	131	7	113
8+	3	12	0	0	2	0	0	6

Age	1996	1997	1998	1999	2000	2001	2002	2003
1	30480	19347	29979	84613	33848	27570	8670	54781
2	82020	28837	18755	51740	75869	44645	31959	87376
3	48240	30616	16361	14422	23590	21930	43444	36989
4	11319	9175	10992	8844	2898	2528	9491	21853
5	2192	2392	2976	3077	2257	385	1099	4401
6	240	399	935	857	1548	268	211	461
7	179	2	213	166	474	140	128	31
8+	0	17	106	85	107	19		

Table 5.1.2.6 Whiting in IV and VIId. Industrial bycatch numbers at age (thousands).

Age	1980	1981	1982	1983	1984	1985	1986	1987
1	158500	108252	127998	42591	108431	46801	159249	97446
2	102869	180623	40818	30789	30709	41731	2086	93704
3	45108	104767	68242	17775	8868	9871	14572	17420
4	8162	16729	10514	6723	3790	2522	3987	1722
5	744	2793	2448	1656	3577	685	1456	2
6	55	112	902	63	91	284	0	0
7	18	0	2	25	0	26	0	0
8+	0	0	0	0	0	0	0	0

Age	1988	1989	1990	1991	1992	1993	1994	1995
1	357861	172438	167308	39959	131221	87133	68701	82439
2	158872	108558	205521	70701	62571	37153	17670	33558
3	34205	53491	50508	22062	14198	10870	7632	4351
4	4611	12890	12233	5761	9855	4037	1192	772
5	500	1842	2511	2684	812	776	359	76
6	0	1060	342	743	305	437	222	0
7	0	89	26	78	49	27	64	0
8+	0	72	2	0	6	0	14	0

Age	1996	1997	1998	1999	2000	2001	2002	2003
1	29648	27539	24370	76777	17535	44294	38580	17525
2	5168	21820	6047	12649	16508	13034	18937	5054
3	2643	4091	1395	5342	11436	9646	8638	2580
4	968	1075	754	1539	6663	513	2186	1214
5	21	276	63	743	2134	152	205	391
6	2	2	12	30	586	40	122	49
7	0	0	0	0	74	0	0	0
8+	0	0	0	0	0	0	0	0

Table 5.1.2.7 Whiting in IV and VIId. Total catch mean weights at age (kg).

Age	1980	1981	1982	1983	1984	1985	1986	1987
1	0.075	0.083	0.061	0.107	0.089	0.094	0.105	0.077
2	0.176	0.168	0.184	0.191	0.188	0.192	0.183	0.148
3	0.252	0.242	0.253	0.273	0.271	0.284	0.255	0.247
4	0.328	0.321	0.314	0.325	0.337	0.332	0.318	0.297
5	0.337	0.379	0.376	0.384	0.382	0.402	0.378	0.375
6	0.458	0.411	0.478	0.426	0.391	0.435	0.475	0.379
7	0.458	0.444	0.504	0.452	0.463	0.494	0.468	0.542
8+	0.572	0.72	0.735	0.537	0.567	0.439	0.625	0.584

Age	1988	1989	1990	1991	1992	1993	1994	1995
1	0.054	0.07	0.083	0.103	0.082	0.073	0.08	0.087
2	0.146	0.157	0.137	0.169	0.185	0.175	0.17	0.181
3	0.223	0.225	0.209	0.218	0.257	0.252	0.254	0.258
4	0.301	0.267	0.25	0.29	0.277	0.319	0.323	0.341
5	0.346	0.318	0.279	0.307	0.332	0.329	0.371	0.385
6	0.423	0.391	0.408	0.338	0.346	0.349	0.367	0.43
7	0.506	0.431	0.49	0.365	0.314	0.403	0.414	0.434
8+	0.694	0.394	0.599	0.401	0.503	0.381	0.416	0.42

Age	1996	1997	1998	1999	2000	2001	2002	2003
1	0.093	0.091	0.091	0.076	0.113	0.072	0.067	0.053
2	0.167	0.178	0.18	0.174	0.182	0.191	0.156	0.114
3	0.236	0.243	0.236	0.233	0.238	0.227	0.222	0.195
4	0.302	0.295	0.281	0.256	0.288	0.283	0.281	0.260
5	0.387	0.333	0.314	0.289	0.287	0.270	0.314	0.298
6	0.406	0.381	0.339	0.303	0.277	0.300	0.360	0.352
7	0.428	0.381	0.33	0.309	0.277	0.287	0.357	0.383
8+	0.43	0.418	0.367	0.287	0.273	0.294		

Table 5.1.2.8 Whiting in IV and VIId. Human consumption landings mean weights at age (kg).

Age	1980	1981	1982	1983	1984	1985	1986	1987
1	0.2038	0.1942	0.1863	0.1990	0.1942	0.1870	0.1886	0.1885
2	0.2391	0.2420	0.2304	0.2396	0.2310	0.2475	0.2297	0.2256
3	0.2733	0.2915	0.2818	0.2825	0.2788	0.3069	0.2788	0.2856
4	0.3351	0.3308	0.3398	0.3317	0.3459	0.3370	0.3271	0.3096
5	0.3580	0.3776	0.3961	0.3829	0.3912	0.4081	0.3760	0.3811
6	0.4733	0.4114	0.4606	0.4290	0.4035	0.4428	0.4837	0.3808
7	0.4566	0.4449	0.5066	0.4522	0.4725	0.4983	0.4725	0.5422
8+	0.5718	0.7198	0.7355	0.5384	0.5674	0.4385	0.6323	0.5928

Age	1988	1989	1990	1991	1992	1993	1994	1995
1	0.1941	0.1783	0.2013	0.2040	0.1954	0.1952	0.1836	0.1718
2	0.2262	0.2260	0.2198	0.2496	0.2479	0.2509	0.2497	0.2554
3	0.2559	0.2528	0.2600	0.2518	0.2903	0.2866	0.2974	0.2981
4	0.3276	0.2878	0.2921	0.3086	0.3068	0.3476	0.3454	0.3670
5	0.3515	0.3448	0.3349	0.3182	0.3425	0.3591	0.3927	0.3977
6	0.4248	0.3700	0.4493	0.3493	0.3577	0.3877	0.3823	0.4373
7	0.5064	0.4397	0.5225	0.3878	0.3828	0.4218	0.4128	0.4369
8+	0.7017	0.4050	0.6012	0.4013	0.5027	0.3804	0.4117	0.4217

Age	1996	1997	1998	1999	2000	2001	2002	2003
1	0.1700	0.1715	0.1642	0.1840	0.1659	0.1600	0.199	0.209
2	0.2220	0.2067	0.2090	0.2365	0.2264	0.2168	0.223	0.239
3	0.2743	0.2607	0.2592	0.2702	0.2714	0.2682	0.269	0.263
4	0.3280	0.3140	0.3041	0.2801	0.3001	0.2857	0.304	0.309
5	0.4067	0.3476	0.3299	0.3024	0.2924	0.2692	0.325	0.310
6	0.4133	0.3977	0.3596	0.3139	0.3153	0.3033	0.376	0.373
7	0.4484	0.3807	0.3444	0.3175	0.2781	0.2909	0.365	0.389
8+	0.4302	0.4205	0.4237	0.2951	0.2737	0.2944		

Table 5.1.2.9 Whiting in IV and VIId. Discard mean weights at age (kg).

Age	1980	1981	1982	1983	1984	1985	1986	1987
1	0.1070	0.1310	0.0910	0.1140	0.1010	0.1050	0.1230	0.0900
2	0.1660	0.1640	0.1820	0.1670	0.1620	0.1690	0.1660	0.1490
3	0.2020	0.1970	0.2110	0.2350	0.2160	0.2130	0.1900	0.2060
4	0.2440	0.2300	0.2250	0.2640	0.2460	0.2380	0.2080	0.2050
5	0.2530	0.2890	0.2410	0.2900	0.2650	0.2420	0.2270	0.2630
6	0.2640	0.2520	0.2440	0.3170	0.2480	0.2530	0.1940	0.2570
7	0.0000	0.2680	0.2610	0.2770	0.2780	0.2550	0.2170	0.0000
8+	0.0000	0.0000	0.0000	0.3650	0.0000	0.0000	0.3110	0.2920

Age	1988	1989	1990	1991	1992	1993	1994	1995
1	0.0630	0.0830	0.0950	0.0890	0.0930	0.0870	0.0900	0.1020
2	0.1460	0.1640	0.1300	0.1540	0.1730	0.1600	0.1510	0.1630
3	0.1810	0.1910	0.1830	0.1770	0.2100	0.2050	0.2030	0.2040
4	0.2100	0.2130	0.1860	0.2130	0.2150	0.2370	0.2300	0.2330
5	0.2190	0.2270	0.1960	0.2300	0.2410	0.2350	0.2440	0.2470
6	0.2350	0.2410	0.2490	0.2530	0.2450	0.2250	0.2540	0.2470
7	0.0000	0.3510	0.3020	0.2680	0.2200	0.2130	0.3320	0.3320
8+	0.2840	0.2210	0.0000	0.0000	1.1830	0.0000	0.0000	0.2900

Age	1996	1997	1998	1999	2000	2001	2002	2003
1	0.0940	0.1250	0.0860	0.1000	0.1272	0.0844	0.130	0.057
2	0.1510	0.1810	0.1730	0.1660	0.1669	0.1828	0.167	0.098
3	0.1980	0.2130	0.2040	0.1970	0.1946	0.2169	0.196	0.169
4	0.2250	0.2250	0.2280	0.2010	0.2262	0.2591	0.224	0.215
5	0.2810	0.2330	0.2340	0.2250	0.2086	0.2482	0.224	0.262
6	0.2650	0.2560	0.2240	0.2310	0.2191	0.2398	0.225	0.257
7	0.3040	0.6170	0.2470	0.2120	0.2223	0.2249	0.272	0.293
8+	0.0000	0.3523	0.2063	0.2266	0.2640	0.2425		

Table 5.1.2.10 Whiting in IV and VIId. Industrial bycatch mean weights at age (kg).

Age	1980	1981	1982	1983	1984	1985	1986	1987
1	0.0510	0.0560	0.0380	0.0580	0.0530	0.0540	0.0540	0.0430
2	0.1640	0.1410	0.1330	0.1480	0.1730	0.1500	0.1500	0.0850
3	0.2810	0.2180	0.2320	0.3110	0.2890	0.2630	0.2620	0.1730
4	0.4120	0.3180	0.3200	0.4310	0.3430	0.3820	0.3810	0.2620
5	0.3800	0.4330	0.3660	0.6510	0.3900	0.4540	0.4550	0.4000
6	0.3890	0.5960	0.6740	0.5650	0.2280	0.5040	0.5000	0.5000
7	0.5610	0.6000	0.2840	0.6020	0.6000	0.5840	0.6000	0.6000
8+	1.0000	0.8000	0.8400	0.8023	0.8959	0.8091	0.8000	0.8216

Age	1988	1989	1990	1991	1992	1993	1994	1995
1	0.0500	0.0530	0.0730	0.1010	0.0660	0.0440	0.0420	0.0690
2	0.1150	0.1370	0.1230	0.1360	0.1500	0.1550	0.1320	0.1590
3	0.1970	0.2240	0.1810	0.2130	0.2280	0.2590	0.2420	0.3100
4	0.2450	0.2850	0.1990	0.2690	0.2420	0.2640	0.3740	0.3730
5	0.3800	0.3440	0.2800	0.2650	0.3350	0.3080	0.5210	0.5110
6	0.5000	0.4820	0.3550	0.2790	0.2190	0.2350	0.5550	0.0000
7	0.6000	0.3960	0.3350	0.3220	0.2550	0.3920	0.4400	0.0000
8+	0.8000	0.3854	0.4730	0.0000	0.2820	0.0000	0.5550	0.0000

Age	1996	1997	1998	1999	2000	2001	2002	2003
1	0.0590	0.0480	0.0450	0.0270	0.0410	0.0402	0.044	0.035
2	0.1430	0.1440	0.1050	0.0770	0.1640	0.1643	0.101	0.101
3	0.2350	0.2500	0.2000	0.1460	0.2420	0.1323	0.184	0.189
4	0.2330	0.3210	0.3040	0.1960	0.2890	0.3200	0.293	0.302
5	0.3470	0.3480	0.2860	0.2860	0.3390	0.3510	0.415	0.418
6	0.2500	0.5880	0.0000	0.0000	0.0000	0.3860	0.38	0.462
7	0.0000	0.0000	0.0000	0.0000	0.5880	0.0000	0.0	0.0
8+	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.0

Table 5.1.2.11 Whiting in IV and VIId. Natural mortality and proportion mature by age.

Age	Natural mortality	Maturity
1	0.95	0.11
2	0.45	0.92
3	0.35	1.00
4	0.30	1.00
5	0.25	1.00
6	0.25	1.00
7	0.20	1.00
8+	0.20	1.00

Table 5.1.2.12 Whiting in IV and VIId. Summary of available tuning series.

Country	Fleet	Code	Year range	Age Range
Scotland	Groundfish survey	SCOGFS	1982–2004	0-6
	Seiners	SCOSEI	1978–2003	0–10
	Light trawlers	SCOLTR	1978–2003	0–10
England	Groundfish survey	ENGGFS	1977–2003	0-6
France	Trawlers	FRATRB	1978–2002	1–9
		FRATRO_IV	1986–2003	0-8
		FRATRO-7d	1986-2003	1-7
		FRAGFS-7d	1988–2003	0-3
International	Groundfish survey[1]	IBTS_QI	1967–2004	1-6[4]
	Q II survey[2]	IBTS_Q2_SCO	1991–1997	1-6
	Q IV survey[3]	IBTS_Q4-ENG	1991–1996	0-7

[1]Formerly IYFS.
[2] Scottish sub-set of IBTS data – discontinued in 1997.
[3] English sub-set of IBTS data – discontinued in 1996.
[4]Age 6 is a plus group

Table 5.1.2.13 Whiting in IV and VIId. Complete available tuning series. Numbers in bold show the data used in catch at age analyses.

SCOSEI_IV											
1978	2003										
1	1	0	1								
0	10										
325246.00	5345.92	14993.60	29307.94	43710.81	15390.20	1057.94	1408.92	200.99	36.00	0.00	7.00
316419.00	302.00	90749.85	41091.74	28124.23	14745.01	6083.68	676.92	155.75	3.00	0.00	0.00
297227.00	668.98	27032.33	73704.44	37657.65	11914.98	9367.98	2556.00	260.00	229.00	27.00	7.00
289672.00	93.00	8726.79	22243.64	25047.81	10551.99	2402.00	2084.00	374.00	41.00	4.00	1.00
297730.00	43.00	3720.99	7032.00	26194.14	13117.11	2713.03	539.01	277.00	81.00	5.00	0.00
333168.00	572.01	11565.39	14957.38	21690.02	34199.11	9830.62	2154.56	406.80	157.78	16.26	0.00
388035.00	296.72	4922.50	24015.61	20669.76	14985.59	21269.32	4715.24	959.96	87.28	49.59	6.94
381647.00	773.22	20067.84	20263.32	19695.99	8956.38	4795.86	8013.08	1362.79	333.95	17.89	5.96
425017.00	137.76	139498.17	48705.18	34509.26	11340.96	2624.40	1097.50	1771.08	215.94	7.27	0.00
418536.00	1358.85	13793.33	52715.14	38938.77	18440.26	3637.71	1096.91	297.74	348.42	15.88	3.97
377132.00	26.01	2502.07	28446.11	44869.26	12631.40	4071.61	678.72	63.97	20.99	16.99	2.00
355735.00	10.13	6878.80	15704.13	41407.43	23710.40	4769.04	1323.23	112.08	43.04	10.72	0.71
252732.00	184.88	14229.83	124635.82	27694.11	29920.98	14767.80	720.82	206.52	23.23	0.02	0.00
336675.00	886.65	11951.95	44964.26	63414.28	10436.10	8730.12	1742.93	195.19	93.63	0.00	0.25
300217.00	426.21	16613.69	19452.01	21217.15	27961.87	2804.54	1958.07	564.87	32.42	3.39	0.00
268413.00	599.77	9563.69	31623.36	26012.82	12457.88	14446.11	899.25	332.18	153.13	7.51	8.25
264738.00	82.71	9235.94	21451.65	22570.72	11778.49	5530.94	5611.98	203.91	115.77	14.69	0.00
204545.00	26.01	8287.88	22152.73	30006.96	9018.67	3874.63	1373.44	1270.02	86.01	14.99	18.13
177092.00	223.90	5732.24	26020.51	21430.22	10505.52	3483.37	1031.27	295.71	289.16	28.12	1.00
166817.00	175.60	6627.68	8974.45	16231.23	9922.01	4445.23	575.33	109.85	61.63	37.34	2.35
150361.00	14.45	3710.69	4694.83	6806.23	6840.32	3669.55	1417.13	243.74	12.81	1.89	12.27
93796.00	663.34	13384.17	13750.43	7009.42	6068.11	3461.79	1684.05	409.19	77.42	3.15	0.00
69505.00	2.79	5176.09	11207.84	6458.23	2111.81	1971.96	835.64	297.65	89.60	6.92	0.04
36135.00	929.75	606.97	6352.27	5592.05	1715.36	485.81	352.94	145.84	65.57	10.54	0.00
21830.00	1.94	1017.01	3348.65	7715.86	2181.93	363.15	139.67	78.78	23.47	5.90	0.00
15371.00	5.07	387.66	1088.55	2514.00	2980.16	1045.83	256.33	30.10	16.93	5.08	1.13

Table 5.1.2.13 contd. Whiting in IV and VIId. Complete available tuning series. Numbers in bold show the data used in catch at age analyses.

SCOLTR_IV											
1978	2003										
1	1	0	1								
0	10										
236944.00	7158.39	8785.46	19909.95	30722.31	14472.60	956.04	1612.07	635.03	72.00	6.00	0.00
287494.00	368.00	171147.28	42910.40	23154.59	17995.66	4057.93	376.99	286.00	57.00	5.00	0.00
333197.00	869.00	20805.96	58381.99	38436.16	9525.06	9430.05	1864.01	144.00	145.00	3.00	0.00
251504.00	170.99	6576.46	19069.21	21549.75	9706.15	1777.02	1455.03	310.01	9.00	1.00	0.00
250870.00	6390.16	5214.10	8196.98	26680.54	12944.74	3333.92	646.98	338.99	74.00	16.00	3.00
244349.00	20191.06	37495.68	17925.87	12535.31	19234.31	6123.52	1216.61	182.80	140.85	25.97	1.00
240775.00	2553.17	38266.77	16048.09	10784.18	6306.82	9018.98	2371.19	478.59	13.13	30.29	5.05
267393.00	1221.65	28760.94	9368.37	7616.93	3085.79	1333.19	2901.19	443.13	173.09	13.85	0.00
279727.00	796.71	8138.43	8571.90	9577.94	4108.82	767.44	425.28	608.60	51.64	2.03	0.00
351131.00	599.52	18761.18	25933.34	16160.77	5954.48	1182.95	388.46	116.04	128.99	3.93	0.00
391988.00	60.00	2397.96	15778.77	22525.54	5127.73	1640.63	207.22	31.03	15.02	6.01	6.01
405883.00	491.80	20318.75	10051.62	21389.72	10836.81	2394.09	448.22	33.08	54.36	2.39	0.61
371493.00	371.48	3676.88	35321.99	7664.57	8960.09	3423.01	159.54	39.94	5.34	0.07	0.00
408056.00	688.42	8726.88	11908.03	22145.62	3192.25	2906.40	628.63	49.90	40.87	0.45	0.25
473955.00	1379.23	17580.58	14551.32	11822.72	15417.66	1500.40	1160.44	304.40	12.75	0.34	0.66
447064.00	614.45	16438.91	20513.15	14385.55	6590.76	10105.47	574.20	203.58	97.35	24.36	4.59
480400.00	1259.30	4132.65	15771.00	13004.65	6453.76	2710.23	2997.31	171.83	83.94	13.86	0.00
442010.00	208.07	9248.04	15886.83	19322.30	6261.60	2982.51	1092.21	1131.71	88.83	3.48	14.19
445995.00	188.32	6661.92	12461.08	13523.11	9223.33	3012.11	860.73	281.91	242.80	8.93	0.54
479449.00	100.18	2557.22	6767.92	15603.23	9463.72	4535.19	628.02	181.35	51.94	30.82	0.31
427868.00	39.44	5096.42	5350.24	8058.40	9506.50	4311.78	1728.79	275.71	57.74	12.20	2.67
329750.00	1274.23	26518.76	20672.07	9295.36	6705.67	4079.53	2051.46	487.24	40.79	7.35	0.10
280938.00	1.15	8384.66	16220.42	9287.05	3788.38	2621.24	1469.79	601.84	79.39	7.11	0.17
245489.00	2221.71	1303.16	11409.11	10419.00	3287.13	745.34	430.51	247.31	65.76	26.77	0.00
184099.00	5.78	979.77	4652.75	11067.22	3686.10	817.98	221.33	179.72	60.26	13.00	0.00
98721.00	12.51	871.43	1639.36	3985.89	5135.98	2079.84	286.25	73.38	59.19	7.07	4.84

Table 5.1.2.13 contd. Whiting in IV and VIId. Complete available tuning series. Numbers in bold show the data used in catch at age analyses.

FRATRB_IV

1978	2001								
1	1	0	1						
1	9								
69739	1153.00	10312.00	14789.00	8544.00	807.00	1091.00	227.00	34.00	4.00
89974	698.00	12272.00	14379.00	10884.00	3789.00	394.00	315.00	45.00	14.00
63577	90.00	5388.00	11298.00	4605.00	4051.00	1004.00	78.00	71.00	10.00
76517	144.00	6591.00	13139.00	8196.00	2090.00	1644.00	314.00	16.00	10.00
78523	173.00	1643.00	16561.00	11241.00	3948.00	1035.00	539.00	119.00	14.00
69720	500.00	4407.00	8188.00	16698.00	5541.00	1061.00	228.00	126.00	19.00
76149	317.00	4281.00	7465.00	4576.00	5999.00	1596.00	308.00	32.00	26.00
25915	314.55	3653.12	2942.09	1225.28	565.55	598.65	117.27	12.32	4.23
28611	890.57	3830.33	3990.71	1202.06	368.64	93.79	160.46	22.28	1.28
28692	431.03	4822.77	3667.48	2151.59	496.97	166.11	47.91	45.81	3.04
25208	150.44	2717.69	4815.08	1124.87	529.69	100.13	31.08	3.11	4.17
25184	447.52	2064.11	4351.49	1877.20	313.54	106.16	9.86	3.52	0.78
21758	163.76	3793.84	2123.86	2009.65	619.55	55.06	13.45	1.07	0.14
19840	292.26	2224.03	3828.93	818.81	657.22	137.59	15.33	3.49	0.08
15656	365.35	1597.81	1685.80	2204.15	248.32	195.02	43.88	2.82	0.06
19076	172.98	1224.59	2633.02	1141.30	1233.36	96.75	37.16	13.84	4.10
17315	107.74	1805.61	1720.52	1466.30	412.54	429.99	29.43	8.24	1.34
17794	114.32	1022.59	3304.45	1536.77	1162.94	240.08	211.60	13.83	6.66
18883	20.89	655.48	1594.39	1438.24	482.20	199.09	37.91	29.82	10.03
15574	39.68	356.96	1406.89	1138.71	606.01	85.94	15.86	9.70	2.25
14949	31.88	125.79	316.62	326.18	191.97	62.83	7.94	2.31	1.19
-9	95.73	489.82	489.30	683.82	451.53	239.35	58.67	13.88	1.21
11747	47.25	1148.44	2968.16	1204.67	319.60	298.20	124.42	53.59	5.27
6771	297.73	648.68	528.07	149.80	36.49	35.62	13.53	6.28	2.11

FRATRO_IV

1986	2003								
1	1	0	1						
0	8								
56099.00	19.48	1541.94	1891.94	7145.98	3782.82	599.91	157.52	39.03	2.14
71765.00	12.20	2507.72	4984.96	1271.29	5713.14	412.56	257.90	91.79	69.82
84052.00	0.31	2536.92	8981.89	3222.83	704.34	1320.59	122.85	55.31	0.54
88397.00	26.94	2958.16	3739.55	5628.95	1654.27	208.58	280.47	47.27	10.86
71750.00	37.70	3209.61	6169.85	3780.85	2456.12	365.14	28.65	43.61	1.65
67836.00	323.02	4464.91	6083.87	2864.37	1412.45	776.93	84.61	5.78	2.53
51340.00	355.02	3426.92	6498.04	1939.69	635.38	358.08	96.22	4.78	0.12
62553.00	937.84	3950.46	4586.36	4306.75	877.04	289.87	68.31	39.73	6.21
51241.00	86.53	7005.88	3298.43	1190.63	612.13	108.28	11.05	8.38	0.98
57823.00	262.76	6331.03	6125.08	2673.85	543.82	98.58	19.19	0.03	1.79
50163.00	577.46	5522.73	4742.85	3214.22	890.19	155.83	7.73	12.12	0.03
48904.00	266.77	1961.14	4676.60	3929.12	1020.11	220.78	18.01	3.07	0.02
38103.00	566.68	4893.44	1959.25	532.61	161.28	68.00	35.86	0.39	1.55
-9.00	51.18	7651.96	2885.69	1452.71	960.37	500.08	133.31	45.54	30.71
30082.00	129.16	7366.57	8191.31	2452.95	1056.07	737.31	454.67	345.11	94.79
50846.00	3357.15	10766.56	15475.91	6922.60	3226.67	1700.58	637.70	344.65	127.90
2002 French data not broken down by gear. Given as ALL gears									
52609.00	625.48	9276.84	16879.91	7857.03	5528.14	1701.23	188.34	18.53	23.06

Table 5.1.2.13 contd. Whiting in IV and VIId. Complete available tuning series. Numbers in bold show the data used in catch at age analyses.

SCOGFS_IV							
1982	2004						
1	1	0.5	0.75				
0	6						
100	102.00	**653.00**	**971.00**	**972.00**	**224.00**	**60.00**	**16.00**
100	210.00	**563.00**	**578.00**	**407.00**	**511.00**	**116.00**	**17.00**
100	442.00	**1048.00**	**371.00**	**170.00**	**77.00**	**92.00**	**18.00**
100	169.00	**1577.00**	**973.00**	**247.00**	**63.00**	**36.00**	**18.00**
100	406.00	**1111.00**	**452.00**	**224.00**	**27.00**	**5.00**	**5.00**
100	120.00	**1405.00**	**1150.00**	**208.00**	**77.00**	**16.00**	**3.00**
100	642.00	**967.00**	**1606.00**	**452.00**	**70.00**	**19.00**	**2.00**
100	427.00	**4043.00**	**741.00**	**733.00**	**157.00**	**13.00**	**6.00**
100	1943.00	**2239.00**	**2053.00**	**248.00**	**255.00**	**47.00**	**5.00**
100	1379.00	**1769.00**	**950.00**	**759.00**	**51.00**	**40.00**	**9.00**
100	2417.00	**2925.00**	**1267.00**	**553.00**	**585.00**	**47.00**	**26.00**
100	247.00	**3169.00**	**1168.00**	**423.00**	**156.00**	**182.00**	**6.00**
100	648.00	**2635.00**	**950.00**	**254.00**	**57.00**	**34.00**	**23.00**
100	1243.00	**4176.00**	**2010.00**	**903.00**	**196.00**	**58.00**	**22.00**
100	440.00	**2888.00**	**3047.00**	**1215.00**	**460.00**	**43.00**	**15.00**
100	317.00	**1824.00**	**1434.00**	**1191.00**	**319.00**	**122.00**	**17.00**
100	12302.00	**4141.00**	**1285.00**	**649.00**	**321.00**	**131.00**	**62.00**
100	15275.68	**5409.65**	**2090.38**	**614.72**	**328.51**	**128.72**	**58.35**
100	17076.44	**6645.52**	**3329.07**	**675.66**	**202.25**	**130.20**	**81.17**
100	116.72	**3499.11**	**2450.75**	**844.39**	**207.17**	**51.32**	**48.49**
100	1606.00	**4980.00**	**2422.00**	**1608.00**	**724.00**	**94.00**	**44.00**
100	5392.65	**1890.65**	**1433.16**	**1211.32**	**823.30**	**276.22**	**35.66**
100	2552.95	**2580.29**	**440.05**	**583.29**	**566.21**	**407.95**	**95.53**

Table 5.1.2.13 contd. Whiting in IV and VIId. Complete available tuning series. Numbers in bold show the data used in catch at age analyses.

ENGGFS_IV

1977	2003						
1	1	0.5	0.75				
0	6						
100	28.43	21.95	7.44	1.11	0.22	0.09	0.08
100	18.44	24.71	5.15	1.06	0.34	0.05	0.02
100	35.48	20.06	7.12	1.90	0.84	0.06	0.03
100	19.90	35.33	12.51	4.81	1.20	0.31	0.06
100	34.94	18.31	28.80	16.05	0.62	0.62	0.08
100	6.93	27.72	7.93	8.59	2.22	0.34	0.05
100	71.67	11.85	10.80	1.91	1.70	0.24	0.07
100	17.25	50.61	10.82	3.01	0.89	0.77	0.38
100	19.99	15.88	17.04	1.67	0.98	0.18	0.15
100	16.33	15.16	6.59	3.85	0.41	0.10	0.01
100	13.73	22.76	13.04	2.69	2.01	0.35	0.12
100	38.17	18.81	13.16	4.55	0.64	0.17	0.02
100	116.95	29.47	11.76	7.69	1.67	0.34	0.02
100	87.53	19.01	12.84	3.85	2.32	0.33	0.05
100	16.73	33.30	7.67	3.82	1.09	0.37	0.04
100	45.50	**26.55**	**13.07**	**3.05**	**2.61**	**0.49**	**0.59**
100	25.24	**25.10**	**9.63**	**3.75**	**1.16**	**0.74**	**0.19**
100	21.14	**30.55**	**10.59**	**2.44**	**1.12**	**0.33**	**0.11**
100	36.28	**35.51**	**23.74**	**7.36**	**1.87**	**0.25**	**0.14**
100	9.92	**18.84**	**10.93**	**6.03**	**1.36**	**0.27**	**0.12**
100	48.97	**15.47**	**8.71**	**7.51**	**2.27**	**0.86**	**0.48**
100	158.81	**17.71**	**11.53**	**2.92**	**2.36**	**0.89**	**0.16**
100	105.79	**44.57**	**10.01**	**3.76**	**1.43**	**0.78**	**0.16**
100	70.27	**60.17**	**18.59**	**3.55**	**0.95**	**0.51**	**0.20**
100	99.90	**54.45**	**14.71**	**5.08**	**1.26**	**0.33**	**0.38**
100	5.32	**62.57**	**17.97**	**8.01**	**2.45**	**0.27**	**0.06**
100	15.00	**6.80**	**13.04**	**9.32**	**4.80**	**2.02**	**0.38**

Table 5.1.2.13 contd. Whiting in IV and VIId. Complete available tuning series. Numbers in bold show the data used in catch at age analyses.

IBTS_Q1_IV						
1967	2004					
1	1	0	0.25			
1	6					
1	440.36	97.85	21.16	7.21	0.84	1.15
1	1267.71	81.75	25.43	4.74	0.65	0.31
1	504.74	382.30	19.75	7.98	1.09	0.09
1	57.55	132.91	27.44	5.31	0.60	0.18
1	219.74	19.69	10.02	10.17	0.55	0.25
1	263.69	104.31	33.53	10.68	4.15	0.18
1	1460.01	381.80	53.72	33.61	8.36	5.70
1	312.49	485.97	105.66	7.10	0.58	1.30
1	881.19	174.47	91.13	19.69	3.81	0.57
1	676.19	349.44	130.00	31.29	5.03	0.53
1	411.42	232.59	69.08	12.25	11.03	13.00
1	542.89	256.84	88.72	21.12	4.97	7.50
1	440.93	228.84	112.59	33.06	4.89	1.17
1	674.04	403.34	125.75	25.62	9.15	1.96
1	229.26	464.30	228.31	45.93	9.29	2.78
1	151.38	216.14	257.36	68.51	10.14	4.57
1	**127.09**	**126.86**	**112.57**	**79.19**	**33.39**	6.36
1	**439.01**	**178.88**	**89.20**	**30.25**	**25.38**	10.49
1	**339.01**	**361.76**	**65.70**	**18.53**	**7.03**	7.18
1	**469.37**	**268.42**	**194.60**	**32.42**	**6.60**	3.85
1	**683.38**	**556.49**	**90.42**	**46.17**	**4.98**	1.98
1	**450.74**	**863.72**	**312.75**	**34.17**	**12.28**	1.31
1	**1446.08**	**538.56**	**414.76**	**109.90**	**12.05**	5.09
1	**518.94**	**862.35**	**198.16**	**91.61**	**16.98**	3.62
1	**1009.16**	**686.18**	**479.41**	**70.86**	**37.60**	7.59
1	**904.61**	**677.69**	**250.36**	**162.89**	**14.96**	14.26
1	**1088.20**	**523.70**	**244.52**	**65.48**	**59.00**	11.44
1	**720.99**	**636.97**	**179.84**	**66.59**	**11.56**	8.93
1	**678.59**	**448.48**	**239.45**	**58.07**	**11.87**	5.58
1	**502.36**	**485.97**	**244.70**	**69.74**	**23.09**	9.85
1	**287.87**	**342.07**	**162.52**	**60.43**	**18.01**	9.18
1	**556.11**	**161.26**	**125.49**	**54.05**	**15.50**	9.26
1	**676.27**	**305.45**	**94.67**	**57.45**	**25.82**	11.08
1	**752.89**	**543.74**	**181.81**	**51.89**	**19.69**	14.51
1	**648.62**	**598.34**	**299.14**	**98.28**	**25.68**	26.08
1	**664.60**	**372.73**	**273.12**	**60.67**	**13.34**	5.87
1	**144.15**	**311.32**	**233.24**	**124.73**	**40.75**	7.34
1	**188.72**	**101.99**	**202.64**	**101.90**	**51.33**	19.23

Table 5.1.2.13 contd. Whiting in IV and VIId. Complete available tuning series. Numbers in bold show the data used in catch at age analyses.

FRATRO_7d

1986	2003						
1	1	0.00	1.00				
1	7						
257794.00	2586.59	2249.77	7740.58	4462.98	804.35	198.40	19.35
188236.00	1954.81	5050.15	907.04	4606.14	331.43	218.34	53.97
215422.00	2233.10	7957.35	2551.70	536.69	1192.83	127.34	61.15
320383.00	2577.84	3916.35	6005.56	1489.83	216.08	342.97	50.48
257120.00	2491.70	5240.14	3362.65	2168.19	251.50	29.80	51.08
294594.00	4009.06	8176.54	3984.56	2625.40	1474.03	155.42	10.50
285718.00	5732.56	10924.16	3241.05	881.71	587.01	171.40	3.38
283999.00	3158.34	6542.83	8606.51	1676.81	442.49	123.89	79.06
286019.00	13931.57	7979.57	3268.93	1776.04	443.66	40.33	20.73
268151.00	6301.32	8449.94	5260.61	1217.42	263.53	62.53	8.18
274495.00	6140.12	6465.75	5465.37	1622.56	324.48	47.21	14.16
282216.00	3320.15	8143.54	6607.75	1974.21	450.88	58.75	8.43
291360.00	9921.00	6863.22	2384.88	781.09	264.61	104.76	15.31
-9.00	5536.90	5976.23	2822.66	1672.18	702.49	343.31	69.31
215553.00	7096.32	7026.28	1733.97	1724.37	1374.95	876.77	674.78
163848.00	89.05	6101.35	10124.09	3975.55	2563.21	2302.84	1039.71
192589.00	985.42	1922.07	6247.38	6475.65	2269.58	461.30	463.12
296717.00	154.90	6896.37	5488.74	5551.26	2397.47	311.73	64.69

FRAGFS_7d

1988	2003			
1	1	0.75	1	
0	3			
27	24.77	-	-	-
27	25.56	-	-	-
27	17.92	-	-	-
27	171.89	26.25	2.94	0.48
27	162.73	42.70	7.66	0.85
27	67.53	17.09	7.22	1.14
27	24.25	68.93	8.09	1.42
27	61.68	17.80	2.82	0.26
27	30.12	27.31	5.53	1.02
27	17.76	50.11	16.34	2.52
27	27.52	12.34	8.19	4.53
27	8.24	70.87	5.82	0.99
27	10.82	64.25	27.45	2.58
27	19.37	15.10	14.57	1.41
Awaiting 2002 data				
27	19.56	6.84	30.65	4.12

Table 5.1.2.13 contd. Whiting in IV and VIId. Complete available tuning series. Numbers in bold show the data used in catch at age analyses.

IBTS_Q4_ENG_IV Survey discontinued

1991	1996							
1	1	0.75	1					
0	7							
100	46.826	55.276	19.642	15.092	3.255	1.851	1.329	0.030
100	94.233	45.090	26.462	5.379	5.030	0.645	0.534	0.122
100	78.871	54.210	19.474	7.161	2.335	0.827	0.237	0.008
100	69.848	61.335	26.413	4.140	0.842	0.621	0.106	0.079
100	71.328	107.996	41.715	11.186	2.560	0.523	0.204	0.071
100	29.983	36.556	30.330	8.653	4.815	1.626	0.515	0.326

IBTS_Q2_SCO_IV Survey discontinued

1991	1997					
1	1	0.25	0.5			
1	6					
100	94.900	38.560	22.860	3.740	1.230	0.510
100	129.760	47.500	11.420	4.280	1.140	0.450
100	104.670	41.490	20.860	5.170	4.850	0.360
100	65.400	35.710	8.550	2.380	0.900	0.750
100	191.610	77.300	26.190	4.420	2.210	0.410
100	44.020	49.620	22.300	8.330	1.250	0.590
100	14.070	22.600	18.020	6.430	1.400	0.130

Table 5.1.4.1 Percentage international whiting discards at age from human consumption fleet in ICES IV and VIId assuming Scottish fleet discard rates apply to all fleets.

year	age0	age1	age2	age3	age4	age5	age6	age7
1960	99.997	96.066	78.444	60.06	37.605	4.0805	1.4987	0.1432
1961	100	96.072	77.881	59.771	12.316	10.849	1.7612	0
1962	99.794	95.567	65.885	45.101	33.376	6.6466	4.6382	0.6288
1963	100	96.857	80.51	44.038	30.71	15.968	2.0584	0
1964	99.969	93.207	66.856	35.407	15.127	12.172	11.67	2.4739
1965	100	95.619	79.191	27.893	15.944	6.1047	7.9783	0.4972
1966	99.979	96.136	79.091	34.496	9.8455	7.6404	0.5459	0.7045
1967	100	95.492	69.988	44.673	23.581	4.154	4.021	1.0283
1968	100	92.616	64.819	38.725	25.789	10.728	0.7564	0.8384
1969	100	92.709	81.938	39.836	21.31	28.153	4.9095	4.3484
1970	100	95.192	75.166	49.609	12.834	9.9985	8.5328	5.4574
1971	99.915	93.573	66.44	28.428	12.666	10.184	2.2816	0.4804
1972	100	92.032	69.464	29.828	11.62	5.1678	4.4636	0
1973	100	90.521	70.043	41.095	11.092	3.6591	3.9833	1.8797
1974	96.628	92.939	64.194	34.014	20	11.402	1.5961	0.7153
1975	100	94.72	77.941	49.012	17.09	10.922	0.5432	0
1976	100	95.491	76.736	38.119	15.382	3.2225	1.7036	0
1977	99.97	92.919	70.259	33.328	12.629	5.9918	1.1799	0
1978	100	78.076	53.522	19.514	8.518	3.6648	1.5051	0
1979	99.82	98.24	53.863	17.961	7.594	4.5338	0.8889	0.4157
1980	100	96.579	80.071	36.685	17.121	20.671	7.3445	0
1981	99.299	92.241	58.236	35.489	8.5463	5.1422	1.2205	0.2897
1982	100	83.154	36.566	29.575	23.485	12.206	5.71	1.06
1983	99.999	93.519	55.416	33.114	18.786	12.113	3.4226	1.4173
1984	100	93.307	56.839	14.493	9.7056	7.9923	7.5081	5.0951
1985	99.987	98.538	48.798	20.948	8.4504	5.5426	4.665	1.9557
1986	99.643	96.915	73.029	28.05	12.326	5.2601	3.0935	1.5926
1987	99.778	93.471	73.638	33.063	11.705	5.1109	1.081	0
1988	99.998	89.705	58.696	35.193	16.779	4.8597	0.7567	0
1989	99.245	94.577	56.378	44.378	32.432	26.156	2.5693	1.7997
1990	99.984	91.961	81.849	42.223	31.702	40.363	15.244	12.302
1991	94.125	86.888	64.222	44.815	15.77	7.7698	1.8574	12.821
1992	95.857	91.155	56.069	35.198	27.423	10.752	5.3258	41.569
1993	98.516	95.414	77.531	43.26	21.154	23.608	14.786	8.7852
1994	99.077	81.956	75.554	44.303	20.56	16.776	13.713	0.6952
1995	99.164	83.954	73.323	45.362	19.861	8.7388	3.9751	2.5062
1996	70.179	70.89	75.394	50.337	23.776	15.42	5.1032	13.795
1997	94.158	74.788	55.053	38.826	22.335	13.133	11.884	0.2306
1998	70.331	63.703	48.527	39.541	30.785	16.822	14.647	14.928
1999	99.537	83.526	65.738	35.8	27.099	17.3	11.4	8.1212
2000	99.986	68.721	70.342	45.287	16.823	16.007	18.861	11.167
2001	99.121	69.224	61.038	44.518	12.61	4.2663	5.616	6.2513
2002	100	76.888	75.55	58.469	29.829	14.081	10.99	8.8149
2003	99.459	99.27	88.271	72.556	53.517	31.624	19.856	6.4913

Table 5.1.4.2 Percentage whiting discards at age recorded during 1994 – 2003 from English vessels fishing in ICES area IV.

		Percentage discards at age								
Year	Quarter	0	1	2	3	4	5	6	7	7+
1994	1		100	87	64	18	31	0		
	2	100	100	92	56	54	0	0		
	3	100	100	94	66	0	0	0		
	4	100	98	92	0	0	0	0		
1995	1		100	100	94	98	93	0	0	
	2		100	90	39	68	24	67	0	
	3		97	93	53	68	0	0	0	
	4	100	95	67	67	44	51	0	0	
1996	1		100	97	79	82	0	0	0	
	2		100	98	71	70	0	0		
	3		100	96	65	56	0	0		
	4	100	100	97	51	94	0	0		
1997	1		100	97	54	77	0	0	0	
	2		100	98	84	88	0	0	0	
	3		100	90	47	55	37	0	0	
	4	100	98	89	37	0	19	0	0	0
1998	1		100	96	57	82	25	45	81	
	2		100	86	55	91	39	86	97	100
	3	100	97	73	47	87	50	97	100	
	4	100	96	85	59	88	70	93	100	100
1999	1		100	96	74	92	78	72	96	
	2		0	0	0					
	3	100	93	83	43	0	0	0		
	4	100	93	52	52	0	0			
2000	1		100	85	56	0	0			
	2		100	85	40	93	0	0		
	3		96	60	9	0	0	0		
	4		92	79	53	0	0	0		
2001	1		100	98	69	91	0	0		
	2		100	76	28	51	0	0	0	
	3	100	100	89	56	0	0	0		
	4	100	98	72	20	0	0	0		
2002	1		100	58	22	63	30	0	0	100
	2		100	81	29	73	41	92		100
	3	100	100	85	53	57	22	99		
	4	100	100	92	68	70	0	0	0	
2003	1		100	100	80	98	52	0		100
	2		100	95	72	91	0	97	0	
	3	100	100	81	53	0	81	0		
	4			0	0	0	0	0		

Table 5.1.5.1 Whiting in IV and VIId. Input settings for final XSA run.

Catch data range	1980-2003
ScoSEI	Not used
ScoLTR	Not used
FraTRB	Not used
FraTRO	Not used
ScoGFS	1982-2004, 1-6
EngGFS	1992-2003, 1-5
IBTS Q1*	1982-2003, 0-4
FraGFS	Not used
Plus group	Age 6
Mean F	(2-4)
Time series weights	Tricubic over 15 years
Power model used for catchability	None
Catchability plateau	Age 4
Survival estimate shrunk towards mean	Final 3 years on 2 oldest ages
s.e. of other means	0.5
Min std error for pop. estimates	0.3
Prior weighting	None

* The IBTS Q1 Survey was back-shifted to allow incorporation of 2003 survey indices.

Table 5.1.5.2 Whiting in IV and VIId. Tuning file for final XSA run.

Lowestoft VPA Version 3.1

14/09/2004 13:15

Extended Survivors Analysis

Whiting in the North Sea and eastern Channel, ages 1-8+ (11/09/2004 EDC)

CPUE data from file whi_IV_tuning_xsa_04.txt

Catch data for 24 years. 1980 to 2003. Ages 1 to 8.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
IBTSQ1	1982,	2003,	0,	4,	.991,	1.000
SCOGFS	1982,	2003,	1,	6,	.500,	.750
ENGGFS2	1992,	2003,	1,	6,	.500,	.750

Time series weights :

Tapered time weighting applied
Power = 3 over 15 years

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 4

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 3 years or the 2 oldest ages.

S.E. of the mean to which the estimates are shrunk = 2.000

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 45 iterations

1

Regression weights

.482,	.610,	.725,	.820,	.893,	.944,	.976,	.993,	.999,	1.000

Fishing mortalities

Age,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003
1,	.157,	.149,	.116,	.117,	.116,	.176,	.059,	.089,	.060,	.273
2,	.340,	.345,	.313,	.292,	.235,	.382,	.315,	.171,	.146,	.298
3,	.697,	.611,	.571,	.508,	.344,	.516,	.658,	.304,	.312,	.230
4,	.929,	.799,	.709,	.609,	.515,	.606,	.673,	.540,	.333,	.297
5,	1.050,	1.032,	1.026,	.727,	.626,	.600,	.736,	.665,	.457,	.247
6,	1.267,	1.229,	1.266,	.780,	.643,	.645,	.695,	.535,	.314,	.249
7,	1.440,	1.803,	1.427,	1.181,	.991,	.450,	1.047,	.384,	.312,	.114

1

XSA population numbers (Thousands)

	AGE						
YEAR ,	1,	2,	3,	4,	5,	6,	7,
1994 ,	1.81E+06,	6.40E+05,	2.15E+05,	9.13E+04,	3.03E+04,	2.72E+04,	1.45E+03,
1995 ,	1.60E+06,	5.97E+05,	2.91E+05,	7.55E+04,	2.67E+04,	8.26E+03,	5.97E+03,
1996 ,	1.07E+06,	5.32E+05,	2.70E+05,	1.11E+05,	2.51E+04,	7.41E+03,	1.88E+03,
1997 ,	7.77E+05,	3.67E+05,	2.48E+05,	1.07E+05,	4.06E+04,	7.02E+03,	1.63E+03,
1998 ,	1.05E+06,	2.67E+05,	1.75E+05,	1.05E+05,	4.32E+04,	1.53E+04,	2.51E+03,
1999 ,	1.78E+06,	3.61E+05,	1.35E+05,	8.74E+04,	4.65E+04,	1.80E+04,	6.25E+03,
2000 ,	1.88E+06,	5.76E+05,	1.57E+05,	5.67E+04,	3.53E+04,	1.99E+04,	7.36E+03,
2001 ,	1.59E+06,	6.85E+05,	2.68E+05,	5.73E+04,	2.14E+04,	1.32E+04,	7.73E+03,
2002 ,	1.39E+06,	5.64E+05,	3.68E+05,	1.39E+05,	2.47E+04,	8.58E+03,	6.01E+03,
2003 ,	4.89E+05,	5.05E+05,	3.11E+05,	1.90E+05,	7.40E+04,	1.22E+04,	4.88E+03,

Estimated population abundance at 1st Jan 2004

,	0.00E+00,	1.44E+05,	2.39E+05,	1.74E+05,	1.04E+05,	4.50E+04,	7.40E+03,

Taper weighted geometric mean of the VPA populations:

,	1.27E+06,	4.94E+05,	2.37E+05,	9.84E+04,	3.61E+04,	1.19E+04,	3.97E+03,

Standard error of the weighted Log(VPA populations) :

,	.4567,	.3098,	.3440,	.4137,	.4334,	.4425,	.6497,

1

Log catchability residuals.

Fleet : IBTSQ1

Age	1982	1983
1	99.99	99.99
2	99.99	99.99
3	99.99	99.99
4	99.99	99.99
5	No data for this fleet at this age	
6	No data for this fleet at this age	

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	99.99	99.99	99.99	99.99	99.99	-.31	.34	.29	.19	.23
2	99.99	99.99	99.99	99.99	99.99	-.08	.05	.21	.05	.00
3	99.99	99.99	99.99	99.99	99.99	-.20	.33	.02	-.02	.04
4	99.99	99.99	99.99	99.99	99.99	-.61	.33	.12	.10	-.47
5	No data for this fleet at this age									
6	No data for this fleet at this age									

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-.05	.15	.17	-.27	.07	.17	.10	-.07	-.30	-.09
2	-.02	.08	-.25	-.15	-.18	.33	.28	-.11	-.06	-.02
3	.09	-.12	-.22	-.31	-.07	.29	.89	-.39	-.05	-.22
4	-.32	.41	-.32	-.53	-.10	-.08	.67	.38	-.07	-.12
5	No data for this fleet at this age									
6	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4
Mean Log q	-7.1504	-7.0885	-7.2632	-7.4045
S.E(Log q)	.1847	.1892	.3798	.3776

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	.85	1.256	8.16	.91	15	.15	-7.15
2	.95	.211	7.36	.75	15	.19	-7.09
3	3.20	-2.131	-3.96	.12	15	1.01	-7.26
4	2.20	-1.996	2.50	.28	15	.71	-7.40

1

Fleet : SCOGFS

Age	1982	1983
1	99.99	99.99
2	99.99	99.99
3	99.99	99.99
4	99.99	99.99
5	99.99	99.99
6	99.99	99.99

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	99.99	99.99	99.99	99.99	99.99	-1.10	-.85	-1.09	-.47	-.53
2	99.99	99.99	99.99	99.99	99.99	-1.08	-.86	-.79	-.60	-.47
3	99.99	99.99	99.99	99.99	99.99	-.64	-1.01	-.89	-.36	-.65

4	99.99	99.99	99.99	99.99	99.99	-1.00	-.43	-1.30	-.16	-.49
5	99.99	99.99	99.99	99.99	99.99	-1.06	-.84	-.94	-.16	-.24
6	99.99	99.99	99.99	99.99	99.99	-.76	-.52	-1.25	.06	-.84

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-.63	-.05	-.04	-.18	.34	.12	.19	-.26	.21	.42
2	-.92	-.10	.42	.02	.19	.47	.43	-.14	.02	-.30
3	-.95	-.03	.31	.34	-.02	.29	.32	-.21	.12	-.05
4	-1.41	-.06	.35	-.04	-.08	.19	.18	.11	.34	.14
5	-.78	-.13	-.37	.01	-.04	-.15	.22	-.26	.08	-.07
6	-.93	.20	-.05	-.17	.26	.03	.29	.08	.29	-.31

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6
Mean Log q	-9.8161	-9.7078	-9.7465	-9.8140	-9.8140	-9.8140
S.E(Log q)	.3469	.4036	.3758	.4372	.2952	.3887

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	1.57	-1.452	7.41	.48	15	.51	-9.82
2	2.37	-1.326	5.05	.12	15	.91	-9.71
3	1.47	-.825	8.50	.30	15	.56	-9.75
4	.91	.240	9.96	.52	15	.42	-9.81
5	.93	.313	9.98	.76	15	.26	-9.95
6	.99	.046	9.85	.57	15	.41	-9.85

1

Fleet : ENGGFS2

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.37	-.56
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.22	-.31
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.47	-.29
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.42	-.25
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.43	-.60
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	1.42	.85

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-.28	-.01	-.26	-.14	-.31	.12	.29	.38	.64	-.41
2	-.46	.42	-.26	-.13	.44	.09	.20	-.30	.08	-.04
3	-.51	.24	.09	.35	-.34	.28	.16	-.24	-.10	.17
4	-.18	.43	-.33	.16	.16	-.10	-.03	.15	-.20	.14
5	-.25	-.42	-.31	.20	.11	-.11	-.17	-.16	-.63	.16
6	-1.09	.32	.26	1.40	-.53	-.73	-.55	.39	-1.24	.29

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6
Mean Log q	-14.6208	-14.6662	-14.8312	-14.9611	-14.9611	-14.9611
S.E(Log q)	.3778	.2794	.2846	.2252	.3347	.8512

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	.72	1.433	14.46	.79	12	.25	-14.62
2	1.87	-1.536	16.03	.31	12	.48	-14.67

```
  3,    1.11,    -.307,     15.10,     .53,     12,     .34,  -14.83,
  4,    1.15,    -.644,     15.47,     .73,     12,     .27,  -14.96,
  5,     .80,    1.076,     14.17,     .80,     12,     .23,  -15.11,
  6,  -15.64,   -1.739,    -78.81,     .00,     12,   11.85,  -15.03,
1

 Terminal year survivor and F summaries :

 Age  1   Catchability constant w.r.t. time and dependent on age

 Year class = 2002

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 IBTSQ1                         ,    131343.,   .300,       .000,    .00,   1,  .440,     .296
 SCOGFS                         ,    218169.,   .365,       .000,    .00,   1,  .297,     .188
 ENGGFS2                        ,     95857.,   .398,       .000,    .00,   1,  .250,     .386

   F shrinkage mean  ,    606388.,   2.00,,,,                      .013,     .072

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    143987.,       .20,      .20,    4,   1.018,   .273


1
 Age  2   Catchability constant w.r.t. time and dependent on age

 Year class = 2001

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 IBTSQ1                         ,    204577.,   .212,       .140,    .66,   2,  .418,     .341
 SCOGFS                         ,    236074.,   .277,       .251,    .91,   2,  .244,     .302
 ENGGFS2                        ,    291326.,   .240,       .322,   1.34,   2,  .331,     .251

   F shrinkage mean  ,    348238.,   2.00,,,,                      .007,     .214

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    238963.,       .14,      .12,    7,    .849,   .298


 Age  3   Catchability constant w.r.t. time and dependent on age

 Year class = 2000

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 IBTSQ1                         ,    157048.,   .188,       .048,    .26,   3,  .364,     .252
 SCOGFS                         ,    157318.,   .228,       .086,    .38,   3,  .252,     .251
 ENGGFS2                        ,    207813.,   .188,       .076,    .40,   3,  .380,     .196

   F shrinkage mean  ,     83506.,   2.00,,,,                      .005,     .431

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    174227.,       .11,      .06,   10,    .508,   .230


1
 Age  4   Catchability constant w.r.t. time and dependent on age

 Year class = 1999

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 IBTSQ1                         ,     99641.,   .174,       .052,    .30,   4,  .338,     .310
 SCOGFS                         ,    114513.,   .209,       .070,    .33,   4,  .240,     .275
 ENGGFS2                        ,    103786.,   .163,       .118,    .72,   4,  .417,     .299

   F shrinkage mean  ,     52805.,   2.00,,,,                      .005,     .522

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    104474.,       .10,      .05,   13,    .471,   .297
```

Age 5 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 1998

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
IBTSQ1	45490.,	.180,	.141,	.78,	4,	.236,	.245
SCOGFS	46863.,	.187,	.107,	.57,	5,	.330,	.239
ENGGFS2	43993.,	.156,	.096,	.62,	5,	.429,	.252
F shrinkage mean	14496.,	2.00,,,,				.005,	.626

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
45029.,	.10,	.06,	15,	.604,	.247

1

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 1997

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
IBTSQ1	11121.,	.196,	.150,	.77,	4,	.159,	.172
SCOGFS	7311.,	.198,	.109,	.55,	6,	.448,	.252
ENGGFS2	6467.,	.177,	.169,	.95,	6,	.384,	.280
F shrinkage mean	3068.,	2.00,,,,				.009,	.520

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
7402.,	.12,	.09,	17,	.775,	.249

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 1996

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
IBTSQ1	4281.,	.191,	.231,	1.21,	4,	.152,	.095
SCOGFS	3770.,	.208,	.115,	.55,	6,	.467,	.108
ENGGFS2	3174.,	.184,	.195,	1.06,	6,	.370,	.127
F shrinkage mean	1514.,	2.00,,,,				.012,	.249

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
3567.,	.12,	.10,	17,	.770,	.114

Table 5.1.5.3 Whiting in IV and VIId. XSA final run; fishing mortality at age.

Run title : Whiting in the North Sea and eastern Channel, ages 1-8+ (11/09/2004 EDC)

At 14/09/2004 13:15

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1980,	1981,	1982,	1983,
AGE				
1,	.1016,	.1654,	.1735,	.2105,
2,	.4414,	.3299,	.2936,	.4557,
3,	.8243,	.7556,	.5324,	.7482,
4,	.9808,	1.0040,	.7271,	.7377,
5,	1.2556,	1.1140,	.9071,	.9027,
6,	1.0075,	1.3793,	1.0602,	.9543,
7,	1.1452,	1.2622,	.9948,	.9387,
+gp,	1.1452,	1.2622,	.9948,	.9387,
0 FBAR 2- 6,	.9019,	.9165,	.7041,	.7597,

Table 8 Fishing mortality (F) at age

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
1,	.2234,	.1903,	.2710,	.1407,	.3593,	.1299,	.2274,	.1173,	.2410,	.1918,
2,	.5171,	.2496,	.4259,	.5112,	.4313,	.4328,	.5542,	.4899,	.3891,	.4839,
3,	.8727,	.6368,	.7054,	.8721,	.6640,	.6978,	.9180,	.5269,	.5831,	.7624,
4,	1.0332,	.8780,	1.1999,	1.2475,	.9729,	.8446,	.9897,	.9009,	.6543,	.8423,
5,	1.0594,	1.1846,	1.0608,	1.3780,	1.1589,	1.5387,	1.2678,	1.1261,	.9817,	.9143,
6,	1.2068,	1.2235,	1.2197,	1.7512,	1.2995,	1.5702,	1.0634,	.8224,	1.2108,	1.2262,
7,	1.1467,	1.2189,	1.1540,	1.5856,	1.2445,	1.5753,	1.1850,	1.0309,	1.4083,	1.0548,
+gp,	1.1467,	1.2189,	1.1540,	1.5856,	1.2445,	1.5753,	1.1850,	1.0309,	1.4083,	1.0548,
0 FBAR 2- 6,	.9378,	.8345,	.9223,	1.1520,	.9053,	1.0168,	.9586,	.7732,	.7638,	.8458,

1

Run title : Whiting in the North Sea and eastern Channel, ages 1-8+ (11/09/2004 EDC)

At 14/09/2004 13:15

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	FBAR **-**
AGE											
1,	.1574,	.1491,	.1160,	.1171,	.1162,	.1758,	.0588,	.0886,	.0596,	.2731,	.1404,
2,	.3396,	.3448,	.3125,	.2917,	.2350,	.3817,	.3152,	.1713,	.1460,	.2984,	.2052,
3,	.6972,	.6107,	.5711,	.5081,	.3443,	.5164,	.6582,	.3036,	.3124,	.2296,	.2818,
4,	.9293,	.7987,	.7085,	.6094,	.5155,	.6061,	.6730,	.5398,	.3332,	.2975,	.3901,
5,	1.0497,	1.0319,	1.0255,	.7271,	.6262,	.6001,	.7361,	.6646,	.4572,	.2472,	.4563,
6,	1.2670,	1.2292,	1.2664,	.7805,	.6435,	.6446,	.6951,	.5348,	.3144,	.2491,	.3661,
7,	1.4404,	1.8030,	1.4273,	1.1813,	.9908,	.4501,	1.0474,	.3844,	.3120,	.1136,	.2700,
+gp,	1.4404,	1.8030,	1.4273,	1.1813,	.9908,	.4501,	1.0474,	.3844,	.3120,	.1136,	
0 FBAR 2- 6,	.8566,	.8031,	.7768,	.5834,	.4729,	.5498,	.6155,	.4428,	.3126,	.2643,	

1

Table 5.1.5.4 Whiting in IV and VIId. XSA final run; stock numbers at age.

Run title : Whiting in the North Sea and eastern Channel, ages 1-8+ (11/09/2004 EDC)

At 14/09/2004 13:15

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1980,	1981,	1982,	1983,
AGE				
1,	4418051,	1718383,	1944296,	1741851,
2,	1459975,	1543619,	563265,	632139,
3,	606983,	598732,	707694,	267769,
4,	168646,	187584,	198190,	292830,
5,	83935,	46854,	50920,	70962,
6,	19189,	18623,	11978,	16009,
7,	1867,	5457,	3652,	3231,
+gp,	1218,	492,	833,	1660,
0 TOTAL,	6759864,	4119743,	3480827,	3026451,

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
1,	2597668,	1886952,	3906807,	3270718,	2292851,	4376686,	2006397,	1867616,	1800175,	2004744,
2,	545757,	803502,	603319,	1152262,	1098846,	619115,	1486382,	618156,	642367,	547079,
3,	255547,	207479,	399173,	251279,	440678,	455168,	256082,	544501,	241483,	277554,
4,	89292,	75245,	77342,	138940,	74032,	159856,	159625,	72062,	226561,	94986,
5,	103743,	23540,	23167,	17259,	29563,	20731,	50890,	43953,	21685,	87247,
6,	22409,	28007,	5608,	6246,	3388,	7225,	3466,	11155,	11101,	6327,
7,	4801,	5221,	6417,	1290,	844,	720,	1171,	932,	3817,	2576,
+gp,	974,	1388,	900,	1400,	255,	453,	175,	461,	167,	1283,
0 TOTAL,	3620190,	3031334,	5022733,	4839395,	3940456,	5639954,	3964187,	3158836,	2947356,	3021795,

1

Run title : Whiting in the North Sea and eastern Channel, ages 1-8+ (11/09/2004 EDC)

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Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	GMST 80-**	AMST 80-**
AGE													
1,	1806584,	1595940,	1066423,	777099,	1047086,	1776005,	1879742,	1594880,	1386080,	489220,	0,	1967076,	2153498,
2,	640032,	596934,	531718,	367253,	267322,	360530,	576109,	685438,	564492,	505048,	143987,	670690,	742778,
3,	215020,	290579,	269620,	248043,	174921,	134761,	156936,	268036,	368240,	311036,	238963,	298664,	330365,
4,	91255,	75458,	111178,	107332,	105165,	87360,	56663,	57263,	139431,	189870,	174227,	110781,	123039,
5,	30307,	26691,	25149,	40553,	43231,	46527,	35303,	21416,	24727,	74024,	104474,	37602,	42892,
6,	27233,	8262,	7407,	7024,	15264,	17999,	19884,	13170,	8581,	12191,	45029,	11018,	13044,
7,	1446,	5974,	1882,	1626,	2506,	6246,	7358,	7728,	6008,	4880,	7402,	2726,	3489,
+gp,	650,	608,	1579,	718,	702,	2042,	2114,	4357,	3089,	4062,	6536,		
0 TOTAL,	2812528,	2600447,	2014957,	1549647,	1656198,	2431471,	2734109,	2652288,	2500647,	1590332,	720618,		

Table 5.1.5.5 Whiting in IV and VIId. XSA final run; stock summary.

Run title : Whiting in the North Sea and eastern Channel, ages 1-8+ (11/09/2004 EDC) ,

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Table 17 Summary (with SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 2- 6,
1980,	4418051,	852931,	531352,	223517,	.4207,	1.0207,	.9019,
1981,	1718383,	653842,	502026,	192049,	.3825,	1.0304,	.9165,
1982,	1944296,	501472,	384923,	140195,	.3642,	1.0210,	.7041,
1983,	1741851,	543770,	357485,	161212,	.4510,	1.0635,	.7597,
1984,	2597668,	495831,	276791,	145741,	.5265,	1.0230,	.9378,
1985,	1886952,	479956,	294241,	106363,	.3615,	1.0893,	.8345,
1986,	3906807,	678053,	294361,	161744,	.5495,	1.0222,	.9223,
1987,	3270718,	539822,	300356,	138775,	.4620,	1.0080,	1.1520,
1988,	2292851,	436694,	307248,	133470,	.4344,	1.0441,	.9053,
1989,	4376686,	568449,	283318,	123753,	.4368,	1.0183,	1.0168,
1990,	2006397,	494492,	324475,	153453,	.4729,	1.0291,	.9586,
1991,	1867616,	529621,	319999,	124975,	.3905,	1.1661,	.7732,
1992,	1800175,	416256,	270583,	109704,	.4054,	1.0303,	.7638,
1993,	2004744,	399654,	252843,	116165,	.4594,	1.0681,	.8458,
1994,	1806584,	369985,	229028,	92606,	.4043,	1.0308,	.8566,
1995,	1595940,	425795,	271448,	103268,	.3804,	1.1714,	.8031,
1996,	1066423,	306798,	209225,	73957,	.3535,	1.0249,	.7768,
1997,	777099,	246965,	178282,	59102,	.3315,	1.0077,	.5834,
1998,	1047086,	239633,	149027,	44312,	.2973,	1.0251,	.4729,
1999,	1776005,	282341,	152575,	59179,	.3879,	1.0316,	.5498,
2000,	1879742,	390615,	192025,	60907,	.3172,	1.0017,	.6155,
2001,	1594880,	353606,	234962,	49062,	.2088,	1.0512,	.4428,
2002,	1386080,	327488,	234627,	46552,	.1984,	1.0377,	.3126,
2003,	489220,	226862,	198732,	43208,	.2174,	1.0178,	.2643,
Arith. Mean ,	2052177,	448372,	281247,	110969,	.3839		.7529,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

Table 5.1.5.6 Whiting in IV and VIId. Parameter settings for final TSA run.

Parameter	*Setting*	*Justification*
Age above which selection is constant.	$a_m = 5$	Based on inspection of exploratory TSA runs.
Multipliers on variance matrices of measurements.	$B_{landings}(a) = 2$ for ages 7, 8+	Allows extra measurement variability for older ages with fewer catches.
Multipliers on variances for fishing mortality estimates.	$H(1) = 2$	Allows for more variable fishing mortalities for age 1 fish.
Downweighting of particular data points (implemented by setting the relevant *q* to 9)	Catch values at age 1 in 1986, age 2 in 1990. Industrial bycatch values at age 2 in 1986, age 5 in 1987, age 1 in 1988, ages 1, 4 and 5 in 1999 and qges 4 and 5 in 2000.	Revised discards estimates suggest current value far too high.
Recruitment.	Modelled by a Ricker model, with numbers-at-age 1 assumed to be independent and normally distributed with mean $\eta_1 S \exp(-\eta_2 S)$, where *S* is the spawning stock biomass at the start of the previous year. To allow recruitment variability to increase with mean recruitment, a constant coefficient of variation is assumed.	
Large year classes.	No year classes sufficiently large during 1980–2003 to warrant special modelling treatment.	

Table 5.1.5.7 Whiting in IV and VIId. TSA parameter estimates for TSA run 13. Starting values and lower and upper estimation bounds are also given: these are not empirical standard errors, but user-defined run-time limits that were used to obtain a converged estimate.

Parameter		Estimate	Starting value	Lower bound	Upper bound
Human consumption (and discards)	F_H (1, 1980)	0.0894	0.1	0.05	0.4
	F_H (2, 1980)	0.1522	0.3	0.1	0.8
	F_H (5, 1980)	0.8830	1.2	0.7	1.5
	σ_H	0.1660	0.1	0.01	0.5
	σ_{HF}	0.1859	0.2	0.0	0.4
	σ_{HU}	0.0000	0.05	0.0	0.1
	σ_{HV}	0.0000	0.1	0.0	0.16
	σ_{HY}	0.1305	0.05	0.0	0.4
Industrial	F_I (1, 1980)	0.0291	0.1	0.02	0.8
	F_I (2, 1980)	0.2441	0.2	0.02	2.0
	F_I (5, 1980)	1.0000	0.1	0.02	1.0
	σ_I	0.3697	0.3	0.1	1.2
	σ_{IF}	0.0868	0.2	0.0	0.5
	σ_{IU}	0.0584	0.05	0.0	0.2
	σ_{IV}	0.0000	0.05	0.0	0.5
	σ_{IY}	0.4220	0.3	0.0	0.7
Recruitment	α	11.8773	9.0	5.0	30.0
	β	0.1654	0.05	0.0	0.5
	σ_R	0.3598	0.3	0.2	0.8
Surveys: EngGFS	$\Phi_E(1)$	0.0523	0.2	0.01	2.0
	$\Phi_E(2)$	0.0510	0.2	0.01	3.0
	$\Phi_E(5)$	0.0528	0.2	0.01	2.0
	σ_E	0.2964	0.5	0.1	1.0
	$\sigma_{E\Omega}$	0.0707	0.1	0.0	0.5
	$\sigma_{E\beta}$	0.0960	0.8	0.0	1.0
IBTS Q1	$\Phi_I(1)$	0.2407	0.5	0.001	1.0
	$\Phi_I(2)$	0.5706	0.7	0.01	1.0
	$\Phi_I(5)$	0.4367	0.6	0.001	1.0
	σ_I	0.1312	0.2	0.01	1.0
	$\sigma_{I\Omega}$	0.1331	0.2	0.0	1.0
	$\sigma_{I\beta}$	0.2220	0.4	0.0	1.0
ScoGFS	$\Phi_S(1)$	0.2116	0.2	0.01	0.5
	$\Phi_S(2)$	0.2994	0.3	0.01	0.8
	$\Phi_S(5)$	0.3184	0.3	0.01	0.5
	σ_S	0.2109	0.3	0.1	1.0
	$\sigma_{S\Omega}$	0.1530	0.05	0.0	0.2
	$\sigma_{S\beta}$	0.2764	0.5	0.0	1.0

Table 5.1.5.7 contd. Notation

$F_H(a,y)$ Human consumption fishing mortality at age a in year y

σ_H Standard deviation of human consumption catch-at-age data

σ_{HF} Transitory changes in overall human consumption fishing mortality

σ_{HU} Persistent changes in selection (age effect in human consumption fishing mortality)

σ_{HV} Transitory changes in the year effect in human consumption fishing mortality

σ_{HY} Persistent changes in the year effect in human consumption fishing mortality

$F_I(a,y)$ Industrial fishing mortality at age a in year y

σ_I Standard deviation of industrial catch-at-age data

σ_{IF} Transitory changes in overall industrial fishing mortality

σ_{IU} Persistent changes in selection (age effect in industrial fishing mortality)

σ_{IV} Transitory changes in the year effect in industrial fishing mortality

σ_{IY} Persistent changes in the year effect in industrial fishing mortality

α Ricker parameter (slope at the origin)

β Ricker parameter (curve dome occurs at $1/\beta$)

σ_R Standard error of recruitment data

$\Phi_E(1)$ Selectivity at age 1, EngGFS survey

$\Phi_E(2)$ Selectivity at age 2, EngGFS survey

$\Phi_E(5)$ Selectivity at age 5, EngGFS survey

σ_E Standard deviation of catch-at-age data, EngGFS survey

$\sigma_{E\Omega}$ Standard deviation of transitory changes in "catchability", EngGFS survey

$\sigma_{E\beta}$ Standard deviation of persistent changes in "catchability", EngGFS survey

$\Phi_I(1)$ Selectivity at age 1, IBTS Q1 survey

$\Phi_I(2)$ Selectivity at age 2, IBTS Q1 survey

$\Phi_I(5)$ Selectivity at age 5, IBTS Q1 survey

σ_I Standard deviation of catch-at-age data, IBTS Q1 survey

$\sigma_{I\Omega}$ Standard deviation of transitory changes in "catchability", IBTS Q1 survey

$\sigma_{I\beta}$ Standard deviation of persistent changes in "catchability", IBTS Q1 survey

$\Phi_S(1)$ Selectivity at age 1, ScoGFS survey

$\Phi_S(2)$ Selectivity at age 2, ScoGFS survey

$\Phi_S(5)$ Selectivity at age 5, ScoGFS survey

σ_S Standard deviation of catch-at-age data, ScoGFS survey

$\sigma_{S\Omega}$ Standard deviation of transitory changes in "catchability", ScoGFS survey

$\sigma_{S\beta}$ Standard deviation of persistent changes in "catchability", ScoGFS survey

Table 5.1.5.8 Population numbers at age from final TSA run, including standard errors.

Estimates

1980	41.2155	14.1900	5.8407	1.6152	0.9080	0.1648	0.0158	0.0088
1981	18.8828	14.0140	5.7974	1.7810	0.4082	0.1805	0.0412	0.0053
1982	17.2497	6.0242	6.1647	2.0003	0.5009	0.1092	0.0409	0.0111
1983	17.8691	5.6205	2.7467	2.6231	0.7173	0.1472	0.0286	0.0154
1984	27.6253	5.1910	2.3180	0.9487	0.9292	0.2089	0.0388	0.0108
1985	18.9135	8.5683	2.0699	0.6610	0.2589	0.2372	0.0436	0.0110
1986	34.8804	6.0181	3.9499	0.7715	0.2088	0.0612	0.0500	0.0114
1987	33.7545	11.1816	2.3060	1.2641	0.1803	0.0573	0.0137	0.0127
1988	17.7775	11.5822	4.4408	0.6602	0.2822	0.0335	0.0094	0.0048
1989	37.0513	5.6150	4.8183	1.4656	0.1859	0.0675	0.0073	0.0038
1990	19.7915	12.0781	2.2764	1.5799	0.4408	0.0334	0.0131	0.0027
1991	18.9199	6.1606	5.0739	0.7199	0.4517	0.1002	0.0085	0.0043
1992	17.7496	6.0782	2.4504	2.0638	0.2190	0.1207	0.0310	0.0035
1993	20.7181	5.4446	2.5835	0.8905	0.8052	0.0625	0.0325	0.0095
1994	17.8441	6.5216	2.1691	0.8321	0.2843	0.2364	0.0150	0.0101
1995	15.8478	5.9230	2.8683	0.7707	0.2379	0.0801	0.0529	0.0064
1996	10.3873	5.2756	2.6688	1.0384	0.2559	0.0644	0.0214	0.0145
1997	7.3769	3.5431	2.3768	1.0017	0.3569	0.0715	0.0148	0.0094
1998	10.4981	2.5214	1.6817	0.9557	0.3737	0.1164	0.0246	0.0076
1999	16.3768	3.5975	1.2476	0.7554	0.3827	0.1363	0.0382	0.0111
2000	15.9664	5.0805	1.5958	0.4949	0.2746	0.1338	0.0456	0.0163
2001	12.6138	5.4937	2.1910	0.5893	0.1732	0.0847	0.0349	0.0167
2002	10.9368	4.3390	2.7504	0.9527	0.2084	0.0480	0.0262	0.0162
2003	3.8486	3.8323	2.2482	1.3192	0.4247	0.0757	0.0180	0.0163
2004	*7.7329*	*1.2090*	*1.7943*	*1.1008*	*0.6198*	*0.1833*	*0.0323*	*0.0148*
2005	11.4725	2.7429	0.6232	0.8431	0.4937	0.2462	0.0725	0.0195
2006	10.8342	4.0695	1.4164	0.2972	0.3761	0.1910	0.0967	0.0380

Standard errors

1980	2.5496	1.1498	0.6025	0.1730	0.0721	0.0148	0.0031	0.0012
1981	1.2379	0.9310	0.5043	0.1809	0.0247	0.0154	0.0057	0.0010
1982	1.1061	0.3995	0.3905	0.1646	0.0479	0.0102	0.0084	0.0026
1983	1.1296	0.3563	0.1650	0.1486	0.0486	0.0139	0.0052	0.0034
1984	1.4398	0.3322	0.1342	0.0675	0.0692	0.0206	0.0058	0.0023
1985	1.1744	0.4933	0.1325	0.0431	0.0230	0.0190	0.0073	0.0018
1986	2.3764	0.4180	0.2503	0.0541	0.0163	0.0079	0.0088	0.0030
1987	1.6309	0.5807	0.1669	0.0967	0.0178	0.0043	0.0030	0.0028
1988	1.1177	0.6221	0.3005	0.0568	0.0255	0.0044	0.0017	0.0012
1989	2.1243	0.3201	0.2933	0.0952	0.0136	0.0044	0.0012	0.0005
1990	1.2197	0.8903	0.1618	0.1340	0.0414	0.0049	0.0027	0.0007
1991	1.1136	0.3828	0.2934	0.0526	0.0417	0.0096	0.0018	0.0010
1992	1.1142	0.3859	0.1667	0.1241	0.0189	0.0127	0.0042	0.0008
1993	1.1754	0.3832	0.1733	0.0665	0.0615	0.0072	0.0068	0.0021
1994	1.0193	0.4205	0.1640	0.0654	0.0249	0.0224	0.0032	0.0028
1995	0.9503	0.3672	0.1905	0.0565	0.0206	0.0067	0.0080	0.0014
1996	0.6659	0.3534	0.1847	0.0841	0.0240	0.0074	0.0043	0.0037
1997	0.4913	0.2403	0.1744	0.0823	0.0347	0.0089	0.0034	0.0025
1998	0.7168	0.1733	0.1192	0.0760	0.0332	0.0139	0.0047	0.0020
1999	0.9586	0.2658	0.0876	0.0544	0.0326	0.0135	0.0070	0.0024
2000	0.9611	0.3551	0.1287	0.0424	0.0268	0.0157	0.0076	0.0038
2001	1.0244	0.3714	0.1838	0.0603	0.0214	0.0134	0.0093	0.0049
2002	1.3081	0.3884	0.2098	0.0981	0.0308	0.0110	0.0078	0.0059
2003	1.3737	0.5048	0.2275	0.1258	0.0557	0.0162	0.0060	0.0055
2004	2.9458	0.5098	0.2879	0.1519	0.0889	0.0375	0.0097	0.0052
2005	4.4034	1.0611	0.2720	0.1730	0.0990	0.0593	0.0208	0.0069
2006	4.4284	1.5846	0.5701	0.1416	0.1088	0.0631	0.0352	0.0150

Table 5.1.5.9 Variance-covariance matrix for forecast numbers at age in 2006 from final TSA run.

19.610425	1.427303	1.045817	0.224330	0.156103	0.080520	0.042154	0.018417
1.427303	2.510802	0.200635	0.073129	0.048421	0.024539	0.012655	0.005640
1.045817	0.200635	0.324982	0.036811	0.027443	0.014513	0.007493	0.003300
0.224330	0.073129	0.036811	0.020042	0.009927	0.005306	0.002756	0.001214
0.156103	0.048421	0.027443	0.009927	0.011831	0.005023	0.002697	0.001177
0.080520	0.024539	0.014513	0.005306	0.005023	0.003987	0.001601	0.000702
0.042154	0.012655	0.007493	0.002756	0.002697	0.001601	0.001240	0.000393
0.018417	0.005640	0.003300	0.001214	0.001177	0.000702	0.000393	0.000224

Table 5.1.5.10 Fishing mortality at age from final TSA run. Standard errors are on Log fishing mortality.

Human consumption fishery (including discards)

estimates

1980	0.0474	0.3234	0.6965	0.8512	1.2242	1.0718	1.3389	1.2909
1981	0.0549	0.2060	0.5096	0.8317	0.9630	1.2324	1.2583	1.0280
1982	0.0614	0.2126	0.4013	0.6246	0.8942	1.0904	1.0366	0.9436
1983	0.2226	0.3428	0.6207	0.6758	0.9326	1.0608	1.2378	1.1528
1984	0.1657	0.3875	0.8245	0.9373	1.0314	1.3027	1.2890	1.1848
1985	0.1357	0.2446	0.5630	0.7959	1.1417	1.3064	1.3715	1.2679
1986	0.1425	0.3893	0.6857	1.0732	0.9340	1.2494	1.4093	1.2581
1987	0.0723	0.3599	0.7902	1.1354	1.3747	1.5556	1.4768	1.4852
1988	0.0827	0.2292	0.5961	0.8350	0.9788	1.2343	1.0443	1.0078
1989	0.0605	0.2089	0.5331	0.7633	1.3306	1.3776	1.2081	1.1947
1990	0.0750	0.2328	0.5949	0.8141	1.1308	1.1198	1.1032	1.0223
1991	0.0789	0.2895	0.4408	0.7957	1.0029	0.8911	1.1263	1.0662
1992	0.1002	0.2548	0.5360	0.5670	0.9422	1.0406	1.1004	0.9499
1993	0.1127	0.3357	0.6882	0.7822	0.9296	1.1722	1.2034	1.2034
1994	0.0882	0.2937	0.6243	0.9136	0.9546	1.2233	1.1986	1.1168
1995	0.0703	0.2680	0.5963	0.7614	1.0330	1.0576	1.2096	1.0580
1996	0.0724	0.2823	0.5705	0.7322	1.0035	1.2067	1.1103	1.0969
1997	0.0670	0.2301	0.5044	0.6581	0.8511	0.8095	0.9739	0.8907
1998	0.0695	0.2131	0.4205	0.5966	0.7408	0.8647	0.8781	0.8316
1999	0.1216	0.2653	0.4826	0.6597	0.7721	0.8443	0.9005	0.8944
2000	0.0535	0.2718	0.5079	0.6458	0.8563	1.0307	1.0897	0.9423
2001	0.0548	0.1864	0.4007	0.6280	0.8917	0.8468	0.8725	0.8346
2002	0.0371	0.1569	0.3422	0.4779	0.7188	0.7049	0.7442	0.7051
2003	0.1104	0.2717	0.3309	0.4359	0.5747	0.6000	0.6462	0.6351
2004	0.0533	0.1769	0.3723	0.4816	0.6579	0.6771	0.6840	0.6840
2005	0.0533	0.1751	0.3574	0.4870	0.6840	0.6840	0.6840	0.6840
2006	0.0533	0.1751	0.3574	0.4870	0.6840	0.6840	0.6840	0.6840

standard errors

1980	0.1523	0.1197	0.1090	0.0949	0.0905	0.1333	0.1690	0.1886
1981	0.1453	0.1183	0.1074	0.1067	0.0950	0.1371	0.1646	0.1962
1982	0.1447	0.1204	0.1022	0.1063	0.1057	0.1369	0.1704	0.1922
1983	0.1350	0.1150	0.0985	0.1018	0.1008	0.1292	0.1717	0.1863
1984	0.1368	0.1111	0.0807	0.0966	0.0891	0.1237	0.1578	0.1898
1985	0.1464	0.1245	0.1072	0.0989	0.1067	0.1251	0.1672	0.1941
1986	0.2375	0.1136	0.0982	0.0911	0.0924	0.1341	0.1562	0.1902
1987	0.1525	0.1109	0.0960	0.0841	0.0928	0.1142	0.1738	0.1766
1988	0.1451	0.1133	0.0979	0.0984	0.0897	0.1281	0.1701	0.1874
1989	0.1623	0.1149	0.1050	0.1016	0.0920	0.1252	0.1790	0.1921
1990	0.1415	0.1471	0.0954	0.0997	0.0916	0.1344	0.1660	0.1914
1991	0.1461	0.1102	0.1006	0.0993	0.1020	0.1356	0.1761	0.1900
1992	0.1441	0.1168	0.1069	0.1104	0.1088	0.1360	0.1686	0.1944
1993	0.1440	0.1146	0.0970	0.1020	0.0998	0.1327	0.1654	0.1895
1994	0.1481	0.1183	0.1051	0.0966	0.0985	0.1209	0.1755	0.1841
1995	0.1512	0.1223	0.1094	0.1084	0.1054	0.1416	0.1652	0.1954
1996	0.1511	0.1222	0.1108	0.1097	0.1071	0.1338	0.1775	0.1849
1997	0.1514	0.1248	0.1161	0.1134	0.1163	0.1422	0.1815	0.1880
1998	0.1515	0.1268	0.1206	0.1170	0.1179	0.1395	0.1767	0.1913
1999	0.1458	0.1221	0.1142	0.1116	0.1173	0.1421	0.1768	0.1918
2000	0.1549	0.1215	0.1146	0.1171	0.1198	0.1410	0.1776	0.1905
2001	0.1554	0.1296	0.1241	0.1221	0.1260	0.1478	0.1821	0.1910
2002	0.1638	0.1378	0.1307	0.1354	0.1401	0.1600	0.1910	0.1962
2003	0.1714	0.1498	0.1552	0.1603	0.1750	0.1912	0.2153	0.2162
2004	0.4150	0.2522	0.2480	0.2440	0.2451	0.2447	0.2508	0.2508
2005	0.4349	0.2844	0.2841	0.2840	0.2827	0.2827	0.2827	0.2827
2006	0.4541	0.3129	0.3126	0.3125	0.3114	0.3114	0.3114	0.3114

Table 5.1.5.10 contd. Fishing mortality at age from final TSA run. Standard errors are on Log fishing mortality.

Industrial fishery

estimates

1980	0.0878	0.1394	0.1500	0.1066	0.0833	0.0000	0.0000	0.0000
1981	0.1242	0.2013	0.2200	0.1496	0.1164	0.0000	0.0000	0.0000
1982	0.0949	0.1350	0.1374	0.0969	0.0771	0.0000	0.0000	0.0000
1983	0.0619	0.0944	0.0950	0.0649	0.0522	0.0000	0.0000	0.0000
1984	0.0590	0.0896	0.0837	0.0618	0.0482	0.0000	0.0000	0.0000
1985	0.0527	0.0844	0.0781	0.0568	0.0446	0.0000	0.0000	0.0000
1986	0.0808	0.1218	0.1060	0.0802	0.0622	0.0000	0.0000	0.0000
1987	0.0627	0.1171	0.1026	0.0693	0.0555	0.0000	0.0000	0.0000
1988	0.1385	0.2245	0.1796	0.1282	0.0964	0.0000	0.0000	0.0000
1989	0.1191	0.2315	0.1943	0.1347	0.1043	0.0000	0.0000	0.0000
1990	0.1512	0.2360	0.2154	0.1415	0.1069	0.0000	0.0000	0.0000
1991	0.1015	0.1679	0.1323	0.0972	0.0725	0.0000	0.0000	0.0000
1992	0.1037	0.1431	0.1162	0.0792	0.0608	0.0000	0.0000	0.0000
1993	0.0775	0.1112	0.0886	0.0614	0.0455	0.0000	0.0000	0.0000
1994	0.0586	0.0766	0.0625	0.0415	0.0316	0.0000	0.0000	0.0000
1995	0.0546	0.0629	0.0489	0.0323	0.0249	0.0000	0.0000	0.0000
1996	0.0349	0.0418	0.0337	0.0222	0.0169	0.0000	0.0000	0.0000
1997	0.0371	0.0463	0.0359	0.0230	0.0178	0.0000	0.0000	0.0000
1998	0.0310	0.0361	0.0300	0.0191	0.0146	0.0000	0.0000	0.0000
1999	0.0633	0.0680	0.0649	0.0385	0.0292	0.0000	0.0000	0.0000
2000	0.0513	0.0685	0.0668	0.0404	0.0299	0.0000	0.0000	0.0000
2001	0.0479	0.0511	0.0494	0.0294	0.0225	0.0000	0.0000	0.0000
2002	0.0461	0.0494	0.0452	0.0281	0.0212	0.0000	0.0000	0.0000
2003	0.0358	0.0356	0.0325	0.0200	0.0155	0.0000	0.0000	0.0000
2004	0.0331	0.0358	0.0330	0.0203	0.0155	0.0000	0.0000	0.0000
2005	0.0331	0.0358	0.0330	0.0203	0.0155	0.0000	0.0000	0.0000
2006	0.0331	0.0358	0.0330	0.0203	0.0155	0.0000	0.0000	0.0000

standard errors

1980	0.2299	0.2066	0.2059	0.2083	0.2711	0.0000	0.0000	0.0000
1981	0.2217	0.1934	0.1916	0.1988	0.2602	0.0000	0.0000	0.0000
1982	0.2238	0.1990	0.1957	0.2014	0.2610	0.0000	0.0000	0.0000
1983	0.2263	0.2021	0.2008	0.2034	0.2601	0.0000	0.0000	0.0000
1984	0.2236	0.1998	0.1997	0.2010	0.2567	0.0000	0.0000	0.0000
1985	0.2241	0.2000	0.1985	0.2003	0.2545	0.0000	0.0000	0.0000
1986	0.2273	0.2255	0.2044	0.2061	0.2598	0.0000	0.0000	0.0000
1987	0.2248	0.1987	0.1981	0.2003	0.2613	0.0000	0.0000	0.0000
1988	0.2616	0.1874	0.1934	0.1971	0.2507	0.0000	0.0000	0.0000
1989	0.2194	0.1822	0.1871	0.1917	0.2438	0.0000	0.0000	0.0000
1990	0.2140	0.1821	0.1840	0.1904	0.2429	0.0000	0.0000	0.0000
1991	0.2205	0.1900	0.1927	0.1960	0.2476	0.0000	0.0000	0.0000
1992	0.2188	0.1915	0.1939	0.1962	0.2483	0.0000	0.0000	0.0000
1993	0.2209	0.1952	0.1969	0.1985	0.2510	0.0000	0.0000	0.0000
1994	0.2224	0.1973	0.1984	0.2001	0.2534	0.0000	0.0000	0.0000
1995	0.2227	0.1981	0.1992	0.2010	0.2555	0.0000	0.0000	0.0000
1996	0.2247	0.1997	0.2003	0.2022	0.2584	0.0000	0.0000	0.0000
1997	0.2248	0.1992	0.2001	0.2027	0.2609	0.0000	0.0000	0.0000
1998	0.2273	0.2010	0.2015	0.2069	0.2663	0.0000	0.0000	0.0000
1999	0.2882	0.2216	0.2221	0.2558	0.3020	0.0000	0.0000	0.0000
2000	0.2373	0.2138	0.2141	0.2478	0.2968	0.0000	0.0000	0.0000
2001	0.2323	0.2082	0.2086	0.2157	0.2811	0.0000	0.0000	0.0000
2002	0.2387	0.2162	0.2168	0.2209	0.2883	0.0000	0.0000	0.0000
2003	0.2567	0.2387	0.2394	0.2418	0.3077	0.0000	0.0000	0.0000
2004	0.5192	0.4936	0.4938	0.4950	0.5276	0.0000	0.0000	0.0000
2005	0.6716	0.6520	0.6521	0.6531	0.6781	0.0000	0.0000	0.0000
2006	0.7953	0.7788	0.7790	0.7797	0.8008	0.0000	0.0000	0.0000

Table 5.1.5.10 contd. Fishing mortality at age from final TSA run. Standard errors are on Log fishing mortality.

Total fishery

estimates

1980	0.1352	0.4628	0.8465	0.9578	1.3074	1.0718	1.3389	1.2909
1981	0.1792	0.4073	0.7296	0.9813	1.0794	1.2324	1.2583	1.0280
1982	0.1563	0.3476	0.5387	0.7215	0.9713	1.0904	1.0366	0.9436
1983	0.2845	0.4372	0.7157	0.7406	0.9848	1.0608	1.2378	1.1528
1984	0.2247	0.4771	0.9081	0.9991	1.0796	1.3027	1.2890	1.1848
1985	0.1885	0.3289	0.6411	0.8527	1.1863	1.3064	1.3715	1.2679
1986	0.2233	0.5111	0.7917	1.1534	0.9963	1.2494	1.4093	1.2581
1987	0.1350	0.4769	0.8927	1.2047	1.4302	1.5556	1.4768	1.4852
1988	0.2212	0.4537	0.7758	0.9632	1.0752	1.2343	1.0443	1.0078
1989	0.1796	0.4404	0.7273	0.8980	1.4349	1.3776	1.2081	1.1947
1990	0.2262	0.4687	0.8103	0.9556	1.2377	1.1198	1.1032	1.0223
1991	0.1804	0.4574	0.5731	0.8930	1.0754	0.8911	1.1263	1.0662
1992	0.2039	0.3979	0.6522	0.6462	1.0031	1.0406	1.1004	0.9499
1993	0.1902	0.4469	0.7768	0.8436	0.9751	1.1722	1.2034	1.2034
1994	0.1468	0.3703	0.6868	0.9551	0.9862	1.2233	1.1986	1.1168
1995	0.1249	0.3309	0.6452	0.7937	1.0578	1.0576	1.2096	1.0580
1996	0.1073	0.3241	0.6042	0.7544	1.0205	1.2067	1.1103	1.0969
1997	0.1041	0.2764	0.5403	0.6812	0.8689	0.8095	0.9739	0.8907
1998	0.1005	0.2492	0.4505	0.6157	0.7554	0.8647	0.8781	0.8316
1999	0.1848	0.3333	0.5474	0.6982	0.8013	0.8443	0.9005	0.8944
2000	0.1048	0.3403	0.5747	0.6863	0.8862	1.0307	1.0897	0.9423
2001	0.1027	0.2375	0.4501	0.6575	0.9143	0.8468	0.8725	0.8346
2002	0.0832	0.2063	0.3874	0.5060	0.7400	0.7049	0.7442	0.7051
2003	0.1462	0.3073	0.3634	0.4559	0.5902	0.6000	0.6462	0.6351
2004	0.0865	0.2127	0.4053	0.5019	0.6734	0.6771	0.6840	0.6840
2005	0.0864	0.2109	0.3904	0.5073	0.6996	0.6840	0.6840	0.6840
2006	0.0864	0.2109	0.3904	0.5073	0.6996	0.6840	0.6840	0.6840

standard errors

1980	0.2743	0.2334	0.2255	0.2193	0.2772	0.1333	0.1690	0.1886
1981	0.2567	0.2079	0.1938	0.2128	0.2562	0.1371	0.1646	0.1962
1982	0.2613	0.2274	0.2037	0.2214	0.2755	0.1369	0.1704	0.1922
1983	0.2600	0.2296	0.2148	0.2247	0.2742	0.1292	0.1717	0.1863
1984	0.2554	0.2219	0.2056	0.2181	0.2660	0.1237	0.1578	0.1898
1985	0.2657	0.2324	0.2198	0.2198	0.2724	0.1251	0.1672	0.1941
1986	0.2946	0.2427	0.2155	0.2167	0.2656	0.1341	0.1562	0.1902
1987	0.2704	0.2184	0.2111	0.2121	0.2712	0.1142	0.1738	0.1766
1988	0.2864	0.1915	0.1977	0.2091	0.2546	0.1281	0.1701	0.1874
1989	0.2737	0.1946	0.1980	0.2074	0.2486	0.1252	0.1790	0.1921
1990	0.2436	0.1934	0.1803	0.2028	0.2469	0.1344	0.1660	0.1914
1991	0.2621	0.2073	0.2056	0.2131	0.2623	0.1356	0.1761	0.1900
1992	0.2546	0.2147	0.2122	0.2206	0.2661	0.1360	0.1686	0.1944
1993	0.2585	0.2193	0.2115	0.2191	0.2665	0.1327	0.1654	0.1895
1994	0.2644	0.2257	0.2195	0.2191	0.2696	0.1209	0.1755	0.1841
1995	0.2666	0.2297	0.2242	0.2276	0.2752	0.1416	0.1652	0.1954
1996	0.2705	0.2325	0.2268	0.2295	0.2791	0.1338	0.1775	0.1849
1997	0.2700	0.2322	0.2290	0.2316	0.2850	0.1422	0.1815	0.1880
1998	0.2727	0.2372	0.2343	0.2379	0.2914	0.1395	0.1767	0.1913
1999	0.3117	0.2476	0.2438	0.2755	0.3210	0.1421	0.1768	0.1918
2000	0.2840	0.2420	0.2382	0.2715	0.3185	0.1410	0.1776	0.1905
2001	0.2827	0.2477	0.2441	0.2503	0.3106	0.1478	0.1821	0.1910
2002	0.2992	0.2652	0.2613	0.2693	0.3281	0.1600	0.1910	0.1962
2003	0.3293	0.3040	0.3109	0.3172	0.3771	0.1912	0.2153	0.2162
2004	0.6727	0.5627	0.5606	0.5604	0.5904	0.2447	0.2508	0.2508
2005	0.8068	0.7182	0.7183	0.7194	0.7419	0.2827	0.2827	0.2827
2006	0.9216	0.8452	0.8453	0.8462	0.8654	0.3114	0.3114	0.3114

Table 5.1.5.11 Stock summary from final TSA run.

year	total catch			mean f		ssb		stock biomass		recruitment	
	observed	fitted	se	estimate	se	estimate	se	estimate	se	estimate	se
1980	2.1888	2.2873	0.1672	0.9293	0.0462	5.0415	0.2567	7.9894	0.3347	41.2155	2.5496
1981	1.8637	1.9083	0.1381	0.8860	0.0469	4.5612	0.2063	6.1407	0.2452	18.8828	1.2379
1982	1.3725	1.3594	0.0913	0.7339	0.0424	3.5928	0.1420	4.6212	0.1662	17.2497	1.1061
1983	1.5153	1.5519	0.0860	0.7878	0.0421	3.1586	0.1086	4.9429	0.1732	17.8691	1.1296
1984	1.4235	1.4148	0.0745	0.9533	0.0470	2.5791	0.0928	4.8481	0.1694	27.6253	1.4398
1985	0.9762	1.0784	0.0657	0.8631	0.0489	2.7495	0.1105	4.4666	0.1722	18.9135	1.1744
1986	1.5818	1.5534	0.1232	0.9404	0.0488	2.8062	0.1182	6.1662	0.2913	34.8804	2.3764
1987	1.3767	1.3253	0.0795	1.1120	0.0538	2.8546	0.1113	5.2970	0.1834	33.7545	1.6309
1988	1.2776	1.2736	0.0920	0.9004	0.0459	2.9723	0.1253	3.9699	0.1528	17.7775	1.1177
1989	1.2153	1.2858	0.0874	0.9757	0.0504	2.6632	0.1027	5.0388	0.1948	37.0513	2.1243
1990	1.4911	1.2620	0.0995	0.9184	0.0462	2.7177	0.1402	4.3189	0.1901	19.7915	1.2197
1991	1.0720	1.1492	0.0783	0.7780	0.0408	2.6622	0.1049	4.4815	0.1684	18.9199	1.1136
1992	1.0647	1.0492	0.0692	0.7480	0.0428	2.5214	0.1007	3.9114	0.1484	17.7496	1.1142
1993	1.0877	1.0717	0.0659	0.8429	0.0457	2.2803	0.0954	3.6988	0.1391	20.7181	1.1754
1994	0.8979	0.9107	0.0585	0.8443	0.0447	2.1991	0.0941	3.5519	0.1353	17.8441	1.0193
1995	0.8809	0.8707	0.0572	0.7770	0.0463	2.2893	0.0936	3.5978	0.1351	15.8478	0.9503
1996	0.7207	0.7377	0.0513	0.7820	0.0473	2.0019	0.0868	2.9304	0.1149	10.3873	0.6659
1997	0.5860	0.5828	0.0426	0.6353	0.0395	1.6825	0.0736	2.3305	0.0926	7.3769	0.4913
1998	0.4317	0.4542	0.0306	0.5871	0.0380	1.3551	0.0561	2.2388	0.0928	10.4981	0.7168
1999	0.5733	0.5577	0.0373	0.6449	0.0393	1.3654	0.0596	2.5292	0.1041	16.3768	0.9586
2000	0.6070	0.6125	0.0437	0.7036	0.0451	1.7038	0.0828	3.3905	0.1560	15.9664	0.9611
2001	0.4654	0.5090	0.0377	0.6212	0.0448	1.8175	0.1025	2.7110	0.1539	12.6138	1.0244
2002	0.4484	0.4458	0.0321	0.5089	0.0438	1.6766	0.1185	2.3779	0.1845	10.9368	1.3081
2003	0.4241	0.4026	0.0287	0.4634	0.0536	1.3714	0.1328	1.5879	0.1880	3.8486	1.3737
2004	NA	0.3840	0.0628	0.4941	0.0880	1.1727	0.1945	1.6271	0.3232	7.7329	2.9458
2005	NA	0.3386	0.0699	0.4984	0.1109	1.0929	0.2587	1.7787	0.4354	11.4725	4.4034
2006	NA	0.3452	0.0871	0.4984	0.1276	1.2571	0.3471	1.9230	0.5284	10.8342	4.4284

Table 5.1.6.1 Whiting in IV and VIId. Landings by ICES round fish area.

Landed weight												
IBTS Area	2000 Q1	2000 Q2	2000 Q3	2000 Q4	2001 Q1	2001 Q2	2001 Q3	2001 Q4	2002 Q1	2002 Q2	2002 Q3	2002 Q4
1E	*2371*	1963	1699	2484	1921	1212	896	1205	1194	640	546	739
1W	1933	868	845	779	1047	710	528	534	889	742	607	535
2	486	157	219	243	217	126	115	92	82	39	68	51
3	461	244	293	366	292	169	227	149	148	230	222	191
4	1809	25	58	158	1241	20	28	246	1283	10	26	150
5	1580	7	1	197	2443	24	0	185	1837	2	0	214
6	976	448	3	1682	1368	368	3	2364	926	331	3	2206
7	5	10	2	8	2	20	3	10	1	18	2	6
8	2	21	7	12	2	39	5	9	0	51	2	3
Percentage of landed weight												
IBTS Area	2000 Q1	2000 Q2	2000 Q3	2000 Q4	2001 Q1	2001 Q2	2001 Q3	2001 Q4	2002 Q1	2002 Q2	2002 Q3	2002 Q4
1E	24.6	52.5	54.3	41.9	22.5	45.1	49.7	25.1	18.8	31.0	37.0	18.0
1W	20.1	23.2	27.0	13.1	12.3	26.4	29.2	11.1	14.0	36.0	41.1	13.1
2	5.0	4.2	7.0	4.1	2.5	4.7	6.4	1.9	1.3	1.9	4.6	1.3
3	4.8	6.5	9.4	6.2	3.4	6.3	12.6	3.1	2.3	11.1	15.0	4.7
4	18.8	0.7	1.9	2.7	14.5	0.8	1.5	5.1	20.2	0.5	1.8	3.7
5	16.4	0.2	0.0	3.3	28.6	0.9	0.0	3.9	28.9	0.1	0.0	5.2
6	10.1	12.0	0.1	28.4	16.0	13.7	0.1	49.3	14.6	16.1	0.2	53.9
7	0.0	0.3	0.1	0.1	0.0	0.7	0.2	0.2	0.0	0.9	0.1	0.1
8	0.0	0.6	0.2	0.2	0.0	1.4	0.3	0.2	0.0	2.5	0.1	0.1

Table 5.2.1 Nominal landings (t) of Whiting from Division IIIa as supplied by the Study Group on Division IIIa Demersal Stocks (ICES 1992b) and updated by the Working Group.

Year	Denmark			Norway	Sweden	Others	Total
1975		19,018		57	611	4	19,690
1976		17,870		48	1,002	48	18,968
1977		18,116		46	975	41	19,178
1978		48,102		58	899	32	49,091
1979		16,971		63	1,033	16	18,083
1980		21,070		65	1,516	3	22,654
	Total consumption	Total industrial	Total				
1981	1,027	23,915	24,942	70	1,054	7	26,073
1982	1,183	39,758	40,941	40	670	13	41,664
1983	1,311	23,505	24,816	48	1,061	8	25,933
1984	1,036	12,102	13,138	51	1,168	60	14,417
1985	557	11,967	12,524	45	654	2	13,225
1986	484	11,979	12,463	64	477	1	13,005
1987	443	15,880	16,323	29	262	43	16,657
1988	391	10,872	11,263	42	435	24	11,764
1989	917	11,662	12,579	29	675	-	13,283
1990	1,016	17,829	18,845	49	456	73	19,423
1991	871	12,463	13,334	56	527	97	14,041
1992	555	10,675	11,230	66	959	1	12,256
1993	261	3,581	3,842	42	756	1	4,641
1994	174	5,391	5,565	21	440	1	6,027
1995	85	9,029	9,114	24	431	1	9,570
1996	55	2,668	2,723	21	182	-	2,926
1997	38	568	606	18	94	-	718
1998	35	847	882	16	81	-	979
1999	37	1,199	1,236	15	111	-	1,362
2000	59	386	445	17*	138	1	622
2001	61	n/a	n/a	27*	126	+	214
2002	101	n/a	n/a	23*	127	1	252
2003	93	n/a	n/a	20*	71	2	186

*Preliminary.

Figure 5.1.2.1 Whiting in VI and VIId. Proportion by number in total catch at age.

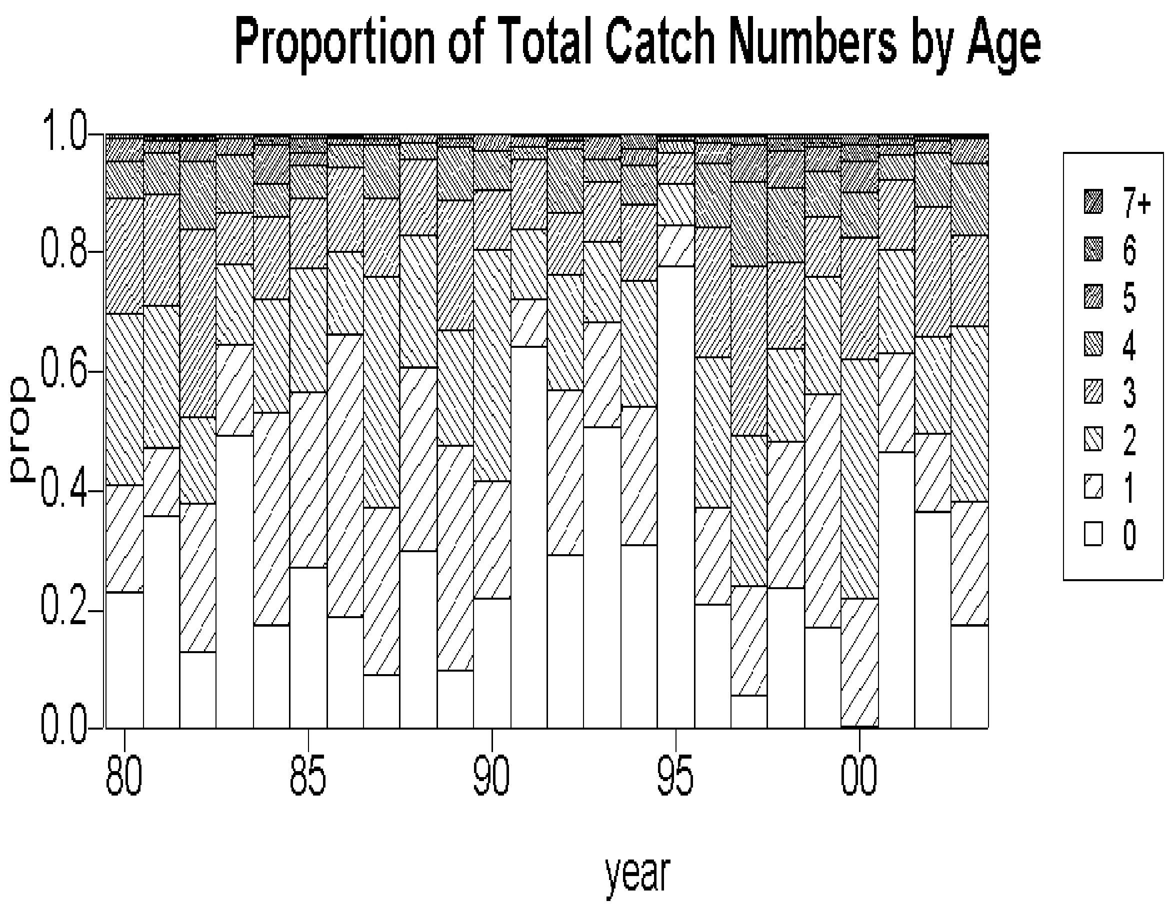


Figure 5.1.2.2 Whiting in VI and VIId. Mean weights at age (kg).

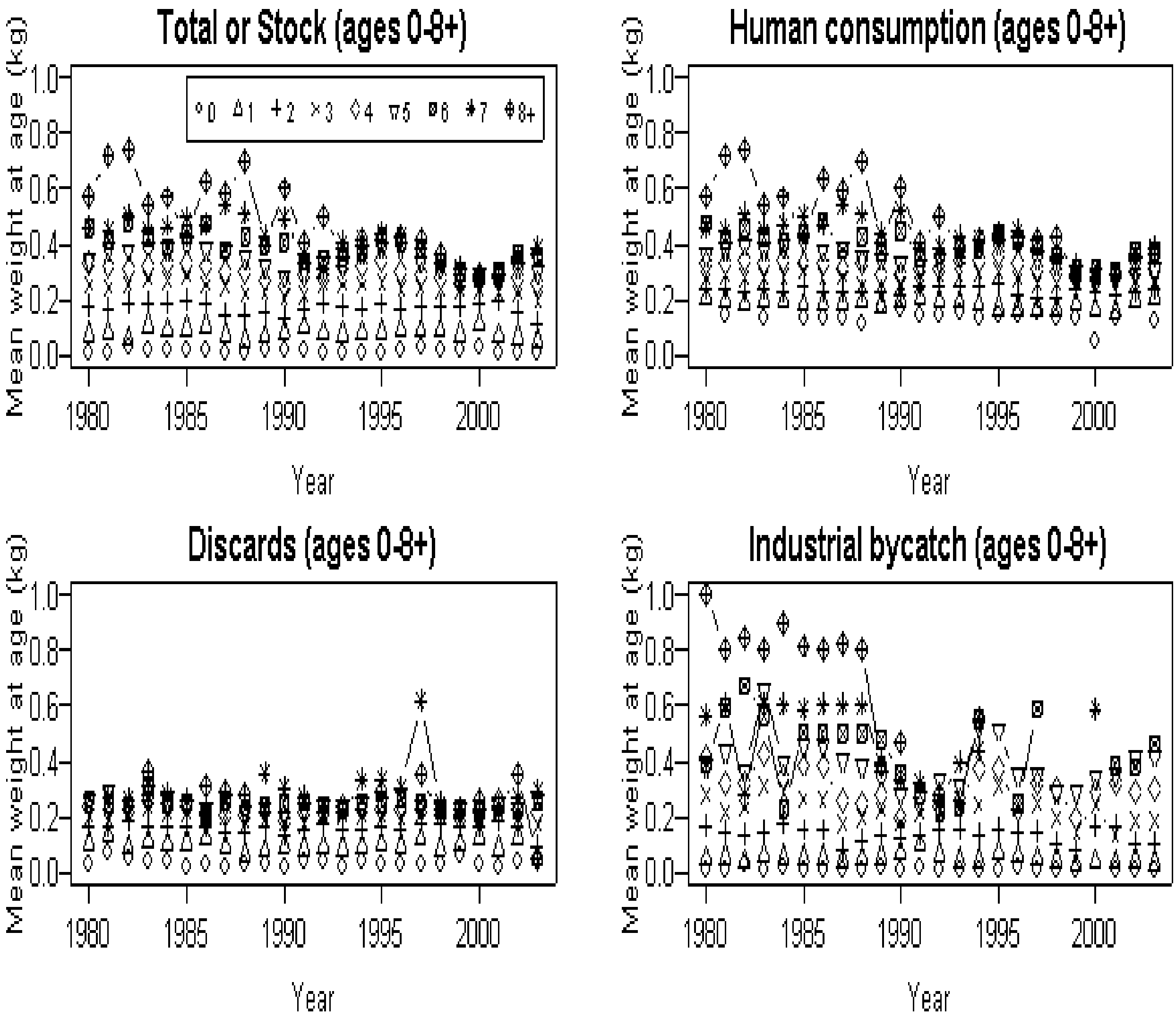


Figure 5.1.3.1 Whiting in IV and VIId. Mean standardised indices and total catch. Ages 0 to 7.

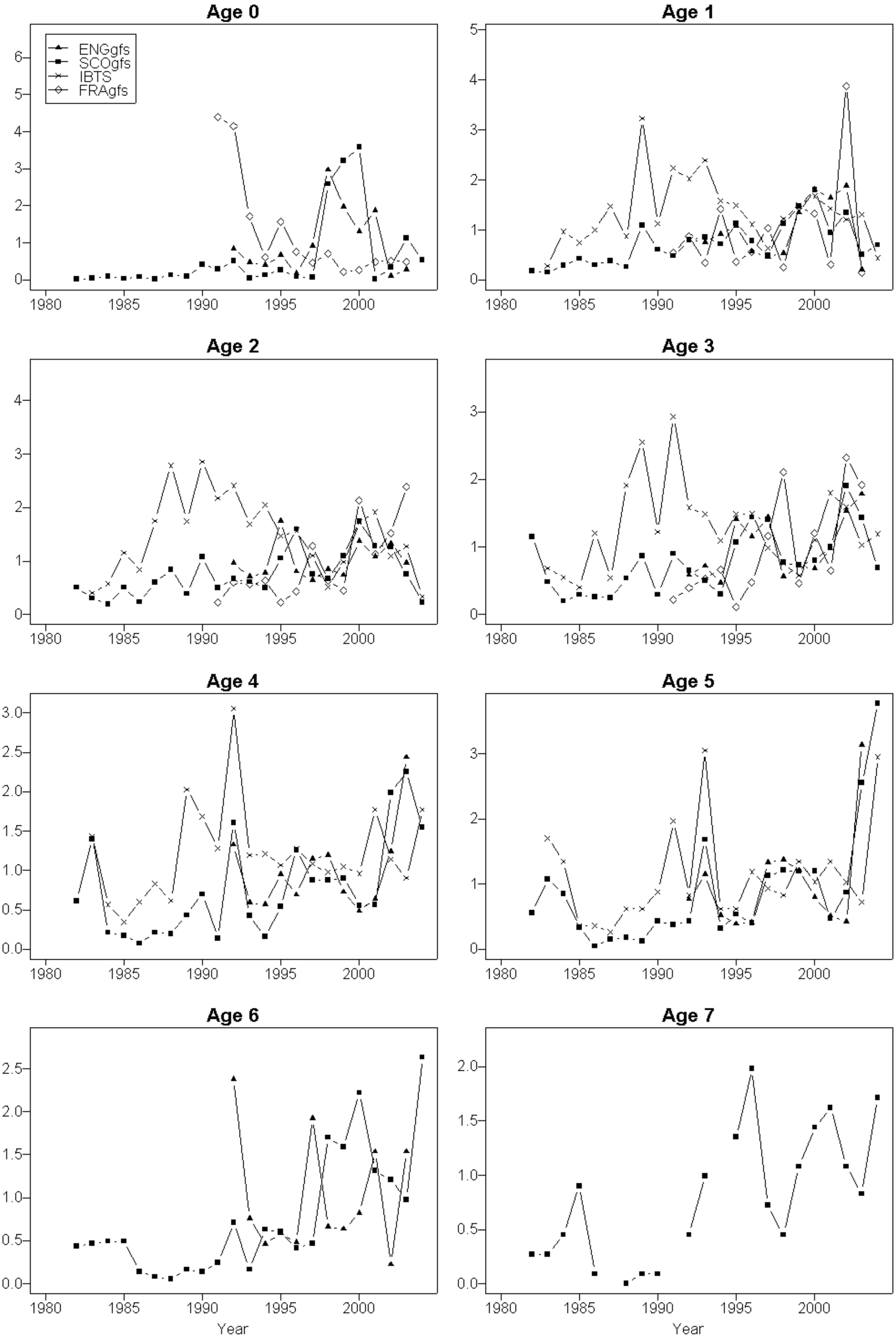


Figure 5.1.3.2 Whiting in IV and VIId. Mean standardised indices and total catch by cohort. Ages 1 to 6 for ScoGFS, EngGFS and IBTS Q1. Ages 0 to 3 for FraGFS.

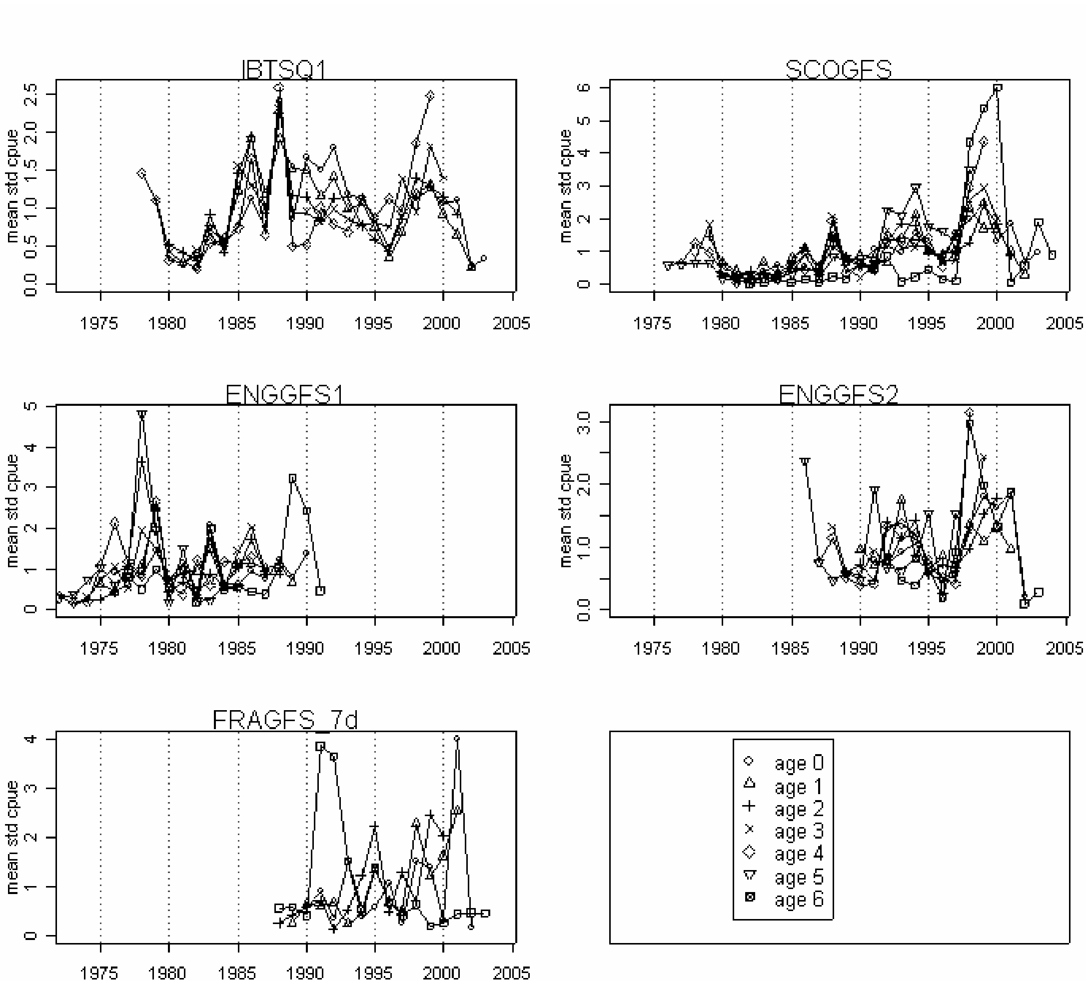


Figure 5.1.3.3 Whiting: Log CPUE by cohort, ScoGFS, IBTS Q1, EngGFS(pre 1992), EngGFS(1992 and later) and FraGFS.

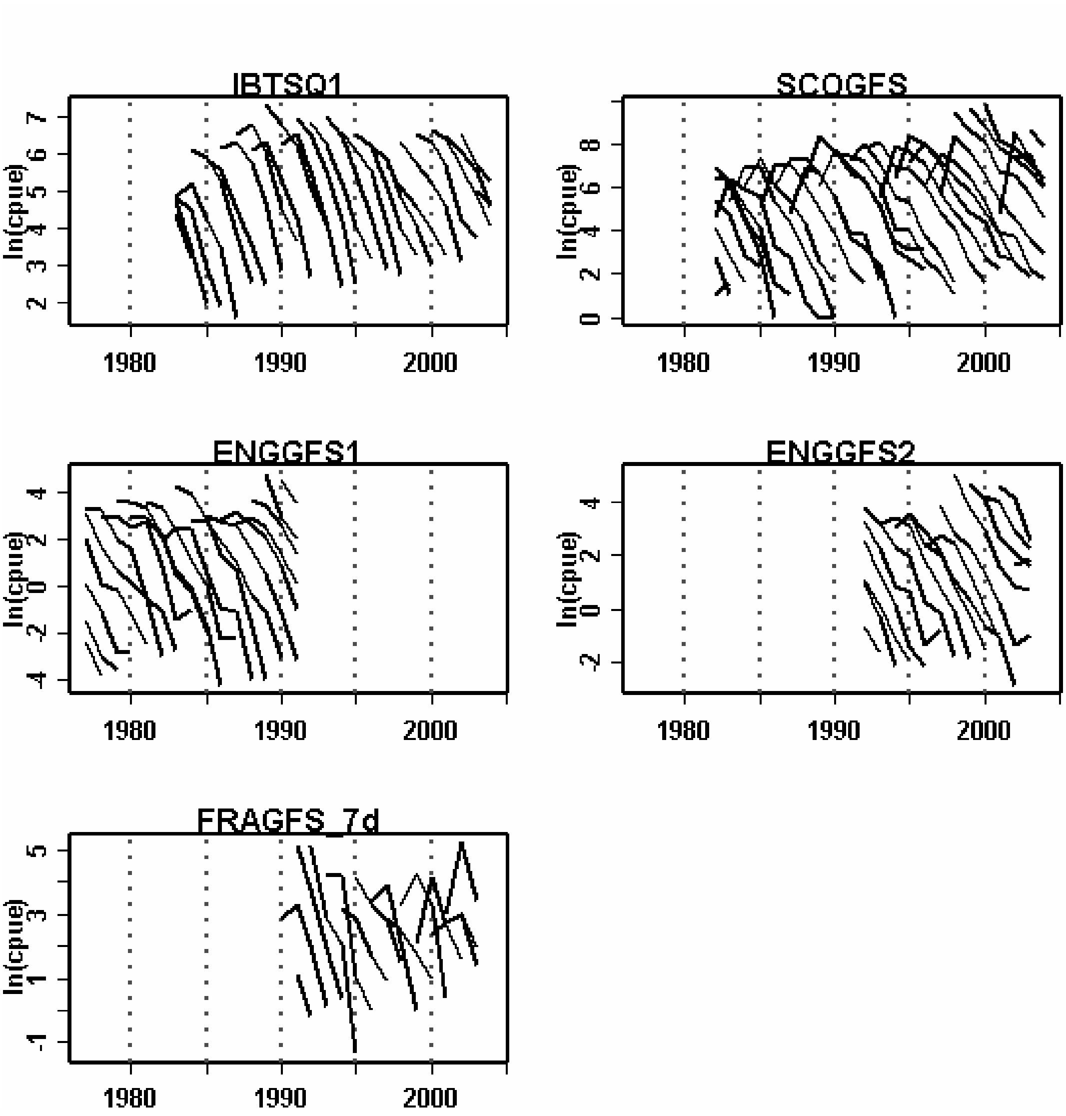


Figure 5.1.3.4 Empirical Z estimates, EngGFS, ScoGFS and IBTS Q1. Thick lines are loess smooths that have been fitted through each time series. The span of the smoother was adjusted for the EngGFS so that the degree of smoothing applied was roughly equivalent between this series and the other two.

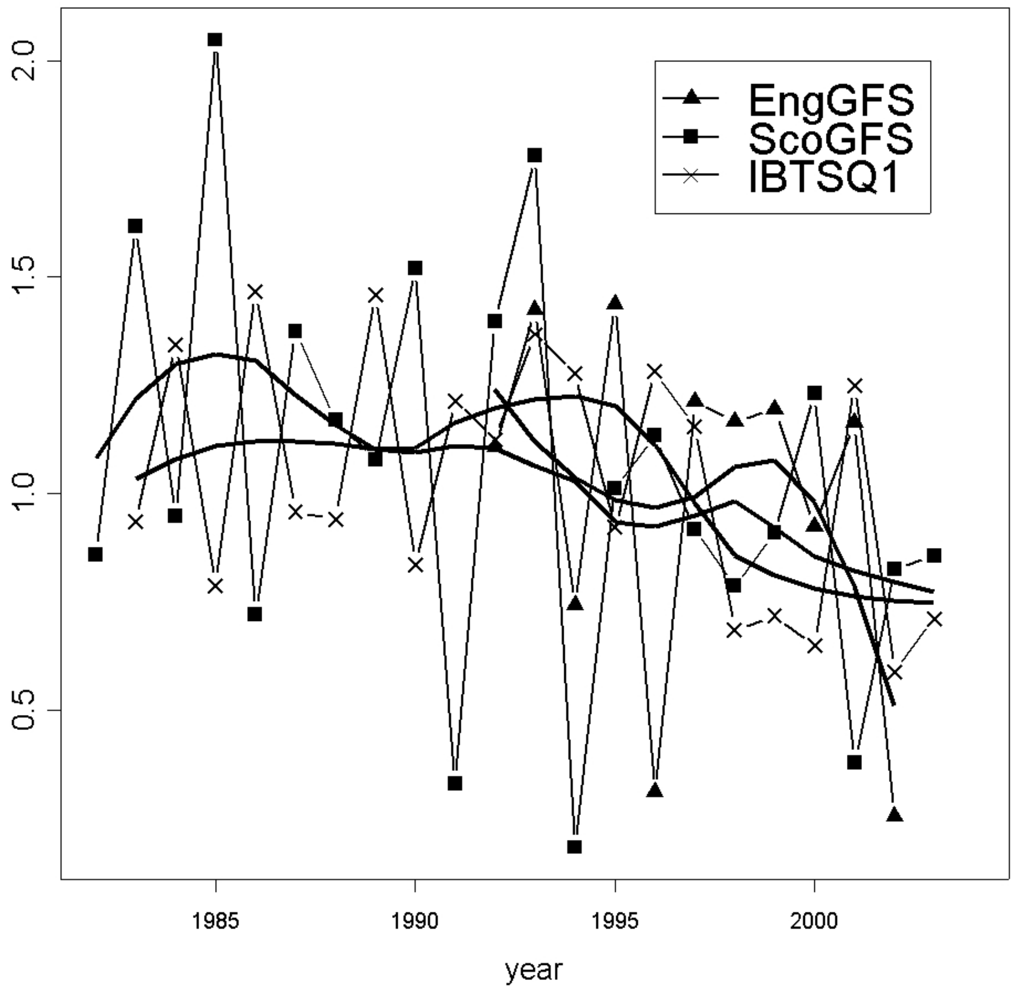


Figure 5.1.3.5 Mean standardised empirical SSB estimates, EngGFS, ScoGFS and IBTS Q1.

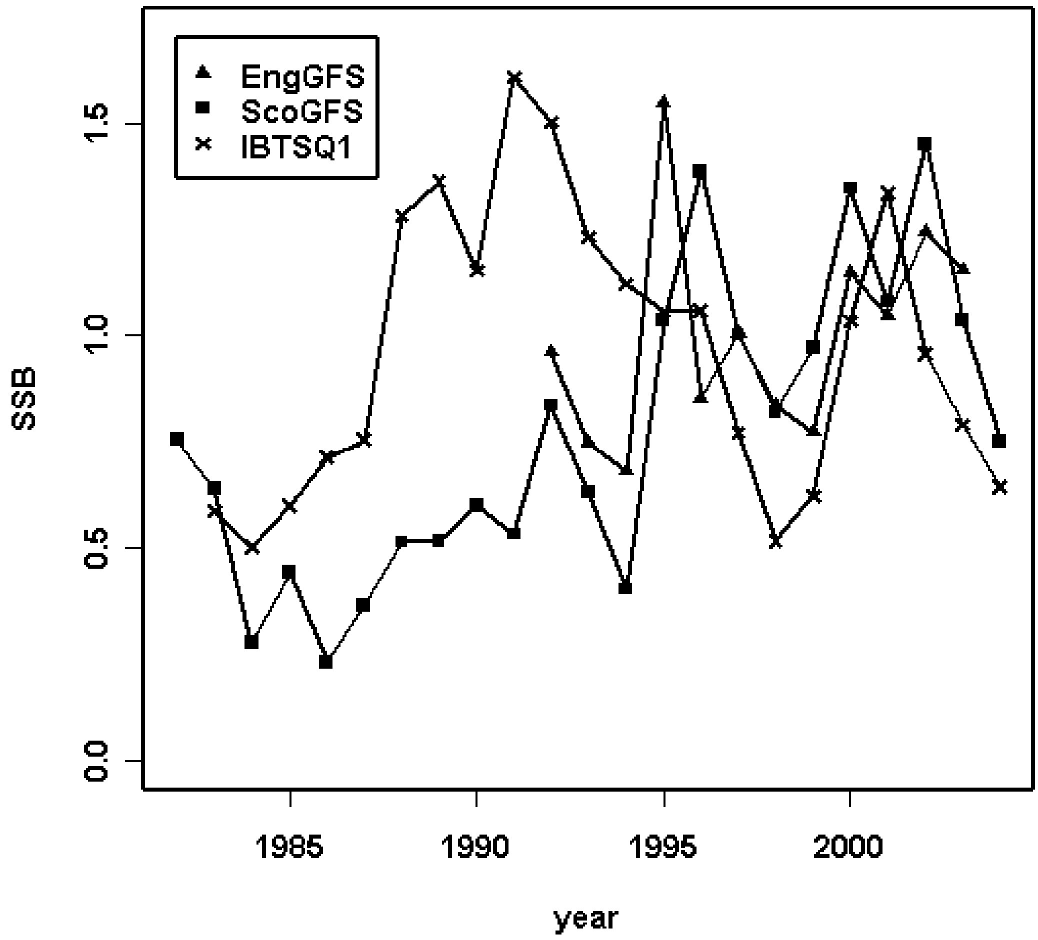


Figure 5.1.4.1 Whiting: catches by category.

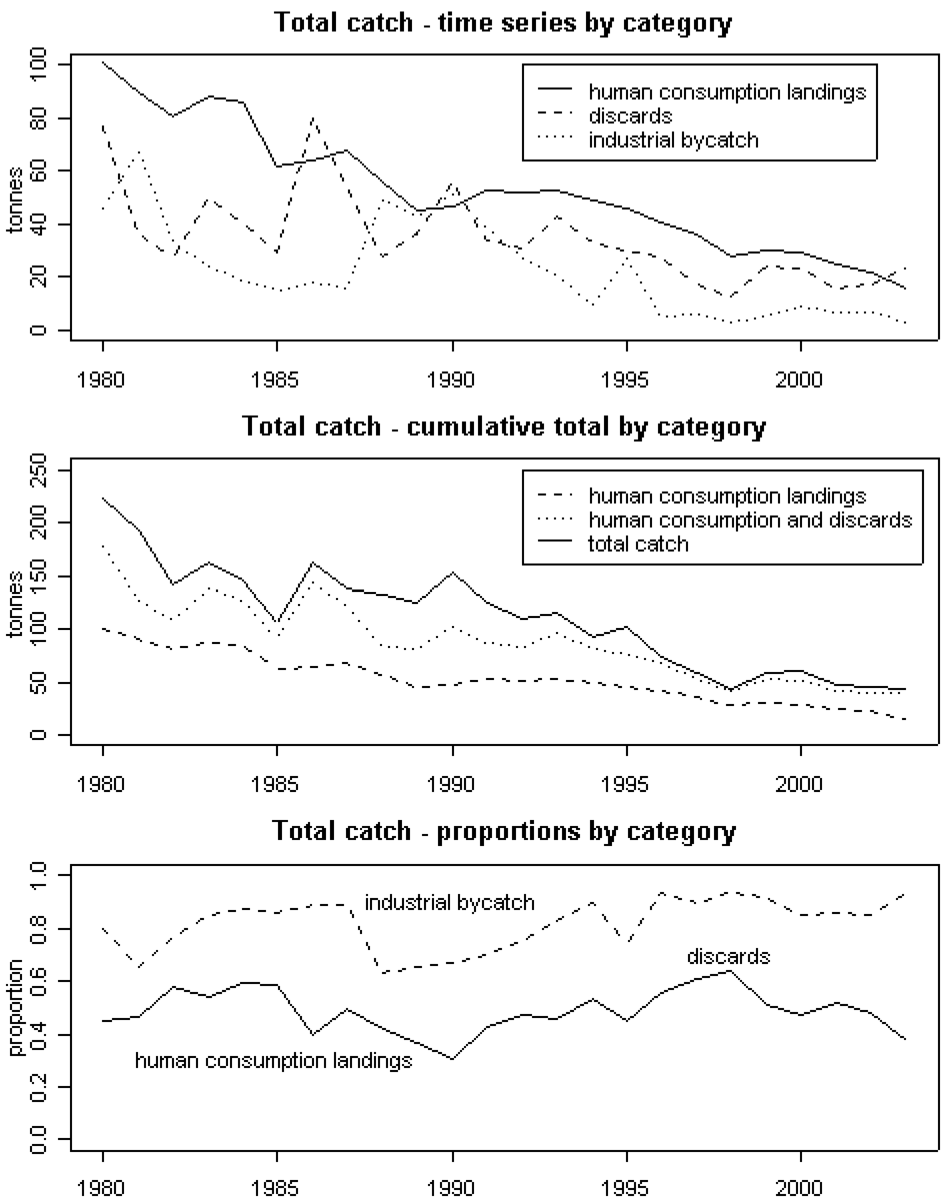


Figure 5.1.4.2 Whiting: landings in Sub-area IV by the Scottish fleet and fleets from all other nations combined. Landings in division VIId by all fleets.

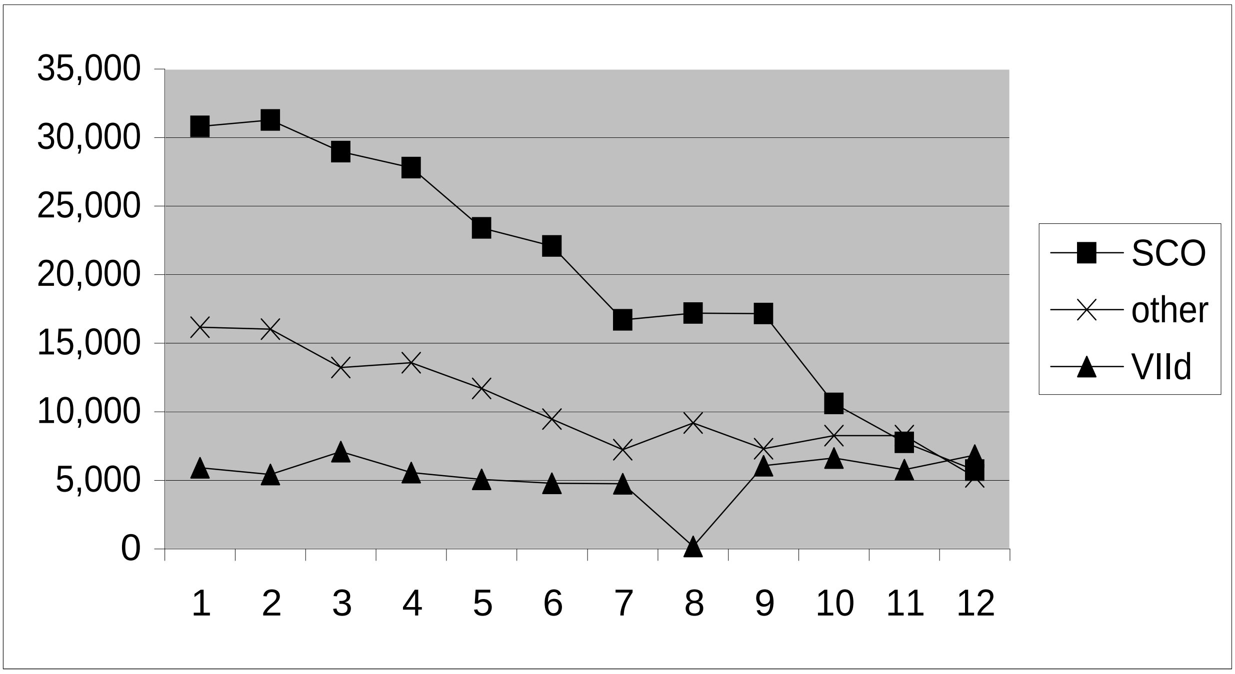


Figure 5.1.4.3 Whiting in IV and VIId. Mean standardised total catch. Ages 0 to 7.

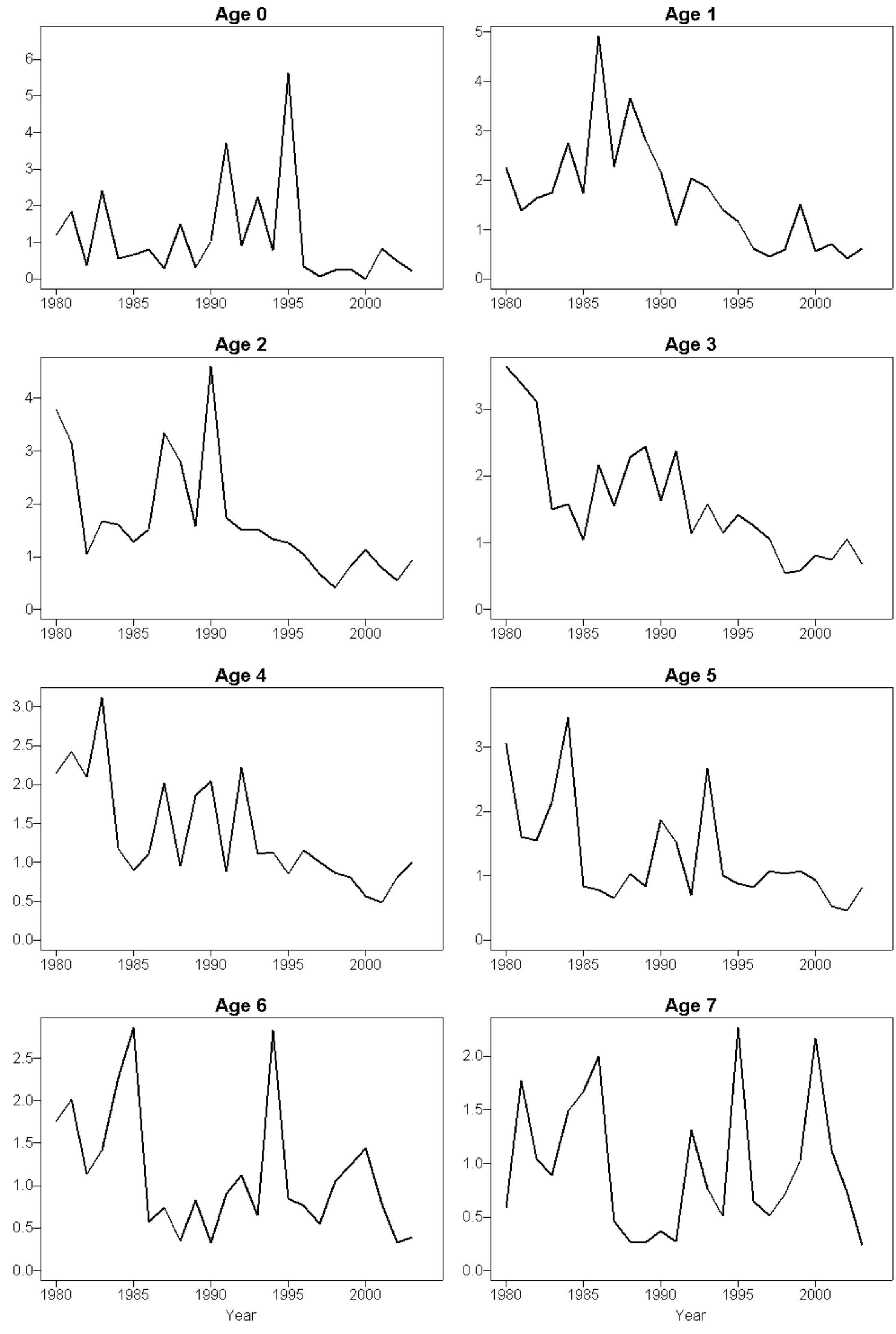


Figure 5.1.4.4 Comparison of discards as percentage of human consumption catches from English data (thick dashed lines) and international data assuming all discard rates are the same as for the Scottish fleet (thin solid line).

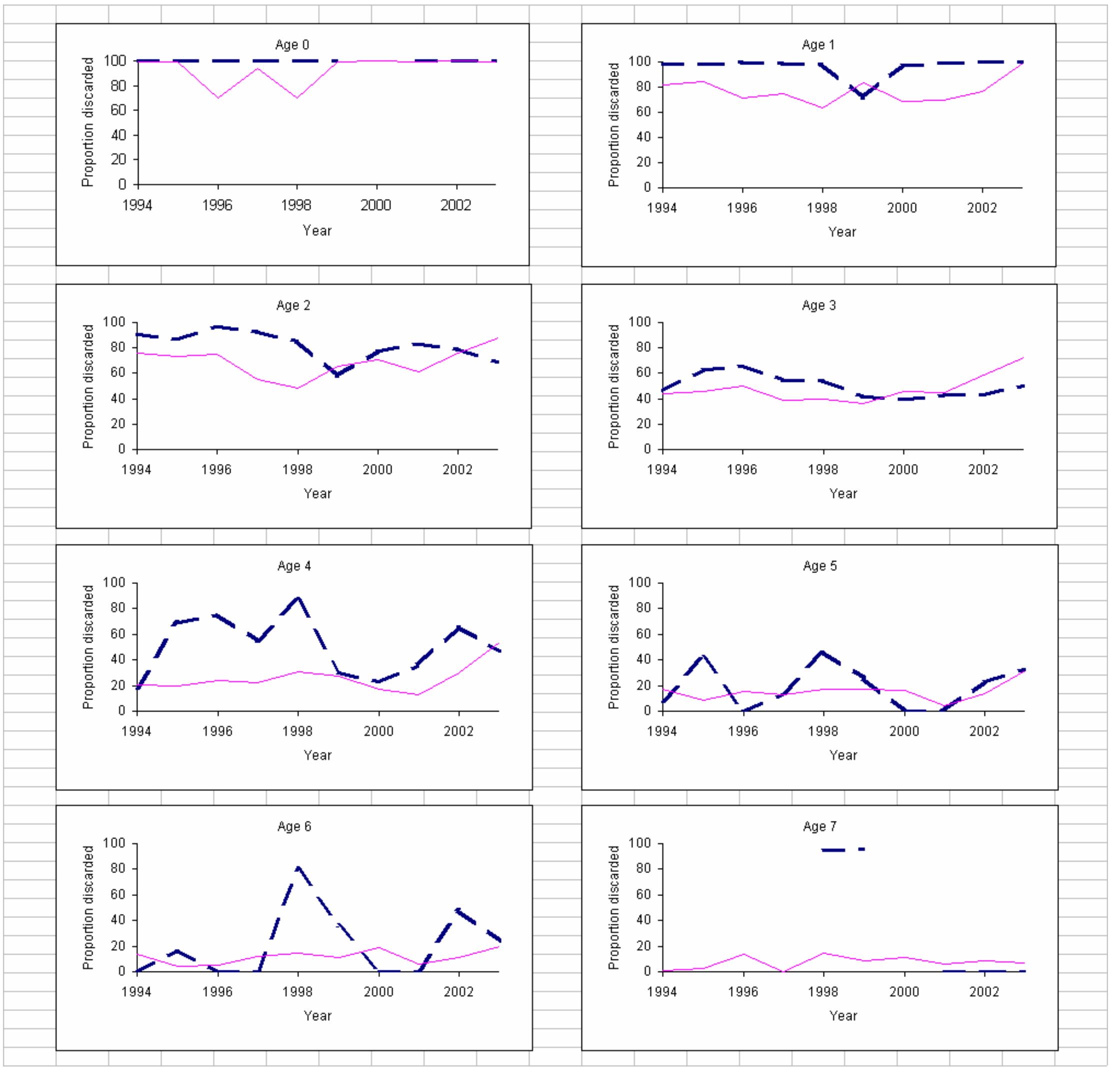


Figure 5.1.4.5 Landings and discards of whiting from the French Otter trawl fleet.

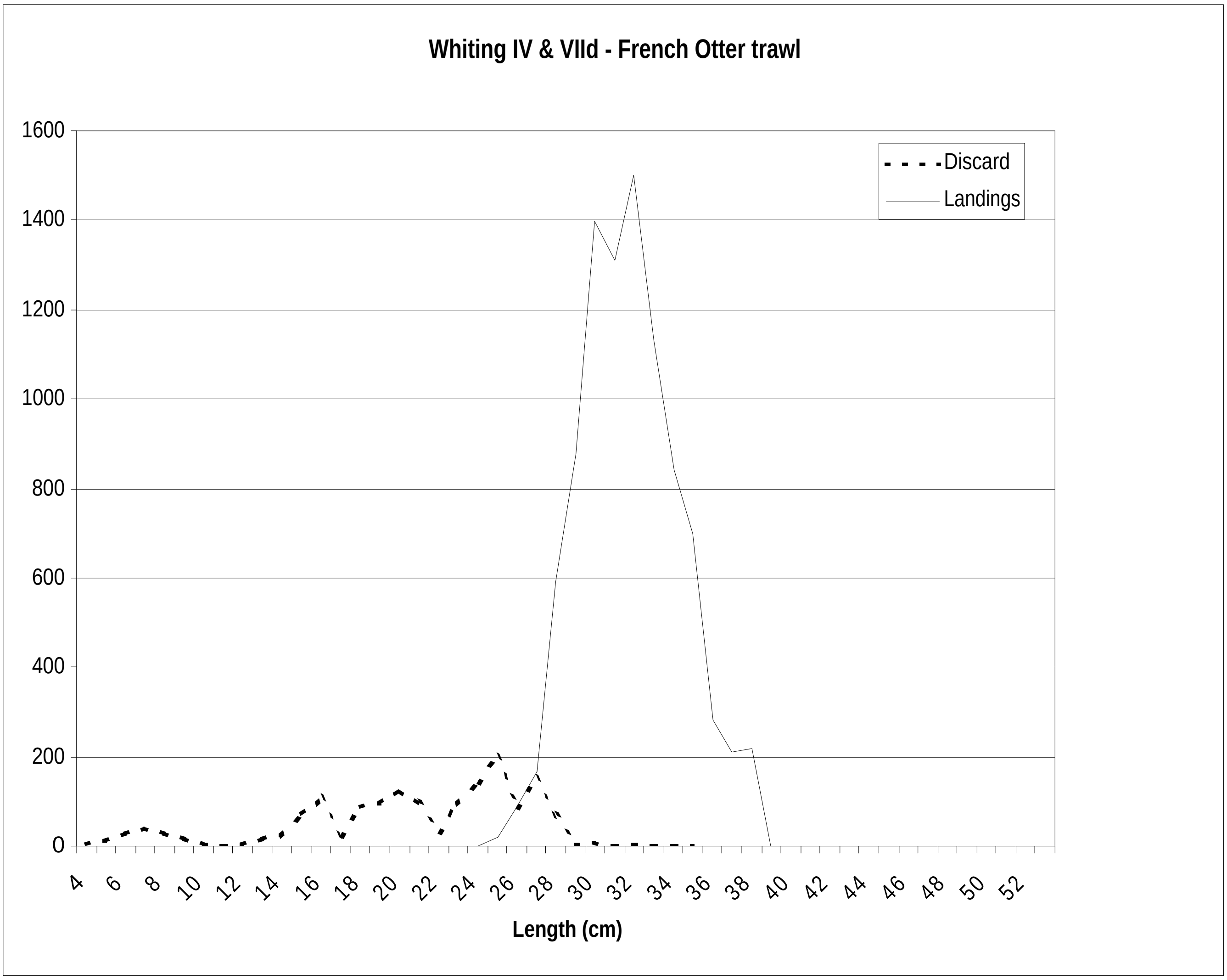


Figure 5.1.4.6 Landings and discards of whiting from the French Gillnet fleet.

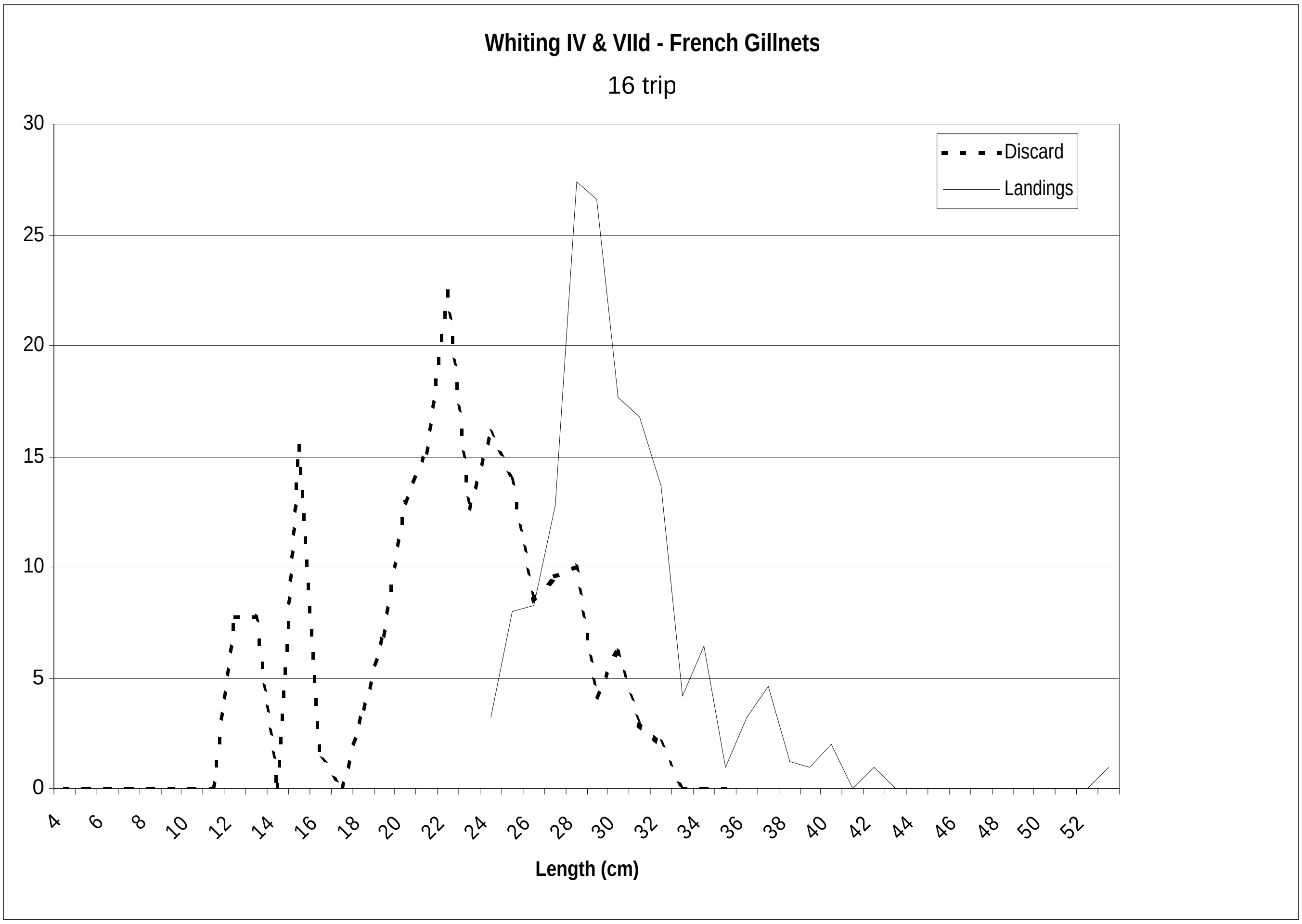


Figure 5.1.5.1 Whiting separable VPA Residuals: all ages; years 1980-2003

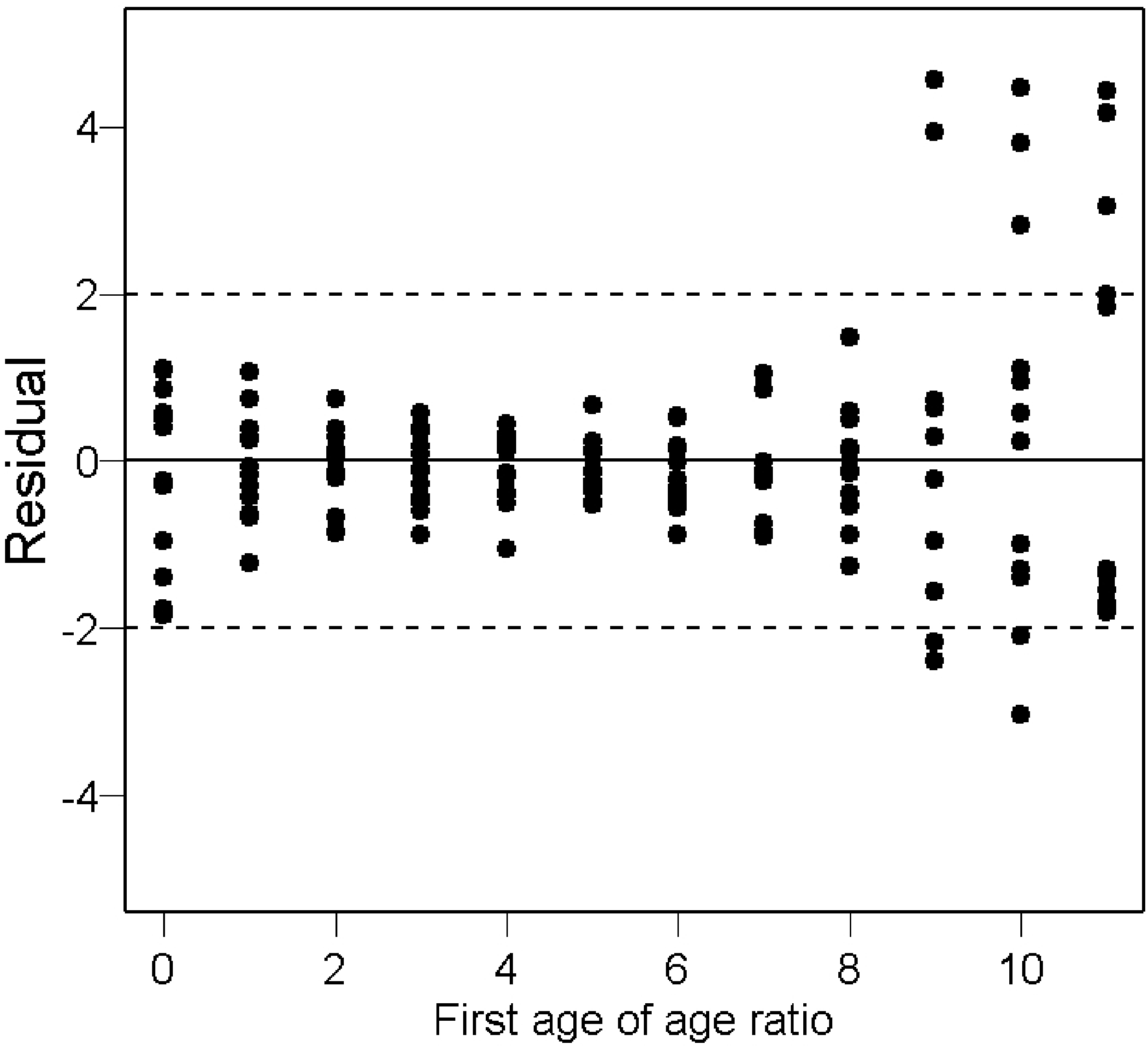


Figure 5.1.5.2 Single-fleet Laurec-Shepherd. Plots of residual time series. IBTS Q1, ScoGFS, EngGFS, (pre 1992), EngGFS, (1992 and later), FraGFS.

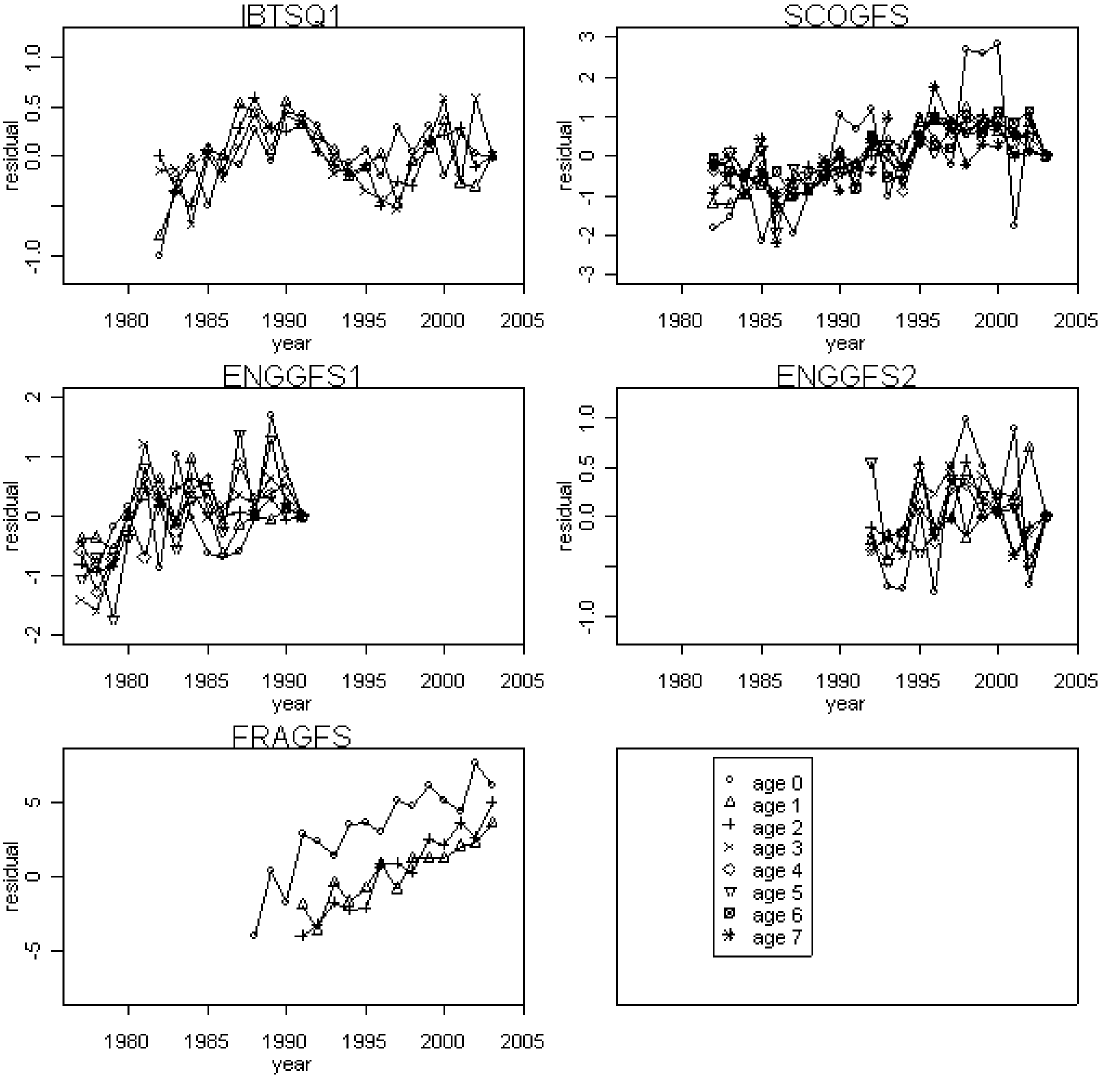


Figure 5.1.5.3 Single-fleet Laurec-Shepherd. Scatter plots of log survey index against log estimated numbers at age. IBTS Q1.

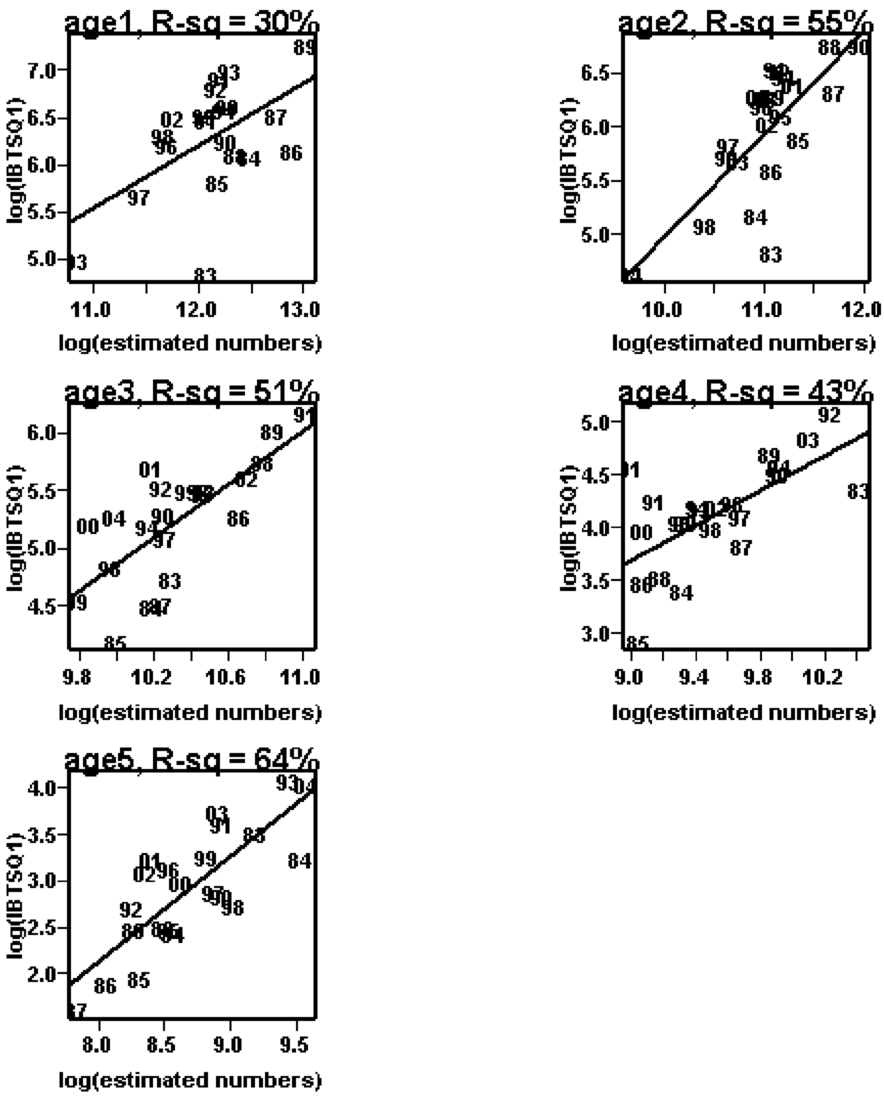


Figure 5.1.5.4 Single-fleet Laurec-Shepherd. Scatter plots of log survey index against log estimated numbers at age. ScoGFS.

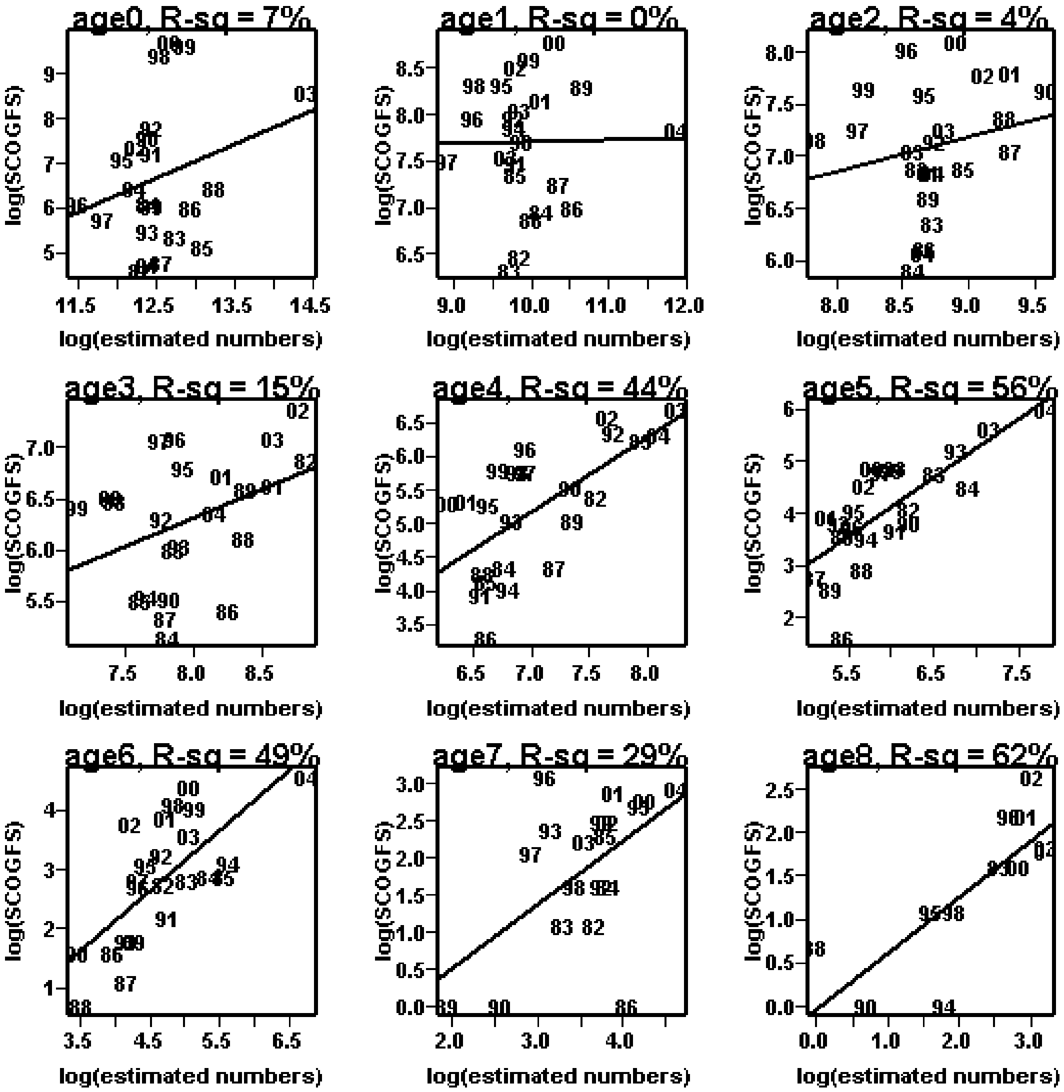


Figure 5.1.5.5 Single-fleet Laurec-Shepherd. Scatter plots of log survey index against log estimated numbers at age. EngGFS, (pre 1992)

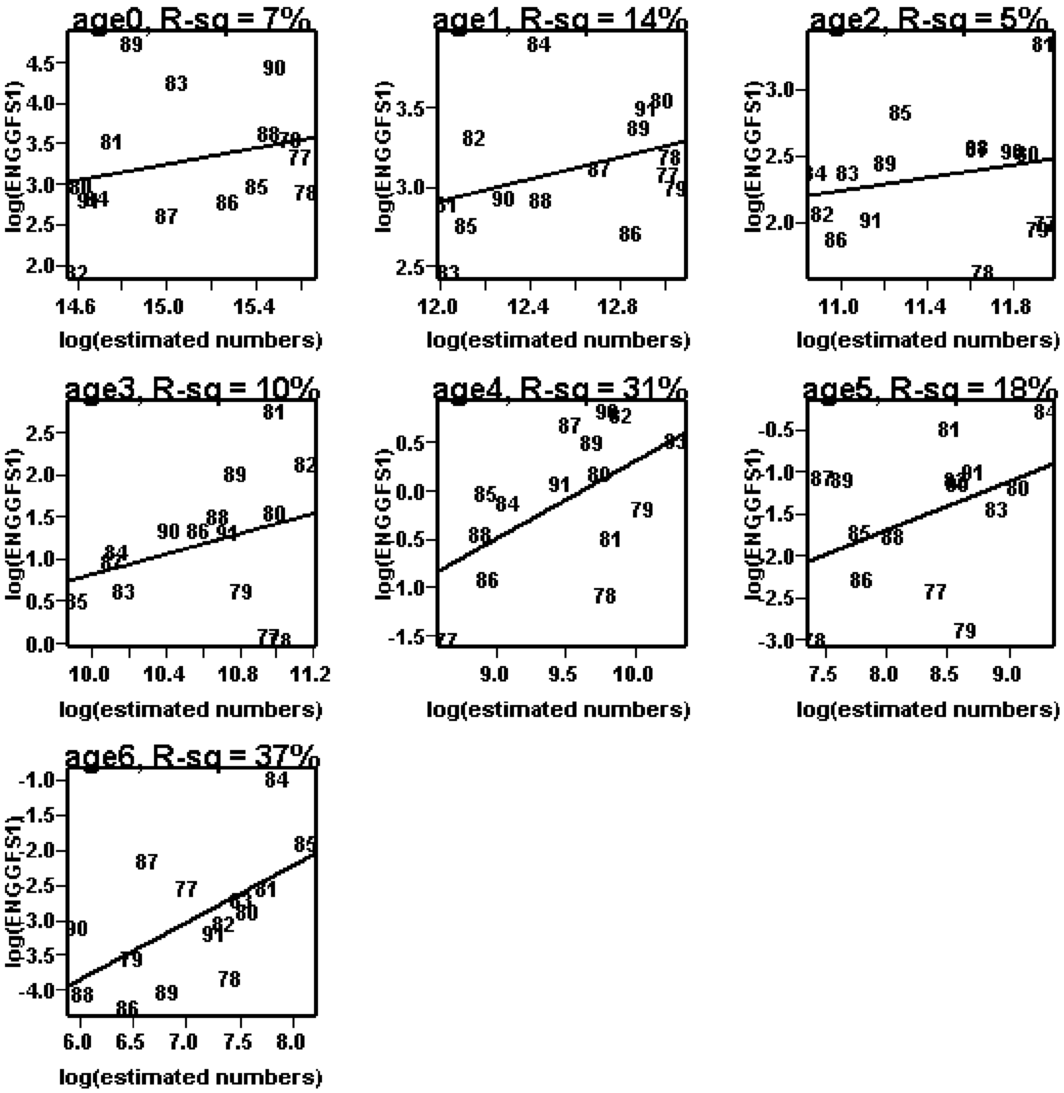


Figure 5.1.5.6 Single-fleet Laurec-Shepherd. Scatter plots of log survey index against log estimated numbers at age. EngGFS, (1992 and later)

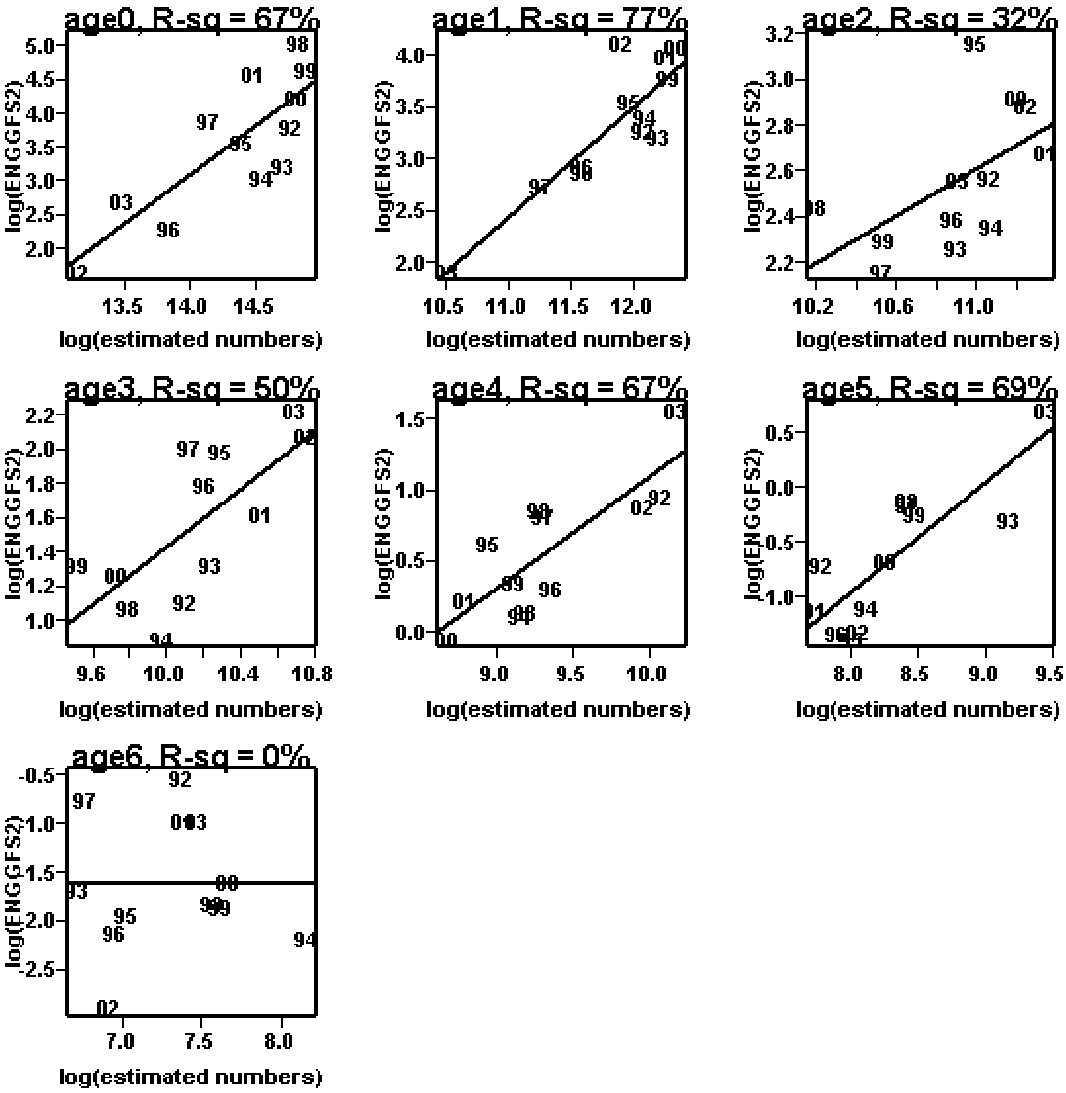


Figure 5.1.5.7 Single-fleet Laurec-Shepherd. Scatter plots of log survey index against log estimated numbers at age. FraGFS

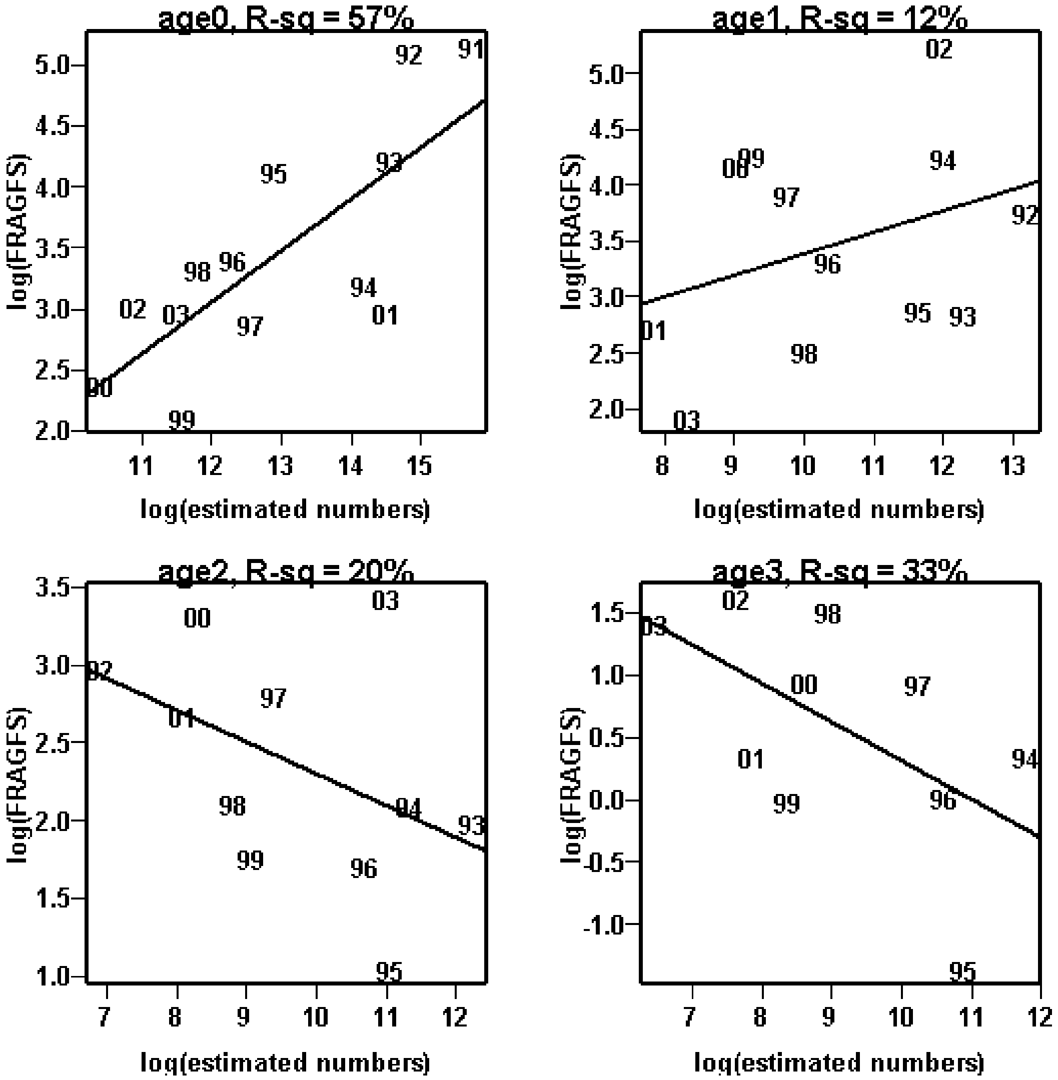


Figure 5.1.5.8 XSA runs comparing the effect of different shrinkage and plus group choices and single fleet runs. For runs where choice of the plus group is at age 6, mean F is required to be calculated over ages 2-4 rather than 2-6, which is used in TSA. This results in much lower historical mean Fs.

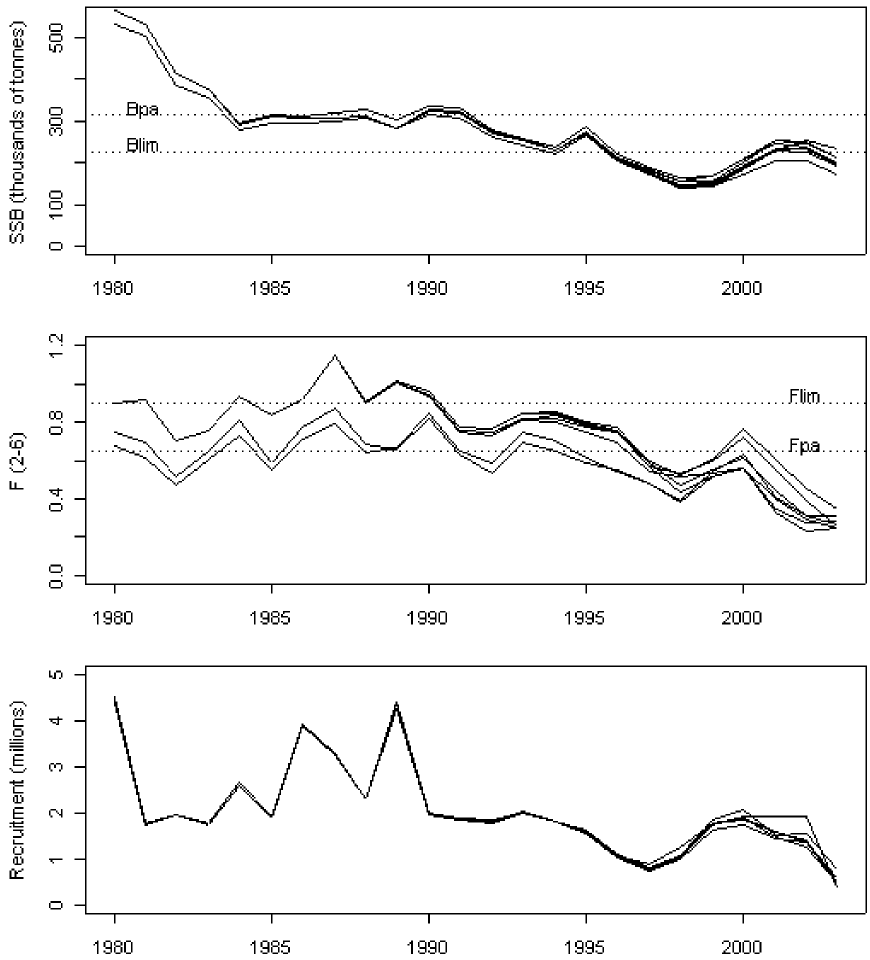


Figure 5.1.5.9 XSA Log catchability residuals.

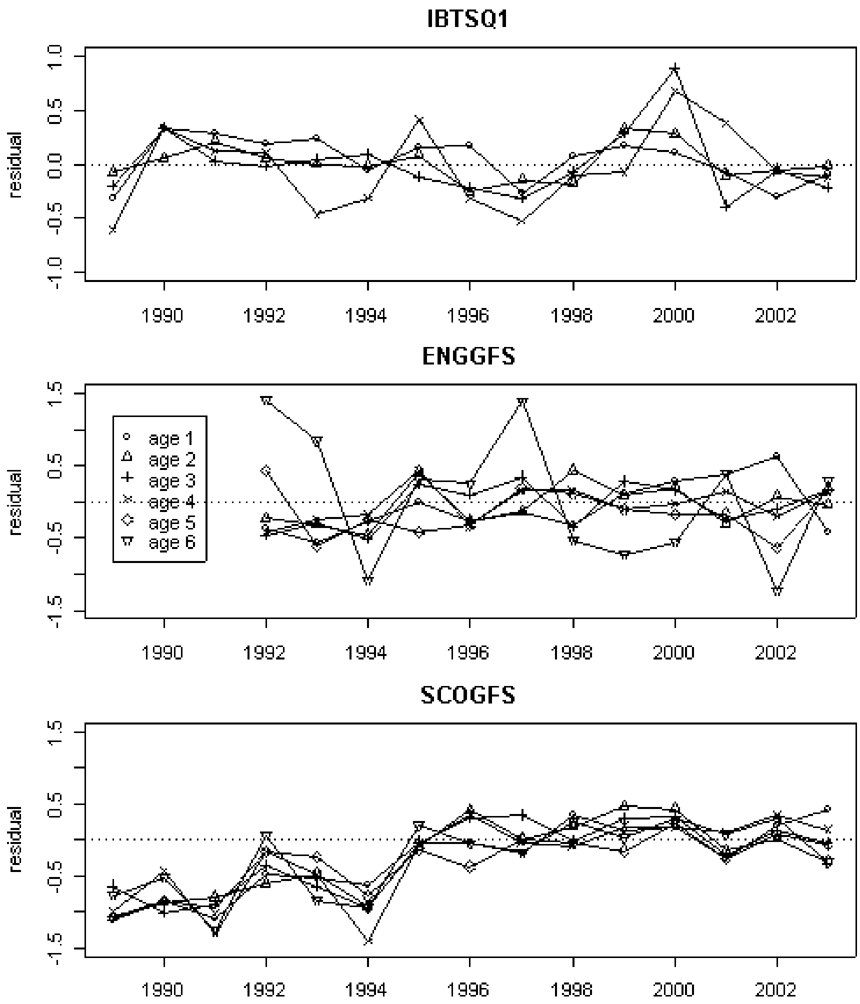


Figure 5.1.5.10 XSA retrospectives for run 3.

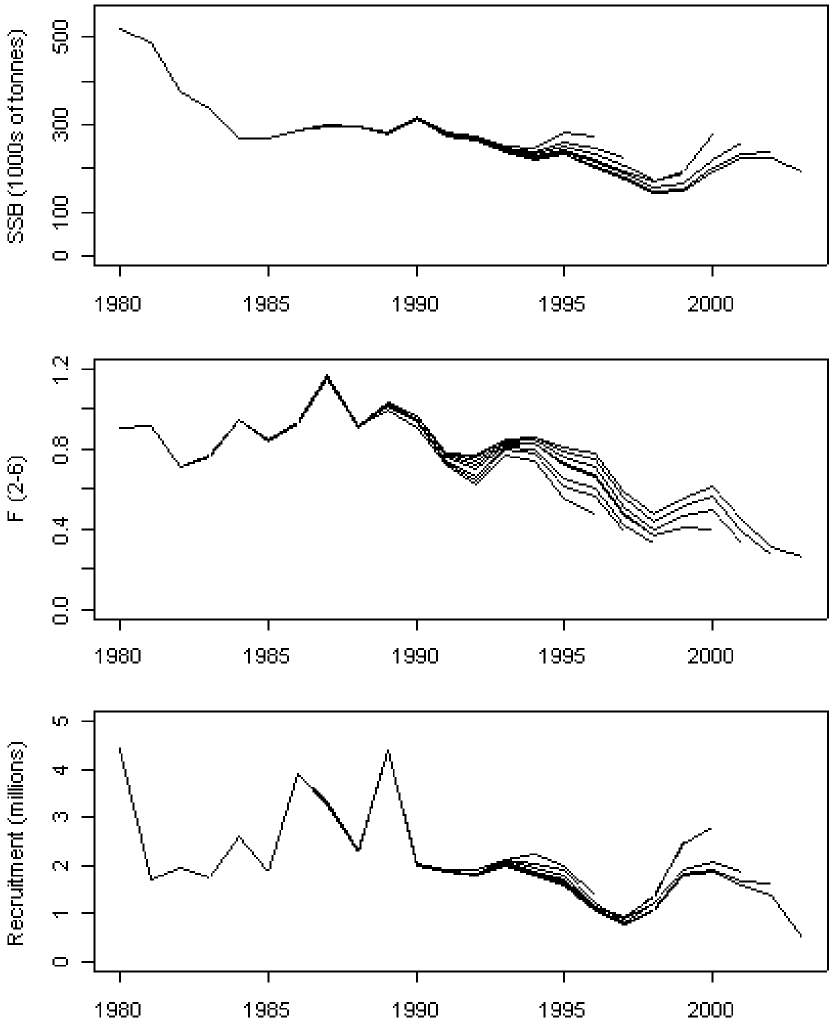


Figure 5.1.5.11 Whiting in IV and VIId. Comparison of TSA model with separable human consumption and industrial bycatch. Grey and black lines represent a run including no surveys and a run including EngGFS, ScoGFS and IBTS Q1 survey tuning fleets respectively. 95% confidence intervals are included as dashed lines for the three survey run. The vertical dotted lines indicate the last year of catch data, all subsequent estimates are TSA forecasts. Circles on the first graph indicate total reported catches (human consumption, discards and industrial bycatch).

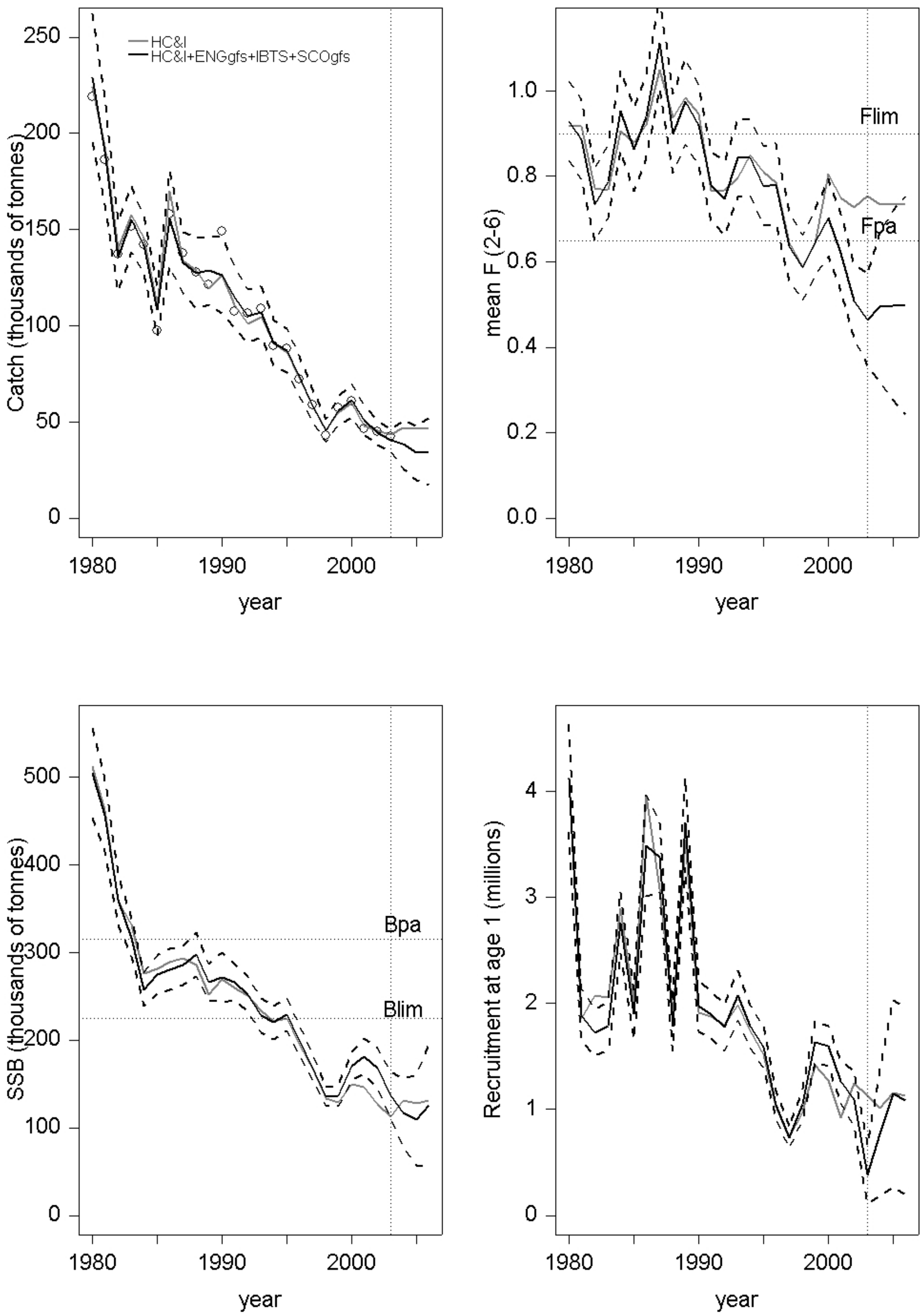


Figure 5.1.5.12 Whiting in IV and VIId. TSA run with separate industrial bycatch. Retrospective analyses for 10 years, for mean F(2-6), SSB and recruitment at age 1.

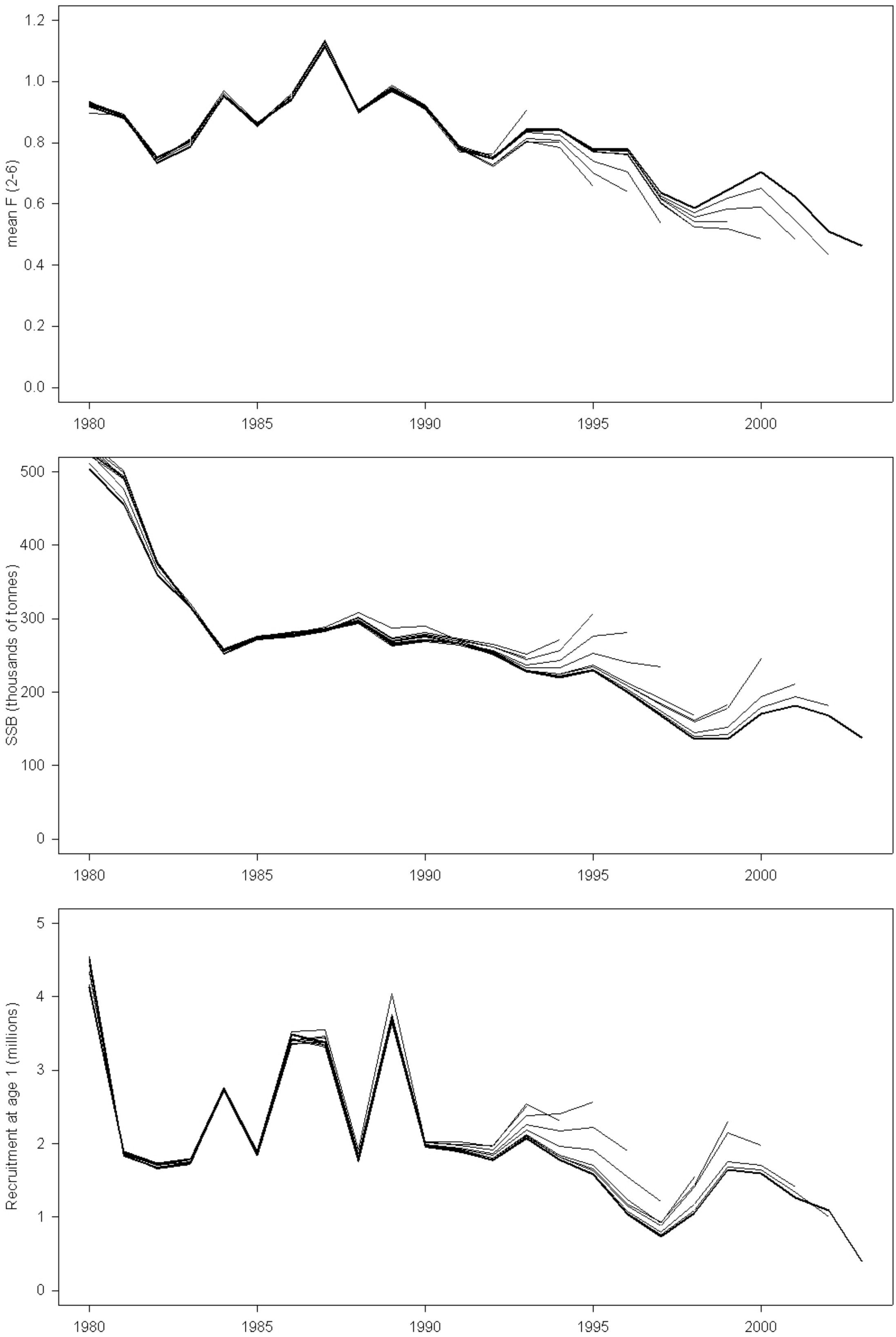


Figure 5.1.5.13 Comparison of SSB time series estimated from catch at age model runs and empirical survey SSB, mean standardised over 1992-2003.

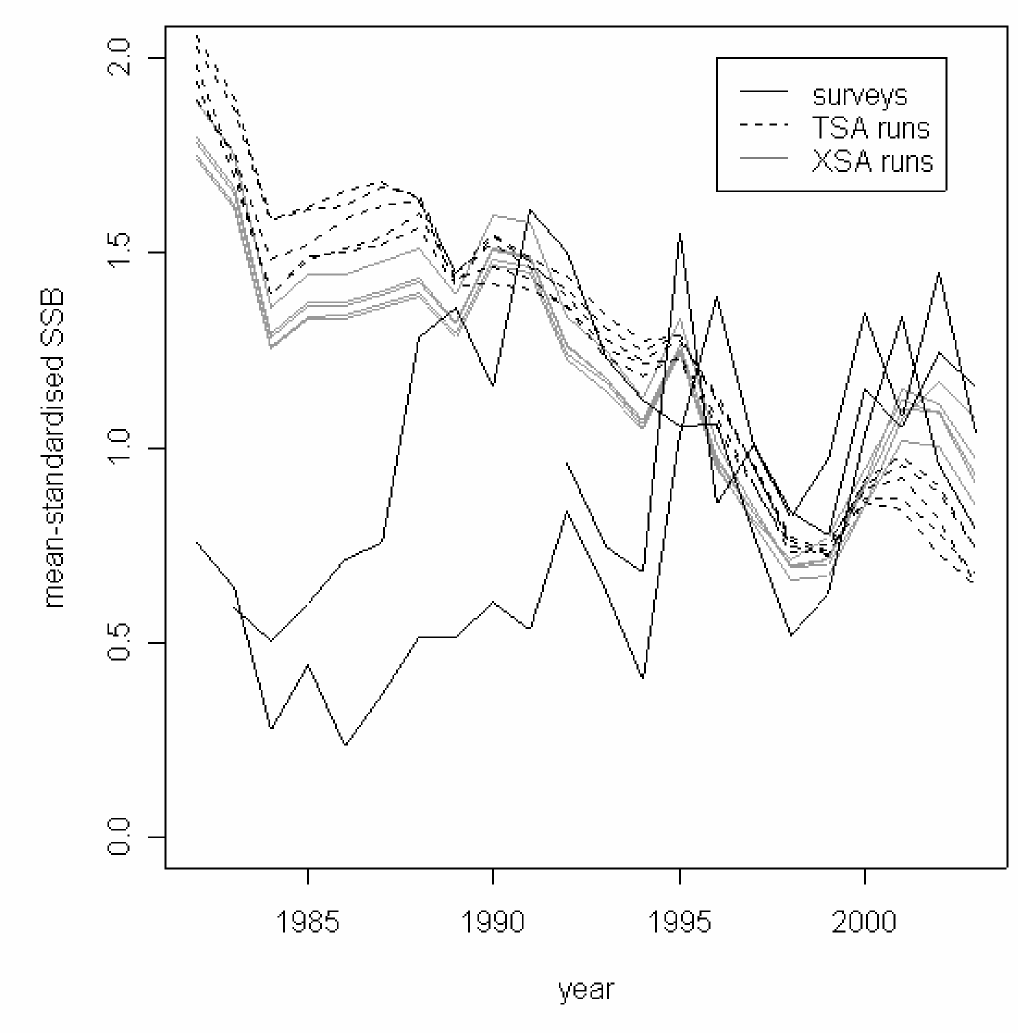


Figure 5.1.6.1 Locations and numbers caught by IBTS Q1 survey

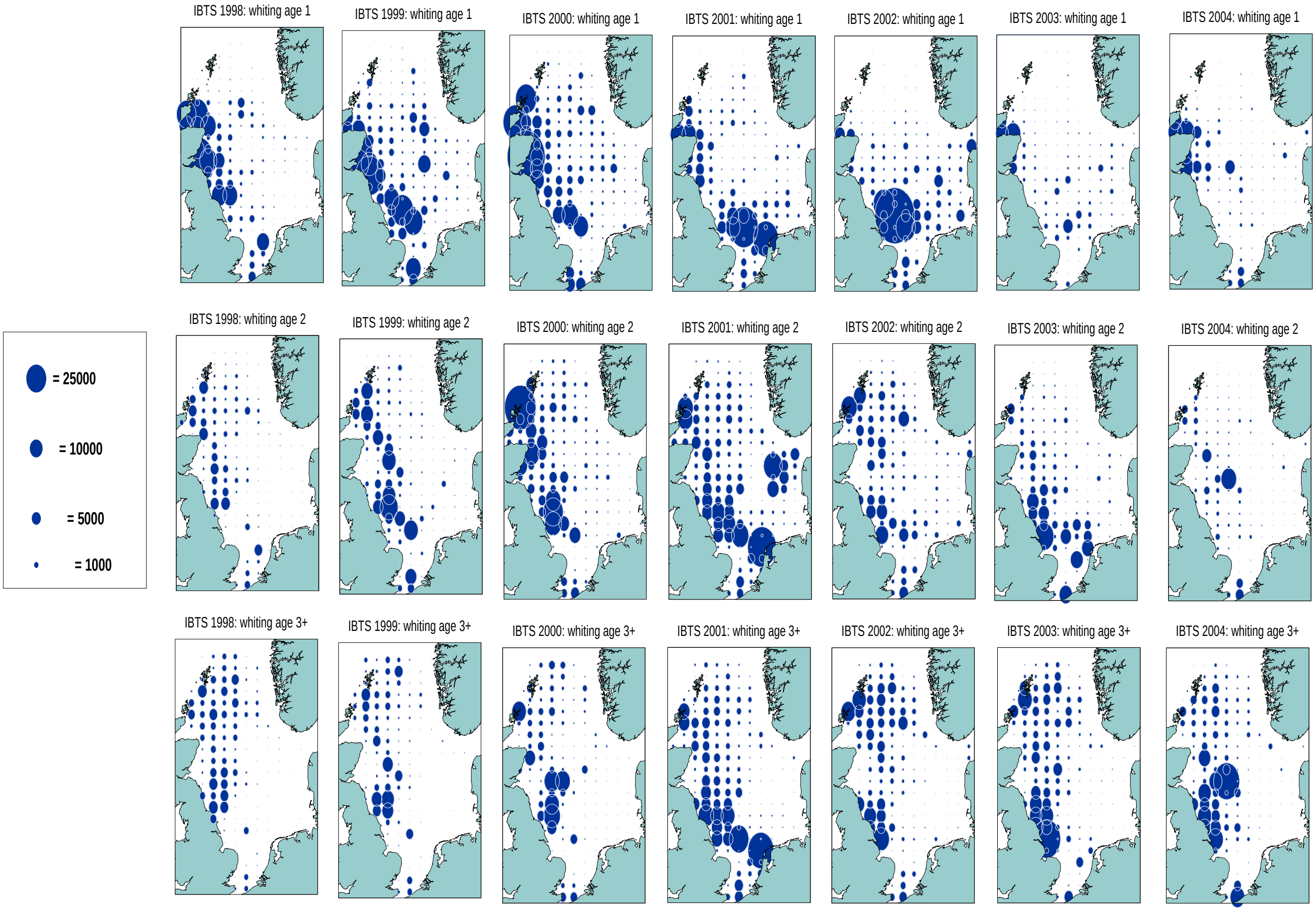


Figure 5.1.6.2 Locations and numbers caught by IBTS Q3 survey

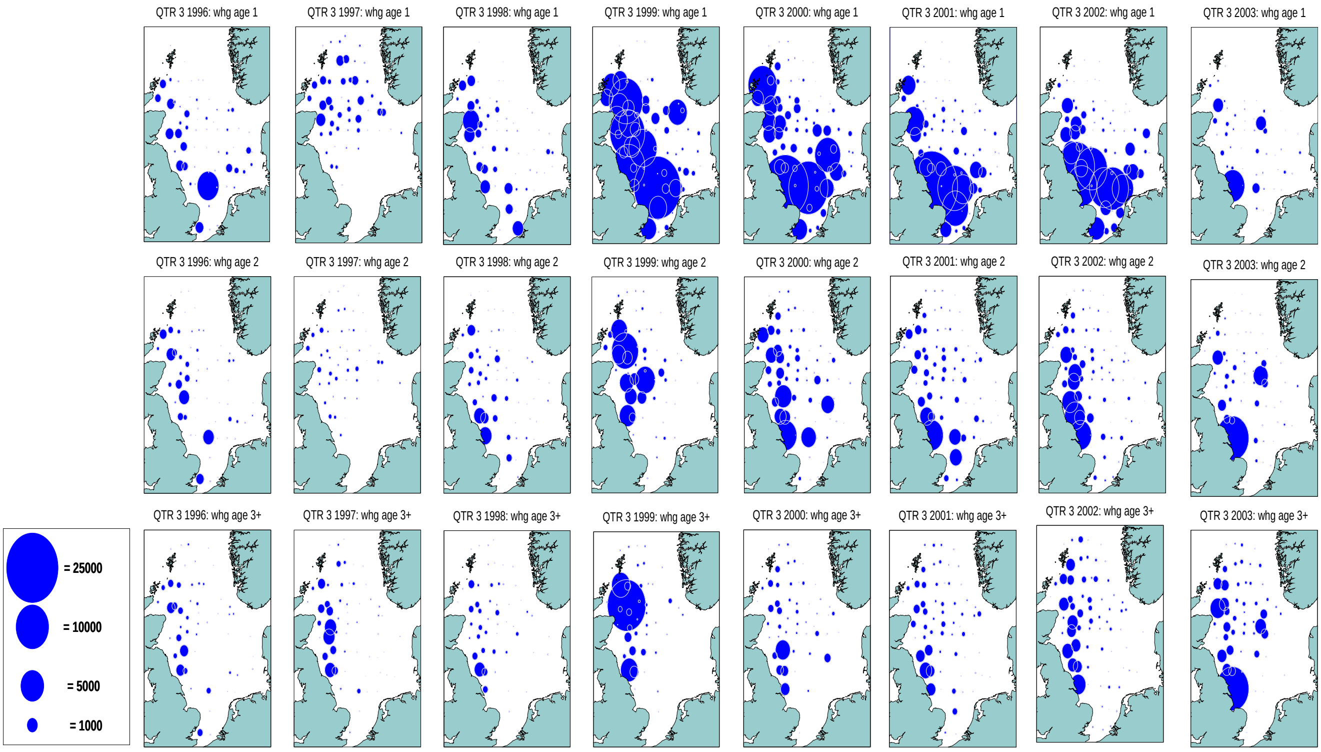


Figure 5.1.6.3 Whiting: IBTS index by ICES round fish area. Age 1

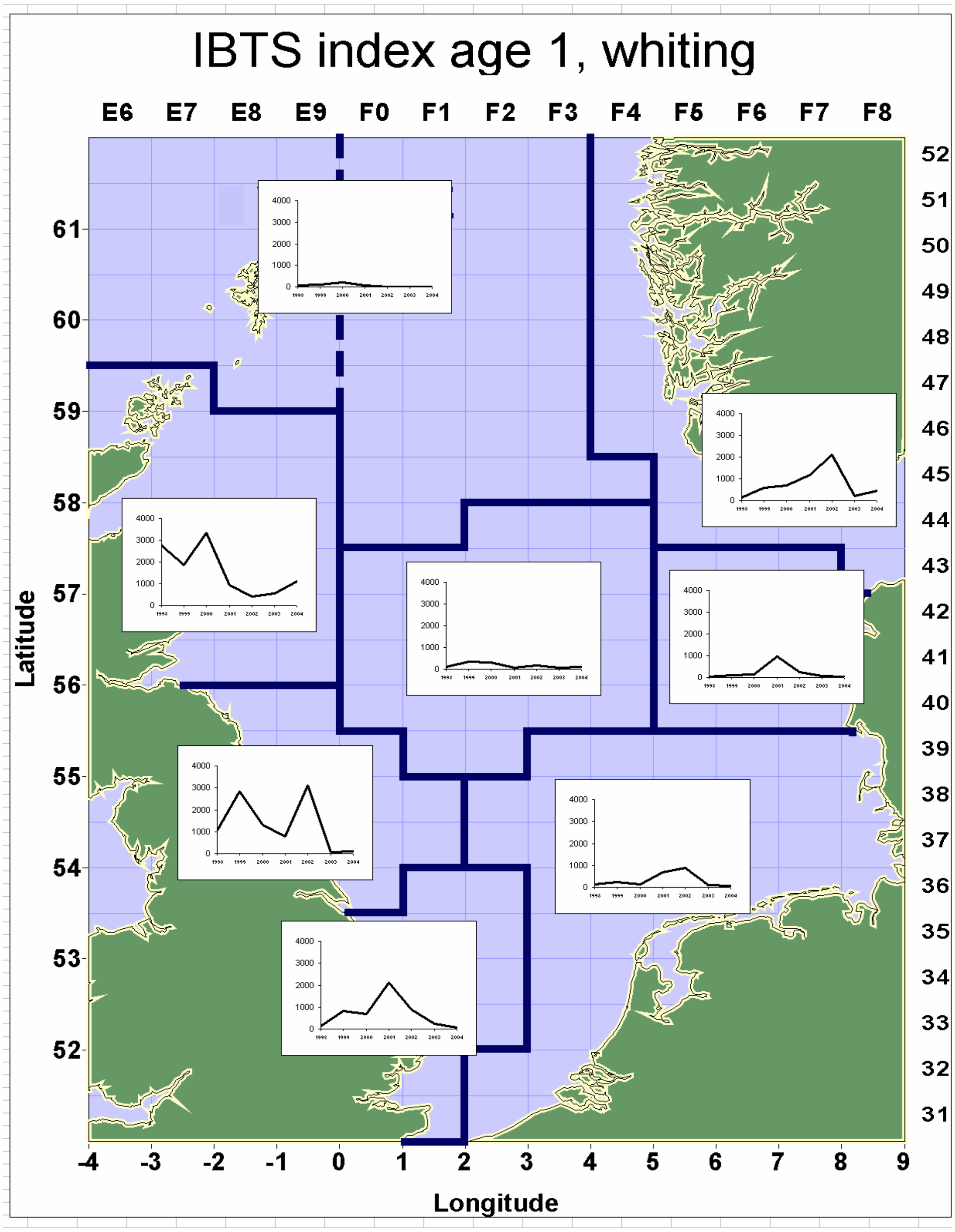


Figure 5.1.6.4 Whiting: estimate of approximate empirical SSB by ICES round fish area. This has been derived by summing (in each ICES round fish area) IBTS index numbers at age 2 and above multiplied by mean total catch weight at age. The weights at age are those derived for Sub-area IV and Division VIId as a whole.

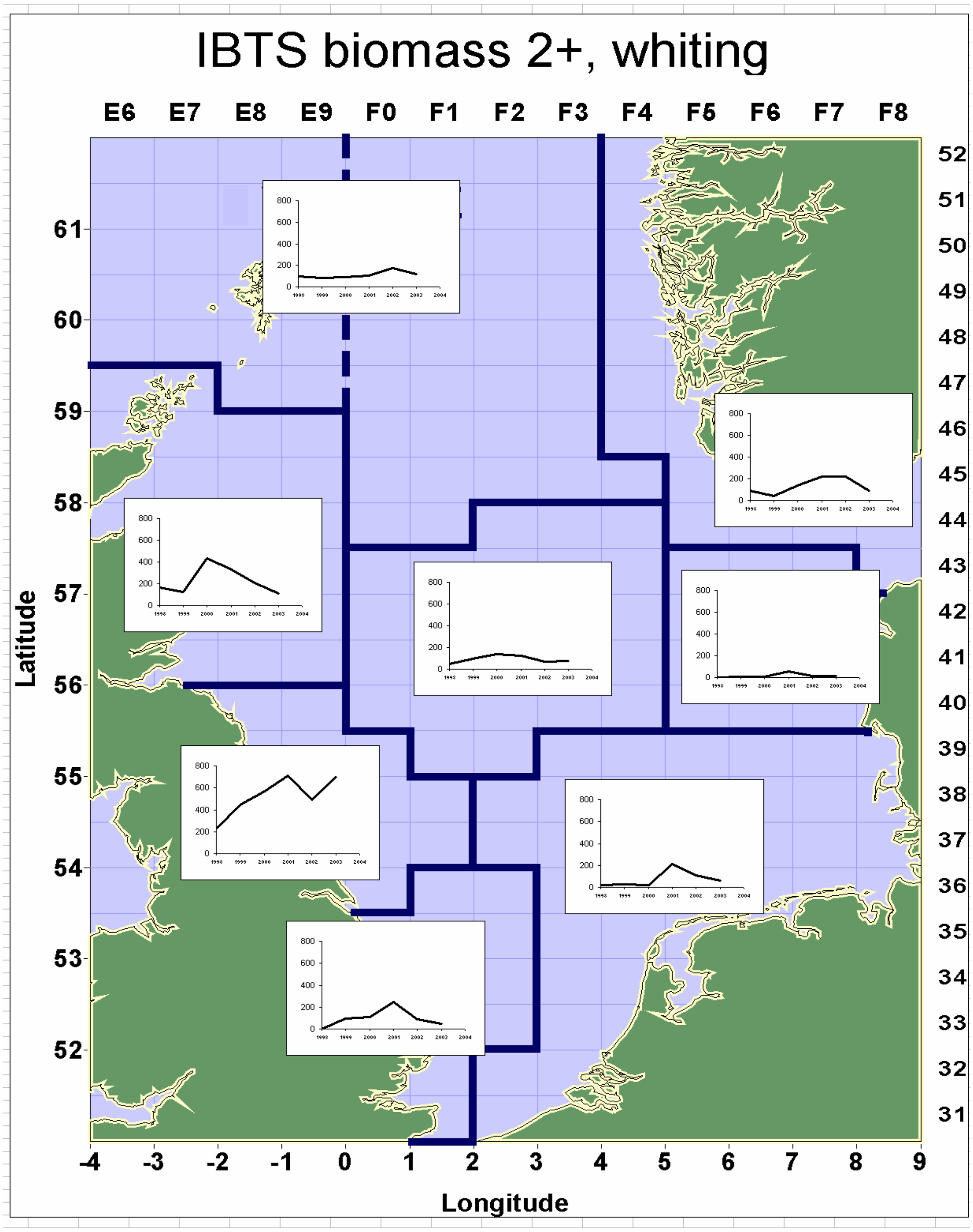


Figure 5.1.6.5 International landings of whiting by ICES rectangle in 2002. Darker rectangles are those with the highest landings. They contribute 70% of total landings.

X

E6	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8	F9	G0	G1
0	0	2	7	17	19	0	0	0							
1	0	57	236	240	176	5	0	0	0						
3	147	171	393	455	237	52	3	0	0						
70	198	112	195	430	152	96	6	0	0						
122	43	196	334	281	65	16	9	0	0						
170	3	55	431	247	33	24	12	0	0	0				0	
85	8	158	222	128	47	8	8	1	0				0	0	0
6	20	180	186	175	73	1	9	12	1	0	0	0	1	3	0
11	29	75	84	67	17	2	4	7	11	5	3	10	15	17	1
	2	23	43	19	7	2	1	2	2	2	7	23	0		
	0	12	42	101	7	3	0	0	1	1	2	0			
	2	6	27	47	3	1	0	0	1	5	1	0			
	7	10	23	14	2	4	1	1	2	2	0	0			
		195	434	42	10	3	1	2	2	5	0	0			
		112	260	33	6	3	8	51	8	3	0	1			
			185	120	33	117	56	81	22	5	10	3			
			0	9	31	53	55	76	28	5	1	0			
				0	1	49	54	118	1	0	0	0			
				0	7	237	313	279	9						
					5	244	273	238							
				0	77	529	291	6							
				1	1347	739	70	1							
		1	33	1257	1250										
		18	93	869	489										
		3	145	43	8										
			30	1											

Figure 5.1.6.6 U.K., Netherlands and Denmark landings of whiting by ICES roundfish area.

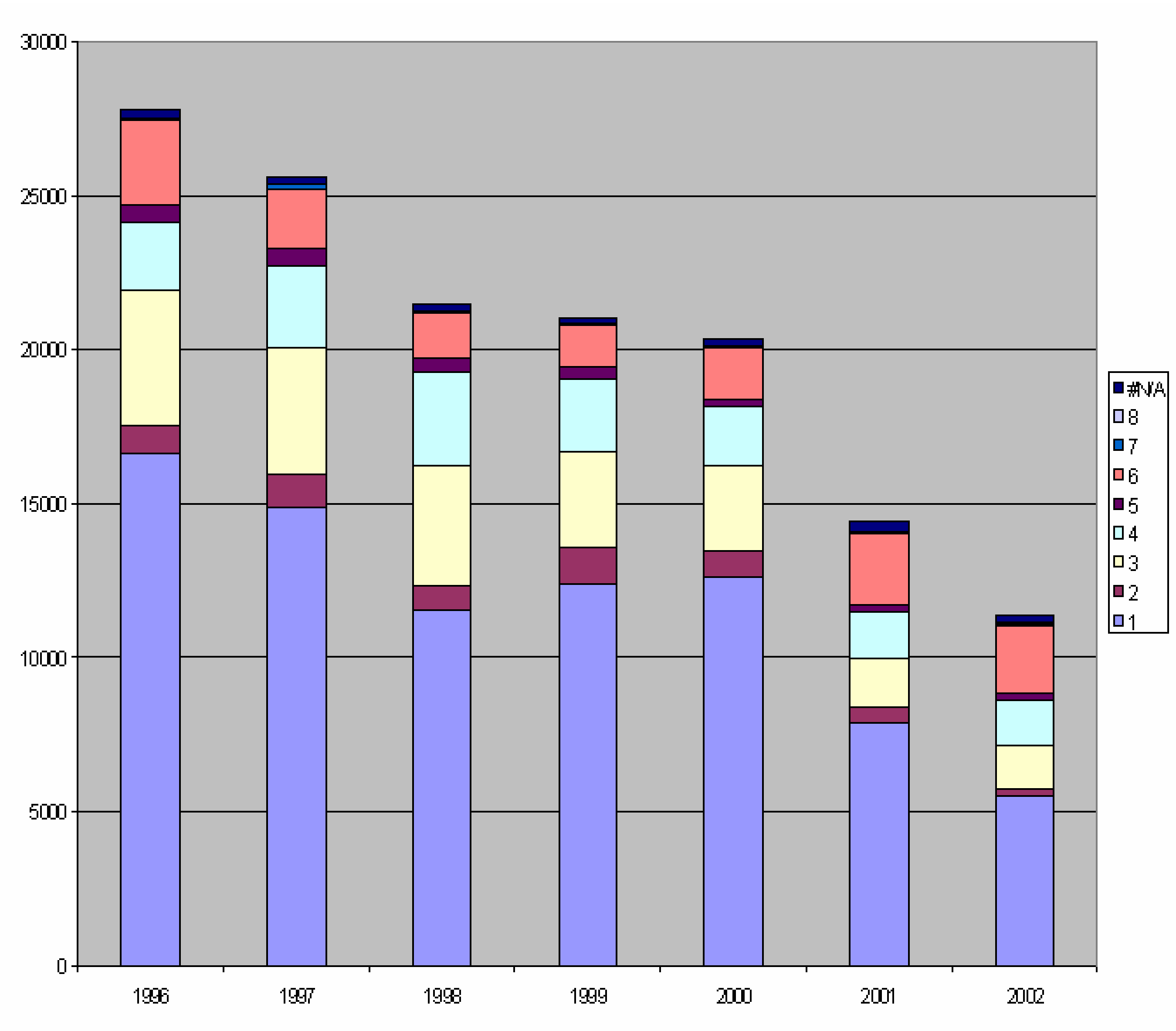
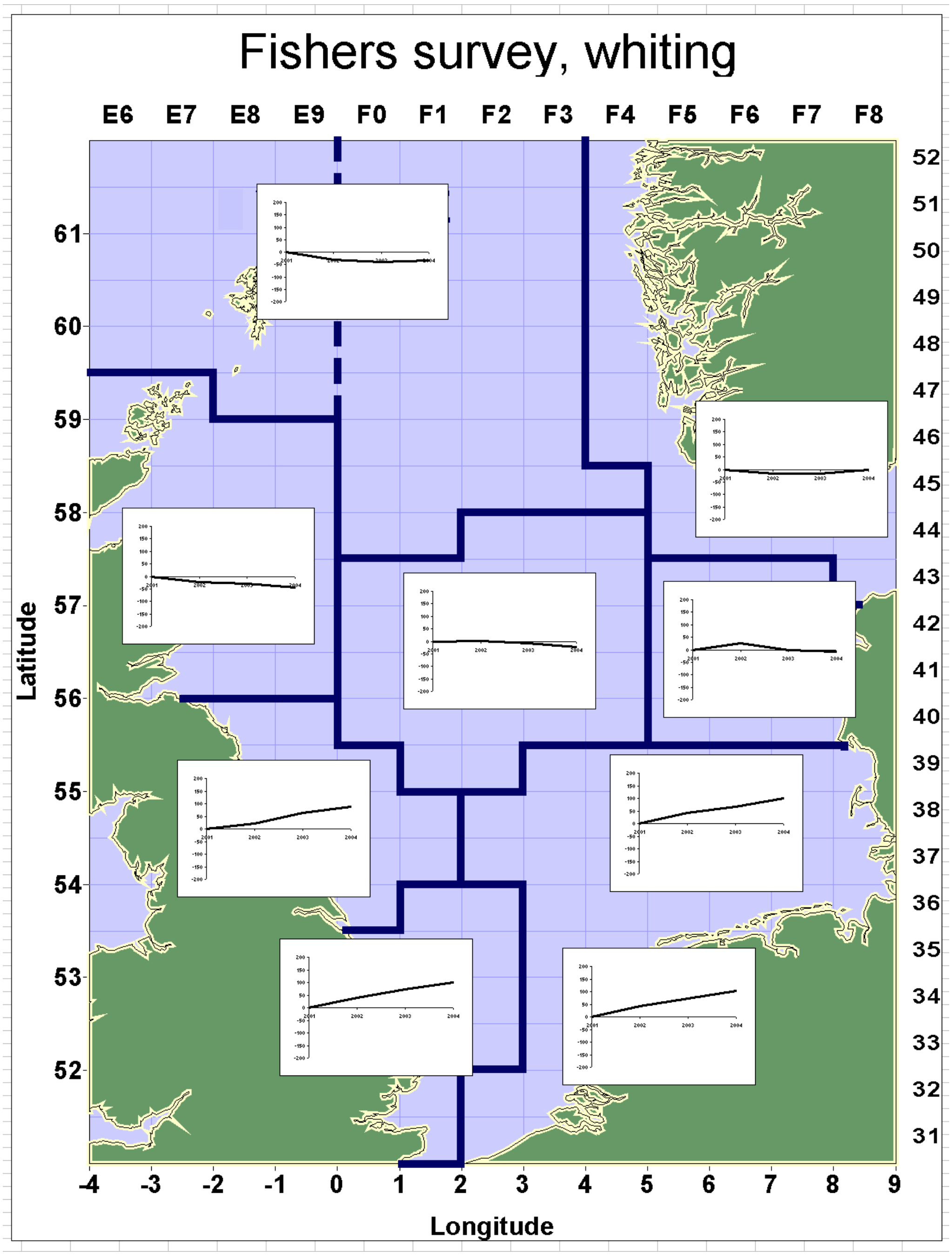


Figure 5.1.11.1 Whiting: graphs of fishers' perceptions of abundance for ICES roundfish areas in the North Sea.



6 SAITHE IN SUB-AREA IV, VI AND DIVISION IIIa

The assessment of saithe in Sub-Areas IV and VI and Division IIIa is presented here as an update assessment. All the relevant biological and methodological information can be found in the relevant Stock Annex. Here, only the basic input and output from the assessment model will be presented.

6.1 The Fishery

A general description of the fishery is given in the Stock Annex.

6.1.1 ICES advice applicable to 2003 and 2004

For 2003 ICES considered the stock to be inside safe biological limits and advised that fishing mortality in 2003 should be below F_{pa}, corresponding to landings less than 193 000 t.

For 2004 ICES classified the stock as being within safe biological limits. In a single species context, ICES recommended a fishing mortality below F_{pa} corresponding to landings less than 232 000 t (211 000 t in IV and IIIa and 20 900 t in VI). However, the ICES advice for the stock was presented in the context of mixed fisheries.

6.1.2 Management applicable in 2003 and 2004

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 2003 was 165 000 t. In Division Vb and Sub-Areas VI, XII, and XIV the TAC for 2003 was 17 000 t. For 2004 the TACs were 190 000 t and 20 000 t, respectively. Current technical measures are described in Section 2.1.1.

6.1.3 The fishery in 2003

In 2003 the landings were estimated to be 102 000 t in Sub-area IV and Division IIIa, and 5 000 t in Sub-Area VI, which is well below the TAC. One of the reasons that the TAC was not taken may have been the very low price for saithe in 2003. Discards are thought to be substantial in the UK fishery which does not target saithe. Sampling levels for saithe in the Scottish discard programme are given in Table 1.3.2, but as Scottish discarding rates are not representative of the majority of the saithe fishery these have not been used in the assessment.

6.2 Data available

6.2.1 Landings

Landings data by country and TACs are presented in Table 6.2.1.

6.2.2 Age compositions

Age compositions of the landings are presented in Table 6.2.2.

6.2.3 Weight at age

Weight at age in the catch is presented in Table 6.2.3. These are also used as stock weights.

6.2.4 Maturity and natural mortality

Maturity and natural mortality are set to fixed values and are described in the Stock Annex.

6.2.5 Catch, effort and research vessel data

Fleet data used for calibration of the assessment and other available tuning series are presented in Table 6.2.4 and Figure 6.2.1. Commercial fleets and surveys used in the assessment are described in the Stock Annex.

6.3 Catch-at-age analysis

Catch-at-age analysis was carried out according to the specifications in the stock annex. Results of the analysis are presented in Table 6.3.1 (diagnostics), Table 6.3.2 (fishing mortality at age), Table 6.3.3 (population numbers at age), and Table 6.3.4 (stock summary). The stock summary is also shown in Figure 6.3.1 and the historical performance of the assessment is shown in Figure 6.3.2.

6.4 Recruitment estimates

The calculation of recruitment estimates is described in the stock annex. Year class strength estimates used for short term prognosis are summarized in the text table below.

Year class	Age in 2004	XSA	GM(85-01)
2000	4	**102 875**	
2001	3	123 756	**129 240***
2002	2	123 258	**162 093***
2003	1		**198 000**
2004	1		**198 000**

*This number is not the GM of ages 2 and 3, but a function of GM of age 1 (see Stock Annex).

6.5 Short term prognosis

The short term prognosis was carried out according to the specifications in the Stock Annex. The input is presented in Table 6.5.1. Results are presented in Tables 6.5.2 and 6.5.3, and Figures 6.5.1 and 6.5.2. The short term prognosis is made using the $\mathbf{F}_{sq}$ assumption for the intermediate year. A $\mathbf{F}_{sq}$ catch for 2004 corresponds to 114 000 t which is well below the agreed TAC (210 000 t). The reported catch in 2003 was also much lower than the TAC, and the reported effort was considerably lower than in 2002. Information from fishermen from several countries indicates that the current low price of saithe is an important contributing factor in these reductions. Norwegian fishermen have also stated that part of the reduction was due to the 120 mm mesh size regulation. Norwegian trawlers are now allowed to use 110 mm mesh size in the EU zone (from August 2004). Whether this will be an incentive to increase Norwegian fishing effort in the second half of 2004 is not yet known. It is therefore difficult to make assumptions about the catches in the intermediate year.

6.6 Comments

There is no conflict between the assessment results and the fishermen's perception of the stock (Figure 6.6.1).

The present assessment estimates increases in $F_{3\text{-}6}$ for the years 2001 and 2002 of about 11% and 33%, respectively, and reductions in SSB for 2001 and 2002 of about 8% and 16%, respectively. This indicates overestimation of SSB and underestimation of F in the assessment year. The observed strong retrospective pattern in recruitment at age 1 is a result of the ages covered by the available data. Saithe do not recruit fully to the fishery before age 4, and as there are (as yet) no fishery-independent indices, stock estimates for ages 1–3 are inevitably very uncertain and subject to considerable annual revisions.

The estimated numbers at age 1, 3 and 4 in 2002 are much lower in this year's assessment relative to last year's assessment. Consequently, the total stock biomass in 2002 is significantly adjusted downward (29% lower in this year's assessment relative to the 2003 assessment). At the benchmark assessment, the WG should consider to run the assessment with age 3 as recruits and the reference points should be re-evaluated.

A survey along the Norwegian coast targeting saithe larvae (0-group) started in 1999. The time series from this survey is currently too short to evaluate its potential as a year class strength predictor. However, this could possibly be done in the forthcoming benchmark assessment.

Variations in EU and Norwegian mesh size regulations in the saithe fishery in 2001-2003 may have contributed to changes in the exploitation pattern. In January 2002 the minimum mesh size (in bottom trawls for human consumption) was changed from 100 to 110 mm in EU waters and from 100 to 120 mm in Norwegian waters (the minimum mesh size for Norwegian vessels was set to 120 mm both in Norwegian and EU waters). This regulation was not strictly enforced in the first half of 2002 to allow a transition period. The selection pattern (*F* at age) does not seem to have changed much during 2001-2003, but mesh size regulations may have affected catch rates and the spatial distribution of trawl fleets. For example, the spatial distribution of German landings changed from 2002 to 2003 (WP7). In addition, commercial catch rates dropped significantly from 2002 to 2003. The trawl fishery is directed towards large mature fish in the first quarter of the year (spawning aggregations), while immature fish dominate in the catches the rest of the year. Increasing mesh sizes between years might therefore be a contributing factor to lower catch rates in the last three quarter of the year when the fishery is directed towards small fish.

Discarding of saithe may be considerable in the fleets not targeting saithe and this is possibly a source of bias in the assessment.

Potential issues to be addressed at the forthcoming benchmark assessment (scheduled for 2005) include:

- Run the assessment with age 3 as recruits;
- Evaluate available tuning series (individual retrospective analysis, log catchability residuals etc.);
- Evaluate the performance of the IBTS survey series used for tuning;
- Improve the Norwegian trawl CPUE tuning series;
- Consider the re-estimation of reference points;
- Evaluate the Norwegian 0-group survey as an index of recruitment;

Table 6.2.1. Nominal catch (in tonnes) of Saithe in Subarea IV and Division IIIa and Subarea VI, 1997-2003, as officially reported to ICES.

SAITHE IV and IIIa

Country	1997	1998	1999	2000	2001	2002	2003
Belgium	254	249	200	122	24	107	44[*]
Denmark	4513	3967	4494	3529	3575	5668	6954
Faroe Islands	158	1298	1101				
France	10932	11786[*]	24305[1*]	19200	20472	25441	18001
Germany	12581	10117	10481	9273	9479	10999	8956
Greenland	-	-	-	601[2*]	1526[2*]	-[*]	
Ireland	-	-	-	1	-	-	
Netherlands	40	7	7	11	20	6	11[*]
Norway	46424	50254	56150	43665	43725[*]	58983[*]	61690[*]
Poland	822	813	862	747	727	752	734[*]
Russia	-	-	-	67	-	-	-
Sweden	1647	1857	1929	1468	1627	1863	1876
UK (E/W/NI)	2556	2293	2874	1227	1186	2521	1215
UK (Scotland)	6329	5353	5420	5484	5219	6596	5829
Total reported	86256	87994	107823	85395	87580	112936	105310
Unallocated	17066	12269	-510	2281	2093	3852	-3771
W. G. Estimate	103322	100263	107314	87676	89673	116788	101539
TAC	115000	97000	110000	85000	87000	135000	165000

[*]Preliminary. [1]Reported by TAC area, IIa(EC),IIIa-d(EC) and IV. [2]Preliminary data reported in Division IVa.

SAITHE VI

Country	1997	1998	1999	2000	2001	2002	2003
Belgium	-	-	-	-	-	-	-[*]
Denmark	-	-	-	-	-	-	-
Faroe Islands	1		2				
France	4662	3635[*]	3467[1*]	3310	5157	3062	3499
Germany	492	506	250	305	466	467	54
Ireland	411	216	320	410	399	91	
Norway	26	41	126	58	92[*]	136[*]	22[*]
Portugal	1	-	-	-	-	-	-
Russia	-	-	3	25	1	1	6
Spain	13	54	23	3	15	4	
UK (E/W/NI)	294	526	503	276	273	307	263
UK (Scotland)	2659	2402	2084	2463	2246	1567	1189
Total reported	8559	7380	6778	6850	8649	5635	5033
Unallocated	859	1056	564	-960	-1831	-449	217
W. G. Estimate	9418	8436	7342	5890	6818	5186	5250
TAC	12000	10900	7500	7000	9000	14000	17119

[*]Preliminary. [1]Reported by TAC area, Vb(EC),VI, XII and XIV.

SAITHE IV, IIIa and VI

	1997	1998	1999	2000	2001	2002	2003
WG estimate	112740	108699	114655	93566	96491	121974	106789

Table 6.2.2. Saithe in Sub-Areas IV and VI and Division IIIa. Catch numbers at age.

Catch numbers at age   Numbers*10**-3

YEAR	1967	1968	1969	1970	1971	1972	1973
AGE							
1	0	174	36	234	594	430	4708
2	8879	3832	2099	2261	11156	23833	37832
3	17330	23223	30235	37249	69809	48075	54332
4	16220	21231	17681	76661	57792	66095	37698
5	15531	13184	11057	15000	32737	25317	26849
6	2303	6023	7609	12128	4736	21207	16061
7	1594	429	5738	3894	4248	3672	8428
8	292	242	791	1792	2843	2944	2000
9	198	123	626	318	1874	1641	1357
+gp	183	145	150	267	774	1607	2381

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
1	4753	335	270	2172	1253	916	1321	5457	1970	312
2	19206	74231	34111	14125	20551	17756	24100	20644	29570	36824
3	66938	56987	207823	27461	35059	16332	17494	26178	31895	28242
4	33740	25864	53060	54967	27269	14216	12341	8339	40587	20604
5	14123	10319	11696	14755	18062	11182	9015	6739	9174	26013
6	20688	7566	6253	5490	3312	8699	6718	3675	5978	5678
7	14666	13657	3976	3777	1138	2805	5658	3335	2145	4893
8	5199	9357	5362	3447	1033	733	1150	3396	1454	1494
9	1477	3501	3586	3812	768	540	509	657	982	1036
+gp	1955	2687	3490	4701	3484	2089	2302	2536	1254	1327

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
1	206	231	322	787	32	3664	355	492	319	160
2	37387	9415	7227	31017	8762	9871	5764	13091	6679	10118
3	80933	134024	55435	31220	32578	22128	40808	46117	18404	37823
4	32172	55605	91223	97470	26408	30752	19583	29871	33614	20828
5	12957	13281	15186	13990	35323	13187	11322	7467	12753	11845
6	13011	4765	5381	3158	3828	10951	4714	3583	3193	3125
7	1657	3005	2603	1811	1908	1557	2776	1716	1524	1568
8	1252	682	1456	1240	1104	739	745	953	696	1511
9	335	399	445	910	776	419	281	367	518	814
+gp	646	742	900	700	680	488	364	458	422	1026

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
1	106	157	354	27	218	64	145	4	913	9
2	8033	4338	8963	12396	3706	6634	2692	1846	6878	2912
3	19958	26664	11066	15036	10363	9429	7064	17355	20066	11648
4	40194	26034	38861	19299	31017	13872	17295	18565	42915	20162
5	13034	14797	11786	30177	16367	26684	8940	23497	9003	25724
6	4297	3774	7731	3676	16077	8389	12339	3622	9001	6268
7	947	3494	3163	2640	2231	10070	3159	3518	2441	7059
8	346	674	808	1012	1206	2346	3226	1417	2936	1511
9	427	552	210	291	567	891	641	1121	1828	1979
+gp	794	800	491	288	277	657	441	218	1588	1039

Table 6.2.3. Saithe in Sub-Areas IV and VI and Division IIIa. Catch weights at age (kg)

Catch weights at age (kg)

YEAR AGE	1967	1968	1969	1970	1971	1972	1973
1	.0000	.5006	.4510	.4340	.4950	.3281	.1637
2	.6970	.7700	.6086	.6955	.6101	.5488	.4317
3	.9305	1.2784	.9663	.9414	.8399	.8082	.8212
4	1.3620	1.6521	1.5568	1.4408	1.3480	1.1958	1.4061
5	2.1035	1.9886	2.2614	2.0587	2.1775	1.9610	1.6410
6	3.1858	3.0093	2.7133	2.7180	2.9360	2.3687	2.5709
7	3.7541	4.0404	3.5588	3.5995	3.7657	3.7941	3.3571
8	5.3162	4.4278	4.4063	4.4632	4.6339	4.2276	4.6844
9	5.8905	6.1355	5.2203	5.6871	5.1725	4.6304	4.8138
+gp	7.7190	7.4055	6.7675	6.8452	6.1630	6.3263	6.4449

YEAR AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	.2750	.2160	.4588	.4257	.3548	.4348	.2586	.2774	.2525	.4126
2	.5093	.5021	.5156	.4301	.5165	.4060	.4210	.5958	.5077	.4780
3	.8608	.8928	.7024	.7598	.8215	1.1072	.9546	.9608	1.0857	1.0276
4	1.5606	1.4977	1.3092	1.2560	1.3267	1.6228	1.8212	1.8211	1.5746	1.7178
5	2.3834	2.4904	2.2604	1.9348	2.1545	2.2381	2.3911	2.7175	2.5293	2.1493
6	2.7527	3.3002	3.0706	3.1107	3.3401	3.0950	3.0300	3.5868	3.2202	3.1377
7	3.4286	3.7647	4.0347	4.1618	4.5221	4.0504	4.0895	4.5360	4.2069	3.6906
8	4.4977	4.2957	4.3833	4.6045	4.9005	5.2742	5.1262	5.4776	5.1251	4.6317
9	5.7128	5.5396	5.1117	4.8589	5.4494	6.3077	5.9393	6.9804	5.9049	5.5053
+gp	*7.8570*	*7.5620*	*7.1470*	*6.5419*	*7.4000*	*7.9551*	*8.1476*	*8.7237*	*8.8232*	*8.4529*

YEAR AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	.3886	.1487	.6295	.3711	.5165	.4264	.2717	.4794	.6189	.3585
2	.5009	.5550	.5479	.4181	.6379	.7263	.7025	.5571	.6299	.7437
3	.7948	.6632	.6943	.6739	.7787	.8954	.8441	.7913	.9641	.8994
4	1.6139	1.2654	1.0353	.8763	.9810	1.0362	1.1958	1.1579	1.1893	1.2603
5	2.2966	1.9505	1.7944	1.8236	1.3859	1.4196	1.5828	1.7523	1.6066	1.7544
6	2.6899	2.7715	2.4316	3.0747	2.7907	1.9984	2.2472	2.3646	2.2417	2.6363
7	3.8959	3.4067	3.5717	4.2098	4.0238	3.9139	3.2419	3.1653	3.6677	3.1851
8	4.6647	4.9499	4.2094	5.3300	5.2544	5.0175	4.8583	4.2221	4.3296	3.9798
9	6.1830	5.8649	5.6506	6.1284	6.3221	6.4298	6.3149	6.0661	5.4125	5.0802
+gp	8.4735	8.8543	8.2184	8.6026	8.6489	8.4308	8.4162	8.1914	7.0455	6.8909

YEAR AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	.2866	.5024	.2797	.4324	.6027	.5195	.5634	.5085	.7152	.4518
2	.6975	.7593	.5103	.4357	.6594	.5887	.8033	.7299	.7765	.4589
3	.9439	1.0022	.9668	.9047	.8917	.8808	1.0274	.7961	.8031	.7173
4	1.1188	1.2937	1.1873	1.1448	.9660	1.0605	1.1266	1.0709	.8578	.9527
5	1.6010	1.8159	1.8068	1.4522	1.3925	1.2112	1.5389	1.3025	1.3234	1.0825
6	2.4337	2.5619	2.3678	2.5867	1.7440	1.7537	1.6843	2.0573	1.7556	1.6674
7	3.6175	3.5549	2.9518	3.5556	2.9486	2.3374	2.5936	2.5693	2.2819	2.2583
8	4.7869	4.7670	4.7053	4.5251	3.8829	3.4934	3.0842	3.5225	3.1237	3.3577
9	6.5479	5.2674	6.0922	6.1575	4.9955	4.8438	4.7733	4.1728	3.9395	3.7758
+gp	8.3256	7.8907	8.3821	8.8663	7.2273	6.7452	7.4615	6.1926	3.7783	4.3222

Table 6.2.4. Saithe in Sub-Areas IV and VI and Division IIIa. Combined tuning data available to the WG. The data which were used in the assessment are in bold.

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FRATRB_IV
1978 2003
1 1 0 1
2 10

69739	248.000	**1853.000**	**3183.000**	**5447.000**	**762.000**	**190.000**	**154.000**	**122.000**	**163.000**
89974	230.000	**4525.000**	**3618.000**	**4128.000**	**2809.000**	**329.000**	**87.000**	**51.000**	**84.000**
63577	528.000	**3149.000**	**4450.000**	**2322.000**	**1412.000**	**746.000**	**104.000**	**45.000**	**29.000**
76517	4538.000	**9067.000**	**2893.000**	**2423.000**	**939.000**	**456.000**	**258.000**	**36.000**	**48.000**
78523	1285.000	**6001.000**	**10009.000**	**2630.000**	**1328.000**	**543.000**	**164.000**	**98.000**	**21.000**
69720	799.000	**3487.000**	**5770.000**	**8617.000**	**1183.000**	**270.000**	**86.000**	**37.000**	**29.000**
76149	1311.000	**5482.000**	**8632.000**	**5121.000**	**3837.000**	**232.000**	**155.000**	**33.000**	**49.000**
25915	836.335	**5281.644**	**4310.798**	**1509.202**	**448.289**	**267.927**	**24.519**	**28.316**	**21.824**
28611	729.658	**4055.637**	**7070.781**	**1775.235**	**588.972**	**158.056**	**88.067**	**15.597**	**8.863**
28692	935.823	**1309.565**	**7304.318**	**2025.032**	**244.229**	**96.101**	**35.404**	**16.628**	**4.304**
25208	540.473	**1839.994**	**1960.061**	**5873.634**	**481.893**	**84.136**	**21.385**	**11.816**	**10.409**
25184	802.910	**2628.746**	**3697.394**	**1719.062**	**1877.664**	**100.777**	**22.815**	**8.139**	**5.692**
21758	489.433	**3379.574**	**2471.553**	**1405.54**	**304.063**	**290.298**	**32.728**	**14.813**	**6.182**
15248	292.123	**1381.383**	**2538.766**	**731.379**	**372.239**	**130.79**	**67.670**	**11.930**	**5.811**
7902	351.996	**717.161**	**1480.817**	**498.716**	**73.572**	**24.402**	**7.133**	**5.741**	**1.447**
13527	1025.751	**3917.800**	**2253.440**	**1162.230**	**103.625**	**8.299**	**8.648**	**6.183**	**9.637**
14417	434.898	**1770.754**	**3652.840**	**1381.104**	**434.086**	**38.895**	**5.317**	**2.710**	**3.839**
14632	192.925	**3151.807**	**1682.869**	**921.653**	**225.695**	**70.393**	**24.088**	**13.317**	**13.919**
16241	195.815	**895.031**	**4286.247**	**1053.226**	**535.95**	**107.63**	**24.634**	**15.158**	**7.895**
12903	148.823	**1087.280**	**1914.745**	**3175.192**	**190.091**	**83.908**	**16.535**	**13.738**	**6.274**
13559	147.772	**799.753**	**2538.413**	**1870.453**	**1480.902**	**52.256**	**23.023**	**10.381**	**12.464**
14588	187.322	**852.467**	**1233.817**	**2666.699**	**620.174**	**399.661**	**24.212**	**13.688**	**10.661**
8695	183.807	**889.314**	**1993.229**	**1038.898**	**1195.148**	**214.774**	**180.514**	**31.751**	**11.726**
6366	97.087	**724.102**	**1339.454**	**2372.881**	**269.951**	**144.906**	**25.554**	**29.280**	**6.760**
11022	192.801	**3275.662**	**7576.645**	**1220.435**	**1242.118**	**175.302**	**151.434**	**40.935**	**36.378**
10536	333.738	**1516.931**	**3235.528**	**2354.784**	**264.339**	**325.113**	**80.521**	**112.883**	**39.509**

NORTRL_IV
1980 2003
1 1 0 1
3 10

18317	**186.000**	**1290.000**	**658.000**	**980.000**	**797.000**	**261.000**	**60.000**	**82.000**
28229	**88.000**	**844.000**	**1345.000**	**492.000**	**670.000**	**699.000**	**119.000**	**64.000**
47412	**6624.000**	**12016.000**	**2737.000**	**2112.000**	**341.000**	**234.000**	**19.000**	**77.000**
43099	**4401.000**	**4963.000**	**8176.000**	**1950.000**	**2367.000**	**481.000**	**357.000**	**84.000**
47803	**20576.000**	**7328.000**	**2207.000**	**3358.000**	**433.000**	**444.000**	**106.000**	**51.000**
66607	**27088.000**	**21401.000**	**5307.000**	**1569.000**	**637.000**	**56.000**	**46.000**	**4.000**
57468	**5297.000**	**29612.000**	**3589.000**	**818.000**	**393.000**	**122.000**	**25.000**	**33.000**
30008	**2645.000**	**18454.000**	**2217.000**	**290.000**	**235.000**	**201.000**	**198.000**	**64.000**
18402	**3132.000**	**2042.000**	**2214.000**	**141.000**	**157.000**	**74.000**	**134.000**	**43.000**
17781	**649.000**	**2126.000**	**835.000**	**694.000**	**309.000**	**154.000**	**65.000**	**7.000**
10249	**804.000**	**781.000**	**924.000**	**519.000**	**203.000**	**63.000**	**12.000**	**3.000**
28768	**14348.000**	**4968.000**	**1194.000**	**518.000**	**203.000**	**51.000**	**56.000**	**1.000**
35621	**3447.000**	**9532.000**	**4031.000**	**1087.000**	**465.000**	**165.000**	**109.000**	**6.000**
24572	**7635.000**	**4028.000**	**2878.000**	**1018.000**	**526.000**	**365.000**	**252.000**	**252.000**
30628	**3939.000**	**16098.000**	**4276.000**	**926.000**	**251.000**	**72.000**	**203.000**	**21.000**
32489	**4347.000**	**9366.000**	**5412.000**	**833.000**	**1644.000**	**273.000**	**203.000**	**104.000**
40400	**3790.000**	**14429.000**	**4414.000**	**2765.000**	**1144.000**	**189.000**	**16.000**	**13.000**
36026	**2894.000**	**5266.000**	**9837.000**	**1419.000**	**892.000**	**299.000**	**72.000**	**28.000**
24510	**1376.000**	**8279.000**	**5454.000**	**5662.000**	**977.000**	**489.000**	**243.000**	**55.000**
20570	**783.000**	**2527.000**	**6741.000**	**2333.000**	**3573.000**	**1162.000**	**342.000**	**187.000**
15520	**284.189**	**1628.393**	**2054.227**	**4260.877**	**1065.562**	**1203.276**	**221.166**	**86.654**
20593	**4553.766**	**4982.461**	**6332.307**	**922.334**	**1224.328**	**505.707**	**388.118**	**43.571**
29278	**3173.164**	**9666.659**	**2807.922**	**3060.900**	**779.758**	**1298.303**	**838.771**	**837.599**
40324	**1526.250**	**5194.127**	**10190.330**	**3583.292**	**4417.696**	**790.552**	**1003.411**	**569.831**

GER_OTB_IV
1995 2003
1 1 0 1
2 10

21167	36	**1158**	**2359**	**1350**	**589**	**152**	**30**	**16**	**11**
19064	27	**510**	**3167**	**1081**	**517**	**257**	**148**	**41**	**33**
21707	0	**816**	**2475**	**3636**	**292**	**163**	**70**	**24**	**9**
20153	46	**591**	**2744**	**1395**	**1776**	**238**	**100**	**39**	**20**
18596	42	**284**	**1065**	**2264**	**943**	**1015**	**77**	**36**	**23**
12223	10	**542**	**2185**	**823**	**1216**	**242**	**325**	**38**	**15**
11008	62	**892**	**1329**	**2317**	**372**	**532**	**249**	**155**	**22**
12789	18	**650**	**3658**	**1230**	**1100**	**99**	**140**	**69**	**52**
14560	14	**500**	**1399**	**2630**	**438**	**392**	**58**	**72**	**41**

Table 6.2.4. cont. Saithe in Sub-Areas IV and VI and Division IIIa. Combined tuning data available to the WG. The data which were used in the assessment are in bold.

```
SCOLTR_IV+VI
1989  2002
1     1     0     1
2     10
623326      405.295     1784.580    579.547     191.218     311.675     54.991      16.600      6.884       17.590
585390      975.276     2619.365    1047.462    332.604     94.125      105.046     27.507      12.944      8.429
617957      566.888     1183.961    925.105     262.891     123.379     66.874      67.489      26.976      14.154
663243      505.629     556.915     756.673     223.674     49.397      24.078      12.188      19.618      6.286
636989      938.684     691.665     265.418     245.524     121.282     33.495      25.912      22.218      16.882
655279      502.948     758.181     534.386     184.194     149.575     51.725      14.783      10.492      11.609
617641      600.061     1087.996    309.115     283.081     115.441     56.061      22.555      10.139      8.118
660154      501.571     353.712     824.220     161.609     129.105     69.136      41.184      23.764      19.228
659054      385.252     889.588     493.869     875.805     131.943     75.736      30.121      22.140      10.704
570325      582.394     480.486     813.008     307.944     394.840     56.611      34.767      12.468      5.031
428743      666.565     361.113     215.344     433.657     101.330     136.950     35.921      30.959      10.356
354445      170.829     379.520     368.279     130.378     217.785     81.485      87.729      29.038      23.221
281187      124.551     282.129     352.843     583.102     96.656      113.193     38.030      32.684      6.050
199274      34.830      359.082     572.186     233.493     260.941     63.788      60.247      28.408      21.829
108077      124.556     267.987     428.304     474.047     82.315      95.992      28.580      52.381      16.589
```

```
FRASAI_VI
1977  2003
1     1     0     1
3     10
62969 1031.000    1435.000    1156.000    531.000     440.000     308.000     219.000     236.000
68760 1989.000    1771.000    972.000     548.000     163.000     151.000     99.000      199.000
65281 1428.000    1101.000    808.000     444.000     303.000     133.000     198.000     154.000
53693 2626.000    698.000     538.000     492.000     409.000     194.000     69.000      107.000
50917 1562.000    1111.000    387.000     283.000     233.000     141.000     102.000     87.000
48428 2214.000    917.000     829.000     347.000     253.000     153.000     93.000      45.000
42497 2823.000    1762.000    647.000     605.000     434.000     129.000     82.000      71.000
42608 2273.000    1830.000    613.000     461.000     204.000     93.000      37.000      26.000
73608 3412.000    2358.000    1230.000    992.000     478.000     144.000     79.000      39.000
74959 4910.000    7188.000    3119.000    1016.000    678.000     228.000     109.000     65.000
75003 1492.000    5836.000    1651.000    1157.000    660.000     389.000     218.000     148.000
94109 4011.000    2534.000    2004.000    786.000     676.000     472.000     228.000     201.000
72656 4443.000    3975.000    1589.000    893.000     199.000     142.000     71.000      72.000
59465 2975.000    2028.000    684.000     477.000     330.000     161.000     85.000      91.000
51011 1792.000    1697.000    619.000     287.000     184.000     111.000     43.000      96.000
44974 637.000     1528.000    528.000     192.000     50.000      32.000      26.000      9.000
56762 1474.000    1921.000    855.000     196.000     70.000      33.000      22.000      11.000
41971 1810.000    1288.000    600.000     245.000     77.000      49.000      32.000      57.000
42174 206.000     657.000     516.000     257.000     118.000     48.000      33.000      68.000
33655 596.000     484.000     298.000     202.000     50.000      13.000      6.000       11.000
24262 519.000     579.000     640.000     120.000     47.000      18.000      4.000       5.000
33360 650.000     1051.000    359.000     401.000     40.000      24.000      10.000      7.000
-9    -9.000      -9.000      -9.000      -9.000      -9.000      -9.000      -9.000      -9.000
-9    499.662     1294.921    274.276     319.274     89.254      93.236      11.518      9.177
-9    1075.696    1139.870    1206.137    113.492     73.417      46.916      12.666      2.502
-9    812.681     967.758     155.060     209.634     43.372      60.978      30.414      16.571
-9    385.203     938.292     722.359     250.044     134.016     31.472      21.416      12.305
```

```
ENGGFS_IV
1977  2003
1     1     0.5   0.75
2     3
1     104.54      484.92
1     72.39       57.36
1     2.79        104.99
1     18.60       179.60
1     94.55       119.76
1     696.57      2121.11
1     4.18        547.22
1     2715.16     4643.56
1     210.52      2710.97
1     318.57      1708.74
1     24.94       225.12
1     84.74       786.60
1     68.73       178.41
1     580.69      872.71
1     202.96      426.47
1     16.14       94.23
1     183.42      1091.48
1     34.71       123.26
1     51.08       1366.47
1     298.02      296.65
1     103.84      450.00
1     8.23        53.79
1     6.92        87.07
1     20.33       190.00
1     44.00       909.00
1     25.79       230.79
1     67.78       669.12
```

Table 6.2.4. cont. Saithe in Sub-Areas IV and VI and Division IIIa. Combined tuning data available to the WG. The data which were used in the assessment are in bold.

SCOGFS_IV

1982	2002		
1	1	0.5	0.75
2	3		
1	680	1370	
1	500	370	
1	8390	26470	
1	50070	40140	
1	3160	43180	
1	170	1700	
1	350	1430	
1	290	1320	
1	3130	4010	
1	700	3180	
1	310	1840	
1	2010	7890	
1	810	1390	
1	270	13920	
1	1630	4050	
1	200	3670	
1	140	1860	
1	900	710	
1	380	1970	
1	3450	21930	
1	830	6420	

NORACU

1995	2003					
1	1	0.5	0.75			
3	7					
1	**56244**	**4756**		**1214**	**174**	**161**
1	**21480**	**29698**		**6125**	**4593**	**1821**
1	**22585**	**16188**		**24939**	**3002**	**2472**
1	**15180**	**48295**		**13540**	**11194**	**1173**
1	**16933**	**21109**		**27036**	**4399**	**3590**
1	**34551**	**82338**		**14213**	**13842**	**3018**
1	**72108**	**28764**		**17405**	**3870**	**1091**
1	**82501**	**163524**		**17479**	**4475**	**2437**
1	**67774**	**107730**		**41675**	**4581**	**3420**

Table 6.3.1. Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

Lowestoft VPA Version 3.1

25/08/2004 17:29

Extended Survivors Analysis

SAITHE IN IV VI and IIIa : 1967 - 2003

CPUE data from file update04.tun

Catch data for 37 years. 1967 to 2003. Ages 1 to 10.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FRATRB_IV	1990	2003	3	9	.000	1.000
NORTRL_IV	1980	2003	3	9	.000	1.000
GER_OTB_IV	1995	2003	3	9	.000	1.000
NORACU	1995	2003	3	7	.500	.750

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 3

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 3

Catchability independent of age for ages >= 7

Terminal population estimation :

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

S.E. of the mean to which the estimates are shrunk = 1.000

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 37 iterations

1

Regression weights

.751	.820	.877	.921	.954	.976	.990	.997	1.000	1.000

Fishing mortalities

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	.001	.001	.003	.000	.002	.000	.001	.000	.005	.000
2	.032	.035	.048	.145	.023	.067	.011	.011	.044	.021
3	.241	.141	.118	.107	.173	.075	.094	.094	.162	.098
4	.680	.569	.315	.311	.336	.371	.193	.379	.353	.243
5	.662	.577	.552	.433	.475	.543	.435	.436	.319	.371
6	.486	.403	.689	.330	.435	.479	.524	.315	.296	.385
7	.390	.970	.710	.534	.342	.540	.332	.274	.363	.400
8	.310	.537	.621	.518	.501	.740	.329	.243	.388	.402
9	.895	1.230	.314	.477	.624	.883	.456	.181	.567	.494

Table 6.3.1. cont. Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
1994	1.70E+05	2.82E+05	1.03E+05	9.00E+04	2.98E+04	1.23E+04	3.24E+03	1.43E+03	7.98E+02
1995	2.56E+05	1.39E+05	2.23E+05	6.63E+04	3.73E+04	1.26E+04	6.22E+03	1.79E+03	8.62E+02
1996	1.24E+05	2.10E+05	1.10E+05	1.59E+05	3.07E+04	1.72E+04	6.87E+03	1.93E+03	8.59E+02
1997	2.19E+05	1.02E+05	1.63E+05	7.98E+04	9.48E+04	1.45E+04	7.05E+03	2.77E+03	8.49E+02
1998	1.39E+05	1.79E+05	7.19E+04	1.20E+05	4.79E+04	5.03E+04	8.52E+03	3.38E+03	1.35E+03
1999	3.23E+05	1.14E+05	1.43E+05	4.95E+04	7.03E+04	2.44E+04	2.67E+04	4.96E+03	1.68E+03
2000	2.24E+05	2.64E+05	8.72E+04	1.09E+05	2.80E+04	3.34E+04	1.24E+04	1.27E+04	1.94E+03
2001	2.16E+05	1.83E+05	2.14E+05	6.50E+04	7.34E+04	1.48E+04	1.62E+04	7.27E+03	7.50E+03
2002	1.89E+05	1.77E+05	1.48E+05	1.59E+05	3.64E+04	3.89E+04	8.86E+03	1.01E+04	4.67E+03
2003	1.51E+05	1.54E+05	1.39E+05	1.03E+05	9.17E+04	2.17E+04	2.37E+04	5.05E+03	5.61E+03

Estimated population abundance at 1st Jan 2004

0.00E+00 1.24E+05 1.23E+05 1.03E+05 6.62E+04 5.18E+04 1.21E+04 1.30E+04 2.76E+03

Taper weighted geometric mean of the VPA populations:

1.99E+05 1.66E+05 1.29E+05 8.61E+04 4.27E+04 1.81E+04 8.56E+03 3.68E+03 1.68E+03

Standard error of the weighted Log(VPA populations) :

.3010 .3027 .3484 .4045 .5266 .5834 .6696 .7015 .8131

1

Log catchability residuals.

Fleet : FRATRB_IV

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3	99.99	99.99	99.99	99.99	99.99	99.99	.54	-.15	.15	.86
4	99.99	99.99	99.99	99.99	99.99	99.99	.23	.30	.24	.21
5	99.99	99.99	99.99	99.99	99.99	99.99	-.01	-.01	.13	.11
6	99.99	99.99	99.99	99.99	99.99	99.99	-.29	.30	-.37	-.51
7	99.99	99.99	99.99	99.99	99.99	99.99	.91	.62	-.48	-1.64
8	99.99	99.99	99.99	99.99	99.99	99.99	-.16	.66	-.97	-1.19
9	99.99	99.99	99.99	99.99	99.99	99.99	.18	.01	-.30	-.70

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	.35	.09	-.57	-.55	-.06	-.80	.26	-.53	.83	.14
4	.30	-.24	-.39	-.28	-.45	-.34	-.21	.30	.58	.16
5	.18	-.50	-.29	-.14	-.01	-.09	.36	.53	-.03	-.23
6	.29	-.44	.14	-.66	.15	-.05	.83	.37	.37	-.50
7	-.21	-.04	.07	-.05	-.85	.06	.63	.25	.54	.24
8	-1.43	-.05	-.17	-.74	-.67	-.97	.43	-.69	.28	.39
9	-1.26	.37	.02	.23	-.49	-.40	.63	-.62	-.18	.66

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	3	4	5	6	7	8	9
Mean Log q	-13.7766	-12.6675	-12.4236	-12.8880	-13.5028	-13.5028	-13.5028
S.E(Log q)	.5357	.3463	.2802	.4590	.6183	.7616	.5710

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	1.34	-.502	14.46	.19	14	.75	-13.78
4	1.02	-.057	12.69	.57	14	.37	-12.67
5	1.06	-.305	12.52	.77	14	.31	-12.42
6	.72	1.744	12.03	.81	14	.30	-12.89
7	.73	1.350	12.30	.72	14	.43	-13.50
8	.71	1.512	12.24	.74	14	.44	-13.88
9	.95	.246	13.31	.71	14	.55	-13.62

1

Table 6.3.1. cont. Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

Fleet : NORTRL_IV

Age	1980	1981	1982	1983
3	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99
6	99.99	99.99	99.99	99.99
7	99.99	99.99	99.99	99.99
8	99.99	99.99	99.99	99.99
9	99.99	99.99	99.99	99.99

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3	1.33	.89	-.70	.26	.90	-.25	.12	1.82	.48	1.19
4	.01	.61	.87	.52	-.24	-.12	-.20	.31	.57	.16
5	-.86	-.21	-.28	-.13	-.46	-.69	.07	-.41	.46	.17
6	-.04	-.70	-.94	-1.08	-1.35	-.33	.36	-.63	.18	.55
7	-.63	-1.29	-1.39	-.87	-.54	.11	-.10	-.98	-.45	.51
8	-.10	-2.30	-2.12	-.68	-.68	.41	-.16	-1.66	-.74	.55
9	-.19	-1.90	-2.23	-.27	.24	.22	-.68	-.49	-.27	1.00

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	.66	-.12	.22	-.33	.16	-.96	-1.19	.40	.09	-.93
4	.99	.65	-.12	-.33	.11	.00	-1.02	.41	-.19	-.74
5	.31	.22	-.02	-.28	.22	.25	.21	.09	-.42	-.35
6	-.34	-.56	.24	-.30	.27	.30	.89	-.21	-.33	.13
7	-.51	.91	.12	-.12	.08	.50	.25	-.19	-.35	.10
8	-.98	.17	-.45	-.28	.38	1.15	.34	-.29	.04	-.08
9	.89	.89	-2.25	-.54	.66	1.07	.59	-.61	.45	.10

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	3	4	5	6	7	8	9
Mean Log q	-14.0419	-12.6370	-12.1754	-12.2578	-12.0954	-12.0954	-12.0954
S.E(Log q)	.7821	.5520	.3091	.4865	.4682	.6747	.9415

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	.85	.258	13.69	.22	20	.69	-14.04
4	1.66	-.971	13.48	.17	20	.92	-12.64
5	1.15	-.720	12.40	.70	20	.36	-12.18
6	.79	1.071	11.74	.72	20	.38	-12.26
7	.83	.966	11.58	.76	20	.39	-12.10
8	.74	1.251	11.15	.70	20	.48	-12.17
9	.92	.227	11.66	.47	20	.91	-12.01

1

Fleet : GER_OTB_IV

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	99.99	-.12	-.13	-.20	.40	-.98	.59	.29	.23	-.13
4	99.99	.31	-.28	.03	-.19	-.15	.12	.33	.28	-.43
5	99.99	-.11	-.04	-.14	-.32	-.11	.17	.35	.21	-.06
6	99.99	.17	-.04	-.73	-.05	.14	.52	.16	.12	-.31
7	99.99	-.04	.38	-.30	-.13	.35	.01	.61	-.58	-.30
8	99.99	-.60	1.06	-.22	.00	-.46	.28	.64	-.35	-.66
9	99.99	-.21	.45	-.13	.03	-.08	.07	.10	-.21	-.51

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	3	4	5	6	7	8	9
Mean Log q	-14.9366	-13.2455	-12.8075	-12.9033	-13.1051	-13.1051	-13.1051
S.E(Log q)	.4695	.2782	.2111	.3530	.3895	.5851	.2716

Table 6.3.1. cont. Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	1.76	-.945	17.31	.19	9	.83	-14.94
4	1.15	-.502	13.51	.63	9	.34	-13.25
5	1.08	-.444	12.97	.82	9	.24	-12.81
6	.81	.864	12.36	.76	9	.29	-12.90
7	.83	.754	12.48	.76	9	.33	-13.11
8	1.01	-.031	13.19	.58	9	.63	-13.14
9	1.13	-1.015	13.87	.91	9	.30	-13.16

1

Fleet : NORACU

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	99.99	-.05	-.31	-.67	-.20	-.84	.38	.22	.76	.59
4	99.99	-1.57	-.77	-.69	.00	.08	.55	.13	.95	.90
5	99.99	-2.04	-.24	-.04	.06	.41	.62	-.14	.50	.47
6	99.99	-2.52	.62	.14	.28	.10	.95	.36	-.47	.20
7	99.99	-1.44	.72	.89	-.16	-.06	.40	-.92	.54	-.08
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	3	4	5	6	7
Mean Log q	-1.1203	-.5814	-.9054	-1.3846	-1.4825
S.E(Log q)	.5581	.8178	.7722	.9590	.7495

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	.99	.023	1.26	.32	9	.59	-1.12
4	.62	.813	4.68	.42	9	.52	-.58
5	.80	.395	2.88	.38	9	.66	-.91
6	.60	.913	4.85	.44	9	.58	-1.38
7	1.28	-.409	-.69	.25	9	1.01	-1.48

1

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2002

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FRATRB_IV	1.	.000	.000	.00	0	.000	.000
NORTRL_IV	1.	.000	.000	.00	0	.000	.000
GER_OTB_IV	1.	.000	.000	.00	0	.000	.000
NORACU	1.	.000	.000	.00	0	.000	.000
P shrinkage mean	166181.	.30				.916	.000
F shrinkage mean	4959.	1.00				.084	.002

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
123756.	.29	11.77	2	40.614	.000

Table 6.3.1. cont. Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

Age 2 Catchability dependent on age and year class strength

Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FRATRB_IV	1.	.000	.000	.00	0	.000	.000
NORTRL_IV	1.	.000	.000	.00	0	.000	.000
GER_OTB_IV	1.	.000	.000	.00	0	.000	.000
NORACU	1.	.000	.000	.00	0	.000	.000
P shrinkage mean	129349.	.35				.892	.020
F shrinkage mean	82845.	1.00				.108	.031

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
123258.	.33	11.72	2	35.630	.021

Age 3 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
FRATRB_IV	118906.	.559	.000	.00	1	.251	.085
NORTRL_IV	40754.	.814	.000	.00	1	.118	.230
GER_OTB_IV	90468.	.496	.000	.00	1	.318	.110
NORACU	185796.	.590	.000	.00	1	.225	.055
F shrinkage mean	82537.	1.00				.086	.120

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
102875.	.28	.22	5	.786	.098

1

Age 4 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
FRATRB_IV	92433.	.304	.297	.98	2	.303	.180
NORTRL_IV	40343.	.471	.380	.81	2	.126	.373
GER_OTB_IV	50417.	.257	.278	1.08	2	.424	.309
NORACU	148906.	.489	.067	.14	2	.110	.116
F shrinkage mean	46937.	1.00				.037	.328

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
66185.	.17	.18	9	1.056	.243

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FRATRB_IV	50392.	.217	.281	1.29	3	.317	.380
NORTRL_IV	39579.	.269	.143	.53	3	.218	.463
GER_OTB_IV	57620.	.199	.120	.61	3	.367	.339
NORACU	82744.	.427	.198	.46	3	.073	.248
F shrinkage mean	41522.	1.00				.025	.445

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
51824.	.12	.10	13	.789	.371

Table 6.3.1. cont. Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FRATRB_IV	11456.	.202	.169	.83	4	.300	.402
NORTRL_IV	9861.	.242	.226	.93	4	.223	.454
GER_OTB_IV	13403.	.180	.172	.95	4	.384	.353
NORACU	16687.	.408	.080	.20	4	.068	.293
F shrinkage mean	11108.	1.00				.025	.412

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
12064.	.11	.09	17	.754	.385

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FRATRB_IV	15918.	.198	.198	1.00	5	.265	.337
NORTRL_IV	11321.	.226	.187	.83	5	.236	.447
GER_OTB_IV	12885.	.171	.174	1.01	5	.392	.403
NORACU	10129.	.381	.207	.54	5	.080	.489
F shrinkage mean	14149.	1.00				.026	.373

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
12996.	.11	.09	21	.816	.400

1

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FRATRB_IV	3607.	.207	.125	.60	6	.258	.321
NORTRL_IV	2553.	.228	.099	.43	6	.251	.429
GER_OTB_IV	2323.	.177	.166	.94	6	.391	.463
NORACU	3902.	.399	.149	.37	5	.066	.300
F shrinkage mean	2452.	1.00				.034	.443

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2763.	.11	.08	24	.672	.402

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FRATRB_IV	3742.	.234	.176	.75	7	.225	.391
NORTRL_IV	3250.	.245	.143	.58	7	.186	.439
GER_OTB_IV	2347.	.178	.180	1.01	7	.508	.567
NORACU	2056.	.426	.362	.85	5	.043	.626
F shrinkage mean	3658.	1.00				.038	.398

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2800.	.12	.09	27	.773	.494

1
1

Table 6.3.2. Saithe in Sub-Areas IV and VI and Division IIIa. Fishing mortality (*F*) at age

Fishing mortality (F) at age

YEAR	1967	1968	1969	1970	1971	1972	1973
AGE							
1	.0000	.0004	.0001	.0010	.0025	.0017	.0174
2	.0680	.0115	.0065	.0062	.0572	.1320	.2071
3	.1628	.2548	.1178	.1521	.2682	.3711	.4990
4	.2632	.3074	.3145	.4897	.3728	.4397	.5628
5	.3782	.3551	.2599	.4828	.3998	.2768	.3202
6	.4836	.2455	.3574	.5070	.2735	.4925	.2838
7	.4161	.1524	.3913	.3127	.3319	.3538	.3695
8	.2603	.1004	.4639	.2016	.3965	.4054	.3317
9	.3893	.1668	.4070	.3426	.3361	.4202	.3303
+gp	.3893	.1668	.4070	.3426	.3361	.4202	.3303
0 FBAR 3- 6	.3220	.2907	.2624	.4079	.3286	.3950	.4164

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
1	.0078	.0017	.0019	.0166	.0111	.0035	.0076	.0276	.0061	.0007
2	.0916	.1612	.2325	.1296	.2152	.2155	.1194	.1575	.2045	.1507
3	.6880	.4270	.9114	.2975	.5436	.2654	.3417	.1842	.3886	.3075
4	.6749	.6293	.9308	.6551	.5451	.4427	.3292	.2706	.4828	.4696
5	.4242	.4463	.6617	.7378	.4643	.4510	.5645	.3012	.5407	.6652
6	.4388	.4243	.5384	.7718	.3555	.4270	.5417	.4744	.4792	.7811
7	.4556	.5873	.4144	.7472	.3489	.5828	.5503	.5724	.5668	.9537
8	.4106	.5975	.4833	.7845	.4637	.3983	.5041	.7719	.5302	1.0468
9	.4382	.5408	.4824	.7755	.3920	.4729	.5363	.6116	.5297	.9374
+gp	.4382	.5408	.4824	.7755	.3920	.4729	.5363	.6116	.5297	.9374
0 FBAR 3- 6	.5565	.4817	.7606	.6156	.4771	.3965	.4443	.3076	.4728	.5559

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
1	.0005	.0014	.0017	.0068	.0002	.0187	.0025	.0023	.0021	.0005
2	.1033	.0293	.0568	.2195	.0975	.0718	.0370	.1201	.0391	.0852
3	.5737	.6470	.2406	.3686	.3782	.3798	.4716	.4594	.2473	.3223
4	.6950	1.0503	1.4124	.8775	.6172	.7549	.6919	.7737	.7323	.4906
5	.6168	.7054	.9675	.8717	.9726	.7353	.7072	.6248	.9390	.6250
6	.8610	.4831	.7073	.5349	.6252	.9750	.6428	.5067	.6038	.6275
7	.5481	.4864	.5353	.5495	.7383	.5647	.7157	.5127	.4196	.6876
8	.6899	.4569	.4633	.5309	.7878	.7275	.5860	.5774	.4029	.9979
9	.7065	.4884	.6207	.5977	.7669	.8109	.6872	.6521	.7312	1.2353
+gp	.7065	.4884	.6207	.5977	.7669	.8109	.6872	.6521	.7312	1.2353
0 FBAR 3- 6	.6866	.7215	.8319	.6632	.6483	.7113	.6284	.5912	.6306	.5164

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	FBAR 67-03	FBAR 99-03
AGE												
1	.0007	.0007	.0031	.0001	.0017	.0002	.0007	.0000	.0054	.0001	.0042	.0013
2	.0320	.0352	.0484	.1449	.0231	.0666	.0113	.0112	.0439	.0212	.0936	.0308
3	.2410	.1415	.1182	.1072	.1734	.0755	.0938	.0939	.1622	.0975	.3128	.1046
4	.6805	.5695	.3154	.3110	.3358	.3705	.1932	.3794	.3530	.2435	.5413	.3079
5	.6619	.5768	.5522	.4333	.4747	.5435	.4354	.4364	.3192	.3710	.5486	.4211
6	.4857	.4033	.6892	.3296	.4353	.4786	.5239	.3148	.2957	.3853	.5077	.3996
7	.3904	.9702	.7103	.5341	.3416	.5401	.3317	.2741	.3631	.3998	.5060	.3817
8	.3098	.5366	.6210	.5182	.5006	.7404	.3289	.2428	.3878	.4021	.5124	.4204
9	.8947	1.2298	.3144	.4767	.6245	.8827	.4558	.1806	.5671	.4944	.5818	.5161
+gp	.8947	1.2298	.3144	.4767	.6245	.8827	.4558	.1806	.5671	.4944		
0 FBAR 3- 6	.5172	.4228	.4187	.2953	.3548	.3670	.3116	.3061	.2825	.2743		

Table 6.3.3. Saithe in Sub-Areas IV and VI and Division IIIa. Stock number at age (start of year) Numbers*10**-3

Stock number at age (start of year) Numbers*10**-3

	YEAR	1967	1968	1969	1970	1971	1972	1973
	AGE							
	1	453741	438382	492293	270965	260847	273424	301479
	2	149191	371492	358759	403023	221635	213026	223472
	3	127455	114113	300684	291828	327922	171366	152846
	4	77470	88670	72415	218822	205224	205314	96802
	5	54511	48750	53387	43290	109790	115731	108292
	6	6638	30577	27983	33705	21870	60266	71845
	7	5177	3351	19585	16026	16621	13621	30153
	8	1407	2795	2356	10843	9597	9764	7829
	9	680	888	2070	1213	7256	5285	5330
	+gp	621	1041	490	1008	2974	5132	9287
0	TOTAL	876890	1100059	1330022	1290722	1183738	1072930	1007335

	YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
	AGE										
	1	678401	222367	157196	145666	125016	290126	192634	221844	357545	514630
	2	242570	551127	181755	128457	117296	101221	236707	156520	176693	290951
	3	148731	181222	384058	117944	92391	77438	66806	171992	109468	117908
	4	75978	61203	96807	126394	71717	43921	48624	38867	117129	60765
	5	45144	31677	26706	31249	53746	34042	23096	28643	24276	59172
	6	64368	24182	16598	11282	12233	27661	17753	10752	17353	11575
	7	44288	33980	12953	7932	4269	7019	14775	8456	5478	8798
	8	17061	22990	15463	7007	3076	2466	3209	6977	3906	2544
	9	4600	9264	10357	7808	2618	1584	1356	1587	2640	1882
	+gp	6037	7035	9982	9492	11775	6068	6064	6055	3336	2371
0	TOTAL	1327180	1145048	911875	593230	494137	591546	611024	651695	817825	1070596

	YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	AGE										
	1	440319	176957	212795	128144	192304	218241	156567	235891	167662	344304
	2	421061	360316	144671	173930	104203	157416	175366	127865	192686	136981
	3	204890	310906	286483	111907	114337	77386	119950	138362	92842	151714
	4	70980	94518	133279	184393	63373	64133	43336	61283	71553	59360
	5	31107	29003	27072	26577	62773	27991	24682	17762	23145	28168
	6	24909	13744	11729	8424	9101	19432	10986	9963	7785	7410
	7	4339	8621	6941	4734	4039	3988	6001	4729	4915	3485
	8	2776	2054	4339	3328	2237	1581	1856	2402	2319	2645
	9	731	1140	1065	2235	1602	833	625	846	1104	1269
	+gp	1390	2101	2125	1699	1383	956	799	1043	887	1564
0	TOTAL	1202503	999360	830498	645371	555353	571958	540168	600145	564896	736900

	YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	GMST 67-01	GMST 85-01
	AGE													
	1	169603	256060	124429	218838	139257	322881	223633	215943	188817	151165	0	242077	198040
	2	281748	138763	209502	101554	179145	113816	264295	182964	176795	153765	123756	196383	168643
	3	102995	223407	109685	163416	71929	143318	87182	213950	148128	138524	123258	145281	134961
	4	89989	66267	158784	79789	120189	49514	108807	64987	159465	103120	102875	84335	81942
	5	29754	37309	30698	94839	47863	70337	27987	73435	36408	91727	66185	40091	35577
	6	12344	12567	17157	14469	50342	24378	33443	14824	38863	21662	51824	17821	14126
	7	3239	6218	6874	7051	8520	26670	12368	16216	8860	23674	12064	8566	6656
	8	1435	1795	1930	2766	3384	4957	12724	7268	10093	5045	12996	3969	2871
	9	798	862	859	849	1349	1679	1935	7498	4668	5607	2763	1830	1250
	+gp	1460	1222	1997	833	651	1219	1321	1451	4010	2914	4256		
0	TOTAL	693367	744471	661915	684405	622629	758770	773695	798535	776107	697203	499977		

Table 6.3.4. Saithe in Sub-Areas IV and VI and Division IIIa. Summary (without SOP correction)

Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 6
1967	453741	499613	150837	94514	.6266	.3220
1968	438382	1025940	211721	116789	.5516	.2907
1969	492293	1134509	263956	131882	.4996	.2624
1970	270965	1288484	312001	236636	.7584	.4079
1971	260847	1282606	429557	272481	.6343	.3286
1972	273424	1110241	474073	275098	.5803	.3950
1973	301479	993277	534454	259602	.4857	.4164
1974	678401	1143738	554859	309439	.5577	.5565
1975	222367	1068085	472004	308926	.6545	.4817
1976	157196	917980	351455	361680	1.0291	.7606
1977	145666	626479	263025	223395	.8493	.6156
1978	125016	568415	267888	166199	.6204	.4771
1979	290126	585743	240770	135967	.5647	.3965
1980	192634	545131	234687	142395	.6067	.4443
1981	221844	647702	240292	146092	.6080	.3076
1982	357545	688653	209029	189861	.9083	.4728
1983	514630	815107	212024	197774	.9328	.5559
1984	440319	844008	173649	219642	1.2649	.6866
1985	176957	711551	156641	226129	1.4436	.7215
1986	212795	693762	146910	202758	1.3802	.8319
1987	128144	497624	147451	180776	1.2260	.6632
1988	192304	479499	143182	140778	.9832	.6483
1989	218241	458681	109693	117609	1.0722	.7113
1990	156567	421697	96482	107945	1.1188	.6284
1991	235891	458234	92419	115576	1.2506	.5912
1992	167662	494671	94789	104147	1.0987	.6306
1993	344304	544359	102247	119073	1.1646	.5164
1994	169603	556670	111454	115255	1.0341	.5172
1995	256060	688416	134106	125183	.9335	.4228
1996	124429	583710	155011	119669	.7720	.4187
1997	218838	603413	193993	112740	.5812	.2953
1998	139257	586462	192797	108699	.5638	.3548
1999	322881	637445	201998	114655	.5676	.3670
2000	223633	740266	189641	93566	.4934	.3116
2001	215943	716942	212378	96491	.4543	.3061
2002	188817	729772	200939	121974	.6070	.2825
2003	151165	576047	220921	106789	.4834	.2743
2004	198000*		260000*			
Arith. Mean	261632	728782	229712	168059	.8098	.4776
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

*Estimates for 2004 are from short-term prognoses (see Sections 6.4 and 6.5).

Table 6.5.1. Saithe in Sub-Areas IV and VI and Division IIIa.Input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	198000	0.29	WS1	0.56	0.25
N2	162092	0.29	WS2	0.66	0.26
N3	129240	0.29	WS3	0.77	0.06
N4	102875	0.28	WS4	0.96	0.11
N5	66185	0.18	WS5	1.24	0.11
N6	51823	0.12	WS6	1.83	0.11
N7	12063	0.11	WS7	2.37	0.07
N8	12995	0.11	WS8	3.34	0.06
N9	2763	0.11	WS9	3.96	0.05
N10	4255	0.12	WS10	4.76	0.27
H.cons selectivity			Weight in the HC catch		
sH1	0.00	1.68	WH1	0.56	0.25
sH2	0.03	0.67	WH2	0.66	0.26
sH3	0.12	0.35	WH3	0.77	0.06
sH4	0.33	0.18	WH4	0.96	0.11
sH5	0.38	0.12	WH5	1.24	0.11
sH6	0.33	0.18	WH6	1.83	0.11
sH7	0.35	0.24	WH7	2.37	0.07
sH8	0.34	0.30	WH8	3.34	0.06
sH9	0.41	0.52	WH9	3.96	0.05
sH10	0.41	0.52	WH10	4.76	0.27
Natural mortality			Proportion mature		
M1	0.20	0.10	MT1	0.00	0.00
M2	0.20	0.10	MT2	0.00	0.00
M3	0.20	0.10	MT3	0.00	0.10
M4	0.20	0.10	MT4	0.15	0.10
M5	0.20	0.10	MT5	0.70	0.10
M6	0.20	0.10	MT6	0.90	0.10
M7	0.20	0.10	MT7	1.00	0.10
M8	0.20	0.10	MT8	1.00	0.00
M9	0.20	0.10	MT9	1.00	0.00
M10	0.20	0.10	MT10	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF04	1.00	0.06	K04	1.00	0.10
HF05	1.00	0.06	K05	1.00	0.10
HF06	1.00	0.06	K06	1.00	0.10
Recruitment in 2005 and 2006					
R05	198000	0.29			
R06	198000	0.29			

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

Stock numbers in 2004 are VPA survivors.
These are overwritten at Age 1 Age 2 Age 3.

Data from file:C:\arbeid\linjearbeid\wg_04\pred\SAI46.SEN on 25/08/2004 at 14:02

Table 6.5.2. Saithe in Suba-Areas IV and VI and Division IIIa. Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 2004	2005									
Mean F Ages H.cons 3 to 6	0.29	0.00	0.04	0.10	0.20	0.29	0.30	0.36	0.40	0.44	0.50
Effort relative to 2003 H.cons	1.00	0.00	0.14	0.35	0.69	1.00	1.03	1.24	1.38	1.52	1.72
Biomass											
Total 1 January	695	693	693	693	693	693	693	693	693	693	693
SSB at spawning time	260	271	271	271	271	271	271	271	271	271	271
Catch weight (,000t) H.cons	114	0	18	44	83	115	118	137	150	161	178
Biomass in year.... 2006											
Total 1 January		829	808	777	731	694	690	667	653	639	620
SSB at spawning time		386	368	343	305	274	271	252	241	230	214

	Year 2004	2005									
Effort relative to 2003 H.cons	1.00	0.00	0.14	0.35	0.69	1.00	1.03	1.24	1.38	1.52	1.72
Est. Coeff. of Variation											
Biomass											
Total 1 January	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
SSB at spawning time	0.09	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Catch weight H.cons	0.13	0.00	0.44	0.20	0.14	0.13	0.13	0.12	0.12	0.12	0.12
Biomass in year.... 2006											
Total 1 January		0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.13	0.13	0.13
SSB at spawning time		0.12	0.12	0.12	0.12	0.13	0.13	0.13	0.13	0.13	0.13

Table 6.5.3. Saithe in Sub-Areas IV and VI and Division IIIa. Detailed forecast tables.

Forecast for year 2004
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	198000	359	359
2	162092	3629	3629
3	129240	13063	13063
4	102875	26012	26012
5	66185	18917	18917
6	51823	13343	13343
7	12063	3216	3216
8	12995	3448	3448
9	2763	855	855
10	4255	1316	1316
Wt	695	114	114

Forecast for year 2005
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	198000	359	359
2	161785	3622	3622
3	129433	13083	13083
4	94035	23777	23777
5	60856	17394	17394
6	37205	9579	9579
7	30442	8117	8117
8	6988	1854	1854
9	7543	2333	2333
10	3798	1175	1175
Wt	*693*	*115*	*115*

Figure 6.2.1. Saithe in Sub-areas IV and VI and Division IIIa. Commercial effort series (mean standardised hours trawled) and commercial CPUE (mean standardised total catch per total hours trawled).

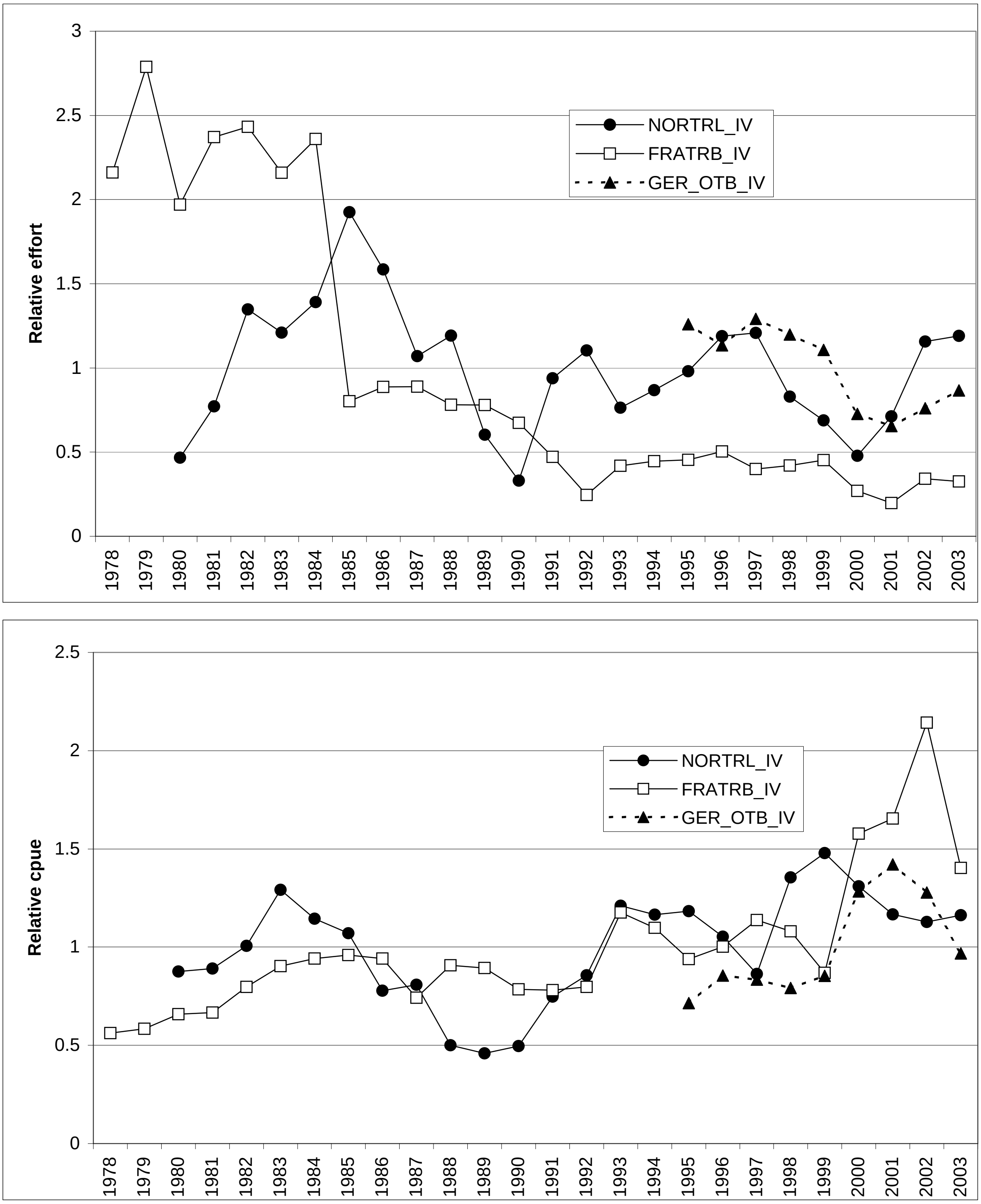


Figure 6.3.1. Saithe in Sub-area IV, Division IIIa and Sub-area VI. Stock summary. Note that the recruitment in 2004 is the geometric mean from the period 1985-2001 and SSB in 2004 is taken from the short-term prognosis (see Table 6.5.2).

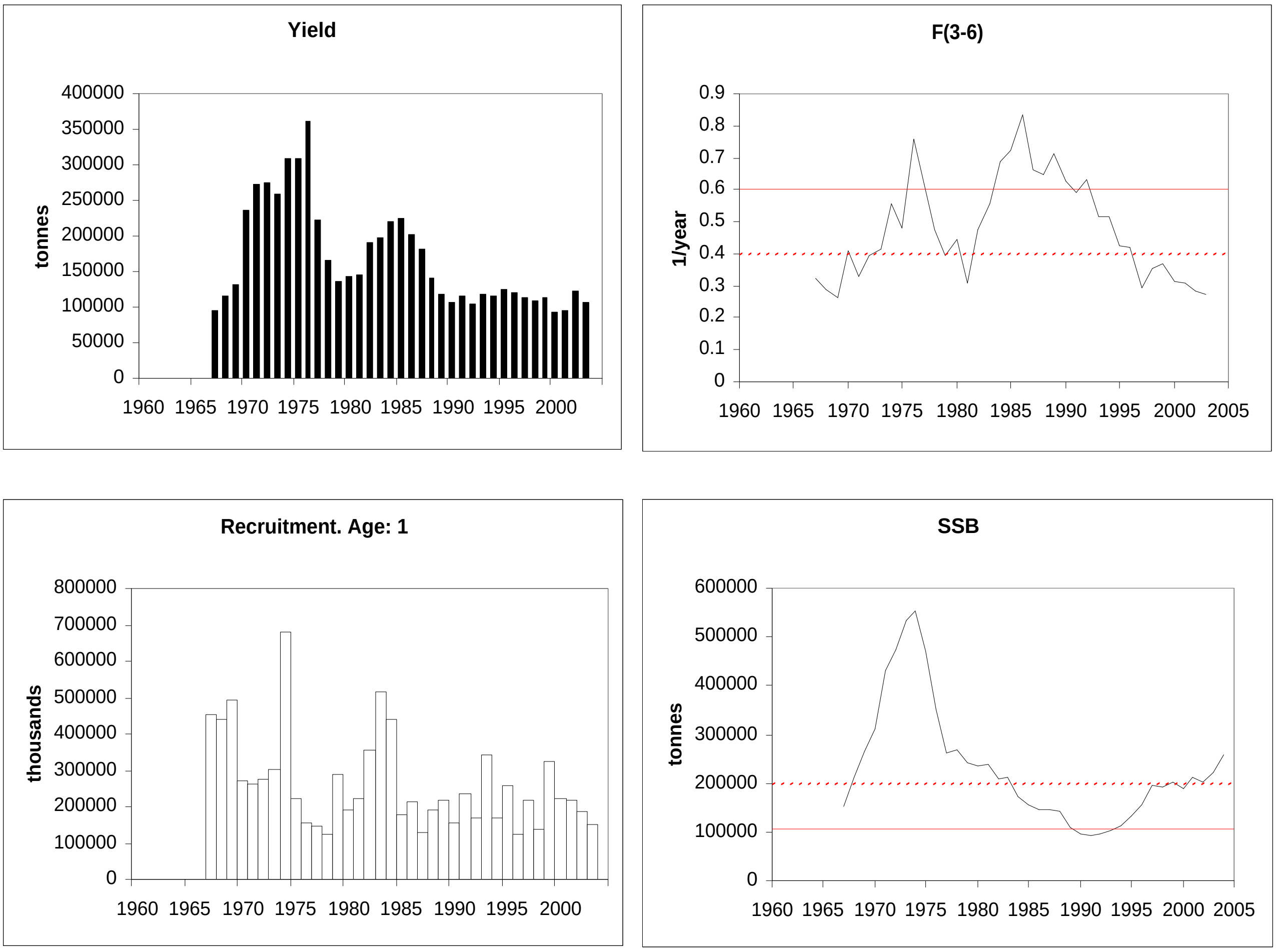
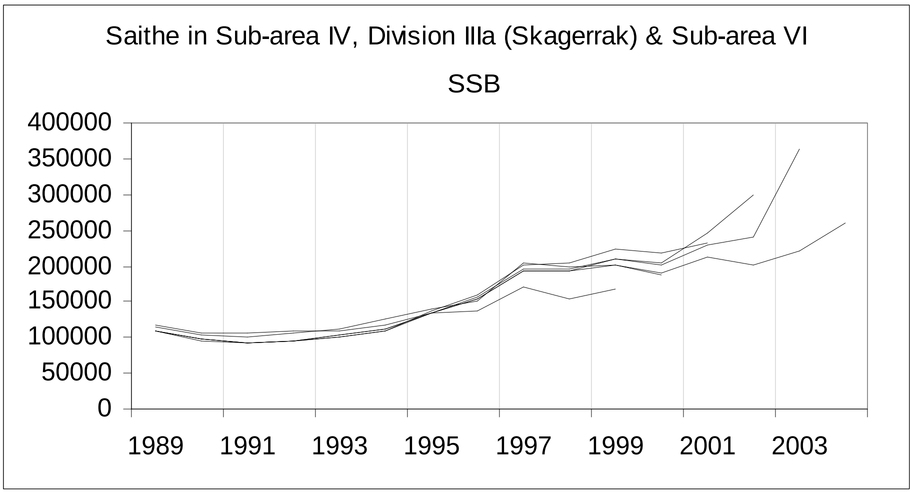
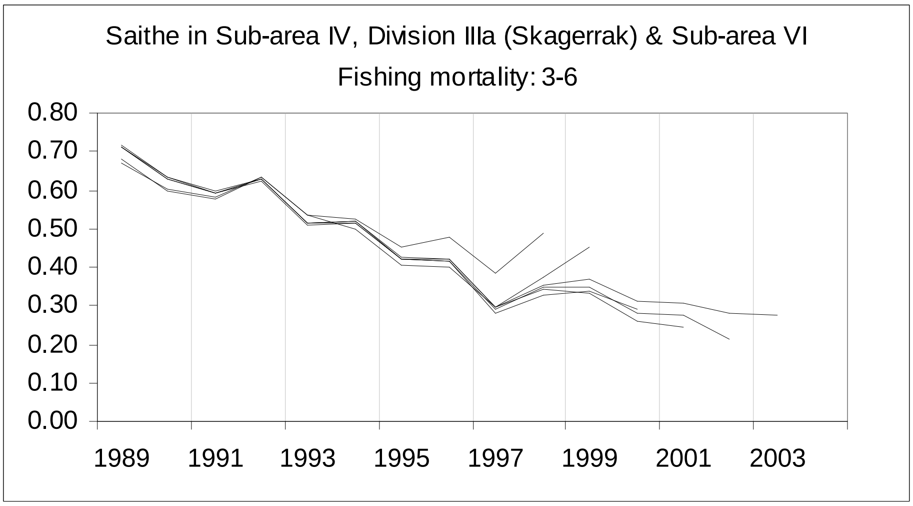


Figure 6.3.2. Saithe in Sub-Area IV, Division IIIa, and Sub-Area VI. Comparison of historical performance of the assessments.





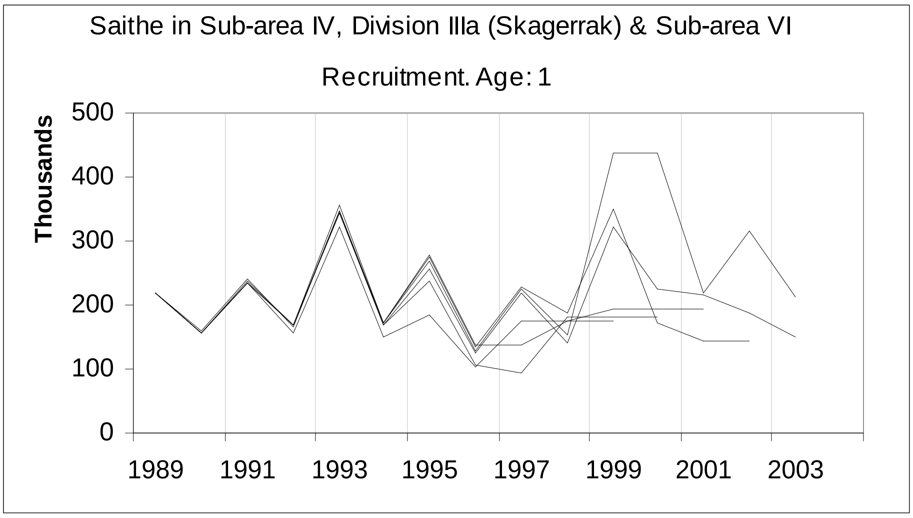


Figure 6.5.1. Saithe in Sub-areas IV and VI and Division IIIa. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

Year-class			2000	2001	2002	2003	2004
Stock No. (thousands) of		1 year-olds	215943	198000	198000	198000	198000
Source			VPA	GM	GM	GM	GM
Status Quo F:							
% in	2004	landings	21.8	8.8	2.1	0.2	-
% in	2005		18.8	19.9	8.8	2.1	0.2
% in	2004	SSB	5.7	0.0	0.0	0.0	-
% in	2005	SSB	19.5	5.0	0.0	0.0	0.0
% in	2006	SSB	21.3	18.3	5.1	0.0	0.0

GM : geometric mean recruitment

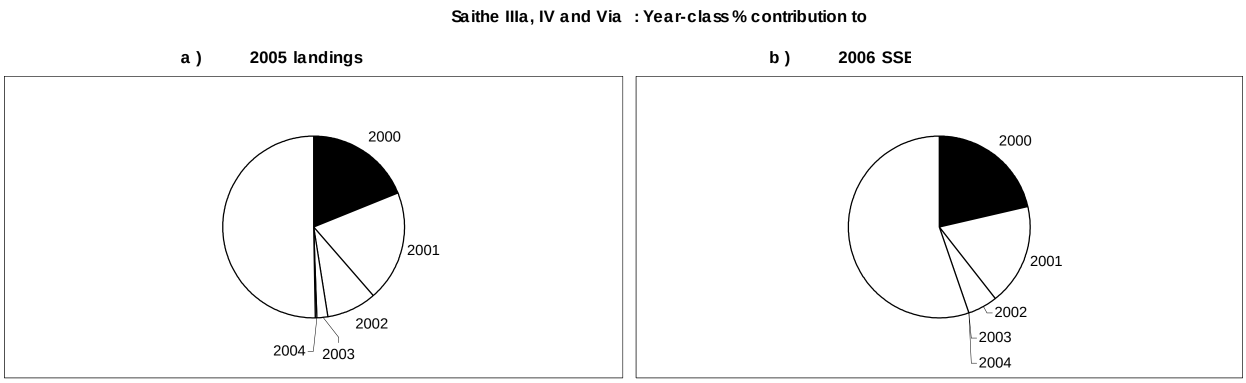


Figure 6.5.2. Saithe in Sub-areas IV and VI and Division IIIa. Probability profiles for short term forecast.

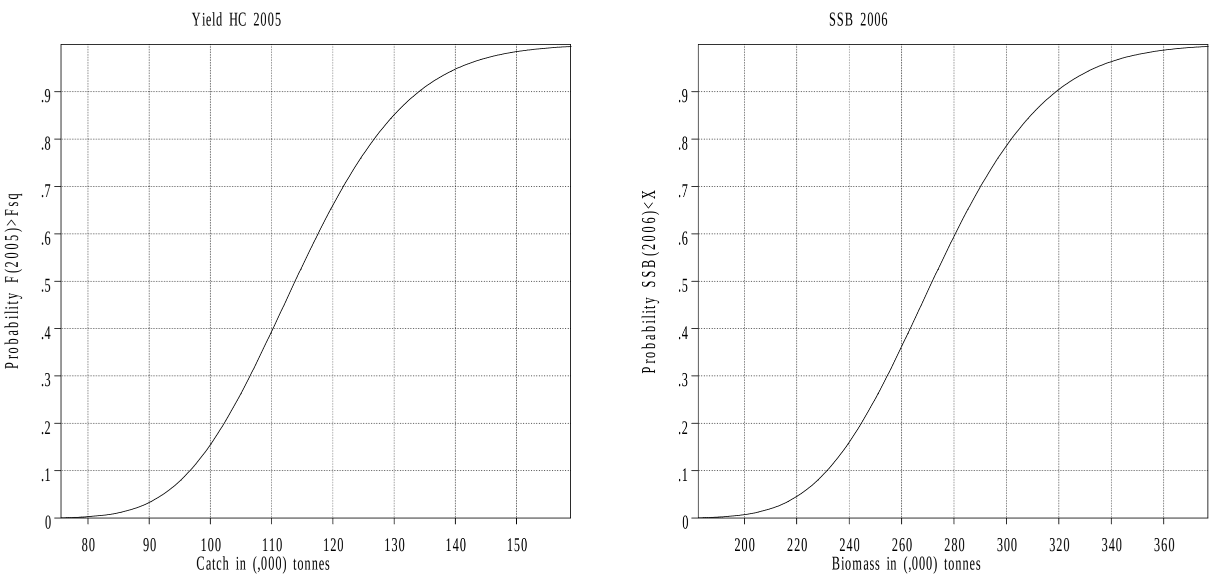
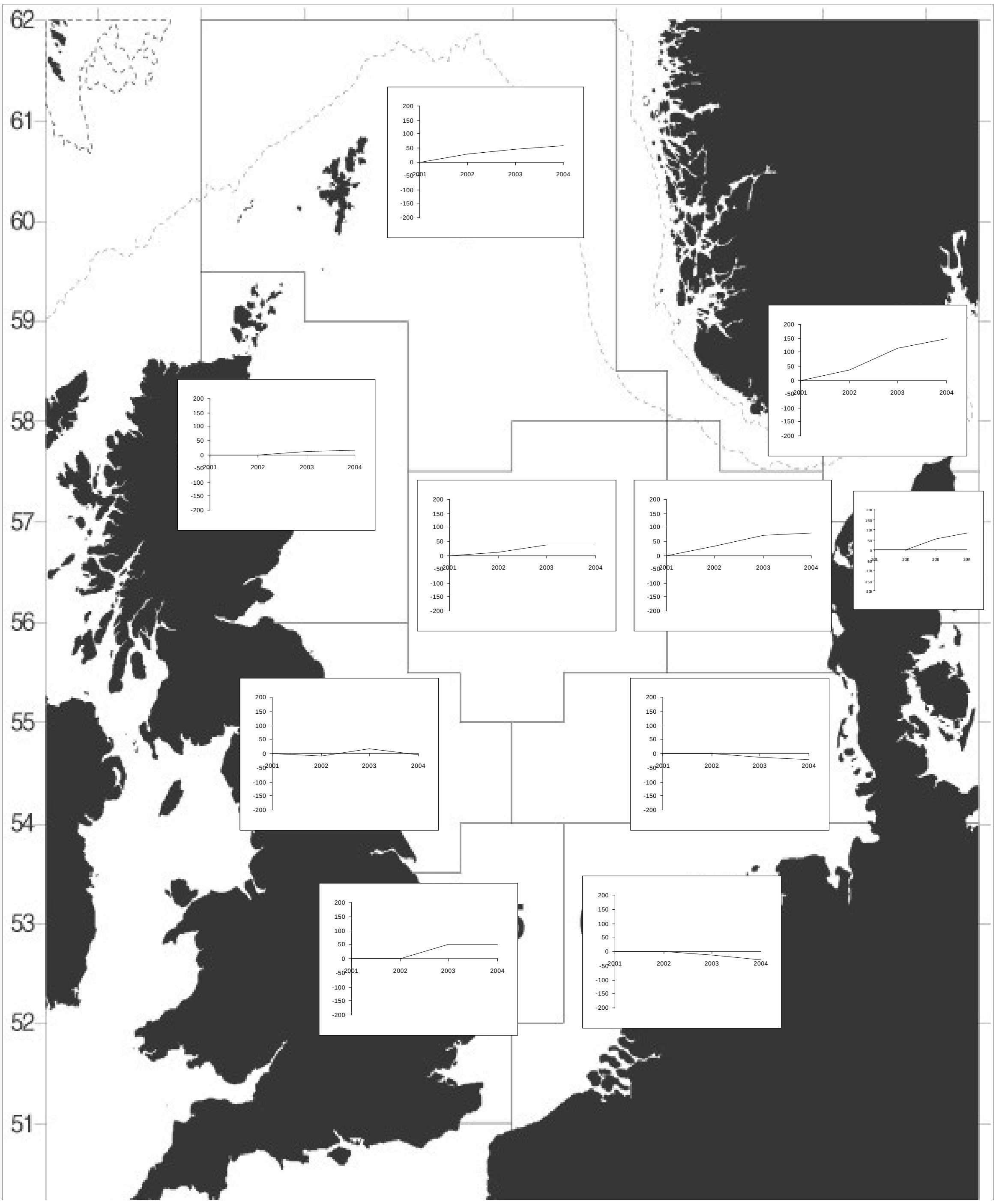


Figure 6.6.1. Saithe in Sub-Area IV, Division IIIa and Sub-Area VI. Results from North Sea fishermen's survey for saithe in different areas of the North Sea from 2001 to 2004.



7 Sole in Sub-area IV

The assessment of sole in Sub-Area IV is presented here as an update 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. The most recent benchmark assessment was carried out in 2003 for this stock. The assessment of the stock will be subject to review this year by the North Sea Commission Fisheries Partnership (NSCFP).

7.1 The fishery

A general description of the fishery is given in the Stock Annex.

The national uptake rates in 2004 by the Netherlands (the main sole-landing country) indicate that approximately 64% of the national quota was taken by the beginning of September 2004. The indications are that the 2004 TAC will be fished out by the end of December.

7.2 ICES advice applicable to 2003 and 2004

ICES commented that the stock was being harvested outside safe biological limits in 2003. ICES recommended that fishing mortality in 2004 should be reduced to less than F_{pa} (= 0.40) corresponding to landings less than 17,900t in 2004. The TAC for 2004 was set at 17,000t. The advice on the exploitation of the stock was presented in the context of mixed fisheries.

7.3 Data available

7.3.1 Landings

Landings data by country and TACs are presented in Table 7.3.1.

7.3.2 Age compositions

Age compositions of the landings are presented in Table 7.3.2.

7.3.3 Weight at age

Weight at age in the catch is presented in Table 7.3.3 and weight at age in the stock in Table 7.3.4. The procedure for calculating mean weights is described in the Stock Annex.

7.3.4 Maturity and natural mortality

Maturity and natural mortality are assumed at fixed values and are described in the Stock Annex.

7.3.5 Catch, effort and research vessel data

The effort and CPUE data are presented in Table 7.3.5. Trends in relative effort and CPUE are shown in Figure 7.3.1. Survey data used for calibration of the assessment are presented in Tables 7.3.6.

7.4 Catch at age analysis

Catch at age analysis was carried out according to the specifications in the Stock Annex. The model used was XSA. Results of the analysis are presented in Tables 7.4.1 (diagnostics), 7.4.2 (fishing mortality at age), 7.4.3 (population numbers at age), and 7.4.4 (stock summary). The stock summary is also shown in Figure 7.4.1 and the historic performance is shown in Figure 7.4.2.

7.5 Recruitment estimates

Recruitment estimation was carried out according to the specifications in the Stock Annex. The model used was RCT3. Input to the RCT3 model is presented in Table 7.5.1. Results are presented in Table 7.5.2a and 7.5.2b. Average recruitment in the period 1957-2001 was around 96 million (geometric mean) 1-year-old-fish. Year class strength estimates used for short term prognosis are summarized in the text Table below. These recruitment estimates are preliminary and will be updated prior to the ACFM October meeting when the BTS 2004 indices become available.

Year Class	Age in 2004	XSA thousands	RCT3 thousands	GM(1957-2001) thousands
2002	2	93034	**76353**	85043
2003	1		62378	**95890**
2004	Recruit			**95890**

7.6 Short-term prognosis

The short-term prognosis was carried out according to the specifications in the Stock Annex. The software used was WGFRANSW. Inputs to WGFRANSW are presented in Table 7.6.1. Results are presented in Tables 7.6.2 and 7.6.3. A scaled three-year mean was used for $\boldsymbol{F}_{sq}$, the exploitation pattern in the intermediate year (2004). On this basis, catches in 2004 are forecast to be 21000 t, and would hence exceed the 2004 TAC (15850 t). With F(2005) also set to $\boldsymbol{F}_{sq}$, SSB(2006) would be slightly above $\boldsymbol{B}_{pa}$ (= 35000 t). In order to account for a possible reduction in F(2004) resulting from management measures (restrictive TAC and days at sea limits), exploratory runs were carried out using the TAC constraint option and $\boldsymbol{F}_{sq}$ defined as above. With a TAC constraint of 15850 t, F(2004) would be 70% of F(2003). With an intermediate TAC constraint of 18000 t, F(2004) would be 80% of F(2003). SSB(2006) would be around 40000 t with F(2005) = $\boldsymbol{F}_{pa}$, when applying any of these TAC constraint options.

Table 7.6.4 show the relative contribution of the year classes to landings and SSB. Figure 7.6.1 show the probability profiles for the short term forecast.

7.7 Biological reference points

Biological reference points are described in the Stock Annex.

7.8 Comments

This year's assessment was carried out as an update assessment. No changes were made to the estimation procedure used last year.

Sole is mainly caught in a mixed beam trawl fishery with plaice using 80mm mesh in the southern North Sea. This mesh size results in large number of undersized plaice being discarded. In general, it is expected that both plaice and sole would benefit from measures to reduce discards in the beam trawl fishery.

Skippers were asked to compare the state of their catch in January to June 2004 with the same period in 2003. Findings were based upon the catch not the landings. The skippers were asked to describe the catch rates (less, the same or more than last year), the size range (mostly small, all sizes, mostly large) and the discard rates (less, the same or more than last year). Questionnaire returns were received from skippers of vessels registered in Belgium, Denmark, England, the Netherlands, Scotland and Sweden. A total of 322 views were collected on the state of sole catches (all gear types combined). The area covered by this survey was subdivided into 10 zones, 8 within the North Sea and 2 in subdivision IIIa.

In the southern North Sea and the Skagerrak and Kattegat, there are strong indications that the abundance of sole is increasing (Figure 7.8.1). The assessment indicates little or no increase in SSB. The increase reported by the industry may represent the large numbers of small sole that were frequently mentioned by Dutch and Danish fishermen in the comments Section of the 2003 survey. Following this, the majority of the respondents reported catches of all sizes. In zone 3 (Western North Sea) catches of relatively small Sole were reported in 2004 as in 2003. No strong trends in discarding are reported, the discard rates have remained the same or showed a slight decrease. Only zone 8 (roughly the Northern part of ICES Area IIIa) reported a increase in discarding. This possibly reflects an increase in abundance.
The next benchmark assessment for this stock is foreseen in 2006. During this benchmark, attention should be paid to:

- In 2003 a proposal was made for the revision of the biological referencepoints. This revision was rejected by ACFM. The revision of the reference points will be re-investigated.
- The small increase in the number of males at older ages resulting in a lower weight at age (WG2003).
- The changes in maturity as studied within the COMPASS project
- Potential misreporting (VIId)
- Tuning with of without commercial fleet data

Table 7.3.1. Nominal catch (tonnes) of Sole in Sub-Area IV, and landings as estimated by the Working Group.

Year	Belgium	Denmark	France	Germany Fed. Rep.	Netherlands	UK (Engl. Wales, North. I.)	Other countries	Total reported	Unallocated landings	WG Total	TAC
1982	1927	522	686	290	17749	403		21577	2	21579	20000
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	1428	352	2296	18202	1614	263	26544	8576	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	20351	2300	22651	23000
1997	1519	689	99	510	10241	479	204	13741	1160	14901	18000
1998	1844	520	510	782	15198	549	338	19739	1129	20868	19100
1999	1919	828	357	1458	16283	645	501	21991	1484	23475	22000
2000	1806	1069	362	1280	15273	600	346	20736	1796	22532	22000
2001	1874	773	370	958	11547	596	310	16428	3421	19849	19000
2002	1437	644	266	759	12120	451	292	15969	331	16300	16000
2003	1622*	703	264	749	12482*	521	364*	16705	1215	17920	15850

*preliminary

Table 7.3.2. North Sea sole: catch numbers at age

Run title : Sole in IV
At 9/09/2004 10:45

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,
AGE							
1,	0,	0,	0,	0,	0,	0,	0,
2,	1415,	1854,	3659,	12042,	959,	1594,	676,
3,	10148,	8440,	12025,	14133,	49786,	6210,	8339,
4,	12642,	14169,	10401,	16798,	19140,	59191,	8555,
5,	3762,	9500,	8975,	9308,	12404,	15346,	46201,
6,	2924,	3484,	5768,	8367,	4695,	10541,	8490,
7,	6518,	3008,	1206,	4846,	3944,	4826,	6658,
8,	1733,	4439,	2025,	1593,	4279,	4112,	2423,
9,	509,	2253,	2574,	1056,	836,	2087,	3393,
+gp,	6288,	6557,	5615,	7901,	7254,	7494,	8384,
0 TOTALNUM,	45939,	53704,	52248,	76044,	103297,	111401,	93119,
TONSLAND,	12067,	14287,	13832,	18620,	23566,	26877,	26164,
SOPCOF %,	104,	100,	101,	99,	101,	99,	99,

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
1,	55,	0,	0,	0,	1037,	396,	1299,	420,	358,	703,
2,	155,	47100,	12278,	3686,	17148,	23922,	6140,	33369,	7594,	12228,
3,	2113,	1089,	133617,	25683,	13896,	21451,	25993,	14425,	36759,	12783,
4,	5712,	1599,	990,	85127,	24973,	5326,	8235,	12757,	7075,	16187,
5,	3809,	5002,	1181,	1954,	48571,	12388,	1784,	4485,	4965,	4025,
6,	17337,	2482,	3689,	536,	462,	25139,	3231,	1442,	1565,	2324,
7,	3126,	12500,	744,	1919,	245,	331,	11960,	2327,	523,	994,
8,	1810,	1557,	6324,	760,	1644,	244,	246,	7214,	1232,	765,
9,	818,	1525,	702,	5047,	324,	1190,	140,	192,	4706,	1218,
+gp,	3015,	3208,	2450,	2913,	6523,	5272,	5234,	4594,	2801,	5790,
0 TOTALNUM,	37950,	76062,	161975,	127625,	114823,	95659,	64262,	81225,	67578,	57017,
TONSLAND,	11342,	17043,	33340,	33439,	33179,	27559,	19685,	23652,	21086,	19309,
SOPCOF %,	97,	96,	99,	102,	100,	102,	100,	101,	99,	102,

1

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
1,	101,	264,	1041,	1747,	27,	9,	637,	423,	2660,	389,
2,	15380,	22954,	3542,	22328,	25031,	8179,	1209,	29217,	26435,	34408,
3,	21540,	28535,	27966,	12073,	29292,	41170,	12511,	3259,	45746,	41386,
4,	5487,	11717,	14013,	15306,	6129,	16060,	17781,	6866,	1843,	21189,
5,	7061,	2088,	4819,	7440,	6639,	2996,	7297,	8223,	3535,	624,
6,	1922,	3830,	966,	1779,	4250,	3222,	1450,	3661,	4789,	1378,
7,	1585,	790,	1909,	319,	1738,	1747,	2197,	948,	1678,	1950,
8,	658,	907,	550,	1112,	611,	816,	1409,	886,	615,	978,
9,	401,	508,	425,	256,	646,	241,	367,	766,	605,	386,
+gp,	4814,	3445,	2663,	2115,	1602,	1527,	1203,	908,	1278,	1176,
0 TOTALNUM,	58949,	75038,	57894,	64475,	75965,	75967,	46061,	55157,	89184,	103864,
TONSLAND,	17989,	20773,	17326,	18003,	20280,	22598,	15807,	15403,	21579,	24927,
SOPCOF %,	99,	101,	102,	102,	100,	101,	102,	103,	101,	100,

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
1,	191,	165,	374,	94,	10,	117,	863,	120,	980,	54,
2,	30734,	16618,	9363,	29053,	13219,	46387,	11939,	13163,	6832,	50451,
3,	43931,	43213,	18497,	22046,	47182,	18263,	104454,	25420,	44378,	16768,
4,	22554,	20286,	17702,	8899,	15232,	22654,	9767,	77913,	16204,	31409,
5,	8791,	9403,	7747,	6512,	4381,	4624,	9194,	6724,	38319,	13869,
6,	741,	3556,	5515,	3119,	3882,	1653,	3349,	3675,	2477,	24035,
7,	854,	209,	2270,	1567,	1551,	1437,	1043,	1736,	3041,	1489,
8,	1043,	379,	110,	903,	891,	647,	1198,	719,	741,	1184,
9,	524,	637,	283,	81,	524,	458,	554,	730,	399,	461,
+gp,	894,	975,	1682,	694,	317,	468,	845,	1090,	1180,	842,
0 TOTALNUM,	110257,	95441,	63543,	72968,	87189,	96708,	143206,	131290,	114551,	140562,
TONSLAND,	26839,	24248,	18201,	17368,	21590,	21805,	35120,	33513,	29341,	31491,
SOPCOF %,	100,	99,	99,	99,	100,	98,	99,	98,	99,	99,

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
1,	718,	4801,	172,	1590,	244,	287,	2351,	884,	1055,	1048,
2,	7804,	12767,	18824,	6047,	56648,	15762,	15073,	25846,	11053,	32330,
3,	87403,	16822,	16190,	23651,	15141,	72470,	32738,	21595,	32852,	17498,
4,	13550,	68571,	16964,	7325,	14934,	8187,	42803,	19876,	12290,	16090,
5,	18739,	6308,	27257,	5108,	3496,	6111,	3288,	16730,	8215,	5820,
6,	5711,	7307,	3858,	12793,	1941,	1212,	2477,	1427,	6448,	3906,
7,	11310,	1995,	4780,	1201,	4768,	664,	804,	834,	673,	2430,
8,	464,	6015,	943,	2326,	794,	1984,	435,	274,	597,	400,
9,	916,	295,	3305,	333,	1031,	331,	931,	168,	89,	128,
+gp,	908,	668,	988,	1688,	846,	812,	714,	724,	364,	451,
0 TOTALNUM,	147523,	125549,	93281,	62062,	99843,	107820,	101614,	88358,	73636,	80101,
TONSLAND,	33002,	30467,	22651,	14901,	20868,	23475,	22641,	19944,	16945,	17920,
SOPCOF %,	99,	99,	99,	99,	99,	99,	99,	97,	99,	100,

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Table 7.3.3. North Sea sole: catch weights at age

Run title : Sole in IV

At 9/09/2004 10:45

Table 2 Catch weights at age (kg)

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,
AGE							
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.1540,	.1450,	.1620,	.1530,	.1460,	.1550,	.1630,
3,	.1770,	.1780,	.1880,	.1850,	.1740,	.1650,	.1710,
4,	.2040,	.2200,	.2280,	.2350,	.2110,	.2080,	.2190,
5,	.2480,	.2540,	.2610,	.2540,	.2550,	.2410,	.2580,
6,	.2790,	.2730,	.3010,	.2770,	.2880,	.2950,	.3090,
7,	.2900,	.3140,	.3280,	.3010,	.3190,	.3200,	.3230,
8,	.3350,	.3230,	.3210,	.3090,	.3040,	.3210,	.3870,
9,	.4360,	.3880,	.3730,	.3810,	.3460,	.3340,	.3760,
+gp,	.4081,	.4135,	.4262,	.4177,	.4193,	.4119,	.4846,
0 SOPCOFAC,	1.0402,	1.0050,	1.0095,	.9936,	1.0137,	.9940,	.9918,

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
1,	.1530,	.0000,	.0000,	.0000,	.1570,	.1520,	.1540,	.1450,	.1690,	.1460,
2,	.1750,	.1690,	.1770,	.1920,	.1890,	.1910,	.2120,	.1930,	.2040,	.2080,
3,	.2130,	.2090,	.1900,	.2010,	.2070,	.1960,	.2180,	.2370,	.2520,	.2380,
4,	.2520,	.2460,	.1800,	.2520,	.2670,	.2550,	.2850,	.3220,	.3340,	.3460,
5,	.2740,	.2860,	.3010,	.2770,	.3270,	.3110,	.3500,	.3580,	.4340,	.4040,
6,	.3090,	.2820,	.3320,	.3890,	.3420,	.3730,	.4040,	.4250,	.4250,	.4480,
7,	.3270,	.3450,	.4290,	.4190,	.3540,	.5530,	.4410,	.4200,	.5320,	.5520,
8,	.3460,	.3780,	.3990,	.3390,	.4550,	.3980,	.4630,	.4900,	.4850,	.5670,
9,	.3880,	.4040,	.4490,	.4240,	.4650,	.4680,	.4430,	.5340,	.5580,	.5090,
+gp,	.4805,	.4797,	.5015,	.4912,	.5075,	.5227,	.5326,	.5471,	.6291,	.5858,
0 SOPCOFAC,	.9661,	.9592,	.9892,	1.0225,	.9968,	1.0202,	1.0001,	1.0119,	.9890,	1.0189,

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
1,	.1640,	.1290,	.1430,	.1470,	.1520,	.1370,	.1410,	.1430,	.1410,	.1340,
2,	.1920,	.1820,	.1900,	.1880,	.1960,	.2080,	.1990,	.1870,	.1880,	.1820,
3,	.2330,	.2250,	.2220,	.2360,	.2310,	.2460,	.2440,	.2260,	.2160,	.2170,
4,	.3380,	.3200,	.3060,	.3070,	.3140,	.3230,	.3310,	.3240,	.3070,	.3010,
5,	.4180,	.4060,	.3890,	.3690,	.3700,	.3910,	.3710,	.3780,	.3710,	.3890,
6,	.4480,	.4560,	.4410,	.4240,	.4260,	.4480,	.4180,	.4240,	.4090,	.4160,
7,	.5200,	.5290,	.5120,	.4300,	.4660,	.5340,	.4990,	.4420,	.4370,	.4670,
8,	.5590,	.5950,	.5620,	.5200,	.4170,	.5440,	.5500,	.5160,	.4910,	.4890,
9,	.6090,	.6290,	.6670,	.5620,	.5720,	.6090,	.5980,	.5420,	.5800,	.5050,
+gp,	.6533,	.6693,	.6647,	.6194,	.6663,	.7630,	.6841,	.6302,	.6557,	.6422,
0 SOPCOFAC,	.9864,	1.0104,	1.0216,	1.0188,	.9956,	1.0124,	1.0201,	1.0262,	1.0138,	1.0040,

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
1,	.1530,	.1220,	.1350,	.1390,	.1270,	.1180,	.1240,	.1270,	.1460,	.0970,
2,	.1710,	.1870,	.1790,	.1850,	.1750,	.1730,	.1830,	.1860,	.1780,	.1670,
3,	.2210,	.2160,	.2130,	.2050,	.2170,	.2160,	.2270,	.2100,	.2130,	.1960,
4,	.2860,	.2880,	.2990,	.2770,	.2700,	.2880,	.2920,	.2630,	.2580,	.2390,
5,	.3610,	.3570,	.3570,	.3560,	.3540,	.3360,	.3710,	.3150,	.2980,	.2640,
6,	.3860,	.4270,	.4070,	.3780,	.4280,	.3750,	.4130,	.4360,	.3800,	.3000,
7,	.4650,	.4470,	.4850,	.4280,	.4840,	.4560,	.4150,	.4430,	.4090,	.3380,
8,	.5550,	.5440,	.5430,	.4810,	.5210,	.4920,	.5140,	.4670,	.4600,	.4410,
9,	.5750,	.6120,	.5680,	.3930,	.5590,	.4700,	.4760,	.5070,	.4870,	.4960,
+gp,	.6339,	.6447,	.6096,	.6569,	.7124,	.6111,	.6198,	.5579,	.5557,	.6031,
0 SOPCOFAC,	1.0034,	.9898,	.9937,	.9946,	.9990,	.9841,	.9897,	.9829,	.9850,	.9885,

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
1,	.1430,	.1510,	.1630,	.1510,	.1280,	.1630,	.1450,	.1430,	.1400,	.1360,
2,	.1800,	.1860,	.1770,	.1800,	.1820,	.1790,	.1700,	.1850,	.1830,	.1820,
3,	.2020,	.1960,	.2020,	.2060,	.1890,	.2120,	.2000,	.2020,	.2110,	.2140,
4,	.2280,	.2470,	.2340,	.2360,	.2520,	.2290,	.2480,	.2700,	.2430,	.2560,
5,	.2570,	.2650,	.2740,	.2670,	.2620,	.2870,	.2900,	.2750,	.2810,	.2730,
6,	.3000,	.3190,	.2850,	.2960,	.2890,	.3240,	.2990,	.3330,	.3120,	.3170,
7,	.3170,	.3440,	.3180,	.3230,	.3360,	.3540,	.3230,	.3910,	.3660,	.3400,
8,	.4320,	.3560,	.3700,	.3060,	.2920,	.3720,	.3680,	.4140,	.3190,	.3440,
9,	.4090,	.4440,	.3900,	.3840,	.3350,	.3720,	.4020,	.4330,	.5710,	.5030,
+gp,	.5101,	.5914,	.5943,	.4396,	.5039,	.4527,	.4274,	.4935,	.5361,	.4305,
0 SOPCOFAC,	.9879,	.9927,	.9886,	.9901,	.9914,	.9898,	.9904,	.9690,	.9914,	.9989,

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Table 7.3.4. North Sea sole: stock weights at age

Run title : Sole in IV

At 9/09/2004 10:45

Table 3 Stock weights at age (kg)

YEAR, AGE	1957,	1958,	1959,	1960,	1961,	1962,	1963,
1,	.0250,	.0250,	.0250,	.0250,	.0250,	.0250,	.0250,
2,	.0700,	.0700,	.0700,	.0700,	.0700,	.0700,	.0700,
3,	.1470,	.1640,	.1590,	.1630,	.1480,	.1480,	.1480,
4,	.1870,	.2050,	.1980,	.2070,	.2060,	.1920,	.1930,
5,	.2080,	.2260,	.2390,	.2340,	.2350,	.2400,	.2430,
6,	.2530,	.2280,	.2710,	.2400,	.2320,	.3010,	.2750,
7,	.2620,	.2970,	.2920,	.2680,	.2590,	.2930,	.3110,
8,	.3550,	.3180,	.2760,	.2420,	.2740,	.2820,	.3630,
9,	.3900,	.3930,	.3030,	.3600,	.2810,	.2730,	.3290,
+gp,	.3652,	.4215,	.4258,	.4313,	.3964,	.4414,	.4654,

YEAR, AGE	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
1,	.0250,	.0250,	.0250,	.0250,	.0250,	.0250,	.0250,	.0340,	.0380,	.0390,
2,	.0700,	.1400,	.0700,	.1770,	.1220,	.1370,	.1370,	.1480,	.1550,	.1490,
3,	.1590,	.1980,	.1600,	.1640,	.1710,	.1740,	.2010,	.2130,	.2180,	.2260,
4,	.2140,	.2230,	.1490,	.2350,	.2480,	.2520,	.2750,	.3130,	.3130,	.3220,
5,	.2400,	.2510,	.3890,	.2420,	.3120,	.3240,	.3410,	.3610,	.4190,	.3710,
6,	.2910,	.2970,	.3100,	.3990,	.2800,	.3640,	.3670,	.4100,	.4430,	.4330,
7,	.3050,	.3370,	.4060,	.3620,	.6290,	.5790,	.4230,	.4320,	.4430,	.4520,
8,	.3060,	.3580,	.3770,	.2830,	.4160,	.4150,	.4580,	.4740,	.4430,	.4720,
9,	.3650,	.5260,	.3850,	.3810,	.4100,	.4690,	.3900,	.4830,	.5080,	.4460,
+gp,	.4739,	.4605,	.5045,	.4591,	.4856,	.5211,	.5544,	.5325,	.6018,	.5355,

YEAR, AGE	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
1,	.0350,	.0350,	.0350,	.0350,	.0350,	.0450,	.0390,	.0500,	.0500,	.0500,
2,	.1460,	.1480,	.1420,	.1470,	.1390,	.1480,	.1570,	.1370,	.1300,	.1400,
3,	.2180,	.2060,	.2010,	.2020,	.2110,	.2110,	.2000,	.2000,	.1930,	.2000,
4,	.3290,	.3110,	.3010,	.2910,	.2900,	.3000,	.3040,	.3050,	.2700,	.2850,
5,	.4080,	.4030,	.3790,	.3650,	.3650,	.3520,	.3450,	.3640,	.3590,	.3290,
6,	.4290,	.4460,	.4580,	.4090,	.4290,	.4290,	.3940,	.4020,	.4110,	.4350,
7,	.4990,	.5080,	.5080,	.4780,	.4270,	.5210,	.4890,	.4540,	.4290,	.4640,
8,	.5650,	.5820,	.5170,	.4870,	.3850,	.5620,	.5370,	.5220,	.4760,	.4830,
9,	.5420,	.5800,	.6440,	.5310,	.5420,	.5670,	.5790,	.5610,	.5830,	.5100,
+gp,	.6180,	.6501,	.6648,	.6443,	.6444,	.7434,	.6451,	.6221,	.6422,	.6362,

YEAR, AGE	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
1,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,
2,	.1330,	.1270,	.1330,	.1540,	.1330,	.1330,	.1480,	.1390,	.1560,	.1280,
3,	.2030,	.1850,	.1910,	.1910,	.1930,	.1950,	.2030,	.1840,	.1940,	.1840,
4,	.2680,	.2670,	.2780,	.2620,	.2600,	.2900,	.2940,	.2540,	.2570,	.2290,
5,	.3480,	.3240,	.3450,	.3570,	.3350,	.3500,	.3570,	.3010,	.3070,	.2650,
6,	.3860,	.3810,	.4230,	.3810,	.4090,	.3400,	.4470,	.4130,	.3980,	.2930,
7,	.4880,	.3800,	.4950,	.4060,	.4170,	.4110,	.3990,	.4470,	.4060,	.3440,
8,	.5910,	.6260,	.4870,	.4540,	.4740,	.4750,	.4940,	.5220,	.4720,	.4820,
9,	.5670,	.5540,	.5870,	.3320,	.4860,	.4190,	.4810,	.5480,	.5000,	.4370,
+gp,	.6636,	.6423,	.6863,	.6196,	.6543,	.5946,	.6528,	.5733,	.5401,	.5833,

YEAR, AGE	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
1,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,
2,	.1430,	.1510,	.1470,	.1500,	.1400,	.1310,	.1390,	.1440,	.1450,	.1460,
3,	.1740,	.1790,	.1780,	.1900,	.1730,	.1870,	.1850,	.1850,	.1970,	.1940,
4,	.2090,	.2400,	.2080,	.2250,	.2340,	.2160,	.2260,	.2230,	.2450,	.2400,
5,	.2570,	.2530,	.2740,	.2520,	.2670,	.2590,	.2640,	.2630,	.2670,	.2560,
6,	.3260,	.3210,	.2680,	.3030,	.2810,	.2960,	.2750,	.3190,	.2670,	.2880,
7,	.3490,	.3650,	.3210,	.3190,	.3280,	.3400,	.2870,	.3270,	.2990,	.3300,
8,	.4020,	.3570,	.3750,	.3250,	.2730,	.3220,	.3370,	.4210,	.3080,	.3120,
9,	.4940,	.5450,	.4020,	.3600,	.3360,	.3690,	.3910,	.4100,	.4350,	.5090,
+gp,	.4589,	.5452,	.5465,	.4240,	.4548,	.4639,	.3762,	.5302,	.4351,	.4697,

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Table 7.3.5. North Sea sole: effort and CPUE series

Note: only NL beam is used for tuning

	Effort			CPUE		
	B beam	UK otter	NL beam	B beam	UK otter	NL beam
year	1000 HP hour[1]	1000 HP hour	1000000 HP day	kg/1000 HP h[1]	kg/HP h	kg/1000 HP d
1972	29.8			33.5		
1973	29.4			33.1		
1974	32.2			23.7		
1975	39.2			26.2		
1976	44.7			24.5		
1977	47.6			27.2		
1978	50.3		44.3	25.9		375.8
1979	40.0		44.9	38.7		423.2
1980	35.2		45.0	30.9		282.1
1981	31.1		46.3	35.2		267.8
1982	34.9		57.3	44.7		309.8
1983	35.4		65.6	42.8		319.9
1984	42.8		70.8	35.2		307.3
1985	51.4		70.3	40.8		276.3
1986	42.5		68.2	38.8		213.4
1987	50.7		68.5	28.9		204.5
1988	53.0		76.3	19.2		235.9
1989	54.3		61.6	22.7		272.7
1990	64.7	6409.1	71.4	24.8	35.5	378.1
1991	74.3	6643.4	68.5	33.5	30.3	350.9
1992	67.7	5279.3	71.1	22.5	25.3	307.1
1993	71.1	5787.2	76.9	27.2	27.4	306.4
1994	60.0	4913.3	81.4	32.5	25.4	295.6
1995	46.5	4766.3	81.2	34.9	25.5	275.1
1996	64.9	3352.8	72.1	29.0	23.9	227.1
1997	47.2	2852.8	72.0	24.2	23.6	151.7
1998	43.6	1933.4	70.2	25.0	25.9	230.7
1999	55.7	2184.1	67.3	24.3	24.9	257.9
2000	49.3	1667.6	67.7	24.0	25.7	240.6
2001	45.5	1446.0	61.4	27.7	22.6	220.1
2002	51.6	1153.5	56.6	23.0	24.9	229.0
2003	42.6	1306.7	51.6	33.0	20.5	260.9
avg (1990-2003)	56.1	3549.7	69.2	27.5	25.8	266.5

[1] corrected for fishing power

Table 7.3.6. North Sea sole: tuning data

```
FLT01:NL BTS-ISIS
1985 2003
1 1 0.67 0.75
1 9
1 2.651 7.893 3.541 1.669 0.620 0.279 0.000 0.000 0.000 0.000
1 7.880 4.494 1.726 0.826 0.590 0.216 0.101 0.002 0.021 0.099
1 6.993 12.548 1.834 0.563 0.583 0.223 0.230 0.061 0.026 0.009
1 81.230 12.807 2.776 0.997 0.131 0.154 0.121 0.095 0.013 0.116
1 9.419 68.084 4.191 4.096 0.677 0.128 0.242 0.000 0.138 0.034
1 22.623 22.363 20.090 0.611 0.682 0.511 0.078 0.055 0.013 0.010
1 3.344 23.187 5.843 6.011 0.100 0.135 0.075 0.033 0.012 0.034
1 74.220 23.200 9.879 2.332 2.903 0.061 0.142 0.065 0.016 0.066
1 4.980 27.359 0.987 4.367 2.376 4.295 0.027 0.094 0.064 0.051
1 5.879 4.992 15.422 0.134 1.407 0.097 0.995 0.014 0.004 0.013
1 27.622 8.456 7.039 6.718 0.476 0.913 0.314 0.966 0.049 0.000
1 3.511 6.166 1.909 1.488 2.493 0.309 0.408 0.054 0.290 0.063
1 173.238 5.367 3.234 0.800 0.769 0.403 0.105 0.038 0.045 0.060
1 14.122 29.211 1.998 1.346 0.079 0.016 0.424 0.000 0.000 0.000
1 11.413 19.257 16.626 0.629 2.061 0.334 0.224 0.651 0.003 0.323
1 12.888 6.527 4.093 1.597 0.284 0.155 0.064 0.008 0.162 0.074
1 7.973 10.837 2.350 1.681 0.740 0.081 0.040 0.030 0.000 0.184
1 21.457 4.238 3.412 0.930 0.354 0.355 0.022 0.060 0.000 0.068
1 10.759 10.547 2.506 1.752 0.380 0.202 0.337 0.000 0.022 0.000

FLT02:NL SNS
1970 2003
1 1 0.67 0.75
1 4
1 4938 745 204 31
1 613 1961 99 7
1 1410 341 161 0.1
1 4686 905 73 35
1 1924 397 69 0.1
1 597 887 174 44
1 1413 79 187 70
1 3724 762 77 85
1 1552 1379 267 27
1 104 388 325 60
1 4483 80 99 45
1 3739 1411 51 13
1 5098 1124 231 7
1 2640 1137 107 43
1 2359 1081 307 102
1 2151 709 159 59
1 3791 465 67 30
1 1890 955 59 15
1 11227 594 284 81
1 3052 5369 248 50
1 2900 1078 907 100
1 1265 2515 527 607
1 11081 114 319 194
1 1351 3489 46 166
1 559 475 943 10
1 1501 234 126 365
1 691 473 27 48
1 10132 143 231 51
1 2876 1993 131 52
1 1649 919 381 12.3
1 1735 150 189 95.7
1 949 638 99 32
1 7093 361 174 0
1 -1 -1 -1 -1

FLT03:NL Comm BT
1990 2003
1 1 0 1
2 15
71.4 9071.1 84629.7 7242 6586.7 1669.1 634.6 819.2 375.9 137.6 134.1 42.5 10.1 12.6 138.2
68.5 7336.6 17182.4 59754 4638.3 2137.6 682.7 312.1 392.3 156.6 98.4 180.5 6.3 6 48.1
71.1 5046.7 33880.5 11131 29835.9 1457.9 2081.2 446.1 218.6 274.8 75.7 164.1 66.4 3.9 109
76.9 39284.5 10948 24132 9625.4 18624 887.1 811.5 236.1 66.4 186.3 50.2 41.6 59.1 21.8
81.4 5389.9 69878.8 7411.7 13010.4 3104.8 8932.9 190 524.2 175.9 25.9 158.5 25.2 20.1 149.5
81.2 9778 11329.4 53488.8 2839.2 5128.8 896.5 4682.4 147.4 204.8 24.4 22.4 34.7 6.4 108.6
72.1 15843.4 9093.9 11170.8 21211.9 1570 3173.4 471.9 2773.8 160 190.5 85.7 23.3 62.4 99.5
72 4505.9 18426.8 4503.6 3329 9771.1 497.2 1800.4 94.6 1155.3 5.7 76.9 11.1 14.3 43.5
70.2 50570.7 9023.1 11123.1 1826.2 1145.6 3395 210.7 337 21.4 286.6 5.2 37.2 4.9 42.9
67.3 11820.5 55177.2 4152.6 4458.8 730.2 335.7 1526.8 133.4 362.5 6 126.7 2 21.5 30.1
67.7 12308.6 29559.5 21746.8 2046.1 1579.9 454.8 322.4 640.8 209.8 115.4 23.2 53.6 2.9 44
61.4 18723.6 13660.3 14969 13081 721 506 136 93 369 8 33.9 6.8 40.3 17.3
56.6 9006.1 24797.2 7936.1 6033.8 5081.8 423.6 384.2 53.6 23.9 101.8 11.7 17.2 0.0 21.1
51.6 25945.1 11539.1 12441.0 3394.5 2824.0 1961.6 225.2 62.3 59.0 60.5 65.2 23.1 25.5 1.2
```

Not used in assessment: (boxed values at the right of FLT03 rows)

Table 7.4.1. North Sea sole: XSA diagnostics

```
Lowestoft VPA Version 3.1

   8/09/2004  15:05

 Extended Survivors Analysis

 Sole in IV

 CPUE data from file fleet03

 Catch data for  47 years. 1957 to 2003. Ages  1 to  10.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 FLT01:NL BTS-ISIS   ,   1985, 2003,   1,     9,   .670,   .750
 FLT02:NL SNS        ,   1970, 2003,   1,     4,   .670,   .750
 FLT03:NL Comm BT    ,   1990, 2003,   2,     9,   .000,  1.000


 Time series weights :

      Tapered time weighting not applied


 Catchability analysis :

      Catchability dependent on stock size for ages <    2

         Regression type = C
         Minimum of   5 points used for regression
         Survivor estimates shrunk to the population mean for ages <  2


      Catchability independent of age for ages >=    7


 Terminal population estimation :

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

      S.E. of the mean to which the estimates  are shrunk =   2.000

      Minimum standard error for population
      estimates derived from each fleet =    .300

      Prior weighting not applied


 Tuning converged after   27 iterations

1

 Regression weights
       , 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000


 Fishing mortalities
    Age,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003

      1,  .013,  .054,  .004,  .006,  .002,  .004,  .019,  .013,  .006,  .011
      2,  .140,  .306,  .274,  .155,  .273,  .163,  .237,  .260,  .205,  .209
      3,  .479,  .444,  .695,  .577,  .623,  .585,  .520,  .549,  .538,  .509
      4,  .635,  .761,  .976,  .697,  .788,  .727,  .732,  .612,  .617,  .488
      5,  .670,  .609,  .696,  .800,  .758,  .781,  .643,  .627,  .487,  .591
      6,  .878,  .530,  .836,  .737,  .723,  .569,  .755,  .566,  .465,  .400
      7,  .497,  .782,  .703,  .597,  .596,  .512,  .826,  .544,  .506,  .283
      8,  .623,  .475,  .966,  .795,  .908,  .470,  .663,  .662,  .847,  .567
      9,  .901,  .935,  .461, 1.008,  .904, 1.144,  .373,  .513,  .411,  .380
```

Table 7.4.1. cont. North Sea sole: XSA diagnostics

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
1994	5.71E+04	6.27E+04	2.41E+05	3.03E+04	4.03E+04	1.03E+04	3.04E+04	1.05E+03	1.62E+03
1995	9.62E+04	5.10E+04	4.93E+04	1.35E+05	1.45E+04	1.87E+04	3.87E+03	1.67E+04	5.11E+02
1996	4.91E+04	8.24E+04	3.40E+04	2.86E+04	5.71E+04	7.16E+03	9.95E+03	1.60E+03	9.41E+03
1997	2.78E+05	4.43E+04	5.67E+04	1.53E+04	9.75E+03	2.58E+04	2.81E+03	4.46E+03	5.51E+02
1998	1.22E+05	2.50E+05	3.43E+04	2.88E+04	6.92E+03	3.96E+03	1.12E+04	1.40E+03	1.82E+03
1999	8.34E+04	1.10E+05	1.72E+05	1.67E+04	1.19E+04	2.94E+03	1.74E+03	5.56E+03	5.11E+02
2000	1.34E+05	7.52E+04	8.49E+04	8.67E+04	7.29E+03	4.91E+03	1.50E+03	9.44E+02	3.15E+03
2001	7.01E+04	1.19E+05	5.37E+04	4.56E+04	3.77E+04	3.47E+03	2.09E+03	5.95E+02	4.40E+02
2002	2.01E+05	6.26E+04	8.30E+04	2.81E+04	2.24E+04	1.82E+04	1.78E+03	1.10E+03	2.78E+02
2003	1.04E+05	1.80E+05	4.61E+04	4.38E+04	1.37E+04	1.24E+04	1.04E+04	9.72E+02	4.26E+02

Estimated population abundance at 1st Jan 2004

	0.00E+00	9.30E+04	1.33E+05	2.51E+04	2.44E+04	6.87E+03	7.55E+03	7.07E+03	4.99E+02

Taper weighted geometric mean of the VPA populations:

	9.76E+04	8.59E+04	6.33E+04	3.50E+04	1.77E+04	9.39E+03	5.23E+03	2.96E+03	1.65E+03

Standard error of the weighted Log(VPA populations) :

	.7693	.8124	.8350	.8730	.9146	.9220	.9888	1.0303	1.1051

1

Log catchability residuals.

Fleet : FLT01:NL BTS-ISIS

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	99.99	-.64	-.62	.09	-.18	-.12	-.06	-.35	.01	-.08
2	99.99	.15	-.67	-.26	.55	.30	.63	.14	1.09	-.32
3	99.99	-.13	-.21	-.52	-.60	.51	.04	.27	.26	-1.10
4	99.99	.28	-.43	-.25	.00	.93	-.43	-.21	.26	.42
5	99.99	-.19	.13	-.02	-.90	.34	-.06	-1.35	-.25	1.19
6	99.99	.25	-.18	.15	-.40	-.03	1.03	-.80	-.78	1.08
7	99.99	99.99	-.25	.19	-.11	.32	-.23	-.41	-.33	-.98
8	99.99	99.99	-1.66	.03	-.24	99.99	-.55	-.39	.15	-.07
9	99.99	99.99	-.16	1.62	-.56	.53	-1.21	-1.32	-.26	.98

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	.22	.71	.04	.80	.02	.26	-.12	.21	-.21	.01
2	-.42	.43	-.39	.01	.06	.38	-.27	-.20	-.54	-.68
3	.14	.91	.16	.09	.14	.62	-.12	-.19	-.26	-.01
4	-2.07	.44	.64	.44	.40	.14	-.57	.04	-.07	.03
5	.12	.01	.36	1.03	-.94	1.80	.21	-.49	-.80	-.17
6	-.74	.66	.75	-.33	-1.70	1.53	.38	-.05	-.31	-.53
7	-.04	1.07	.34	.17	.18	1.34	.46	-.54	-1.00	-.20
8	-.85	.52	.33	-1.17	99.99	1.22	-1.27	.51	.72	99.99
9	-2.34	1.35	-.12	1.24	99.99	-1.29	.33	99.99	99.99	.34

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9
Mean Log q	-8.8482	-9.3825	-9.7413	-9.8342	-10.1398	-9.8674	-9.8674	-9.8674
S.E(Log q)	.4804	.4548	.6346	.7666	.7879	.6034	.8307	1.1405

Table 7.4.1. cont. North Sea sole: XSA diagnostics

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1,	.64,	2.572,	9.99,	.75,	19,	.37,	-9.04,

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	1.09,	-.459,	8.60,	.60,	19,	.54,	-8.85,
3,	.94,	.399,	9.50,	.69,	19,	.44,	-9.38,
4,	.96,	.186,	9.78,	.55,	19,	.63,	-9.74,
5,	.99,	.047,	9.83,	.46,	19,	.78,	-9.83,
6,	.91,	.382,	10.05,	.52,	19,	.73,	-10.14,
7,	.99,	.061,	9.85,	.63,	18,	.61,	-9.87,
8,	.74,	1.629,	9.41,	.76,	15,	.57,	-10.05,
9,	1.76,	-1.388,	12.22,	.21,	15,	1.94,	-9.93,

1

Fleet : FLT02:NL SNS

Age	1970	1971	1972	1973
1	.31	-.06	-.05	.52
2	.77	.85	.24	.57
3	.39	.13	-.17	.20
4	.33	-1.38	-5.26	-.13
5	No data for this fleet at this age			
6	No data for this fleet at this age			
7	No data for this fleet at this age			
8	No data for this fleet at this age			
9	No data for this fleet at this age			

Age	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	-.17	-.07	-.43	.09	.50	-.13	.15	.02	.24	-.19
2	-.61	.24	-1.30	.06	.42	.21	-.02	.37	.13	.20
3	-.60	-.09	.09	.02	.42	.43	.23	.88	.05	-.81
4	-4.76	.55	.44	.86	.47	.50	.02	-.26	.42	.04
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	.42	.22	-.03	.23	-.26	.19	-.34	-.05	-.02	.02
2	.19	.48	-.20	-.09	.22	.51	.35	.67	-1.48	.37
3	.41	-.19	-.41	-.92	.16	.72	-.02	.90	-.13	-1.13
4	.74	.47	-.21	-.34	1.02	.06	1.30	1.03	1.31	.68
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-.45	-.20	-.14	.16	.02	-.01	-.44	-.25	.21	99.99
2	-.02	-.41	-.21	-.87	.12	.09	-1.29	-.28	-.25	99.99
3	.38	-.07	-1.06	.49	.46	-.11	-.15	-.32	-.20	99.99
4	-1.13	1.06	.74	1.23	.68	-.26	.15	-.39	99.99	99.99
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age ,	2,	3,	4
Mean Log q,	-4.6875,	-5.5147,	-6.3681,
S.E(Log q),	.5744,	.5072,	1.4630,

Table 7.4.1. cont. North Sea sole: XSA diagnostics

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1,	.76,	3.674,	5.65,	.88,	33,	.26,	-3.77,

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	.79,	1.885,	6.09,	.72,	33,	.44,	-4.69,
3,	1.08,	-.565,	5.06,	.61,	33,	.55,	-5.51,
4,	.59,	1.941,	7.99,	.43,	32,	.83,	-6.37,

1

Fleet : FLT03:NL Comm BT

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	No data for this fleet at this age									
2	99.99	99.99	99.99	99.99	99.99	99.99	-.34	-1.02	-.50	-.11
3	99.99	99.99	99.99	99.99	99.99	99.99	-.13	-.23	-.12	-.38
4	99.99	99.99	99.99	99.99	99.99	99.99	-.12	-.04	-.32	-.12
5	99.99	99.99	99.99	99.99	99.99	99.99	-.09	.19	-.18	.16
6	99.99	99.99	99.99	99.99	99.99	99.99	-.23	-.39	-.04	.05
7	99.99	99.99	99.99	99.99	99.99	99.99	-.20	-.28	.25	.27
8	99.99	99.99	99.99	99.99	99.99	99.99	.06	-.21	-.01	-.07
9	99.99	99.99	99.99	99.99	99.99	99.99	.07	.09	.20	.06

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	No data for this fleet at this age									
2	-.54	.34	.45	-.24	.53	-.12	.33	.40	.37	.46
3	-.11	-.35	.03	.17	.01	.23	.28	.07	.31	.21
4	-.38	.16	.36	-.05	.29	-.13	-.13	.19	.12	.16
5	-.11	-.63	.17	.13	-.12	.29	-.07	.23	.00	.05
6	.08	-.16	-.13	.37	.12	-.05	.28	-.14	.19	.04
7	-.04	-.15	.25	-.38	.18	-.27	.31	.07	.11	-.13
8	-.47	-.10	.28	.53	-.38	.07	.37	.06	.65	.21
9	.23	.13	.07	-.24	-.18	.30	-.28	-.08	-.14	-.34

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age ,	2,	3,	4,	5,	6,	7,	8,	9
Mean Log q,	-6.1933,	-5.2538,	-5.0848,	-5.0645,	-5.2319,	-5.2976,	-5.2976,	-5.2976,
S.E(Log q),	.4805,	.2275,	.2195,	.2342,	.2059,	.2357,	.3282,	.2021,

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,	.94,	.282,	6.52,	.64,	14,	.47,	-6.19,
3,	1.01,	-.076,	5.21,	.91,	14,	.24,	-5.25,
4,	1.00,	.016,	5.09,	.92,	14,	.23,	-5.08,
5,	1.00,	.057,	5.09,	.92,	14,	.24,	-5.06,
6,	.95,	.720,	5.42,	.95,	14,	.20,	-5.23,
7,	.98,	.301,	5.37,	.94,	14,	.24,	-5.30,
8,	1.02,	-.163,	5.19,	.88,	14,	.34,	-5.23,
9,	.98,	.285,	5.33,	.96,	14,	.21,	-5.31,

Table 7.4.1. cont. North Sea sole: XSA diagnostics

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2002

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01:NL BTS-ISIS	,	93990.,	.382,	.000,	.00,	1,	.794,	.011
FLT02:NL SNS	,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT03:NL Comm BT	,	1.,	.000,	.000,	.00,	0,	.000,	.000
P shrinkage mean	,	85854.,	.81,,,,				.177,	.012
F shrinkage mean	,	114693.,	2.00,,,,				.029,	.009

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
93034.,	.34,	.04,	3,	.106,	.011

1

Age 2 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
FLT01:NL BTS-ISIS	,	89981.,	.303,	.229,	.75,	2,	.414,	.294
FLT02:NL SNS	,	164259.,	.300,	.000,	.00,	1,	.421,	.172
FLT03:NL Comm BT	,	210069.,	.497,	.000,	.00,	1,	.154,	.137
F shrinkage mean	,	120220.,	2.00,,,,				.012,	.228

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
132500.,	.19,	.18,	5,	.945,	.209

Age 3 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
FLT01:NL BTS-ISIS	,	23904.,	.255,	.210,	.82,	3,	.339,	.528
FLT02:NL SNS	,	19488.,	.267,	.001,	.00,	2,	.286,	.617
FLT03:NL Comm BT	,	32183.,	.258,	.065,	.25,	2,	.364,	.417
F shrinkage mean	,	21904.,	2.00,,,,				.011,	.565

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
25102.,	.15,	.10,	8,	.680,	.509

1

Age 4 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
FLT01:NL BTS-ISIS	,	21196.,	.249,	.063,	.25,	4,	.260,	.544
FLT02:NL SNS	,	17110.,	.239,	.075,	.32,	3,	.221,	.639
FLT03:NL Comm BT	,	30784.,	.204,	.062,	.30,	3,	.508,	.404
F shrinkage mean	,	15157.,	2.00,,,,				.011,	.698

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
24353.,	.13,	.09,	11,	.631,	.488

Table 7.4.1. cont. North Sea sole: XSA diagnostics

```
 Age  5   Catchability constant w.r.t. time and dependent on age

 Year class = 1998

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT01:NL BTS-ISIS   ,      6438.,   .263,       .097,    .37,   5,  .208,     .621
 FLT02:NL SNS        ,      5131.,   .238,       .318,   1.33,   3,  .137,     .732
 FLT03:NL Comm BT    ,      7498.,   .184,       .036,    .19,   4,  .641,     .553

   F shrinkage mean  ,      5899.,   2.00,,,,                        .013,     .662

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      6872.,       .14,      .07,   13,    .500,   .591


1
 Age  6   Catchability constant w.r.t. time and dependent on age

 Year class = 1997

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT01:NL BTS-ISIS   ,      5984.,   .280,       .169,    .60,   6,  .177,     .483
 FLT02:NL SNS        ,      7354.,   .237,       .066,    .28,   4,  .095,     .409
 FLT03:NL Comm BT    ,      8088.,   .169,       .047,    .28,   5,  .717,     .378

   F shrinkage mean  ,      4343.,   2.00,,,,                        .011,     .618

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      7547.,       .13,      .06,   16,    .426,   .400


 Age  7   Catchability constant w.r.t. time and dependent on age

 Year class = 1996

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT01:NL BTS-ISIS   ,      6214.,   .339,       .150,    .44,   7,  .173,     .316
 FLT02:NL SNS        ,      7712.,   .239,       .066,    .28,   4,  .043,     .262
 FLT03:NL Comm BT    ,      7337.,   .166,       .077,    .46,   6,  .774,     .274

   F shrinkage mean  ,      2815.,   2.00,,,,                        .010,     .599

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      7074.,       .14,      .06,   18,    .414,   .283


1
 Age  8   Catchability constant w.r.t. time and age (fixed at the value for age)  7

 Year class = 1995

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT01:NL BTS-ISIS   ,       316.,   .343,       .220,    .64,   7,  .118,     .790
 FLT02:NL SNS        ,       441.,   .238,       .232,    .98,   4,  .028,     .622
 FLT03:NL Comm BT    ,       538.,   .167,       .057,    .34,   7,  .837,     .535

   F shrinkage mean  ,       366.,   2.00,,,,                        .016,     .713

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       499.,       .15,      .07,   19,    .465,   .567
```

Table 7.4.1. cont. North Sea sole: XSA diagnostics

```
Age  9   Catchability constant w.r.t. time and age (fixed at the value for age)  7

Year class = 1994

Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FLT01:NL BTS-ISIS   ,       337.,   .441,       .201,    .46,   9,  .106,     .309
FLT02:NL SNS        ,       270.,   .240,       .195,    .81,   4,  .009,     .373
FLT03:NL Comm BT    ,       257.,   .185,       .147,    .79,   8,  .869,     .388

  F shrinkage mean  ,       204.,   2.00,,,,                        .016,     .467

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      264.,       .17,      .09,   22,    .535,   .380
```

Table 7.4.2. North Sea sole: fishing mortality at age

Run title : Sole in IV

At 9/09/2004 15:50

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,
AGE							
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0207,	.0169,	.0336,	.0290,	.0182,	.0188,	.0525,
3,	.1272,	.1487,	.1299,	.1577,	.1446,	.1411,	.1787,
4,	.2547,	.2349,	.2464,	.2410,	.2952,	.2287,	.4218,
5,	.2592,	.2756,	.2050,	.3234,	.2515,	.3629,	.4016,
6,	.2283,	.3608,	.2395,	.2671,	.2393,	.3128,	.5092,
7,	.2922,	.3448,	.1818,	.2893,	.1738,	.3669,	.4819,
8,	.1671,	.2949,	.3657,	.3440,	.3967,	.2468,	.4572,
9,	.2408,	.3030,	.2482,	.2937,	.2719,	.3044,	.4792,
+gp,	.2408,	.3030,	.2482,	.2937,	.2719,	.3044,	.4792,
0 FBAR 2- 6,	.1780,	.2074,	.1709,	.2036,	.1898,	.2129,	.3128,

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
1,	.0001,	.0000,	.0000,	.0000,	.0110,	.0084,	.0099,	.0107,	.0049,	.0068,
2,	.0198,	.1071,	.1244,	.1136,	.3081,	.3309,	.1552,	.3321,	.2417,	.2061,
3,	.3257,	.1689,	.4375,	.3657,	.6957,	.6909,	.6367,	.5728,	.6532,	.7105,
4,	.2497,	.3886,	.2044,	.4884,	.6433,	.5547,	.5488,	.6594,	.5432,	.5951,
5,	.4865,	.3208,	.4904,	.6825,	.5060,	.6831,	.3209,	.5799,	.5135,	.6045,
6,	.3649,	.6000,	.3686,	.3820,	.2954,	.4728,	.3319,	.4125,	.3611,	.4264,
7,	.5159,	.4321,	.3180,	.2961,	.2679,	.3176,	.3825,	.3759,	.2290,	.3642,
8,	.3251,	.4647,	.3599,	.5492,	.3948,	.4126,	.3668,	.3719,	.3106,	.5377,
9,	.3896,	.4427,	.3492,	.4813,	.4228,	.4899,	.3914,	.4816,	.3927,	.5075,
+gp,	.3896,	.4427,	.3492,	.4813,	.4228,	.4899,	.3914,	.4816,	.3927,	.5075,
0 FBAR 2- 6,	.2893,	.3171,	.3251,	.4064,	.4897,	.5465,	.3987,	.5113,	.4625,	.5085,

Table 8 Fishing mortality (F) at age

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
1,	.0010,	.0068,	.0097,	.0132,	.0006,	.0008,	.0044,	.0030,	.0185,	.0029,
2,	.1817,	.2787,	.1073,	.2636,	.2355,	.2242,	.1305,	.2547,	.2298,	.3098,
3,	.5900,	.5251,	.5671,	.5560,	.5751,	.6592,	.5531,	.5364,	.6968,	.5925,
4,	.6753,	.6603,	.4698,	.6192,	.5399,	.6367,	.5895,	.5941,	.5864,	.7250,
5,	.4977,	.5204,	.5537,	.4336,	.5294,	.4890,	.5924,	.5285,	.6194,	.3544,
6,	.5766,	.4888,	.4293,	.3592,	.4196,	.4689,	.4114,	.5945,	.5946,	.4613,
7,	.5122,	.4374,	.4265,	.2178,	.6286,	.2703,	.5993,	.4585,	.5300,	.4549,
8,	.3878,	.5501,	.5484,	.4191,	.7236,	.6052,	.3239,	.4555,	.5397,	.5982,
9,	.5320,	.5178,	.4777,	.4713,	.4069,	.6215,	.5333,	.2611,	.5716,	.6858,
+gp,	.5320,	.5178,	.4777,	.4713,	.4069,	.6215,	.5333,	.2611,	.5716,	.6858,
0 FBAR 2- 6,	.5042,	.4947,	.4254,	.4463,	.4599,	.4956,	.4554,	.5016,	.5454,	.4886,

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
1,	.0028,	.0021,	.0025,	.0014,	.0000,	.0011,	.0051,	.0018,	.0029,	.0008,
2,	.2898,	.3193,	.1448,	.2383,	.2381,	.1259,	.1372,	.0903,	.1196,	.1814,
3,	.7182,	.7388,	.6212,	.5198,	.6595,	.5286,	.4062,	.4247,	.4343,	.4227,
4,	.6673,	.7684,	.6832,	.6123,	.7351,	.6842,	.5304,	.5329,	.4664,	.5542,
5,	.6698,	.5749,	.6694,	.5084,	.6154,	.4530,	.5808,	.7600,	.4822,	.8258,
6,	.8168,	.5559,	.7005,	.5518,	.5737,	.4379,	.6136,	.4275,	.6225,	.5612,
7,	.5132,	.5004,	.7435,	.3837,	.5187,	.3812,	.4831,	.6642,	.6691,	.8528,
8,	.4163,	.3989,	.4744,	.6636,	.3480,	.3761,	.5579,	.6409,	.5884,	.5273,
9,	.6634,	.4286,	.5184,	.6814,	.9264,	.2698,	.5657,	.6992,	.8004,	.8004,
+gp,	.6634,	.4286,	.5184,	.6814,	.9264,	.2698,	.5657,	.6992,	.8004,	.8004,
0 FBAR 2- 6,	.6324,	.5915,	.5638,	.4861,	.5644,	.4459,	.4536,	.4471,	.4250,	.5091,

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	FBAR 01-03
AGE											
1,	.0133,	.0539,	.0037,	.0060,	.0021,	.0036,	.0186,	.0133,	.0055,	.0107,	.0098,
2,	.1403,	.3056,	.2745,	.1549,	.2725,	.1627,	.2365,	.2595,	.2053,	.2087,	.2245,
3,	.4792,	.4442,	.6949,	.5772,	.6229,	.5850,	.5202,	.5491,	.5382,	.5087,	.5320,
4,	.6346,	.7614,	.9764,	.6967,	.7876,	.7267,	.7317,	.6121,	.6165,	.4877,	.5721,
5,	.6700,	.6087,	.6960,	.8000,	.7575,	.7806,	.6427,	.6272,	.4873,	.5909,	.5684,
6,	.8776,	.5297,	.8358,	.7374,	.7229,	.5693,	.7547,	.5664,	.4646,	.4003,	.4771,
7,	.4967,	.7819,	.7030,	.5970,	.5964,	.5124,	.8264,	.5437,	.5061,	.2827,	.4442,
8,	.6229,	.4750,	.9659,	.7950,	.9079,	.4700,	.6628,	.6617,	.8473,	.5669,	.6920,
9,	.9007,	.9348,	.4609,	1.0080,	.9037,	1.1441,	.3728,	.5130,	.4106,	.3797,	.4344,
+gp,	.9007,	.9348,	.4609,	1.0080,	.9037,	1.1441,	.3728,	.5130,	.4106,	.3797,	
0 FBAR 2- 6,	.5603,	.5299,	.6955,	.5932,	.6327,	.5649,	.5772,	.5229,	.4624,	.4393,	

1

Table 7.4.3. North Sea sole: stock numbers at age

Run title : Sole in IV

At 9/09/2004 15:50

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1957	1958	1959	1960	1961	1962	1963
AGE							
1	128908	128642	488759	61713	99479	22894	20427
2	72454	116641	116401	442247	55840	90012	20716
3	89307	64213	103778	101843	388707	49614	79930
4	59106	71155	50074	82463	78708	304359	38986
5	17318	41456	50906	35415	58637	53011	219091
6	15057	12092	28474	37524	23191	41258	33369
7	27046	10843	7627	20278	25994	16518	27305
8	11836	18272	6950	5754	13738	19769	10355
9	2500	9062	12311	4362	3691	8361	13976
+gp	30811	26295	26788	32546	31943	29933	32249
0 TOTAL	454344	498670	892067	824146	779929	635729	496404

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
1	538982	121935	39876	75137	99751	50027	138549	41536	76644	108295
2	8305	487638	110332	36081	67987	89272	44890	124129	37184	69009
3	7991	7367	396430	88153	29141	45205	58022	34777	80575	26422
4	27180	5221	5630	231605	55334	13150	20499	27775	17746	37941
5	10395	19160	3203	4153	128589	26313	6832	10715	12997	9328
6	59617	5783	12579	1775	1899	70150	12025	4485	5429	7037
7	8153	37452	2872	7873	1096	1279	39562	7807	2687	3423
8	6856	4404	21998	1891	5298	759	842	24420	4851	1934
9	2665	4482	2504	13889	988	3230	454	528	15234	3217
+gp	9788	9390	8709	7981	19810	14246	16928	12580	9034	15224
0 TOTAL	679932	702832	604132	468537	409893	313631	338603	288753	262380	281830

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
1	109736	40742	113040	140430	47346	11494	151663	150029	152865	142349
2	97321	99197	36613	101293	125405	42815	10392	136624	135350	135788
3	50811	73430	67923	29760	70414	89661	30960	8253	95831	97324
4	11748	25486	39299	34857	15444	35850	41966	16113	4367	43196
5	18933	5411	11915	22229	16980	8144	17162	21059	8049	2198
6	4611	10414	2910	6197	13037	9049	4519	8587	11233	3920
7	4157	2344	5780	1714	3915	7753	5123	2710	4288	5608
8	2152	2254	1370	3414	1247	1889	5354	2546	1550	2284
9	1022	1321	1176	716	2032	547	933	3504	1461	818
+gp	12208	8919	7339	5891	5019	3449	3045	4143	3070	2476
0 TOTAL	312699	269518	287365	346502	300839	210652	271117	353568	418063	435961

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
1	70838	80883	159609	72577	455684	108323	177943	70520	354435	69344
2	128433	63915	73029	144064	65581	412311	97903	160189	63695	319774
3	90136	86976	42025	57173	102718	46766	328949	77230	132424	51135
4	48695	39770	37594	20431	30762	48063	24943	198286	45700	77608
5	18930	22607	16689	17177	10022	13345	21940	13279	105303	25938
6	1396	8766	11511	7731	9348	4901	7677	11106	5619	58832
7	2236	558	4549	5169	4029	4766	2862	3761	6554	2728
8	3220	1211	306	1957	3187	2170	2946	1597	1751	3037
9	1136	1921	735	172	912	2036	1348	1526	761	880
+gp	1927	2929	4350	1468	547	2075	2046	2264	2236	1596
0 TOTAL	366946	309536	350397	327921	682790	644755	668556	539757	718479	610871

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	GMST 57-03	AMST 57-03
AGE													
1	57093	96165	49142	277595	122216	83441	133845	70122	200507	103920	0	95890	129134
2	62694	50977	82447	44302	249666	110353	75227	118872	62609	180422	93034	85043	116297
3	241353	49304	33981	56695	34334	172022	84858	53731	82974	46137	132500	63336	89059
4	30319	135245	28611	15347	28802	16664	86716	45642	28076	43829	25102	35040	52321
5	40346	14544	57148	9751	6919	11856	7290	37748	22392	13713	24353	17746	28676
6	10277	18681	7160	25782	3965	2935	4914	3469	18242	12447	6872	9193	14451
7	30371	3866	9953	2809	11159	1741	1503	2091	1782	10373	7547	5273	8709
8	1052	16722	1601	4459	1399	5562	944	595	1098	972	7074	3103	5282
9	1622	511	9409	551	1822	511	3145	440	278	426	499	1774	3209
+gp	1595	1147	2801	2770	1483	1240	2404	1888	1132	1495	1189		
0 TOTAL	476720	387162	282252	440061	461764	406324	400848	334598	419088	413733	298170		

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Table 7.4.4. North Sea sole: XSA summary

Run title : Sole in IV ,

At 8/09/2004 15:06

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 2- 6,
1957,	128908,	63402,	55107,	12067,	.2190,	.1780,
1958,	128642,	72300,	60919,	14287,	.2345,	.2074,
1959,	488759,	85947,	65580,	13832,	.2109,	.1709,
1960,	61713,	105898,	73398,	18620,	.2537,	.2036,
1961,	99479,	123494,	117098,	23566,	.2012,	.1898,
1962,	22894,	123703,	116829,	26877,	.2301,	.2129,
1963,	20427,	115587,	113626,	26164,	.2303,	.3128,
1964,	538982,	51182,	37126,	11342,	.3055,	.2893,
1965,	121935,	101346,	30029,	17043,	.5676,	.3171,
1966,	39876,	92950,	84230,	33340,	.3958,	.3251,
1967,	75137,	91203,	82938,	33439,	.4032,	.4064,
1968,	99751,	83064,	72276,	33179,	.4591,	.4897,
1969,	50027,	68714,	55233,	27559,	.4990,	.5465,
1970,	138549,	60339,	50725,	19685,	.3881,	.3987,
1971,	41536,	63494,	43710,	23652,	.5411,	.5113,
1972,	76644,	56161,	47485,	21086,	.4441,	.4625,
1973,	108295,	51250,	36744,	19309,	.5255,	.5085,
1974,	109736,	54084,	36034,	17989,	.4992,	.5042,
1975,	40742,	55052,	38945,	20773,	.5334,	.4947,
1976,	113040,	49766,	40611,	17326,	.4266,	.4254,
1977,	140430,	53266,	33461,	18003,	.5380,	.4463,
1978,	47346,	56702,	37614,	20280,	.5392,	.4599,
1979,	11494,	51252,	44398,	22598,	.5090,	.4956,
1980,	151663,	42083,	34536,	15807,	.4577,	.4554,
1981,	150029,	51004,	24785,	15403,	.6215,	.5016,
1982,	152865,	57820,	32581,	21579,	.6623,	.5454,
1983,	142349,	66029,	39902,	24927,	.6247,	.4886,
1984,	70838,	64014,	43391,	26839,	.6185,	.6324,
1985,	80883,	53451,	41290,	24248,	.5873,	.5915,
1986,	159609,	52616,	34923,	18201,	.5212,	.5638,
1987,	72577,	55120,	29305,	17368,	.5927,	.4861,
1988,	455684,	70502,	38995,	21590,	.5537,	.5644,
1989,	108323,	94724,	34471,	21805,	.6326,	.4459,
1990,	177943,	113342,	89955,	35120,	.3904,	.4536,
1991,	70520,	103600,	77808,	33513,	.4307,	.4471,
1992,	354435,	104734,	77076,	29341,	.3807,	.4250,
1993,	69344,	99408,	55010,	31491,	.5725,	.5091,
1994,	57093,	86426,	74607,	33002,	.4423,	.5603,
1995,	96165,	71751,	59245,	30467,	.5143,	.5299,
1996,	49142,	53262,	38685,	22651,	.5855,	.6955,
1997,	277595,	48737,	28212,	14901,	.5282,	.5932,
1998,	122216,	62034,	20970,	20868,	.9951,	.6327,
1999,	83441,	61482,	42853,	23475,	.5478,	.5649,
2000,	133845,	58605,	41456,	22641,	.5461,	.5772,
2001,	70122,	53892,	33268,	19944,	.5995,	.5229,
2002,	200507,	54662,	35558,	16945,	.4765,	.4624,
2003,	**76353**[1],	62748,	31210,	17920,	.5742,	.4393,
2004,	**95890**[2],		**45400**[3],			
Arith. Mean ,	130116,	71749,	51792,	22384,	.4811,	.4520,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

[1]Replaced by RCT3 estimate
[2]Replaced by long term GM
[3]Assuming mean weights at age in 2004 as the mean of 2001-2003

Table 7.5.1. North Sea Sole. Input RCT3 – age 1.

```
Sole North Sea - Age1.
8 36 2
'yc' 'VPA-1' 'DFS-0' 'SNS-1' 'DFS-1' 'SNS-2' 'SNS-3' 'Solea-3' 'BTS-1' 'BTS-2'
1968 50027 -11 -11 -11 745 99 -11 -11 -11
1969 138549 -11 4938 -11 1961 161 -11 -11 -11
1970 41536 -11 613 -11 341 73 -11 -11 -11
1971 76644 -11 1410 -11 905 69 -11 -11 -11
1972 108295 -11 4686 -11 397 174 -11 -11 -11
1973 109736 -11 1924 -11 887 187 31.5 -11 -11
1974 40742 -11 597 2.86 79 77 16.3 -11 -11
1975 113040 168.84 1413 6.95 762 267 34.4 -11 -11
1976 140430 82.28 3724 9.69 1379 325 -11 -11 -11
1977 47346 33.80 1552 2.13 388 99 41.5 -11 -11
1978 11494 96.87 104 2.27 80 51 1.9 -11 -11
1979 151663 392.08 4483 48.21 1411 231 76.1 -11 -11
1980 150029 404.00 3739 13.90 1124 107 77.1 -11 -11
1981 152865 289.72 5098 14.06 1137 307 147.1 -11 -11
1982 142349 330.38 2640 25.87 1081 159 77.8 -11 -11
1983 70838 115.96 2359 12.45 709 67 10.8 -11 7.89
1984 80883 187.17 2151 3.32 465 59 29.8 2.65 4.49
1985 159609 292.92 3791 13.66 955 284 24.6 7.88 12.55
1986 72577 72.97 1890 6.19 594 248 20.3 6.99 12.81
1987 455684 527.45 11227 38.02 5369 907 66.9 81.23 68.08
1988 108323 56.08 3052 12.62 1078 527 86.4 9.42 22.36
1989 177943 62.77 2900 12.30 2515 319 54.1 22.62 23.19
1990 70520 22.54 1265 8.52 114 46 11.3 3.34 23.2
1991 354435 360.44 11081 17.66 3489 943 180.7 74.22 27.36
1992 69344 25.38 1351 10.60 475 126 -11 4.98 4.99
1993 57093 25.01 559 6.12 234 27 -11 5.88 8.46
1994 96165 74.25 1501 9.46 473 231 12.9 27.62 6.17
1995 49142 18.82 691 3.64 143 131 0.9 3.51 5.37
1996 277595 58.51 10132 19.92 1993 381 45.7 173.24 29.21
1997 122216 53.35 2876 -11.00 919 189 13.6 14.12 19.26
1998 83441 -11 1649 -11.00 150 99 -11 11.41 6.53
1999 133845 -11 1735 4.56 638 174 -11 12.89 10.84
2000 -11 16.15 949 3.07 361 -11 -11 7.97 4.24
2001 -11 86.41 7093 18.35 -11 -11 -11 21.46 10.55
2002 -11 64.71 -11 5.34 -11 -11 -11 10.76 -11
2003 -11 18.77 -11 -11 -11 -11 -11 -11 -11
```

Table 7.5.1 (cont'd). North Sea Sole. Input RCT3 – age 2.

```
Sole North Sea - Age2.
8 36 2
'yc' 'VPA-2' 'DFS-0' 'SNS-1' 'DFS-1' 'SNS-2' 'SNS-3' 'Solea-3' 'BTS-1' 'BTS-2'
1968 44890 -11 -11 -11 745 99 -11 -11 -11
1969 124129 -11 4938 -11 1961 161 -11 -11 -11
1970 37184 -11 613 -11 341 73 -11 -11 -11
1971 69009 -11 1410 -11 905 69 -11 -11 -11
1972 97321 -11 4686 -11 397 174 -11 -11 -11
1973 99197 -11 1924 -11 887 187 31.5 -11 -11
1974 36613 -11 597 2.86 79 77 16.3 -11 -11
1975 101293 168.84 1413 6.95 762 267 34.4 -11 -11
1976 125405 82.28 3724 9.69 1379 325 -11 -11 -11
1977 42815 33.80 1552 2.13 388 99 41.5 -11 -11
1978 10392 96.87 104 2.27 80 51 1.9 -11 -11
1979 136624 392.08 4483 48.21 1411 231 76.1 -11 -11
1980 135350 404.00 3739 13.90 1124 107 77.1 -11 -11
1981 135788 289.72 5098 14.06 1137 307 147.1 -11 -11
1982 128433 330.38 2640 25.87 1081 159 77.8 -11 -11
1983 63915 115.96 2359 12.45 709 67 10.8 -11 7.89
1984 73029 187.17 2151 3.32 465 59 29.8 2.65 4.49
1985 144064 292.92 3791 13.66 955 284 24.6 7.88 12.55
1986 65581 72.97 1890 6.19 594 248 20.3 6.99 12.81
1987 412311 527.45 11227 38.02 5369 907 66.9 81.23 68.08
1988 97903 56.08 3052 12.62 1078 527 86.4 9.42 22.36
1989 160189 62.77 2900 12.30 2515 319 54.1 22.62 23.19
1990 63695 22.54 1265 8.52 114 46 11.3 3.34 23.2
1991 319774 360.44 11081 17.66 3489 943 180.7 74.22 27.36
1992 62694 25.38 1351 10.60 475 126 -11 4.98 4.99
1993 50977 25.01 559 6.12 234 27 -11 5.88 8.46
1994 82447 74.25 1501 9.46 473 231 12.9 27.62 6.17
1995 44302 18.82 691 3.64 143 131 0.9 3.51 5.37
1996 249666 58.51 10132 19.92 1993 381 45.7 173.24 29.21
1997 110353 53.35 2876 -11 919 189 13.6 14.12 19.26
1998 75227 -11 1649 -11 150 99 -11 11.41 6.53
1999 118872 -11 1735 4.56 638 174 -11 12.89 10.84
2000 -11 16.15 949 3.07 361 -11 -11 7.97 4.24
2001 -11 86.41 7093 18.35 -11 -11 -11 21.46 10.55
2002 -11 64.71 -11 5.34 -11 -11 -11 10.76 -11
2003 -11 18.77 -11 -11 -11 -11 -11 -11 -11
```

Table 7.5.2a. North Sea Sole. Output RCT3 – age 1.

```
Analysis by RCT3 ver3.1 of data from file :

 s4rct-1_.txt

 SoleNorthSea  -    Age1.

 Data for    8 surveys over   36 years :  1968 - 2003

 Regression type = C

 Tapered time weighting not applied
 Survey weighting not applied

 Final estimates shrunk towards mean
 Minimum S.E. for any survey taken as    .20
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Yearclass =   2001

          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 DFS-0     1.37   5.21   1.22   .290     23   4.47   11.35    1.309     .023
 SNS-1      .77   5.60    .27   .878     31   8.87   12.44     .287     .474
 DFS-1     1.35   8.35    .64   .602     24   2.96   12.36     .694     .081
 SNS-2
 SNS-3
 Solea-
 BTS-1      .66   9.91    .38   .760     16   3.11   11.97     .422     .219
 BTS-2     1.14   8.63    .51   .633     17   2.45   11.42     .557     .125

                                        VPA Mean =   11.49     .701     .079

Yearclass =   2002

          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 DFS-0     1.37   5.21   1.22   .290     23   4.19   10.96    1.313     .056
 SNS-1
 DFS-1     1.35   8.35    .64   .602     24   1.85   10.85     .691     .202
 SNS-2
 SNS-3
 Solea-
 BTS-1      .66   9.91    .38   .760     16   2.46   11.54     .420     .546
 BTS-2

                                        VPA Mean =   11.49     .701     .196
```

Yearclass = 2003

```
          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 DFS-0     1.37   5.21   1.22   .290     23   2.98    9.31    1.379     .206
 SNS-1
 DFS-1
 SNS-2
 SNS-3
 Solea-
 BTS-1
 BTS-2

                                        VPA Mean =   11.49     .701     .794


 Year     Weighted       Log     Int     Ext     Var     VPA      Log
 Class     Average       WAP     Std     Std     Ratio            VPA
          Prediction            Error   Error

 2001      180213      12.10     .20     .18      .84
 2002       85569      11.36     .31     .17      .29
 2003       62378      11.04     .63     .88     1.99
```

Table 7.5.2b. North Sea Sole. Output RCT3 – age 2.

Analysis by RCT3 ver3.1 of data from file :

s4rct-2_.txt

SoleNorthSea - Age2.

Data for 8 surveys over 36 years : 1968 - 2003

Regression type = C

Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2001

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction				---------I
DFS-0	1.37	5.11	1.22	.290	23	4.47	11.24	1.305	.023
SNS-1	.77	5.51	.26	.880	31	8.87	12.33	.284	.482
DFS-1	1.35	8.24	.64	.604	24	2.96	12.25	.691	.081
SNS-2									
SNS-3									
Solea-									
BTS-1	.67	9.79	.39	.751	16	3.11	11.86	.433	.207
BTS-2	1.14	8.53	.50	.640	17	2.45	11.32	.551	.128
						VPA Mean =	11.38	.701	.079

Yearclass = 2002

Survey/ Series	**Slope**	**Inter- cept**	**Std Error**	**Rsquare**	**No. Pts**	**Index Value**	**Predicted Value**	**Std Error**	**WAP Weights**
	I-----------Regression			**----------I**	**I-----------Prediction**				**---------I**
DFS-0	**1.37**	**5.11**	**1.22**	**.290**	**23**	**4.19**	**10.85**	**1.310**	**.058**
SNS-1									
DFS-1	**1.35**	**8.24**	**.64**	**.604**	**24**	**1.85**	**10.74**	**.688**	**.209**
SNS-2									
SNS-3									
Solea-									
BTS-1	**.67**	**9.79**	**.39**	**.751**	**16**	**2.46**	**11.43**	**.432**	**.532**
BTS-2									
						VPA Mean =	**11.38**	**.701**	**.202**

Yearclass = 2003

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction				---------I
DFS-0	1.37	5.11	1.22	.290	23	2.98	9.21	1.375	.206
SNS-1									
DFS-1									
SNS-2									
SNS-3									
Solea-									
BTS-1									
BTS-2									
						VPA Mean =	11.38	.701	.794

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2001	162337	12.00	.20	.18	.85		
2002	**76353**	**11.24**	**.31**	**.17**	**.28**		
2003	56014	10.93	.62	.88	1.99		

Table 7.6.1. North Sea Sole. Input data for catch forecast and linear sensitivity analysis.

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	95889	0.78	WS1	0.05	0.00
N2	76353	0.34	WS2	0.15	0.01
N3	132499	0.19	WS3	0.19	0.03
N4	25101	0.15	WS4	0.24	0.05
N5	24352	0.13	WS5	0.26	0.02
N6	6871	0.14	WS6	0.29	0.09
N7	7547	0.13	WS7	0.32	0.05
N8	7074	0.14	WS8	0.35	0.18
N9	498	0.15	WS9	0.45	0.11
N10	1188	0.17	WS10	0.48	0.10
H.cons selectivity			Weight in the HC catch		
sH1	0.01	0.37	WH1	0.14	0.03
sH2	0.21	0.06	WH2	0.18	0.01
sH3	0.49	0.06	WH3	0.21	0.03
sH4	0.53	0.10	WH4	0.26	0.05
sH5	0.53	0.12	WH5	0.28	0.02
sH6	0.44	0.09	WH6	0.32	0.03
sH7	0.41	0.27	WH7	0.37	0.07
sH8	0.64	0.22	WH8	0.36	0.14
sH9	0.40	0.07	WH9	0.50	0.14
sH10	0.40	0.07	WH10	0.49	0.11
Natural mortality			Proportion mature		
M1	0.10	0.10	MT1	0.00	0.00
M2	0.10	0.10	MT2	0.00	0.10
M3	0.10	0.10	MT3	1.00	0.10
M4	0.10	0.10	MT4	1.00	0.00
M5	0.10	0.10	MT5	1.00	0.00
M6	0.10	0.10	MT6	1.00	0.00
M7	0.10	0.10	MT7	1.00	0.00
M8	0.10	0.10	MT8	1.00	0.00
M9	0.10	0.10	MT9	1.00	0.00
M10	0.10	0.10	MT10	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF04	1.00	0.09	K04	1.00	0.10
HF05	1.00	0.09	K05	1.00	0.10
HF06	1.00	0.09	K06	1.00	0.10
Recruitment in 2005 and 2006					
R05	95890	0.78			
R06	95890	0.78			

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

Stock numbers in 2004 are VPA survivors.
These are overwritten at Age 2 and replaced by RCT3 estimates

Table 7.6.2. North Sea Sole. Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 2004	2005						
Mean F Ages								
H.cons 2 to 6	0.44	0.00	0.09	0.18	0.26	0.40	0.44	0.53
Effort relative to 2003								
H.cons	1.00	0.00	0.20	0.40	0.60	0.90	1.00	1.20
Biomass								
Total 1 January	61.2	57.4	57.4	57.4	57.4	57.4	57.4	57.4
SSB at spawning time	45.4	40.2	40.2	40.2	40.2	40.2	40.2	40.2
Catch weight (,000t)								
H.cons	21.1	0.0	4.6	8.8	12.7	17.8	19.4	22.3
Biomass in year.... 2006								
Total 1 January		73.9	69.3	65.1	61.2	56.1	54.5	51.6
SSB at spawning time		56.5	51.9	47.7	43.9	38.8	37.2	34.3

	Year 2004	2005						
Effort relative to 2003								
H.cons	1.00	0.00	0.20	0.40	0.60	0.90	1.00	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.12	0.20	0.20	0.20	0.20	0.20	0.20	0.20
SSB at spawning time	0.13	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Catch weight								
H.cons	0.13	0.00	0.46	0.26	0.21	0.18	0.18	0.17
Biomass in year.... 2006								
Total 1 January		0.23	0.24	0.24	0.25	0.26	0.27	0.28
SSB at spawning time		0.23	0.24	0.25	0.26	0.27	0.28	0.29

Table 7.6.3. North Sea Sole. Detailed forecast tables.

Forecast for year 2004
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
1	95889	818	818
2	76000	13605	13605
3	132499	49198	49198
4	25101	9856	9856
5	24352	9520	9520
6	6871	2340	2340
7	7547	2429	2429
8	7074	3199	3199
9	498	157	157
10	1188	375	375
Wt	61	21	21

Forecast for year 2005
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Catch number: Total
1	95890	818	818
2	85987	15393	15393
3	55854	20739	20739
4	73301	28782	28782
5	13382	5232	5232
6	13022	4435	4435
7	4000	1287	1287
8	4527	2047	2047
9	3375	1067	1067
10	1021	323	323
Wt	57	19	19

Table 7.6.4 **Sole IV**

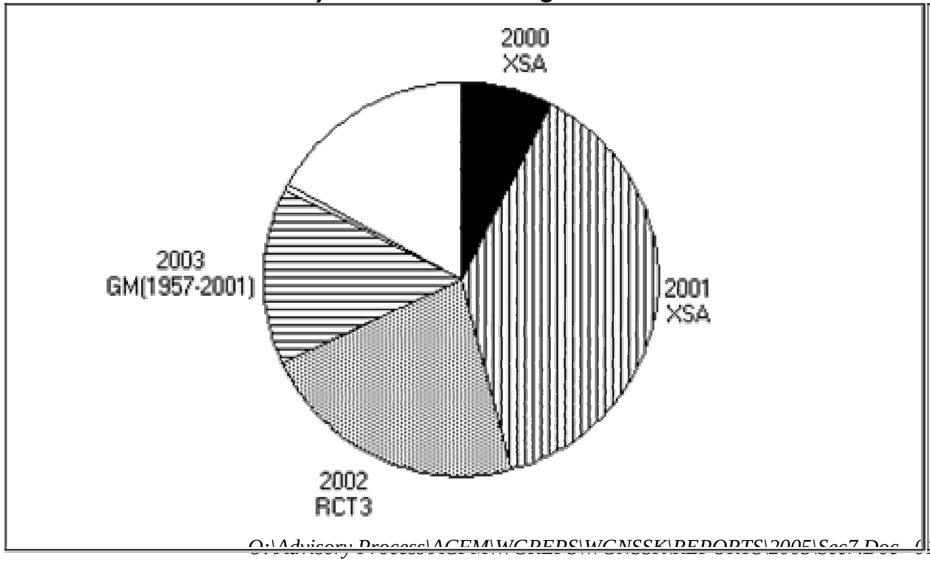
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class			2000	2001	2002	2003	2004
Stock No. (thousands) of 1year-olds			70122	200507	76353	96000	96000
Source			XSA	XSA	RCT3	GM(1957-2001)	GM(1957-2001)
Status Quo F:							
% in	2004	landings	12.1	48.8	11.6	0.5	-
% in	2005		7.5	38.4	22.3	14.2	0.6
% in	2004	SSB	13.3	55.7	0.0	0.0	-
% in	2005	SSB	8.6	43.6	26.3	0.0	0.0
% in	2006	SSB	5.6	27.3	20.0	32.3	0.0

GM : geometric mean recruitment

Sole IV : Year-class % contribution to

a) 2005landings



b) 2006SSB

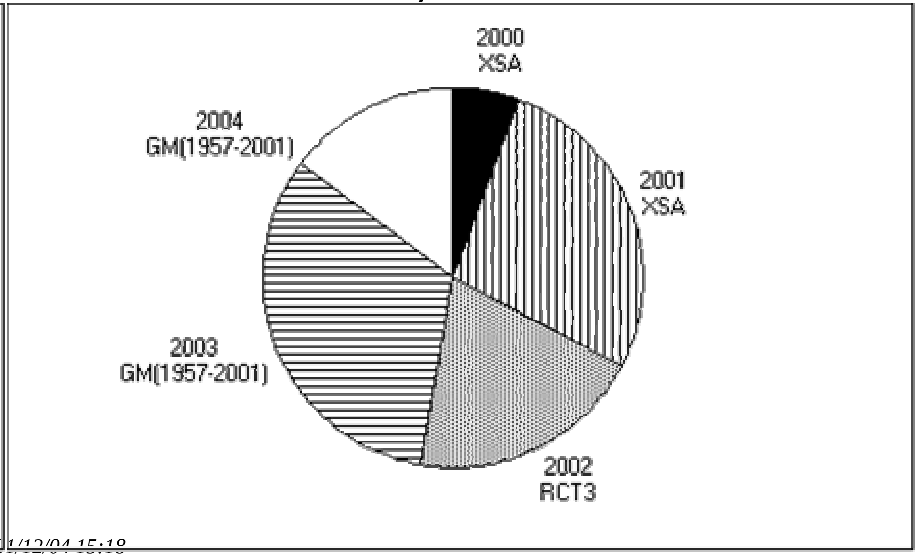
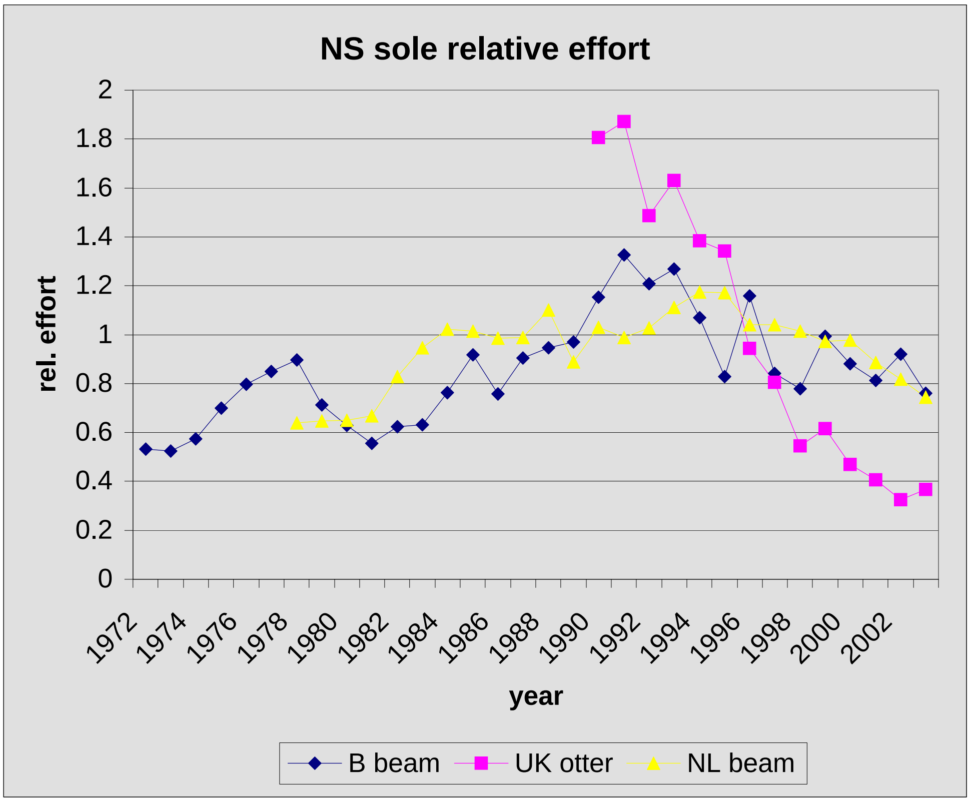


Figure 7.3.1. North Sea sole: trends in relative effort and cpue



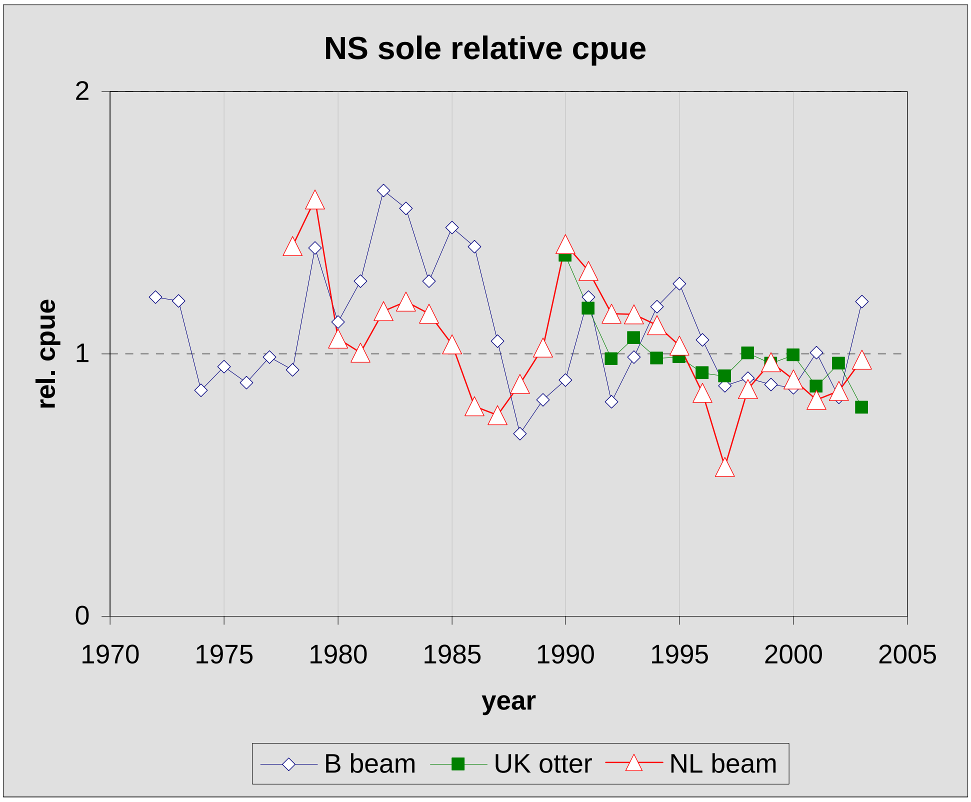


Figure 7.4.1. North Sea sole. Stock summary plots

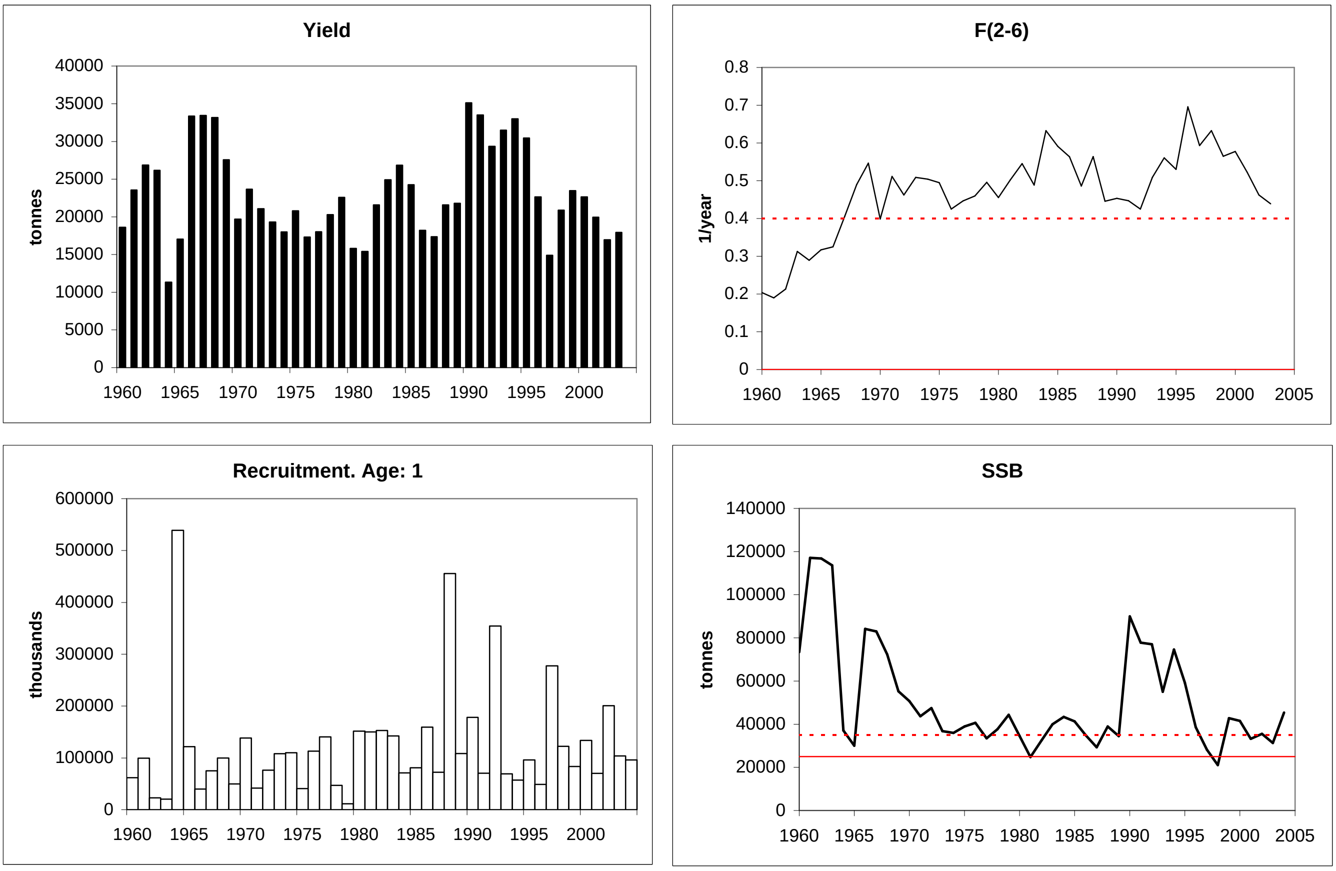


Figure 7.4.2. North Sea sole: Historic performance of the assessment.

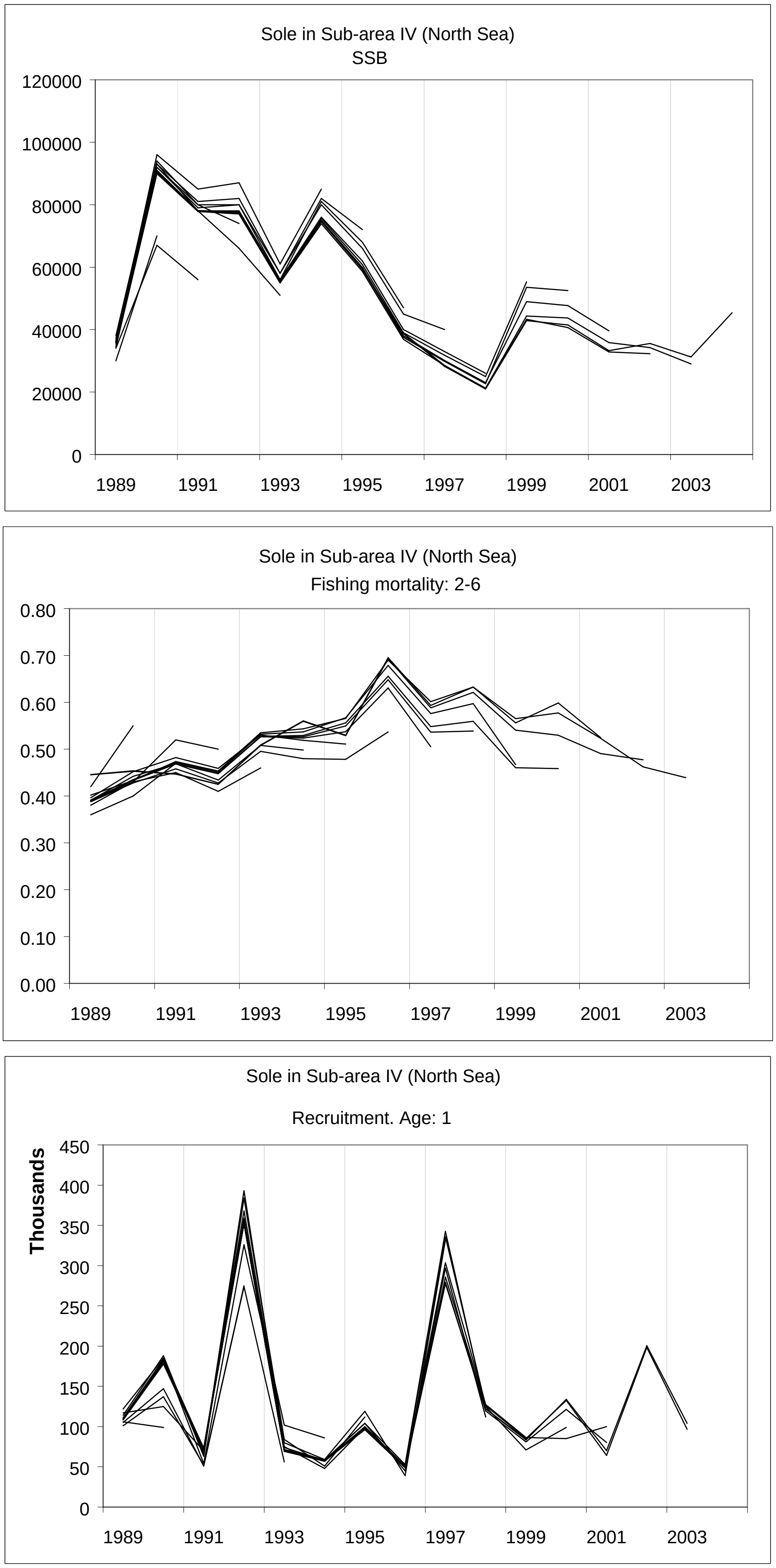


Figure 7.6.1. North Sea Sole. Probability profiles for short term forecasts.

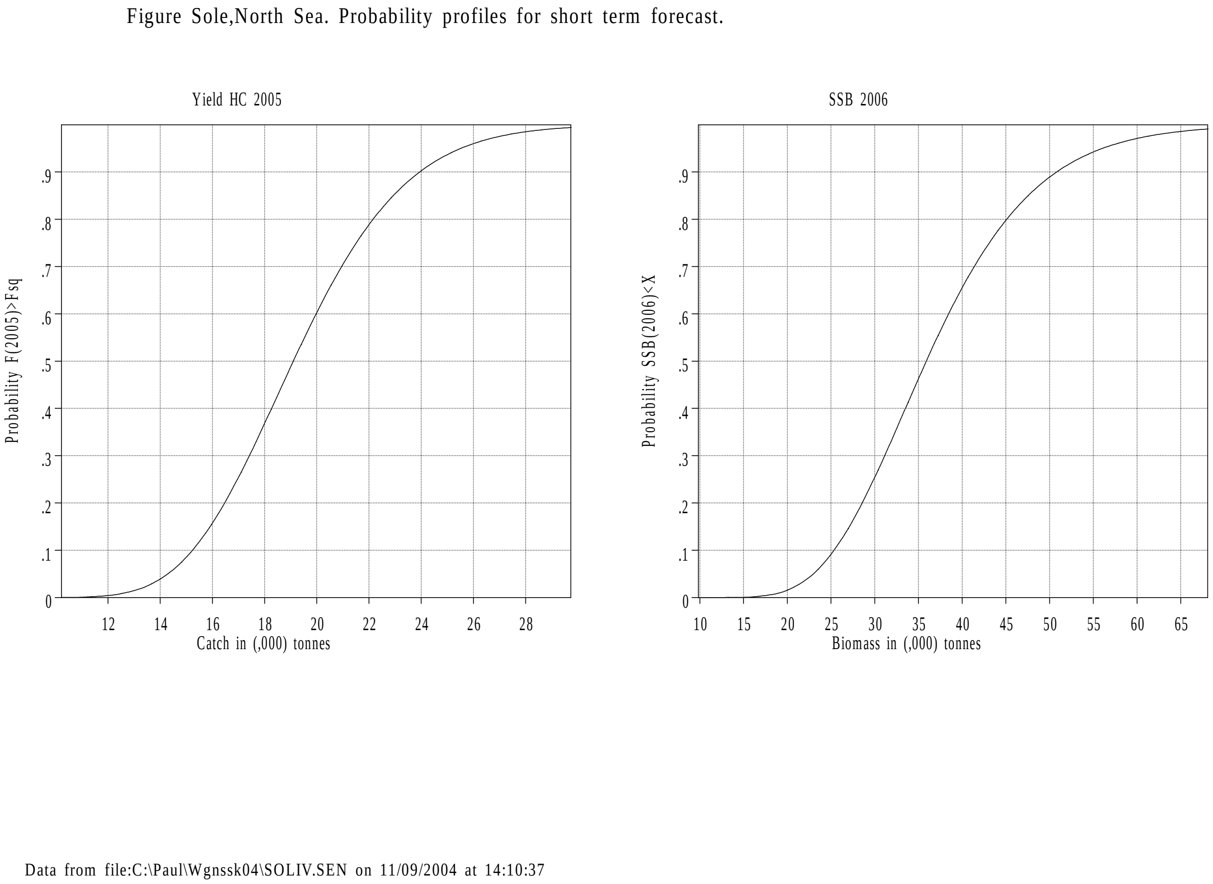
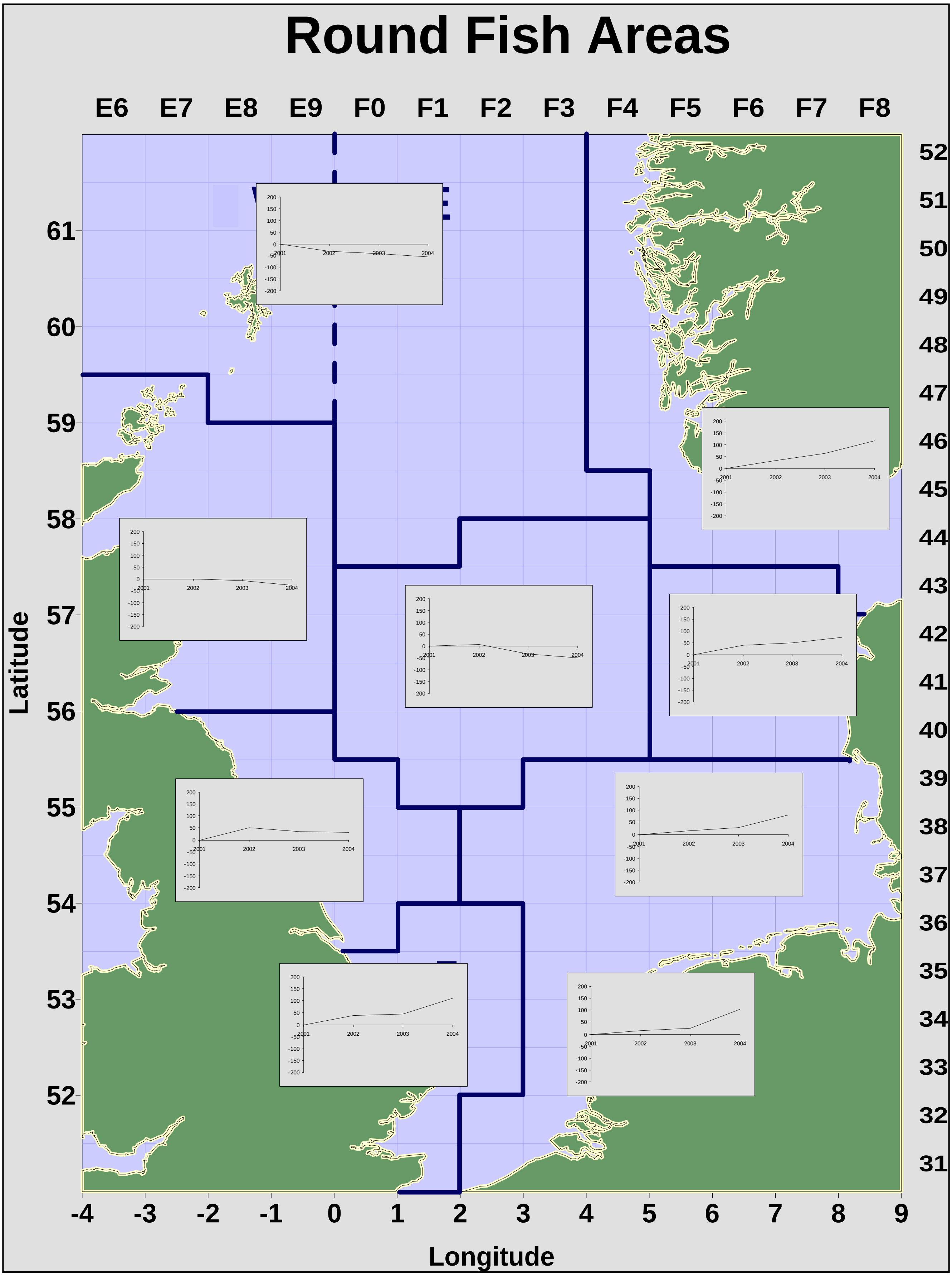


Figure 7.8.1. North Sea sole: results of the fishermen's survey



8 SOLE IN DIVISION VIID

The assessment of sole in Division VIId is presented here as an update assessment. Procedures and settings are the same as in last year's assessment, except for:

- revisions to landing data for the historical time series from 1986 onwards, taking into account misreporting in adjacent areas (see Section 8.2.1);
- modification of the shrinkage setting in XSA (see Section 8.3); and
- the use of XSA estimates in prediction for age 2 survivors and not RCT3 estimates (see Section 8.4).

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.

8.1 The fishery

A detailed description of the fishery can be found in the Stock Annex

8.1.1 ICES advice applicable to 2003 and 2004

Both in 2002 and in 2003, ICES considered the stock to be within safe biological limits. ICES recommended that fishing mortality should be maintained below the proposed $\boldsymbol{F}_{pa,}$ corresponding to landings of less than 5400t in 2003 and less than 5900t in 2004.

8.1.2 Management applicable in 2003 and 2004

The TAC for sole was set at 5400t in 2003 and 5900 t in 2004.

8.1.3 The fishery in 2003

The 2003 landings used by the Working Group were 5038t which is 7% below the agreed TAC of 5400t and around the catch predicted at status quo fishing mortality in 2003 (4930t). The contribution of Belgium, France and the UK to the landings in 2003 is 29%, 51% and 19% respectively (Table 8.2.1).

8.2 Data available

8.2.1 Landings

Landings data reported to ICES are shown in Table 8.2.1, together with the total landings estimated by the Working Group. There are strong indications of misreporting by beam trawlers from Division VIIe into Division VIId. Prior to this year's meeting, the historical landings data from 1986 have been investigated and reallocated to the appropriate ICES sub-areas. Specifically, historical landings have been adjusted for misallocated UK landings between the Eastern and Western Channel over the period 1986-2001. The Belgian historical data have also been adjusted when the sum of products did not correspond to the real landings or when landings into foreign harbours were not accounted for in the total Belgian landings (see also the section on sole in Division VIIe in the 2004 report of WGSSDS). There is also a considerable under-reporting by small vessels, which take up to 60% of the landings in the eastern Channel. However, it has not been possible to quantify the level of these for inclusion in the assessment.

There are no discards included in the assessment, but in general discards for sole are minor (Table 8.2.2 and Figure 8.2.1).

8.2.2 Age compositions

Age compositions of the landings are presented in Table 8.2.3.

8.2.3 Weight at age

Weight at age in the catch is presented in Table 8.2.4 and weight at age in the stock in Table 8.2.5. The procedure for calculating mean weights is described in the Stock Annex.

8.2.4 Maturity and natural mortality

Maturity and natural mortality are assumed at fixed values and are described in the Stock Annex.

8.2.5 Catch, effort and research vessel data

Available estimates of commercial effort and LPUE are presented in Table 8.2.6 and Figure 8.2.2.

Survey and commercial data used for calibration of the assessment are presented in Table 8.2.7. Additional information that is used for recruitment estimation is presented in Table 8.4.1.

8.3 Catch at age analysis

Catch at age analysis was carried out according to the specifications in the Stock Annex. The model used was XSA. Although this stock was scheduled as an update assessment, revisions to the historical landings series (see Section 8.2.1) made the Working Group decide to make some extra investigation, especially on the appropriateness of strong shrinkage. In the following discussion, last year's final run is referred to as Run1. An exploratory run (Run2) was carried out with the same settings as last year, using the revised historical landings. Similar values were observed on fishing mortality and recruitment, and a somewhat lower SSB over the whole time series (Figure 8.3.1). In previous years, heavy shrinkage (s.e. = 0.5) has influenced the final estimate of the one-year-olds quite substantially with estimation weighting of 43% in last year's assessment (Run1) and 39% in Run2. In last year's assessment the high XSA value for the 2001 year class was replaced with the RCT3 value, which now appears to have been an under-estimate (Figure 8.3.1). Investigations on weaker levels of shrinkage (1.0, 1.5 and 2.0) resulted in better diagnostics and a reduced estimation weighting of *F*-shrinkage to less than 5% on one-year-olds. Using a weaker shrinkage did not remove the retrospective patterns in fishing mortality and SSB, but improved the recruitment estimates (Figure 8.3.2). Therefore the Working Group decided to depart from the strong shrinkage used in previous years and apply a shrinkage of 2.0 for the final XSA.

Results of the analysis are presented in Table 8.3.1 (diagnostics), 8.3.2 (fishing mortality at age), 8.3.3 (population numbers at age), and 8.3.4 (stock summary). The stock summary is also shown in Figure 8.3.3 and the retrospective performance of the assessment is shown in Figure 8.3.2. A historical performance of the assessment is presented in Figure 8.3.4.

8.4 Recruitment estimates

For this year's assessment the WG did not use, as in previous years, the RCT3 estimates for predictions, but the XSA final survivors-estimates.

The 2001 year-class in 2002 was estimated by XSA to be the highest of the time series with 62 million fish at age 1. 98% of the estimation weighting for this year-class comes from the tuning fleets, giving rather similar results. The XSA survivor estimates for this year class were used for further prediction.

The 2002 year class in 2003 was estimated by XSA to be 26 million one year olds, which is around average. *F* shrinkage only gets 4% of the weight; the other 94% comes from the surveys. The XSA survivor estimates for this year class were used for further prediction.

The long term GM recruitment (22 million, 1982-2001) was assumed for the 2003 and subsequent year classes.
For comparison, RCT3 runs were carried out. Input to the RCT3 model is given in Table 8.4.1 and results are presented in Table 8.4.2 and Table 8.4.3. However RCT3 estimates were not taken forward into predictions since they performed poorly in recent assessments and current XSA estimates are now less influenced by shrinkage.
The WG estimates of year-class strength used for prediction can be summarised as follows:

Year class	At age in 2004	XSA	GM 82-01	RCT3	Accepted Estimate
2001	3	<u>39745</u>	15133	-	XSA
2002	2	<u>23195</u>	19615	20577	XSA
2003	1	-	<u>22326</u>	20821	GM 1982-01
2004 & 2005	recruits	-	<u>22326</u>	-	GM 1982-01

8.5 Short-term prognosis

The short-term prognosis was carried out according to the specifications in the Stock Annex. As fishing mortality has declined since 1999, the selection pattern for prediction has been taken as a 3 year average, rescaled to the 2003 mean $F_{3\text{-}8}$. Weights at age in the catch and in the stock are averages for the years 2001–003.

Input to the short term predictions and the sensitivity analysis are presented in Table 8.5.1. Results are presented in Table 8.5.2 (management options) and Table 8.5.3 (detailed output).

Assuming *status quo* F, the proportional contributions of recent year classes to the landings in 2005 and SSB in 2006 are given in Table 8.5.4.

Result of a sensitivity analysis are presented in Figure 8.5.1 (probability profiles).

8.6 Comments

- Although this is a scheduled update assessment, the Working Group has investigated different shrinkage values to overcome the discrepancies between XSA and RCT3 estimates, resulting in not using RCT3 estimates for any year class in predictions. Lighter shrinkage has also been used. The other parameters have not been altered.

- In last year’s assessment, the replacement of the XSA estimate for the 2001 year class with the RCT3 estimate has proven to be an underestimate of the apparent strongest year class in the time series.

- The year classes 1998 to 2002 are estimated to be above average and explain the increase in SSB.

- There is a tendency to underestimate fishing mortality and overestimate SSB in this assessment.

- The historical performance of this assessment is rather poor (Figure 8.3.4).

- Uncertainties in the assessment include under-reporting by important segments of the inshore fleet, since this fleet takes a major part of the landings of sole in VIId, and the misreporting of beam trawl fleets fishing in adjacent areas. In this year’s assessment, revisions have been made to current and historical landings, taking into account these discrepancies.

- The EU regulation enforced in 2004 invoked a limitation of 22 days at sea per month for trawlers with mesh size less than 99 mm, and 14 days at sea for beam trawlers. Gill-netters have a derogation of 20 days at sea in the Eastern Channel provided that their mesh size is less than 110 mm. However these effort limitations from the cod recovery plan are not likely to decrease the effort on sole in Division VIId and therefore the short-term prognosis was not modified in the intermediate year.

The WG proposes the following work plan for forthcoming benchmark (scheduled for 2006):

- Analyse the consistency of the tuning fleets by individual retrospective analysis

- Consider redefinition of the current tuning fleets (prior to the Working Group) and/or the integration of new ones like the UK beam trawlers that have been provided for this assessment but not used.

- In depth analysis of possible effects of under- and misreporting.

Table 8.2.1 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

* Unallocated mainly due misreporting

** Preliminary

Table 8.2.2 - Sole VIId - Length structure of discards and landings collected by observations on board.

(numbers raised to sampled trips)

	Fr Otter trawl		Fr Gillnet		Fr Beam trawl	
	Discards	Landings	Discards	Landings	Discards	Landings
Length (cm)	11 trips 196 hauls		10 trips		4 trips 26 hauls	
5	0		0		75	
6	0		0		0	
7	0		0		0	
8	0		0		75	
9	0		0		0	
10	50		0		0	
11	0		0		75	
12	0		0		149	
13	0		0		299	
14	0		1		0	
15	25		0		0	
16	0		0		6	
17	0		5		0	
18	0		8		0	
19	10	0	21	1	0	0
20	0	4	29	4	0	1
21	0	8	39	17	0	0
22	0	16	39	42	6	15
23	0	59	30	83	0	21
24	10	86	28	138	23	45
25	0	63	20	267	0	62
26	0	96	20	351	0	65
27	0	59	17	427	0	103
28	0	68	4	383	0	111
29	0	33	2	312	0	89
30	0	35	1	270	0	79
31	0	8	1	206	0	46
32	0	7	0	142	0	26
33	0	12	1	108	0	28
34	0	0	0	50	0	47
35	0	26	0	60	0	38
36	0	9	0	38	0	35
37	0	0	1	43	0	8
38		13		29		8
39		0		14		18
40		0		4		3
41		0		12		12
42		0		14		0
43		0		13		3
44		0		0		3
45		0		0		0
46		0		2		0
47		0		0		0
48		0		1		0

Table 8.2.3 - Sole VIId - Catch numbers at age (kg)

Run title : Sole in VIId

At 9/09/2004 10:32

Table 1 Catch numbers at age Numbers*10**-3

	YEAR	1982	1983
	AGE		
	1	155	0
	2	2625	852
	3	5256	3452
	4	1727	3930
	5	570	897
	6	653	735
	7	549	627
	8	240	333
	9	122	108
	10	83	89
	+gp	202	193
0	TOTALNUM	12182	11216
	TONSLAND	3190	3458
	SOPCOF %	97	99

Table 1 Catch numbers at age Numbers*10**-3

	YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	AGE										
	1	24	49	49	9	95	163	1245	383	105	85
	2	1977	3693	1251	3117	2162	3484	2851	7166	4046	5028
	3	3157	5211	5296	3730	7174	3220	5580	4105	8789	6442
	4	2610	1646	3195	3271	1602	4399	1151	4160	1888	5444
	5	1900	1027	904	2053	1159	1434	1496	604	1993	1008
	6	742	1860	768	1042	856	840	301	996	288	563
	7	457	144	1056	1090	388	571	390	257	368	162
	8	317	158	155	784	255	201	260	247	135	188
	9	136	156	190	111	256	166	129	258	171	116
	10	99	69	212	163	83	224	126	92	95	62
	+gp	238	128	372	459	275	282	489	382	231	129
0	TOTALNUM	11657	14141	13448	15829	14305	14984	14018	18650	18109	19227
	TONSLAND	3575	3837	3932	4791	3853	3805	3647	4351	4072	4299
	SOPCOF %	99	100	100	100	100	100	100	100	100	100

Run title : Sole in VIId

At 9/09/2004 10:32

Table 1 Catch numbers at age Numbers*10**-3

	YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	AGE										
	1	31	838	9	24	33	168	138	168	707	379
	2	694	2977	1825	1489	1376	3268	3586	6042	7011	10957
	3	6203	4375	7764	6068	5609	8506	4852	6194	7513	5086
	4	5902	4765	3035	5008	2704	3307	4395	1595	3767	3178
	5	3404	2968	3206	2082	1636	1311	1076	2491	1414	1805
	6	584	1980	1823	1670	609	869	505	728	655	671
	7	567	375	1283	916	558	350	319	290	298	588
	8	109	278	271	775	441	672	148	128	129	198
	9	147	88	319	239	354	351	328	56	97	70
	10	93	106	112	169	239	192	150	81	57	88
	+gp	258	241	344	267	301	359	248	265	197	245
0	TOTALNUM	17992	18991	19991	18707	13860	19353	15745	18038	21845	23265
	TONSLAND	4383	4420	4797	4764	3363	4135	3476	4025	4733	5038
	SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 8.2.4 - Sole VIId - Catch weights at age (kg)

Run title : Sole in VIId

At 9/09/2004 10:32

Table 2 Catch weights at age (kg)

YEAR	1982	1983
AGE		
1	0.102	0.000
2	0.171	0.173
3	0.225	0.230
4	0.312	0.302
5	0.386	0.404
6	0.428	0.436
7	0.439	0.435
8	0.509	0.524
9	0.502	0.537
10	0.463	0.583
+gp	0.673	0.628
0 SOPCOFAC	0.971	0.991

Table 2 Catch weights at age (kg)

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
1	0.100	0.090	0.135	0.095	0.102	0.106	0.120	0.114	0.103	0.085
2	0.178	0.182	0.180	0.175	0.152	0.154	0.178	0.161	0.153	0.147
3	0.234	0.230	0.212	0.236	0.226	0.192	0.238	0.208	0.203	0.197
4	0.314	0.281	0.306	0.295	0.278	0.271	0.289	0.266	0.267	0.247
5	0.380	0.368	0.363	0.353	0.360	0.293	0.349	0.354	0.290	0.335
6	0.436	0.394	0.387	0.407	0.409	0.358	0.339	0.394	0.403	0.384
7	0.417	0.516	0.437	0.411	0.459	0.388	0.470	0.421	0.391	0.537
8	0.538	0.543	0.520	0.482	0.514	0.472	0.465	0.430	0.462	0.553
9	0.529	0.594	0.502	0.465	0.553	0.515	0.487	0.434	0.459	0.515
10	0.565	0.595	0.523	0.538	0.563	0.547	0.518	0.478	0.463	0.766
+gp	0.714	0.801	0.602	0.618	0.665	0.701	0.562	0.566	0.566	0.667
0 SOPCOFAC	0.988	0.998	1.001	1.000	1.000	0.999	1.000	1.000	1.000	1.000

Run title : Sole in VIId

At 9/09/2004 10:32

Table 2 Catch weights at age (kg)

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
1	0.099	0.129	0.142	0.139	0.132	0.130	0.145	0.108	0.120	0.114
2	0.150	0.176	0.165	0.153	0.159	0.151	0.142	0.152	0.162	0.170
3	0.186	0.179	0.178	0.188	0.172	0.189	0.176	0.211	0.204	0.208
4	0.235	0.230	0.229	0.233	0.235	0.215	0.223	0.283	0.253	0.257
5	0.288	0.255	0.269	0.292	0.286	0.260	0.332	0.288	0.316	0.277
6	0.355	0.333	0.324	0.343	0.343	0.280	0.377	0.334	0.375	0.357
7	0.381	0.357	0.361	0.390	0.383	0.290	0.424	0.367	0.376	0.381
8	0.505	0.385	0.405	0.404	0.417	0.341	0.427	0.374	0.393	0.438
9	0.484	0.490	0.435	0.503	0.484	0.358	0.384	0.493	0.469	0.482
10	0.496	0.494	0.465	0.474	0.435	0.374	0.459	0.511	0.420	0.494
+gp	0.616	0.654	0.585	0.651	0.616	0.535	0.680	0.545	0.531	0.527
0 SOPCOFAC	1.000	1.000	1.000	1.000	1.001	0.999	1.001	1.001	1.000	1.000

Table 8.2.5 - Sole VIId - Stock weights at age (kg)

Run title : Sole in VIId

At 9/09/2004 10:32

Table 3 Stock weights at age (kg)

YEAR	1982	1983
AGE		
1	0.059	0.070
2	0.114	0.135
3	0.167	0.197
4	0.217	0.255
5	0.263	0.309
6	0.306	0.359
7	0.347	0.406
8	0.384	0.448
9	0.418	0.487
10	0.450	0.522
+gp	0.530	0.601

Table 3 Stock weights at age (kg)

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
1	0.067	0.065	0.070	0.072	0.050	0.050	0.050	0.050	0.050	0.050
2	0.131	0.129	0.136	0.139	0.145	0.113	0.138	0.138	0.144	0.130
3	0.192	0.192	0.198	0.203	0.223	0.182	0.232	0.225	0.199	0.189
4	0.249	0.254	0.256	0.262	0.268	0.269	0.305	0.279	0.277	0.246
5	0.304	0.315	0.309	0.318	0.365	0.323	0.400	0.380	0.305	0.366
6	0.355	0.376	0.358	0.370	0.425	0.335	0.361	0.384	0.454	0.377
7	0.403	0.436	0.403	0.417	0.477	0.480	0.476	0.410	0.405	0.545
8	0.448	0.495	0.443	0.461	0.498	0.504	0.535	0.449	0.459	0.560
9	0.490	0.554	0.480	0.500	0.572	0.586	0.571	0.474	0.430	0.559
10	0.529	0.611	0.512	0.536	0.636	0.536	0.507	0.451	0.528	0.813
+gp	0.627	0.780	0.576	0.616	0.750	0.714	0.577	0.620	0.527	0.566

Run title : Sole in VIId

At 9/09/2004 10:32

Table 3 Stock weights at age (kg)

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
1	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
2	0.116	0.126	0.155	0.139	0.140	0.128	0.122	0.127	0.136	0.151
3	0.161	0.129	0.176	0.165	0.158	0.180	0.148	0.157	0.179	0.207
4	0.215	0.220	0.258	0.220	0.233	0.205	0.208	0.216	0.209	0.249
5	0.273	0.234	0.286	0.264	0.299	0.253	0.402	0.226	0.258	0.314
6	0.316	0.333	0.308	0.317	0.374	0.277	0.440	0.223	0.254	0.376
7	0.368	0.357	0.366	0.376	0.363	0.298	0.395	0.231	0.301	0.399
8	0.530	0.330	0.391	0.404	0.357	0.324	0.554	0.253	0.234	0.418
9	0.461	0.614	0.438	0.563	0.450	0.336	0.443	0.256	0.326	0.446
10	0.470	0.382	0.466	0.494	0.372	0.323	0.420	0.301	0.404	0.444
+gp	0.612	0.629	0.630	0.654	0.577	0.512	0.682	0.420	0.417	0.503

Table 8.2.6a Sole in VIId. Indices of effort

Year	France Beam trawl[1]	England & Wales Beam trawl[2]	Belgium Beam trawl[2]
1971			
1972			
1973			
1974			
1975			5.02
1976			6.56
1977			6.87
1978			8.22
1979			7.30
1980			12.81
1981			19.00
1982			23.94
1983			23.64
1984			28.00
1985			25.29
1986		2.79	23.54
1987		5.64	27.11
1988		5.09	38.52
1989		5.65	35.67
1990		7.27	30.33
1991	10.69	7.67	24.29
1992	10.52	8.78	21.99
1993	10.22	6.40	20.02
1994	10.61	5.43	25.17
1995	12.38	6.89	24.17
1996	14.09	10.31	25.00
1997	10.92	10.25	30.89
1998	11.71	7.31	18.12
1999	10.63	5.86	21.39
2000	13.78	5.65	30.54
2001	11.38	7.64	32.39
2002		7.90	33.68
2003		6.69	39.75

[1]in Kg/1000 h*KW-04

[1] Beam trawl >= 10m in millions hp hrs >10% sole

[2]Fishing hours (x 10^3) corrected for fishing power using P = 0.000204 BHP^1.23

Table 8.2.6b **Sole in VIId. LPUE indices**

Year	France[1] Beam trawl	England & Wales[2] Beam trawl	Belgium[3] Beam trawl
1971			
1972			
1973			
1974			
1975			24.09
1976			27.28
1977			29.99
1978			26.27
1979			37.42
1980			23.26
1981			24.52
1982			23.65
1983			22.37
1984			21.61
1985			22.90
1986		39.48	33.48
1987		32.82	36.56
1988		27.67	15.89
1989		26.59	16.82
1990		26.88	25.94
1991	18.52	22.09	22.56
1992	18.12	25.29	29.11
1993	21.60	23.75	34.77
1994	17.78	31.83	27.89
1995	18.46	28.39	24.70
1996	19.79	25.79	29.80
1997	14.41	25.40	32.57
1998	17.33	25.71	23.51
1999	30.4	27.29	26.41
2000	19.1	27.46	24.49
2001	46.1	26.58	24.58
2002		31.63	27.33
2003		32.81	33.13

[1] in h*KW-04

[2] in Kg/1000 HP*HRS >10% sole

[3] in Kg/hr corrected for fishing power using P = 0.000204 BHP^1.23

Table 8.2.7 - Sole VIId - tuning files

Bolded numbers = used in XSA

SOLE	7d,TUNING													
104	1													
BEL	**BT**													
1980	**2003**													
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
UK	**BT**													
1986	**2003**													
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	**383.1**	**219.1**	**148.3**	**64.3**	**27.0**	**31.8**	**14.9**	**5.6**	**5.8**	0.9	4.2	2.8	1.9	5.1
UK	**BTS**													
1988	**2003**													
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**								
YFS														
1981	**2003**													
1	**1**	**0.5**	**0.75**											
0	1													
1	1.881	-11												
1	2.6555	0.2005												
1	11.887	0.695												
1	-11	-11												
1	-11	-11												
1	-11	-11												
1	7.995	**0.66**												
1	1.1875	**0.94**												
1	12.588	**0.36**												
1	3.3285	**1.15**												
1	1.3865	**1.87**												
1	1.281	**0.80**												
1	6.534	**0.62**												
1	8.1035	**1.59**												
1	5.3135	**1.46**												
1	0.9865	**0.34**												
1	1.942	**0.52**												
1	9.3725	**0.56**												
1	2.7455	**0.85**												
1	1.8475	**1.28**												
1	4.5135	**0.84**												
1	2.52	**1.93**												
1	2.16	**0.82**												

Table 8.3.1 - Sole VIId - XSA diagnostics

Lowestoft VPA Version 3.1

9/09/2004 10:31

Extended Survivors Analysis

Sole in VIId

CPUE data from file tun.txt

Catch data for 22 years. 1982 to 2003. Ages 1 to 11.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
BEL BT	1986	2003	2	10	0	1
UK BT	1986	2003	2	10	0	1
UK BTS	1988	2003	1	6	0.5	0.75
YFS	1987	2003	1	1	0.5	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

Terminal population estimation :

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

S.E. of the mean to which the estimates are shrunk = 2.000

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning had not converged after 70 iterations

Total absolute residual between iterations
69 and 70 = .00011

Final year F values

Age	1	2	3	4	5	6	7	8	9	10
Iteration 69	0.0154	0.2329	0.4057	0.3485	0.3761	0.4433	0.363	0.2547	0.1667	0.3317
Iteration 70	0.0154	0.2329	0.4057	0.3485	0.376	0.4432	0.363	0.2547	0.1667	0.3317

Regression weights

	1	1	1	1	1	1	1	1	1	1

Table 8.3.1 - Sole VIId - XSA diagnostics - continued

Fishing mortalities

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.001	0.046	0	0.001	0.002	0.007	0.005	0.006	0.012	0.015
2	0.049	0.14	0.121	0.095	0.06	0.241	0.171	0.248	0.348	0.233
3	0.337	0.436	0.566	0.641	0.539	0.548	0.591	0.44	0.488	0.406
4	0.494	0.416	0.543	0.783	0.585	0.627	0.538	0.346	0.465	0.348
5	0.414	0.439	0.483	0.791	0.56	0.555	0.376	0.592	0.52	0.376
6	0.311	0.4	0.469	0.442	0.494	0.58	0.38	0.418	0.268	0.443
7	0.266	0.3	0.435	0.404	0.23	0.52	0.384	0.347	0.267	0.363
8	0.283	0.181	0.328	0.451	0.308	0.422	0.384	0.233	0.228	0.255
9	0.265	0.345	0.289	0.475	0.34	0.381	0.333	0.218	0.248	0.167
10	0.618	0.276	0.866	0.219	1.113	0.278	0.247	0.114	0.321	0.332

XSA population numbers (Thousands)

YEAR \ AGE	1	2	3	4	5	6	7	8	9	10
1994	2.66E+04	1.51E+04	2.28E+04	1.59E+04	1.06E+04	2.30E+03	2.55E+03	4.65E+02	6.65E+02	2.12E+02
1995	1.95E+04	2.40E+04	1.30E+04	1.47E+04	8.78E+03	6.31E+03	1.52E+03	1.77E+03	3.17E+02	4.61E+02
1996	1.90E+04	1.68E+04	1.89E+04	7.62E+03	8.80E+03	5.12E+03	3.83E+03	1.02E+03	1.33E+03	2.03E+02
1997	2.75E+04	1.72E+04	1.35E+04	9.70E+03	4.00E+03	4.91E+03	2.90E+03	2.24E+03	6.65E+02	9.04E+02
1998	1.78E+04	2.49E+04	1.41E+04	6.42E+03	4.01E+03	1.64E+03	2.86E+03	1.75E+03	1.29E+03	3.74E+02
1999	2.67E+04	1.61E+04	2.12E+04	7.47E+03	3.24E+03	2.08E+03	9.07E+02	2.05E+03	1.16E+03	8.32E+02
2000	3.21E+04	2.40E+04	1.14E+04	1.11E+04	3.61E+03	1.68E+03	1.05E+03	4.88E+02	1.22E+03	7.20E+02
2001	2.79E+04	2.89E+04	1.83E+04	5.73E+03	5.86E+03	2.24E+03	1.04E+03	6.48E+02	3.00E+02	7.91E+02
2002	6.20E+04	2.51E+04	2.04E+04	1.07E+04	3.66E+03	2.93E+03	1.34E+03	6.65E+02	4.64E+02	2.19E+02
2003	2.60E+04	5.54E+04	1.60E+04	1.14E+04	6.05E+03	1.97E+03	2.03E+03	9.26E+02	4.79E+02	3.28E+02

Estimated population abundance at 1st Jan 2004

0.00E+00	2.32E+04	3.97E+04	9.67E+03	7.25E+03	3.76E+03	1.14E+03	1.28E+03	6.49E+02	3.67E+02

Taper weighted geometric mean of the VPA populations:

2.36E+04	2.08E+04	1.54E+04	8.40E+03	4.48E+03	2.57E+03	1.56E+03	9.36E+02	5.95E+02	3.75E+02

Standard error of the weighted Log(VPA populations) :

0.4118	0.4132	0.3507	0.4328	0.4467	0.4793	0.5156	0.5234	0.532	0.5881

Log catchability residuals.

Fleet : BEL BT

Age	1986	1987	1988	1989	1990	1991	1992	1993
1	: at this age							
2	0.12	0.66	-0.64	-2.49	1.2	-0.68	0.05	1.39
3	0.62	-0.3	-0.53	-0.1	-0.01	0.74	0	0.16
4	0.12	0.29	-0.78	-0.47	-0.21	-0.01	0.34	-0.11
5	-0.17	0.49	-0.33	0.93	-0.18	-0.13	0.13	-0.12
6	-0.16	0.87	-0.28	0.21	-0.22	0.58	-0.53	-0.92
7	-0.24	0.56	0.02	0.28	0.49	0.04	-0.27	-0.02
8	0.03	-0.15	-0.8	-0.09	-0.32	-0.11	-0.19	-0.31
9	0.73	0.31	-0.8	-0.38	0.33	-0.74	-0.13	0.66
10	0.05	2.2	1.45	-2.15	-0.15	0.56	-0.75	-0.68

Table 8.3.1 - Sole VIId - XSA diagnostics - continued

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1 : at this age										
2	-0.21	-0.67	-0.04	-0.65	-0.25	0.48	0.13	0.53	0.87	0.21
3	-0.13	-0.39	-0.15	0.29	-0.32	-0.05	0.35	-0.08	-0.06	-0.06
4	0.5	-0.41	0.21	0.29	0.21	0.44	0.3	-0.37	-0.21	-0.14
5	0.17	-0.15	-0.22	0.38	-0.24	0.37	-0.43	0.07	-0.3	-0.26
6	0.37	0.02	0.09	0.08	-0.31	-0.13	0.03	0.62	-0.81	0.5
7	-0.04	-0.06	0.2	0.2	-0.29	-0.04	-0.26	0.1	-0.32	-0.35
8	0.27	-1.18	-0.06	-0.26	0.05	-0.28	0.48	-0.68	-0.39	-0.28
9	-0.25	0.16	-0.22	0.03	-0.12	-0.02	-0.35	-0.65	-0.63	-1.54
10	1.37	-0.83	1.1	-1.05	-0.1	-0.61	-0.35	-1.46	0.3	0.08

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	-7.1548	-5.7222	-5.6194	-5.4741	-5.7042	-5.6527	-5.6527	-5.6527	-5.6527
S.E(Log q)	0.8814	0.3298	0.3581	0.3515	0.4841	0.2711	0.4504	0.5938	1.0985

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	0.88	0.263	7.49	0.23	18	0.8	-7.15
3	1.14	-0.547	5.16	0.48	18	0.38	-5.72
4	0.87	0.76	6.08	0.67	18	0.31	-5.62
5	1.07	-0.308	5.28	0.58	18	0.38	-5.47
6	0.97	0.126	5.77	0.5	18	0.48	-5.7
7	0.98	0.18	5.69	0.79	18	0.27	-5.65
8	1.3	-1.457	5.6	0.59	18	0.48	-5.89
9	1.38	-1.135	5.65	0.36	18	0.76	-5.85
10	-2.63	-5.472	6.68	0.12	18	1.76	-5.71

Fleet : UK BT

Age	1986	1987	1988	1989	1990	1991	1992	1993
1 : at this age								
2	-0.3	0.46	0.65	0	-0.14	-0.02	-0.34	-0.29
3	0.57	0	0.41	0.03	0.15	-0.22	-0.05	-0.45
4	0.57	0.46	0.01	0.27	-0.07	0.08	-0.38	-0.14
5	0.31	0.56	0.42	-0.47	0.01	-1.2	0.49	-0.33
6	0.4	-0.25	0.26	0.1	-0.38	-0.27	-0.6	0.04
7	0.65	-0.26	-0.11	0.21	-0.29	-0.92	-0.2	-0.53
8	-0.7	0.4	0.3	-0.23	0.01	-0.62	-0.39	-0.14
9	0.13	-0.64	0.07	-0.34	-0.13	0.12	0.38	0.04
10	0.02	-1.24	0.68	0.3	0.53	0.08	-0.29	-0.5

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1 : at this age										
2	-1.14	-0.12	0.32	0.19	0.08	0.42	-0.09	0.1	0.35	-0.13
3	-0.05	-0.58	-0.44	0.21	-0.21	0.17	0.32	-0.1	0.29	-0.06
4	-0.26	-0.04	-0.74	-0.19	0	0.16	0.24	0	0.18	-0.17
5	-0.02	-0.12	-0.05	-0.51	0.16	0.19	0.26	0.3	0.25	-0.26
6	0.01	0.03	-0.24	0.18	-0.09	0.29	0.24	0.21	0.06	-0.01
7	0.48	-0.14	-0.1	-0.12	0.18	0.24	0.45	0.2	0.06	0.18
8	-0.14	0.37	-0.17	0.12	0.12	0.14	0.25	0.66	0.53	0.16
9	0.36	0.23	0.18	-0.09	0.19	-0.03	0.45	0.2	-0.23	-0.2
10	0.48	0.38	0.23	0.17	0.41	-0.31	0.14	0.11	-0.1	0.29

Table 8.3.1 - Sole VIId - XSA diagnostics - continued

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9	10
Mean Log q	-6.5825	-5.8971	-5.8511	-5.9579	-5.9245	-6.019	-6.019	-6.019	-6.019
S.E(Log q)	0.4007	0.3085	0.305	0.4348	0.2618	0.3803	0.3739	0.2786	0.4559

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	1.13	-0.501	6.13	0.47	18	0.46	-6.58
3	1.07	-0.314	5.63	0.54	18	0.34	-5.9
4	0.98	0.117	5.92	0.68	18	0.31	-5.85
5	0.73	1.591	6.62	0.69	18	0.3	-5.96
6	0.83	1.602	6.25	0.84	18	0.21	-5.92
7	0.76	1.894	6.35	0.8	18	0.27	-6.02
8	0.81	1.449	6.14	0.79	18	0.29	-5.98
9	0.83	1.803	6.05	0.88	18	0.22	-5.98
10	1.01	-0.065	5.94	0.67	18	0.47	-5.94

Fleet : UK BTS

Age	1986	1987	1988	1989	1990	1991	1992	1993
1	99.99	99.99	0.36	-0.35	0.23	0.16	-1.67	-2
2	99.99	99.99	1.04	0.21	-0.74	0.12	-0.34	0.08
3	99.99	99.99	0.65	0.63	-0.49	-0.37	0.12	0.06
4	99.99	99.99	-0.26	-0.03	0.06	0.06	-0.6	0.63
5	99.99	99.99	0.44	0.19	-0.14	-0.21	-0.09	0.03
6	99.99	99.99	0.13	-0.78	-0.23	0.1	0.39	0.33
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	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-0.2	-0.17	-0.18	1.14	-0.67	1.57	0.4	0.4	0.85	0.13
2	-1	-0.21	-0.24	-0.28	0.4	0.13	0.54	0.35	-0.05	0
3	0.12	-0.97	-0.33	-0.12	-0.48	0.79	0.27	0.41	-0.1	-0.18
4	0.02	-0.31	-0.76	-0.23	-0.21	0.59	0.66	-0.06	0.45	-0.02
5	0.41	-0.4	-0.3	-1.19	0.17	1.01	0.29	0.56	-0.97	0.2
6	-0.81	0.25	-0.01	-0.57	-1.05	1.33	0.61	0.28	0.19	-0.17
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	-8.3582	-7.3646	-7.7646	-8.1344	-8.1574	-8.2844
S.E(Log q)	0.9122	0.4896	0.4777	0.4155	0.5527	0.5995

Table 8.3.1 - 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	0.48	1.733	9.31	0.45	16	0.41	-8.36
2	0.97	0.092	7.44	0.44	16	0.49	-7.36
3	0.92	0.238	7.92	0.39	16	0.45	-7.76
4	0.77	1.292	8.35	0.7	16	0.31	-8.13
5	0.99	0.029	8.16	0.41	16	0.57	-8.16
6	1.04	-0.113	8.3	0.38	16	0.64	-8.28

Fleet : YFS

Age	1986	1987	1988	1989	1990	1991	1992	1993
1	99.99	0.57	0.06	-0.46	-0.26	0.46	-0.36	0.08
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	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.56	0.82	-0.64	-0.59	-0.08	-0.06	0.16	-0.12	-0.08	-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	-10.2247
S.E(Log q)	0.4157

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	1.23	-0.721	10.24	0.4	17	0.52	-10.22

Table 8.3.1 - 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 = 2002

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	26425	0.94	0	0	1	0.165	0.014
YFS	21655	0.428	0	0	1	0.798	0.017
F shrinkage mean	56972	2				0.037	0.006

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
23195	0.38	0.14	3	0.359	0.015

Age 2 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	48999	0.906	0	0	1	0.068	0.193
UK BT	34809	0.412	0	0	1	0.33	0.262
UK BTS	47934	0.445	0.354	0.8	2	0.282	0.197
YFS	36582	0.428	0	0	1	0.302	0.251
F shrinkage mean	43716	2				0.018	0.214

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
39745	0.24	0.11	6	0.449	0.233

Age 3 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	9928	0.319	0.264	0.83	2	0.269	0.397
UK BT	10315	0.254	0.186	0.73	2	0.397	0.385
UK BTS	8959	0.335	0.121	0.36	3	0.216	0.432
YFS	8578	0.428	0	0	1	0.108	0.447
F shrinkage mean	7037	2				0.011	0.523

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
9669	0.16	0.07	9	0.469	0.406

Table 8.3.1 - Sole VIId - XSA diagnostics - continued

Age 4 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	6712	0.248	0.097	0.39	3	0.291	0.372
UK BT	7365	0.204	0.149	0.73	3	0.418	0.344
UK BTS	7600	0.275	0.102	0.37	4	0.227	0.335
YFS	8502	0.428	0	0	1	0.057	0.304
F shrinkage mean	4496	2				0.008	0.514

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7252	0.13	0.06	12	0.44	0.348

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	3083	0.215	0.052	0.24	4	0.355	0.443
UK BT	3615	0.193	0.105	0.55	4	0.381	0.389
UK BTS	5741	0.258	0.13	0.51	5	0.216	0.262
YFS	3533	0.428	0	0	1	0.04	0.396
F shrinkage mean	2502	2				0.008	0.523

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3761	0.12	0.08	15	0.639	0.376

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	1171	0.21	0.195	0.93	5	0.305	0.435
UK BT	1247	0.18	0.073	0.41	5	0.476	0.413
UK BTS	894	0.261	0.184	0.71	6	0.189	0.539
YFS	1059	0.428	0	0	1	0.022	0.472
F shrinkage mean	1191	2				0.009	0.429

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1144	0.12	0.08	18	0.654	0.443

Table 8.3.1 - Sole VIId - XSA diagnostics - continued

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	972	0.19	0.139	0.73	6	0.417	0.454
UK BT	1482	0.176	0.037	0.21	6	0.442	0.32
UK BTS	2066	0.272	0.109	0.4	6	0.119	0.24
YFS	709	0.428	0	0	1	0.015	0.581
F shrinkage mean	1331	2				0.007	0.351

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1278	0.12	0.08	20	0.692	0.363

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	540	0.181	0.136	0.75	7	0.421	0.299
UK BT	748	0.168	0.04	0.24	7	0.471	0.224
UK BTS	804	0.265	0.148	0.56	6	0.09	0.21
YFS	341	0.428	0	0	1	0.011	0.44
F shrinkage mean	507	2				0.007	0.316

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
649	0.11	0.07	22	0.591	0.255

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	292	0.184	0.23	1.25	8	0.358	0.205
UK BT	407	0.159	0.106	0.67	8	0.57	0.152
UK BTS	531	0.278	0.224	0.81	6	0.06	0.118
YFS	832	0.428	0	0	1	0.006	0.077
F shrinkage mean	187	2				0.006	0.305

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
367	0.11	0.1	24	0.881	0.167

Table 8.3.1 - Sole VIId - XSA diagnostics - continued

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	148	0.194	0.093	0.48	9	0.33	0.447
UK BT	250	0.162	0.121	0.75	9	0.615	0.289
UK BTS	331	0.289	0.315	1.09	6	0.042	0.226
YFS	374	0.428	0	0	1	0.004	0.202
F shrinkage mean	221	2				0.009	0.322

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
213	0.12	0.09	26	0.714	0.332

Table 8.3.2 - Sole VIId - Fishing mortality (F) at age

Run title : Sole in VIId

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Table 8 Fishing mortality (F) at age

YEAR	1982	1983
AGE		
1	0.0129	0.0000
2	0.1862	0.0822
3	0.3095	0.3530
4	0.4884	0.3563
5	0.2303	0.4486
6	0.2266	0.4605
7	0.4671	0.3146
8	0.4109	0.5094
9	0.3464	0.2913
10	0.3372	0.4061
+gp	0.3372	0.4061
0 FBAR 3- 8	0.3555	0.4071

Table 8 Fishing mortality (F) at age

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
1	0.0012	0.0040	0.0020	0.0009	0.0039	0.0103	0.0299	0.0116	0.0033	0.0053
2	0.1136	0.2217	0.1200	0.1517	0.2600	0.1702	0.2222	0.2148	0.1467	0.1904
3	0.4319	0.4314	0.4999	0.5446	0.5390	0.6707	0.3982	0.5040	0.3926	0.3259
4	0.4366	0.3729	0.4549	0.5847	0.4211	0.6617	0.4741	0.5158	0.4051	0.3992
5	0.2596	0.2719	0.3206	0.5260	0.3726	0.7297	0.4348	0.4335	0.4422	0.3491
6	0.7288	0.3867	0.2987	0.6567	0.3841	0.4489	0.2867	0.5120	0.3368	0.1907
7	0.5141	0.2614	0.3514	0.7895	0.4814	0.4234	0.3436	0.3759	0.3189	0.2862
8	0.2314	0.2968	0.4392	0.4238	0.3723	0.4370	0.3083	0.3382	0.3077	0.2383
9	0.3564	0.1527	0.6147	0.5734	0.2113	0.3923	0.4922	0.5041	0.3680	0.4188
10	0.4194	0.2746	0.2848	1.6353	1.0214	0.2581	0.5158	0.6956	0.3103	0.1963
+gp	0.4194	0.2746	0.2848	1.6353	1.0214	0.2581	0.5158	0.6956	0.3103	0.1963
0 FBAR 3- 8	0.4337	0.3368	0.3941	0.5875	0.4284	0.5619	0.3743	0.4466	0.3672	0.2983

Run title : Sole in VIId

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Table 8 Fishing mortality (F) at age

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	FBAR 01-03
AGE											
1	0.0012	0.0463	0.0005	0.0009	0.0020	0.0066	0.0045	0.0063	0.0121	0.0154	0.0113
2	0.0495	0.1397	0.1212	0.0954	0.0599	0.2406	0.1711	0.2477	0.3478	0.2329	0.2761
3	0.3368	0.4360	0.5661	0.6415	0.5392	0.5476	0.5911	0.4403	0.4882	0.4057	0.4447
4	0.4945	0.4155	0.5429	0.7825	0.5850	0.6268	0.5385	0.3465	0.4649	0.3485	0.3866
5	0.4141	0.4393	0.4830	0.7911	0.5596	0.5551	0.3760	0.5922	0.5204	0.3760	0.4962
6	0.3113	0.4002	0.4691	0.4423	0.4940	0.5803	0.3797	0.4175	0.2676	0.4432	0.3761
7	0.2664	0.3000	0.4345	0.4040	0.2299	0.5205	0.3843	0.3469	0.2671	0.3630	0.3257
8	0.2830	0.1808	0.3277	0.4515	0.3077	0.4217	0.3844	0.2329	0.2279	0.2547	0.2385
9	0.2647	0.3450	0.2895	0.4746	0.3398	0.3812	0.3326	0.2181	0.2481	0.1667	0.2110
10	0.6178	0.2764	0.8665	0.2189	1.1127	0.2778	0.2474	0.1139	0.3205	0.3317	0.2554
+gp	0.6178	0.2764	0.8665	0.2189	1.1127	0.2778	0.2474	0.1139	0.3205	0.3317	
0 FBAR 3- 8	0.3510	0.3620	0.4705	0.5855	0.4526	0.5420	0.4423	0.3961	0.3727	0.3652	

Table 8.3.3 - Sole VIId - Stock numbers at age

Run title : Sole in VIId

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Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1982	1983
	AGE		
	1	12711	21394
	2	16244	11354
	3	20761	12201
	4	4699	13785
	5	2913	2609
	6	3385	2094
	7	1546	2442
	8	749	877
	9	438	449
	10	305	280
	+gp	740	606
0	TOTAL	64491	68091

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	AGE										
	1	21601	12910	25781	10982	25962	16799	44389	34844	33805	16793
	2	19358	19522	11635	23281	9929	23401	15045	38981	31164	30488
	3	9463	15635	14152	9337	18101	6927	17860	10901	28455	24350
	4	7757	5560	9191	7767	4901	9554	3205	10852	5959	17387
	5	8735	4536	3465	5277	3917	2911	4461	1805	5862	3596
	6	1507	6096	3127	2275	2822	2441	1269	2613	1059	3409
	7	1195	658	3747	2099	1068	1739	1410	862	1417	684
	8	1613	647	458	2386	862	597	1030	905	536	932
	9	477	1158	435	267	1413	538	349	685	584	356
	10	304	302	899	213	136	1035	329	193	374	366
	+gp	728	559	1574	591	448	1300	1270	796	908	759
0	TOTAL	72737	67583	74464	64477	69557	67241	90617	103438	110123	99120

Run title : Sole in VIId

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Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	GMST 82-01	AMST 82-01
	AGE													
	1	26554	19457	19019	27525	17791	26673	32140	27905	62018	26033	0[a]	22326	23752
	2	15114	23998	16808	17200	24883	16066	23975	28950	25090	55444	23195	19615	20870
	3	22804	13016	18882	13472	14147	21206	11429	18283	20448	16033	39745	15133	16069
	4	15905	14733	7616	9700	6418	7465	11097	5726	10651	11355	9669	8174	8964
	5	10553	8777	8799	4004	4013	3235	3609	5860	3664	6054	7252	4456	4947
	6	2295	6311	5119	4912	1642	2075	1680	2242	2933	1970	3761	2586	2919
	7	2549	1521	3827	2897	2856	907	1051	1040	1336	2031	1144	1548	1776
	8	465	1767	1020	2243	1750	2053	488	648	665	926	1278	953	1101
	9	665	317	1334	665	1292	1164	1219	300	464	479	649	609	705
	10	212	461	203	904	374	832	720	791	219	328	367	388	462
	+gp	585	1046	619	1425	467	1552	1187	2583	753	910	804		
0	TOTAL	97702	91405	83245	84947	75634	83230	88594	94328	128241	121562	87865		

[a] Replaced with GM in prediction

Table 8.3.4 - Sole VIId - Summary

Run title : Sole in VIId

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Table 16 Summary (without SOP correction)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 8
1982	12711	10427	7825	3190	0.4077	0.3555
1983	21394	12620	9590	3458	0.3606	0.4071
1984	21601	12977	8993	3575	0.3975	0.4337
1985	12910	13362	10004	3837	0.3835	0.3368
1986	25781	14021	10634	3932	0.3698	0.3941
1987	10982	13064	9037	4791	0.5301	0.5875
1988	25962	12886	10148	3853	0.3797	0.4284
1989	16799	12006	8522	3805	0.4465	0.5619
1990	44389	13979	9684	3647	0.3766	0.3743
1991	34844	15957	8835	4351	0.4924	0.4466
1992	33805	17507	11329	4072	0.3594	0.3672
1993	16793	18105	13302	4299	0.3232	0.2983
1994	26554	15727	12646	4383	0.3466	0.351
1995	19457	15228	11231	4420	0.3935	0.362
1996	19019	15806	12250	4797	0.3916	0.4705
1997	27525	14486	10719	4764	0.4445	0.5855
1998	17791	12569	8196	3363	0.4103	0.4526
1999	26673	12521	9131	4135	0.4529	0.542
2000	32140	13059	8527	3476	0.4077	0.4423
2001	27905	12808	7737	4025	0.5203	0.3961
2002	62018	15201	8688	4733	0.5448	0.3727
2003	26033	20476	10802	5038	0.4664	0.3652
2004	22326[1]		13827[2]			0.3652[3]
Arith. Mean	25595	14309	9901	4088	0.4184	0.4241
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

[1] Geometric mean 1982-2001

[2] From forecast

[3] $F_{(01\text{-}03)}$ rescaled to F_{2003}

Table 8.4.1 - Sole VIId – RCT3 input

Yearclass	XSA (Age 1)	XSA (Age 2)	yfs0	yfs1	bts1	bts2
1981	12711	11354	1.881	0.2005	-11	-11
1982	21394	19358	2.6555	0.695	-11	-11
1983	21601	19522	11.887	-11	-11	-11
1984	12910	11635	-11	-11	-11	-11
1985	25781	23281	-11	-11	-11	-11
1986	10982	9929	-11	0.6595	-11	14.2
1987	25962	23401	7.995	0.935	8.2	15.4
1988	16799	15045	1.1875	0.356	2.6	3.7
1989	44389	38981	12.588	1.152	12.1	22.8
1990	34844	31164	3.3285	1.8695	8.9	12
1991	33805	30488	1.3865	0.796	1.4	17.5
1992	16793	15114	1.281	0.615	0.5	3.2
1993	26554	23998	6.534	1.591	4.8	10.6
1994	19457	16808	8.1035	1.4635	3.5	7.4
1995	19019	17200	5.3135	0.339	3.5	7.3
1996	27525	24883	0.9865	0.5205	19	21.23
1997	17791	16066	1.942	0.559	2	9.44
1998	26673	23975	9.3725	0.854	28.14	22.03
1999	32140	28950	2.7455	1.282	10.49	21.01
2000	-11	-11	1.8475	0.8365	9.09	-11
2001	-11	-11	4.5135	1.93	31.76	28.48
2002	-11	-11	2.52	0.82	6.47	-11
2003	-11	-11	2.16	-11	-11	-11

Table 8.4.2 - 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 23 years : 1981 - 2003

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2001

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
yfs0	1.49	7.72	.99	.107	16	1.71	10.27	1.088	.052
yfs1	2.44	8.58	.50	.389	16	1.08	11.20	.605	.168
bts1	.63	8.95	.47	.329	13	3.49	11.15	.595	.173
bts2	1.08	7.34	.51	.372	14	3.38	10.98	.609	.166
					VPA Mean =		10.00	.373	.441

Yearclass = 2002

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
yfs0	1.49	7.72	.99	.107	16	1.26	9.60	1.093	.056
yfs1	2.44	8.58	.50	.389	16	.60	10.04	.546	.225
bts1	.63	8.95	.47	.329	13	2.01	10.22	.529	.239
bts2									
					VPA Mean =		10.00	.373	.481

Yearclass = 2003

Survey/ Series	**Slope**	**Inter- cept**	**Std Error**	**Rsquare**	**No. Pts**	**Index Value**	**Predicted Value**	**Std Error**	**WAP Weights**
	I-----------Regression----------I					**I-----------Prediction---------I**			
yfs0	**1.49**	**7.72**	**.99**	**.107**	**16**	**1.15**	**9.44**	**1.099**	**.103**
yfs1									
bts1									
bts2									
					VPA Mean =		**10.00**	**.373**	**.897**

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2001	39277	10.58	.25	.27	1.22		
2002	22907	10.04	.26	.08	.10		
2003	**20821**	**9.94**	**.35**	**.17**	**.24**		

**Table 8.4.3 - ** 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 23 years : 1981 - 2003

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2001

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction				---------I
yfs0	1.55	7.52	1.03	.099	16	1.71	10.17	1.135	.048
yfs1	2.46	8.45	.51	.377	16	1.08	11.10	.617	.161
bts1	.63	8.84	.47	.329	13	3.49	11.04	.593	.174
bts2	1.06	7.27	.49	.379	14	3.38	10.86	.596	.173
					VPA Mean =		9.89	.371	.444

Yearclass = 2002

Survey/ Series	**Slope**	**Inter- cept**	**Std Error**	**Rsquare**	**No. Pts**	**Index Value**	**Predicted Value**	**Std Error**	**WAP Weights**
	I-----------Regression			**----------I**	**I-----------Prediction**				**---------I**
yfs0	**1.55**	**7.52**	**1.03**	**.099**	**16**	**1.26**	**9.47**	**1.141**	**.052**
yfs1	**2.46**	**8.45**	**.51**	**.377**	**16**	**.60**	**9.93**	**.557**	**.217**
bts1	**.63**	**8.84**	**.47**	**.329**	**13**	**2.01**	**10.11**	**.527**	**.243**
bts2									
					VPA Mean =		**9.89**	**.371**	**.488**

Yearclass = 2003

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction				---------I
yfs0	1.55	7.52	1.03	.099	16	1.15	9.31	1.147	.095
yfs1									
bts1									
bts2									
					VPA Mean =		9.89	.371	.905

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2001	35172	10.47	.25	.27	1.22		
2002	**20577**	**9.93**	**.26**	**.08**	**.10**		
2003	18736	9.84	.35	.17	.24		

Table 8.5.1 - 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	22326	0.37	WS1	0.05	0.00
N2	23195	0.20	WS2	0.14	0.09
N3	39745	0.20	WS3	0.18	0.14
N4	9669	0.20	WS4	0.23	0.10
N5	7251	0.20	WS5	0.27	0.17
N6	3760	0.20	WS6	0.28	0.28
N7	1143	0.20	WS7	0.31	0.27
N8	1278	0.20	WS8	0.30	0.34
N9	649	0.20	WS9	0.34	0.28
N10	366	0.20	WS10	0.38	0.19
N11	803	0.20	WS11	0.45	0.11
H.cons selectivity			Weight in the HC catch		
sH1	0.01	0.44	WH1	0.11	0.05
sH2	0.27	0.24	WH2	0.16	0.06
sH3	0.43	0.10	WH3	0.21	0.02
sH4	0.37	0.19	WH4	0.26	0.06
sH5	0.48	0.19	WH5	0.29	0.07
sH6	0.36	0.25	WH6	0.35	0.06
sH7	0.32	0.16	WH7	0.38	0.02
sH8	0.23	0.09	WH8	0.40	0.08
sH9	0.20	0.19	WH9	0.48	0.02
sH10	0.25	0.50	WH10	0.47	0.10
sH11	0.25	0.50	WH11	0.53	0.02
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		
HF04	1	0.04	K04	1	0.1
HF05	1	0.04	K05	1	0.1
HF06	1	0.04	K06	1	0.1
Recruitment in 2005 and 2006					
R05	22326	0.37			
R06	22326	0.37			

Table 8.5.2 Sole in VIId - Management option table

MFDP version 1a
Run: S7D_FinP
Sole in VIId
Time and date: 10:34 10/09/2004
Fbar age range: 3-8

2004 Biomass	SSB	FMult	FBar	Landings
18145	13827	1.0000	0.3652	5931

2005 Biomass	SSB	FMult	FBar	Landings	2006 Biomass	SSB
16628	12754	0.0000	0.0000	0	20494	16589
.	12754	0.1000	0.0365	618	19903	16002
.	12754	0.2000	0.0730	1213	19333	15435
.	12754	0.3000	0.1096	1787	18785	14890
.	12754	0.4000	0.1461	2340	18256	14364
.	12754	0.5000	0.1826	2874	17747	13858
.	12754	0.6000	0.2191	3388	17256	13370
.	12754	0.7000	0.2556	3884	16784	12901
.	12754	0.8000	0.2921	4362	16328	12448
.	12754	0.9000	0.3287	4824	15889	12012
.	12754	1.0000	0.3652	5269	15466	11592
.	12754	1.1000	0.4017	5698	15058	11187
.	12754	1.2000	0.4382	6112	14665	10797
.	12754	1.3000	0.4747	6512	14286	10421
.	12754	1.4000	0.5113	6897	13920	10058
.	12754	1.5000	0.5478	7269	13568	9709
.	12754	1.6000	0.5843	7627	13228	9372
.	12754	1.7000	0.6208	7974	12901	9048
.	12754	1.8000	0.6573	8308	12585	8735
.	12754	1.9000	0.6938	8630	12281	8434
.	12754	2.0000	0.7304	8941	11987	8143

Input units are thousands and kg - output in tonnes

Table 8.5.3 Sole in VIId. Detailed results

MFDP version 1a
Run: S7D_FinP
Time and date: 10:34 10/09/2004
Fbar age range: 3-8

Year: 2004		F multiplier: 1		Fbar: 0.3652					
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
1	0.0109	230	26	22326	1116	0	0	0	0
2	0.2668	5180	836	23195	3201	0	0	0	0
3	0.4297	13258	2753	39745	7194	39745	7194	39745	7194
4	0.3736	2877	761	9669	2172	9669	2172	9669	2172
5	0.4794	2639	775	7252	1929	7252	1929	7252	1929
6	0.3634	1094	389	3761	1069	3761	1069	3761	1069
7	0.3146	295	110	1144	355	1144	355	1144	355
8	0.2304	251	101	1278	386	1278	386	1278	386
9	0.2038	114	55	649	222	649	222	649	222
10	0.2467	77	36	367	141	367	141	367	141
11	0.2467	168	90	804	359	804	359	804	359
Total		26182	5931	110190	18145	64669	13827	64669	13827

Year: 2005		F multiplier: 1		Fbar: 0.3652					
Age	**F**	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0109	230	26	22326	1116	0	0	0	0
2	0.2668	4463	720	19983	2758	0	0	0	0
3	0.4297	5362	1113	16073	2909	16073	2909	16073	2909
4	0.3736	6963	1841	23401	5258	23401	5258	23401	5258
5	0.4794	2191	643	6022	1602	6022	1602	6022	1602
6	0.3634	1182	420	4063	1155	4063	1155	4063	1155
7	0.3146	609	228	2366	734	2366	734	2366	734
8	0.2304	148	60	756	228	756	228	756	228
9	0.2038	161	78	918	315	918	315	918	315
10	0.2467	100	47	479	183	479	183	479	183
11	0.2467	173	92	828	370	828	370	828	370
Total		21582	5269	97215	16628	54906	12754	54906	12754

Year: 2006		F multiplier: 1		Fbar: 0.3652					
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
1	0.0109	230	26	22326	1116	0	0	0	0
2	0.2668	4463	720	19983	2758	0	0	0	0
3	0.4297	4619	959	13847	2506	13847	2506	13847	2506
4	0.3736	2816	744	9464	2126	9464	2126	9464	2126
5	0.4794	5303	1557	14574	3877	14574	3877	14574	3877
6	0.3634	981	349	3374	959	3374	959	3374	959
7	0.3146	658	247	2556	793	2556	793	2556	793
8	0.2304	307	123	1563	472	1563	472	1563	472
9	0.2038	95	46	543	186	543	186	543	186
10	0.2467	141	67	678	260	678	260	678	260
11	0.2467	193	103	924	413	924	413	924	413
Total		19807	4942	89831	15466	47522	11592	47522	11592

Input units are thousands and kg - output in tonnes

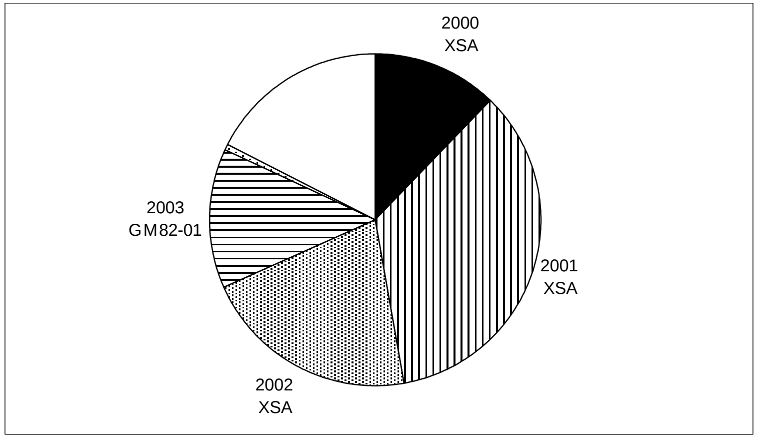
Table 8.5.4 Sole VIId
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class		2000	2001	2002	2003	2004
Stock No. (thousands) of 1 year-olds		27905	62018	26033	22326	22326
Source		XSA	XSA	XSA	GM82-01	GM82-01
Status Quo F:						
% in 2004	landings	12.8	46.4	14.1	0.4	-
% in 2005		12.2	34.9	21.1	13.7	0.5
% in 2004	SSB	15.7	52.0	0.0	0.0	-
% in 2005	SSB	12.6	41.2	22.8	0.0	0.0
% in 2006	SSB	8.3	33.4	18.3	21.6	0.0

GM : geometric mean recruitment

Sole VIId : Year-class % contribution to

a) 2005 landings



b) 2006 SSB

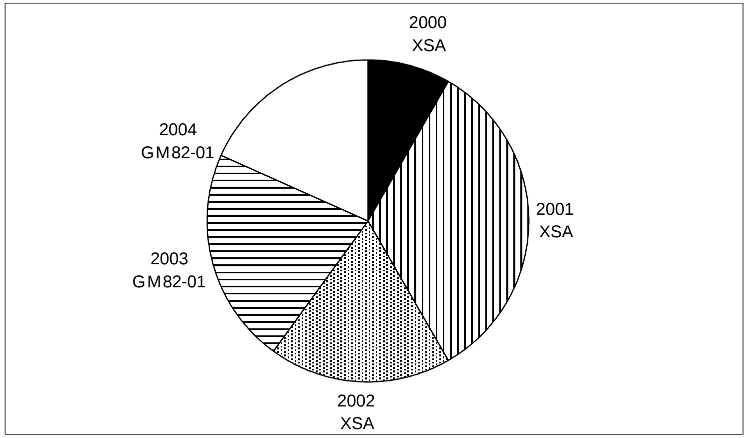
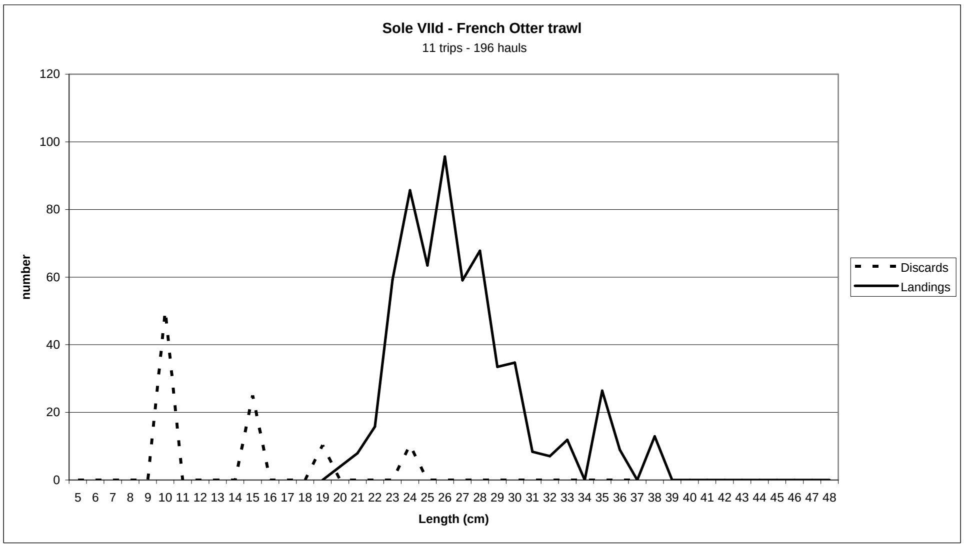
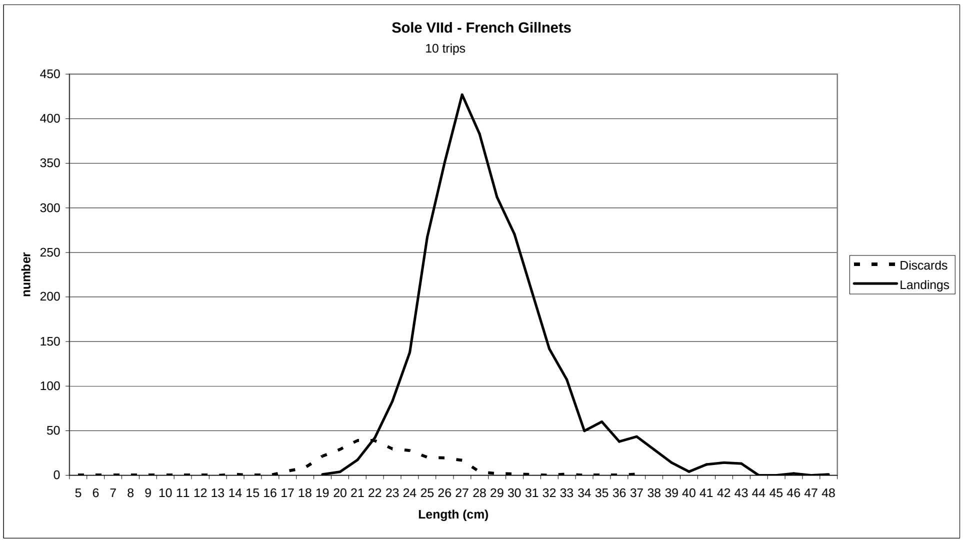


Figure 8.2.1 - Sole VIId - Length distributions of discarded and retained fish from discard sampling studies





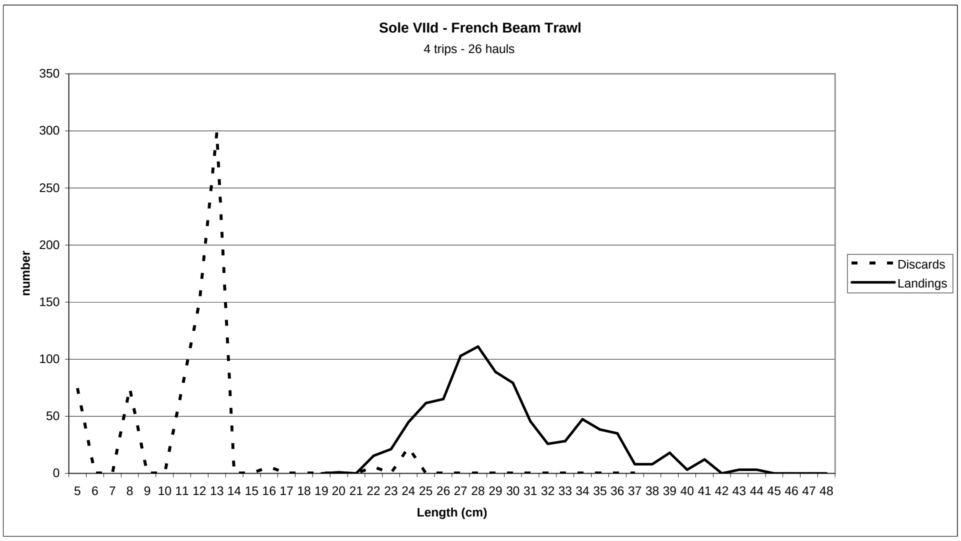


Figure 8.2.2a **Sole VIId - Commercial Effort series**

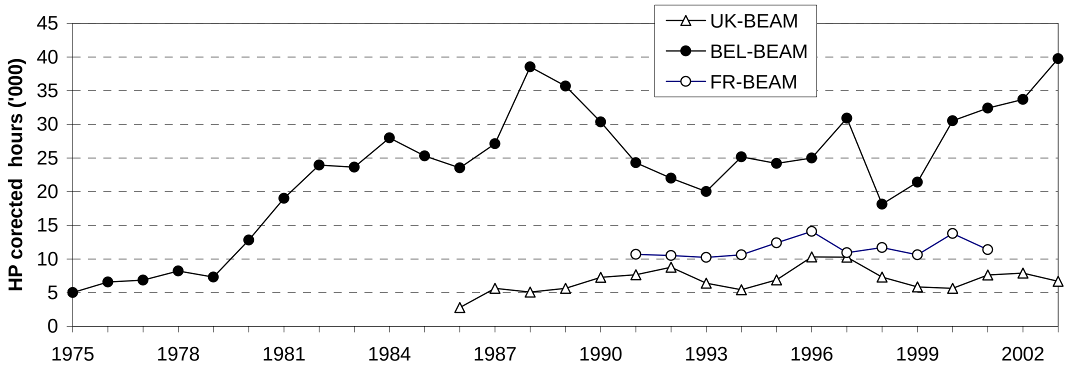


Figure 8.2.2b **Sole VIId - Commercial Relative LPUE series**

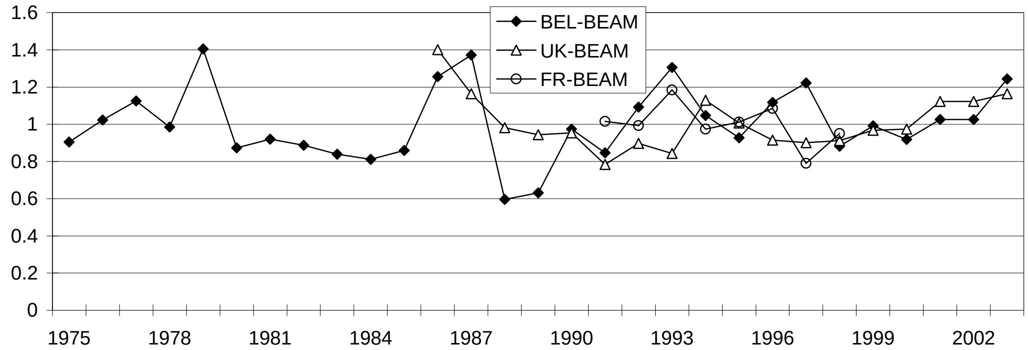


Figure 8.3.1 - Sole VIId - Comparison between F,SSB and Recruits from a SPALY-run, last years and this year's WG

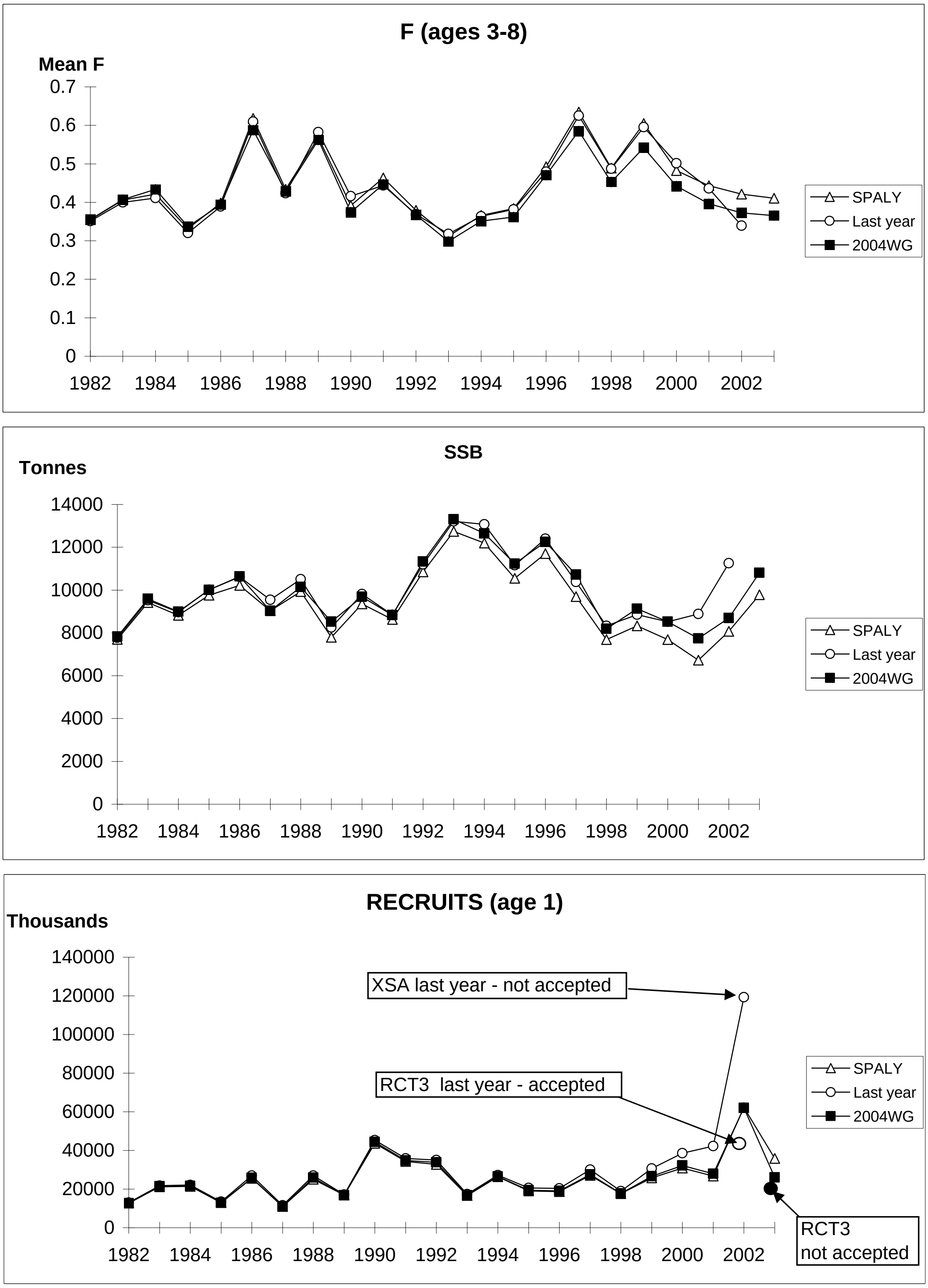


Figure 8.3.2 - Sole VIId retrospective XSA analysys (shinkage SE=2.0)

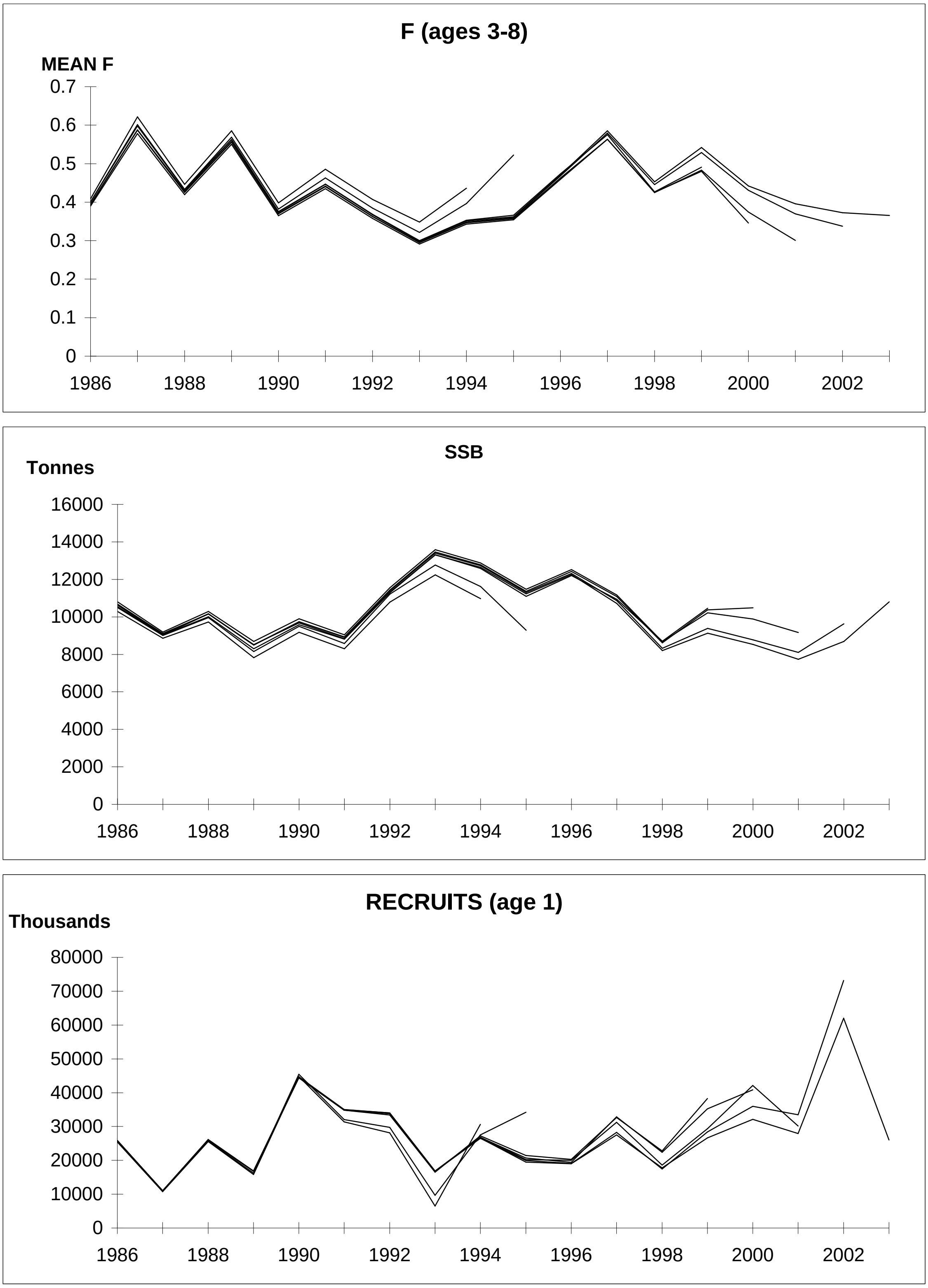


Figure 8.3.3 Sole in VIId. Summary plots

Recruitment in 2004 = GM 82-01 (shaded)
SSB in 2004 from forecast (square in graph)

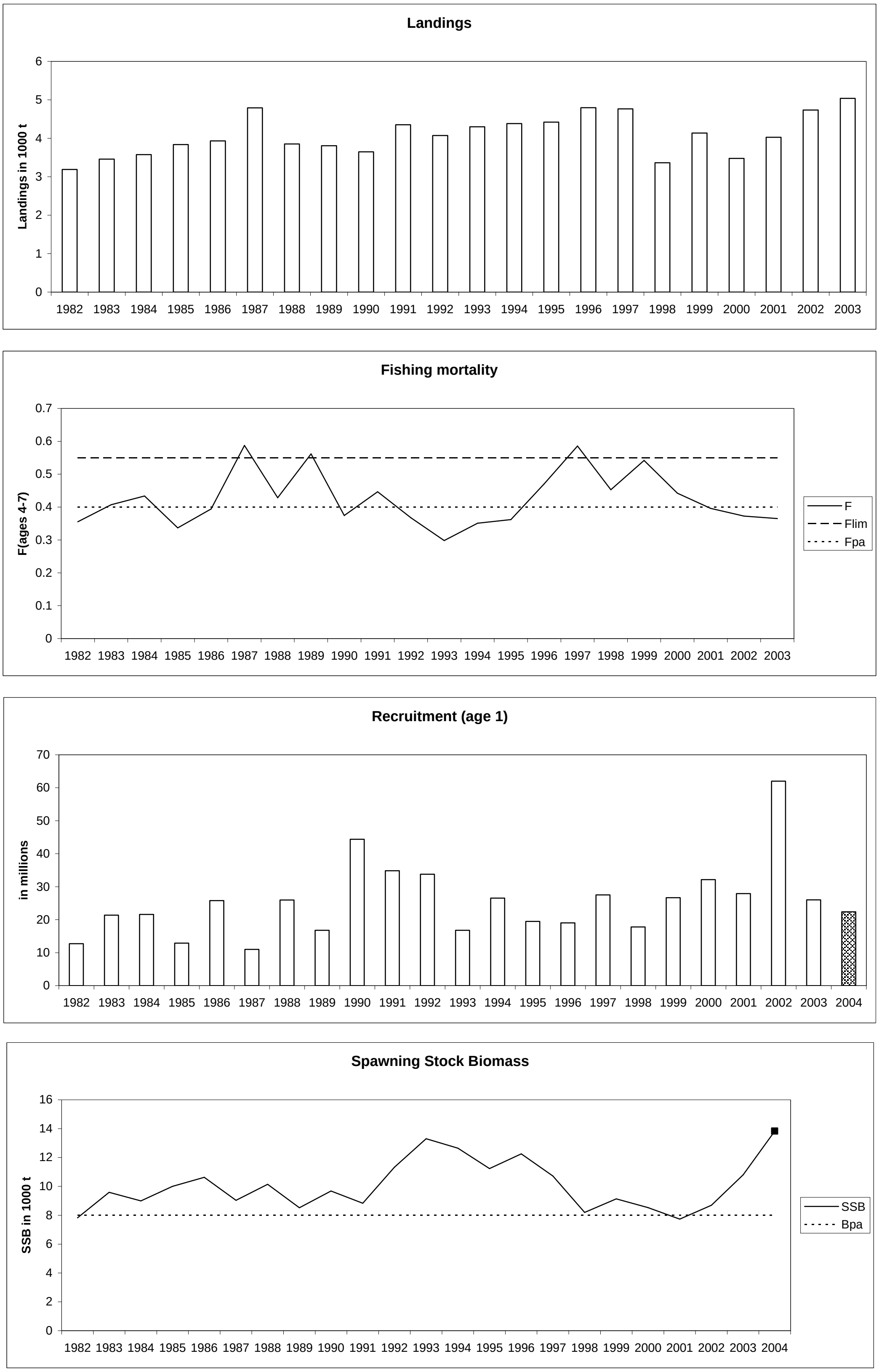


Figure 8.3.4 Sole in VIId. Historical Performance of assessment

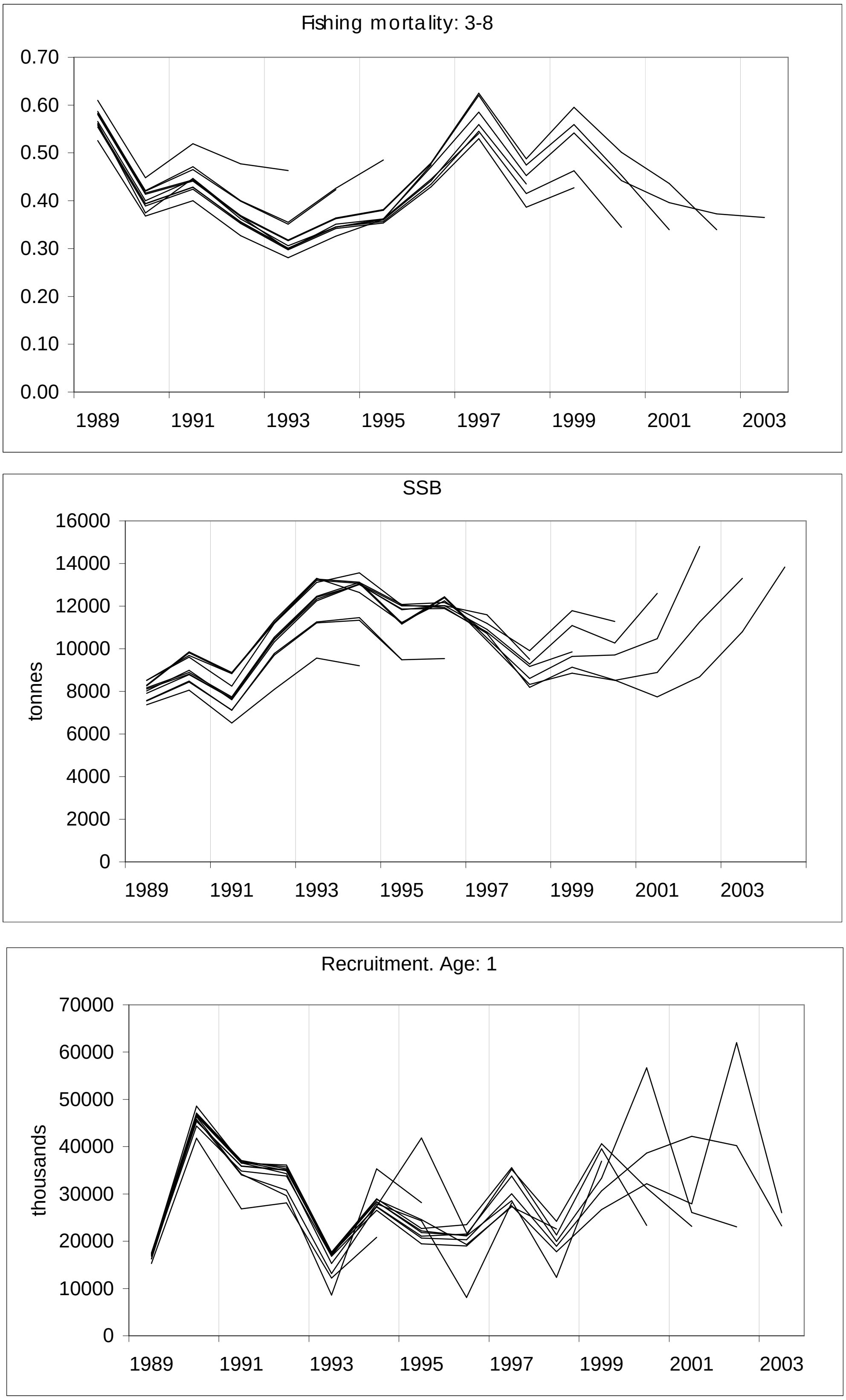
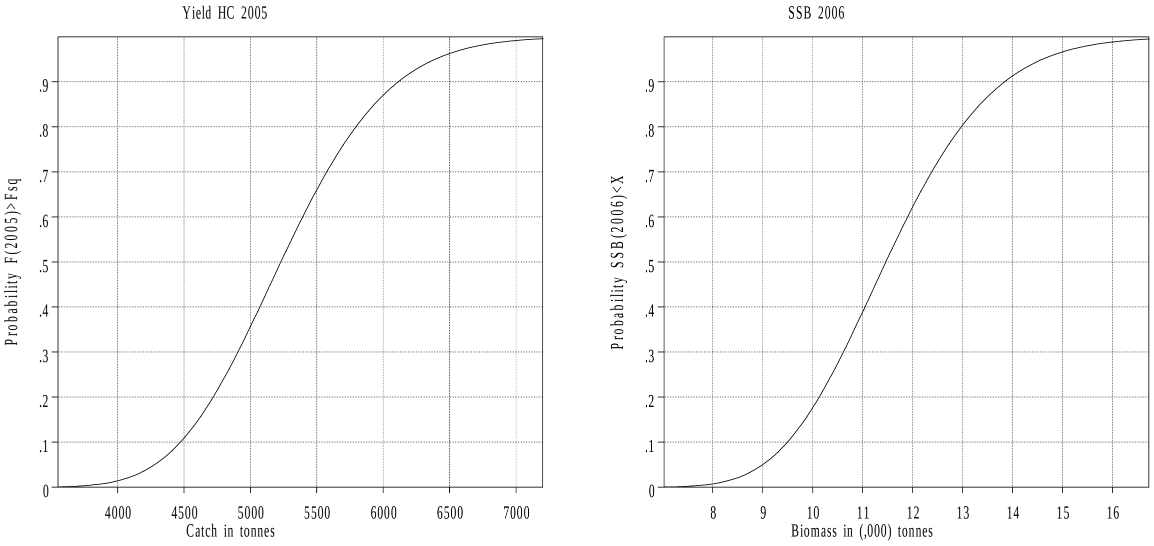


Figure 8.5.1 - Sole in VIId Probability profiles for short term forecast.



Data from file:D:\2004\North_Sea\Pred\Sensetivity_insens\Pie & profile\SOLVIID.S

9 North Sea plaice

North Sea plaice has been placed on the observation list for this WG, which means that a benchmark assessment is carried out every year. The assessment of the stock will be subject to review this year by the North Sea Commission Fisheries Partnership (NSCFP).

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.

9.1 The fishery

North Sea plaice is taken mainly in a mixed flatfish fishery by beam trawlers in the southern and south-eastern North Sea. Directed fisheries are also carried out with seines, gill nets, and twin trawls, and by beam trawlers in the central North Sea. Due to the minimum mesh size enforced (80 mm in the mixed beam trawl fishery), large numbers of (undersized) plaice are discarded.

Fleets exploiting North Sea plaice have generally decreased in number of vessels in the last 10 years, partly due to the MAGP policy. However, in some instances, reflagging vessels to other countries has compensated these reductions. The Dutch beam trawl fleet, one of the major operators in the mixed flatfish fishery in the North Sea, has seen a reduction in the number of vessels and also a shift 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.

9.1.1 ICES advice applicable to 2003 and 2004

In October 2002 ICES stated that the stock was still outside safe biological limits, as it was in 2001. SSB in 2002 was below $\boldsymbol{B_{pa}}$ and fishing mortality in 2001 was above $\boldsymbol{F_{pa}}$. ICES recommended that fishing mortality be less than F = 0.23 in order to bring SSB above $\mathbf{B}_{pa}$ in 2004. This corresponded to landings of less than 60 000 t in 2003, and implied a reduction in fishing mortality of at least 40%. Management of fisheries taking plaice were to respect the stringent restrictions on the catch and discard rates advised for cod, with effective monitoring of compliance with those restrictions**.**

In October 2003, ICES classified the stock as being outside safe biological limits, but noted that the estimate of the fishing mortality was uncertain. ICES recommended that fishing mortality in 2004 should be less than $\boldsymbol{F_{pa}}$ and furthermore that the mixed fishery aspects should be taken into account. ICES recommended that demersal fisheries in Division IIIa (Skagerrak-Kattegat), in Sub-area IV (North Sea) and in Division VIId (Eastern Channel) should in 2004 be managed according to the following rules, which should be applied simultaneously. They should fish:

- without bycatch or discards of cod;
- within a recovery plan for North Sea plaice. Until a recovery plan has been implemented that ensures rapid and sure recovery of SSB above $\boldsymbol{B_{pa}}$, fishing mortality should be restricted to the lowest possible level and well below $\boldsymbol{F_{pa}}$. Management must include measures that ensure that discards of plaice be significantly reduced and quantified;
- within the biological exploitation limits for all other stocks.

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

9.1.2 Management applicable to 2003 and 2004

The TAC in 2003 was agreed at 73,250 tonnes, which was substantially higher than the ICES recommendation. For 2004 the TAC was set at 61,000 tonnes. The ICES advice for 2004 was to fish at the lowest F possible.

In 1999, the EU and Norway agreed to implement a long-term management plan for the plaice stock, which is consistent with the precautionary approach and is intended to constrain harvesting within safe biological limits and designed to provide for sustainable fisheries and greater potential yield. The plan is re-instigated every year and consists of the following elements:

1. *Every effort shall be made to maintain a minimum level of SSB greater than 210,000 tonnes (*B_{lim}*)*

2. *For 2000 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality of 0.3 for appropriate age groups as defined by ICES.*

3. *Should the SSB fall below a reference point of 300,000 tonnes (*B_{pa}*), the fishing mortality referred to under paragraph 2, shall be adapted in the light of scientific estimates of the conditions then prevailing. Such adaptation shall ensure a safe and rapid recovery of SSB to a level in excess of 300,000 tonnes.*

4. *In order to reduce discarding and to enhance the spawning biomass of plaice, the Parties agreed that the exploitation pattern shall, while recalling that other demersal species are harvested in these fisheries, be improved in the light of new scientific advice from, inter alia, ICES.*

5. *The Parties shall, as appropriate, review and revise these management measures and strategies on the basis of any new advice provided by ICES.*"

The current Multi-annual guidance program (MAGP-IV) has defined national targets for EU fleet reductions in fleet capacity and/or days at sea.

Technical measures applicable to the plaice fishery in the North Sea included mesh size regulations, minimum landing size, gear restrictions and a closed area (the plaice box). Mesh size regulations for towed 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. 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 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.

9.1.3 The fishery in 2003 and 2004

Landings

Total landings of North Sea plaice in 2003 (Table 9.1.1) were estimated by the WG to be just over 66 000 t, which is approximately 4000 t less than the 2002 landings. The TAC was taken in 2003. Since 1996, the TAC has been fished out only in 2001 and 2003.

The national uptake rates in 2004 by the Netherlands (the main plaice landing country) indicate that approximately 63% of the national quota was taken by the beginning of September 2004. The indications are that the 2004 TAC will be fished out by the end of December.

Discards

There are indications that the North Sea plaice stock has been subject to increased discarding in recent years. It has been suggested that the slow growth of the strong 1996 year-class and changes in the distribution of young fish have contributed to these changes in discard patterns. In 1999 a discard sampling programme was started to obtain discard estimates from the Dutch beam trawl fleet. This sampling programme gives information on discard rates in recent years but not for the historical time series. Therefore discard rates prior to 1999 were reconstructed using a growth model and length based selection, availability and sorting ogives (see Section 9.2.3).

9.2 Natural mortality, maturity, age compositions and mean weight at age

9.2.1 Natural mortality and maturity-at-age

Natural mortality is assumed to be 0.1 for all age groups and constant over time.

A fixed maturity ogive (Table 9.2.1) is generally used for the estimation of SSB in North Sea plaice, but maturity-at-age is not likely to be constant over time. Grift *et al.* (2003) showed that the age and length at maturation have decreased over the past half century. Within an ongoing international collaboration an attempt is being made to collate international maturity data and provide annual maturity ogives for male and female plaice. These data are not yet available but preliminary annual maturity ogives, based on Dutch market samples only, are available and have been used in this year's report to explore the sensitivity of SSB to the assumption of fixed maturity-at-age. These Dutch maturity ogives were calculated using the observed maturity-at-age of females in market samples, a fixed maturity-at-age for males based on a dedicated survey carried out in 1985, and the observed sex-ratio at age in survey and market samples. The maturity and sex-ratio at age estimates were raised to the catches and smoothed using a 5-year running mean. These preliminary maturity-at-age data are presented in Table 9.2.2 and Figure 9.2.1, and the calculation procedures are described in detail in WP11. The maturity-at-age of females varies over time (Figure 9.2.1, top panel) but, assuming that the maturity of males has not changed, these fluctuations are partly compensated for by changes in sex-ratios over time (Figure 9.2.1, bottom panel).

9.2.2 Catch numbers and weights-at-age in the landings

Market sampling programmes (Table 1.3.1) supplied age distributions representative for 76% of the official total landings in 2003. 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 (Figure 9.2.2). However, the omission of the UK age composition data will only marginally affect the international age composition because of the relatively small proportion of the UK landings. The landings of flag vessels (see Section 9.1) were not sampled prior to 2002. From 2002 onwards, following EU regulation (1639/2001), each country is obliged to sample landings from foreign vessels that land in their country. These samples from flag vessels are now included in the Dutch age composition. The catch numbers at age in the landings are presented in Table 9.2.3. Mean weights-at-age in the landings were estimated from market samples taken throughout the year (Table 9.2.4). No SOP-correction was applied to the results of the assessment.

9.2.3 Catch numbers and weights-at-age in the discards

Discard sampling programmes onboard Dutch vessels were carried out intermittently in the period 1969-1990 and continuously since 1999 (Table 9.2.5). These indicate that the proportions of plaice catches discarded at present are large (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). Age composition data have been collected in the Dutch discard sampling programme that started in 1999, allowing an estimation of the catch at age for the Dutch beam trawl fleet. The discards numbers at age were raised to discards numbers at age of plaice in the North Sea by the ratio of the landings of the international fleet to the landings of the Dutch fleet. A detailed description of the calculation procedures and results is presented in WP12 and by Van Keeken et al. (2004).

English discard data for the period 1999–2003, and Danish data for the period 2002–2003, were made available to the WG. However, these data are only partially available as percentages discards by age and can therefore not be incorporated in an age-based assessment (see Section 9.11.1).

It has been generally agreed (see, for example, last year's WG report, and the ACFM October 2003 report) that the quality of the assessment of North Sea plaice is questionable if discards are not included. As the continuous time series of discard observations is short, reconstructed discard numbers at age in the past are required. Previous attempts to reconstruct discards were hampered by the fact that landings of age 1 plaice were low or zero, and multiplication of discard proportions and landing numbers at age 1 therefore were erroneous. Through correcting values of *F*-at-age for discarding, this problem can be circumvented. This method is a further development of the approach of Casey (1996), and continues earlier work on the effects of area closures on the exploitation (ICES, 1987; Rijnsdorp & Van Beek, 1991).

To reconstruct the number of plaice discards at age, catch numbers at age are calculated from corrected levels of fishing mortality at age, using a reconstructed population and selection and distribution ogives. Figure 9.2.3 shows a $\mathbf{F}_{low}$ diagram explaining the steps used in the reconstruction. From modelled mean length at age and standard deviation, obtained from survey and otolith back-calculation estimates of mean length at age, the proportion of a length class at age in the population was calculated. Using a gear-selection ogive and distribution ogives per year, the proportion of the population at the fishing ground being retained in the net was calculated. Using a discards sorting ogive, this part was split up in a discarded and a landed part. Mean *F* at ages 5 and 6 from the assessment was used as the level of *F* for fully recruited age groups. Using the proportions calculated above and this mean $F_{5\text{-}6}$, corrected *F* for ages 1–4 were calculated. Using the newly calculated *F* for discards, new population and catch numbers at age were calculated. Discards numbers at age were finally calculated by subtracting landings numbers at age from the newly calculated catch numbers at age. The method to reconstruct discards is described in more detail in Appendix 1.
This procedure described was used to reconstruct discards for the period 1957-1998. The actual observations from the Dutch discard sampling program were used for the period 1999-2003, because in most recent years *F* at ages 5 and 6 may be biased by the disproportional discarding of the large 1996 year-class. Table 9.2.6 presents the reconstructed (1957-1998) and observed (1999-2003) discard numbers at age. Figure 9.2.4 shows the estimated number of discards

compared to the number of landings for ages 1–6. The discard reconstruction can also be used to reconstruct discards for the full time series. In this case the output of a VPA model including data up to 2003 is used as input for the discard reconstruction, which results in different discard estimates for the period 1957-1999. The estimates are presented in Table 9.2.7.

Mean weight-at-age in the discards was calculated from the size distribution used in the discard reconstruction and a fixed length-weight relationship. The weight at age in the period 1999-2003 is also obtained from the Dutch discard-sampling program (Table 9.2.8).

9.2.4 Stock weights-at-age

Traditionally weights-at-age in this stock have been estimated as first quarter weights in the market samples (Table 9.2.9). However these samples overestimate the weight of the youngest age groups because these are not yet fully recruited. The modelled mean length based on survey and back-calculation data (see Appendix 1) converted to mean weight using a fixed length-weight relationship can be used as alternative estimate of stock weights for the younger age groups. Figure 9.2.5 shows that for ages 1 to 4 the weights-at-age in the catches overestimate stock weights compared to survey and back-calculation estimates. The alternative stock weights are presented in Table 9.2.10 and have been used in the final assessment.

Weight at age has varied considerably over time. For age groups 4–6, weights appear to have decreased strongly in the period 1998-2001 (Figure 9.2.6), but are more or less stable since 2001. The survey estimates of weights at ages 2 and 3 indicate these have not changed much either in the last 3 years (Figure 9.2.5).

9.3 Catch, effort and survey data

9.3.1 Commercial CPUE data

At the ACFM meeting in October 2001 the validity of the information provided by commercial tuning fleets was discussed and it was decided to exclude commercial tuning fleets from the assessment. A working document presented to ACFM October 2001 showed that *"The CPUE series of the Dutch beam trawl fleet and the new English beam trawl fleet (excluding flag vessels) are reasonably consistent, and show a decreasing trend in CPUE in the early 1990s. However, the time series of the English flag vessels show a different pattern of a more or less flat CPUE trend. The observed differences can be due to different spatial coverages by the different fleets or to different management measures applicable to the fleets. Therefore, CPUE data may rather reflect trends in management rather than trends in the stock."* (Pastoors *et al*. 2002). Poos *et al*. (2001) showed that the CPUE of individual vessels indeed declined when quota restrictions were more severe. In general, commercial CPUE series are considered to be unreliable due to potential gear efficiency changes and, if alternative tuning fleets are available, are not used in the final assessment. Although the fleets may not be incorporated in the final assessment these series are always examined to evaluate the quality of the final assessment. Previously only the NL beam trawl and the UK beam trawl CPUE series were available by age. This year the CPUE by age of UK registered vessels landing in the Netherlands (flag vessels) were made available to the working group. This fleet segment is assumed to be less affected by quota restrictions.

Commercial CPUE series available :

- NL beam trawl CPUE (1989-2003)
- UK beam-trawl CPUE, excluding all flag vessels (1990-2002)
- NL flag vessels (UK register landing in NL, 1991-2004)

The Dutch commercial beam-trawl CPUE consists of the total catch at age by the Dutch (beam trawl) fleet and the effort in horsepower days (days absent from port times the horsepower of the vessel). The effort series are estimated by the Agricultural Economics Institute (LEI-DLO), except for the final year, which is a preliminary estimate by the WG. The series are available for 1979 onwards and for the age 2 to 9.

The UK commercial beam-trawl CPUE is derived from the catch at age of the beam trawlers registered in England and Wales but excluding Scottish registered vessels and Dutch flag vessels. Effort was calculated on a trip basis as hours fishing multiplied by the horsepower (HP) of the vessel. The series is available for 1990-2002 onwards and for the age 4 to 12. The series was not continued in 2003.

The NL flag vessel CPUE consists of the catches per unit of effort in the first half year. Effort was calculated on a trip basis as days fished. This is the first year that the series is available in age structured form. The series is available for the period 1991-2004 for ages 1 –15.

The effort and CPUE in biomass of the three commercial fleets is presented in Figure 9.3.1 and Table 9.3.1. Effort has decreased in the NL and UK beam trawl fleets since the early/mid 1990s. The flag vessel effort increased until 2001, decreased in 2002 and is more or less at the same level since then. The relative CPUE of the NL and UK beam trawl fleets appear to be more or less at the same level since 1995. The flag vessel CPUE may show a slight increase since 1995, but the CPUE estimates fluctuate strongly from year to year.

The CPUE for the three commercial fleets is presented in numbers at age in Figure 9.3.2 and Table 9.3.2. In the 4+ age groups the 3 commercial fleets generally show the same trends in time. At age 3 the 1996 year-class appears to be relatively strong according to the NL beam trawl series, which corresponds to the information provided by the surveys, but it does not seem to have recruited to the NL flag vessel fishery yet. The flag vessel CPUE is already available for 2004 (quarter 1 and 2 data only included in this CPUE). The increase in CPUE in 2004 at age 3 suggests that the 2001 year-class is recruiting to this fleet as a relatively strong year-class.

9.3.2 Survey data

Survey indices that have been used as tuning fleets (Table 9.3.3):

- Beam Trawl Survey RV 'Isis' (BTS)
- Sole Net Survey in September-Oktober (SNS)
- Beam Trawl Survey RV 'Tridens' (BTS-tri)

Survey indices that have been used for recruitment estimates:

- Demersal Young Fish Survey (DFS)

The Beam Trawl Survey (BTS & BTS-tri) was initiated in 1985 and was set up to obtain indices of the younger age groups of plaice and sole. However, due to its spatial distribution the BTS survey also catches considerable numbers of older plaice and sole. Initially, the survey only covered the south-eastern part of the North Sea (RV Isis). Since 1996 the survey area of the BTS has been extended. The RV Tridens now covers the north-western part of the North Sea. Both vessels use an 8-m beam trawl with 40 mm stretched mesh cod-end, but the Tridens beam trawl is rigged with a modified net. The BTS-Isis survey is used as a tuning series for the plaice assessment and consists of average catches in numbers by fishing hour. 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 2004 indices of the BTS and BTS-tri were not available to the WG, but preliminary indices will be made available to the ACFM meeting in October 2004.

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. 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. The decision to move the SNS to the spring was revisited and in 2004 the SNS will be carried out in the autumn as before.

The Demersal Young Fish Survey (DFS) is an international survey (The Netherlands, England, Belgium and Germany) that covers the coastal and estuarine areas of the southern North Sea. This survey is directed to 0 and 1-group plaice and sole. In the Wadden Sea and Scheldt estuaries a light 3-m beam trawl is used with a 20-mm cod-end and one light tickler chain. The coastal area is fished with a 6-m beam trawl rigged with a similar net as the 3-m beam trawl. The combined index is calculated as the mean of the national indices with a weighting by country, based on the size of the nursery area. In 1998 and 1999 no estimates of the DFS were available due to bad weather conditions during the period of the survey and technical problems with one of the Dutch research vessels. The combined DFS index is only used for the RCT3 analysis and not for tuning the VPA. The 2004 indices of the DFS were not available to the working group and will not be available before the ACFM meeting in October 2004.

The standardised CPUE of the commercial fleets and all surveys are plotted by age in Figure 9.3.2. All fleets indicate at some age that the 1996 and 1985 year-classes are strong. The 2001 year-class appears to be strong based on the SNS survey at age 0 and the BTS and BTS-tridens surveys at ages 1 and 2. However the DFS survey at age 1 suggests that this year-class is one of the weakest year-classes on record. This can be explained by the offshore movement of juvenile plaice, especially of 1 group plaice out of the Wadden Sea, that has been observed in recent years (Figure 9.3.3; Grift et al., 2004). The DFS 1-group index is not used in the assessment and its influence on RCT3 analyses for forecasts is minimal (see Table 9.5.2a).

9.4 Catch at age analyses

9.4.1 Data explorations - catch at age & tuning fleet data

Separable models

The catch-at-age data were examined using a separable VPA. Three catch at age matrices were examined: the landings at age; the catch at age including reconstructed discards for the period 1958-1998 and observed discards for the period 1999-2003; and catch at age including reconstructed discards for the whole period. The age range was set at 1-14 and the year range at 1994-2003. The diagnostics are presented in Table 9.4.1 and Figure 9.4.1. A dome-shaped selection pattern is apparent for plaice in the North Sea, with selection declining from age 5 to approximately age 10, and thereafter remaining at more or less the same level. The selection pattern of the younger ages is adjusted upward if discards are included, especially if observed discards are included. The residuals in log-catch ratios at the younger ages decrease slightly if reconstructed and observed discards are included, and strongly if only reconstructed discards are included. The latter is probably caused by the fact that the discards were generated from the catch matrix. No consistent trends could be detected in the residual plots.

Single-fleet XSA

Single-fleet XSA runs were carried out for all CPUE series, using a low F-shrinkage (1.5), no power model, no tuning window and no time taper. The age range was set at 1-10+ and the q-plateau at age 6, as in last year's assessment. The discard estimates were not included in the catch-at-age data for these analyses.

Log-catchability residuals derived from these runs are presented in Figure 9.4.2. The surveys have high residuals indicating noisy data. The BTS-Tridens series does not include age 1, because the survey area does not cover the mayor areas of distribution of 1-group plaice. The residuals of this fleet are relatively low compared to the other two survey fleets. No obvious trends were observed in the catchability residuals of the surveys except in the first year of the BTS-Tridens and at age 3 in the SNS. The UK beam trawl does not show any clear trends in catchability but both Dutch commercial CPUE series show a year-class effect, indicating that these CPUE series are not suitable as tuning fleets. The similarity in the patterns of the two Dutch commercial series may be caused by the fact that both are based on the same age information although raised to a different market category composition.

The trends in SSB, *F* and recruitment are very similar in all single-fleet runs except for the UK beam trawl and the SNS in the most recent years (Figure 9.4.3). Note that tuning the VPA using only the SNS is not very reliable because only ages 1-3 are included in this survey. Furthermore, SNS indices for 2003 are missing (see Section 9.3.2) causing erratic patterns in SSB and *F* in the most recent years. The result of the UK beam trawl differs most from the other single fleet runs giving a higher SSB and lower *F* estimates. This series was terminated in 2002.

SURBA

SURBA was used as a supplementary analysis tool to explore trends in relative SSB from surveys and commercial CPUE. SURBA is a survey-only method, which fits survey indices assuming a separable *F* selection pattern. However, this option was not used in the analysis since the relative abundance ratios (q_a) at age were not determined. Instead, empirical SSB and *Z* (total mortality) estimates were obtained directly from survey indices after these were smoothed by fitting a cubic spline smoother down cohorts (see Section 1.4.3). The implicit assumption behind these empirical calculations is that the survey is equally efficient in catching each age, which is unlikely to be true.

A summary plot is presented in Figure 9.4.4 for the two beam trawl surveys (BTS and BTS-Tridens) and for the Dutch flag vessels CPUE. Trends from the SNS survey were not considered useful because this survey is restricted to the immediate coastal area and is therefore not representative of the adult population. The BTS-Tridens survey and the NL flag vessel CPUE appear to indicate an increase in the spawning stock after 1998-1999. The BTS survey appears to pick up changes in the spawning stock earlier than the other indices, which could be explained by the spatial coverage of the survey relative to the distribution of the adult population.

9.4.2 Data explorations - additional data sources

Maturity data and new stock weight estimates

Neither maturity nor stock weight-at-age affect numbers estimated by the VPA but are used to calculate the SSB from stock numbers-at-age. If the proportion mature or the stock weights do not change in time then a measurement error of these variables will only cause re-scaling of biomass estimates and associated reference points. However if trends in time occur then perception of trends in SSB may be biased.

This year, preliminary estimates of annual maturity-at-age were made available to the WG and were used to examine the sensitivity of SSB estimates to annual varying maturity ogives. Furthermore weights of the younger age groups in the population were estimated using survey data (see Section 9.2.1). The step-wise inclusion of these additional data is illustrated in Figure 9.4.5. The top panel shows the absolute estimates and the bottom panel shows the relative SSB compared to the last year's WG estimate for the 1997 value. Inclusion of annual varying maturity ogives and modelled stock weights mainly affects the level of SSB, but it seems that SSB was relatively overestimated in the period 1983-1990.

Discard data

Different catch at age matrices have been examined using XSA, configured as last years assessment (high F-shrinkage (0.5), no power model, no tuning window or time taper, plusgroup set at 10+ and q-plateau at age 6). Three datasets were considered: one with no discards included; one including reconstructed discards for 1957-2003; and one including reconstructed discards for the period 1957-1998 and observed discards for the period 1999-2003.

The model including only landings-at-age is very consistent with last year's assessment. So the addition of the 2003 landing data does not greatly affect our perception of SSB, F and recruitment in previous years (Figure 9.4.6). If discard data are included in the catch-at-age matrix then the level and pattern of total *F* changes considerably, but the pattern and level of human-consumption *F* hardly changes (Figure 9.4.6). The overall level of recruitment increases if discards are included. Superficially the trends in recruitment appear to be the same, but recruitment estimates in the 1980s and especially the strong 1985 year-class are adjusted more by including discard data. The overall level of SSB is not strongly affected by including discards. Slightly higher SSBs are estimated for the 1980s when discard data are included, and since 1995 in the case of observed discard data.

If observed discard data are used for the most recent years, then both SSB and F since 1995 appear to be at a higher level and more variable than if reconstructed discard data are used for the whole time series. The reconstructed discard numbers at age in the most recent years are believed to be less reliable than the observed discard rates for two reasons. Firstly the overall level of discard rates which have been reconstructed for the most recent years do not correspond with the observed levels (Figure 9.4.7). Although the Dutch discard sampling programme only covers a small proportion of the fishing trips (0.15% in effort), the discard percentages are similar to those observed in other fleets (SGDBI 2002). Secondly the age composition of the reconstructed and observed discards differ. The reconstructed discards appear to underestimate the discarding of the 2001 year-class and in general the discarding at age 2 (Figure 9.4.8). This corresponds to the differences in selection pattern observed in the separable VPA (Figure 9.4.1). The raised age compositions of the discard sampling programme are considered to provide a more reliable estimate of the discarding of the relatively strong year-class 2001.

The WG decided that the final assessment of North Sea plaice should include discards and that the time series based on reconstructed discards for the period 1957-1998 and observed discards for the period 1999-2003 is the best series available to the WG at the moment.

9.4.3 Model explorations

XSA

In general in this WG (see Section 1.4.3), the preferred configuration of an XSA assessment is to use only survey indices as tuning fleets, for reasons explained in Section 9.3.1. This is of course only possible if survey data covering sufficient number age groups are available. In the case of North Sea plaice, the coverage of the older age groups has improved after including the BTS Tridens survey, and the model was adjusted to the age range covered by the surveys (revisions of the model carried out by the WG in 2003, see ICES 2004). Nevertheless, unbiased CPUE series, which targeted older age groups, may improve the quality of the North Sea plaice assessment. Therefore the NL flag vessel fleet was examined because this fleet is presumably less restricted by quotas compared to other CPUE series (see Section 9.3.1). However, the single fleet XSA showed similar trends in the log-catchability plots as was observed for the NL beam trawl fleet (see Section 9.4.1). It was decided that the NL flag vessel would not be included in the final assessment for this reason. As a sensitivity analyses, the results of a (low shrinkage) XSA run including all tuning fleets was compared to (low and high shrinkage) XSA runs including only survey tuning fleets. This clearly shows that, at present, our perception of SSB, F and recruitment is not strongly affected by the tuning fleets included in the assessment (Figure 9.4.9).

Traditionally high shrinkage has been used in the North Sea plaice assessment because of strong retrospective patterns. We carried out retrospective XSA analyses at high (0.5) and low (2.0) F-shrinkage using the landings at age data (Figure 9.4.10) and the catch-at-age data including observed and reconstructed discard estimates (Figure 9.4.11). All other settings were the same as those of the final run in last year's assessment (3 survey tuning fleets, no power model, no tuning window or time taper, 10+ group and the q-plateau at age 6). These comparisons were also carried for models in which the BTS-Tridens fleet was excluded because of the restricted time span of this series (figures are available in the stockfiles), but this does not alter the following conclusions. The retrospective patterns improve if estimates of discards-at-age are included in the catch-at-age matrix, which supports the decision to include discard estimates in the final assessment. Although the tendency to over- or underestimate appears to decrease after including the discard data, the retrospective pattern is still considered to be too severe to allow low shrinkage. In general, the risk of using high shrinkage is that a bias will be introduced if trends in *F* and SSB occur (see WP6). The WG considered this risk to be low because the present assessment including discards does not show clear trends in *F* and SSB in the last 5 years.

Figure 9.4.12 shows the estimation weights in XSA of the tuning fleets and *F*-shrinkage, when using the high shrinkage XSA model and including discard estimates. The relative weight of *F*-shrinkage is 22-35% at ages 2 to 9, and

55% at age 1. This relatively high weight at age 1 is caused by the fact that age 1 is predominantly determined by the SNS survey, but the SNS quarter 3 survey was not carried out in 2003.

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The addition of another data year to the XSA assessment hardly affects the *F* and SSB estimates in previous years (that is, there is little retrospective pattern). So, the drastic downward revision of the WG perception of the state of the stock that occurred last year is confirmed by an additional data year. We examined if these patterns were also confirmed if another assessment model was used. Figure 9.4.13 compares the XSA and ICA results for an assessment including discard estimates. The historic SSB estimates diverge if the plus group is set at 10+, but comparison of models in which the plus group is set at 15+ show very similar trends in SSB until approximately 1997. Therefore it is concluded that the downward revision does not appear to be an artefact of XSA.

Since 1997, the SSB estimates are variable and differ between the models. Similarly the historic mean *F* and recruitment estimates are very similar in both models but start to differ from 1997 onwards. The two models differ in the last six years, which corresponds to the separable period of the ICA model. Within this period no clear trends in SSB or *F* are observed in either of the models, but the estimates in the final year differ by 15% for SSB and 30% for mean $F_{2–6}$.

9.4.4 Final assessment

The settings of the final XSA assessment are given below:

North Sea Plaice final assessment settings

	2003					2004				
year of assessment	2003					2004				
catch at age	landings only					landings and (reconstructed) discards				
		years	age	alpha	beta		years	age	alpha	beta
fleets	BTS	1985-2002	1-9	0.660	0.750	BTS	1985-2003	1-9	0.660	0.750
	SNS	1982-2002	1-3	0.660	0.750	SNS	1982-2002	1-3	0.660	0.750
	BTS-tri	1996-2002	1-9	0.660	0.750	BTS-tri	1996-2003	1-9	0.660	0.750
plus group	10					10				
first tuning year	1982					1982				
last data year	2002					2003				
time series weights	no taper					no taper				
Catchability dependent on stocksize for age<	1					1				
Catchability independent of age for ages >=	6					6				
Survivor estimates shrunk towards the mean F	5 years / 2 ages					5 years / 2 ages				
s.e. of the mean	0.5					0.5				
Minumum standard error for pop Estimates	0.3					0.3				
Prior weighting	not applied					not applied				
Number of iterations	49					34				
Convergence	Yes					Yes				

As last year, 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 and will not be used in RCT3, due to age-reading problems in that year. Diagnostics of the final run are presented in Table 9.4.2. Figure 9.4.14 shows the log catchability residuals for the tuning fleets in the final run. Fishing mortality and stock numbers are shown in Tables 9.4.3 and 9.4.4. Weighting of the different data sources in the assessment is shown in Figure 9.4.12. The retrospective analysis is shown in Figure 9.4.11 (right panels) and was carried out by chopping off one year at the end and without a tuning window.

NOTE: The WG proposed the XSA assessment including discards forward as the final assessment, but the incorporation of discards has a considerable effect on the perception of the stock status in relation to the precautionary reference points. Therefore the recruitment estimates, all projections and the biological reference points were estimated both for the final assessment including discards, and for an update assessment in which the same settings and data sources are used as last year. The results for the final assessment (denoted by “a” in Figure and Table captions) are presented in Sections 9.5 and 9.7–9.10. The results for the update assessment (denoted by “b”) are presented in Appendix 2.

9.5 Recruitment estimates

Input to the RCT3 analysis is presented in Table 9.5.1a. Results for age 1 and 2 are presented in Tables 9.5.2a and 9.5.3a respectively. The geometric mean (GM) recruitment is 906 million and the arithmetic mean is 1056 million.

The 2002 year-class in 2004 (at age 2) is estimated at 521 million in XSA and 522 million in RCT3. All indices estimate this year-class to be below average (672 million), and the RCT3 estimate was used for further analysis.

The 2003 year-class in 2004 (at age 1) is poorly estimated by the RCT3 analysis (only one survey index available). The long term GM for this year-class was used for further analysis.

For the 2004 and subsequent year-classes, the long term GM was used as there were no RCT3 estimates.

The text table below summarises the year-class strength estimates:

Yearclass	At age in 2004	XSA	RCT3	GM 57-01	Accepted estimate
2002	2	520606	**522118**	671852	RCT3
2003	1	-	1001290	**906483**	GM 1957-2001
2004 & subsequent	Recruits	-		**906483**	GM 1957-2001

9.6 Historical stock trends

Table 9.6.1 and Figure 9.6.1 present the trends in landings, mean F_{2-6}, SSB and recruitment since 1957. Reported landings gradually increased up to the late 1980s and then rapidly declined until 1996, in line with the decrease in TAC. The landings have levelled off in the most recent years.

Fishing mortality increased until the late 1990s and reached its highest observed level during 1997-1998. Overall F and F_{HC} have decreased after 1998, but $F_{discards}$ has increased in the most recent years. Current fishing mortality is estimated at 0.71 (F_{HC} = 0.43, $F_{discards}$ = 0.28). The overall F of an assessment including discards cannot be compared to the current $\boldsymbol{F_{pa}}$, but F_{HC} is above $\boldsymbol{F_{pa}}$ (= 0.3).

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 270 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 followed by a rapid decline (up to 1995). SSB has remained low in the most recent 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. VPA estimates of recruitment show 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 2000 and 2002 year-class are relatively weak.

9.7 Short-term prognosis

Short-term prognoses have been carried out with the same model settings as last year. Inputs are given in Table 9.7.1a. 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 2003. Population numbers at ages 3 and older are XSA survivor estimates. Numbers at age 2 are estimated from RCT3. Numbers at age 1 and recruitment of the 2004 year-class are taken from the long-term geometric mean (1957-2001)

The management option table is given in Table 9.7.2a, and the short-term forecast is summarise in Figure 9.7.1a. Given that $\boldsymbol{F_{pa}}$ was previously defined for a stock assessed without discards, it must be revised to account for the new stock perception with discards included. Therefore no management option referring to $\boldsymbol{F_{pa}}$ is presented. F in 2004 is set at the status quo level. The detailed table for a forecast based on $\boldsymbol{F_{sq}}$ is given in Table 9.7.3a. At status quo fishing mortality in 2004 and 2005, SSB is expected to be at 192,000 tonnes in 2005 and 174,000 tonnes in 2006.

The yield at $\boldsymbol{F_{sq}}$ is expected to be around 77,000 tonnes in 2004, which is close to the predicted value for 2004 from last years status quo forecast. The landings in 2005 are predicted to be around 69,000 tonnes at $\boldsymbol{F_{sq}}$.

A sensitivity analysis has been carried out to identify the different sources of uncertainty underlying the predictions and is presented in Figure 9.7.2a.

The probability profiles relative to the short term forecast is given in Figure 9.7.3a. At the current yield of around 66,500 tonnes, the probability that F is higher that $\boldsymbol{F_{sq}}$ is around 45%. The probability that SSB will stay below 210,000 tonnes is predicted to be about 85%.

9.8 Medium term prognoses

A 10-year average was used for the catch weight at age and stock weight at age. A Ricker stock-recruit curve was used to fit the model. The estimated parameters and the residuals from the fit were exported to the input-file for the WGTERMC program.

Figure 9.8.1a shows the stock-recruitment fit and the medium term forecasts at $\boldsymbol{F_{sq}}$. The probability that the SSB remains under 220,000 tonnes over the medium time period is around 75%. There is a high probability (90%) that the SSB remains under 260,000 tonnes over the medium time period.

Figure 9.8.2a shows the probability of SSB to remain below 300,000 tonnes over the next 10 years. At F of 0.7 there is a 90% that SSB<300,000 tonnes.

9.9 Long term prognoses

The Aberdeen suite was used to determine the effect of the inclusion of discards on the yield on the long term. The input files for the medium-term analyses (SEN and SUM files) were used with a truncated year range at 40 years. The yield was calculated based on the long-term geometric mean (1957-2003).

The results show that the maximum human consumption yield calculated is around 130,000 t (Figure 9.9.1a) and could be reached at an overall F = 0.19 (Figure 9.9.2a). The discard yield at this F is around 23,000t.

9.10 Reference points

9.10.1 Biological reference points

The estimated biological reference points are presented in Table 9.10.1a and Figure 9.10.1a.

$\boldsymbol{B_{loss}}$ is now estimated to be 160 600 tonnes, which is the SSB in 1999, whereas in last year's assessment the $\boldsymbol{B_{loss}}$ was the SSB in 1997.

$\boldsymbol{F_{max}}$ is estimated to be 0.17, $\boldsymbol{F_{med}}$ = 0.47, and $\boldsymbol{F_{high}}$ = 0.75.

9.10.2 PA reference points

The PA reference points of North Sea plaice must be revised due to the model revisions carried out last year (ICES 2004) and the inclusion of (reconstructed) discard estimates in the catch at age data of this years final assessment. The current state of the stock, especially the level of fishing mortality, cannot be evaluated in relation to the old PA reference points.

Appendix 3 describes the general background to PA reference points, the general procedures to determine PA reference points and the technical basis on which the current reference points for North Sea plaice have been set.

Note that $\boldsymbol{B_{lim}}$ has to be defined first, because $\boldsymbol{F_{lim}}$ is defined with reference to $\boldsymbol{B_{lim}}$, $\boldsymbol{B_{pa}}$ with reference to $\boldsymbol{B_{lim}}$, and $\boldsymbol{F_{pa}}$ with reference to $\boldsymbol{F_{lim}}$ (see Appendix 3).

Two different approaches can be followed in setting new PA reference points:

1. Re-apply the old technical basis, which means that $\boldsymbol{B_{lim}}$ is set at $\boldsymbol{B_{loss}}$ (= lowest observed value).

2. Examine if the old technical basis is still valid. Should SSB be set at the lowest observed value because no SSB has been observed below which recruitment was impaired? Or has a decrease in recruitment related to SSB been observed? This approach involves re-examination of the stock-recruitment plot. The best method currently available to determine the SSB at which recruitment is impaired, is segmented or changepoint regression. If a breakpoint in the SR relation exists than $\boldsymbol{B_{lim}}$ should be set be set to this value (S*).

The PA reference points have been re-calculated (as far as possible) for both approaches and for two XSA models: the final XSA assessment including discard estimates and a XSA assessment without discards configured according to last years settings. The results are presented in the Table below.

If the technical basis is re-applied, then the re-calculation of $\boldsymbol{B_{pa}}$ and $\boldsymbol{F_{lim}}$ is straight-forward. However, the re-calculation of $\boldsymbol{F_{pa}}$ is complicated (see Appendix 3) and questionable because it is based on the 10% probability curve in the medium term projection, which is now considered to be unreliable (Patterson et al., 2001).

If it is decided that the old technical basis is no longer valid then the segmented regression should be used to determine $\boldsymbol{B_{lim}}$. $\boldsymbol{F_{lim}}$ can then be calculated following the guidelines set by the Study Group on the Precautionary Approach to Fisheries Management (see Appendix 3, ICES 1997, 1998), however these have not been calculated at the WG. $\boldsymbol{F_{pa}}$ and $\boldsymbol{B_{pa}}$ can be determined from limit values by fixed multipliers. Assuming that there is no reason to change the multiplier for $\boldsymbol{B_{pa}}$, new values have been calculated for $\boldsymbol{B_{pa}}$. The PA study group has proposed an alternative method to determine PA-values from LIM-values but software to apply this complicated method is not yet available.

Model	**Approach**	$\boldsymbol{B_{lim}}$	$\boldsymbol{B_{pa}}$	$\boldsymbol{F_{lim}}$	$\boldsymbol{F_{pa}}$
Current values (set in 1998)		*210 000t*	*300 000 t*	*0.6*	*0.3*
Final assessment including discards	Technical basis	161 000 t	230 000 t	0.74	?
"	Segmented regression	159 000 t	227 000 t		?
Update assessment excluding discards	Technical basis	134 000 t	192 000 t	0.40	?
"	Segmented regression	267 000 t	382 000 t		?

The underlying stock-recruitment plots and segmented regression curves are presented in Figure 9.10.2. Comparing the two upper figures clearly shows that in the final assessment, which includes discard estimates, a breakpoint in the stock recruitment relationship is far less evident than in an assessment without discards. In an assessment without discards it can be argued that the stock are currently at a level of SSB which causes impaired recruitment, but including discards almost completely takes away suggestion of impaired recruitment.

Comparing the top right plot with the bottom right plot in Figure 9.10.2 shows that the breakpoint of the segmented regression can change considerably if the range of the stock recruitment plot is changed. Notably, the segmented regression breakpoint is very sensitive to the addition of the most recent datum. This could either be due to a decreasing limb of the SRR curve becoming apparent in the SRR data, or to the non-converged part of the VPA delivering very uncertain estimates.

Given that the final assessment includes discards, the WG concluded that both possible approaches (technical basis and segmented regression) give estimates of $\boldsymbol{B}_{lim}$ in the area of 160 000 t. Therefore the WG proposes to set $\boldsymbol{B}_{lim}$ at $\boldsymbol{B}_{loss}$ and calculate the other reference points accordingly:

$\boldsymbol{B}_{lim}$ = 160 000 tonnes

$\boldsymbol{B}_{pa}$ = 230 000 tonnes

$\boldsymbol{F}_{lim}$ = 0.74, which is the sum of the appropriate F_{HC} and F_{discards}.

9.11 Quality of the assessment

9.11.1 Incorporation of discards into the assessment

The assessment presented by the WG incorporates discards for the first time. For a number of years it has been noted in the ACFM report that discards were important for assessing the state of this stock. Observations from (scanty) discards trips indicated that the level of discarding of plaice was high and there were also indications that discarding had increased in recent years compared to the historic observations from the mid-1970s.

Compilation of discards data for North Sea plaice (as for other species) has been attempted by SGDBI in 2002 (ICES 2002). The data were mainly from towed-gear fisheries for cod, haddock, whiting, saithe, sole and plaice in IIIa and IV as collected by Germany, England, Denmark, and Sweden between 1999 and 2001 under EC project 98/097. Some data from other projects going back to 1997 were also available to the SGBDI. WGNSSK noted in 2002 (ICES 2003) that not considering discard catches in stock assessments may introduce bias and affect estimates of F and stock biomass, particularly when discard patterns vary over time. The collection and collation of data as undertaken by the SGDBI was not yet useful for assessment purposes. Since 2002, the EC data regulation (EC 2001) has introduced the obligation for EU member states to collect discards data for their major fleets. The data collected needs to be submitted to the EC in annual reports, however, there is no official requirement to submit the data in a suiTable format to the relevant ICES working groups. Therefore, the discards data that has been collected for North Sea plaice by the different countries has not yet been made available to WGNSSK.

In order to be able to evaluate the effects of discards on the assessment of North Sea plaice, the working group has followed a double strategy. A working paper was presented on a method of reconstructing discard data based on growth information, spatial distribution of plaice by length, selection ogives and discard ogives (Van Keeken et al. 2004). Substantial advances have been made in this method of reconstructing discards. The general principles of the reconstruction are described in Section 9.2.3. Even though the method of reconstructing discards appeared to behave reasonably well, one major drawback was that the reconstruction was relatively sensitive to the assessment that was used to generate the discards estimates. Notably, reconstructing discards from 1999 backwards and from 2003 backwards gave substantial different perceptions on both the overall amount and the relative age compositions of the reconstructed discards in the 1990s. The assessment of North Sea plaice has shown a substantial revision in estimated stock size and fishing mortality during WGNSSK 2003 (ICES 2004) when the size of the 1996 year-class was estimated to be much smaller than previously assumed. This revision will also have affected the reconstruction of discards as shown in Figure 9.4.7.

Recent discard trips indicated that the percentage discards of plaice in the most recent 3-4 years was higher than the percentages discards observed in the 1970s and 1980s. As indicated above, no international estimates of discards at age are available. As a proxy, the Dutch discards estimates have been raised to the international level (see WP6). Given the low sampling level of the Dutch discards program, this could introduce additional variability (or bias) in the discards at age, but the WG considered that it would still be a preferable to use the observed discards rates for the recent years (see Section 9.2.3 for a full discussion).

The introduction of discards in the assessment of North Sea plaice has a large effect on the recruitment estimates and also substantial effects on trends in fishing mortality and SSB. The trends in fishing mortality are heavily affected by the estimated fishing mortality on the discards component; the fishing mortality in the human consumption component is very comparable with the assessment without discards. The recruitment estimate of the strong 1985 year-class is much higher when including discards into the assessment. This re-evaluation of the strength of the 1985 year-class is beyond what has been observed in the surveys. According to the surveys, the 1985 and 1996 year-classes should have been in the same order of magnitude. The assessment including discards also indicates that the strength of the 2001 year-class is larger than previously assumed. Preliminary indications of the CPUE in the first half of 2004 appear to confirm this picture.

The inclusion of discards into the assessment has not resolved the main problem that was identified in last year's WG: the revision of the stock size due to the revision of the estimated strength of the 1996 year-class. Last year it was stated that the absence of discards in the assessment was the likely cause for that revision. The retrospective analysis that was carried out during this WG has shown that a retrospective pattern is still persistent for this assessment. With the inclusion of discards this can no longer be attributed to that factor, but it could still be due to the mismatch between the catch and discards data and the relative abundance indices. Further investigations are required to explore what the most likely causes are for this retrospective pattern.

9.11.2 Contrasting the assessment with external information

The assessment presented by the WG combines information from research vessel surveys and catches (landings + discards) at age. Not all auxiliary information that was available to the WG was used in the final assessment. Nevertheless it is useful to contrast the outcome of the assessment with external information, to explore how consistent the different data sources are for this stock. There are two main sources of information that can be contrasted to the XSA-based stock estimate: commercial CPUE data and the results of the Fishermen survey.

Commercial CPUE

Trends in surveys, commercial CPUE and different assessment model configurations are presented in Figure 9.11.1. The biomass indices are standardised over the period 1996-2003 in terms of log relative trends (log(SSB/avg SSB)). The results indicate that the different assessment methods give generally the same interpretation of the data: high stock size in the late 1980s, followed by a decrease until the mid-1990s after which it stabilises. A slightly alternative interpretation is presented by the BTS (as SSB index) and to a lesser extent by the NL flag CPUE series, which indicates that the decrease in SSB has not been as large as indicated by the catch based assessments.

Fishermen's survey

The results of the fishermen survey is presented in Figure 9.11.2 in terms of relative increases and decreases compared to the year before. The fishermen survey indicates that in most areas, fishermen perceive there to be more plaice in all areas except in the western part of the North Sea. The level of increase cannot really be determined from this information, but as a whole the fishermen are observing an increasing trend in the stock, which is to a certain extent consistent with the outcome of the assessment.

9.11.3 PA reference points

The WG and ACFM consider discards important for assessing the state of this stock. This year, for the first time, an assessment including reconstructed discard estimates is presented as the final assessment. However this revision (and last years revision) change our perception of the stock in relation to the fixed PA reference points. Therefore a revision of the PA reference is necessary. Without revised PA reference points the state of the stock in relation to biological reference points cannot be evaluated.

The background to PA reference points, the general procedures to determine PA reference points and the technical basis on which the current reference points for North Sea plaice have been set are described in Appendix 3. In this report we have listed a number of options regarding the estimation of new reference points. The WG proposed the assessment including discards as the final assessment: therefore, the WG also had to choose between updating the reference points using the original approach with which the reference points were set in 1998 (ICES 1998; ICES 1999) or using the approach proposed by the SGPA (ICES 2003b). The WG did not have the time to follow the complete procedure outlined by SGPA, but has been able to recalculate the old technical basis and to calculate the breakpoint of the segmented regression. The newly estimated $\boldsymbol{B}_{loss}$ is practically equal to the breakpoint in the segmented regression suggesting a $\boldsymbol{B}_{lim}$ of 160,000 t. (current $\boldsymbol{B}_{lim}$ is 210,000 tonnes). $\boldsymbol{F}_{loss}$ (which can be taken as a proxy for $\boldsymbol{F}_{lim}$) was calculated as 0.74, but it should be noted that this estimate includes discards mortality.

9.12 Management considerations

The minimum mesh size (80 mm) in the mixed beam-trawl fishery for plaice and sole in the southern North Sea means that large numbers of (undersized) plaice are discarded. Measures to reduce discarding in the mixed beam-trawl fishery would greatly benefit the plaice stock and future yields. There are indications from recent surveys that undersized plaice are distributed further offshore and may therefore have become available to the fishery, which generated additional discards.

Effort in the major fisheries has been reduced. Since 1998 overall F and F_{HC} appear to have decreased slightly and $F_{discards}$ has increased. However, on a longer time scale these changes are minor. TACs set by managers since 1997 have been intended to result in substantial reductions in F to $F = 0.3$. Although landings have been at or below the TAC in each year, F did not decline as expected and the magnitude of the reduction is highly uncertain.

The reduction in plaice TACs in combination with the reduction in the days at sea has had a potential spin-off of limiting the fishery more to the southern North Sea. Given the spatial distribution of plaice, this could have resulted in additional pressure on the plaice stock and notably on the juvenile part of the plaice population.

The effects of the "plaice box" was evaluated in 1999 and has recently again been evaluated by an EU-Norway expert group. The report of the latter group is not available yet and could not be evaluated by the WG.

Special request

During the week before the start of the WG meeting, the Dutch Delegate to ICES (Ir. Ger de Peuter) requested that the following analyses be done by this WG:

1. *An evaluation of the current levels of reference points ($\boldsymbol{B}_{lim}$, $\boldsymbol{F}_{lim}$, $\boldsymbol{B}_{pa}$, $\boldsymbol{F}_{pa}$) during the ICES WGNSSK in September 2004 and the development of proposals for updated levels, based on the most recent knowledge.*

2. *Advice on what levels of F are required to restore the North Sea plaice stock to safe biological levels over a period of about 5–10 years.*

In response to this request, the WG have proposed new PA reference points for plaice (Section 9.10.2). Evaluation of these reference points requires answers to questions such as "Given likely future climate scenarios, how realistic is the goal of rebuilding to a reference biomass level?" The WG are currently unable to answer such questions satisfactorily, and this will remain the case unless considerable changes are made to WG practice (see Section 15). The WG have also produced medium-term projections of the plaice stock, and have indicated the likely level of biomass if the current fishing mortality was continued for the next 10 years. However, in the absence of agreed precautionary reference points for the new plaice assessment including discards, it is difficult for the WG to conclude whether or not this level of biomass could be considered "safe".

Table 9.1.1. North Sea plaice. Nominal landings (tonnes) in Sub-Area IV as officially reported to ICES, 1997-2003.

YEAR	1997	1998	1999	2000	2001	2002	2003
Belgium	5223	5592	6160	7260	6369	4859	4570
Denmark	13940	10087	13468	13408	13797	12552	13742
France	254	489	624	547	429	552	343
Germany	4159	2773	3144	4310	4739	3927	3800
Netherlands	34143	30541	37513	35030	33290	29081	27372
Norway	1620	965	643	866	1926	1996	1967
Sweden	10	2	4	3	3	2	2
UK (E/W/NI)	13789	11473	9743	13131	11025	8504	7135
UK (Scotland)	8345	8442	7318	7579	8122	8236	6757
Others	0	1	0	0	0	0	0
Total	81483	70365	78617	82134	79700	69709	65688
Unallocated	1565	1169	2045	-984	2263	508	814
WG estimate	**83048**	**71534**	**80662**	**81150**	**81963**	**70217**	**66502**
TAC	91000	87000	102000	97000	78000	77000	73250

Table 9.2.1. North Sea plaice. Natural mortality and maturity at age.

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Natural mortality	0.1	0.1	0.1	0.1	0.1	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	1	1	1	1	1	1	1	1	1	1	1

Table 9.2.2. North Sea plaice. Annual varying maturity ogives based on Dutch market samples.

	1	2	3	4	5	6	7+
1957	0.00	0.29	0.44	0.64	0.83	0.97	1.00
1958	0.00	0.29	0.44	0.64	0.83	0.97	1.00
1959	0.00	0.29	0.43	0.64	0.84	0.97	1.00
1960	0.00	0.29	0.42	0.67	0.88	0.98	1.00
1961	0.00	0.29	0.40	0.67	0.88	0.97	1.00
1962	0.00	0.29	0.38	0.66	0.87	0.98	1.00
1963	0.00	0.29	0.37	0.66	0.87	0.98	1.00
1964	0.00	0.29	0.36	0.66	0.89	0.99	1.00
1965	0.00	0.29	0.35	0.62	0.86	0.98	1.00
1966	0.00	0.33	0.35	0.62	0.85	0.97	1.00
1967	0.00	0.33	0.35	0.61	0.86	0.95	1.00
1968	0.00	0.33	0.37	0.61	0.86	0.96	1.00
1969	0.00	0.34	0.39	0.63	0.84	0.92	1.00
1970	0.00	0.34	0.41	0.66	0.85	0.93	1.00
1971	0.00	0.29	0.42	0.69	0.89	0.93	1.00
1972	0.00	0.30	0.44	0.72	0.89	0.96	1.00
1973	0.00	0.30	0.42	0.71	0.90	0.95	1.00
1974	0.00	0.30	0.44	0.69	0.91	0.97	1.00
1975	0.00	0.31	0.46	0.68	0.86	0.95	1.00
1976	0.00	0.31	0.48	0.69	0.85	0.93	1.00
1977	0.00	0.31	0.48	0.70	0.87	0.93	1.00
1978	0.00	0.31	0.49	0.72	0.89	0.95	1.00
1979	0.00	0.30	0.48	0.76	0.92	0.95	1.00
1980	0.00	0.30	0.45	0.76	0.94	0.97	1.00
1981	0.00	0.29	0.43	0.75	0.94	0.99	1.00
1982	0.00	0.29	0.42	0.71	0.94	0.98	1.00
1983	0.00	0.29	0.40	0.68	0.94	0.97	1.00
1984	0.00	0.29	0.39	0.64	0.91	0.97	1.00
1985	0.00	0.29	0.38	0.64	0.89	0.97	1.00
1986	0.00	0.29	0.37	0.60	0.91	0.96	1.00
1987	0.00	0.29	0.37	0.60	0.86	0.98	1.00
1988	0.00	0.29	0.37	0.61	0.84	0.99	1.00
1989	0.00	0.29	0.37	0.61	0.84	0.98	1.00
1990	0.00	0.29	0.39	0.61	0.86	0.98	1.00
1991	0.00	0.29	0.41	0.63	0.85	0.98	1.00
1992	0.00	0.29	0.42	0.69	0.88	0.97	1.00
1993	0.00	0.29	0.44	0.74	0.91	0.98	1.00
1994	0.00	0.30	0.47	0.80	0.93	0.98	1.00
1995	0.00	0.29	0.47	0.83	0.96	0.99	1.00
1996	0.00	0.29	0.45	0.84	0.98	0.99	1.00
1997	0.00	0.29	0.44	0.83	0.98	1.00	1.00
1998	0.00	0.34	0.44	0.78	0.98	0.99	1.00
1999	0.00	0.33	0.44	0.76	0.97	1.00	1.00
2000	0.00	0.35	0.44	0.74	0.97	1.00	1.00
2001	0.00	0.40	0.45	0.73	0.96	1.00	1.00
2002	0.00	0.51	0.50	0.70	0.94	0.99	1.00
2003	0.00	0.51	0.50	0.70	0.94	0.99	1.00

Table 9.2.3. North Sea plaice. Catch numbers at age in the landings.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1957	0	4315	59818	44718	31771	8885	11029	9028	4973	4300	2580	1312	787	875	1005
1958	0	7129	22205	62047	34112	19594	8178	8000	6110	4093	4530	1740	1110	528	1147
1959	0	16556	30427	25489	41099	22936	13873	6408	6596	5360	3386	3564	1507	869	1494
1960	0	5959	61876	51022	21321	27329	14186	9013	5087	4711	3418	2391	1966	1014	1653
1961	0	2264	33392	67906	32699	12759	14680	9748	5996	3446	3621	2887	1743	1345	1618
1962	0	2147	35876	66779	50060	20628	9060	9035	5257	3428	2659	2266	2001	1061	1386
1963	0	4340	21471	76926	54364	31799	12848	6833	7047	3863	3591	2117	2089	1536	3396
1964	0	14708	40486	64735	57408	37091	15819	6595	3980	3804	3066	1905	1518	1300	5293
1965	0	9858	42202	53188	43674	30151	18361	8554	4213	4015	2807	2221	1745	1338	5461
1966	0	4144	65009	51488	36667	27370	16500	10784	6467	3336	1843	2552	1624	1032	4541
1967	0	5982	30304	112917	41383	22053	16175	8004	6728	3045	2033	968	1303	783	3043
1968	0	9474	40698	38140	123619	17139	10341	10102	3925	4891	2273	1556	607	1007	3031
1969	3	15017	45187	36084	35585	102014	10410	6086	8192	3739	4760	1796	1223	703	3871
1970	76	17294	51174	56153	40686	35074	78886	6311	4185	4778	2202	2871	1150	939	2900
1971	19	29591	48282	33475	26059	22903	16913	29730	6414	4602	3377	2213	1910	929	3879
1972	2233	36528	62199	52906	23043	16998	14380	10903	18585	3467	2841	2538	1553	1591	3661
1973	1268	31733	59099	73065	42255	13817	8885	9848	6084	13829	1680	1995	1516	1355	3603
1974	2223	23120	55548	42125	41075	19666	8005	6321	5568	3931	10118	1634	1686	1242	3369
1975	981	28124	61623	31262	25419	21188	11873	5923	4106	3337	1741	7935	1080	1424	4178
1976	2820	33643	77649	96398	13779	9904	9120	6391	2947	2020	2111	911	4478	388	2644
1977	3220	56969	43289	66013	83705	9142	5912	5022	4061	1927	1301	1357	489	2290	1827
1978	1143	60578	62343	54341	50102	35510	5940	3352	2419	2176	1145	603	689	330	2525
1979	1318	58031	118863	48962	47886	39932	24228	4161	2807	2333	1849	1113	707	707	2579
1980	979	64904	133741	77523	24974	17982	13761	8458	1864	1326	952	1173	433	284	1209
1981	253	100927	122296	57604	35745	12414	9564	8092	4874	1406	1097	830	796	468	1306
1982	3334	47776	209007	69544	28655	16726	7589	5470	4482	3706	1134	712	575	519	2007
1983	1214	119695	115034	99076	29359	12906	8216	4193	3013	2947	2144	1219	581	344	1052
1984	108	63252	274209	53549	37468	13661	6465	5544	2720	2088	1307	1143	455	310	1262
1985	121	73552	144316	185203	32520	15544	6871	3650	2698	1543	1030	1070	727	371	1057
1986	1674	67125	163717	93801	84479	24049	9299	4490	2733	2026	1178	1084	806	628	1228
1987	0.1	85123	115951	111239	64758	34728	11452	4341	2154	1743	1033	663	529	296	1214
1988	0.1	15146	250675	74335	47380	25091	16774	5381	3162	1671	932	932	505	516	1677
1989	1261	46757	105929	231414	52909	19247	10567	7561	2120	1692	927	630	446	328	1557
1990	1550	32533	97766	110997	159814	26757	8129	4216	3451	1097	716	456	293	208	1038
1991	1461	43266	83603	116155	72961	77557	14910	5233	3141	2325	956	592	356	289	1073
1992	3410	43954	85120	72494	72703	33406	29547	6970	3200	2240	1516	925	524	490	1233
1993	3461	53949	98375	72286	51405	29001	13472	11272	3645	1888	1241	932	743	215	864
1994	1394	45148	101617	80236	38542	20388	15323	6399	5368	2319	942	646	580	300	646
1995	7751	36575	81398	78370	36499	17953	9772	4366	2336	1682	864	427	229	209	342
1996	1104	42496	64382	46359	32130	14460	10605	4528	2624	1659	1170	511	260	238	1054
1997	892	42855	86948	43669	22541	13518	6362	3632	2179	1252	690	889	396	224	730
1998	196	30401	68920	56329	16713	6432	4986	2506	1761	912	500	403	431	176	697
1999	549	8689	155971	39857	24112	6829	2783	2246	1521	1180	515	381	230	267	520
2000	2694	15819	39550	164330	14993	9343	2130	1030	940	544	392	393	203	134	431
2001	4509	35886	52480	48238	89949	6836	4418	1127	637	566	296	465	232	173	577
2002	1233	15596	58262	48361	36551	37877	4644	1788	742	312	484	264	156	121	249
2003	694	42594	47802	48894	27126	15999	17069	1608	650	249	97	303	32	91	87

Table 9.2.4. North Sea plaice. Catch weights at age in the landings.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1957	0.000	0.165	0.201	0.258	0.353	0.456	0.533	0.589	0.396	0.821	0.957	1.048	1.233	1.141	1.487
1958	0.000	0.198	0.221	0.259	0.337	0.453	0.513	0.615	0.665	0.802	0.920	1.045	1.134	1.370	1.563
1959	0.000	0.218	0.246	0.293	0.362	0.473	0.592	0.623	0.750	0.791	0.918	1.009	1.190	1.267	1.563
1960	0.000	0.200	0.236	0.289	0.386	0.485	0.601	0.683	0.724	0.874	0.959	1.162	1.232	1.360	1.572
1961	0.000	0.191	0.233	0.302	0.412	0.509	0.604	0.671	0.812	0.870	0.942	1.033	1.224	1.239	1.553
1962	0.000	0.211	0.248	0.300	0.400	0.541	0.570	0.692	0.777	0.959	0.995	1.100	1.187	1.410	1.540
1963	0.000	0.253	0.286	0.319	0.399	0.533	0.624	0.667	0.715	0.860	0.920	1.033	1.004	1.182	1.276
1964	0.000	0.250	0.273	0.312	0.388	0.487	0.628	0.700	0.737	0.841	0.890	0.954	0.938	1.098	1.204
1965	0.000	0.242	0.282	0.321	0.385	0.471	0.539	0.663	0.726	0.615	0.792	0.857	0.974	0.878	1.121
1966	0.000	0.232	0.270	0.348	0.436	0.484	0.559	0.624	0.690	0.813	0.858	0.843	0.943	1.018	1.080
1967	0.000	0.232	0.279	0.322	0.425	0.547	0.597	0.662	0.738	0.837	0.870	0.902	0.950	1.032	1.214
1968	0.000	0.267	0.298	0.331	0.366	0.517	0.590	0.596	0.686	0.750	0.817	0.939	0.936	0.973	1.201
1969	0.217	0.294	0.310	0.333	0.359	0.412	0.573	0.655	0.658	0.694	0.810	0.838	1.022	0.863	1.179
1970	0.315	0.286	0.318	0.356	0.419	0.443	0.499	0.672	0.744	0.762	0.780	0.892	0.941	1.021	1.128
1971	0.256	0.318	0.356	0.403	0.448	0.514	0.542	0.607	0.699	0.724	0.818	0.848	0.922	1.004	1.133
1972	0.246	0.296	0.352	0.428	0.493	0.541	0.608	0.646	0.674	0.785	0.841	0.901	0.900	0.964	1.192
1973	0.272	0.316	0.344	0.405	0.486	0.539	0.605	0.627	0.677	0.729	0.978	0.907	0.942	0.983	1.079
1974	0.285	0.311	0.354	0.405	0.476	0.554	0.609	0.693	0.707	0.779	0.849	0.971	1.002	1.040	1.224
1975	0.249	0.300	0.330	0.420	0.495	0.587	0.636	0.703	0.783	0.853	0.854	0.983	0.953	1.138	1.264
1976	0.265	0.295	0.338	0.375	0.513	0.594	0.641	0.705	0.741	0.813	0.851	0.928	1.019	1.009	1.159
1977	0.254	0.323	0.353	0.380	0.418	0.556	0.647	0.721	0.715	0.791	0.898	0.970	0.855	1.063	1.165
1978	0.244	0.315	0.369	0.397	0.438	0.491	0.609	0.687	0.776	0.781	0.886	0.983	1.039	0.933	1.094
1979	0.235	0.311	0.349	0.388	0.429	0.474	0.550	0.675	0.796	0.871	0.818	0.894	1.083	1.044	1.115
1980	0.238	0.286	0.344	0.401	0.473	0.545	0.588	0.662	0.772	0.931	0.943	0.848	1.015	1.308	1.248
1981	0.237	0.274	0.329	0.416	0.505	0.558	0.604	0.642	0.725	0.869	0.950	0.931	0.933	1.179	1.236
1982	0.279	0.262	0.311	0.424	0.514	0.608	0.664	0.712	0.738	0.840	0.983	1.045	1.174	0.970	1.177
1983	0.200	0.250	0.300	0.383	0.515	0.604	0.677	0.771	0.815	0.893	0.913	0.984	1.240	1.209	1.167
1984	0.233	0.263	0.283	0.375	0.491	0.613	0.684	0.725	0.837	0.916	0.981	1.026	1.112	1.250	1.214
1985	0.247	0.264	0.290	0.337	0.462	0.577	0.678	0.729	0.804	0.900	1.001	0.950	1.071	1.139	1.215
1986	0.221	0.269	0.304	0.347	0.425	0.488	0.675	0.751	0.853	0.921	0.948	1.063	1.078	1.074	1.110
1987	0.221	0.249	0.300	0.351	0.402	0.504	0.583	0.728	0.829	0.826	0.996	1.015	1.045	1.127	1.150
1988	0.221	0.254	0.278	0.352	0.453	0.512	0.608	0.699	0.813	0.936	0.964	1.041	1.137	1.115	1.038
1989	0.236	0.280	0.309	0.332	0.392	0.533	0.603	0.670	0.792	0.819	0.923	0.952	1.157	1.084	0.994
1990	0.271	0.285	0.298	0.317	0.366	0.447	0.597	0.692	0.761	0.826	1.044	1.098	1.117	0.991	1.094
1991	0.227	0.286	0.294	0.306	0.365	0.455	0.528	0.671	0.747	0.843	0.930	0.944	1.000	0.976	1.026
1992	0.251	0.263	0.290	0.318	0.341	0.425	0.531	0.605	0.715	0.755	0.843	0.945	0.994	0.928	1.098
1993	0.249	0.273	0.289	0.326	0.356	0.423	0.518	0.631	0.721	0.775	0.806	0.903	0.846	0.919	1.046
1994	0.229	0.263	0.286	0.339	0.397	0.449	0.502	0.611	0.732	0.787	0.936	0.948	1.034	0.920	1.131
1995	0.272	0.277	0.301	0.338	0.402	0.454	0.528	0.611	0.734	0.881	0.865	0.923	0.918	0.943	1.104
1996	0.240	0.280	0.307	0.355	0.420	0.486	0.499	0.589	0.720	0.854	0.928	0.933	0.923	0.829	0.739
1997	0.208	0.271	0.313	0.364	0.457	0.524	0.603	0.616	0.683	0.803	0.907	0.957	0.884	1.100	1.076
1998	0.152	0.260	0.310	0.394	0.497	0.607	0.633	0.695	0.700	0.800	0.975	1.078	0.888	0.907	0.943
1999	0.245	0.253	0.280	0.355	0.455	0.547	0.630	0.682	0.752	0.608	0.750	0.933	1.031	0.936	1.093
2000	0.228	0.267	0.284	0.314	0.432	0.500	0.684	0.710	0.751	0.831	0.843	0.749	0.853	1.013	1.102
2001	0.238	0.267	0.292	0.309	0.365	0.482	0.592	0.708	0.795	0.776	0.765	0.725	0.831	0.799	0.892
2002	0.237	0.264	0.289	0.316	0.348	0.445	0.511	0.692	0.761	0.855	0.964	0.749	0.797	1.022	0.997
2003	0.232	0.253	0.287	0.326	0.371	0.414	0.487	0.654	0.766	0.933	0.911	0.794	1.087	0.688	0.867

Table 9.2.5. North Sea plaice. Sampling effort of the Dutch discards sampling programme during 1999-2003.

Year	# trips	# hauls	# hours
1999	3	106	183
2000	13	420	762
2001	4	128	235
2002	6	172	342
2003	10	306	554

Table 9.2.6. North Sea plaice. Catch numbers at age in the discards (1957-1998 is reconstructed, 1999-2003 is observed).

	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	103539	189167	99382	669	62	78	0	0	8	0
2000	174719	313166	72492	83443	114	51	9	9	2	5
2001	24171	357233	141404	48086	44836	97	3	3	0	0
2002	380104	246015	93159	10361	1298	188	8	5	5	5
2003	101383	835509	52105	13683	3969	185	735	0	0	0

Table 9.2.7. North Sea plaice. Catch numbers at age in the discards (reconstructed for full time series).

	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	116087	127770	46402	11407	4737	106	0	0	0	0
1960	73938	167893	44948	997	1067	519	0	0	0	0
1961	75578	144609	89014	538	1612	130	0	0	0	0
1962	51265	181322	87599	21716	799	186	0	0	0	0
1963	90914	136181	129779	9963	2112	188	0	0	0	0
1964	66035	153275	64155	33826	3011	323	0	0	0	0
1965	43708	426013	59262	3403	923	267	0	0	0	0
1966	38497	163125	349351	14400	1402	125	0	0	0	0
1967	20199	133545	87531	152490	623	260	0	0	0	0
1968	73971	72193	46340	26530	22436	58	0	0	0	0
1969	85191	67377	16747	19334	773	2024	0	0	0	0
1970	123554	152476	27746	1288	5061	161	0	0	0	0
1971	69334	96948	42351	2674	426	81	0	0	0	0
1972	70014	55462	33882	5712	567	73	0	0	0	0
1973	132255	49825	4003	673	1289	67	0	0	0	0
1974	211096	308154	3654	284	610	109	0	0	0	0
1975	244856	280021	190325	4817	253	123	0	0	0	0
1976	183863	140797	70982	17906	173	41	0	0	0	0
1977	255761	103704	79261	33532	9306	128	0	0	0	0
1978	225995	153328	27264	10750	1241	569	0	0	0	0
1979	288919	213941	56952	18404	586	307	0	0	0	0
1980	220311	119566	918	677	191	84	0	0	0	0
1981	120691	185063	1826	365	425	54	0	0	0	0
1982	372053	178365	4577	1094	209	95	0	0	0	0
1983	238334	387065	17343	2210	798	67	0	0	0	0
1984	290686	285671	30704	19127	1485	67	0	0	0	0
1985	392924	221441	30469	2231	200	76	0	0	0	0
1986	1068293	486357	48488	26159	1456	147	0	0	0	0
1987	344214	1325536	182074	1401	1341	250	0	0	0	0
1988	336872	570632	426086	59753	870	174	0	0	0	0
1989	218710	462136	172810	68397	7213	110	0	0	0	0
1990	153263	293070	163305	22076	5083	176	0	0	0	0
1991	200351	334308	161291	44103	5628	971	0	0	0	0
1992	154860	248825	113346	44545	4341	903	0	0	0	0
1993	95581	169687	56626	16021	1621	222	0	0	0	0
1994	64812	91066	41284	1022	825	140	0	0	0	0
1995	54293	82406	8357	838	655	121	0	0	0	0
1996	34857	143018	29276	1201	440	113	0	0	0	0
1997	95494	133076	52271	528	280	100	0	0	0	0
1998	74274	453963	12530	666	270	36	0	0	0	0
1999	66335	180104	187738	284	403	42	0	0	0	0
2000	87252	140715	84741	11263	97	52	0	0	0	0
2001	100756	146840	69350	30562	11475	38	0	0	0	0
2002	235284	102090	49242	14966	3854	591	0	0	0	0
2003	159600	312600	11748	268	1771	454	0	0	0	0

Table 9.2.8. North Sea plaice. Catch weights at age in the discards (1957-1998 is reconstructed, 1999-2003 is observed).

reconstructed	1	2	3	4	5	6	7	8	9	10
1957	0.047	0.102	0.148	0.179	0.203	0.231	0.244	0.231		
1958	0.050	0.094	0.159	0.186	0.197	0.244	0.244	0.244		
1959	0.054	0.105	0.156	0.184	0.193	0.231				
1960	0.047	0.110	0.160	0.186	0.199	0.210	0.231			
1961	0.046	0.098	0.161	0.192	0.199	0.212	0.211	0.244		
1962	0.045	0.096	0.156	0.191	0.211	0.219	0.219	0.220		
1963	0.050	0.103	0.157	0.186	0.203	0.231	0.220	0.231		
1964	0.034	0.112	0.161	0.191	0.199	0.219	0.231	0.231		
1965	0.040	0.071	0.166	0.190	0.205	0.220	0.220	0.244		
1966	0.040	0.099	0.128	0.192	0.203	0.231	0.220	0.231		
1967	0.038	0.103	0.158	0.168	0.211	0.212	0.231	0.231		
1968	0.063	0.094	0.157	0.189	0.189	0.244	0.211	0.244		
1969	0.055	0.143	0.162	0.185	0.205	0.210	0.244	0.220		
1970	0.056	0.114	0.179	0.186	0.192	0.244	0.212	0.231		
1971	0.059	0.109	0.183	0.198	0.210			0.231		
1972	0.064	0.144	0.174	0.205	0.204	0.244				
1973	0.045	0.127	0.179	0.193	0.204	0.231	0.244			
1974	0.057	0.105	0.174	0.210	0.211	0.231	0.244			
1975	0.070	0.134	0.163	0.204	0.220	0.244	0.231			
1976	0.088	0.150	0.176	0.192	0.219	0.244	0.244	0.244		
1977	0.071	0.157	0.186	0.193	0.195	0.211				
1978	0.072	0.140	0.196	0.203	0.205	0.211	0.220			
1979	0.069	0.155	0.184	0.202	0.219	0.231	0.219	0.231		
1980	0.057	0.146	0.190	0.211	0.220	0.244	0.244			
1981	0.050	0.132	0.180	0.210	0.219	0.244				
1982	0.057	0.124	0.182	0.198	0.231	0.231	0.244			
1983	0.054	0.123	0.180	0.203	0.204	0.244	0.244			
1984	0.055	0.124	0.173	0.210	0.203		0.244			
1985	0.056	0.137	0.177	0.193	0.231	0.244				
1986	0.051	0.122	0.180	0.192	0.211	0.244	0.231			
1987	0.044	0.104	0.166	0.202	0.210	0.231				
1988	0.045	0.097	0.155	0.184	0.211	0.231				
1989	0.048	0.101	0.163	0.180	0.192	0.244	0.244			
1990	0.054	0.112	0.160	0.184	0.205	0.231				
1991	0.058	0.130	0.162	0.184	0.198	0.219	0.220	0.220		
1992	0.055	0.124	0.168	0.186	0.199	0.205	0.220	0.231		
1993	0.060	0.119	0.172	0.196	0.205	0.231	0.231	0.244		
1994	0.062	0.141	0.175	0.192	0.211	0.231	0.244	0.220		
1995	0.061	0.140	0.186	0.198	0.212	0.231	0.231	0.244		
1996	0.053	0.122	0.178	0.203	0.219	0.231		0.244		
1997	0.042	0.118	0.160	0.202	0.220	0.244				
1998	0.049	0.086	0.168	0.196	0.211		0.244			
1999	0.055	0.096	0.145	0.193	0.211	0.244				
2000	0.061	0.109	0.152	0.173	0.231		0.197			
2001	0.070	0.122	0.168	0.176	0.193	0.231		0.231		
2002	0.058	0.119	0.172	0.191	0.196	0.211				
2003	0.069	0.114	0.174	0.184	0.198	0.204	0.219	0.178		
observed	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1999	0.057	0.109	0.148	0.173	0.163	0.154		0.223	0.176	0.267
2000	0.044	0.079	0.104	0.136	0.298	0.315	0.358	0.305	0.478	0.392
2001	0.018	0.066	0.126	0.126	0.136	0.200	0.218	0.218		
2002	0.070	0.085	0.117	0.168	0.189	0.225	0.197	0.196	0.196	0.196
2003	0.045	0.073	0.130	0.124	0.162	0.191	0.181			

Table 9.2.9. North Sea plaice. Stock weights at age derived from first quarter landing weights at age.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1957	0.141	0.200	0.268	0.238	0.325	0.485	0.719	0.682	0.844	0.918	1.137	1.182	1.385	1.480	1.585
1958	0.141	0.200	0.197	0.226	0.303	0.442	0.577	0.778	0.793	0.945	1.081	0.785	1.042	1.615	2.159
1959	0.141	0.146	0.194	0.240	0.329	0.470	0.650	0.686	0.908	0.897	0.901	1.138	1.410	0.945	1.340
1960	0.141	0.190	0.208	0.240	0.364	0.469	0.633	0.726	0.845	0.918	0.975	1.126	1.148	1.373	1.522
1961	0.141	0.126	0.202	0.254	0.337	0.483	0.579	0.691	0.779	0.911	0.947	1.079	1.184	1.186	1.424
1962	0.141	0.187	0.258	0.306	0.424	0.573	0.684	0.806	0.873	1.335	1.074	1.240	1.141	1.800	1.619
1963	0.141	0.200	0.232	0.290	0.378	0.540	0.663	0.788	0.882	0.961	1.097	1.261	1.246	1.403	1.678
1964	0.141	0.200	0.228	0.276	0.373	0.477	0.645	0.673	0.845	0.973	0.999	1.255	1.201	1.620	1.460
1965	0.141	0.200	0.246	0.274	0.333	0.430	0.516	0.601	0.722	0.578	0.790	0.843	1.072	0.721	1.234
1966	0.141	0.200	0.243	0.301	0.403	0.455	0.503	0.565	0.581	0.848	0.949	0.704	1.052	1.056	1.216
1967	0.141	0.203	0.246	0.281	0.442	0.528	0.585	0.650	0.703	0.833	0.907	1.007	0.898	0.976	1.221
1968	0.141	0.200	0.265	0.301	0.344	0.532	0.592	0.362	0.667	0.746	0.791	0.919	0.810	0.938	1.170
1969	0.175	0.203	0.258	0.297	0.344	0.390	0.565	0.621	0.679	0.635	0.772	0.741	0.995	0.907	1.179
1970	0.175	0.250	0.261	0.311	0.369	0.410	0.468	0.636	0.732	0.747	0.771	0.898	0.839	1.155	1.175
1971	0.175	0.248	0.305	0.363	0.413	0.489	0.512	0.583	0.696	0.707	0.817	0.847	0.941	0.936	1.102
1972	0.175	0.274	0.321	0.401	0.473	0.534	0.579	0.606	0.655	0.759	0.815	0.869	0.849	0.971	1.237
1973	0.175	0.264	0.322	0.380	0.468	0.521	0.566	0.583	0.617	0.690	0.926	0.899	0.961	0.977	0.998
1974	0.170	0.234	0.304	0.375	0.437	0.524	0.570	0.629	0.652	0.690	0.774	0.932	1.017	0.962	1.113
1975	0.170	0.275	0.294	0.417	0.483	0.544	0.610	0.668	0.704	0.762	0.830	0.886	0.874	1.070	1.217
1976	0.170	0.217	0.281	0.332	0.484	0.550	0.593	0.658	0.694	0.743	0.784	0.875	0.972	1.158	1.107
1977	0.160	0.250	0.309	0.364	0.405	0.551	0.627	0.690	0.667	0.759	0.818	0.909	0.838	1.055	1.116
1978	0.150	0.242	0.336	0.367	0.411	0.467	0.547	0.630	0.704	0.773	0.848	0.939	0.959	1.024	1.119
1979	0.150	0.243	0.303	0.363	0.414	0.459	0.543	0.667	0.764	0.826	0.894	0.880	1.127	1.041	1.255
1980	0.150	0.229	0.307	0.372	0.444	0.524	0.582	0.651	0.778	1.025	0.947	0.838	1.209	1.194	1.310
1981	0.150	0.250	0.282	0.378	0.473	0.536	0.570	0.624	0.707	0.849	0.910	0.866	1.114	1.218	1.324
1982	0.150	0.242	0.265	0.381	0.490	0.589	0.631	0.679	0.726	0.828	0.981	1.066	1.182	0.897	1.197
1983	0.150	0.211	0.248	0.329	0.494	0.559	0.624	0.712	0.754	0.791	0.824	1.011	1.130	1.257	1.124
1984	0.150	0.203	0.242	0.338	0.464	0.571	0.649	0.692	0.787	0.898	0.932	1.042	1.235	1.127	1.235
1985	0.150	0.208	0.243	0.310	0.452	0.536	0.635	0.656	0.764	0.869	0.955	0.906	1.068	1.108	1.308
1986	0.150	0.195	0.253	0.336	0.440	0.533	0.692	0.779	0.888	0.971	0.953	1.107	1.153	1.126	1.354
1987	0.150	0.194	0.265	0.330	0.401	0.503	0.573	0.711	0.747	0.817	1.009	1.018	1.019	1.214	1.114
1988	0.150	0.212	0.238	0.315	0.426	0.467	0.547	0.644	0.706	0.897	0.937	1.009	1.065	1.135	0.972
1989	0.150	0.215	0.248	0.282	0.362	0.484	0.553	0.616	0.759	0.837	0.791	0.968	1.215	0.899	0.857
1990	0.150	0.245	0.272	0.281	0.342	0.421	0.555	0.648	0.713	0.769	1.051	1.154	1.022	1.090	1.084
1991	0.131	0.208	0.263	0.275	0.340	0.400	0.463	0.640	0.658	0.762	0.855	0.990	0.982	0.860	0.928
1992	0.131	0.262	0.266	0.300	0.316	0.402	0.501	0.575	0.696	0.751	0.844	0.886	0.998	0.859	1.078
1993	0.131	0.257	0.264	0.301	0.328	0.391	0.491	0.595	0.646	0.737	0.805	0.942	0.866	0.912	1.101
1994	0.131	0.222	0.249	0.302	0.366	0.410	0.467	0.548	0.679	0.752	0.912	0.961	1.027	0.846	1.020
1995	0.124	0.245	0.265	0.311	0.401	0.451	0.520	0.607	0.705	0.836	0.739	0.885	0.827	0.913	1.128
1996	0.124	0.245	0.282	0.329	0.390	0.464	0.490	0.572	0.689	0.845	0.906	0.973	0.900	0.781	0.870
1997	0.124	0.217	0.254	0.342	0.442	0.491	0.563	0.586	0.684	0.771	0.913	0.865	0.898	1.287	1.052
1998	0.124	0.205	0.269	0.362	0.471	0.578	0.588	0.657	0.676	0.709	1.004	1.092	0.788	1.175	0.829
1999	0.124	0.211	0.251	0.346	0.436	0.524	0.591	0.680	0.696	0.639	0.764	0.898	1.185	0.839	1.102
2000	0.124	0.224	0.236	0.290	0.409	0.468	0.687	0.742	0.707	0.864	0.872	0.744	0.818	1.082	1.081
2001	0.124	0.213	0.247	0.273	0.331	0.452	0.560	0.641	0.798	0.816	0.805	0.698	0.784	0.811	0.986
2002	0.124	0.223	0.252	0.297	0.344	0.433	0.463	0.650	0.709	0.805	0.961	0.917	0.996	0.931	0.812
2003	0.124	0.214	0.240	0.291	0.344	0.391	0.464	0.600	0.714	0.960	0.774	0.679	1.261	0.522	0.783

Table 9.2.10. North Sea plaice. Stock weights at ages 1-4 derived from survey samples.

	1	2	3	4
1957	0.040	0.100	0.162	0.247
1958	0.043	0.091	0.185	0.278
1959	0.047	0.103	0.178	0.270
1960	0.040	0.108	0.187	0.278
1961	0.039	0.095	0.190	0.312
1962	0.037	0.094	0.178	0.307
1963	0.043	0.101	0.181	0.279
1964	0.026	0.111	0.189	0.302
1965	0.033	0.066	0.204	0.301
1966	0.033	0.097	0.130	0.312
1967	0.030	0.101	0.184	0.209
1968	0.057	0.092	0.180	0.293
1969	0.049	0.154	0.193	0.271
1970	0.049	0.113	0.246	0.279
1971	0.053	0.107	0.262	0.352
1972	0.058	0.155	0.227	0.412
1973	0.038	0.130	0.245	0.319
1974	0.051	0.103	0.227	0.425
1975	0.066	0.139	0.195	0.397
1976	0.085	0.166	0.236	0.314
1977	0.067	0.180	0.277	0.318
1978	0.067	0.148	0.333	0.382
1979	0.064	0.175	0.269	0.373
1980	0.051	0.160	0.302	0.438
1981	0.043	0.137	0.249	0.431
1982	0.050	0.126	0.261	0.359
1983	0.047	0.125	0.253	0.389
1984	0.050	0.127	0.225	0.422
1985	0.050	0.145	0.239	0.325
1986	0.045	0.125	0.254	0.316
1987	0.037	0.103	0.205	0.382
1988	0.038	0.096	0.178	0.270
1989	0.041	0.100	0.198	0.250
1990	0.046	0.109	0.186	0.268
1991	0.051	0.132	0.192	0.268
1992	0.048	0.123	0.205	0.274
1993	0.053	0.117	0.215	0.326
1994	0.055	0.143	0.221	0.296
1995	0.052	0.141	0.262	0.341
1996	0.044	0.117	0.235	0.374
1997	0.033	0.116	0.188	0.374
1998	0.040	0.080	0.207	0.337
1999	0.045	0.090	0.154	0.320
2000	0.052	0.106	0.170	0.223
2001	0.063	0.121	0.208	0.237
2002	0.049	0.118	0.220	0.305
2003	0.062	0.112	0.228	0.269

Table 9.3.1. North Sea plaice: effort and CPUE trends for the NL and UK commercial fleets

	Effort				CPUE	
	NL beam-trawlers		English beam-trawlers	NL beam-trawlers	UK beam-trawlers	
Year	HP days * 100000		HP days *million			
1979	44.3			1693		
1980	45			1729		
1981	46.3			1853		
1982	57.3			1707		
1983	65.6			1441		
1984	70.8			1439		
1985	70.3			1511		
1986	68.2			1651		
1987	68.4			1440		
1988	76.2			1194		
1989	72.5			1379		
1990	71.1		102.3	1104	86	
1991	68.5		123.6	1022	70	
1992	71.1		151.5	745	59	
1993	76.9		146.6	656	51	
1994	81.4		131.4	626	47	
1995	81.2		105.0	565	49	
1996	72.1		82.9	510	46	
1997	72		76.3	492	55	
1998	70.3		68.8	451	55	
1999	67.3		68.6	577	45	
2000	67.7	(1)	57.8	536	68	(2)
2001	61.4	(3)	54.1	550	61	

(1) Updated at ACFM meeting october 2001
(2) Revised 2002
(3) Provisional

Table 9.3.2. North Sea plaice. Commercial tuning fleets (not used in the final assessment)

Plaice	in	the	North	Sea	(Area	IV)								
106														
NL	Beam	Trawl												
1989	2003													
1	1	0	1											
2	9													
72.5	40443	73696	131915	23064	9634	5240	2715	947						
71.1	21956	60038	49862	76521	12187	3682	1790	1161						
68.5	27501	42376	53152	30697	34092	6879	1954	1137						
71.1	24271	44306	31854	27165	12219	9485	2464	993						
76.9	27552	46536	31333	19705	10984	6040	3611	1025						
81.4	30194	48106	35901	15371	7938	6174	2866	1929						
81.2	22519	43505	33883	14453	6575	3418	1549	931						
72.1	26600	27628	20922	13980	5313	3644	1366	944						
72	23098	45655	18156	6884	4337	2016	975	460						
70.3	15288	32486	26751	6389	2290	1359	669	314						
67.3	4341	76295	18251	11058	2999	998	833	506						
67.7	8973	16995	72228	5789	3880	735	336	214						
61.4	16227	22535	19715	40807	2745	1759	390	196						
56.6	10034	32616	21690	14223	16567	1048	565	156						
51.6	19234	19957	20943	9620	5354	6659	311	259						
UK	Beam	Trawl												
1990	2002													
1	1	0	1											
4	12													
102.3	2764	9488	1786	1133	722	842	251	170	98					
123.6	2711	3538	6599	1325	837	427	610	226	183					
151.5	2909	4446	2787	3674	968	558	485	497	166					
146.6	3436	3060	2530	923	1876	635	400	357	255					
131.4	3038	2890	1772	1252	593	850	431	189	160					
105	3574	1657	1475	1020	620	332	378	287	143					
82.9	1105	1579	890	836	543	388	207	274	163					
76.3	1253	844	1066	599	686	505	211	148	229					
68.8	1623	892	617	598	347	415	317	134	110					
68.6	1011	1045	457	327	367	258	224	193	98					
57.8	3655	865	575	255	141	201	108	103	146					
54.1	794	2436	481	336	134	93	112	49	91					
30.6	716	637	906	157	126	43	53	46	41					
NL	Flag													
1991	2003													
1	1	0	1											
1	15													
96	43	472	735	546	770	159	64	35	17	8	4	2	1	4
166	367	1251	1103	1021	571	537	134	67	31	19	15	7	6	8
211	173	1351	1505	1124	727	427	294	94	51	25	20	14	5	7
194	297	1047	1569	806	486	390	192	138	53	19	9	5	5	4
219	389	1486	1549	819	358	214	118	71	45	17	7	3	2	2
152	269	855	1013	821	353	243	101	74	42	29	9	3	3	3
155	207	1542	1166	510	357	199	95	48	26	18	10	4	2	5
207	128	1335	2042	653	342	176	97	41	22	17	15	6	4	3
275	0	1785	1319	1153	302	119	95	58	38	13	17	9	9	4
272	148	817	5612	625	430	79	42	23	14	7	5	5	2	5
353	542	1284	1680	4857	377	288	63	36	28	12	22	6	1	13
253	271	2117	2007	1561	2236	134	81	25	6	20	2	4	4	11
246	369	1184	2002	1058	682	929	37	42	13	4	29	0	7	11

Table 9.3.3. North Sea plaice. Surveys tuning fleets (all used in the final assessment).

Plaice	in	the	North	Sea	(Area	IV)				
103										
BTS										
	1985	2003								
	1	1	0.66	0.75						
	1	9								
1	115.577	179.898	38.813	11.843	1.371	1.048	0.362	0.167	0.098	0.246
1	660.199	131.772	51.003	8.886	3.285	0.428	0.338	0.129	0.038	0.211
1	225.822	764.285	33.065	4.773	2.039	1.017	0.352	0.087	0.072	0.314
1	577.319	140.105	173.719	9.241	2.594	0.775	0.421	0.036	0.115	0.22
1	428.699	319.272	38.66	47.305	5.85	0.822	0.289	0.661	0.144	0.096
1	112.063	102.639	55.674	22.78	5.572	0.801	0.205	0.379	0.261	0.165
1	185.442	122.051	28.553	11.86	4.264	5.691	0.259	0.231	0.118	0.102
1	171.538	125.93	27.314	5.62	3.184	2.662	1.136	0.259	0.053	0.091
1	124.762	179.103	38.399	6.116	0.931	0.812	0.636	0.444	0.173	0.085
1	145.212	64.217	35.242	10.875	2.857	0.638	0.861	0.957	0.401	0.032
1	252.168	43.622	14.235	8.106	1.195	0.868	0.357	1.135	0.223	0.119
1	218.284	212.134	22.882	4.834	3.717	0.919	0.047	0.173	0.131	0.118
1	-11	-11	19.914	2.788	0.219	0.39	0.171	0.121	0	0.034
1	338.198	436.197	47.413	8.906	1.44	0.755	0.145	0.078	0.105	0.087
1	305.874	130.001	182.54	3.656	2.109	0.137	0.139	0.029	0.032	0.085
1	278.776	75.219	31.594	24.21	0.613	0.174	0.539	0.029	0.019	0.055
1	225.784	78.903	19.557	10.049	9.525	0.294	0.15	0.041	0.043	0.192
1	568.654	45.463	15.365	5.501	2.683	1.427	0.083	0.14	0	0.113
1	125.505	170.076	10.784	5.941	1.525	1.214	0.684	0.112	0.101	0.022
SNS										
1982	2002									
1	1	0.66	0.75							
1	3									
1	70108	8503	1146							
1	34884	14708	308							
1	44667	10413	2480							
1	27832	13789	1584							
1	93573	7558	1155							
1	33426	33021	1232							
1	36672	14430	13140							
1	37238	14952	3709							
1	24903	7287	3248							
1	57349	11149	1507							
1	48223	13742	2257							
1	22184	9484	988							
1	18225	4866	884							
1	24900	2786	415							
1	24663	10377	1189							
1	-11	-11	1393							
1	33391	29431	5739							
1	35188	9235	14347							
1	23028	2489	905							
1	10193	2416	356							
1	30265	1047	264							
BTS	Tridens									
1996	2003									
1	1	0.66	0.75							
2	9									
1	5.576	4.39	3.307	2.388	1.841	0.83	0.479	0.177	0.495	
1	-11	10.355	3.96	2.837	1.927	0.463	1.123	0.447	0.59	
1	30.786	9.969	5.521	2.705	1.349	0.899	0.782	0.327	0.448	
1	8.292	36.931	6.462	2.649	2.133	0.6	0.764	0.333	0.169	
1	9.453	12.736	17.227	2.936	1.893	1.076	0.954	0.247	0.621	
1	6.926	9.051	7.224	7.646	1.204	0.691	0.48	0.593	0.605	
1	14.405	10.724	7.611	4.262	4.132	0.519	0.629	0.358	0.779	
1	34.836	11.912	8.571	4.752	2.722	3.973	0.702	0.72	1.618	

Table 9.4.1. North Sea plaice. Diagnostics of the separable VPA using (a) the landings at age matrix; (b) the catch at age matrix using reconstructed discards; (c) the catch at age matrix using reconstructed and observed discards.

Title : Plaice in IV (a) the landings at age matrix;

At 9/09/2004 14:52

Separable analysis
from 1994 to 2003 on ages 1 to 14
with Terminal F of .500 on age 5 and Terminal S of .500

Initial sum of squared residuals was 161.081 and
final sum of squared residuals is 16.210 after 37 iterations

Matrix of Residuals

Years	1994/95	1995/96	1996/97	1997/98	1998/99	1999/**	2000/**	2001/**	2002/**	TOT	WTS
1/ 2	-0.508	1.345	-0.687	-0.727	-0.774	-0.569	0.473	1.751	-0.861	0.02	0.086
2/ 3	0.412	0.721	0.492	0.586	-0.358	-0.443	0.16	0.775	-0.137	-0.001	0.186
3/ 4	-0.114	0.505	0.236	0.152	0.507	-0.289	-0.131	0.031	-0.129	-0.01	0.3
4/ 5	-0.188	0.267	-0.011	0.101	0.255	0.187	0.137	-0.321	-0.27	-0.011	0.38
5/ 6	-0.43	0.095	-0.077	0.181	0.097	-0.053	0.119	0.062	-0.233	-0.008	0.436
6/ 7	-0.368	-0.221	-0.035	0.009	0.119	0.243	0.158	-0.338	-0.185	-0.003	0.389
7/ 8	0.073	-0.057	0.139	-0.141	-0.006	-0.019	-0.044	0.093	-0.02	0.003	1
8/ 9	0.072	-0.086	0.035	-0.112	-0.079	0.085	0.017	-0.17	0.155	0.008	0.798
9/10	0.139	-0.338	-0.04	-0.054	-0.266	0.149	-0.048	0.036	0.138	0.009	0.491
10/11	0.011	-0.279	0.139	0.03	-0.064	0.251	0.077	-0.493	0.236	0.006	0.355
11/12	0.349	0.4	0.057	0.182	0.158	-0.046	-0.181	-0.011	0.078	-0.001	0.463
12/13	-0.221	-0.414	-0.756	-0.439	-0.34	-0.49	-0.263	0.178	0.911	-0.007	0.176
13/14	0.308	-0.429	-0.333	0.178	0.089	-0.063	-0.132	0.246	-0.149	-0.009	0.335
TOT	0.025	0.034	0.029	0.032	0.024	0.007	-0.005	-0.014	-0.011	0.14	
WTS	0.001	0.001	0.001	0.001	1	1	1	1	1		

Fishing Mortalities (F)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
F-values	0.9029	0.7326	0.7949	0.8014	0.6766	0.7103	0.5907	0.6609	0.6747	0.5

Selection-at-age (S)

	1	2	3	4
S-values	0.0051	0.1151	0.5439	0.896

	5	6	7	8	9	10	11	12	13	14
S-values	1	0.924	0.8885	0.7383	0.723	0.6243	0.5178	0.7501	0.4966	0.5

Title : Plaice in IV (b) the catch at age matrix using reconstructed discards;

At 10/09/2004 10:30

Separable analysis
from 1994 to 2003 on ages 1 to 14
with Terminal F of .500 on age 5 and Terminal S of .500

Initial sum of squared residuals was 38.053 and
final sum of squared residuals is 7.765 after 39 iterations

Matrix of Residuals

Years	1994/95	1995/96	1996/97	1997/98	1998/99	1999/**	2000/**	2001/**	2002/**	TOT	WTS
1/ 2	-0.127	-0.346	-0.927	-1.134	-0.248	-0.36	0.077	0.552	-0.023	-0.004	0.215
2/ 3	-0.207	-0.067	-0.132	0.167	-0.031	-0.147	0.006	0.142	0.025	-0.004	0.858
3/ 4	-0.259	0.115	0.107	0.065	0.119	-0.106	0.008	0.054	-0.079	-0.004	0.855
4/ 5	-0.185	0.256	-0.028	0.01	0.143	0.088	-0.006	-0.043	-0.185	-0.004	0.761
5/ 6	-0.33	0.17	-0.025	0.174	0.068	-0.073	0.096	0.121	-0.216	-0.003	0.619
6/ 7	-0.248	-0.122	0.049	0.036	0.118	0.251	0.17	-0.346	-0.194	-0.002	0.535
7/ 8	0.186	0.037	0.22	-0.115	-0.006	-0.011	-0.031	0.086	-0.038	0	1
8/ 9	0.173	0.001	0.111	-0.088	-0.08	0.092	0.03	-0.177	0.136	0.001	0.926
9/10	0.236	-0.254	0.034	-0.03	-0.268	0.156	-0.035	0.028	0.118	0	0.639
10/11	0.098	-0.201	0.21	0.053	-0.066	0.257	0.091	-0.5	0.215	-0.002	0.451
11/12	0.436	0.479	0.126	0.205	0.157	-0.038	-0.167	-0.017	0.06	-0.004	0.512
12/13	-0.124	-0.33	-0.68	-0.413	-0.34	-0.482	-0.248	0.173	0.893	-0.006	0.235
13/14	0.388	-0.356	-0.265	0.202	0.09	-0.055	-0.116	0.242	-0.166	-0.005	0.438
TOT	0.001	-0.002	-0.003	-0.006	-0.006	-0.006	-0.005	-0.003	-0.001	-2.684	
WTS	0.001	0.001	0.001	0.001	1	1	1	1	1		

Fishing Mortalities (F)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
F-values	0.8113	0.6776	0.7643	0.8088	0.6938	0.7245	0.6038	0.6832	0.6923	0.5

Selection-at-age (S)

	1	2	3	4
S-values	0.2382	0.6866	0.8591	0.9556

	5	6	7	8	9	10	11	12	13	14
S-values	1	0.9009	0.8621	0.7172	0.7029	0.6078	0.5054	0.7356	0.491	0.5

Title : Plaice in IV (c) the catch at age matrix using reconstructed and observed discards

At 13/09/2004 14:45

Separable analysis
from 1994 to 2003 on ages 1 to 14
with Terminal F of .500 on age 5 and Terminal S of .500

Initial sum of squared residuals was 50.939 and
final sum of squared residuals is 11.409 after 67 iterations

Matrix of Residuals

Years	1994/95	1995/96	1996/97	1997/98	1998/99	1999/**	2000/**	2001/**	2002/**	TOT
1/ 2	0.319	0.216	-0.411	-0.608	0.496	-0.108	0.521	-1.002	0.095	0
2/ 3	-0.672	-0.357	-0.494	-0.187	0.158	-0.324	-0.039	0.242	-0.035	0
3/ 4	-0.524	0.013	-0.08	-0.033	1.014	-0.889	-0.442	0.455	-0.138	0
4/ 5	-0.407	0.136	-0.13	-0.129	0.555	-0.046	-0.092	0.085	-0.501	0
5/ 6	-0.416	0.176	-0.049	0.174	-0.062	-0.101	0.064	0.406	-0.307	0
6/ 7	-0.277	-0.064	0.08	0.093	0.047	0.29	0.195	-0.297	-0.235	0
7/ 8	0.149	0.087	0.243	-0.064	-0.085	0.01	-0.012	0.118	-0.032	0
8/ 9	0.135	0.047	0.131	-0.039	-0.162	0.117	0.053	-0.15	0.141	0
9/10	0.2	-0.205	0.058	0.023	-0.342	0.181	-0.016	0.047	0.13	0
10/11	0.056	-0.161	0.227	0.101	-0.145	0.278	0.11	-0.473	0.23	0
11/12	0.401	0.523	0.147	0.254	0.086	-0.013	-0.152	0.014	0.064	0
12/13	-0.163	-0.283	-0.659	-0.36	-0.417	-0.453	-0.232	0.206	0.898	0

13/14	0.351	-0.311	-0.245	0.255	0.018	-0.029	-0.101	0.273	-0.161	0
TOT	0	0	0	0	0	0	0	0	0	-2.728
WTS	0.001	0.001	0.001	0.001	1	1	1	1	1	

Fishing Mortalities (F)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	
F-values	0.8352	0.6636	0.7684	0.8199	0.7402	0.7153	0.6005	0.6781	0.6984	0.5	

Selection-at-age (S)

	1	2	3	4
S-values	0.1857	0.9766	1.0193	1.0675

	5	6	7	8	9	10	11	12	13	14	
S-values	1	0.8683	0.8351	0.6949	0.6812	0.5915	0.4919	0.72	0.4847	0.5	

Table 9.4.2. North Sea plaice. Diagnostics of the final XSA run.

```
Lowestoft VPA Version 3.1
   13/09/2004  14:18
 Extended Survivors Analysis
 Plaice in IV
 CPUE data from file fleet

 Catch data for  47 years. 1957 to 2003. Ages  1 to  10.
      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 BTS                 ,   1985, 2003,   1,     9,   .660,   .750
 SNS                 ,   1982, 2003,   1,     3,   .660,   .750
 BTS Tridens         ,   1996, 2003,   2,     9,   .660,   .750

 Time series weights :
      Tapered time weighting not applied
 Catchability analysis :
      Catchability independent of stock size for all ages
      Catchability independent of age for ages >=    6
 Terminal population estimation :
      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   2 oldest ages.
      S.E. of the mean to which the estimates  are shrunk =    .500
      Minimum standard error for population
      estimates derived from each fleet =    .300
      Prior weighting not applied
 Tuning converged after   34 iterations

 Regression weights
       , 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000

 Fishing mortalities
    Age,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003
      1,  .166,  .122,  .103,  .072,  .160,  .126,  .204,  .053,  .198,  .171
      2,  .494,  .468,  .552,  .893,  .568,  .451,  .636,  .807,  .797,  .813
      3,  .617,  .669,  .711,  .947, 1.389,  .384,  .441,  .866,  .751,  .723
      4,  .727,  .787,  .786,  .801, 1.144,  .729,  .696,  .748,  .618,  .715
      5,  .642,  .778,  .784,  .913,  .737,  .736,  .583,  .929,  .660,  .695
      6,  .654,  .611,  .714,  .799,  .630,  .671,  .629,  .513,  .651,  .583
      7,  .847,  .664,  .789,  .698,  .683,  .541,  .396,  .608,  .688,  .642
      8,  .590,  .544,  .660,  .607,  .579,  .669,  .351,  .334,  .470,  .475
      9,  .533,  .392,  .654,  .687,  .592,  .753,  .582,  .336,  .342,  .275

 XSA population numbers (Thousands)
                               AGE
 YEAR ,      1,         2,         3,         4,         5,         6,         7,         8,         9,
 1994 ,    4.37E+05, 3.80E+05, 3.13E+05, 1.65E+05, 8.73E+04, 4.50E+04, 2.82E+04, 1.51E+04, 1.37E+04,
 1995 ,    1.16E+06, 3.35E+05, 2.09E+05, 1.53E+05, 7.23E+04, 4.16E+04, 2.12E+04, 1.09E+04, 7.57E+03,
 1996 ,    1.21E+06, 9.26E+05, 1.90E+05, 9.71E+04, 6.30E+04, 3.00E+04, 2.04E+04, 9.86E+03, 5.74E+03,
 1997 ,    1.95E+06, 9.85E+05, 4.82E+05, 8.44E+04, 4.00E+04, 2.60E+04, 1.33E+04, 8.40E+03, 4.61E+03,
 1998 ,    7.43E+05, 1.64E+06, 3.65E+05, 1.69E+05, 3.43E+04, 1.45E+04, 1.06E+04, 5.99E+03, 4.14E+03,
 1999 ,    9.21E+05, 5.73E+05, 8.42E+05, 8.23E+04, 4.88E+04, 1.49E+04, 7.00E+03, 4.84E+03, 3.04E+03,
 2000 ,    1.01E+06, 7.35E+05, 3.30E+05, 5.19E+05, 3.59E+04, 2.12E+04, 6.87E+03, 3.69E+03, 2.25E+03,
 2001 ,    5.83E+05, 7.46E+05, 3.52E+05, 1.92E+05, 2.34E+05, 1.82E+04, 1.02E+04, 4.18E+03, 2.35E+03,
 2002 ,    2.23E+06, 5.00E+05, 3.02E+05, 1.34E+05, 8.24E+04, 8.37E+04, 9.83E+03, 5.03E+03, 2.71E+03,
 2003 ,    6.83E+05, 1.66E+06, 2.04E+05, 1.29E+05, 6.53E+04, 3.85E+04, 3.95E+04, 4.47E+03, 2.84E+03,

 Estimated population abundance at 1st Jan 2004

    ,     0.00E+00, 5.21E+05, 6.65E+05, 8.95E+04, 5.70E+04, 2.95E+04, 1.95E+04, 1.88E+04, 2.51E+03,

 Taper weighted geometric mean of the VPA populations:

    ,     9.18E+05, 6.81E+05, 3.76E+05, 2.00E+05, 1.04E+05, 5.35E+04, 2.93E+04, 1.63E+04, 9.75E+03,

 Standard error of the weighted Log(VPA populations) :

    ,        .5322,    .5394,    .4783,    .4902,    .5380,    .5828,    .6302,    .6998,    .7505,

 Log catchability residuals.
```

```
 Fleet : BTS

  Age  ,  1984,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992,  1993
     1 , 99.99, -1.20,  -.38,  -.60,   .43,   .52,  -.72,  -.04,   .03,   .11
     2 , 99.99,   .21,  -.43,   .44,  -.43,   .45,  -.38,  -.03,   .17,   .62
     3 , 99.99,  -.15,   .24,  -.45,   .33,  -.38,  -.02,  -.35,  -.18,   .29
     4 , 99.99,  -.35,  -.29,  -.68,  -.31,   .42,   .45,  -.17,  -.56,  -.28
     5 , 99.99,  -.62,  -.23,  -.33,   .12,   .56,  -.33,   .16,  -.03,  -.93
     6 , 99.99,   .23,  -.79,  -.37,  -.19,   .00,  -.45,   .85,   .80,  -.29
     7 , 99.99,   .00,  -.26,  -.22,  -.55,  -.45,  -.75,  -.88,   .08,   .11
     8 , 99.99,  -.10,  -.33, -1.02, -1.72,   .55,   .42,   .05,  -.18,  -.14
     9 , 99.99,  -.20,  -.73,  -.17,   .00,   .35,   .18,  -.05,  -.53,   .13

  Age  ,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003
     1 ,   .40,  -.05,  -.25, 99.99,   .71,   .37,   .24,   .47,   .16,  -.19
     2 ,  -.01,  -.29,   .33, 99.99,   .49,   .25,  -.41,  -.26,  -.42,  -.28
     3 ,   .28,  -.19,   .41,  -.49,   .97,   .77,  -.01,  -.25,  -.42,  -.40
     4 ,   .46,   .29,   .23,  -.17,   .53,   .07,   .10,   .25,  -.08,   .10
     5 ,   .30,  -.28,   .99, -1.30,   .62,   .65,  -.39,   .72,   .31,   .00
     6 ,  -.24,   .12,   .57,  -.08,  1.05,  -.65,  -.80,  -.20,  -.05,   .51
     7 ,   .67,  -.06, -1.96,  -.30,  -.25,   .02,  1.29,  -.23,  -.73,  -.04
     8 ,  1.22,  1.68,  -.02,  -.25,  -.37, -1.09, -1.04,  -.83,   .31,   .21
     9 ,   .41,   .31,   .24, 99.99,   .30,  -.46,  -.80,  -.21, 99.99,   .41


Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

    Age ,         1,         2,         3,         4,         5,         6,         7,         8,
9
 Mean Log q,   -8.2233,   -8.2564,   -8.8661,   -9.5097,  -10.1069,  -10.3957,  -10.3957,  -10.3957,
-10.3957,
 S.E(Log q),     .4946,     .3725,     .4232,     .3585,     .5907,     .5465,     .6947,     .8248,
.3991,

Regression statistics :

 Ages with q independent of year class strength and constant w.r.t. time.

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q
  1,    1.59,   -1.972,      4.84,     .41,     18,     .73,   -8.22,
  2,     .88,     .810,      8.88,     .76,     18,     .33,   -8.26,
  3,     .91,     .506,      9.24,     .65,     19,     .39,   -8.87,
  4,    1.03,    -.204,      9.42,     .72,     19,     .38,   -9.51,
  5,     .97,     .133,     10.15,     .55,     19,     .59,  -10.11,
  6,     .90,     .505,     10.42,     .62,     19,     .50,  -10.40,
  7,    1.23,    -.741,     10.81,     .37,     19,     .81,  -10.63,
  8,     .67,    1.438,     10.08,     .53,     19,     .53,  -10.54,
  9,     .74,    1.950,      9.95,     .79,     17,     .27,  -10.44,

 Fleet : SNS

  Age  ,  1982,  1983
     1 ,   .25,  -.01
     2 ,   .24,   .01
     3 ,  -.25, -1.43
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age
     6 , No data for this fleet at this age
     7 , No data for this fleet at this age
     8 , No data for this fleet at this age
     9 , No data for this fleet at this age

  Age  ,  1984,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992,  1993
     1 ,   .32,  -.57,  -.28,  -.45,  -.27,   .13,  -.17,   .85,   .82,   .44
     2 ,   .12,   .45,  -.48,   .10,   .10,   .20,  -.22,   .39,   .77,   .49
     3 ,  -.11,  -.15,  -.34,  -.54,   .95,   .48,   .34,  -.09,   .53,  -.17
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age
     6 , No data for this fleet at this age
     7 , No data for this fleet at this age
     8 , No data for this fleet at this age
     9 , No data for this fleet at this age

  Age  ,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003
     1 ,   .38,  -.31,  -.37, 99.99,   .45,   .27,  -.19,  -.56,  -.72, 99.99
     2 ,   .22,  -.23,   .13, 99.99,   .61,   .42, -1.01,  -.93, -1.38, 99.99
     3 ,  -.20,  -.52,   .66,   .05,  2.06,  1.43,  -.36, -1.05, -1.28, 99.99
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age
```

```
    6 , No data for this fleet at this age
    7 , No data for this fleet at this age
    8 , No data for this fleet at this age
    9 , No data for this fleet at this age

 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

    Age ,         1,         2,         3
 Mean Log q,   -3.3741,   -4.1600,   -5.1607,
 S.E(Log q),     .4589,     .5640,     .8370,

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,    1.68,   -2.406,     -3.82,     .41,     20,     .69,   -3.37,
  2,     .86,     .650,      5.47,     .55,     20,     .49,   -4.16,
  3,     .63,    1.592,      8.10,     .49,     21,     .50,   -5.16,
 Fleet : BTS Tridens

  Age  ,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003
     1 , No data for this fleet at this age
     2 , 99.99, 99.99,  -.94, 99.99,   .21,  -.13,  -.12,  -.32,   .80,   .50
     3 , 99.99, 99.99,  -.39,  -.29,   .26,   .02,  -.06,  -.17,   .07,   .55
     4 , 99.99, 99.99,  -.29,   .04,  -.08,   .50,  -.38,  -.22,   .10,   .33
     5 , 99.99, 99.99,  -.39,   .32,   .31,  -.07,   .23,  -.44,  -.17,   .20
     6 , 99.99, 99.99,  -.18,   .06,   .17,   .64,   .13,  -.25,  -.44,  -.13
     7 , 99.99, 99.99,  -.54,  -.76,   .12,   .03,   .53,  -.16,  -.35,   .26
     8 , 99.99, 99.99,  -.45,   .52,   .48,   .73,  1.00,   .18,   .36,   .59
     9 , 99.99, 99.99,  -.91,   .26,  -.02,   .42,   .31,   .97,   .32,   .92

 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

    Age ,         2,         3,         4,         5,         6,         7,         8,         9
 Mean Log q,  -10.6243,   -9.7186,   -9.3718,   -9.1656,   -8.9423,   -8.9423,   -8.9423,   -8.9423,
 S.E(Log q),     .5694,     .3030,     .3067,     .3101,     .3312,     .4452,     .6261,     .6619,

 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,     .95,     .107,     10.79,     .44,      7,     .59,  -10.62,
  3,    1.09,    -.323,      9.44,     .68,      8,     .35,   -9.72,
  4,    1.46,   -1.925,      8.21,     .74,      8,     .38,   -9.37,
  5,    1.63,   -3.074,      7.99,     .80,      8,     .34,   -9.17,
  6,    1.73,   -2.680,      8.05,     .69,      8,     .42,   -8.94,
  7,    1.12,    -.367,      9.01,     .60,      8,     .52,   -9.05,
  8,    6.27,   -2.213,      8.02,     .03,      8,    2.17,   -8.52,
  9,   -2.72,   -3.124,      6.57,     .10,      8,    1.07,   -8.66,

Terminal year survivor and F summaries :

 Age  1   Catchability constant w.r.t. time and dependent on age

 Year class = 2002

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 BTS                 ,    431765.,   .508,       .000,    .00,   1,  .449,     .203
 SNS                 ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 BTS Tridens         ,         1.,   .000,       .000,    .00,   0,  .000,     .000

   F shrinkage mean  ,    606490.,    .50,,,,                        .551,     .149

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    520606.,       .36,      .25,    2,    .705,   .171

 Age  2   Catchability constant w.r.t. time and dependent on age

 Year class = 2001

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
```

BTS	,	575729.,	.307,	.206,	.67,	2,	.393,	.896
SNS	,	324656.,	.470,	.000,	.00,	1,	.146,	1.273
BTS Tridens	,	1093840.,	.609,	.000,	.00,	1,	.106,	.567
F shrinkage mean	,	903615.,	.50,,,,				.355,	.655

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
665187.,	.23,	.22,	5,	.925,	.813

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2000

Fleet, ,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
BTS	,	68908.,	.271,	.231,	.85,	3,	.309,	.867
SNS	,	36447.,	.365,	.400,	1.10,	2,	.101,	1.283
BTS Tridens	,	159692.,	.294,	.079,	.27,	2,	.336,	.467
F shrinkage mean	,	81985.,	.50,,,,				.254,	.770

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
89541.,	.19,	.20,	8,	1.060,	.723

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 1999

Fleet, ,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
BTS	,	54574.,	.250,	.132,	.53,	4,	.326,	.738
SNS	,	26593.,	.368,	.328,	.89,	3,	.056,	1.175
BTS Tridens	,	71274.,	.235,	.114,	.48,	3,	.396,	.607
F shrinkage mean	,	49392.,	.50,,,,				.222,	.791

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
57004.,	.17,	.10,	11,	.592,	.715

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1998

Fleet, ,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
BTS	,	26967.,	.252,	.079,	.31,	5,	.260,	.740
SNS	,	18085.,	.353,	.453,	1.28,	3,	.033,	.969
BTS Tridens	,	33085.,	.210,	.072,	.34,	4,	.479,	.639
F shrinkage mean	,	27391.,	.50,,,,				.228,	.732

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
29464.,	.17,	.06,	13,	.369,	.695

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet, ,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
BTS	,	27716.,	.259,	.079,	.31,	6,	.248,	.442
SNS	,	24982.,	.345,	.240,	.70,	3,	.027,	.480
BTS Tridens	,	16768.,	.199,	.020,	.10,	5,	.510,	.651
F shrinkage mean	,	17866.,	.50,,,,				.215,	.621

Weighted prediction :

```
Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    19460.,       .16,      .06,   15,    .398,   .583

Age  7   Catchability constant w.r.t. time and age (fixed at the value for age)  6
Year class = 1996

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
BTS                 ,     21380.,   .313,       .134,    .43,   6,  .217,     .583
SNS                 ,     49778.,   .498,       .408,    .82,   2,  .008,     .293
BTS Tridens         ,     16155.,   .217,       .149,    .68,   6,  .480,     .717

  F shrinkage mean  ,     21275.,    .50,,,,                        .295,     .586

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    18794.,       .19,      .09,   15,    .446,   .642

Age  8   Catchability constant w.r.t. time and age (fixed at the value for age)  6
Year class = 1995

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
BTS                 ,      2170.,   .335,       .161,    .48,   7,  .221,     .533
SNS                 ,      5159.,   .464,      1.209,   2.61,   2,  .003,     .260
BTS Tridens         ,      2719.,   .223,       .175,    .78,   6,  .462,     .446

  F shrinkage mean  ,      2468.,    .50,,,,                        .314,     .482

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     2514.,       .20,      .09,   16,    .441,   .475

Age  9   Catchability constant w.r.t. time and age (fixed at the value for age)  6

Year class = 1994

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
BTS                 ,      2570.,   .304,       .123,    .40,   9,  .399,     .216
SNS                 ,      1811.,   .349,       .142,    .41,   3,  .003,     .294
BTS Tridens         ,      2615.,   .255,       .160,    .63,   8,  .354,     .212

  F shrinkage mean  ,       822.,    .50,,,,                        .244,     .561

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1956.,       .19,      .15,   21,    .758,   .275
```

Table 9.4.3. North Sea plaice. F derived from final XSA run.

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,
AGE							
1,	.0767,	.1050,	.1511,	.1081,	.0964,	.0955,	.1493,
2,	.2250,	.2481,	.3102,	.3147,	.2885,	.3168,	.3620,
3,	.2533,	.2961,	.3515,	.3530,	.3393,	.3721,	.4150,
4,	.2962,	.3541,	.3658,	.3785,	.3564,	.3898,	.4316,
5,	.3439,	.3604,	.4052,	.3513,	.4086,	.4333,	.4098,
6,	.2015,	.3181,	.3637,	.4086,	.3117,	.4130,	.4731,
7,	.2532,	.2568,	.3454,	.3544,	.3482,	.3343,	.4291,
8,	.2673,	.2626,	.2924,	.3513,	.3901,	.3331,	.4017,
9,	.2608,	.2603,	.3197,	.3538,	.3702,	.3346,	.4167,
+gp,	.2608,	.2603,	.3197,	.3538,	.3702,	.3346,	.4167,
FBAR 2- 6,	.2640,	.3154,	.3593,	.3612,	.3409,	.3850,	.4183,

Table 8 Fishing mortality (F) at age

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
1,	.0315,	.0679,	.0709,	.0541,	.1976,	.1481,	.2224,	.1952,	.2313,	.1130,
2,	.3987,	.2660,	.3527,	.3487,	.2853,	.3133,	.4331,	.3310,	.3799,	.3927,
3,	.4446,	.3960,	.3859,	.3994,	.3391,	.3239,	.4935,	.3854,	.3993,	.4313,
4,	.4627,	.4074,	.4288,	.4055,	.3534,	.3342,	.4978,	.3900,	.4095,	.5383,
5,	.5358,	.3484,	.4683,	.4736,	.3626,	.3057,	.4495,	.3986,	.4221,	.5370,
6,	.4634,	.5015,	.3341,	.4892,	.3203,	.4216,	.4829,	.3785,	.4290,	.4175,
7,	.4015,	.3852,	.4950,	.2983,	.3904,	.2911,	.5789,	.3995,	.3829,	.3684,
8,	.3624,	.3499,	.3639,	.4206,	.2743,	.3719,	.2567,	.3954,	.4305,	.4356,
9,	.3831,	.3686,	.4308,	.3605,	.3332,	.3324,	.4191,	.3986,	.4080,	.4032,
+gp,	.3831,	.3686,	.4308,	.3605,	.3332,	.3324,	.4191,	.3986,	.4080,	.4032,
FBAR 2- 6,	.4610,	.3839,	.3939,	.4233,	.3321,	.3398,	.4714,	.3767,	.4080,	.4633,

Table 8 Fishing mortality (F) at age

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
1,	.2200,	.3540,	.3330,	.3237,	.3052,	.4267,	.2379,	.1771,	.2412,	.2372,
2,	.3977,	.4990,	.4053,	.4713,	.4294,	.6396,	.4690,	.4847,	.5141,	.5179,
3,	.4875,	.5284,	.4231,	.4909,	.4637,	.6677,	.6696,	.5762,	.6943,	.5605,
4,	.5117,	.5500,	.4295,	.4938,	.4652,	.6735,	.6259,	.6045,	.6737,	.7452,
5,	.5897,	.5923,	.3762,	.6579,	.4525,	.6683,	.5057,	.5883,	.6106,	.6044,
6,	.4413,	.6050,	.4246,	.4085,	.5091,	.6845,	.4970,	.4469,	.5304,	.5414,
7,	.4007,	.4590,	.4995,	.4270,	.4420,	.6784,	.4642,	.4727,	.4764,	.4742,
8,	.4311,	.5159,	.4254,	.5014,	.4062,	.5627,	.4692,	.4844,	.4812,	.4663,
9,	.4172,	.4892,	.4640,	.4658,	.4255,	.6231,	.4683,	.4802,	.4805,	.4719,
+gp,	.4172,	.4892,	.4640,	.4658,	.4255,	.6231,	.4683,	.4802,	.4805,	.4719,
FBAR 2- 6,	.4856,	.5550,	.4117,	.5045,	.4640,	.6667,	.5535,	.5401,	.6046,	.5939,

Table 8 Fishing mortality (F) at age

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
1,	.3002,	.2618,	.2853,	.2200,	.2316,	.2110,	.1614,	.2394,	.2146,	.2233,
2,	.5524,	.4732,	.6072,	.6461,	.6328,	.5798,	.4736,	.6063,	.5566,	.4895,
3,	.5812,	.4928,	.6327,	.6755,	.6700,	.6316,	.5699,	.6605,	.6542,	.6113,
4,	.5886,	.6920,	.6361,	.7295,	.6670,	.6369,	.6026,	.6928,	.6748,	.6511,
5,	.6357,	.4639,	.7044,	.7767,	.7102,	.6257,	.7163,	.7249,	.7811,	.7522,
6,	.5407,	.5003,	.6586,	.6162,	.6853,	.6137,	.5629,	.8007,	.7214,	.6859,
7,	.5033,	.5053,	.5570,	.6686,	.6005,	.6068,	.4994,	.6205,	.7144,	.6146,
8,	.6024,	.5246,	.6440,	.4854,	.6815,	.5277,	.4589,	.6177,	.5874,	.5793,
9,	.5550,	.5879,	.8459,	.6527,	.6991,	.5539,	.4317,	.6528,	.8618,	.6198,
+gp,	.5550,	.5879,	.8459,	.6527,	.6991,	.5539,	.4317,	.6528,	.8618,	.6198,
FBAR 2- 6,	.5797,	.5245,	.6478,	.6888,	.6730,	.6175,	.5850,	.6971,	.6776,	.6380,

Table 8 Fishing mortality (F) at age

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	FBAR **-**
AGE											
1,	.1656,	.1223,	.1030,	.0724,	.1603,	.1264,	.2038,	.0531,	.1978,	.1710,	.1406,
2,	.4945,	.4681,	.5521,	.8935,	.5677,	.4510,	.6364,	.8066,	.7975,	.8135,	.8058,
3,	.6174,	.6686,	.7112,	.9471,	1.3889,	.3838,	.4410,	.8662,	.7507,	.7234,	.7801,
4,	.7275,	.7866,	.7860,	.8008,	1.1437,	.7288,	.6964,	.7479,	.6184,	.7150,	.6938,
5,	.6422,	.7779,	.7841,	.9135,	.7368,	.7357,	.5832,	.9292,	.6599,	.6951,	.7614,
6,	.6537,	.6106,	.7138,	.7991,	.6304,	.6711,	.6289,	.5134,	.6507,	.5828,	.5823,
7,	.8469,	.6642,	.7892,	.6981,	.6828,	.5411,	.3965,	.6077,	.6882,	.6425,	.6461,
8,	.5899,	.5440,	.6596,	.6066,	.5792,	.6687,	.3513,	.3342,	.4697,	.4752,	.4264,
9,	.5329,	.3920,	.6543,	.6866,	.5924,	.7531,	.5818,	.3357,	.3423,	.2747,	.3176,
+gp,	.5329,	.3920,	.6543,	.6866,	.5924,	.7531,	.5818,	.3357,	.3423,	.2747,	
FBAR 2- 6,	.6271,	.6624,	.7094,	.8708,	.8935,	.5941,	.5972,	.7727,	.6955,	.7060,	

Table 9.4.4. North Sea plaice. Stock numbers derived from final XSA run.

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1957	1958	1959	1960	1961	1962	1963
AGE							
1	460650	698409	870210	758653	864419	591497	689154
2	260380	386035	568976	676973	616125	710267	486444
3	324321	188125	272553	377543	447178	417783	468156
4	187128	227787	126599	173534	240001	288187	260573
5	118244	125919	144643	79455	107538	152056	176583
6	51320	75856	79455	87278	50598	64667	89207
7	51837	37961	49937	49976	52482	33522	38714
8	40466	36413	26569	31989	31726	33524	21714
9	22772	28027	25338	17945	20371	19434	21739
+gp	49596	60156	61964	53276	49633	47171	50987
TOTAL	1566714	1864688	2226245	2306621	2480071	2358108	2303271

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
1	2237758	699829	591143	403511	433666	650732	651804	411094	367683	1314432
2	537092	1961992	591655	498270	345898	322034	507767	472162	306000	263981
3	306483	326192	1360663	376241	318131	235299	213012	297952	306843	189369
4	279732	177779	198635	837020	228348	205065	153993	117669	183383	186232
5	153124	159359	107029	117058	504899	145101	132835	84700	72084	110171
6	106057	81080	101772	60631	65962	317919	96708	76678	51447	42766
7	50291	60375	44429	65933	33637	43326	188701	53989	47518	30313
8	22809	30458	37164	24506	44273	20599	29301	95705	32763	29318
9	13148	14365	19423	23370	14560	30450	12850	20509	58318	19274
+gp	55582	59757	44655	38684	49422	59625	45387	53870	48925	75676
TOTAL	3762076	3571185	3096568	2445225	2038794	2030151	2032359	1684329	1474964	2261531

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
1	1135922	867188	692988	987718	911302	891337	1128745	870659	2034130	1307402
2	1062244	824869	550709	449448	646549	607686	526393	805069	659964	1446138
3	161289	645796	453152	332252	253848	380801	290062	297978	448635	357119
4	111319	89628	344479	268578	184007	144461	176727	134354	151530	202730
5	98368	60384	46789	202867	148310	104557	66654	85514	66419	69903
6	58266	49354	30218	29064	95076	85355	48496	36372	42964	32636
7	25489	33911	24386	17882	17479	51708	38953	26694	21050	22872
8	18976	15449	19390	13390	10557	10165	23741	22156	15056	11828
9	17160	11158	8345	11465	7339	6363	5240	13436	12350	8420
+gp	67478	53281	35391	25838	22567	20939	15051	16201	23739	23059
TOTAL	2756512	2651017	2205847	2338501	2297034	2303373	2320062	2308433	3475838	3482106

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
1	1259721	1851012	4739127	1924351	1772820	1185927	1035623	911473	773924	524443
2	933180	844217	1289136	3223695	1397337	1272518	868983	797369	649151	565044
3	779611	486008	475885	635587	1528767	671504	644796	489665	393466	336657
4	184493	394502	268649	228722	292664	707855	323085	329990	228879	185086
5	87068	92666	178677	128679	99785	135919	338790	160024	149345	105467
6	34559	41722	52724	79935	53551	44381	65785	149764	70135	61878
7	17185	18210	22892	24691	39058	24419	21740	33904	60844	30847
8	12880	9400	9941	11868	11448	19385	12044	11938	16495	26948
9	6714	6381	5033	4724	6609	5240	10348	6887	5824	8295
+gp	16123	13641	12706	11945	12947	13724	11373	12189	12516	13314
TOTAL	3331533	3757760	7054769	6274195	5214986	4080874	3332566	2903204	2360579	1857980

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE											
1	437408	1156083	1207190	1951141	743403	921277	1011454	583250	2233559	682668	0
2	379572	335365	925628	985436	1642239	573033	734594	746498	500465	1658268	520606
3	313387	209469	190016	482201	364894	842309	330295	351748	301513	203987	665187
4	165300	152941	97123	84432	169231	82326	519253	192286	133847	128784	89541
5	87330	72260	63021	40044	34298	48793	35942	234150	82361	65251	57004
6	44977	41575	30034	26032	14534	14854	21154	18152	83657	38520	29464
7	28198	21167	20427	13310	10593	7001	6870	10205	9829	39487	19460
8	15096	10939	9857	8396	5992	4842	3688	4182	5029	4469	18794
9	13661	7573	5745	4612	4142	3038	2245	2348	2709	2845	2514
+gp	13760	12122	10648	8795	7297	6105	4984	8485	5751	3749	4533
TOTAL	1498691	2019493	2559688	3604398	2996622	2503577	2670478	2151303	3358718	2828028	1407103

	GMST 57-**	AMST 57-**
AGE	906483	1055815
1	671852	783425
2	382841	434956
3	204082	233029
4	105478	122952
5	53387	63843
6	29785	36110
7	17227	21230
8	10306	13169

Table 9.5.1a. North Sea plaice. Inputs to RCT3 analysis, discards included.

'yc'	'VPA-1'	'VPA-2'	'SNS-0'	'SNS-1'	'SNS-2'	'SNS-3'	'SNS-4'	'BTS-1'	'BTS-2'	'BTS-3'	'BTS-4'	'comb DFS/YFS-0'	'comb DFS/YFS-1'
1967	433666	322034	-11	-11	-11	2813	156	-11	-11	-11	-11	-11	-11
1968	650732	507767	-11	-11	9450	1008	70	-11	-11	-11	-11	-11	-11
1969	651804	472162	-11	8032	23848	4484	795	-11	-11	-11	-11	-11	-11
1970	411094	306000	3678	18101	9584	1631	258	-11	-11	-11	-11	-11	-11
1971	367683	263981	6705	6437	4191	1261	33	-11	-11	-11	-11	-11	-11
1972	1314432	1062244	9242	57238	17985	10744	185	-11	-11	-11	-11	-11	-11
1973	1135922	824869	5451	15648	9171	791	591	-11	-11	-11	-11	-11	-11
1974	867188	550709	2193	9781	2274	1720	136	-11	-11	-11	-11	-11	-11
1975	692988	449448	1151	9037	2900	435	159	-11	-11	-11	-11	-11	-11
1976	987718	646549	11544	19119	12714	1577	110	-11	-11	-11	-11	-11	-11
1977	911302	607686	4378	13924	9540	456	34	-11	-11	-11	-11	-11	-11
1978	891337	526393	3252	21681	12084	785	93	-11	-11	-11	-11	-11	-11
1979	1128745	805069	27835	58049	16106	1146	78	-11	-11	-11	-11	-11	-11
1980	870659	659964	4039	19611	8503	308	16	-11	-11	-11	-11	-11	-11
1981	2034130	1446138	31542	70108	14708	2480	351	-11	-11	-11	12	634	287
1982	1307402	933180	23987	34884	10413	1584	145	-11	-11	39	9	457	160
1983	1259721	844217	36722	44667	13789	1155	198	-11	180	51	5	432	117
1984	1851012	1289136	7958	27832	7558	1232	1357	116	132	33	9	263	101
1985	4739127	3223695	47385	93573	33021	13140	4034	660	764	174	47	718	269
1986	1924351	1397337	8818	33426	14429	3709	828	226	140	39	23	345	189
1987	1772820	1272518	21270	36672	14952	3248	1161	577	319	56	12	465	105
1988	1185927	868983	15598	37238	7287	1507	612	429	103	29	6	331	135
1989	1035623	797369	24198	24903	11149	2257	98	112	122	27	6	463	129
1990	911473	649151	9559	57349	13742	988	78	185	126	38	11	468	151
1991	773924	565044	17120	48223	9484	884	96	172	179	35	8	496	131
1992	524443	379572	5398	22184	4866	415	42	125	64	14	5	357	74
1993	437408	335365	9226	18225	2786	1189	34	145	44	23	3	263	31
1994	1156083	925628	27901	24900	10377	1393	41	252	212	20	9	445	38
1995	1207190	985436	13029	24663	-11	5739	1040	218	-11	47	4	184	117
1996	1951141	1642239	91713	-11	29431	14347	982	-11	436	183	24	572	153
1997	743403	573033	15363	33391	9235	905	196	338	130	32	10	157	-11
1998	921277	734594	22720	35188	2489	356	58	305	75	20	6	-11	-11
1999	1011454	746498	39201	23028	2416	263	-11	279	79	15	6	-11	14
2000	-11	-11	24185	10193	1047	-11	-11	226	45	11	-11	185	5
2001	-11	-11	101291	30265	-11	-11	-11	569	170	-11	-11	500	19
2002	-11	-11	29905	-11	-11	-11	-11	126	-11	-11	-11	213	11
2003	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	363	-11

Table 9.5.2a. North Sea plaice. RCT3 output for 1 year olds, discards included.

Analysis by RCT3 ver3.1 of data from file :

p4rct1.csv

Plaice North Sea - 1-Y-Rcr.,,,,,,,,,,,,

Data for 11 surveys over 37 years : 1967 - 2003

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2000

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.96	4.84	.81	.302	30	10.09	14.55	.864	.073
SNS-1	1.20	1.66	.59	.443	30	9.23	12.70	.644	.132
SNS-2	1.34	1.63	.81	.309	31	6.95	10.93	.964	.059
SNS-3									
SNS-4									
BTS-1	1.89	3.56	.90	.307	15	5.42	13.84	1.003	.054
BTS-2	.96	9.18	.39	.699	16	3.83	12.85	.467	.251
BTS-3	1.06	10.11	.49	.563	18	2.48	12.76	.578	.164
BTS-4									
comb D	2.79	-2.56	1.02	.248	17	5.23	11.99	1.222	.037
comb D	1.26	8.18	.80	.339	17	1.79	10.43	1.194	.038
					VPA Mean =		13.81	.535	.191

Yearclass = 2001

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.96	4.84	.81	.302	30	11.53	15.93	.921	.078
SNS-1	1.20	1.66	.59	.443	30	10.32	14.01	.624	.169
SNS-2									
SNS-3									
SNS-4									
BTS-1	1.89	3.56	.90	.307	15	6.35	15.58	1.082	.056
BTS-2	.96	9.18	.39	.699	16	5.14	14.11	.433	.350
BTS-3									
BTS-4									
comb D	2.79	-2.56	1.02	.248	17	6.22	14.75	1.134	.051
comb D	1.26	8.18	.80	.339	17	3.00	11.95	.997	.066
					VPA Mean =		13.81	.535	.230

Yearclass = 2002

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.96	4.84	.81	.302	30	10.31	14.75	.869	.181
SNS-1									
SNS-2									
SNS-3									
SNS-4									
BTS-1	1.89	3.56	.90	.307	15	4.84	12.74	1.045	.125
BTS-2									
BTS-3									

BTS-4									
comb D	2.79	-2.56	1.02	.248	17	5.37	12.38	1.188	.097
comb D	1.26	8.18	.80	.339	17	2.48	11.31	1.072	.119
					VPA Mean =		13.81	.535	.478

Yearclass = 2003

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
SNS-0									
SNS-1									
SNS-2									
SNS-3									
SNS-4									
BTS-1									
BTS-2									
BTS-3									
BTS-4									
comb D	2.79	-2.56	1.02	.248	17	5.90	13.86	1.122	.185
comb D									
					VPA Mean =		13.81	.535	.815

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	416622	12.94	.23	.34	2.06		
2001	1376228	14.13	.26	.35	1.85		
2002	665757	13.41	.37	.52	1.99		
2003	1001290	13.82	.48	.02	.00		

Table 9.5.3a. North Sea plaice. RCT3 output for 2 year olds, discards included.

Analysis by RCT3 ver3.1 of data from file :

p4rct2.csv

Plaice North Sea - 2-Y-Rcr.,,,,,,,,,,,,

Data for 11 surveys over 37 years : 1967 - 2003

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2000

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.87	5.34	.70	.374	30	10.09	14.16	.743	.090
SNS-1	1.14	1.87	.54	.484	30	9.23	12.42	.593	.141
SNS-2	1.32	1.46	.79	.320	31	6.95	10.65	.944	.056
SNS-3									
SNS-4									
BTS-1	1.79	3.83	.85	.316	15	5.42	13.55	.942	.056
BTS-2	.92	9.05	.37	.712	16	3.83	12.59	.441	.255
BTS-3	1.02	9.97	.46	.581	18	2.48	12.51	.543	.168
BTS-4									
comb D	2.85	-3.26	1.06	.225	17	5.23	11.64	1.270	.031
comb D	1.28	7.79	.83	.316	17	1.79	10.08	1.231	.033
						VPA Mean =	13.49	.537	.172

Yearclass = 2001

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.87	5.34	.70	.374	30	11.53	15.41	.792	.095
SNS-1	1.14	1.87	.54	.484	30	10.32	13.67	.574	.182
SNS-2									
SNS-3									
SNS-4									
BTS-1	1.79	3.83	.85	.316	15	6.35	15.20	1.017	.058
BTS-2	.92	9.05	.37	.712	16	5.14	13.80	.409	.358
BTS-3									
BTS-4									
comb D	2.85	-3.26	1.06	.225	17	6.22	14.47	1.179	.043
comb D	1.28	7.79	.83	.316	17	3.00	11.62	1.027	.057
						VPA Mean =	13.49	.537	.207

Yearclass = 2002

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.87	5.34	.70	.374	30	10.31	14.35	.748	.230
SNS-1									
SNS-2									
SNS-3									
SNS-4									
BTS-1	1.79	3.83	.85	.316	15	4.84	12.51	.982	.133
BTS-2									
BTS-3									

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BTS-4									
comb D	2.85	-3.26	1.06	.225	17	5.37	12.04	1.235	.085
comb D	1.28	7.79	.83	.316	17	2.48	10.96	1.105	.106
					VPA Mean =		13.49	.537	.446

Yearclass = 2003

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
SNS-0									
SNS-1									
SNS-2									
SNS-3									
SNS-4									
BTS-1									
BTS-2									
BTS-3									
BTS-4									
comb D	2.85	-3.26	1.06	.225	17	5.90	13.56	1.166	.175
comb D									
					VPA Mean =		13.49	.537	.825

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	321750	12.68	.22	.33	2.15		
2001	1037027	13.85	.24	.33	1.87		
2002	522118	13.17	.36	.51	2.03		
2003	728231	13.50	.49	.03	.00		

Table 9.6.1. North Sea plaice. Summary table derived from the final XSA run.

Year	Recruits millions	SSB '000 t	TSB '000 t	Catch '000 t	Landings '000 t	Discards '000 t	Fbar 2-6	F-HC	F-Discards
1957	461	289.6	347.3	78.5	70.6	7.9	0.264	0.213	0.051
1958	698	309.3	374.3	88.3	73.4	14.9	0.315	0.232	0.083
1959	870	310.9	405.4	109.3	79.3	30.0	0.359	0.231	0.129
1960	759	318.0	420.2	117.2	87.5	29.6	0.361	0.264	0.097
1961	864	328.5	433.9	118.4	86.0	32.4	0.341	0.230	0.111
1962	591	388.9	481.4	125.2	87.5	37.7	0.385	0.248	0.137
1963	689	380.4	476.9	148.4	107.1	41.3	0.418	0.263	0.155
1964	2238	378.4	495.3	147.4	110.5	36.9	0.461	0.296	0.165
1965	700	353.6	474.7	139.9	97.1	42.7	0.384	0.278	0.105
1966	591	367.1	503.8	167.3	101.8	65.5	0.394	0.238	0.156
1967	404	427.5	499.4	163.0	108.8	54.2	0.423	0.248	0.175
1968	434	409.7	479.0	139.5	111.5	28.0	0.332	0.205	0.127
1969	651	386.1	465.4	142.8	121.7	21.2	0.340	0.245	0.095
1970	652	343.6	430.4	160.9	130.3	30.5	0.471	0.346	0.125
1971	411	323.1	409.2	136.1	113.9	22.1	0.377	0.283	0.094
1972	368	326.7	406.6	142.5	122.8	19.7	0.408	0.324	0.084
1973	1314	280.6	370.9	143.8	130.4	13.4	0.463	0.405	0.058
1974	1136	289.0	419.9	157.8	112.5	45.3	0.486	0.403	0.083
1975	867	301.0	478.5	195.3	108.5	86.8	0.555	0.368	0.187
1976	693	312.6	470.6	167.0	113.7	53.3	0.412	0.291	0.121
1977	988	322.4	475.0	176.8	119.2	57.6	0.504	0.333	0.172
1978	911	308.4	459.6	159.8	114.0	45.8	0.464	0.355	0.109
1979	891	301.5	462.9	213.4	145.3	68.1	0.667	0.483	0.184
1980	1129	276.5	419.9	171.1	140.0	31.2	0.553	0.489	0.065
1981	871	265.4	395.1	172.5	139.7	32.7	0.540	0.472	0.068
1982	2034	268.1	470.0	204.5	154.5	49.9	0.605	0.515	0.090
1983	1307	317.4	514.4	218.0	144.0	73.9	0.594	0.482	0.112
1984	1260	326.9	536.8	225.9	156.1	69.8	0.580	0.427	0.153
1985	1851	348.1	560.0	220.7	159.8	60.9	0.524	0.431	0.094
1986	4739	374.6	728.8	296.4	165.3	131.0	0.648	0.481	0.167
1987	1924	448.2	750.6	343.2	153.7	189.5	0.689	0.479	0.210
1988	1773	395.7	666.2	311.8	154.5	157.4	0.673	0.399	0.274
1989	1186	419.3	598.0	277.5	169.8	107.6	0.618	0.380	0.238
1990	1036	376.0	531.0	228.6	156.2	72.4	0.585	0.399	0.186
1991	911	340.7	486.8	229.6	148.0	81.6	0.697	0.460	0.237
1992	774	273.3	390.7	183.4	125.2	58.2	0.678	0.460	0.217
1993	524	236.4	333.4	152.2	117.1	35.1	0.638	0.501	0.137
1994	437	203.8	289.6	134.4	110.4	24.0	0.627	0.522	0.105
1995	1156	184.2	295.4	120.4	98.4	22.1	0.662	0.570	0.092
1996	1207	180.3	309.9	133.8	81.7	52.1	0.709	0.553	0.156
1997	1951	188.1	354.9	180.0	83.0	96.9	0.871	0.570	0.301
1998	743	204.4	337.5	174.6	71.5	103.1	0.894	0.466	0.427
1999	921	160.6	292.7	122.0	80.7	41.4	0.594	0.474	0.120
2000	1011	220.9	340.5	132.5	81.1	51.4	0.597	0.370	0.227
2001	583	230.3	348.8	136.0	82.0	54.0	0.773	0.362	0.411
2002	2234	183.0	355.1	130.7	70.2	60.4	0.695	0.426	0.269
2003	683	214.3	372.7	141.3	66.5	74.8	0.706	0.425	0.281
2004	906	187.0							0.706

Table 9.7.1a. North Sea plaice. Short term forecast input data, discards included.

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	906483	0.53	WS1	0.06	0.13
N2	522118	0.36	WS2	0.12	0.04
N3	665186	0.23	WS3	0.22	0.05
N4	89541	0.20	WS4	0.27	0.13
N5	57003	0.17	WS5	0.34	0.02
N6	29463	0.17	WS6	0.43	0.07
N7	19460	0.16	WS7	0.50	0.11
N8	18793	0.19	WS8	0.63	0.04
N9	2514	0.20	WS9	0.74	0.07
N10	4532	0.19	WS10	0.84	0.07
H.cons selectivity			Weight in the HC catch		
sH1	0.01	1.24	WH1	0.24	0.01
sH2	0.05	0.28	WH2	0.26	0.03
sH3	0.29	0.23	WH3	0.29	0.01
sH4	0.47	0.24	WH4	0.32	0.03
sH5	0.62	0.07	WH5	0.36	0.03
sH6	0.56	0.17	WH6	0.45	0.08
sH7	0.62	0.11	WH7	0.53	0.10
sH8	0.41	0.24	WH8	0.69	0.04
sH9	0.31	0.11	WH9	0.77	0.02
sH10	0.31	0.12	WH10	0.85	0.06
Discard selectivity			Weight in the discards		
sD1	0.13	0.62	WD1	0.04	0.59
sD2	0.73	0.08	WD2	0.08	0.13
sD3	0.47	0.21	WD3	0.12	0.05
sD4	0.20	0.60	WD4	0.14	0.18
sD5	0.12	1.03	WD5	0.16	0.16
sD6	0.01	0.35	WD6	0.21	0.09
sD7	0.01	1.59	WD7	0.20	0.09
sD8	0.00	0.94	WD8	-3.53	0.08
sD9	0.00	1.73	WD9	-7.27	0.00
sD10	0.00	1.73	WD10	-7.27	0.00
Natural mortality			Proportion mature		
M1	0.10	0.10	MT1	0.00	0.10
M2	0.10	0.10	MT2	0.50	0.10
M3	0.10	0.10	MT3	0.50	0.10
M4	0.10	0.10	MT4	1.00	0.10
M5	0.10	0.10	MT5	1.00	0.00
M6	0.10	0.10	MT6	1.00	0.00
M7	0.10	0.10	MT7	1.00	0.00
M8	0.10	0.10	MT8	1.00	0.00
M9	0.10	0.10	MT9	1.00	0.00
M10	0.10	0.10	MT10	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF04	1.00	0.06	K04	1.00	0.10
HF05	1.00	0.06	K05	1.00	0.10
HF06	1.00	0.06	K06	1.00	0.10
Recruitment in 2005 and 2006					
R05	906483	0.53			
R06	906483	0.53			

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

Stock numbers in 2004 are VPA survivors.
These are overwritten at Age 2
Human consumption + discard Fs are obtained from mean exploitation pattern over 2001 to 2003.
This is scaled to give a value for mean F (ages 2 to 6) equal to that in 2003, i.e. 0.706
Fs are distributed between consumption and discards by mean proportion retained over 2001 to 2003.
N.B. Above value for HCO +DIS ref F is value for both catch categories combined.

Table 9.7.2a. North Sea plaice. Management option table, discards included.

Table_____.plaice,north sea
Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 2004	2005						
Mean F Ages								
H.cons 2 to 6	0.71	0.00	0.14	0.28	0.42	0.56	0.71	0.85
Effort relative to 2003								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Biomass								
Total 1 January	343	310	310	310	310	310	310	310
SSB at spawning time	187	192	192	192	192	192	192	192
Catch weight (,000t)								
H.cons	76.8	0.0	17.6	33.0	46.6	58.5	68.9	78.2
Discards	52.3	0.0	11.7	21.8	30.7	38.4	45.1	51.0
Total Catch	129.1	0.0	29.2	54.8	77.2	96.8	114.1	129.2
Biomass in year.... 2006								
Total 1 January		483	436	395	359	328	301	277
SSB at spawning time		312	276	245	218	195	174	156

	Year 2004	2005						
Effort relative to 2003								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.15	0.20	0.20	0.20	0.20	0.20	0.20	0.20
SSB at spawning time	0.12	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Catch weight								
H.cons	0.17	0.00	0.33	0.22	0.19	0.18	0.18	0.17
Discards	0.23	0.00	0.45	0.37	0.36	0.35	0.35	0.34
Biomass in year.... 2006								
Total 1 January		0.21	0.21	0.21	0.22	0.22	0.23	0.23
SSB at spawning time		0.18	0.19	0.19	0.19	0.20	0.21	0.21

Table 9.7.3a. North Sea plaice. Detailed forecast table, discards included.

Forecast for year 2004
F multiplier H.cons=1.00

Age	Stock No. (Populations)	H.Cons (Catch number)	Discards	Total
1	906483	6457	104112	110569
2	522118	18017	253968	271985
3	665186	128050	211037	339088
4	89541	29534	12524	42058
5	57003	23861	4703	28564
6	29463	12078	129	12207
7	19460	8567	124	8691
8	18793	6093	15	6107
9	2514	637	2	639
10	4532	1149	0	1149
Wt	343	77	52	129

Forecast for year 2005
F multiplier H.cons=1.00

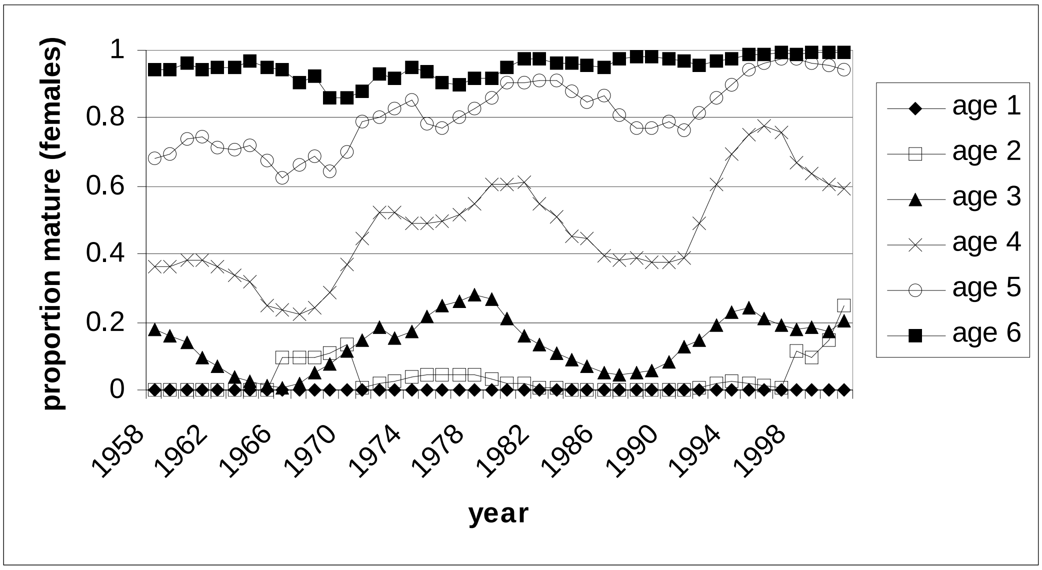
Age	Stock No. (Populations)	H.Cons (Catch number)	Discards	Total
1	906483	6457	104112	110569
2	715207	24680	347890	372570
3	215485	41482	68365	109847
4	281481	92844	39371	132215
5	41252	17268	3403	20671
6	24584	10078	108	10186
7	15107	6650	97	6747
8	9387	3043	7	3051
9	11218	2844	9	2853
10	4679	1187	0	1187
Wt	310	69	45	114

Table 9.10.1a. North Sea plaice. Biological reference points, discards included.

Reference point	**Deterministic**	**Median**	**75th percentile**	**95th percentile**	**Hist SSB < ref pt %**
MedianRecruits	871000	871000	911000	1011000	
MBAL	0				0.00
B_{loss}	160600				
SSB90%R90%Surv	301729	278868	303761	333094	42.55
SPR%ofVirgin	3.25	3.29	3.64	4.22	
VirginSPR	5.33	5.31	6.08	6.94	
SPRloss	0.16	0.16	0.18	0.22	
	Deterministic	**Median**	**25th percentile**	**5th percentile**	**Hist F > ref pt %**
FBar	0.71	0.70	0.67	0.63	10.64
F_{max}	0.17	0.17	0.16	0.15	100.00
$F_{0.1}$	0.12	0.12	0.11	0.10	100.00
F_{low}	0.33	0.31	0.29	0.27	95.74
F_{med}	0.47	0.47	0.45	0.42	59.57
F_{high}	0.75	0.77	0.72	0.66	6.38
F35%SPR	0.13	0.13	0.13	0.12	100.00
F_{loss}	0.74	0.72	0.67	0.60	6.38

For estimation of Gloss and F_{loss}:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.
For estimation of the stock recruitment relationship used in equilibrium calculations:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.
north sea plaice
Steady state selection provided as input
FBar averaged from age 2 to 6
Number of iterations = 100
Random number seed = -99
Stock recruitment data Monte Carloed using residuals from the equilibrium LOWESS fit
Data source:
D:\Groups\Working_groups\WGNSSK\2004\at_wg\ple\longterm\with_discards\PLED2.SEN
D:\Groups\Working_groups\WGNSSK\2004\at_wg\ple\longterm\with_discards\PLED2.SUM
FishLab DLL used FLVB32.DLL built on Jun 14 1999 at 11:53:37
PASoft 4 October 1999 14/09/2004 13:27:51

Figure 9.2.1. North Sea plaice. Maturity at age of female plaice (top panel) and combined sexes (bottom panel).



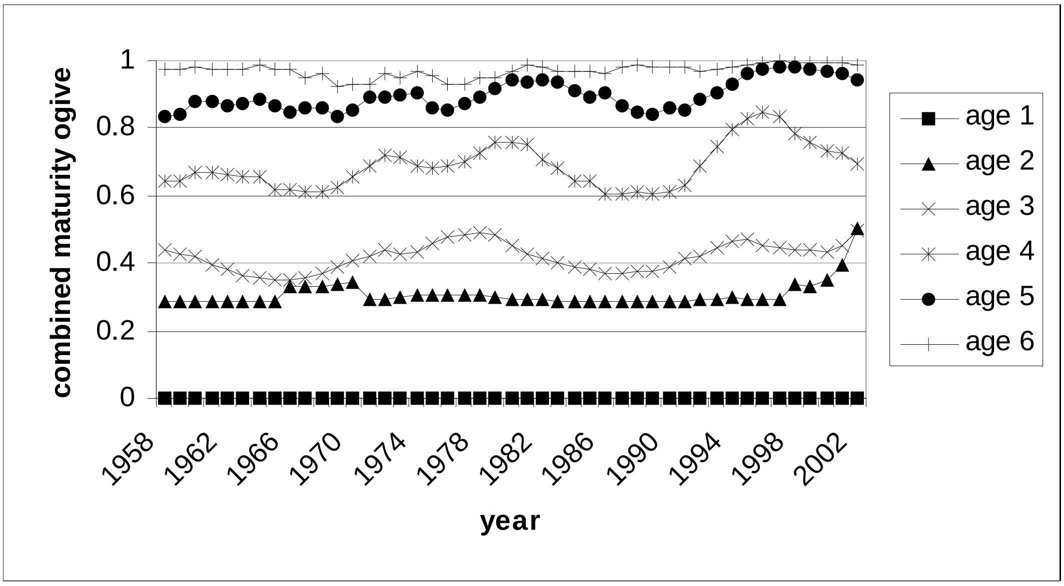


Figure 9.2.2. North Sea plaice. Relative age compositions of the landings by country in 2002 and 2003. The percentages in the legend indicate the proportion of the total landings for each country.

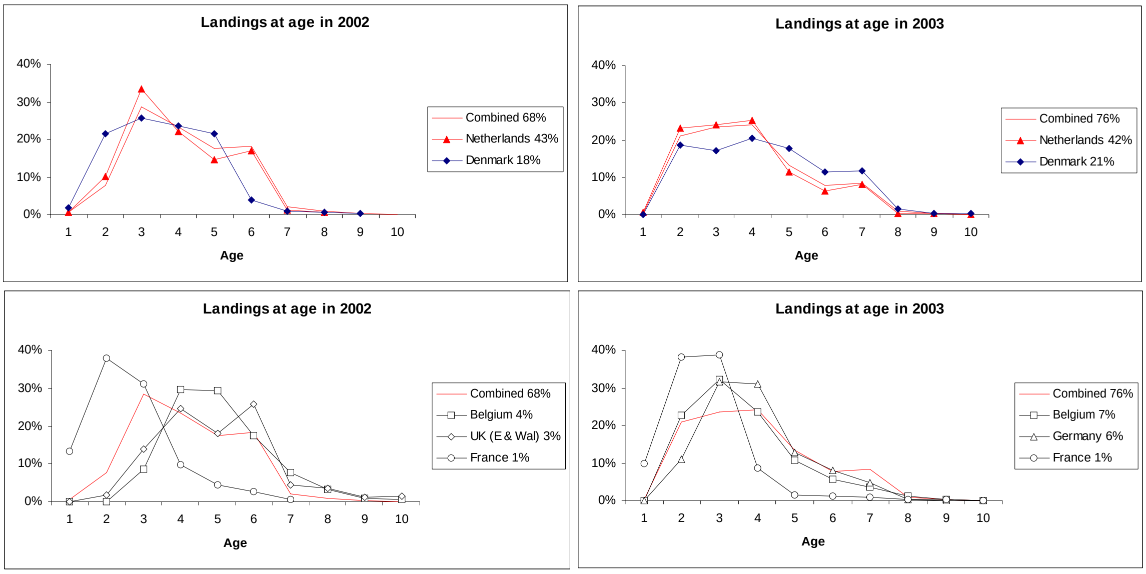


Figure 9.2.3. North Sea plaice. Schematic overview of the discards reconstruction method.

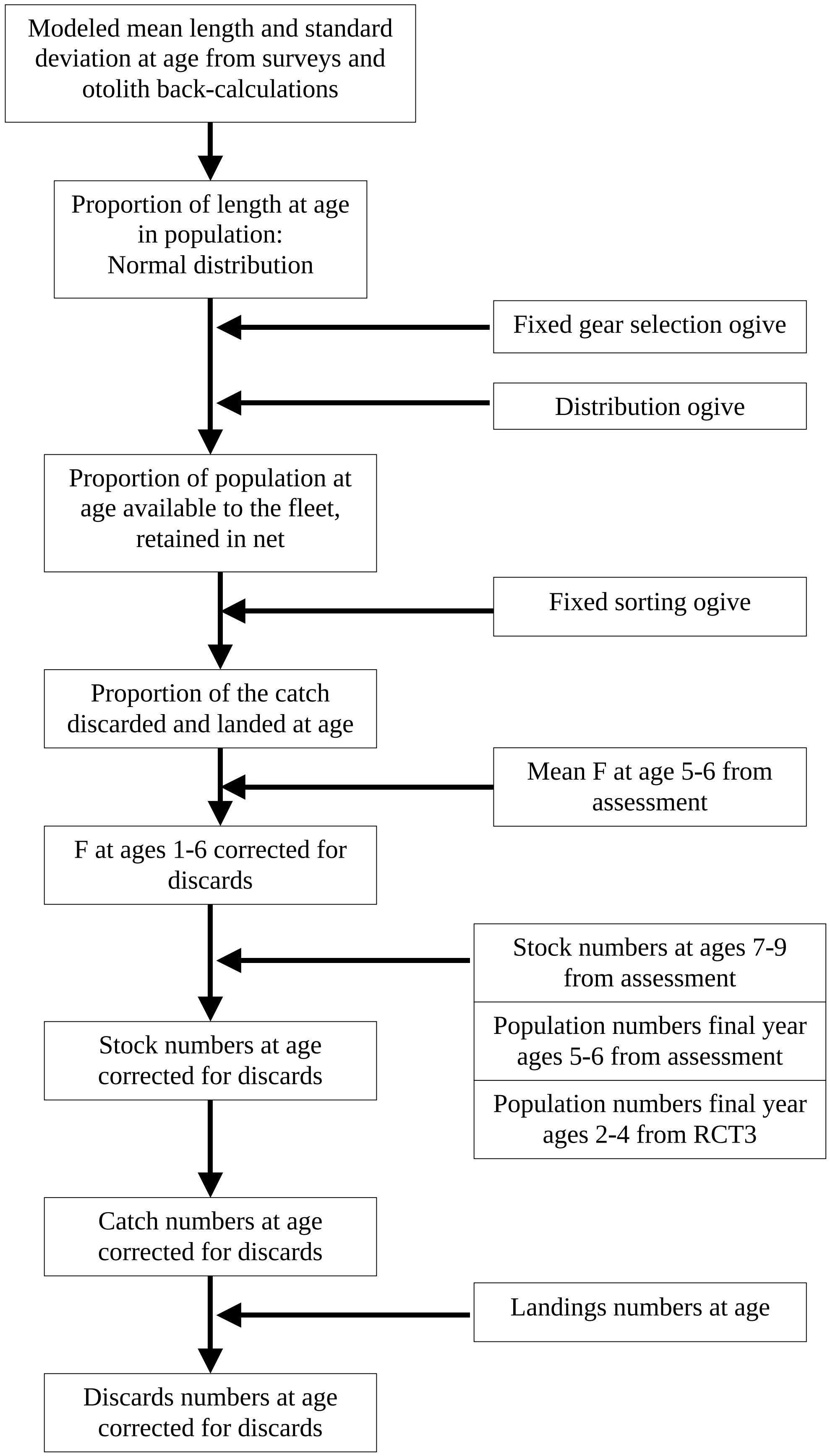


Figure 9.2.4. North Sea plaice. Landing and discard (observed + reconstructed) numbers by age.

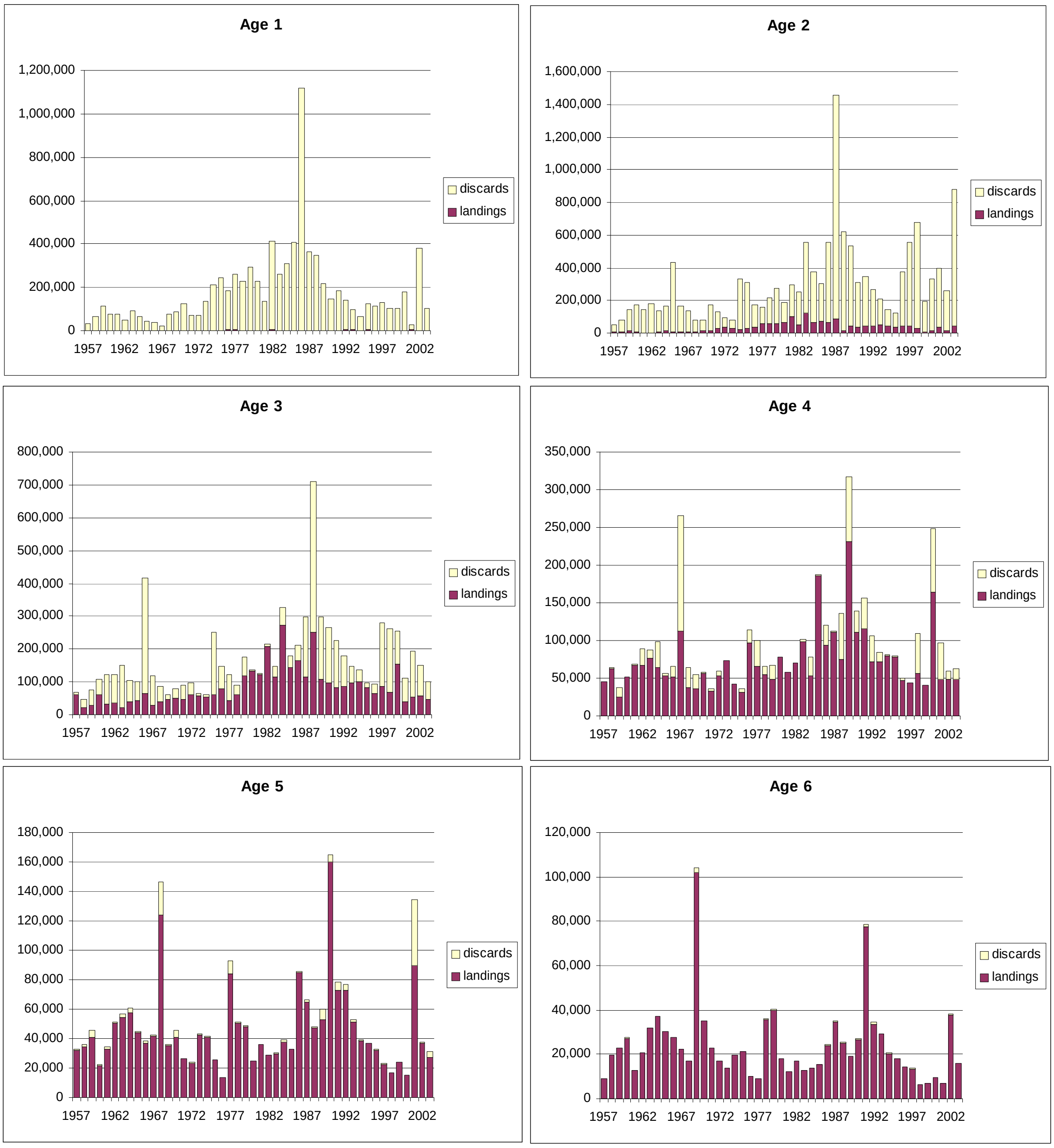


Figure 9.2.5. North Sea plaice. Weights at age in the landings based on market samples, and in the discards and stock based on survey data and discard reconstructions.

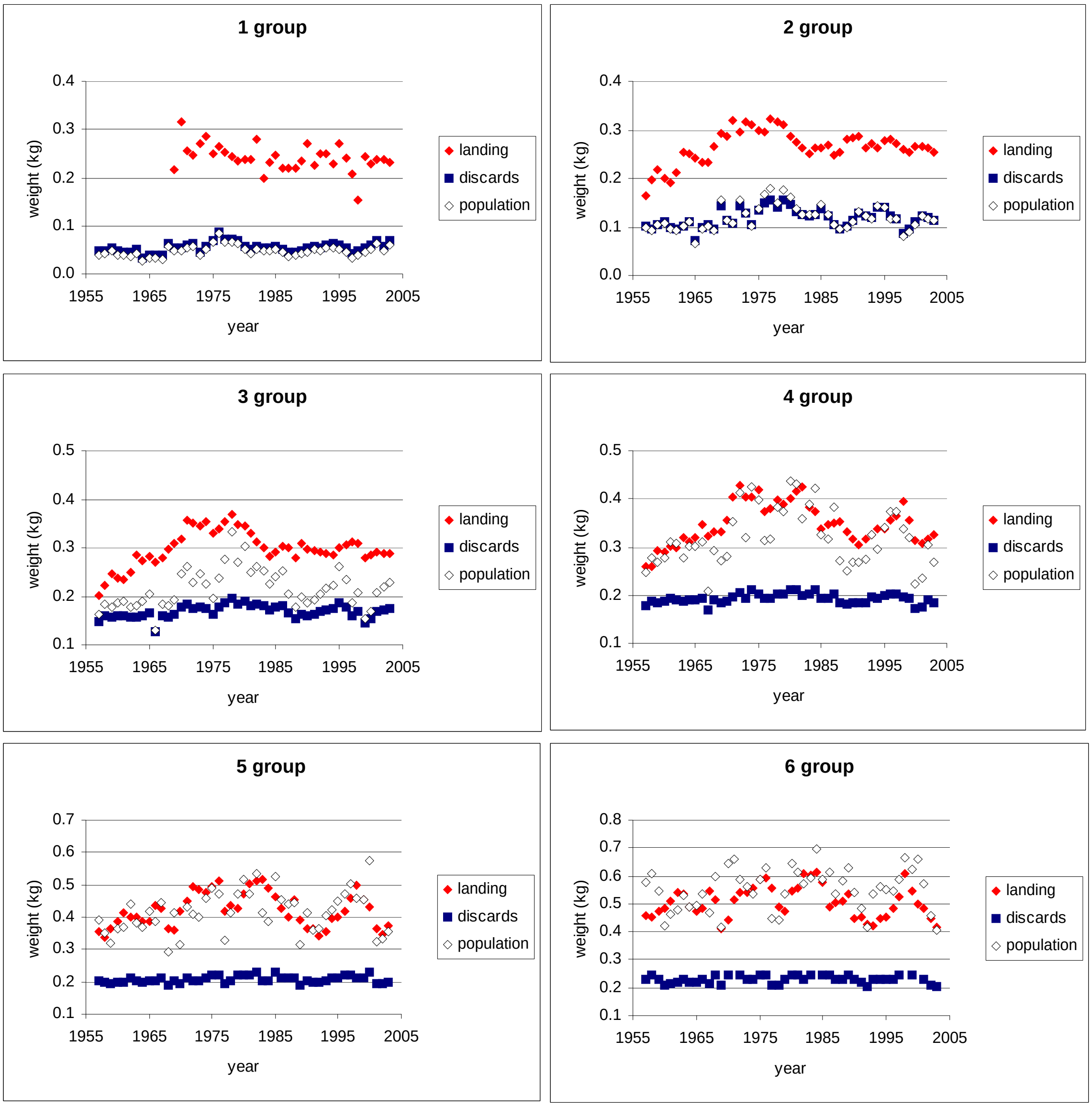
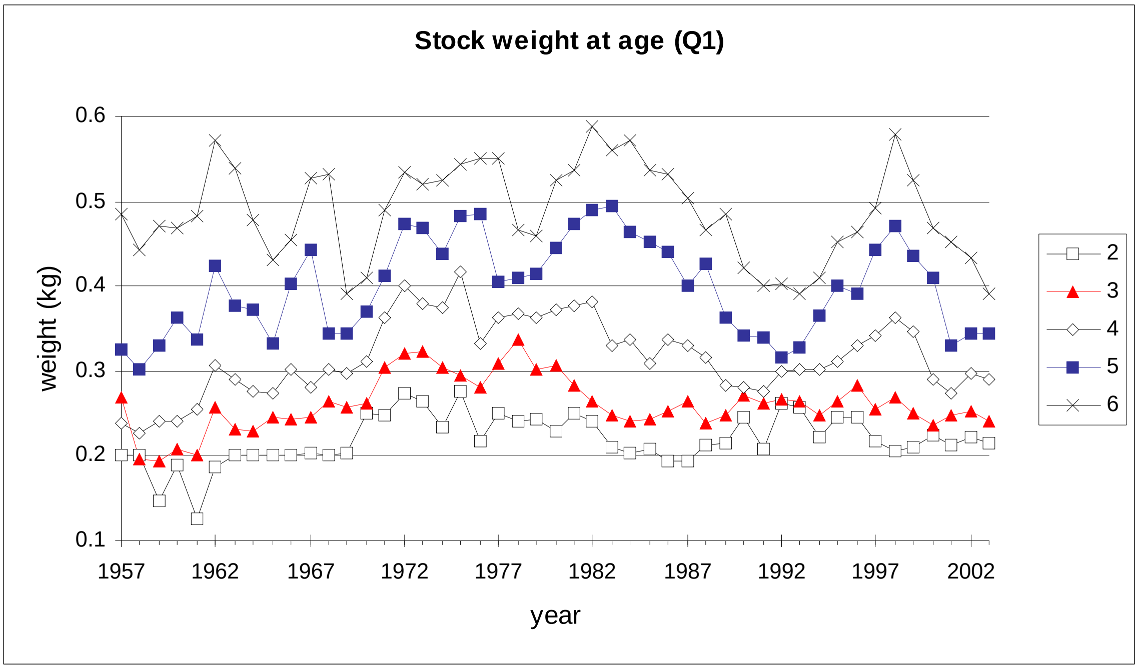


Figure 9.2.6. North Sea plaice. Stock weights at ages as derived from the market sampling programmes.



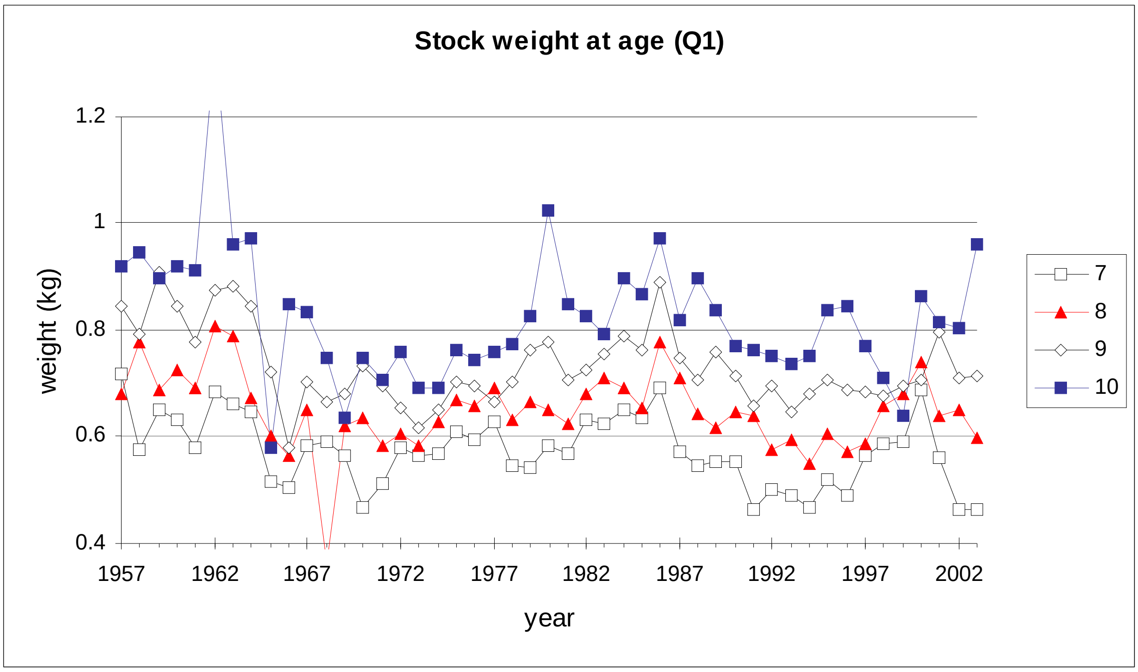
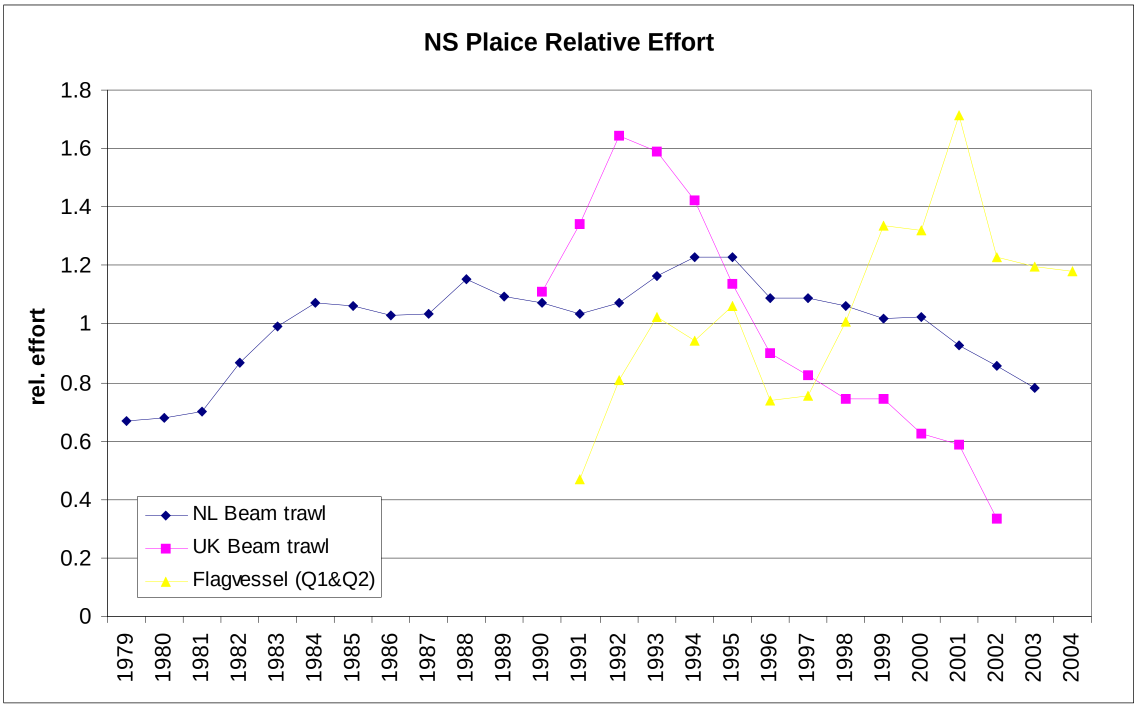


Figure 9.3.1. North Sea plaice. Relative effort and CPUE.



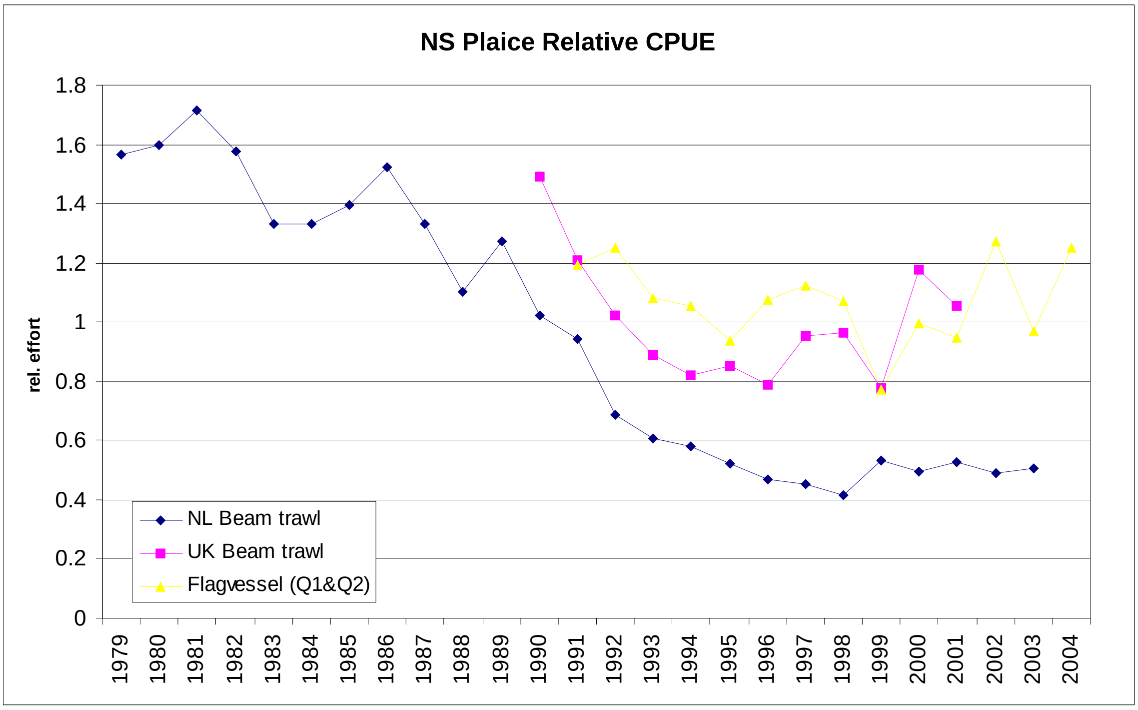


Figure 9.3.2. North Sea plaice. Standardised CPUE for commercial fleets and surveys by age group. The fleets between brackets have not been used in the assessments of previous years.

Figure 9.3.3. North Sea plaice. Catch rates of 1+ group in the DFS survey in the Wadden Sea.

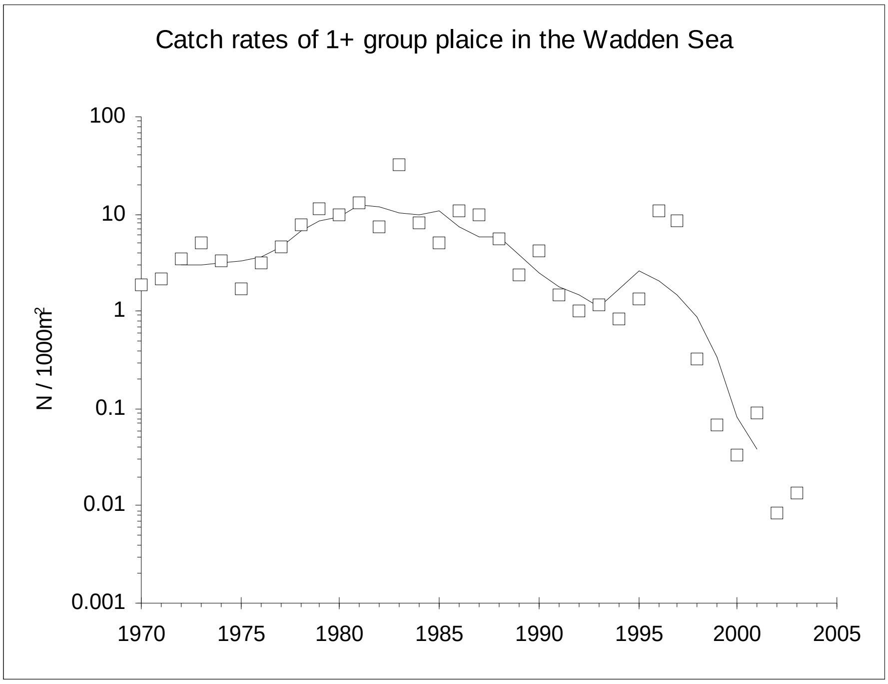
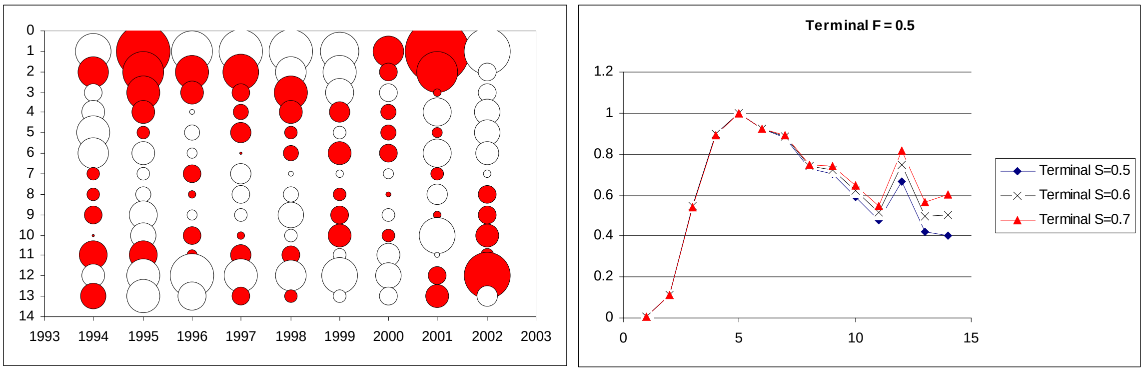
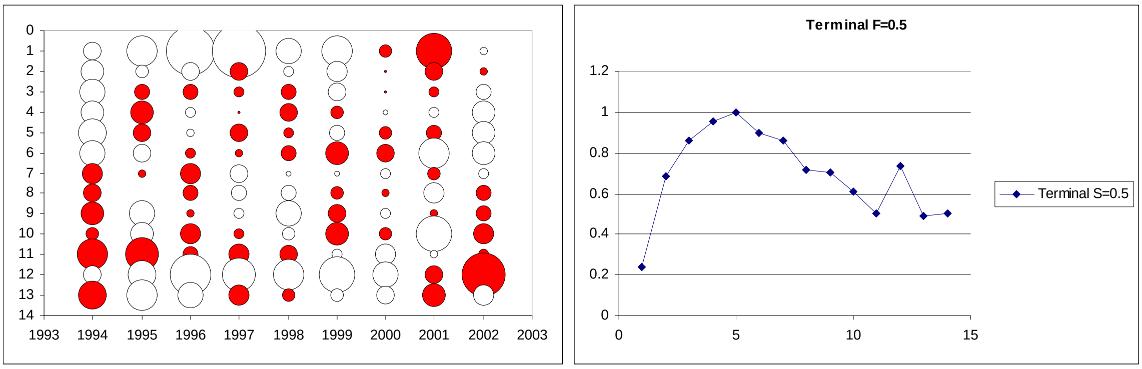


Figure 9.4.1. North Sea plaice. Separable VPA residuals and selection patterns.

Without discards



With reconstructed discards



With reconstructed and observed discards

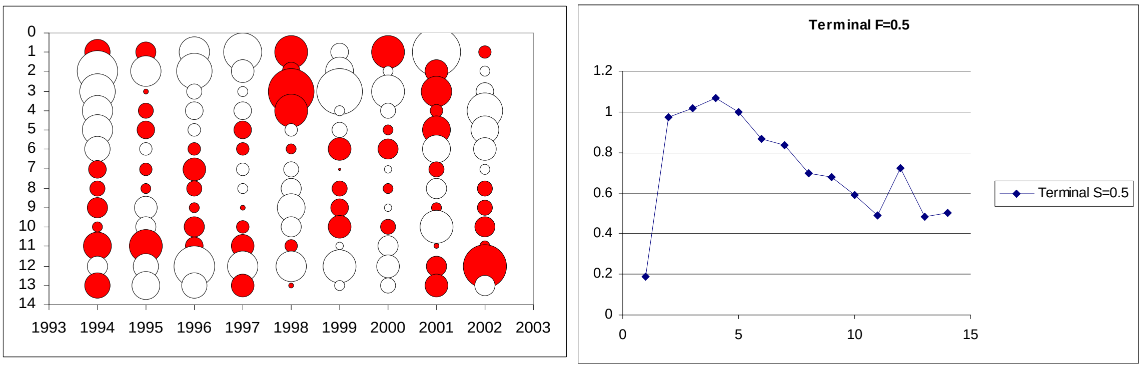


Figure 9.4.2. North Sea plaice. Log-catchability residuals derived from single-fleet XSA using only the landing at age (F-shrinkage=1.5).

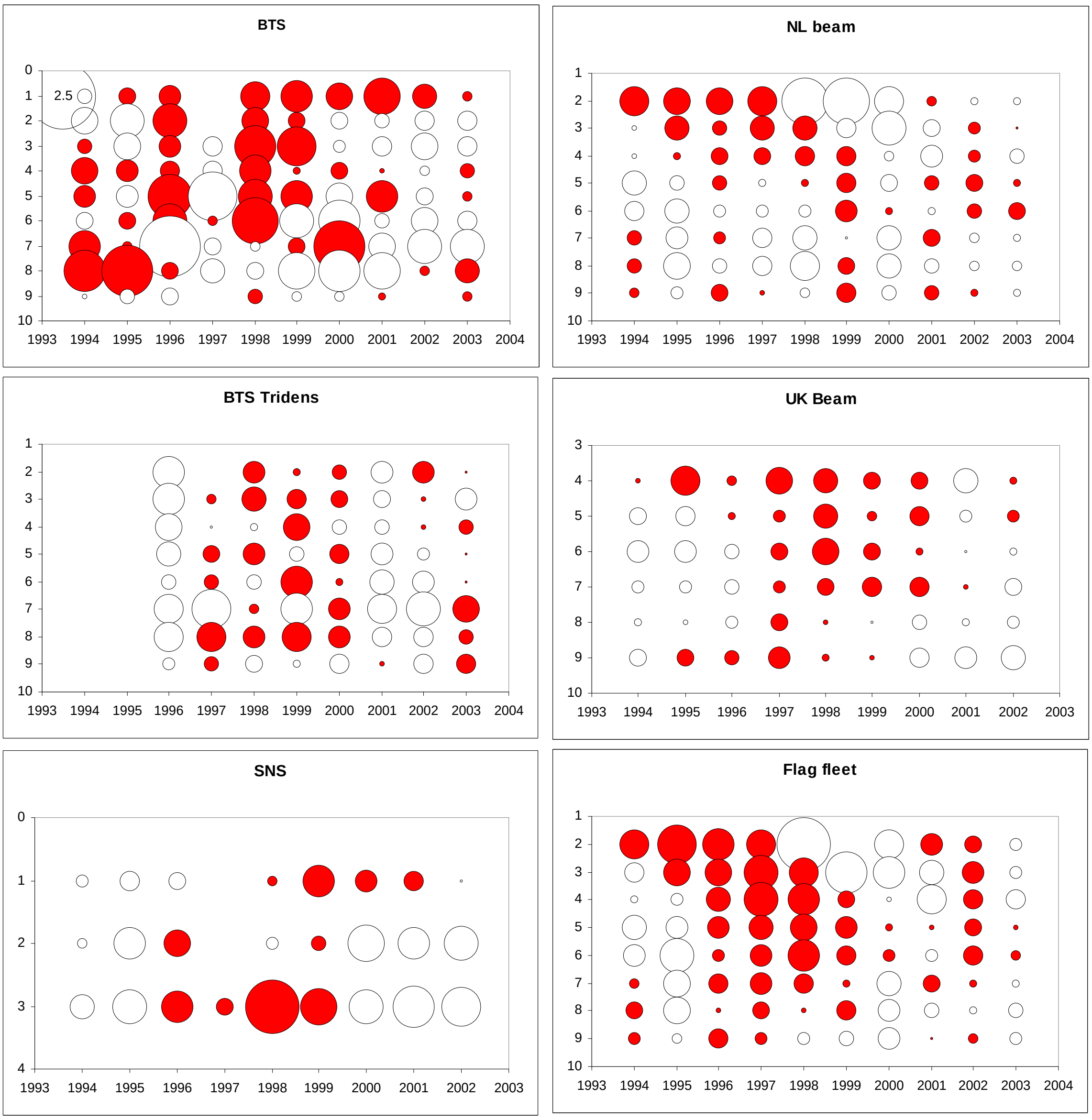


Figure 9.4.3. North Sea plaice. Comparison of the results of single fleet XSA models using only the landings at age data (F-shrinakge=1.5).

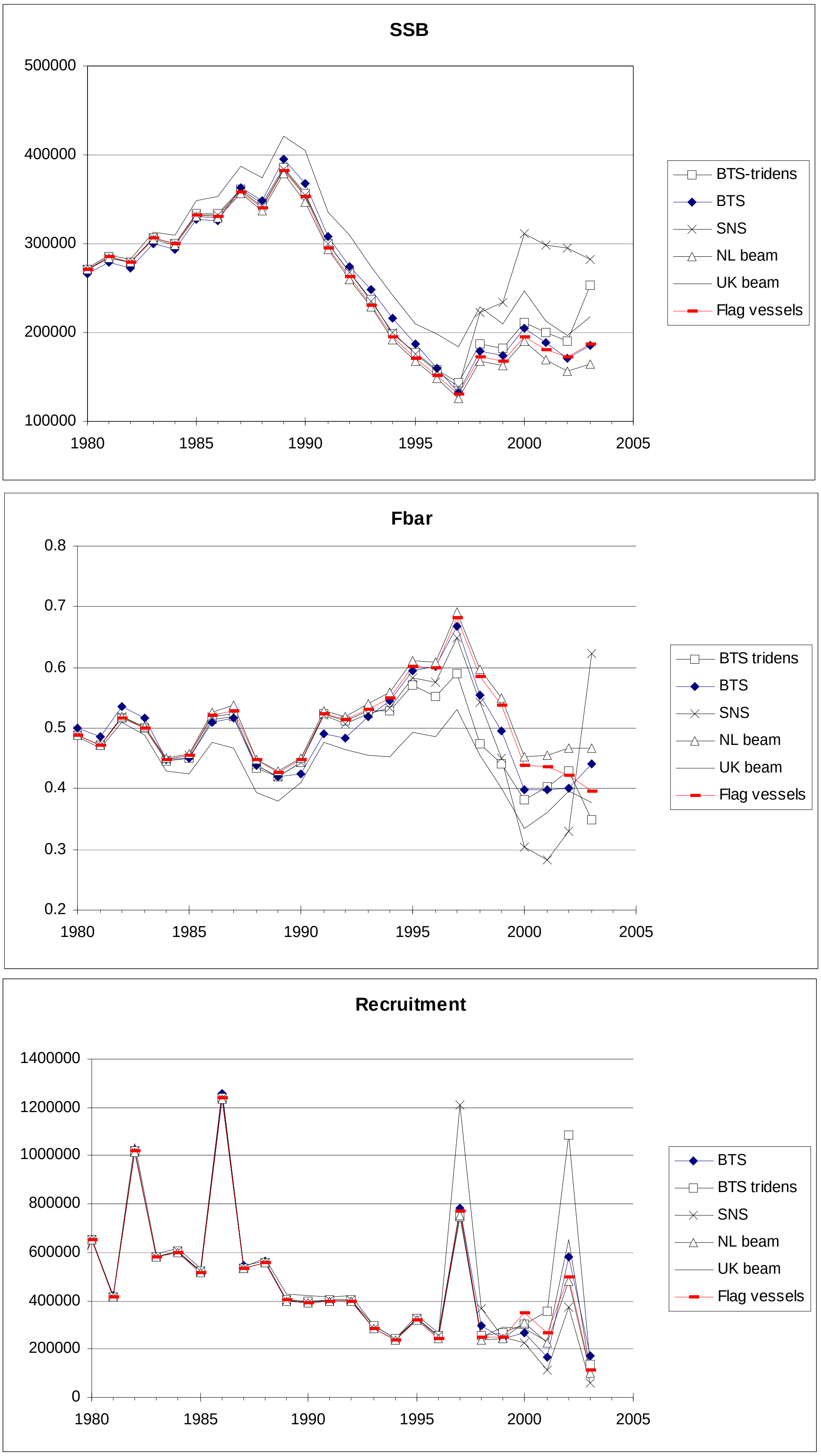


Figure 9.4.4. North Sea plaice. Relative SSB from tuning indices standardized to the period 1996-2003.

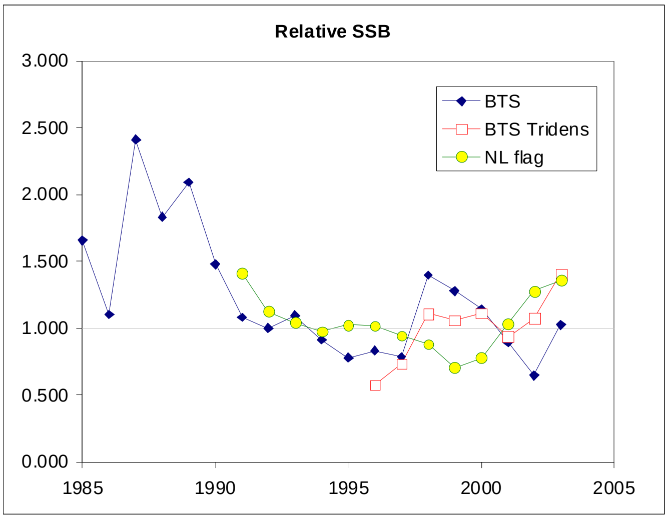
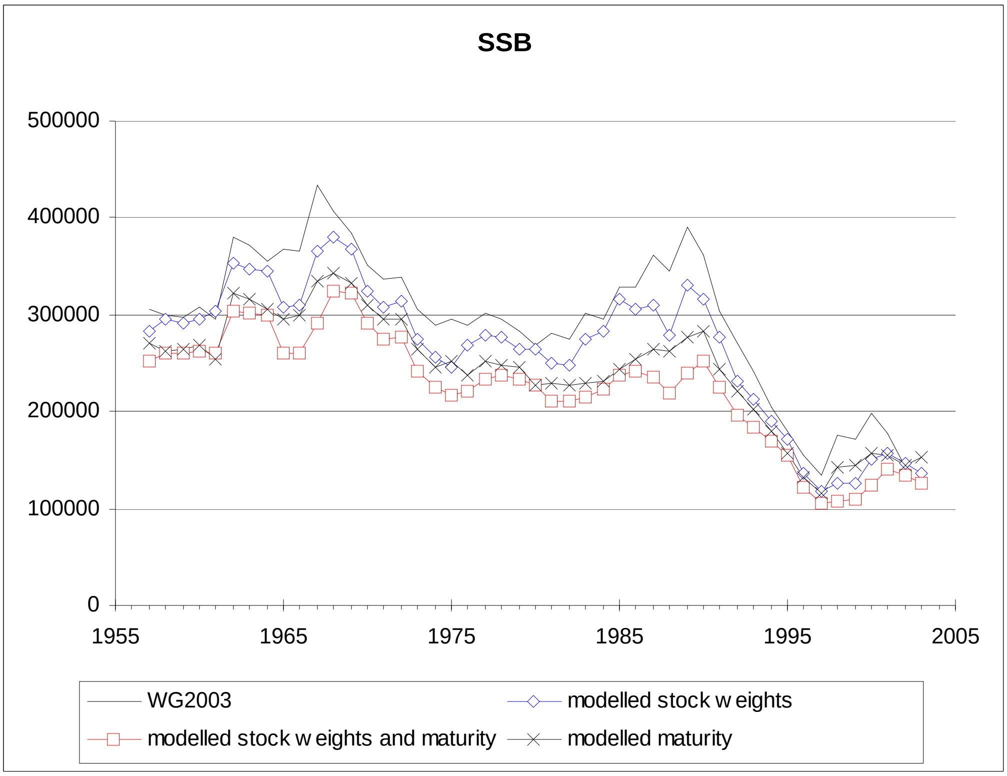


Figure 9.4.5. North Sea plaice. Changes in trends in SSB related to maturity at age and stock weight estimations.



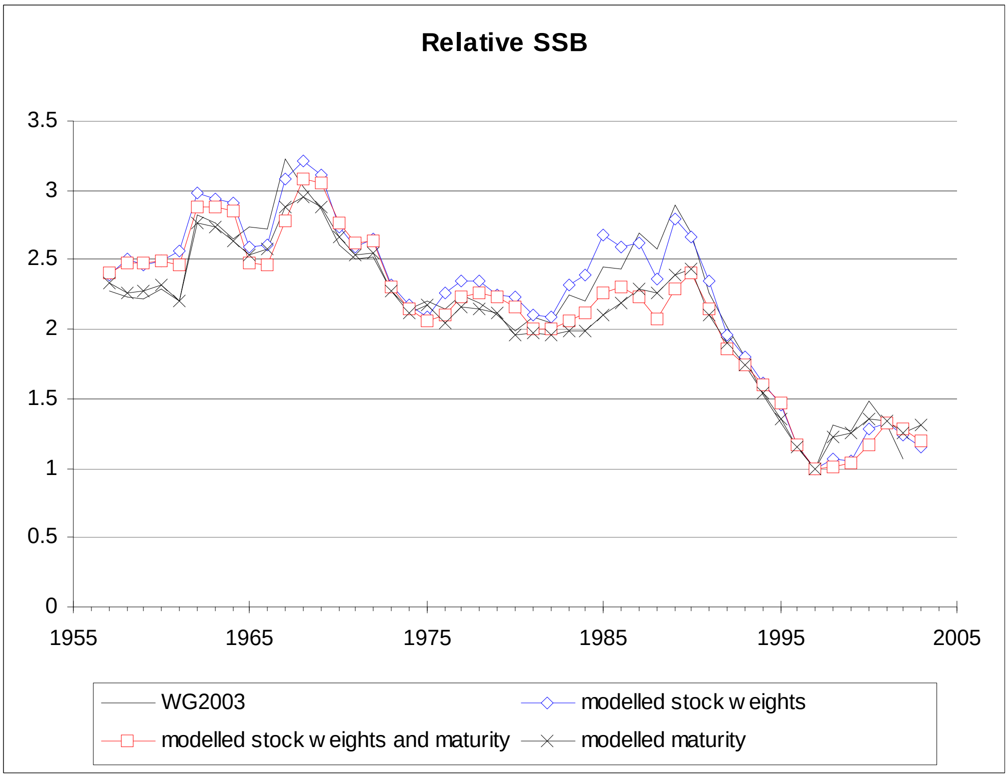


Figure 9.4.6. North Sea plaice. Comparison of XSA model results for catch at age data with no discards; reconstructed discards; and reconstructed + observed discards.

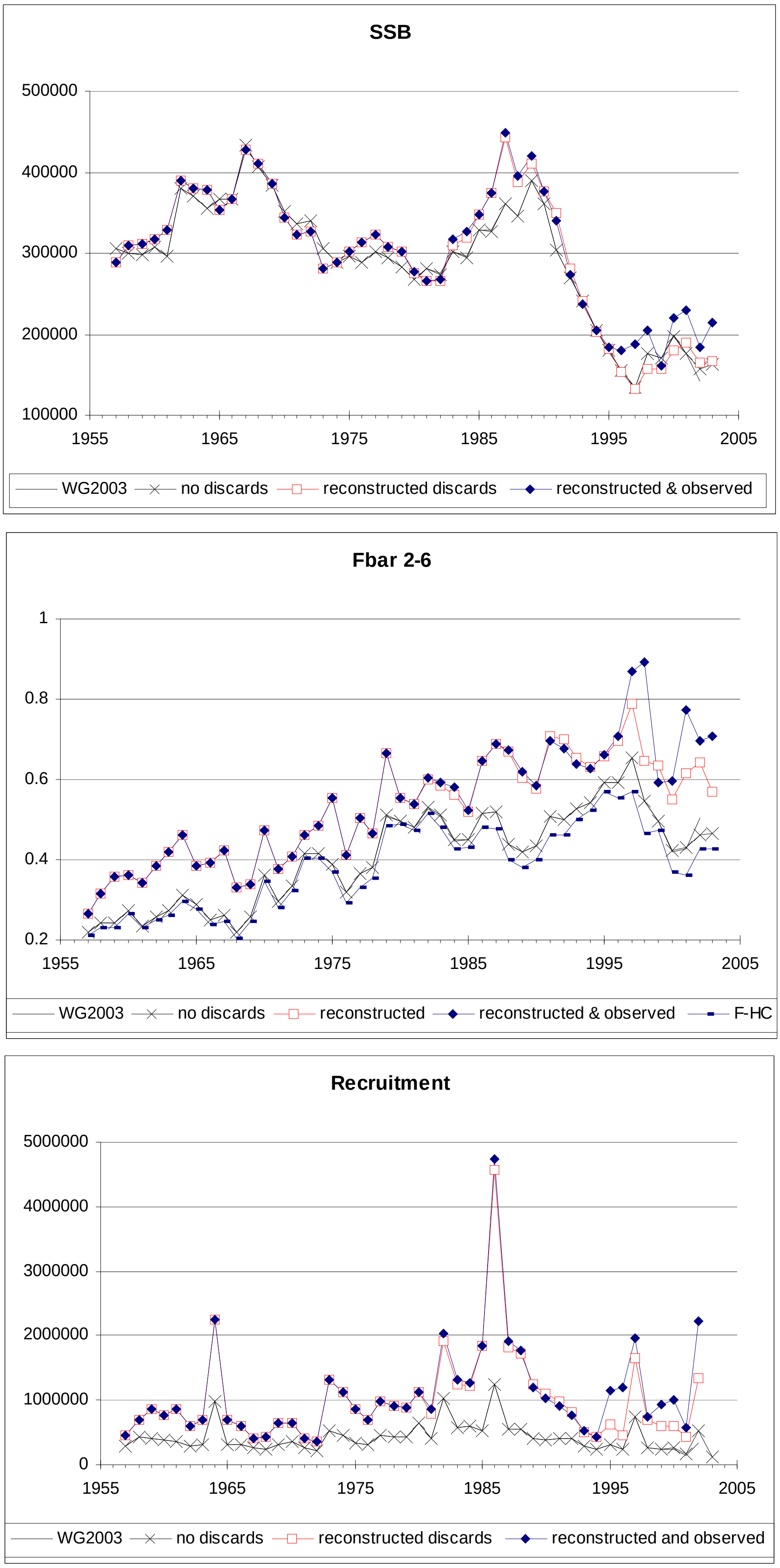


Figure 9.4.7. North Sea plaice. Observed and reconstructed discard proportions (percentage of the of the catch in numbers discarded).

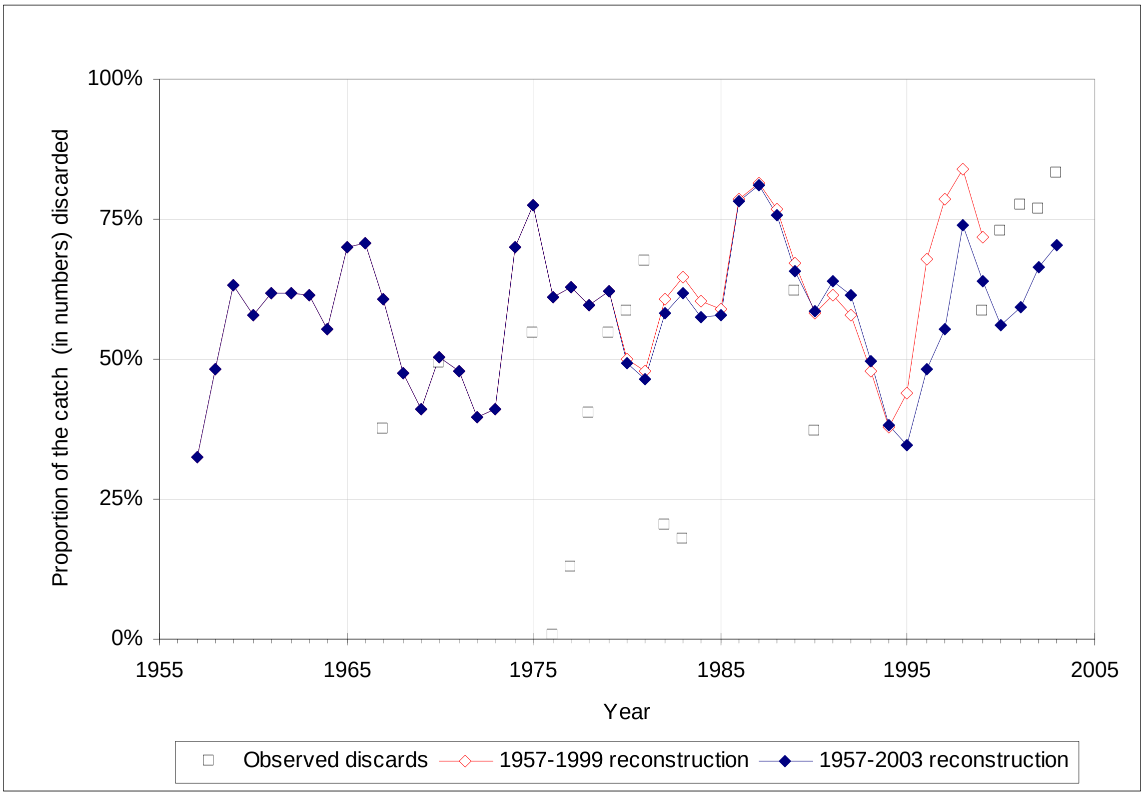


Figure 9.4.8. North Sea plaice. Observed and reconstructed discard numbers at age.

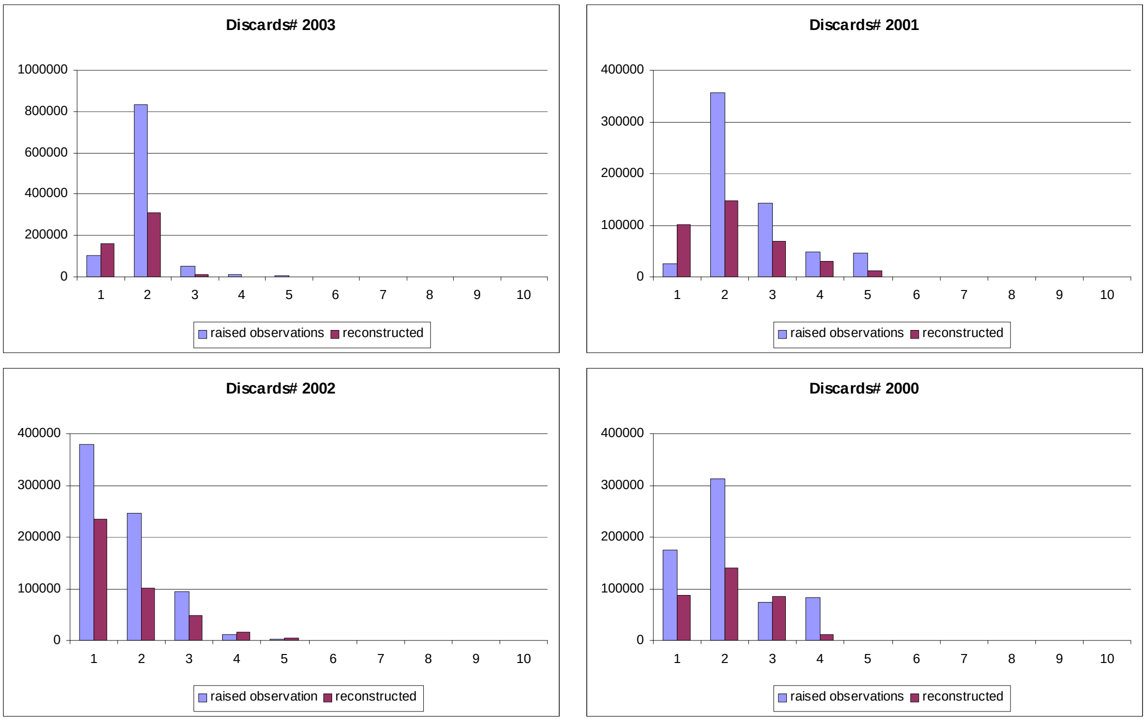


Figure 9.4.9. North Sea plaice. Comparison of XSA model results using different F-shrinkage and tuning fleets.

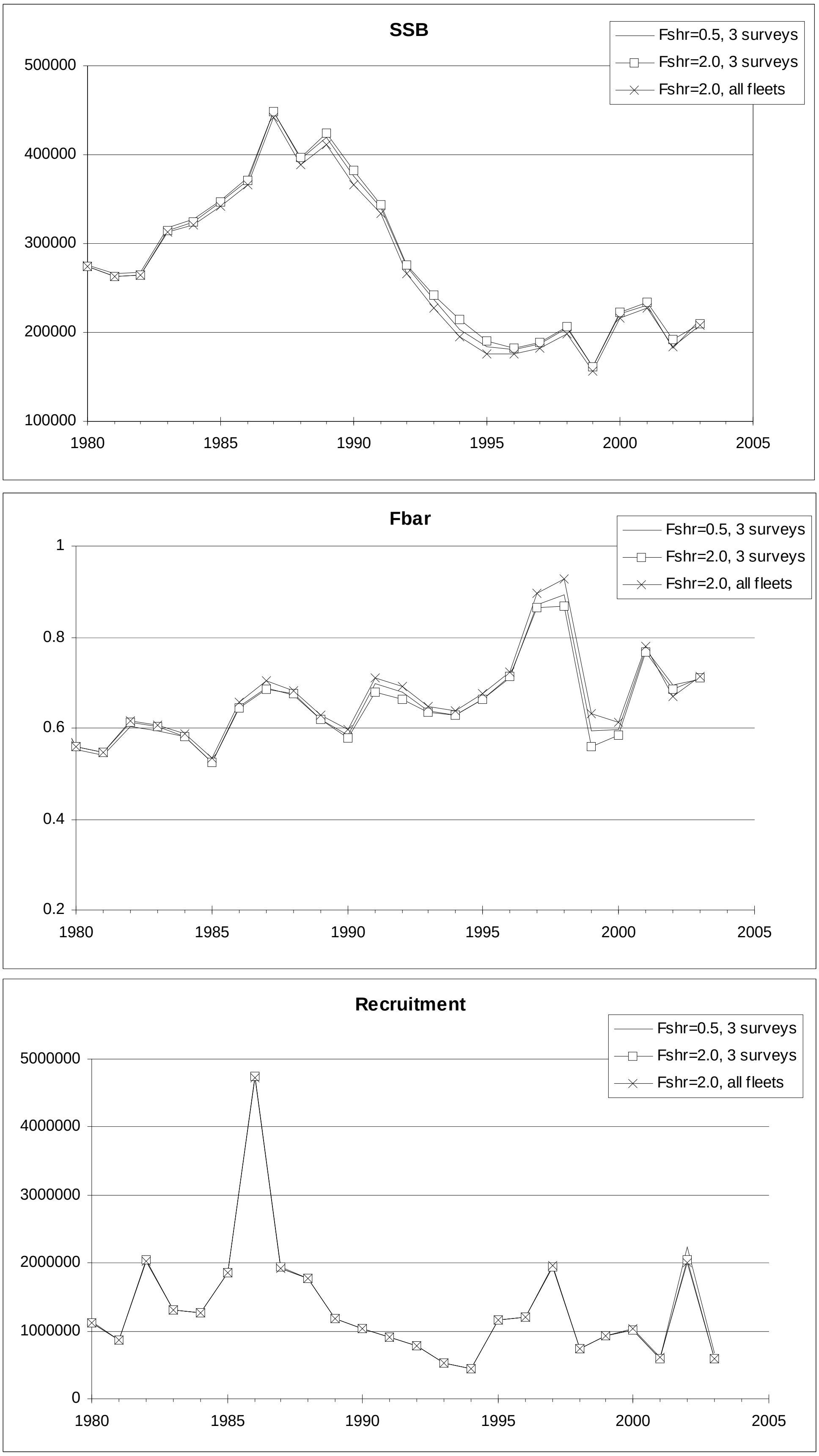


Figure 9.4.10. North Sea plaice. Retrospective patterns of low and high shrinkage XSA models – **without discard data**.

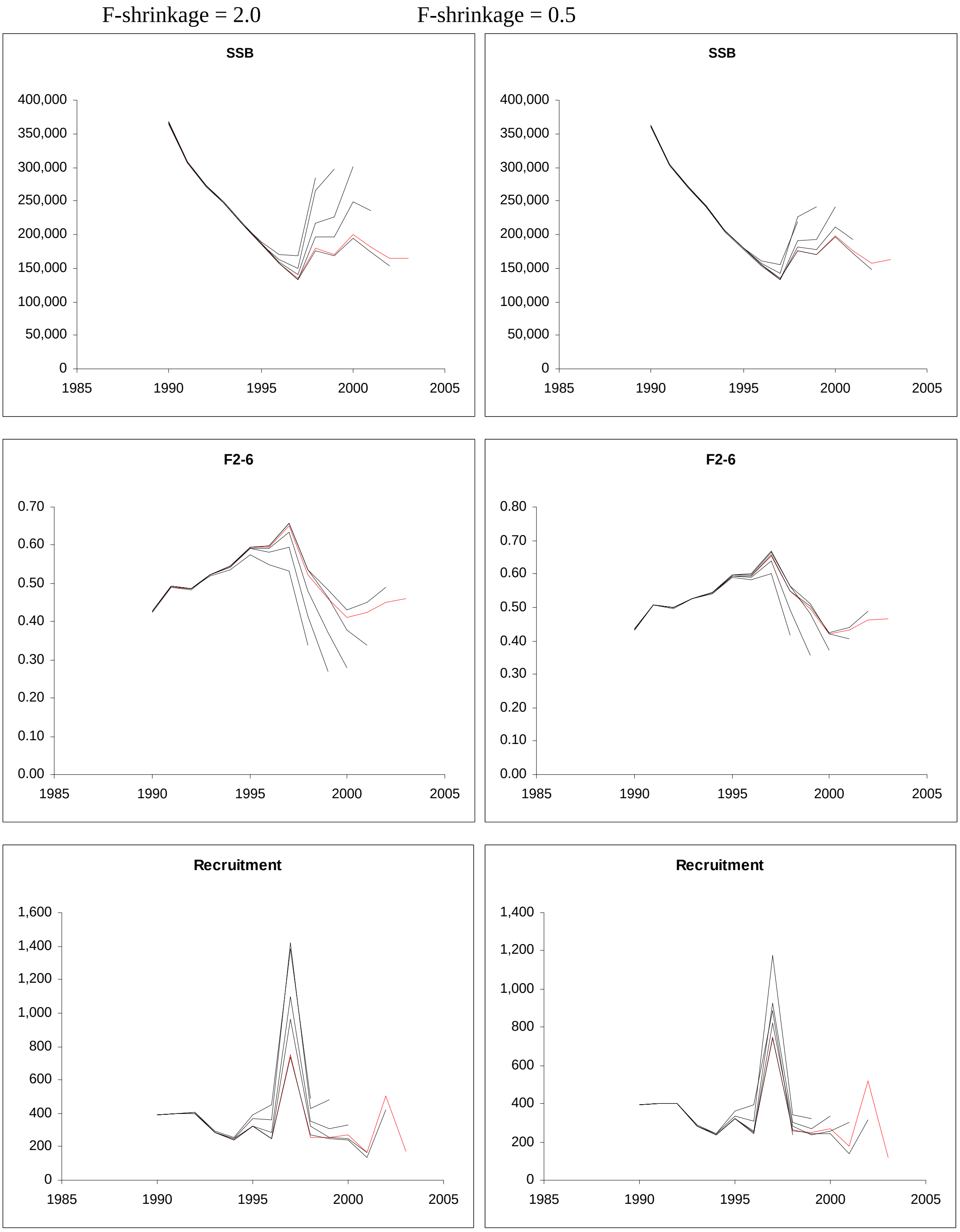


Figure 9.4.11. North Sea plaice. Retrospective patterns of low and high shrinkage XSA models – **including reconstructed and observed discard data**.

F-shrinkage = 2.0 F-shrinkage = 0.5

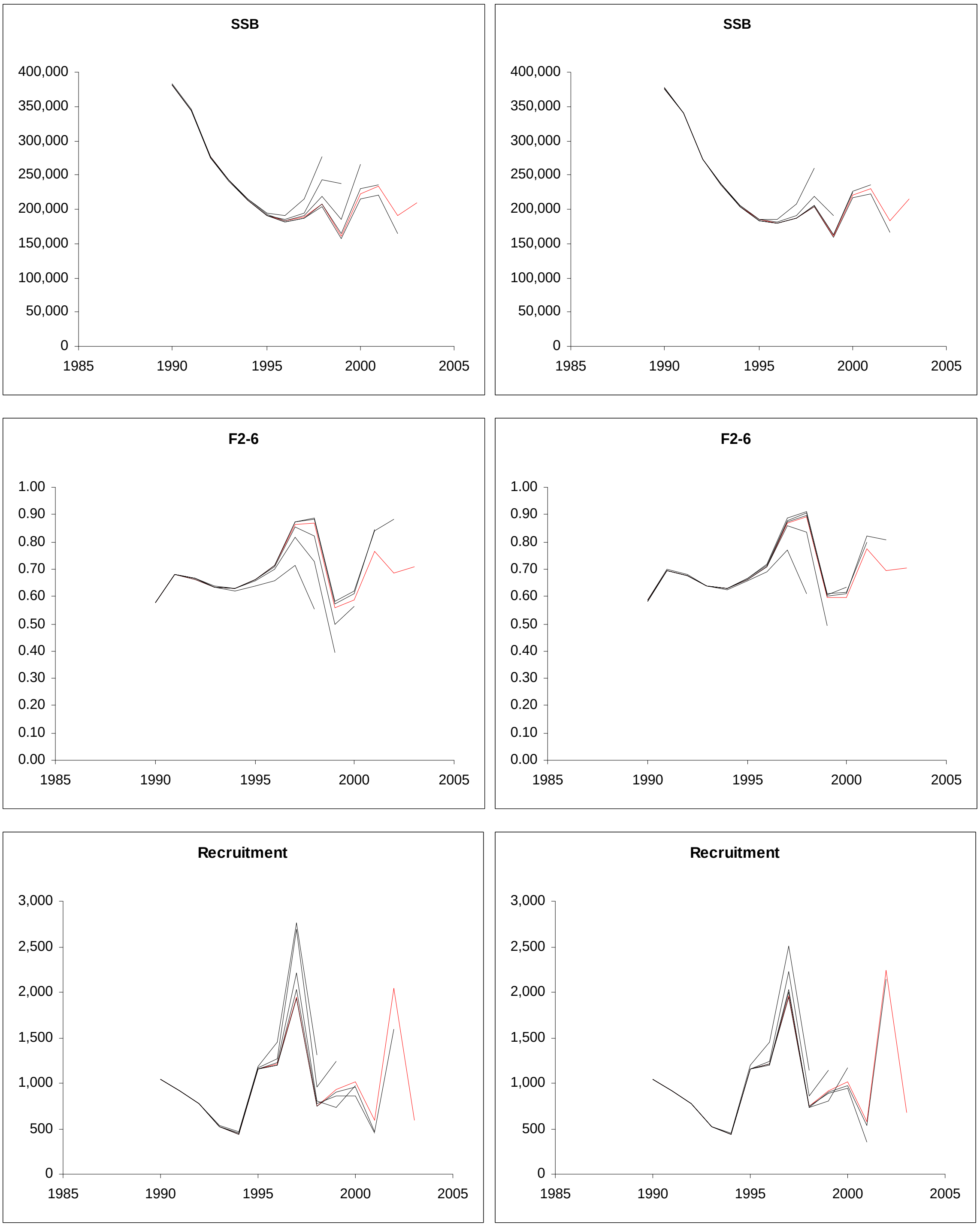


Figure 9.4.12. North Sea plaice. Relative weights of F-shrinkage and the tuning fleets in the final XSA model.

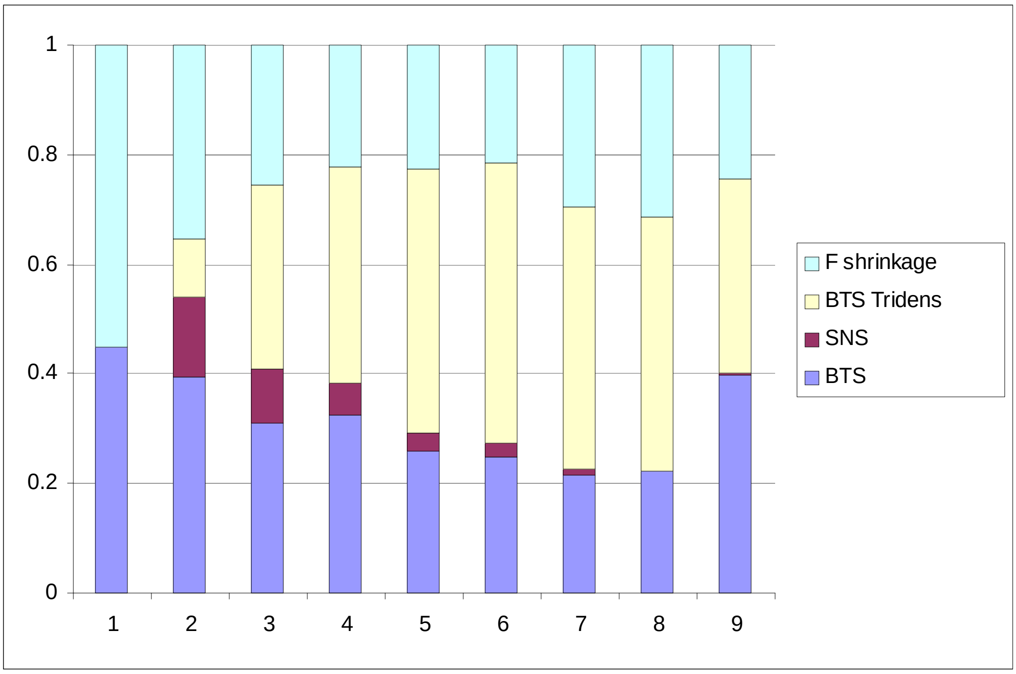


Figure 9.4.13. North Sea plaice. Comparison between XSA and ICA.

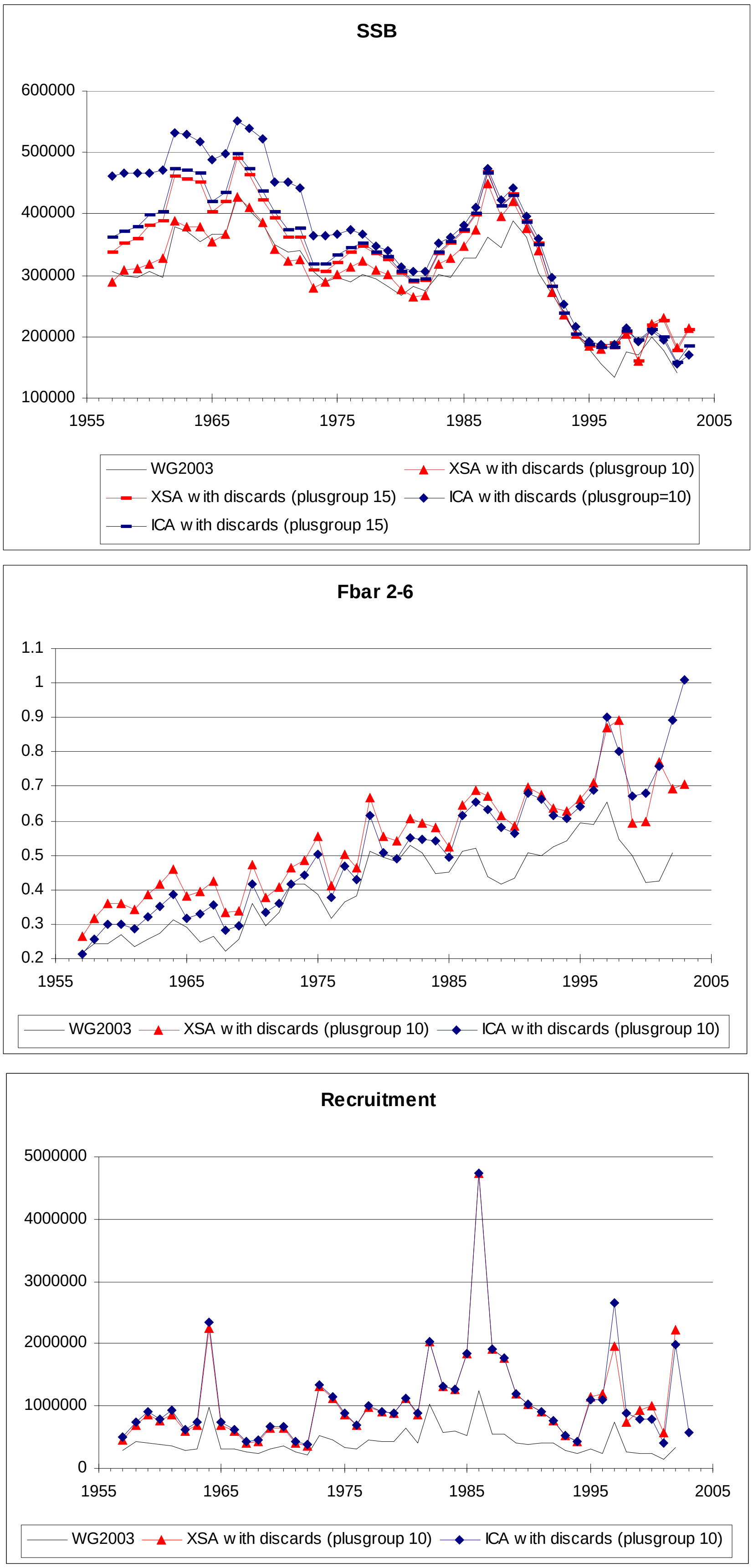


Figure 9.4.14. North Sea plaice. Log catchability residuals from the final run.

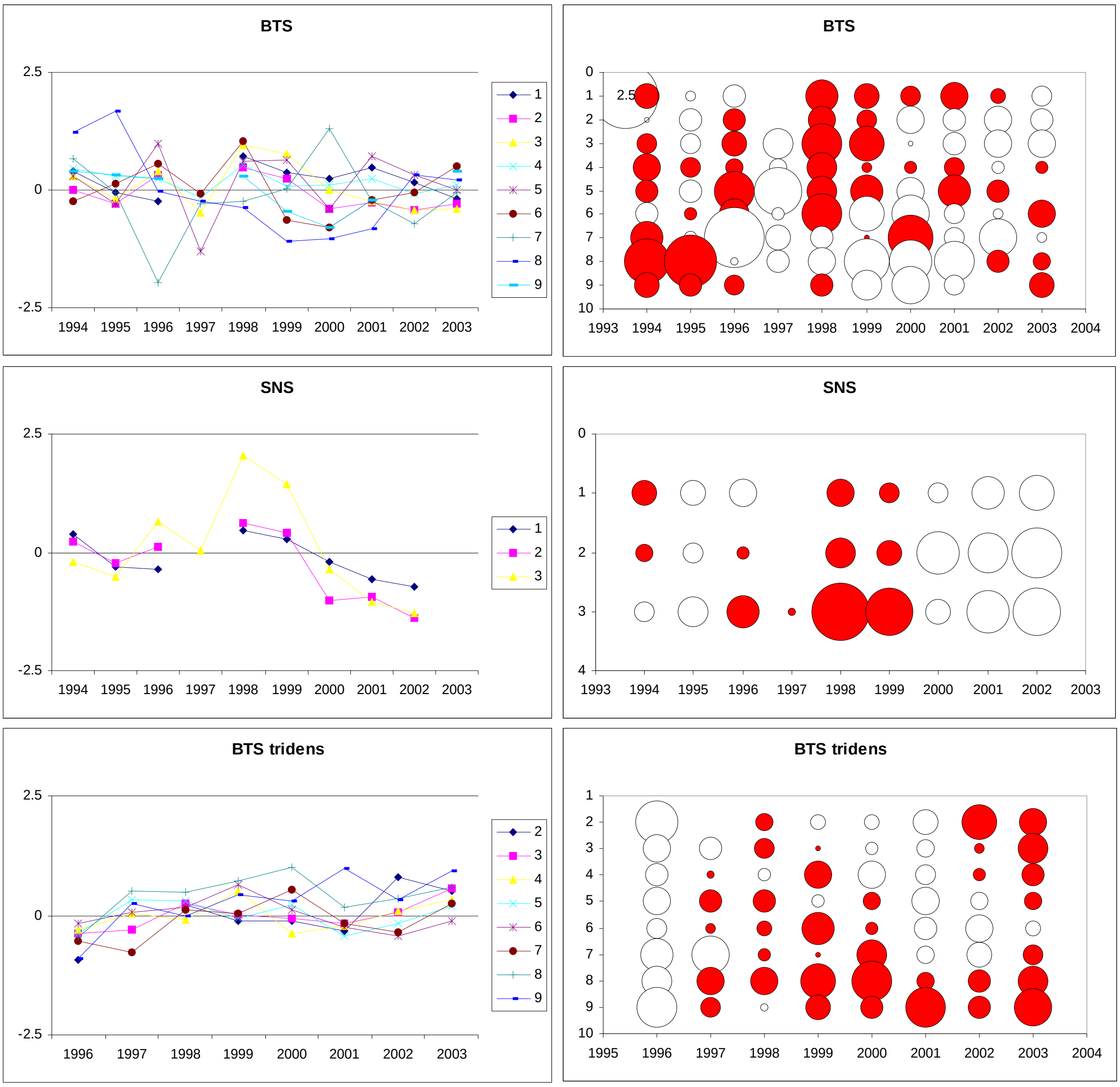


Figure 9.6.1. North Sea plaice. Stock summaries. Estimates of recruitment and SSB for 2004 are based on intermediate-year forecasts. The yield and fishing mortality are shown for each catch component separately (human consumption landings and discards), as well as together.

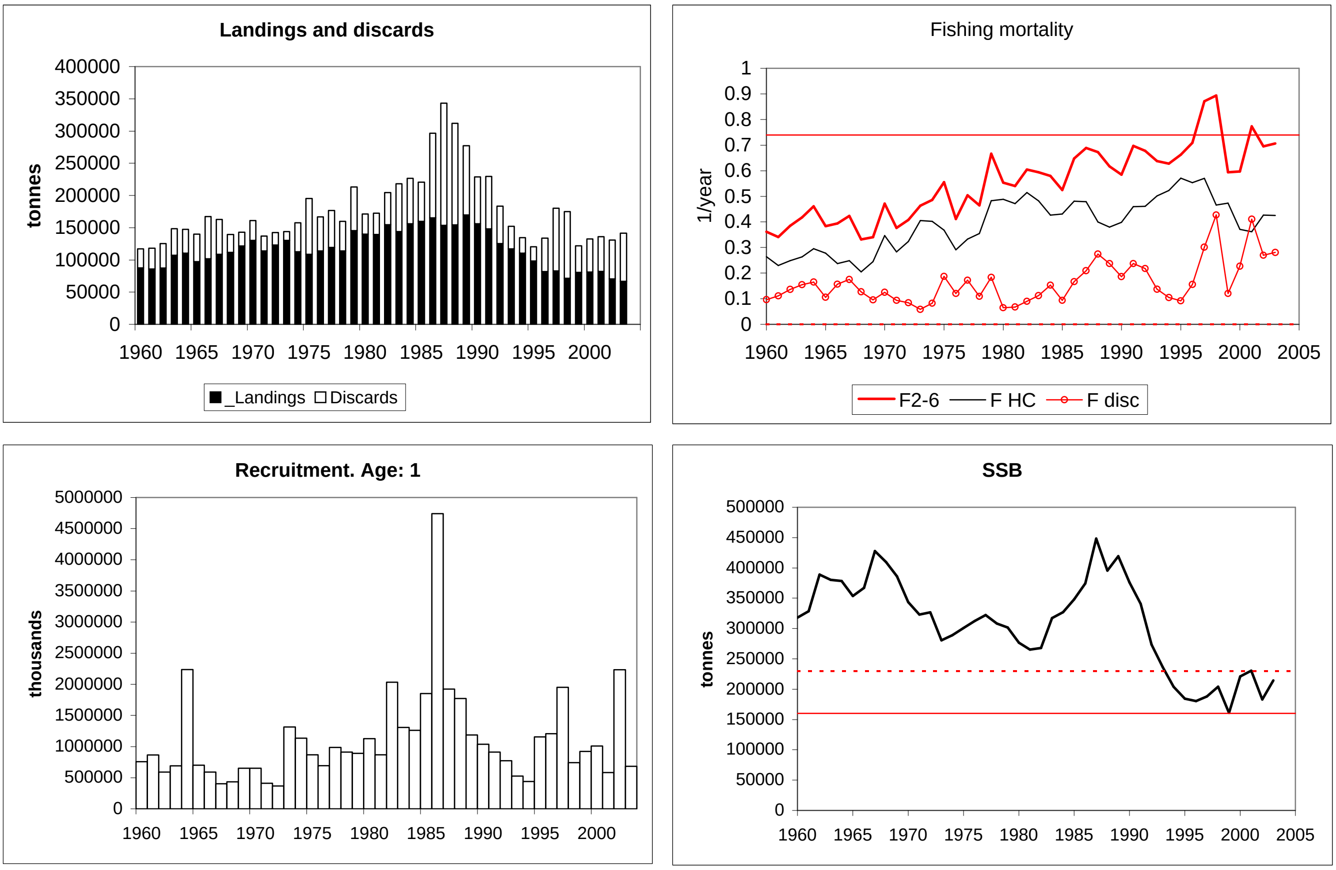
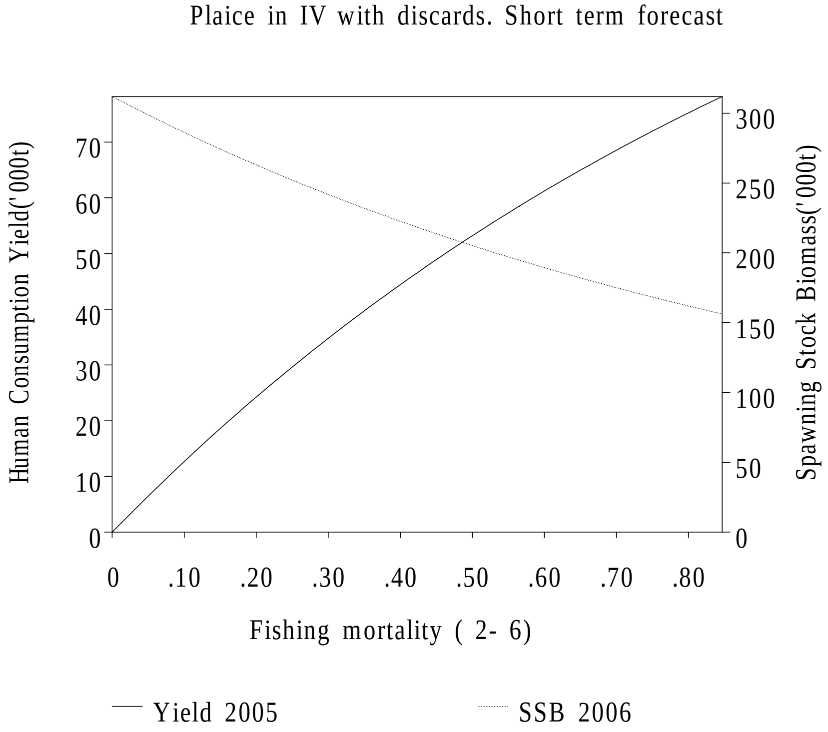


Figure 9.7.1a. North Sea plaice. Short term forecast, discards included.



Data from file:C:\CLARA\TEMP2\PLED2.SEN on 14/09/2004 at 19:18:23

Figure 9.7.2a. North Sea plaice. Sensitivity analysis of the short term forecast, discards included.

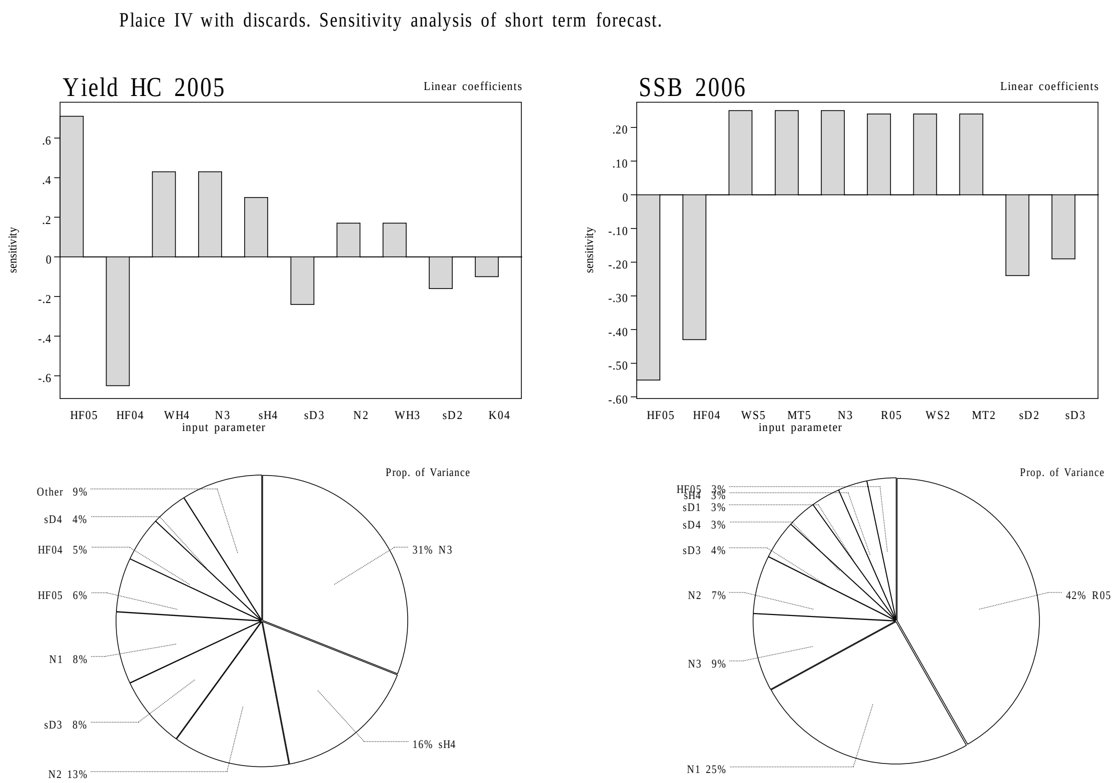


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Figure 9.7.3a. North Sea plaice. Probability profiles for short term forecast, discards included.

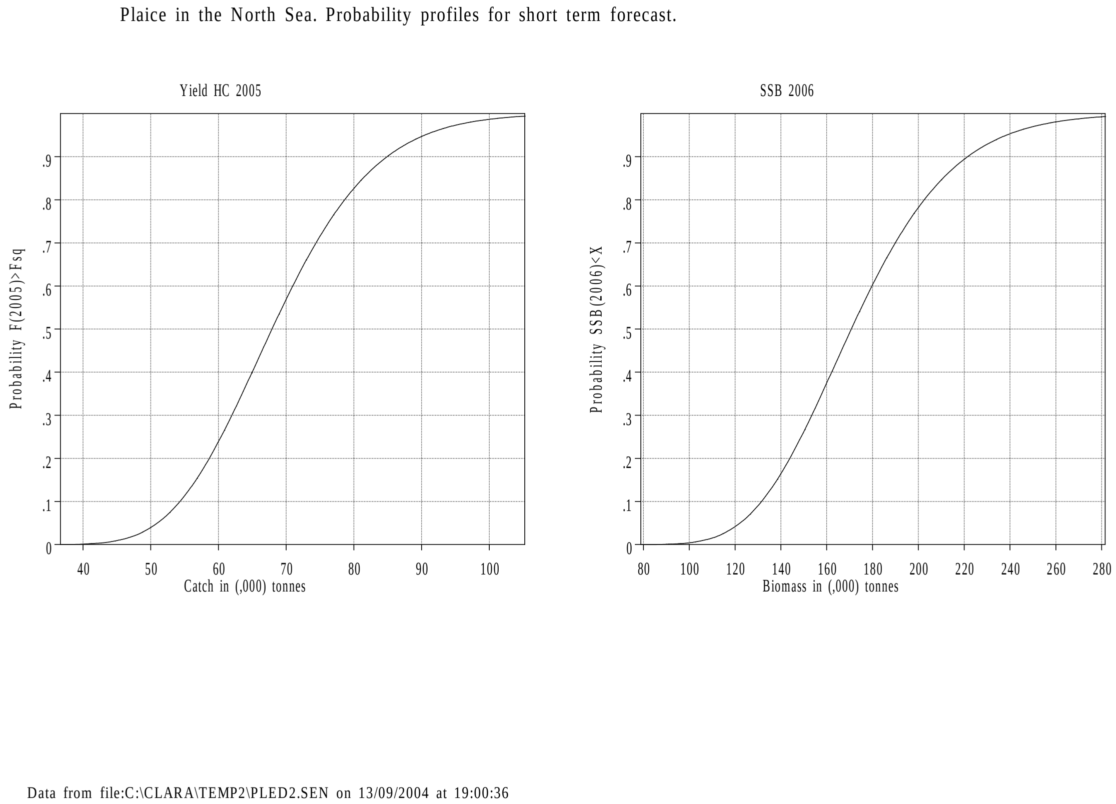


Figure 9.8.1a. North Sea Plaice. Medium term analysis, discards included.

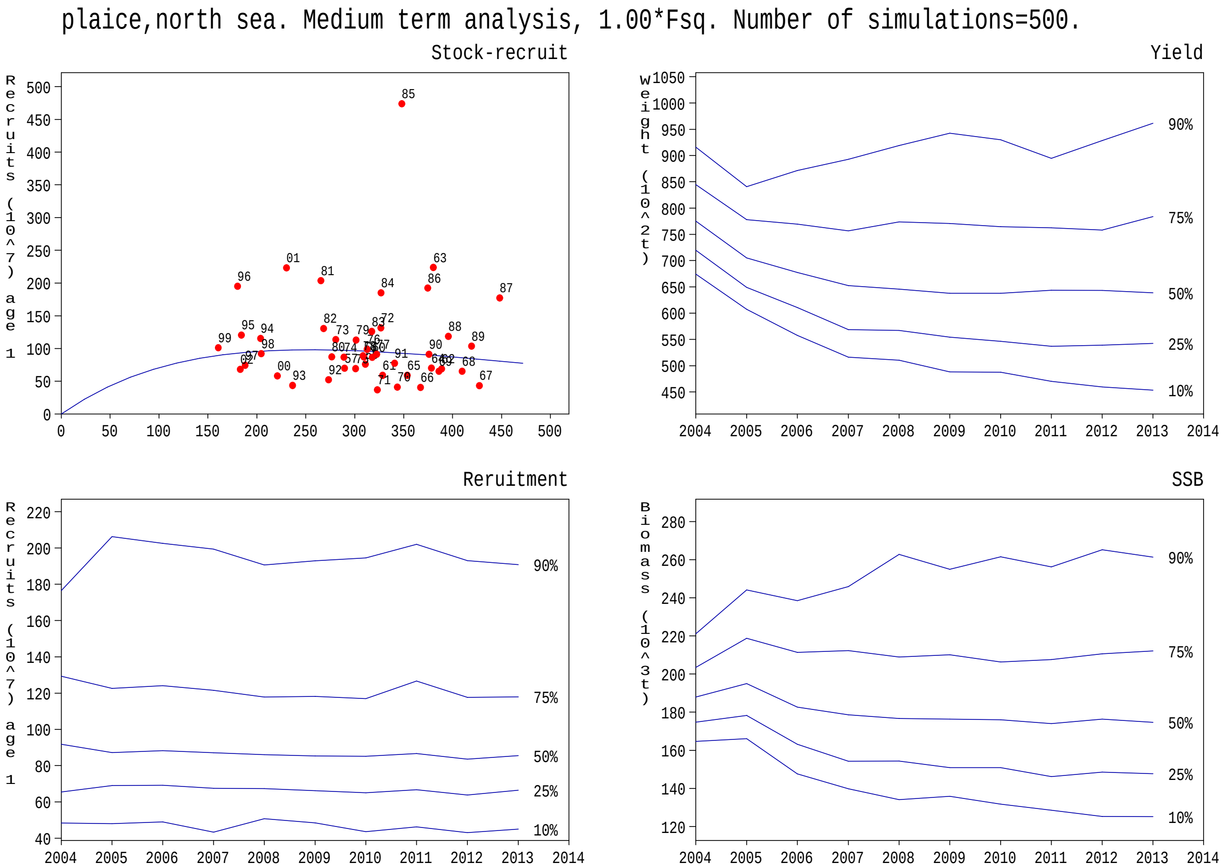


Figure 9.8.2a. North Sea plaice. Summary of medium-term analysis, discards included. Contours show the probability that SSB will be below $\mathbf{B}_{pa}$ for any combination of year and fishing mortality.

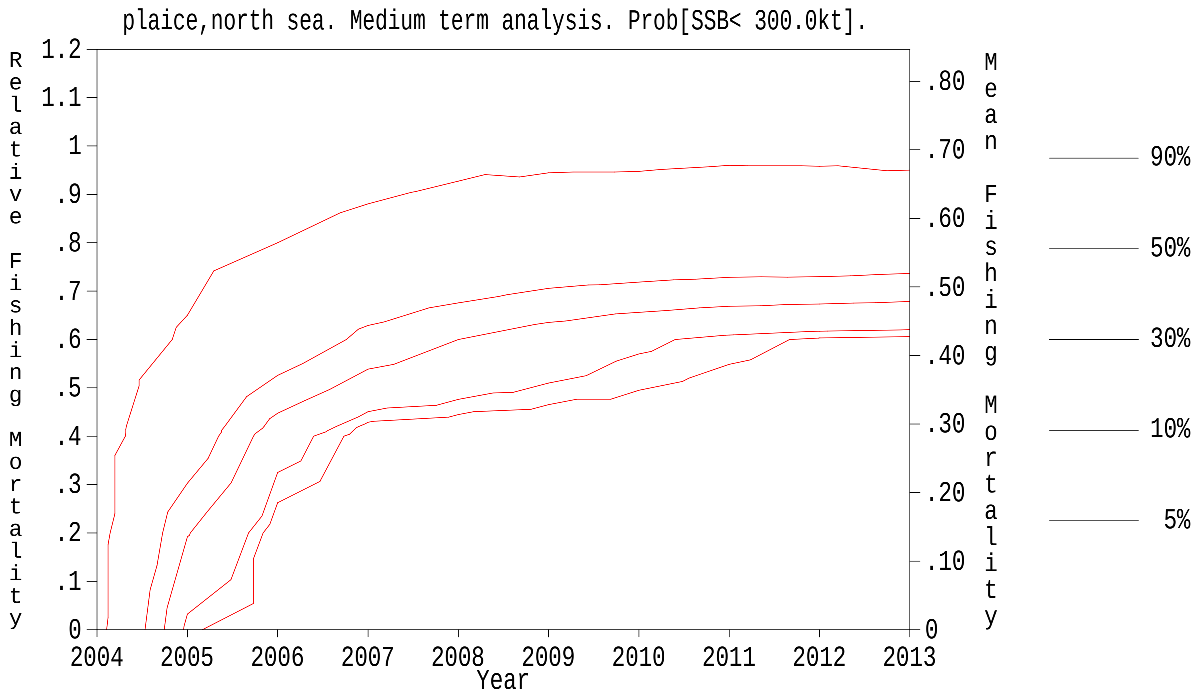


Figure 9.9.1a. North Sea plaice. Long term yield, discards included.

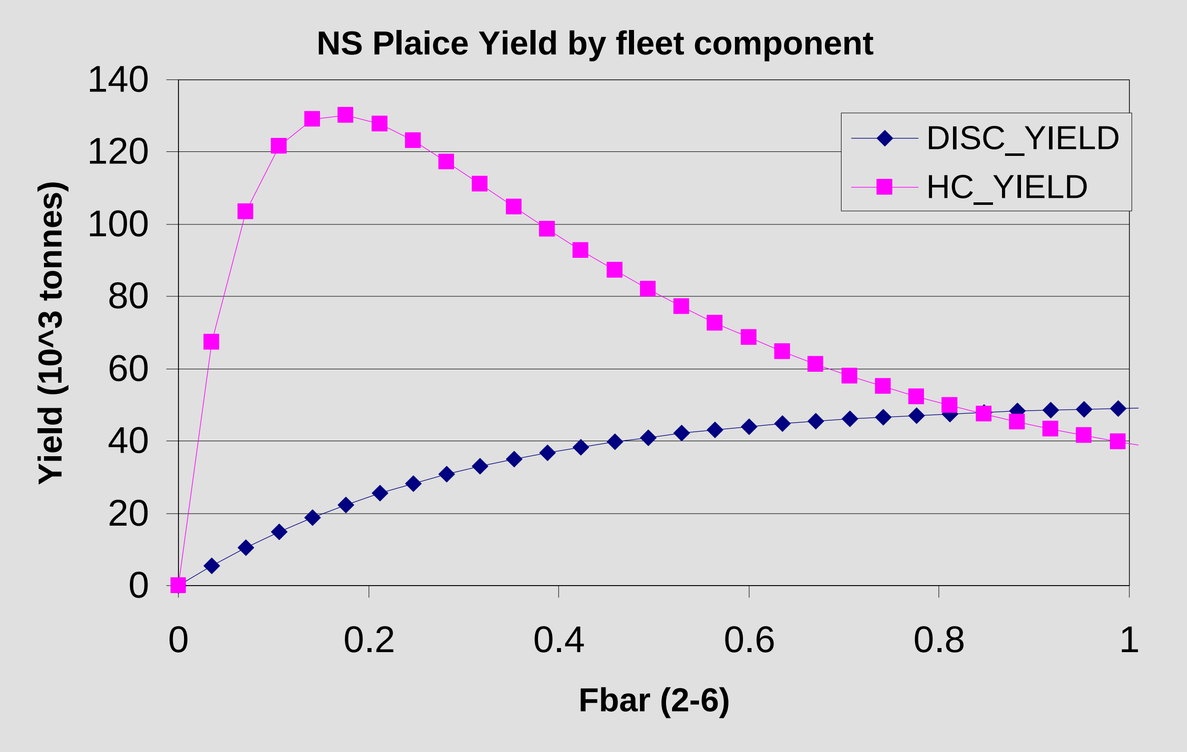
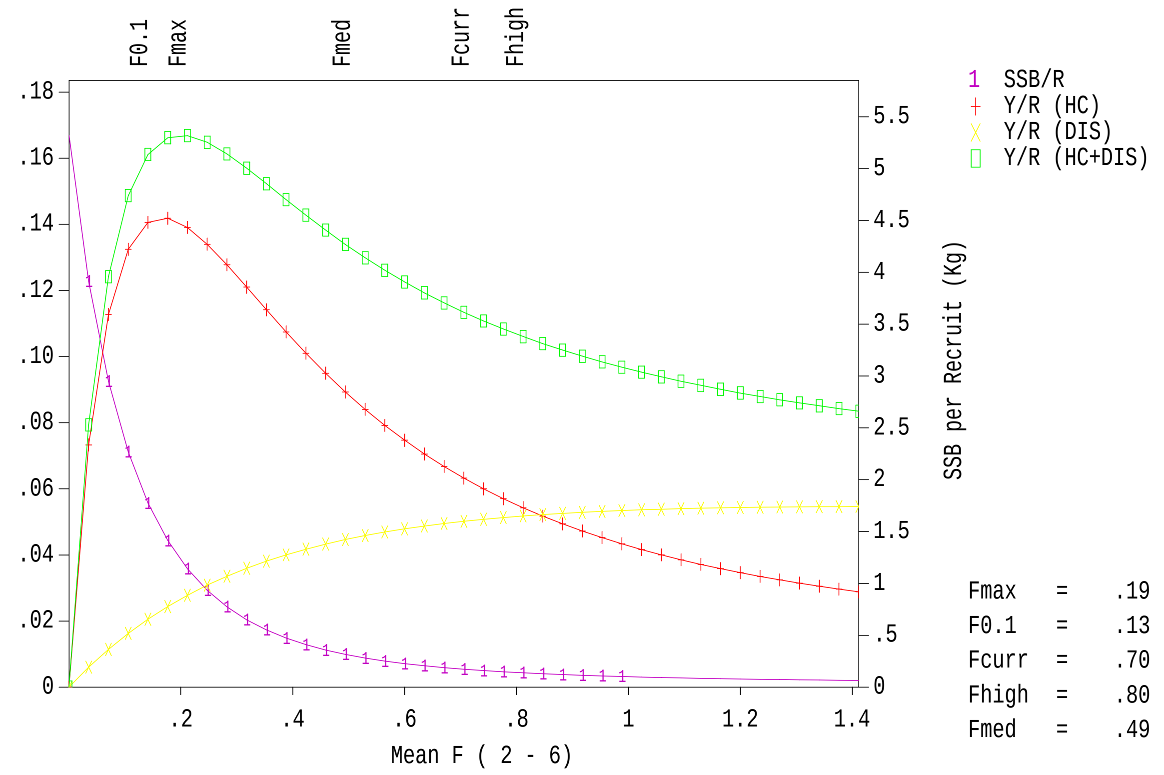


Figure 9.9.2a. North Sea plaice. Long term yield and stock recruitment, discards included.



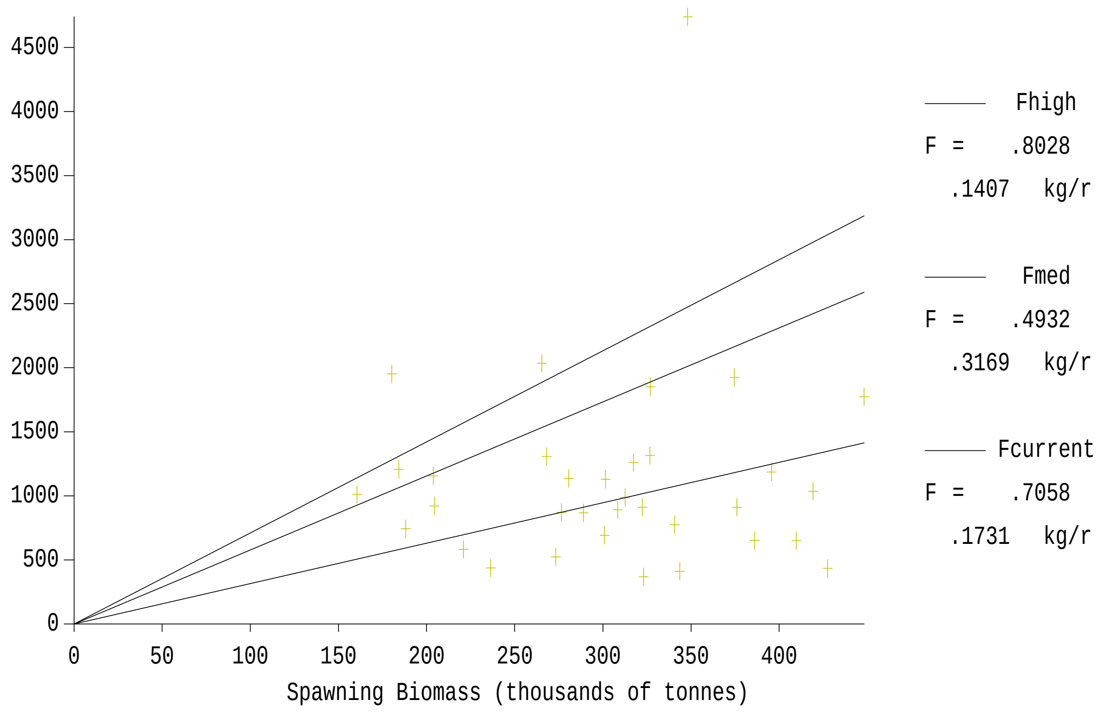


Figure 9.10.1a. North Sea plaice. Biological reference points, discards included.

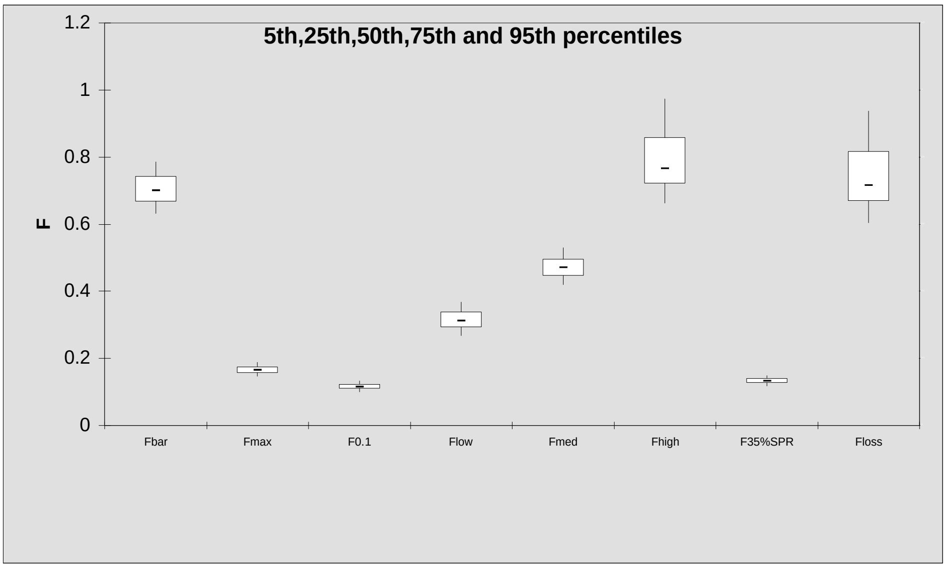


Figure 9.10.2. North Sea plaice. Stock recruitment plots based on the final assessment (left) or an assessment without discards (right), including (top) or excluding (bottom) the last 2 years.

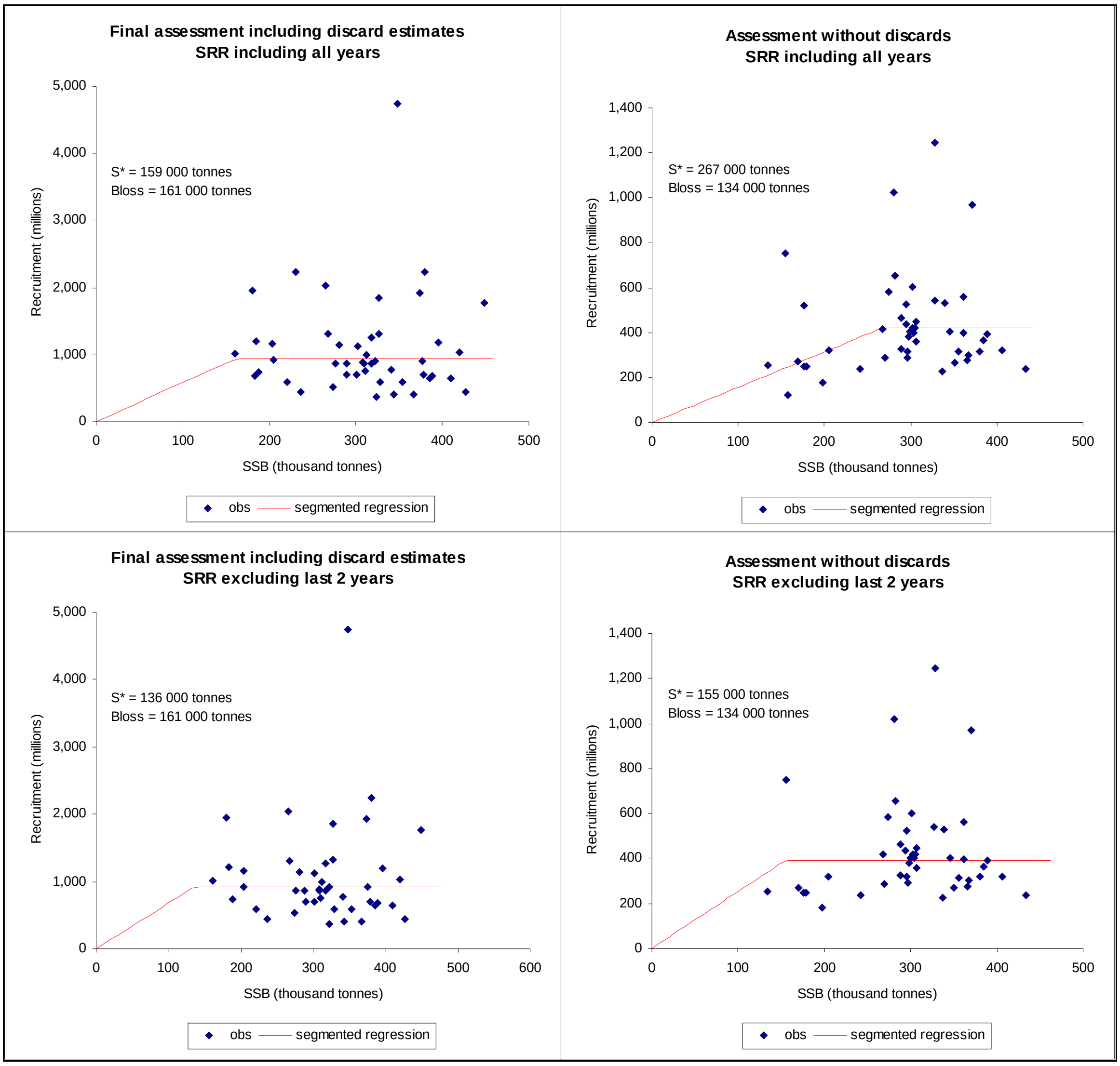


Figure 9.11.1. North Sea plaice. Comparison of SSB time series.

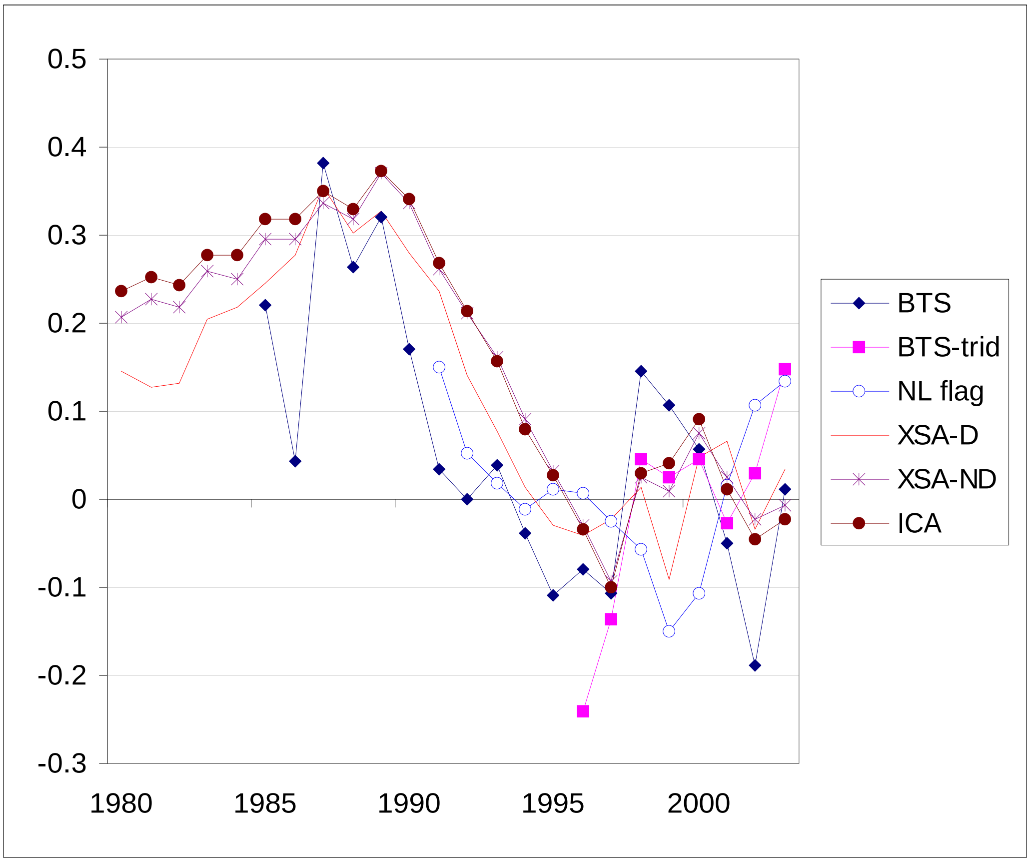
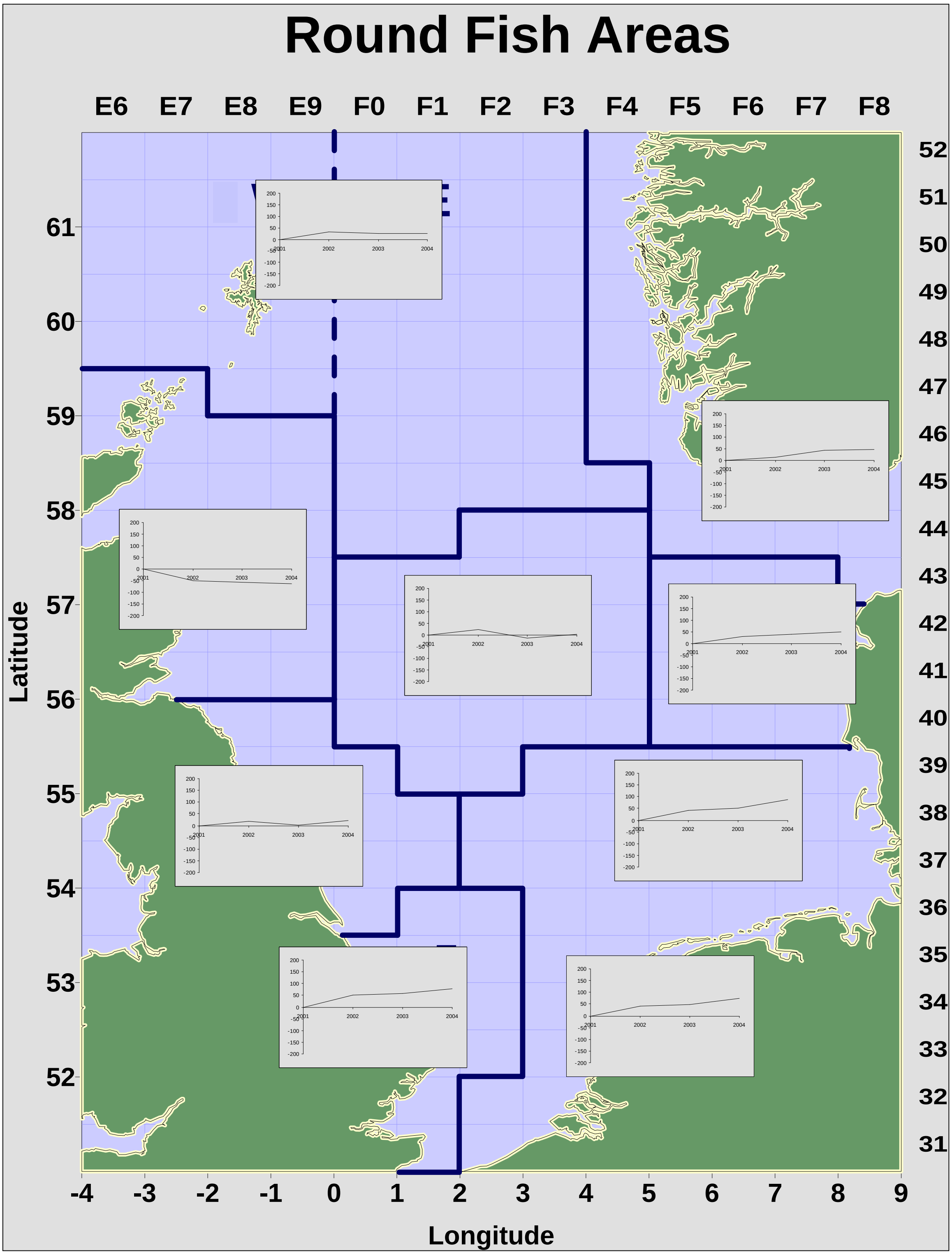


Figure 9.11.2. North Sea plaice. Results fishermen's survey.



10 PLAICE IN DIVISION IIIA

The assessment of plaice in Division IIIa is presented here as an update assessment with modifications in the recruitment estimation procedure (Section 10.4) and in the IBTS time series (Section 10.2.5). 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.

10.1 The Fishery

A general description of the fishery is given in the Stock Annex.

10.1.1 ICES advice applicable to 2003 and 2004

ICES recommended for 2003 to reduce fishing mortality below the proposed F_{pa} (F_{pa} = 0.73), corresponding to landings in 2003 of less than 18,400 t. F_{pa} was set to the value of F_{med} in 1998. B_{pa} was set to a smoothed value of B_{loss}. Neither F_{lim} nor B_{lim} are defined.

ICES recommended for 2004 that fishing mortality in 2004 should be less than F_{pa}, i.e. close to the current levels of exploitation. ICES noted that attention should be paid to the mixed fisheries context, where both North Sea and Kattegat cod stocks, which are caught together with plaice, are well below B_{lim}. Furthermore, ICES indicated that the projected catches in 2003 appeared to be higher than the catches that would be realised.

10.1.2 Management applicable in 2003 and 2004

TAC in 2003 was 16 700 t and 11 363 t in 2004.

Effort reductions for much of the fleets catching plaice in Division IIIa have been implemented in 2004. These range from 13 days-at-sea per month for trawlers and Danish seiners using mesh size equal to or more than 100mm, to 22 days-at-sea per month for *Nephrops* trawlers.

10.1.3 The fishery in 2003

According to ICES official tables (Belgian, Norwegian and German landings) and national statistics (Danish, Swedish and Dutch landings) total landings in 2003 were estimated to be close to those in 2002, around 9000 t (Table 10.1.1). In 2003, the Danish share of landings decreased from 90 to 77%, as the Dutch fleets caught around 1500 tonnes in the Skagerrak. No quantitative information on misreporting is available, but there are recent indications that misreporting from the North Sea to the Skagerrak could have occurred repeatedly in the rectangles being shared between both areas.

10.2 Data available

10.2.1 Catches

The official landings reported to ICES are given in Table 10.1.1. The annual landings used by the Working Group, available since 1972, are given by country for Kattegat and Skagerrak separately in Tables 10.2.1 and 10.2.2. 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. In 2003, around 75% of the landings were taken in Skagerrak.

Some Danish and Swedish estimates of discards by age were available for 2003. Danish discards in the Skagerrak represented 17% and 47% of the catches by weight and in numbers respectively. Swedish discards in Division IIIa represented 57% (weight) and 78% (numbers) of the catches (Table 10.1.2). Almost all catches up to age 2 were discarded, and discarding rate was still important up to age 4, especially during the first quarter.

10.2.2 Age compositions

Age compositions of the landings are presented in Table 10.2.3. Age-disaggregated Swedish samples were available for 2003 and were included for the first time in the total catch at age estimation.

10.2.3 Weight at age

Weights at age in the stock were assumed equal to those in the catch. Weight at age data is presented in Table 10.2.4. The procedure for calculating mean weights is described in the Stock Annex.

10.2.4 Maturity and natural mortality

Maturity and natural mortality are assumed constant for all years. Natural mortality is set at 0.1 for all ages. A knife-edge maturity distribution was employed: age group 2 was assumed to be immature whereas age 3 and older plaice were assumed mature.

10.2.5 Catch, effort and research vessel data

Survey data used for calibration of the assessment are presented in Tables 10.2.5. The tuning fleets consist of three commercial tuning fleets and the four survey tuning series that were added in the 2002 stock assessment (Figures 10.2.1 and 10.2.2). The two IBTS time series were however revised up to 2002 before the Working Group (WP4), following a check and an update of raw data extraction and index estimation methods. Both of these series were used in the exploratory assessments: however, the effect of the revision was minor.

10.3 Catch at age analysis

Catch at age analysis was carried out according to the specifications in the Stock Annex. The model used was XSA Sensitivity analyses showed that the effect of the revision of IBTS time series on the stock perception was minor.. Results of the analysis are presented in Table 10.3.1 (diagnostics), 10.3.2 (fishing mortality at age), 10.3.3 (population numbers at age), and 10.3.4 (stock summary). The stock summary is also shown in Figure 10.3.1 and the historical performance of the assessment is shown in Figure 10.3.2.

SSB in 2003 is well above B_{pa} and fishing mortality is close to F_{pa}.

10.4 Recruitment estimates

The XSA estimated the 2001 year-class at a very high level for 2004, although the surveys indices did not track such a high signal. Therefore recruitment estimation was carried out using RCT3 software for both the 2001 and 2002 year-classes (Tables 10.4.1–10.4.3), which enabled the use of survey indices for age-0 and age-1 (in previous assessments the time-series had been too short). Average recruitment in the period 1978–2001 was 47 million (geometric mean) 2-year-old-fish, which was used as recruitment in 2006. The basis for estimates of year-class strength is summarised below:

Year Class	Age in 2004	XSA Thousands	RCT3 Thousands	GM (1978-2001) Thousands
2000	4	**32448**		
2001	3	103163	**59363**	41898
2002	2		**53790**	47311
2003	Recr. age 2		70457	**47311**
2004	Recr. age 2			**47311**

10.5 Short-term prognosis

The short-term prognosis was carried out according to the specifications in the Stock Annex. The model used was WGFRANSW. Input parameters are presented in Table 10.5.1. Results are presented in Tables 10.5.2 and 10.5.3, and probability profiles in Figure 10.5.1. The strong 1998 and 1999 year-classes will still comprise 50% of the landings, but only 25% of the SSB in 2005 (Table 10.5.4).

10.6 Issues to be addressed in a forthcoming benchmark assessment

During its October 2002 meeting ACFM appreciated the inclusion of new survey tuning series, and recommended that WGNSSK reconsidered using the commercial tuning series in the assessment. The data exploration in 2004 was deliberately limited as assessment of the plaice stock in Division IIIa was regarded as an update assessment only. Some comments are, however, provided on this issue for a forthcoming benchmark assessment.

Current commercial tuning series are considered questionable as measures for stock abundance for several reasons. First, all commercial trips having a non-zero catch of plaice are included, irrespective of whether they are actually targeting plaice. This could lead to high effort estimates and to CPUE values that might not be representative for the fishery. More accurate tuning fleet definitions should be considered. Second, the information on catch and effort in the logbooks are provided by statistical square and fishing trip only. Consequently, fishing effort is defined as standardised days fishing calculated from duration of total trip which may not reflect accurately hours fished. Third, catch composition is based on market weight categories and a common ALK, obtained from the market sorting categories irrespective of geartype and fishing area, is applied to the catch by market categories of the fleets. This results in poor precision of fleet-specific age composition of catches and auto-correlation between the commercial tuning fleets and the catch-at-age matrix. Onboard sampling data by fleet should be explored for potential improvement of age composition of the fleet-specific catches. The further inclusion of commercial tuning series in the assessment should be evaluated in a forthcoming benchmark assessment.

Some intersessional work has been started in 2004 about the biological links between the Kattegat and the Western Baltic (ICES area 22), and the potential extension of the stock beyond its current assessment area (WP5). Preliminary results concluded that there is good evidence for mixing sub-populations in both areas. Migration of plaice outside the assessment area is one of the reasons that could explain the large and probably unrealistic fluctuations in the estimated fishing mortality. A forthcoming benchmark assessment should include a comparison of assessment results with and without the inclusion of Western Baltic in the analysis.

Available discard numbers for 2003 in the plaice fishery in Division IIIa showed higher discarding rates than previously assumed, especially for the young ages. Further work should be attempted to derive estimates for previous years and for the Kattegat as well, for a possible inclusion of discards in a benchmark assessment.

The use of stock weight at age and maturity data available from Swedish IBTS, quarter 1 and 3, should be attempted in future assessments, as well as the inclusion of the Danish maturity data available for the recent years.

The present indices for stock abundance convey two different trends. The commercial tuning series indicating a smaller increase in SSB in the recent years than the survey time series. These differences in perception should be further explored.

Abundance indices from a Danish 0-group survey with R/V "Havkatten" since 1957 should be explored for possible inclusion as a recruitment estimator.

A benchmark assessment for this stock is scheduled for 2006.

Table 10.1.1 Plaice in IIIa. Official landings in tonnes as reported to ICES and WG estimates, 1972-2003

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			98	98			8 431	-1	8 430	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			67	67			8 807	13	8 820	14 000
2001	11 112	11 114	385	385	1	0			61	61			11 559	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			74	74	1494	1584	8 843	109	8 952	16 600
2004																11 363

Table 10.1.2. Plaice in IIIa. Discards estimates in 2003

	DENMARK - SKAGERRAK - 2003												
	Discards No				Landings No				Ratio of catches				
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Total
age0	0	0	21	5	0	0	0	0			100%	100%	100%
age1	47	162	1027	314	0	0	0	5	100%	100%	100%	98%	100%
age2	954	1083	2813	1089	0	0	600	1094	100%	100%	82%	50%	78%
age3	1456	1638	1061	558	42	604	1080	524	97%	73%	50%	52%	68%
age4	1021	944	331	310	413	1910	1783	534	71%	33%	16%	37%	36%
age5	285	450	120	127	736	1871	2143	713	28%	19%	5%	15%	15%
age6	132	99	23	7	604	1521	781	191	18%	6%	3%	3%	8%
age7	27	16	0	5	227	311	136	50	11%	5%	0%	10%	6%
age8	1	1	0	0	37	37	16	11	4%	4%	0%	0%	3%
age9	1	0	0	0	6	0	1	3	10%	100%	6%	0%	10%
age10	0	0	0	0	3	0	0	2	8%	100%		0%	7%
age11	0	0	0	0	0	0	2	0	100%	100%	0%		24%
Total No ('000)	3926	4394	5397	2417	2069	6255	6541	3127	65%	41%	45%	44%	47%
Total weight (tons)	392	345	111	137	593	1620	1789	846	40%	18%	6%	14%	17%
No trips sampled	7	8	5	5									

	SWEDEN - IIIa - 2003												
	Discards No				Landings No				Ratio of catches				
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Total
age0	0	0	0	N/A	0	0	0	0				N/A	
age1	4	22	31	N/A	0	0	0	0	100%	100%	100%	N/A	100%
age2	235	753	2176	N/A	3	13	430	153	99%	98%	83%	N/A	88%
age3	312	66	96	N/A	31	30	67	86	91%	69%	59%	N/A	79%
age4	236	20	0	N/A	123	160	41	29	66%	11%	0%	N/A	44%
age5	2	0	0	N/A	61	120	0	21	4%	0%		N/A	1%
age6	0	0	0	N/A	19	3	22	1	0%	0%	0%	N/A	0%
age7	0	0	0	N/A	4	7	0	0	0%	0%		N/A	0%
age8	0	0	0	N/A	5	0	0	0	0%			N/A	0%
age9	0	0	0	N/A	4	0	0	0	0%			N/A	0%
age10	0	0	0	N/A	2	0	0	0	0%			N/A	0%
age11	0	0	0	N/A	0	0	0	0				N/A	
Total No ('000)	790	861	2303	N/A	252	333	561	290	76%	72%	80%	N/A	78%
Total weight (tons)	92	74	252	N/A	78	92	147	78	54%	45%	63%	N/A	57%
No trips sampled	13	10	9										

Table 10.2.1 Plaice in Kattegat. Landings in tonnes Working Group estimates, 1972-2003

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

* years 1972-1990 landings refers to IIIA

Table 10.2.2. Plaice in Skagerrak. Landings in tonnes. Working Group estimates, 1972-2003

Year	Denmark	Sweden	Germany	Belgium	Norway	letherlands	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	1584	6 656

Table 10.2.3. Plaice in IIIa. Catch numbers at age. Numbers*10**-3

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,
AGE						
2,	489,	1105,	362,	190,	526,	1481,
3,	15692,	9789,	4772,	4048,	2067,	9715,
4,	39531,	29655,	16353,	13098,	9204,	8630,
5,	24919,	20807,	12575,	10970,	10602,	8026,
6,	8011,	7646,	6033,	4306,	5554,	2673,
7,	620,	2514,	2393,	1427,	1851,	925,
8,	63,	170,	949,	546,	758,	531,
9,	63,	75,	203,	213,	301,	257,
10,	48,	50,	54,	119,	113,	96,
+gp,	60,	55,	50,	97,	48,	106,
0 TOTALNUM,	89496,	71866,	43744,	35014,	31024,	32440,
TONSLAND,	26953,	21976,	16445,	12602,	11047,	10780,
SOPCOF %,	102,	104,	106,	103,	102,	101,

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
2,	2154,	1400,	375,	623,	101,	1012,	3147,	2309,	904,	1038,
3,	12620,	8641,	4366,	4227,	3052,	3844,	8748,	8611,	3858,	3505,
4,	11140,	21798,	14749,	12400,	12037,	7102,	8623,	9583,	11759,	10088,
5,	4463,	6232,	19193,	17710,	13783,	6255,	9718,	4663,	17427,	13233,
6,	2183,	1715,	4477,	10205,	6860,	2708,	3222,	2893,	4297,	6891,
7,	985,	698,	633,	2089,	2745,	1171,	981,	892,	1033,	1657,
8,	904,	260,	274,	373,	946,	549,	481,	306,	296,	376,
9,	695,	197,	154,	242,	322,	254,	349,	156,	115,	104,
10,	337,	168,	141,	125,	136,	136,	155,	87,	27,	47,
+gp,	120,	156,	98,	190,	156,	236,	273,	137,	115,	69,
TOTALNUM,	35601,	41265,	44460,	48184,	40138,	23267,	35697,	29637,	39831,	37008,
TONSLAND,	11591,	13482,	14052,	15658,	12850,	7741,	12082,	8700,	11931,	11323,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
2,	1411,	446,	4527,	529,	563,	687,	1223,	3981,	377,	3621,
3,	6919,	2277,	5353,	4733,	6710,	2704,	3937,	9172,	5149,	4872,
4,	8016,	6606,	7971,	6379,	8219,	8432,	8302,	9399,	8870,	9460,
5,	9859,	11530,	5283,	9465,	6856,	8520,	11212,	11001,	7442,	9657,
6,	8002,	6622,	4751,	5104,	2971,	7419,	3599,	4744,	4776,	4511,
7,	2780,	4929,	1812,	3072,	791,	1301,	888,	410,	1740,	1010,
8,	448,	853,	1355,	1369,	385,	380,	139,	102,	442,	144,
9,	111,	137,	151,	849,	234,	77,	17,	19,	50,	20,
10,	38,	65,	23,	114,	170,	106,	7,	14,	17,	11,
+gp,	55,	51,	45,	36,	64,	43,	29,	33,	12,	5,
TOTALNUM,	37639,	33516,	31271,	31650,	26963,	29669,	29353,	38875,	28875,	33311,
TONSLAND,	11325,	10766,	10545,	10291,	8430,	8740,	8820,	11560,	8701,	8952,
SOPCOF %,	100,	100,	101,	100,	100,	100,	101,	100,	100,	96,

Table 10.2.4. Plaice in IIIa. Stock weight at age. Numbers*10-3**

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,
AGE						
2,	.2360,	.2220,	.2610,	.2300,	.2700,	.2850,
3,	.2480,	.2550,	.2740,	.2630,	.3010,	.2740,
4,	.2680,	.2670,	.3060,	.2960,	.2860,	.2930,
5,	.3220,	.2970,	.3450,	.3570,	.3180,	.3560,
6,	.4170,	.3780,	.4140,	.4320,	.3860,	.4230,
7,	.5980,	.4510,	.5790,	.5370,	.5440,	.4830,
8,	.7520,	.6550,	.6400,	.6710,	.7040,	.5310,
9,	.8180,	.9220,	.7530,	.8130,	.8130,	.6470,
10,	.9140,	1.0200,	.8110,	.9120,	.9120,	.9860,
+gp,	.8430,	1.0440,	.9100,	.9990,	.9860,	1.1840,
0 SOPCOFAC,	1.0159,	1.0390,	1.0625,	1.0268,	1.0184,	1.0060,

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
2,	.2820,	.2780,	.2500,	.3220,	.2520,	.2740,	.2920,	.2630,	.3090,	.2670,
3,	.2990,	.2820,	.2770,	.2800,	.2670,	.2630,	.2880,	.2700,	.3100,	.2720,
4,	.3040,	.3080,	.2840,	.2810,	.2680,	.2820,	.2940,	.2590,	.2720	.2710,
5,	.3720,	.3540,	.3100,	.2920,	.2900,	.3200,	.3370,	.2740,	.2800,	.2950,
6,	.4030,	.4370,	.3840,	.3630,	.3500,	.3760,	.3970,	.3650,	.3360,	.3380,
7,	.4060,	.5440,	.5310,	.5270,	.4750,	.4660,	.4980,	.4920,	.5000,	.4410,
8,	.3830,	.6800,	.7070,	.7110,	.5670,	.6350,	.6840,	.5840,	.6460,	.5660,
9,	.3600,	.7370,	.8500,	.9040,	.7550,	.7410,	.7750,	.6700,	.8170,	.7120,
10,	.4430,	.7550,	.9030,	1.0360,	.8330,	.8250,	.9510,	.8820,	.8040,	.8020,
+gp,	1.0610,	.9140,	1.0990,	1.0840,	1.1930,	1.0020,	1.1500,	1.0800,	.9760,	1.1680,
SOPCOFAC,	1.0009,	1.0012,	.9997,	.9996,	1.0002,	.9999,	1.0004,	1.0006,	.9999,	.9991,

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
2,	.2750,	.2630,	.2660,	.3000,	.2600,	.2710,	.2570,	.2570,	.2460,	.2430,
3,	.2630,	.3010,	.2680,	.2940,	.2500,	.2710,	.2620,	.2720,	.2710,	.2520,
4,	.2720,	.3030,	.2940,	.2830,	.2800,	.2900,	.2760,	.2900,	.2700,	.2710,
5,	.2890,	.2890,	.3840,	.2990,	.3270,	.2900,	.3020,	.3220,	.2870,	.2900,
6,	.3300,	.3280,	.3990,	.3410,	.3980,	.2940,	.3550,	.3100,	.3380,	.2980,
7,	.3810,	.3680,	.4360,	.4100,	.4640,	.3360,	.3880,	.4250,	.4020,	.4000,
8,	.5160,	.4990,	.4300,	.4650,	.5150,	.3700,	.5170,	.5890,	.5950,	.4640,
9,	.6580,	.7360,	.5610,	.4450,	.5870,	.6560,	.8570,	.8360,	.7940,	.6050,
10,	.7660,	.7520,	.8700,	.5310,	.6410,	.5670,	.9700,	.6790,	1.1480,	.6410,
+gp,	.9790,	1.0220,	.9570,	.7600,	.8630,	.8310,	.9670,	.8180,	1.1500,	1.2920,
SOPCOFAC,	1.0001,	1.0015,	1.0113,	1.0003,	1.0016,	1.0000,	1.0061,	1.0014,	1.0037,	.9613,

Table 10.2.5. Plaice IIIa. Tuning data by fleet.

```
Tuning Data; Plaice in IIIa (Skagerrak + Kattegat)
107
Danish Gillnetters
1987 2003
1   1   0   1
2   11
 4159     20592   169059   650916   1071313    803165    286784  58777     33991    18818    24877
 3981     27444   168504   529771    606818    410016    309311 134000     55393    19492    23977
 3790     18882    63447   175206    186617    129661    111415  85514     44764    24564    43810
 4205     64308   246880   272984    362432    157274     62094  42383     38230    20604    41001
 3800     43034   181507   242271    148622    168826     68492  32399     14923    11663    17809
 4871     67456   350855   854331   1065380    260669    108795  39021     18755     5675    21064
 5628      4846    80411   339540    652443    591404    199282  42122     12860     3774     2597
11400     93332   788950   992744   1280086   1145581    443000  78443     26304     7859    14155
 9854     93997   320239   744931   1661991    911912    979462 185418     30434    13976    10309
 9607    431700   632571   858288    762350    711940    291167 215022     22193     3298     8388
 8013     67268   468037   544401    912161    684171    509591 271094    101874    19323     7745
 7075     52000   481000   803000    854000    380000    112000  63000     42000    31000    15000
 6966     62000   183000   698000    841000   1001000    206000  70000     21000    13000     9000
 7320     44000   250000   847000   1044000    439000     93000  19000      4000     1000     6000
 7785    257408   421089   734508   1514962    901478    101935  32356      4397     3983     4543
 6614     36711   451342   573342   561560     555556    336972  105617    16792     4906     5391
 4427    167981   194691   516690   611548     386308    135177  21817      3105     1903      753
Danish Trawlers
1987 2003
1   1   0   1
2   11
33444     255915   1177661   2468347    2379126    1046122   215078   50415   32514   24420    37438
30661     108178    839066   1906117    1819047     700988   226895   75481   23885   20953    22426
33983     430316    927355   1291748    1026225     456678   165557   71803   37576   18121    35819
38874    1181442   2311097   2020630    2065160     631904   200416   85590   45586   22634    42975
37885     660031   2459249   2424238    1085399     580774   151470   52786   31364   18475    27441
35127     324054   1244765   2463167    3594631     910595   232058   62318   14226   3014     12454
30064     172192    866648   2265364    2200206    1312213   455227   82231   15921   12071    15309
29412     506609   1815439   1886714    2177012    1785146   732729  113303   17909   12336    11983
26141     262364    791718   1217689    2119319    1052643   706432  144496   23084   11096     8823
28119    1044742   1432920   1503021    1053244     772862   329651  235696   24501    4352     9874
26062     166014   1234787   1637715    1843447     841073   352324  143468   96237   15809     6255
25274     210000   1613000   1953000    1285000     495000   120000   54000   36000   23000     9000
26803     223000    761000   1739000    1403000    1024000   212000   58000   10000   11000     8000
29040     514000   1392000   2182000    2529000     762000   168000   25000    6000    3000     6000
27580    1213134   2297369   2297400    2241237     982424    99667   19672    6921    4216     5405
27737     132625   1517394   2419247    1910112    1210114   368511   82071    7932    3153     1656
23665     671758    892952   2041035    1670860     741923   177271   31289    4085    3534     1377
Danish Seiners
1987 2003
1   1   0   1
2   11
7895   97426   1157332  4050596  5227390 2536790    426009    72398     40925    20944   22943
6957  466750   1343996  3116463  3368983 1446989    521283   158464     47106    16431   19006
9574  334835   1483241  3030013  2733969 1193297    477612   171227     76749    33563   39868
9364 1116082   3542256  3431384  3748325 1097119    299716   116328     81119    32922   60674
8906  515012   2426848  3289407  1838074 1057052    265606    88516     42174    17972   28587
8762  106267    791895  4199036  6819566 1725235    324760    77400     27070     4686   17868
7364  139121    509253  1721085  2800822 1649545    413535    89601     21958     5718    3978
7247  336892   1620907  1883228  2514844 1977352    552285    69993     19937     4536    4288
6801  195908    569871  1348638  2282155 1664669   1118605   153081     23915    11391    8384
6381  949342   1363113  1878662   980782  913661    327089   230807     22762     3019    6502
5767  165538   1193786  1794123  2572264 1359436    909634   392850    278160    26736    5420
5506  144000   2251000  2489000  2044000  884000    231000   109000     61000    49000   14000
6039  173000    721000  2487000  2755000 2425000    367000   103000     16000    36000    9000
5890  286000   1240000  2954000  4300000 1202000    334000    46000      3000     1000    3000
6134 1534686   3619758  3159809  3377381 1347729    137169    33892      5948     4204    4928
5515  109606   1732101  3339718  2960753 1745554    566533   131577     11847     3376    2136
4387  945600   1403590  2707165  2618571 1210328    230619    32943      2658     1506     658
```

Table 10.2.5 (cont.). Plaice IIIa. Tuning data by fleet.

```
KASU_q4
1994 2003
1    1    0.83 0.92
1    6
1     0.87      10.51    5.88     0.37     0.99 0.03
1     1.67      10.33    3.77     0.19     1.10 0.06
1     2.48      37.87   11.07     0.36     0.42 0.10
1    11.14      11.27    4.32     1.25     0.64 0.36
1    17.85      14.80    5.19     3.50     0.00 0.11
1    89.27      33.15    7.70     0.27     0.60 0.65
1    99.71     121.08   15.63     0.00     0.47 0.47
1    52.84      99.58   29.67     1.70     0.49 0.82
1    46.11      18.36   25.18    12.40     1.24 0.15
1    42.10      61.85   15.01     6.15     3.40 0.35
KASU_q1_backshifted
1995 2003
1    1    0.99 1
1    6
1     23.26   26.79     7.00     1.69     0.81     0
1     11.52   20.47     4.77     1.03     0.67     0.2
1     -9.00   -9.00    -9.00    -9.00    -9.00    -9.00
1     25.82   22.27     2.92     1.25     0.15     0
1    196.46   47.55     9.06     1.88     1.64     0
1    127.68   74.02     6.68     1.71     1.41     0.08
1     45.73   78.31    32.05     2.30     0.44     0.33
1    134.21   36.87    34.79     8.27     0.16     0.10
1     77.1    79.3 28.0 11.5  4.0  1.3
IBTSQ1_backshifted (Revised)
1990 2003
1    1    0.99 1
1    6
1     6.65    18.27    10.20     3.17     0.38    0.11
1     8.07    18.83    13.20     2.97     0.45    0.12
1    12.61    11.94    11.89    10.77     4.15    0.51
1    16.82    13.29     3.87     2.30     2.51    0.55
1     8.31    20.07     8.77     2.39     1.80    0.86
1    34.31    25.16     9.17     3.19     0.74    0.29
1    17.19    39.00     8.24     2.99     0.16    0.10
1    15.88    16.09     8.54     3.00     0.67    0.25
1    36.29    19.40     5.51     4.94     0.27    0.14
1    98.25    55.47    13.09     4.31     2.65    0.27
1    42.45    73.24    16.92     2.91     1.76    0.65
1    11.04    47.41    32.34     9.17     1.72    1.30
1    75.23    39.62    36.10    25.75     4.94    0.84
1    30.65    85.54    24.19    19.19    17.77    1.13
IBTSQ3 (Revised)
1995 2003
1    1    0.83 0.92
1    6
1     7.63     9.67     9.88     2.95     1.62     0.87
1     8.67    16.61     6.55     2.17     0.77     0.33
1    15.24    18.35     9.07     2.54     0.91     0.51
1    18.46    20.95     5.16     3.57     0.47     0.00
1    46.72    46.20    13.74     1.52     1.50     0.27
1    -9.00    -9.00    -9.00    -9.00    -9.00    -9.00
1     7.31    81.66    49.68     7.95     2.81     0.90
1    26.92    25.39    18.17    14.00     3.15     0.37
1     2.13    29.14     5.43     7.53     4.06     0.84
```

Table 10.3.1. Plaice in IIIa. Diagnostic from xsa tuning.

```
Lowestoft VPA Version 3.1
    9/09/2004  13:56
 Extended Survivors Analysis

 Plaice IIIa VPA data,2003 WG,ANON,COMBSEX,PLUSGROUP
 CPUE data from file ple3afl1_final.dat
 Catch data for  26 years. 1978 to 2003. Ages  2 to  11.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 Danish Gillnetters  ,   1987, 2003,   2,    10,   .000,  1.000
 Danish Trawlers     ,   1987, 2003,   2,    10,   .000,  1.000
 Danish Seiners      ,   1987, 2003,   2,    10,   .000,  1.000
 KASU_q4             ,   1994, 2003,   1,     6,   .830,   .920
 KASU_q1_backshifted ,   1995, 2003,   1,     6,   .990,  1.000
 IBTSQ1_backshifted  ,   1990, 2003,   1,     6,   .990,  1.000
 IBTSQ3              ,   1995, 2003,   1,     6,   .830,   .920

 Time series weights :
      Tapered time weighting applied
      Power =    3 over  20 years

 Catchability analysis :
      Catchability independent of stock size for all ages
      Catchability independent of age for ages >=    8

 Terminal population estimation :
      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   5 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =    .500

      Minimum standard error for population
      estimates derived from each fleet =    .300

      Prior weighting not applied

 Tuning converged after   27 iterations

 Regression weights
       ,  .751,  .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000

 Fishing mortalities
    Age,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003

      2,  .043,  .012,  .126,  .012,  .015,  .018,  .018,  .053,  .009,  .033
      3,  .268,  .082,  .180,  .169,  .189,  .083,  .119,  .164,  .080,  .134
      4,  .294,  .392,  .402,  .302,  .435,  .340,  .348,  .407,  .212,  .186
      5,  .602,  .786,  .551, 1.046,  .542,  .980,  .905,  .943,  .580,  .333
      6,  .657,  .950,  .785, 1.538, 1.023, 1.970, 1.499, 1.165, 1.394,  .747
      7, 1.133, 1.000,  .653, 1.911,  .984, 1.986, 1.696,  .576, 2.244, 1.231
      8, 1.190, 1.252,  .738, 1.463, 1.597, 2.196, 1.357,  .832, 2.630, 1.473
      9,  .750, 1.483,  .670, 1.412,  .987, 2.044,  .503,  .572, 1.216, 1.031
     10, 1.060, 1.283, 1.001, 1.591, 1.162, 1.847, 1.124,  .902, 1.444,  .861

 XSA population numbers (Thousands)
                              AGE
 YEAR ,          2,         3,         4,         5,         6,         7,         8,         9,        10,

 1994 ,    3.51E+04, 3.10E+04, 3.30E+04, 2.29E+04, 1.75E+04, 4.31E+03, 6.77E+02, 2.21E+02, 6.11E+01,
 1995 ,    3.81E+04, 3.04E+04, 2.14E+04, 2.23E+04, 1.14E+04, 8.20E+03, 1.26E+03, 1.86E+02, 9.45E+01,
 1996 ,    4.02E+04, 3.41E+04, 2.53E+04, 1.31E+04, 9.18E+03, 3.97E+03, 2.73E+03, 3.25E+02, 3.82E+01,
 1997 ,    4.59E+04, 3.20E+04, 2.57E+04, 1.53E+04, 6.83E+03, 3.79E+03, 1.87E+03, 1.18E+03, 1.51E+02,
 1998 ,    4.00E+04, 4.10E+04, 2.45E+04, 1.72E+04, 4.88E+03, 1.33E+03, 5.08E+02, 3.92E+02, 2.60E+02,
 1999 ,    4.14E+04, 3.56E+04, 3.07E+04, 1.43E+04, 9.06E+03, 1.59E+03, 4.49E+02, 9.30E+01, 1.32E+02,
 2000 ,    7.17E+04, 3.68E+04, 2.97E+04, 1.98E+04, 4.87E+03, 1.14E+03, 1.97E+02, 4.52E+01, 1.09E+01,
 2001 ,    8.16E+04, 6.37E+04, 2.95E+04, 1.89E+04, 7.25E+03, 9.84E+02, 1.90E+02, 4.58E+01, 2.48E+01,
 2002 ,    4.57E+04, 7.01E+04, 4.89E+04, 1.78E+04, 6.68E+03, 2.05E+03, 5.01E+02, 7.47E+01, 2.34E+01,
 2003 ,    1.18E+05, 4.10E+04, 5.85E+04, 3.58E+04, 9.02E+03, 1.50E+03, 1.96E+02, 3.27E+01, 2.00E+01,

 Estimated population abundance at 1st Jan 2004
    ,     0.00E+00, 1.03E+05, 3.24E+04, 4.40E+04, 2.32E+04, 3.87E+03, 3.96E+02, 4.07E+01, 1.05E+01,

Taper weighted geometric mean of the VPA populations:
    ,     5.11E+04, 4.13E+04, 3.25E+04, 1.96E+04, 7.75E+03, 2.15E+03, 5.77E+02, 1.59E+02, 6.09E+01,

 Standard error of the weighted Log(VPA populations) :
    ,        .3814,    .2895,    .3155,    .3351,    .3787,    .6132,    .8485,   1.0873,   1.0390,
```

Log catchability residuals.

Fleet : Danish Gillnetters

```
  Age  ,  1987,  1988,  1989,  1990,  1991,  1992,  1993
     2 ,  -.35,   .01, -1.00,   .04,   .11,   .41, -2.12
     3 ,   .11,   .21,  -.67,  -.09,  -.37,   .38, -1.15
     4 ,   .53,   .74,  -.41,   .05,  -.73,   .21,  -.51
     5 ,   .50,   .50,  -.38,   .03,  -.81,   .19,  -.63
```

6	.23	.17	-.41	-.34	-.24	-.40	-.25
7	.06	.28	-.09	-.52	-.24	-.23	.01
8	-.59	.11	-.11	-.28	-.25	-.22	-.51
9	-.23	.12	.04	-.01	.15	-.03	-.41
10	.00	.30	.33	.18	.15	.37	-.66

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	.15	.20	1.76	-.11	-.10	.05	-.89	.70	-.52	.47
3	.77	-.06	.58	.52	.43	-.43	-.18	-.25	-.15	-.03
4	-.09	.25	.25	-.08	.54	.14	.33	.15	-.53	-.42
5	-.27	.25	-.08	.33	.06	.43	.25	.62	-.30	-.63
6	-.78	-.31	-.39	.35	.02	.74	.32	.45	.30	-.23
7	-.47	-.23	-.84	.44	-.25	.57	-.05	-.32	.94	.38
8	-.56	-.15	-.96	.12	.14	.59	-.24	.06	1.08	.45
9	-.72	.04	-1.14	-.42	-.25	.91	-.68	-.63	.66	.12
10	-.51	-.14	-.76	.05	-.07	.01	-.38	.03	.67	.05

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	-8.4405	-6.6935	-5.6581	-4.7192	-4.0189	-3.6841	-3.4503	-3.4503	-3.4503
S.E(Log q)	.8498	.4906	.3868	.4323	.4292	.4958	.5367	.6014	.4012

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	.77	.433	9.00	.26	17	.68	-8.44
3	2.11	-1.034	2.33	.08	17	1.03	-6.69
4	5.37	-2.783	-15.01	.04	17	1.64	-5.66
5	1.69	-1.051	1.14	.19	17	.73	-4.72
6	1.79	-1.333	.13	.22	17	.74	-4.02
7	1.14	-.493	3.12	.55	17	.59	-3.68
8	1.34	-1.406	2.45	.62	17	.69	-3.45
9	1.12	-.671	3.44	.75	17	.66	-3.62
10	.97	.227	3.53	.88	17	.40	-3.51

Fleet : Danish Trawlers

Age	1987	1988	1989	1990	1991	1992	1993
2	-.15	-.89	-.30	.49	.30	-.24	-.46
3	-.05	-.23	-.19	-.08	-.07	-.34	-.46
4	.07	.27	-.31	.13	-.43	-.41	.00
5	-.16	.17	-.25	.16	-.50	.05	-.47
6	-.65	-.39	-.40	-.22	-.35	-.18	-.18
7	-1.09	-.86	-.68	-.36	-.53	-.23	.38
8	-1.40	-1.08	-1.05	-.38	-.63	-.30	-.09
9	-.93	-1.34	-.90	-.63	.03	-.86	-.45
10	-.39	-.24	-.74	-.52	-.26	-.81	.25

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	.66	.02	1.33	-.62	-.22	-.25	-.04	.75	-.91	-.06
3	.65	-.14	.32	.30	.36	-.36	.15	.18	-.38	-.19
4	-.10	.06	.03	.13	.45	.00	.19	.33	-.22	-.43
5	-.06	.13	-.21	.48	-.18	.22	.37	.36	.11	-.68
6	-.34	-.20	-.44	.32	-.04	.36	.44	.22	.59	-.30
7	.30	-.32	-.58	.10	-.24	.47	.38	-.39	.81	.19
8	.29	.05	-.52	-.27	.14	.48	.09	-.28	.82	.56
9	-.62	.22	-.68	-.23	-.25	.25	-.22	-.01	-.10	.15
10	.42	.09	-.13	.09	-.21	-.08	.77	.25	.23	.42

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	-8.2041	-6.6855	-5.9536	-5.3400	-4.9664	-4.8975	-4.8783	-4.8783	-4.8783
S.E(Log q)	.6195	.3327	.2747	.3570	.3606	.4707	.5001	.4647	.4088

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	.83	.413	8.66	.36	17	.53	-8.20
3	1.53	-.994	4.61	.26	17	.51	-6.69
4	3.13	-3.911	-3.47	.25	17	.57	-5.95
5	1.80	-1.442	1.70	.24	17	.61	-5.34
6	1.60	-1.356	2.57	.34	17	.56	-4.97
7	1.14	-.504	4.52	.58	17	.55	-4.90
8	1.36	-1.578	4.35	.66	17	.64	-4.88
9	1.23	-1.910	5.14	.88	17	.43	-5.12
10	1.34	-2.724	5.05	.86	17	.43	-4.81

Fleet : Danish Seiners

Age	1987	1988	1989	1990	1991	1992	1993

2	-.98	.75	-.59	.55	.19	-1.27	-.57
3	-.16	.18	.01	.23	-.18	-.94	-1.12
4	.26	.50	.06	.33	-.43	-.24	-.61
5	.17	.37	.10	.29	-.42	.18	-.72
6	-.28	-.14	-.14	-.21	-.27	-.12	-.51
7	-.88	-.46	-.26	-.44	-.44	-.42	-.22
8	-1.47	-.72	-.79	-.52	-.53	-.56	-.47
9	-1.12	-1.04	-.79	-.50	-.10	-.70	-.59
10	-.97	-.87	-.73	-.59	-.71	-.85	-.96

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	.34	-.23	1.41	-.42	-.38	-.32	-.34	1.18	-.79	.66
3	.39	-.66	.21	.24	.68	-.46	.09	.59	-.17	.41
4	-.45	-.24	-.01	-.02	.47	.10	.34	.40	-.03	-.21
5	-.42	-.34	-.70	.42	-.09	.48	.60	.38	.26	-.44
6	-.80	-.35	-.75	.35	.10	.75	.53	.07	.61	-.09
7	-.49	-.42	-1.01	.65	.02	.59	.75	-.48	.95	.23
8	-.66	-.41	-.92	.38	.50	.68	.42	-.10	1.04	.43
9	-.98	-.27	-1.14	.47	-.06	.34	-1.19	-.53	.05	-.47
10	-1.05	-.41	-.88	.26	.20	.73	-.60	-.12	.04	-.61

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9	10
Mean Log q	-6.8975	-5.1466	-4.2051	-3.4408	-3.0041	-2.9867	-3.0095	-3.0095	-3.0095
S.E(Log q)	.7663	.5366	.3316	.4618	.4915	.6143	.6450	.6945	.6633

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	.58	1.245	8.57	.46	17	.43	-6.90
3	.84	.335	6.04	.30	17	.47	-5.15
4	1.81	-1.475	-.78	.25	17	.57	-4.21
5	1.75	-1.026	-1.39	.16	17	.81	-3.44
6	3.27	-2.000	-10.51	.07	17	1.42	-3.00
7	1.46	-1.052	.83	.34	17	.89	-2.99
8	1.54	-1.652	1.20	.48	17	.92	-3.01
9	.90	.691	3.58	.84	17	.50	-3.42
10	.86	.965	3.46	.84	17	.48	-3.36

Fleet : KASU_q4

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	-.62	-.75	.60	-.85	-.44	.34	1.08	.79	-.36	-.07
3	-.16	-.75	.30	-.59	-.64	-.20	.51	.64	.31	.37
4	-1.30	-1.45	-.97	.17	1.37	-1.50	99.99	.43	1.75	.84
5	-.12	.17	-.47	.23	99.99	.18	-.46	-.34	.34	.43
6	-3.23	-1.85	-1.27	.96	-.33	1.65	1.54	1.40	-.01	-.03
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6
Mean Log q	-7.3646	-8.0828	-9.7533	-9.3127	-9.3835
S.E(Log q)	.6897	.5177	1.2711	.3547	1.5525

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	.56	1.380	8.89	.58	10	.37	-7.36
3	.50	1.873	9.34	.66	10	.23	-8.08
4	.35	1.396	10.15	.43	9	.42	-9.75
5	.70	1.000	9.48	.64	9	.25	-9.31
6	-.54	-2.506	8.75	.27	10	.66	-9.38

Fleet : KASU_q1_backshifted

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	99.99	-.12	-.33	99.99	-.35	.37	.27	.23	.01	-.15
3	99.99	-.17	-.57	99.99	-1.24	-.07	-.37	.69	.60	.97
4	99.99	.04	-.61	99.99	-.35	-.27	-.32	.04	.62	.75
5	99.99	.08	.19	99.99	-1.59	1.42	.87	-.21	-1.52	.75
6	99.99	99.99	-.74	99.99	99.99	99.99	-.32	.37	-.51	1.11
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age ,	2,	3,	4,	5,	6
Mean Log q,	-7.0263,	-8.0249,	-8.9983,	-9.4236,	-9.1100,
S.E(Log q),	.2771,	.7464,	.4868,	1.1063,	.7567,

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,	.87,	.554,	7.53,	.77,	8,	.26,	-7.03,
3,	.43,	1.526,	9.54,	.56,	8,	.29,	-8.02,
4,	.46,	3.739,	9.75,	.89,	8,	.13,	-9.00,
5,	.66,	.340,	9.57,	.15,	8,	.79,	-9.42,
6,	.51,	.602,	9.00,	.34,	5,	.42,	-9.11,

Fleet : IBTSQ1_backshifted

Age ,	1987,	1988,	1989,	1990,	1991,	1992,	1993
2 ,	99.99,	99.99,	99.99,	-.89,	-.49,	-.86,	-.49
3 ,	99.99,	99.99,	99.99,	-.53,	-.35,	-.15,	-1.19
4 ,	99.99,	99.99,	99.99,	-.01,	-.97,	.27,	-.90
5 ,	99.99,	99.99,	99.99,	-.80,	-.99,	.72,	-.15
6 ,	99.99,	99.99,	99.99,	-.89,	-.99,	.13,	-.34
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 ,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003
2 ,	-.06,	.05,	.55,	-.58,	-.25,	.77,	.50,	-.04,	.32,	.17
3 ,	.06,	-.06,	-.18,	-.09,	-.76,	.14,	.40,	.55,	.48,	.67
4 ,	-.83,	-.02,	-.24,	-.35,	.33,	-.13,	-.48,	.73,	1.07,	.57
5 ,	-.05,	-.73,	-1.97,	-.20,	-1.72,	1.18,	.37,	.43,	1.19,	1.52
6 ,	-.54,	-.90,	-1.92,	.04,	-.71,	.27,	1.30,	1.26,	1.14,	.49
7 ,	No data for this fleet at this age									
8 ,	No data for this fleet at this age									
9 ,	No data for this fleet at this age									
10 ,	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age ,	2,	3,	4,	5,	6
Mean Log q,	-7.2639,	-7.8678,	-8.3071,	-8.6997,	-8.6300,
S.E(Log q),	.4995,	.5243,	.6256,	1.1241,	.9956,

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,	.91,	.247,	7.60,	.42,	14,	.47,	-7.26,
3,	.72,	.689,	8.66,	.38,	14,	.38,	-7.87,
4,	.62,	.993,	9.09,	.42,	14,	.39,	-8.31,
5,	.40,	1.518,	9.41,	.40,	14,	.42,	-8.70,
6,	3.93,	-.889,	7.67,	.01,	14,	3.95,	-8.63,

Fleet : IBTSQ3

Age ,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003
2 ,	99.99,	-.70,	-.11,	-.24,	.03,	.79,	99.99,	.71,	.08,	-.70
3 ,	99.99,	.16,	-.28,	.10,	-.69,	.33,	99.99,	1.11,	-.06,	-.69
4 ,	99.99,	.10,	-.37,	-.31,	.19,	-.97,	99.99,	.78,	.67,	-.15
5 ,	99.99,	-.08,	-.50,	-.06,	-1.28,	.45,	99.99,	.76,	.62,	-.04
6 ,	99.99,	-.05,	-.96,	.43,	99.99,	-.11,	99.99,	.62,	.01,	-.04
7 ,	No data for this fleet at this age									
8 ,	No data for this fleet at this age									
9 ,	No data for this fleet at this age									
10 ,	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age ,	2,	3,	4,	5,	6
Mean Log q,	-7.4845,	-8.0349,	-8.5575,	-8.6689,	-8.5042,
S.E(Log q),	.5636,	.6023,	.5873,	.6726,	.4946,

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,	1.24,	-.340,	6.68,	.27,	8,	.75,	-7.48,

3,	.63,	.773,	9.01,	.44,	8,	.39,	-8.03,
4,	.79,	.394,	8.94,	.38,	8,	.50,	-8.56,
5,	.88,	.159,	8.81,	.23,	8,	.64,	-8.67,
6,	-2.93,	-1.298,	10.54,	.02,	7,	1.37,	-8.50,

Terminal year survivor and F summaries :

Age 2 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
Danish Gillnetters ,	164301.,	.884,	.000,	.00,	1,	.044,	.021
Danish Trawlers ,	97040.,	.645,	.000,	.00,	1,	.083,	.035
Danish Seiners ,	199493.,	.798,	.000,	.00,	1,	.054,	.017
KASU_q4 ,	96057.,	.726,	.000,	.00,	1,	.066,	.035
KASU_q1_backshifted ,	89218.,	.300,	.000,	.00,	1,	.385,	.038
IBTSQ1_backshifted ,	122056.,	.521,	.000,	.00,	1,	.128,	.028
IBTSQ3 ,	51020.,	.600,	.000,	.00,	1,	.096,	.065
F shrinkage mean ,	152011.,	.50,,,,				.143,	.022

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
103163.,	.19,	.13,	8,	.699,	.033

Age 3 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
Danish Gillnetters ,	27888.,	.442,	.213,	.48,	2,	.092,	.154
Danish Trawlers ,	22874.,	.305,	.298,	.98,	2,	.194,	.184
Danish Seiners ,	32999.,	.458,	.562,	1.23,	2,	.086,	.131
KASU_q4 ,	36283.,	.436,	.352,	.81,	2,	.095,	.120
KASU_q1_backshifted ,	37051.,	.281,	.317,	1.13,	2,	.228,	.118
IBTSQ1_backshifted ,	52751.,	.377,	.172,	.45,	2,	.127,	.084
IBTSQ3 ,	24554.,	.438,	.386,	.88,	2,	.094,	.173
F shrinkage mean ,	34134.,	.50,,,,				.083,	.127

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
32448.,	.14,	.11,	15,	.815,	.134

Age 4 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
Danish Gillnetters ,	35403.,	.298,	.237,	.79,	3,	.127,	.226
Danish Trawlers ,	32841.,	.214,	.247,	1.15,	3,	.245,	.242
Danish Seiners ,	41846.,	.276,	.304,	1.10,	3,	.149,	.195
KASU_q4 ,	73497.,	.415,	.172,	.41,	3,	.062,	.116
KASU_q1_backshifted ,	65240.,	.247,	.163,	.66,	3,	.174,	.129
IBTSQ1_backshifted ,	59994.,	.327,	.190,	.58,	3,	.101,	.140
IBTSQ3 ,	51837.,	.359,	.275,	.77,	3,	.085,	.160
F shrinkage mean ,	21512.,	.50,,,,				.056,	.349

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
43952.,	.11,	.10,	22,	.962,	.186

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1998

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Danish Gillnetters ,	13631.,	.251,	.095,	.38,	4,	.144,	.515
Danish Trawlers ,	17991.,	.188,	.186,	.99,	4,	.252,	.412
Danish Seiners ,	21340.,	.242,	.196,	.81,	4,	.154,	.358
KASU_q4 ,	42362.,	.283,	.181,	.64,	4,	.119,	.196
KASU_q1_backshifted ,	35417.,	.244,	.112,	.46,	4,	.131,	.231
IBTSQ1_backshifted ,	49628.,	.318,	.200,	.63,	4,	.079,	.170
IBTSQ3 ,	40525.,	.384,	.328,	.85,	3,	.061,	.204
F shrinkage mean ,	7584.,	.50,,,,				.060,	.794

Weighted prediction :

Survivors, at end of year	Int, s.e	Ext, s.e	N,	Var, Ratio,	F
23224.,	.10,	.11,	28,	1.200,	.333

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Danish Gillnetters ,	3310.,	.241,	.083,	.35,	5,	.158,	.831
Danish Trawlers ,	3837.,	.185,	.128,	.69,	5,	.253,	.751
Danish Seiners ,	4426.,	.240,	.113,	.47,	5,	.147,	.678
KASU_q4 ,	5478.,	.288,	.059,	.20,	5,	.084,	.578
KASU_q1_backshifted ,	5214.,	.257,	.300,	1.17,	5,	.098,	.600
IBTSQ1_backshifted ,	7417.,	.333,	.114,	.34,	5,	.060,	.456
IBTSQ3 ,	5261.,	.338,	.221,	.65,	4,	.087,	.596
F shrinkage mean ,	1369.,	.50,,,,				.113,	1.419

Weighted prediction :

Survivors, at end of year	Int, s.e	Ext, s.e	N,	Var, Ratio,	F
3867.,	.10,	.09,	35,	.883,	.747

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Danish Gillnetters ,	559.,	.329,	.080,	.24,	6,	.166,	1.001
Danish Trawlers ,	510.,	.272,	.106,	.39,	6,	.215,	1.060
Danish Seiners ,	531.,	.357,	.106,	.30,	6,	.125,	1.033
KASU_q4 ,	295.,	.302,	.062,	.21,	4,	.029,	1.448
KASU_q1_backshifted ,	276.,	.279,	.057,	.20,	5,	.038,	1.499
IBTSQ1_backshifted ,	491.,	.361,	.302,	.84,	5,	.024,	1.084
IBTSQ3 ,	460.,	.366,	.152,	.42,	4,	.037,	1.127
F shrinkage mean ,	274.,	.50,,,,				.366,	1.507

Weighted prediction :

Survivors, at end of year	Int, s.e	Ext, s.e	N,	Var, Ratio,	F
396.,	.21,	.07,	37,	.349,	1.231

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Danish Gillnetters ,	67.,	.459,	.066,	.14,	7,	.134,	1.118
Danish Trawlers ,	70.,	.417,	.065,	.16,	7,	.158,	1.081
Danish Seiners ,	64.,	.541,	.079,	.15,	7,	.095,	1.141
KASU_q4 ,	27.,	.299,	.291,	.97,	5,	.005,	1.800
KASU_q1_backshifted ,	42.,	.444,	.333,	.75,	4,	.004,	1.458
IBTSQ1_backshifted ,	43.,	.368,	.403,	1.09,	5,	.004,	1.440
IBTSQ3 ,	49.,	.370,	.365,	.98,	4,	.006,	1.340
F shrinkage mean ,	29.,	.50,,,,				.595,	1.734

Weighted prediction :

Survivors, at end of year	Int, s.e	Ext, s.e	N,	Var, Ratio,	F
41.,	.31,	.10,	40,	.327,	1.473

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 8

Year class = 1994

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Danish Gillnetters ,	13.,	.532,	.107,	.20,	8,	.141,	.919
Danish Trawlers ,	13.,	.429,	.073,	.17,	8,	.226,	.924
Danish Seiners ,	8.,	.618,	.158,	.25,	8,	.105,	1.254
KASU_q4 ,	14.,	.310,	.281,	.91,	5,	.002,	.879
KASU_q1_backshifted ,	8.,	.332,	.243,	.73,	4,	.002,	1.180
IBTSQ1_backshifted ,	20.,	.400,	.272,	.68,	5,	.001,	.658
IBTSQ3 ,	13.,	.347,	.117,	.34,	4,	.001,	.910
F shrinkage mean ,	10.,	.50,,,,				.523,	1.070

Weighted prediction :

Survivors, at end of year	Int, s.e	Ext, s.e	N,	Var, Ratio,	F
11.,	.30,	.04,	43,	.136,	1.031

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 8

Year class = 1993

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Danish Gillnetters	,	9.,	.349,	.067,	.19,	9,	.260,	.795
Danish Trawlers	,	10.,	.329,	.087,	.26,	9,	.275,	.706
Danish Seiners	,	5.,	.499,	.117,	.23,	9,	.113,	1.116
KASU_q4	,	10.,	.463,	.440,	.95,	4,	.000,	.726
KASU_q1_backshifted	,	6.,	.302,	.312,	1.03,	3,	.001,	1.057
IBTSQ1_backshifted	,	6.,	.347,	.265,	.76,	5,	.001,	.987
IBTSQ3	,	5.,	.316,	.207,	.65,	5,	.001,	1.111
F shrinkage mean	,	6.,	.50,,,,				.350,	.968

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
8.,	.22,	.05,	45,	.217,	.861

Table 10.3.2. Plaice in IIIa. Fishing mortality (F) at age.

Run title : Plaice IIIa VPA data,2003 WG,ANON,COMBSEX,PLUSGROUP

At 9/09/2004 13:57

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,
AGE						
2,	.0084,	.0257,	.0111,	.0078,	.0115,	.0166,
3,	.2335,	.2058,	.1327,	.1487,	.0988,	.2685,
4,	.7572,	.7969,	.5479,	.5627,	.5156,	.6524,
5,	1.0753,	1.0747,	.8465,	.7787,	1.1261,	1.0505,
6,	1.0199,	1.0636,	.9628,	.7009,	1.0772,	.8688,
7,	.5951,	.9543,	1.0673,	.5503,	.6588,	.4407,
8,	.2824,	.2829,	1.0973,	.6559,	.5634,	.3504,
9,	.4844,	.5608,	.5648,	.6835,	.8318,	.3334,
10,	.6945,	.7910,	.9124,	.6768,	.8557,	.6113,
+gp,	.6945,	.7910,	.9124,	.6768,	.8557,	.6113,
0 FBAR 4- 8,	.7460,	.8345,	.9044,	.6497,	.7882,	.6726,

Table 8 Fishing mortality (F) at age

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
2,	.0326,	.0305,	.0107,	.0191,	.0032,	.0162,	.0462,	.0490,	.0212,	.0314,
3,	.1721,	.1591,	.1130,	.1434,	.1103,	.1454,	.1697,	.1544,	.0973,	.0961,
4,	.4947,	.4438,	.3936,	.4706,	.6640,	.3566,	.4911,	.2535,	.2902,	.3498,
5,	.7464,	.5037,	.7844,	1.0217,	1.3401,	.7793,	1.0439,	.4764,	.8673,	.5426,
6,	.8184,	.6371,	.7336,	1.2038,	1.4316,	.9473,	1.1140,	.9301,	.9714,	.9245,
7,	.8293,	.5936,	.4517,	.8171,	1.1825,	.9187,	.9997,	.9838,	.9306,	1.2026,
8,	.9118,	.4729,	.4332,	.4649,	1.0013,	.6934,	1.1509,	.8967,	.9524,	.9621,
9,	.9341,	.4440,	.5038,	.7534,	.8318,	.7152,	1.2137,	1.4896,	.9234,	.9627,
10,	.8522,	.5322,	.5837,	.8857,	1.1983,	.9305,	1.2190,	1.0549,	1.0704,	1.1569,
+gp,	.8522,	.5322,	.5837,	.8857,	1.1983,	.9305,	1.2190,	1.0549,	1.0704,	1.1569,
FBAR4- 8,	.7601,	.5302,	.5593,	.7956,	1.1239,	.7390,	.9599,	.7081,	.8024,	.7963,
1										

Run title : Plaice IIIa VPA data,2003 WG,ANON,COMBSEX,PLUSGROUP

At 9/09/2004 13:57

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	FBAR 01-03
AGE											
2,	.0432,	.0124,	.1261,	.0122,	.0149,	.0176,	.0181,	.0526,	.0087,	.0328,	.0314,
3,	.2678,	.0820,	.1805,	.1688,	.1886,	.0831,	.1194,	.1641,	.0804,	.1335,	.1260,
4,	.2944,	.3917,	.4017,	.3018,	.4351,	.3401,	.3484,	.4072,	.2115,	.1863,	.2683,
5,	.6021,	.7858,	.5512,	1.0462,	.5421,	.9797,	.9048,	.9427,	.5795,	.3333,	.6185,
6,	.6568,	.9497,	.7850,	1.5380,	1.0235,	1.9703,	1.4991,	1.1648,	1.3936,	.7465,	1.1016,
7,	1.1331,	1.0000,	.6525,	1.9107,	.9836,	1.9864,	1.6958,	.5759,	2.2436,	1.2311,	1.3502,
8,	1.1902,	1.2516,	.7383,	1.4633,	1.5970,	2.1960,	1.3572,	.8324,	2.6296,	1.4730,	1.6450,
9,	.7499,	1.4834,	.6700,	1.4121,	.9868,	2.0436,	.5025,	.5724,	1.2163,	1.0314,	.9400,
10,	1.0605,	1.2829,	1.0006,	1.5908,	1.1617,	1.8473,	1.1238,	.9020,	1.4437,	.8612,	1.0690,
+gp,	1.0605,	1.2829,	1.0006,	1.5908,	1.1617,	1.8473,	1.1238,	.9020,	1.4437,	.8612,	
FBAR4-8,	.7753,	.8758,	.6257,	1.2520,	.9162,	1.4945,	1.1610,	.7846,	1.4116,	.7940,	
1											

Table 10.3.3. Plaice in IIIA. Stock numbers at age (start of year) Numbers 10*-3

Run title : Plaice IIIa VPA data,2003 WG,ANON,COMBSEX,PLUSGROUP

At 9/09/2004 13:57

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,
AGE						
2,	61661,	45790,	34418,	25724,	48495,	94310,
3,	79224,	55328,	40382,	30798,	23095,	43379,
4,	78263,	56758,	40751,	31999,	24017,	18931,
5,	39763,	33213,	23148,	21318,	16495,	12976,
6,	13172,	12276,	10260,	8984,	8854,	4840,
7,	1453,	4298,	3834,	3545,	4033,	2728,
8,	269,	725,	1497,	1193,	1850,	1888,
9,	173,	184,	495,	452,	560,	953,
10,	101,	96,	95,	254,	207,	221,
+gp,	125,	105,	87,	206,	87,	242,
0 TOTAL,	274204,	208773,	154967,	124473,	127692,	180469,

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
2,	70510,	48963,	37160,	34604,	33106,	66177,	73255,	50792,	45378,	35304,
3,	83926,	61751,	42971,	33267,	30718,	29859,	58917,	63290,	43762,	40199,
4,	30010,	63935,	47655,	34729,	26080,	24892,	23361,	44989,	49076,	35928,
5,	8921,	16558,	37116,	29090,	19629,	12148,	15767,	12936,	31592,	33221,
6,	4107,	3826,	9054,	15327,	9476,	4650,	5042,	5023,	7269,	12008,
7,	1837,	1639,	1831,	3934,	4161,	2048,	1632,	1498,	1793,	2490,
8,	1589,	725,	819,	1055,	1572,	1154,	740,	543,	507,	640,
9,	1204,	578,	409,	481,	599,	523,	522,	212,	201,	177,
10,	618,	428,	335,	224,	205,	236,	231,	140,	43,	72,
+gp,	218,	395,	232,	337,	232,	406,	403,	219,	182,	105,
0 TOTAL,	202939,	198798,	177582,	153047,	125779,	142094,	179871,	179641,	179802,	160143,

1

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE							
2,	35068,	38128,	40169,	45903,	39967,	41376,	71680,
3,	30957,	30389,	34076,	32041,	41032,	35628,	36785,
4,	33040,	21429,	25331,	25741,	24489,	30744,	29666,
5,	22913,	22271,	13106,	15338,	17224,	14341,	19798,
6,	17472,	11354,	9184,	6834,	4875,	9063,	4872,
7,	4311,	8197,	3974,	3790,	1328,	1585,	1143,
8,	677,	1256,	2729,	1873,	508,	449,	197,
10,	61,	95,	38,	151,	260,	132,	11,
+gp,	88,	73,	74,	47,	97,	53,	45,
0 TOTAL,	144807,	133379,	129007,	132897,	130172,	133465,	164241,

1

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	2001,	2002,	2003,	2004,	GMST 78-01	AMST 78-01
AGE						
2,	81642,	45689,	117818,	0,	47311,	49982,
3,	63695,	70086,	40982,	103163,	41898,	44395,
4,	29540,	48909,	58519,	32448,	33133,	35473,
5,	18946,	17788,	35818,	43952,	19636,	21159,
6,	7249,	6678,	9016,	23224,	7808,	8545,
7,	984,	2046,	1500,	3867,	2458,	2836,
8,	190,	501,	196,	396,	827,	1027,
9,	46,	75,	33,	41,	313,	425,
10,	25,	23,	20,	11,	127,	178,
+gp,	58,	16,	9,	11,		
0 TOTAL,	202374,	191812,	263910,	207113,		

Table 10.3.4. Plaice in IIIa. Summary Table

Run title : Plaice IIIa VPA data,2003 WG,ANON,COMBSEX,PLUSGROUP ,

At 9/09/2004 13:57

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 2	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 4- 8,
1978,	61661,	74881,	60329,	26953,	.4468,	.7460,
1979,	45790,	56723,	46558,	21976,	.4720,	.8345,
1980,	34418,	48458,	39475,	16445,	.4166,	.9044,
1981,	25724,	38489,	32573,	12602,	.3869,	.6497,
1982,	48495,	39803,	26710,	11047,	.4136,	.7882,
1983,	94310,	54420,	27541,	10780,	.3914,	.6726,
1984,	70510,	61367,	41483,	11591,	.2794,	.7601,
1985,	48963,	60746,	47135,	13482,	.2860,	.5302,
1986,	37160,	52166,	42876,	14052,	.3277,	.5593,
1987,	34604,	48129,	36986,	15658,	.4233,	.7956,
1988,	33106,	36311,	27969,	12850,	.4594,	1.1239,
1989,	66177,	41318,	23185,	7741,	.3339,	.7390,
1990,	73255,	54949,	33558,	12082,	.3600,	.9599,
1991,	50792,	49033,	35674,	8700,	.2439,	.7081,
1992,	45378,	53825,	39803,	11931,	.2997,	.8024,
1993,	35304,	45722,	36296,	11323,	.3120,	.7963,
1994,	35068,	41429,	31786,	11325,	.3563,	.7753,
1995,	38128,	39755,	29727,	10766,	.3622,	.8758,
1996,	40169,	39155,	28469,	10545,	.3704,	.6257,
1997,	45903,	40458,	26687,	10291,	.3856,	1.2520,
1998,	39967,	36437,	26046,	8430,	.3237,	.9162,
1999,	41376,	37486,	26273,	8740,	.3327,	1.4945,
2000,	71680,	44594,	26172,	8820,	.3370,	1.1610,
2001,	81642,	55854,	34872,	11560,	.3315,	.7846,
2002,	45689,	52026,	40787,	8701,	.2133,	1.4116,
2003,	**66685**,(1)	68625,	39995,	8952,	.2238,	.7940,
2004,	**53790**,(1)		**47064**,(2)			
Arith. Mean ,	52426,	48929,	34960,	12206,	.3496,	.8639,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

(1) RCT3 estimate
(2) Assuming 3-years average stock weight.

Table 10.4.1. Plaice in IIIa. Input to RCT3.

Y.CLASS	XSA a.2	XSA a.3	IBTSq1 a.1	IBTSq1 a.2	KASUq1 a.1	KASUq1 a.2	KASUq4 a.1	KASUq4 a.2	KASUq4 a.0	IBTSq3 a.1	IBTSq3 a.2
1989	50792	43762	-11	6.65	-11	-11	-11	-11	-11	-11	-11
1990	45378	40199	-11	8.07	-11	-11	-11	-11	-11	-11	-11
1991	35304	30957	-11	12.61	-11	-11	-11	-11	-11	-11	-11
1992	35068	30389	0.71	16.82	-11	-11	-11	10.51	-11	-11	-11
1993	38128	34076	0.64	8.31	-11	-11	0.87	10.33	-11	-11	9.67
1994	40169	32041	0.5	34.31	-11	23.26	1.67	37.87	0.09	7.63	16.61
1995	45903	41032	0	17.19	2.3	11.52	2.48	11.27	0.02	8.67	18.35
1996	39967	35628	0.26	15.88	0.1	0	11.14	14.8	0.1	15.24	20.95
1997	41376	36785	1.39	36.29	0	25.82	17.85	33.15	0.28	18.46	46.2
1998	71680	63695	3.29	98.25	4.7	196.46	89.27	121.08	5.61	46.72	-11
1999	81642	70086	3.87	42.45	33.2	127.68	99.71	99.58	6.11	-11	81.66
2000	45689	40982	0.15	11.04	11.5	45.73	52.84	18.36	0	7.31	25.39
2001	-11	-11	1.02	75.23	20.9	134.21	46.11	61.85	14.78	26.92	29.14
2002	-11	-11	1.77	30.65	9.4	77.09	42.1	-11	1.64	2.13	-11
2003	-11	-11	1.88	-11	7.7	-11	-11	-11	12.26	-11	-11

Table 10.4.2. Plaice in IIIa. RCT3 output at age 2.

Analysis by RCT3 ver3.1 of data from file :

input2.txt

PLE IIIa _ WG 2004. Input from the XSA run 2 at age 2, non shifted indices

Data for 9 surveys over 15 years : 1989 - 2003

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2000

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IBq1.1	.67	10.29	.23	.674	8	.14	10.38	.304	.086
IBq1.2	.62	8.86	.43	.319	11	2.49	10.40	.502	.032
HVq1.1	.25	10.57	.15	.861	5	2.53	11.19	.233	.147
HVq1.2	.22	10.14	.29	.597	6	3.84	10.98	.391	.052
HVq4.1	.22	10.25	.20	.735	7	3.99	11.13	.274	.106
HVq4.2	.38	9.50	.20	.735	8	2.96	10.62	.250	.128
HVq4.0	.35	10.59	.08	.948	6	.00	10.59	.116	.199
IBq3.1	.45	9.48	.21	.649	5	2.12	10.44	.328	.074
IBq3.2	.49	9.14	.25	.626	6	3.27	10.74	.329	.074
					VPA Mean =		10.74	.276	.104

Yearclass = 2001

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IBq1.1	.66	10.33	.25	.616	9	.70	10.80	.295	.099
IBq1.2	.62	8.89	.42	.307	12	4.33	11.58	.532	.030
HVq1.1	.29	10.43	.28	.591	6	3.09	11.31	.413	.050
HVq1.2	.23	10.07	.30	.542	7	4.91	11.20	.397	.054
HVq4.1	.23	10.17	.25	.605	8	3.85	11.06	.320	.084
HVq4.2	.37	9.52	.19	.728	9	4.14	11.07	.238	.151
HVq4.0	.34	10.62	.09	.926	7	2.76	11.56	.156	.214
IBq3.1	.44	9.55	.22	.555	6	3.33	11.03	.315	.086
IBq3.2	.49	9.14	.22	.626	7	3.41	10.81	.282	.108
					VPA Mean =		10.74	.264	.123

Yearclass = 2002

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IBq1.1	.66	10.33	.25	.616	9	1.02	11.01	.302	.130
IBq1.2	.62	8.89	.42	.307	12	3.45	11.03	.481	.051
HVq1.1	.29	10.43	.28	.591	6	2.34	11.10	.385	.080
HVq1.2	.23	10.07	.30	.542	7	4.36	11.07	.385	.080
HVq4.1	.23	10.17	.25	.605	8	3.76	11.04	.318	.117
HVq4.2									
HVq4.0	.34	10.62	.09	.926	7	.97	10.95	.117	.297
IBq3.1	.44	9.55	.22	.555	6	1.14	10.06	.406	.072
IBq3.2									
					VPA Mean =		10.74	.264	.171

Yearclass = 2003

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IBq1.1	.66	10.33	.25	.616	9	1.06	11.03	.304	.190
IBq1.2									
HVq1.1	.29	10.43	.28	.591	6	2.16	11.05	.381	.121

HVq1.2									
HVq4.1									
HVq4.2									
HVq4.0	.34	10.62	.09	.926	7	2.58	11.50	.151	.437
IBq3.1									
IBq3.2									
					VPA Mean =		10.74	.264	.252

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	46691	10.75	.09	.09	1.07	45689	10.73
2001	66685	11.11	.09	.10	1.16		
2002	53790	10.89	.11	.10	.80		
2003	70457	11.16	.13	.18	1.89		

Table 10.4.3. Plaice in IIIa. RCT3 output at age 3.

Analysis by RCT3 ver3.1 of data from file :

inp_age3.txt

"PLE IIIa _ WG 2004. Input from the XSA run 2 at age 3, non shifted indices"

Data for 9 surveys over 15 years : 1989 - 2003

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2000

	I-----------	Regression	----------	I		I-----------	Prediction	---------	I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IBq1.1	.69	10.14	.25	.655	8	.14	10.24	.322	.082
IBq1.2	.66	8.61	.46	.290	11	2.49	10.25	.542	.029
HVq1.1	.24	10.45	.16	.845	5	2.53	11.06	.239	.148
HVq1.2	.24	9.94	.34	.533	6	3.84	10.86	.457	.040
HVq4.1	.22	10.11	.19	.758	7	3.99	11.00	.261	.124
HVq4.2	.40	9.28	.24	.665	8	2.96	10.47	.299	.094
HVq4.0	.36	10.44	.11	.924	6	.00	10.44	.146	.211
IBq3.1	.47	9.30	.20	.704	5	2.12	10.29	.312	.087
IBq3.2	.49	9.00	.25	.624	6	3.27	10.60	.329	.078
					VPA Mean =		10.60	.279	.109

Yearclass = 2001

	I-----------	Regression	----------	I		I-----------	Prediction	---------	I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IBq1.1	.69	10.18	.27	.583	9	.70	10.67	.319	.090
IBq1.2	.66	8.63	.45	.273	12	4.33	11.50	.583	.027
HVq1.1	.28	10.33	.27	.588	6	3.09	11.17	.399	.058
HVq1.2	.24	9.89	.33	.497	7	4.91	11.09	.445	.047
HVq4.1	.23	10.05	.23	.646	8	3.85	10.93	.296	.106
HVq4.2	.40	9.30	.23	.652	9	4.14	10.96	.288	.111
HVq4.0	.35	10.47	.12	.888	7	2.76	11.45	.200	.231
IBq3.1	.47	9.34	.23	.568	6	3.33	10.91	.331	.084
IBq3.2	.49	9.01	.22	.624	7	3.41	10.67	.283	.116
					VPA Mean =		10.60	.266	.131

Yearclass = 2002

	I-----------	Regression	----------	I		I-----------	Prediction	---------	I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IBq1.1	.69	10.18	.27	.583	9	1.02	10.89	.327	.114
IBq1.2	.66	8.63	.45	.273	12	3.45	10.92	.527	.044
HVq1.1	.28	10.33	.27	.588	6	2.34	10.97	.372	.088
HVq1.2	.24	9.89	.33	.497	7	4.36	10.95	.430	.066
HVq4.1	.23	10.05	.23	.646	8	3.76	10.91	.294	.141
HVq4.2									
HVq4.0	.35	10.47	.12	.888	7	.97	10.82	.149	.306
IBq3.1	.47	9.34	.23	.568	6	1.14	9.88	.426	.067
IBq3.2									
					VPA Mean =		10.60	.266	.173

Yearclass = 2003

	I-----------	Regression	----------	I		I-----------	Prediction	---------	I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IBq1.1	.69	10.18	.27	.583	9	1.06	10.91	.329	.165
IBq1.2									
HVq1.1	.28	10.33	.27	.588	6	2.16	10.92	.368	.132
HVq1.2									
HVq4.1									

```
HVq4.2
HVq4.0      .35  10.47    .12   .888      7   2.58   11.39     .192     .448
IBq3.1
IBq3.2

                                        VPA Mean =   10.60     .266     .254
```

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	40737	10.61	.09	.10	1.09	40982	10.62
2001	59363	10.99	.10	.11	1.21		
2002	47271	10.76	.11	.10	.81		
2003	62801	11.05	.13	.19	2.00		

Table 10.5.1. Plaice in IIIa. Input data for catch forecast and linear sensitivity analysis.

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N2	53790	0.33	WS2	0.25	0.03
N3	59363	0.19	WS3	0.27	0.04
N4	32448	0.14	WS4	0.28	0.04
N5	43952	0.11	WS5	0.30	0.06
N6	23223	0.11	WS6	0.32	0.07
N7	3866	0.10	WS7	0.41	0.03
N8	396	0.21	WS8	0.55	0.13
N9	40	0.31	WS9	0.75	0.17
N10	11	0.30	WS10	0.82	0.34
N11	11	0.22	WS11	1.09	0.22
H.cons selectivity			Weight in the HC catch		
sH2	0.03	0.80	WH2	0.25	0.03
sH3	0.10	0.54	WH3	0.27	0.04
sH4	0.21	0.64	WH4	0.28	0.04
sH5	0.49	0.67	WH5	0.30	0.06
sH6	0.88	0.27	WH6	0.32	0.07
sH7	1.08	0.37	WH7	0.41	0.03
sH8	1.31	0.29	WH8	0.55	0.13
sH9	0.75	0.31	WH9	0.75	0.17
sH10	0.85	0.06	WH10	0.82	0.34
sH11	0.85	0.06	WH11	1.09	0.22
Natural mortality			Proportion mature		
M2	0.10	0.10	MT2	0.00	0.10
M3	0.10	0.10	MT3	1.00	0.10
M4	0.10	0.10	MT4	1.00	0.00
M5	0.10	0.10	MT5	1.00	0.00
M6	0.10	0.10	MT6	1.00	0.00
M7	0.10	0.10	MT7	1.00	0.00
M8	0.10	0.10	MT8	1.00	0.00
M9	0.10	0.10	MT9	1.00	0.00
M10	0.10	0.10	MT10	1.00	0.00
M11	0.10	0.10	MT11	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF04	1.00	0.36	K04	1.00	0.10
HF05	1.00	0.36	K05	1.00	0.10
HF06	1.00	0.36	K06	1.00	0.10
Recruitment in 2005 and 2006					
R05	47311	0.33			
R06	47311	0.33			

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

Stock numbers in 2004 are VPA survivors.
These are overwritten at Age 2 Age 3

Table 10.5.2. Plaice in IIIa. Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year							
	2004	2005						
Mean F Ages 4 to 8								
H.cons	0.79	0.56	0.64	0.71	0.73	0.79	0.87	0.95
Effort relative to 2003								
H.cons	1.00	0.70	0.80	0.90	0.92	1.00	1.10	1.20
Biomass								
Total 1 January	60.5	56.9	56.9	56.9	56.9	56.9	56.9	56.9
SSB at spawning time	47.1	45.1	45.1	45.1	45.1	45.1	45.1	45.1
Catch weight (,000t)								
H.cons	13.6	10.4	11.5	12.6	12.8	13.6	14.6	15.5
Biomass in year.... 2006								
Total 1 January		57.4	56.2	55.0	54.8	53.9	52.8	51.8
SSB at spawning time		45.7	44.4	43.2	43.0	42.1	41.0	40.0

	Year							
	2004	2005						
Effort relative to 2003								
H.cons	1.00	0.70	0.80	0.90	0.92	1.00	1.10	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.10	0.14	0.14	0.14	0.14	0.14	0.14	0.14
SSB at spawning time	0.09	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Catch weight								
H.cons	0.35	0.45	0.40	0.35	0.35	0.32	0.30	0.28
Biomass in year.... 2006								
Total 1 January		0.17	0.17	0.17	0.17	0.17	0.17	0.17
SSB at spawning time		0.19	0.19	0.19	0.19	0.19	0.20	0.20

Table 10.5.3. Plaice in IIIa. Detailed forecast tables.

Forecast for year 2004
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
2	53790	1264	1264
3	59363	5380	5380
4	32448	5959	5959
5	43952	16346	16346
6	23223	13008	13008
7	3866	2446	2446
8	396	278	278
9	40	20	20
10	11	6	6
11	11	6	6
Wt	60	14	14

Forecast for year 2005
F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
2	47311	1112	1112
3	47470	4302	4302
4	48602	8926	8926
5	23704	8815	8815
6	24291	13606	13606
7	8733	5525	5525
8	1193	838	838
9	97	49	49
10	17	9	9
11	8	5	5
Wt	57	14	14

Table 10.5.4 Plaice in IIIa

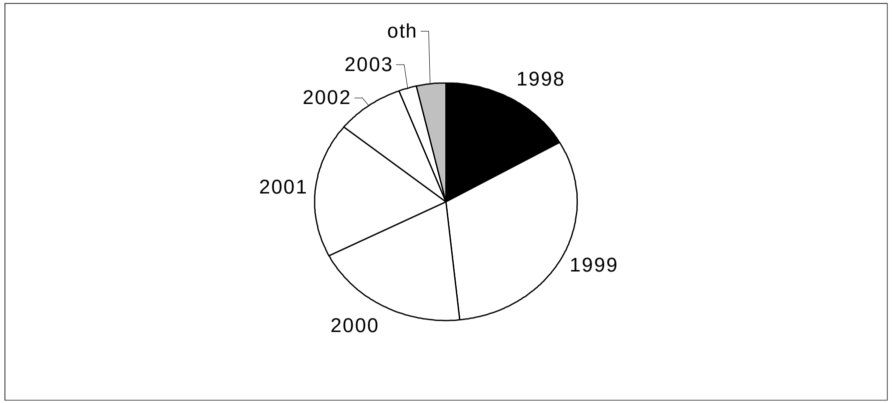
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

			1998	1999	2000	2001	2002	2003	oth
	Year-class		1998	1999	2000	2001	2002	2003	oth
of	Stock No. (thousa 2 year-olds		71680	81642	45689	117818	53790	47311	
Source				VPA	VPA	VPA	GM	GM	
Status Quo F:									
% in	2004	landings	30.2	36.1	12.1	10.5	2.3	-	8.7
% in	2005		16.6	31.6	19.4	18.2	8.4	2.1	3.7
% in	2004	SSB	15.6	28.0	19.1	33.4	0.0	-	3.9
% in	2005	SSB	7.9	17.0	15.7	29.8	27.9	0.0	1.7
% in	2006	SSB	3.5	8.9	9.8	25.3	25.6	26.3	0.6

GM : geometric mean recruitment

Plaice in IIIa : Year-class % contribution to

a) 2005 landings



b) 2006 SSB

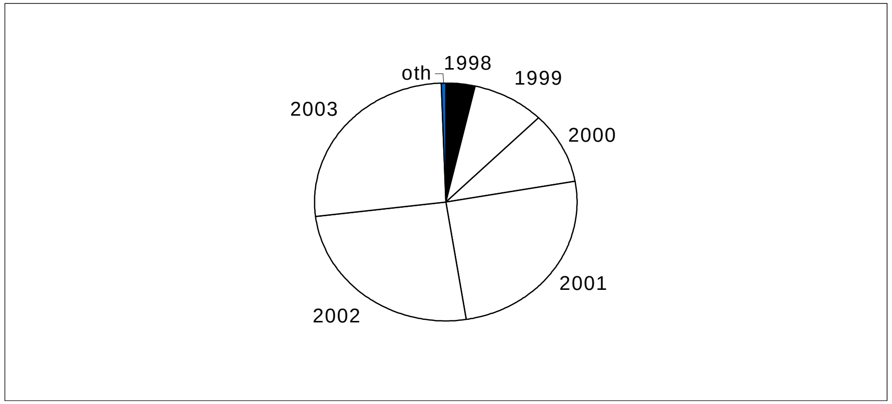


Figure 10.2.1. Plaice in IIIa. Commercial fleet effort and CPUE.

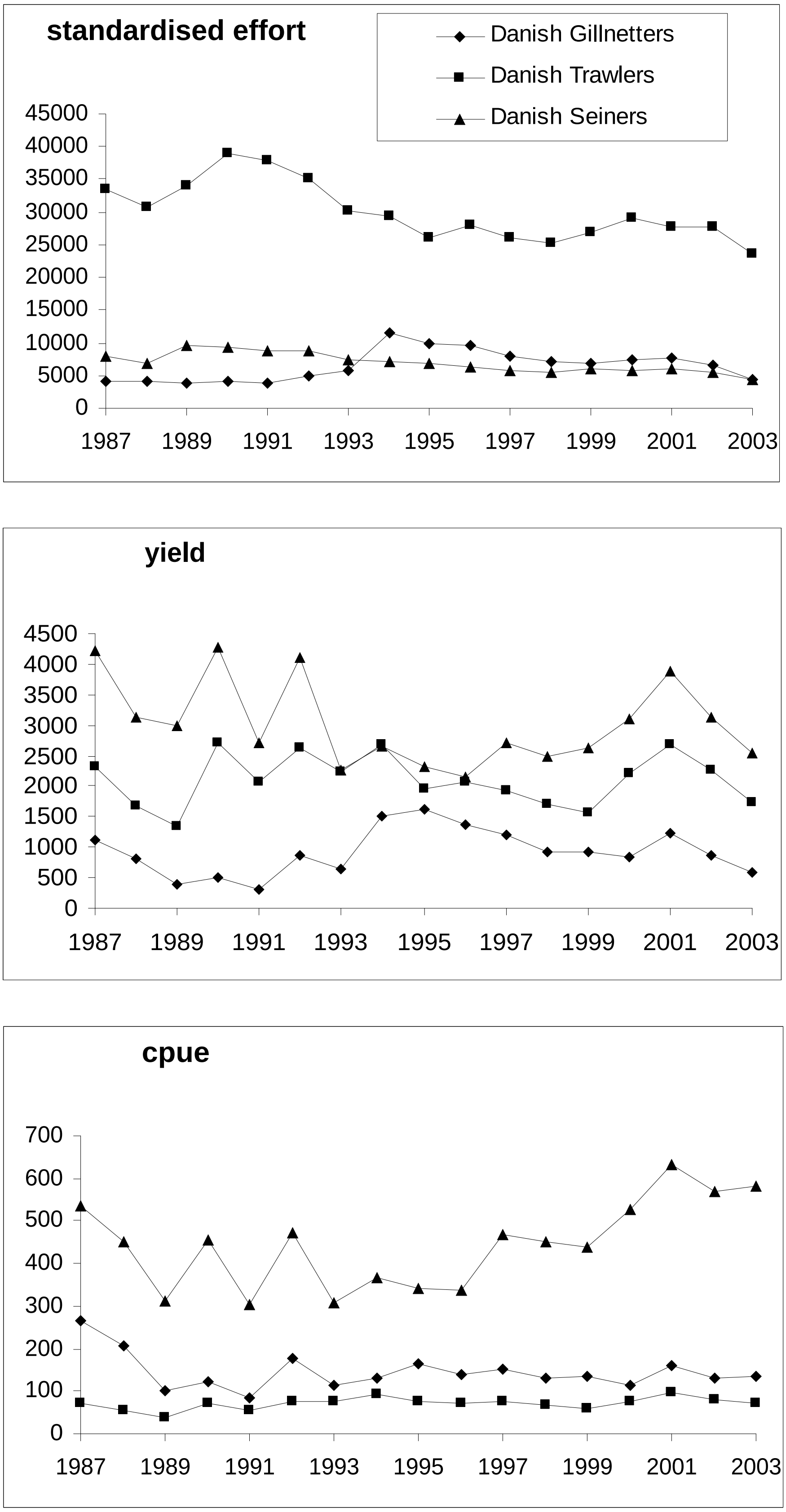


Figure 10.2.2. Plaice in IIIa. Relative survey indices by age.

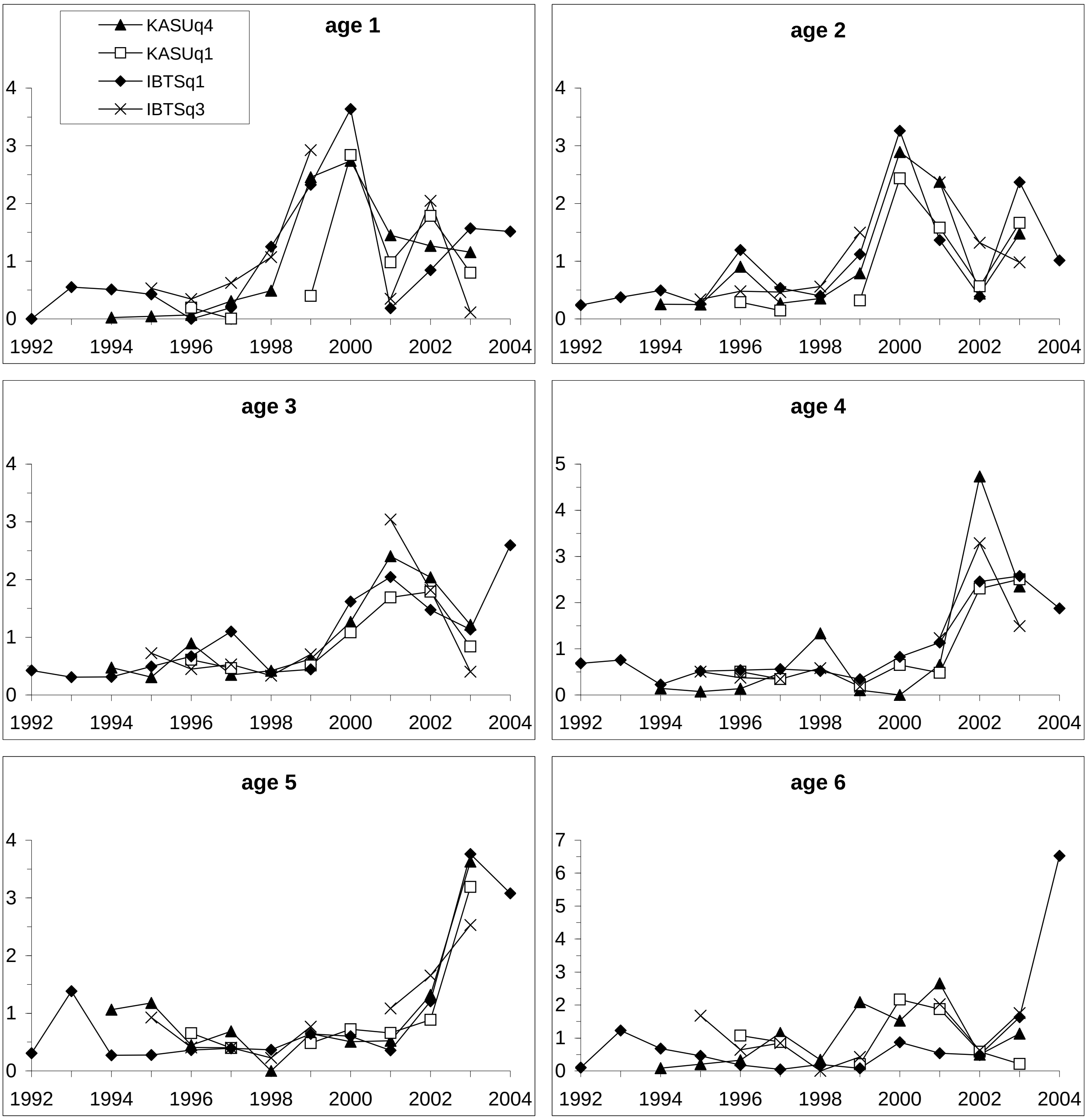


Figure 10.3.1. Plaice in IIIa. Stock summary plots.

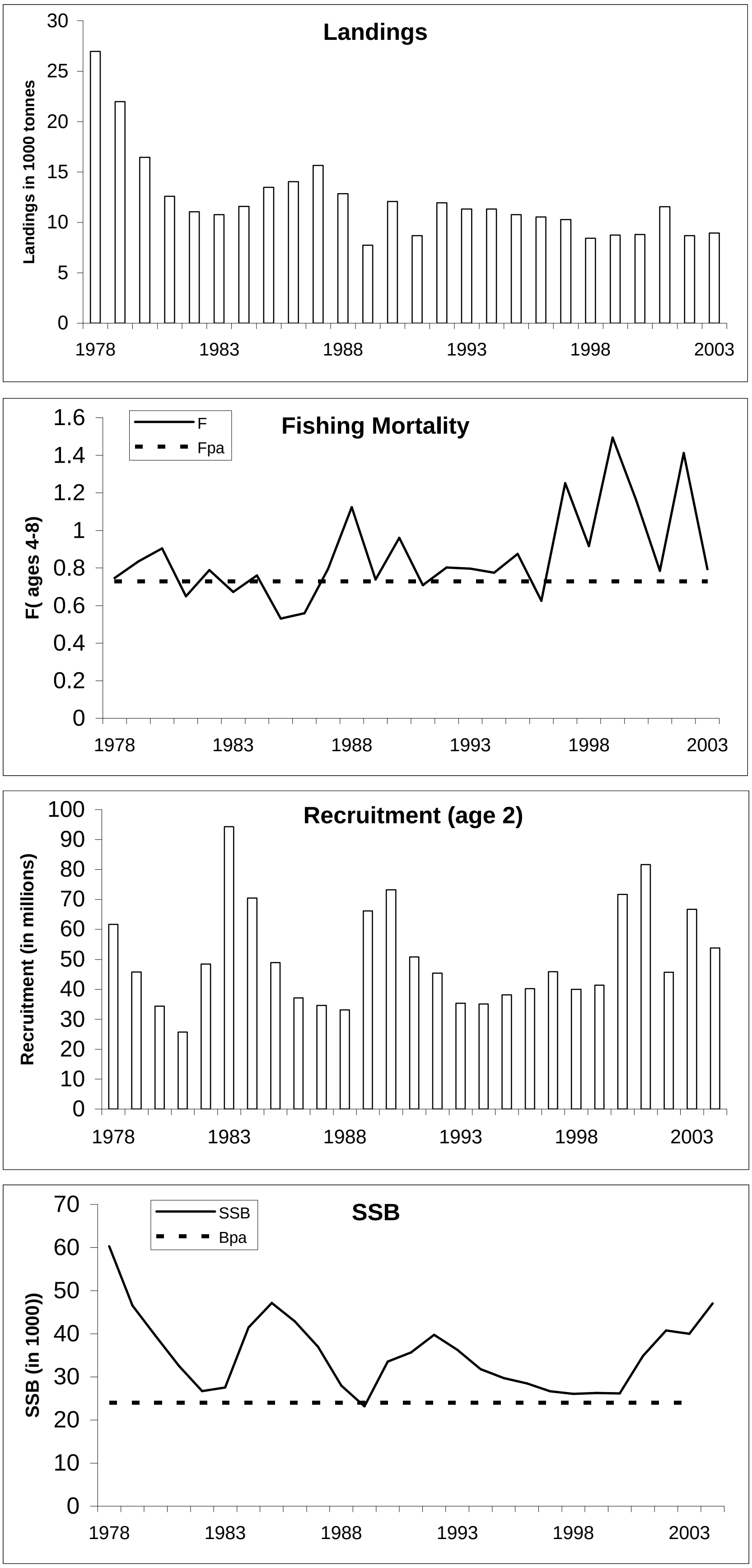
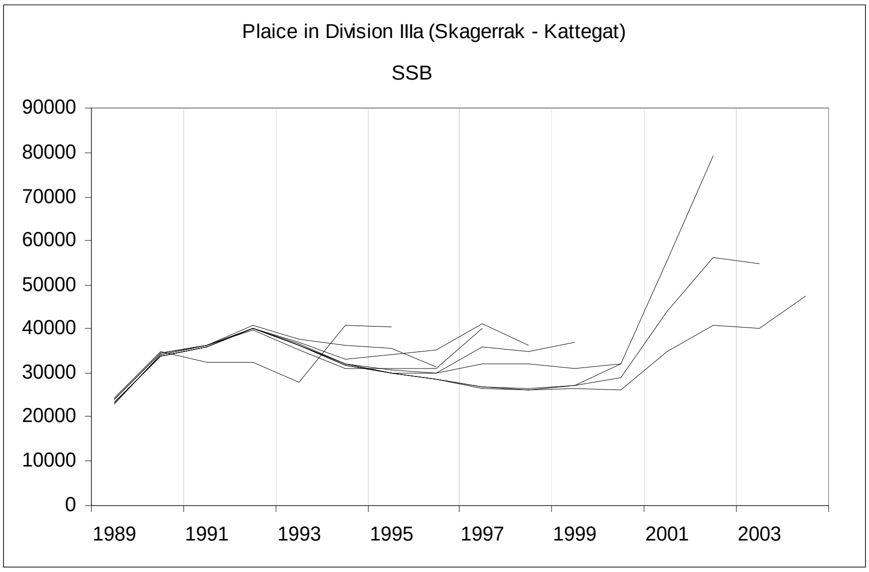
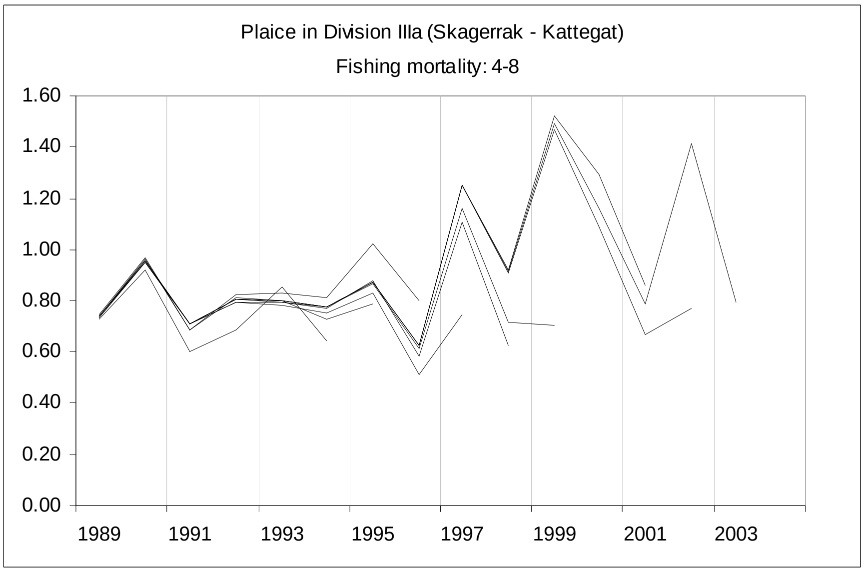


Figure 10.3.2. Plaice in IIIa. Historical performance of the assesssment.





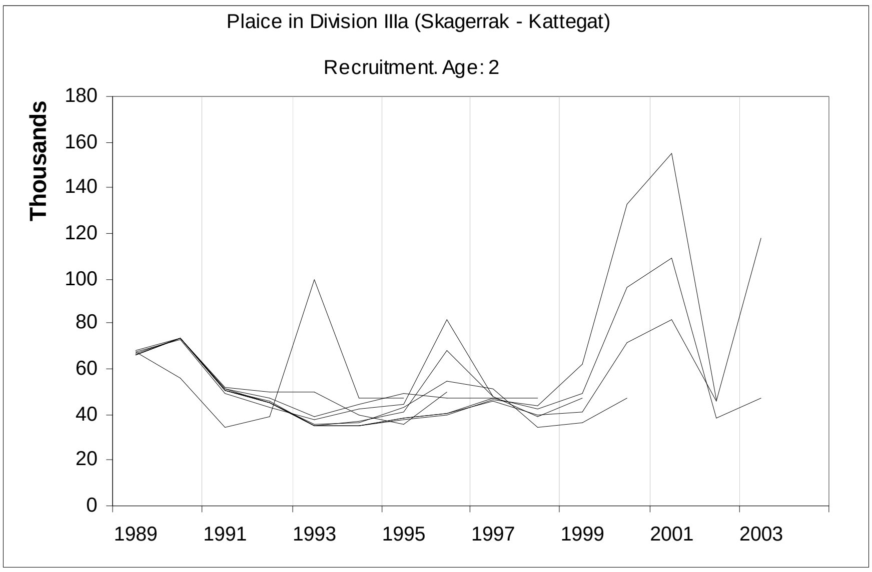
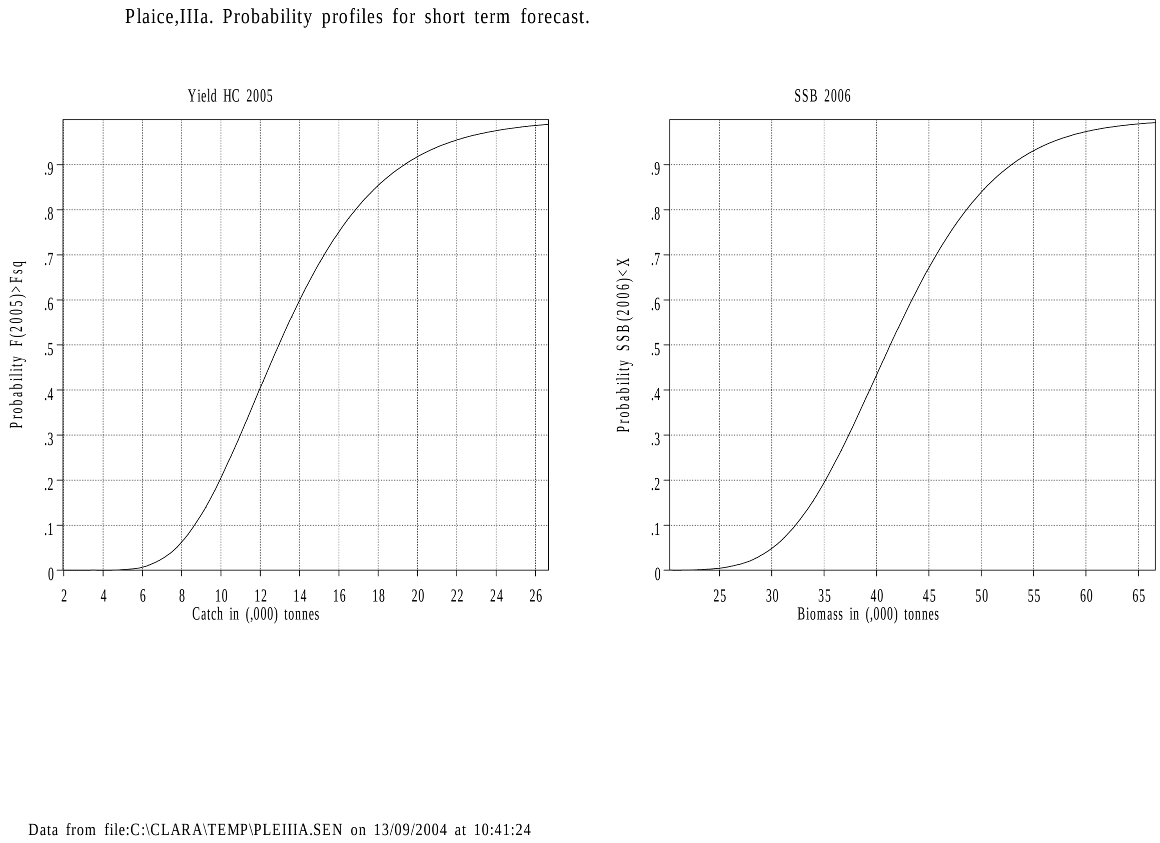


Figure 10.5.1. Plaice in IIIa. Probability profiles for the short-term forecast.



11 PLAICE IN DIVISION VIId

The assessment of plaice in Division VIId is presented here as an update 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.

11.1 The fishery

Relevant information on the fishery can be found in the Stock Annex.

11.1.1 ICES advice applicable to 2003 and 2004

ICES advice for 2003 and 2004 was that the stock was harvested outside safe biological limits.

The fishing mortality in 2003 should be reduced to less than the proposed F_{pa} (0.45), corresponding to landings in 2003 of less than 5300t.

The fishing mortality in 2004 should be reduced to less than the proposed F_{pa} (0.45), corresponding to landings in 2004 of less than 5400t.

11.1.2 Management applicable in 2003 and 2004

The TAC in 2003 and 2004 were set respectively to 5970 t and 6060 t. for the combined ICES Division VIIde.

11.1.3 The fishery in 2003

The first quarter is usually the most important for the fisheries but the relative part of the catch for this quarter has been decreasing from the early 1990s. The landings (in weight) in the first quarter was 32% of the annual total in 2003, compared to 44% in 2000, 41% in 2001 and 35% in 2002.

11.2 Data available

11.2.1 Landings

Landings data as reported to ICES together with the total landings estimated by the Working Group are shown in Table 11.2.1. Since 1992, the landings have remained steady between 5100 t and 6300 t. The 2003 landings of 4536 t. represents one of the weakest value of the historical time series, 30% below the 6470 t. predicted at F_{sq} from last year's assessment. France contributed to 61% of the official landings in 2003 followed by Belgium (22%) and UK (17%).

There is relatively little information on discarding practices on this stock. Routine discard monitoring has recently begun following the introduction of the EU data collection regulations. Discards data for 2003 are available from France (Table 11.2.2 and Figure 11.2.1) though sampling levels are not high. Initial indications are that discard rates may be substantial.

11.2.2 Age compositions

Age compositions of the landings are presented in Table 11.2.3

11.2.3 Weight at age

Weight at age in the catch is presented in Table 11.2.4 and weight at age in the stock in Table 11.2.5. The procedure for calculating mean weights is described in the Stock Annex.

11.2.4 Maturity and natural mortality

Maturity and natural mortality are assumed at fixed values and are presented in Stock Annex.

11.2.5 Catch, effort and research vessel data

Commercial effort and CPUE data are available from four commercial fleets (Figure 11.2.2). All survey and commercial data available for calibration of the assessment are presented in Tables 11.2.6

11.3 Catch at age analysis

Catch at age analysis was carried out according to the specifications in the Stock Annex. The model used was XSA. Results of the analysis are presented in Tables 11.3.1 (diagnostics), 11.3.2 (fishing mortality at age), 11.3.3 (population numbers at age), and 11.3.4 (stock summary). The stock summary is also shown in Figure 11.3.1 and the historical performance of the assessment is shown in Figure 11.3.2.

11.4 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 11.4.1. Results are presented in Table 11.4.2 and Table 11.4.3.

Average recruitment in the period 1980-2003 was 23 millions (geometric mean) 1-year-old-fish. Year class strength estimates used for short term prognosis are summarised in the text table below.

Year Class	Age in 2004	XSA Thousands	RCT3 Thousands	GM (1980-2001) Thousands
2001	3	**16767**		13544
2002	2	8063	**12676**	19913
2003	1		22972	**23146**
2004	0			**23146**

11.5 Short-term prognosis

The short-term prognosis was carried out according to the specifications in the Stock Annex. The exploitation pattern used was the unscaled mean F-at-age over the period 2001-2003. Input to the WGFRANSW model is presented in Table 11.5.1. Results are presented in Tables 11.5.2 and 11.5.3. The relative contributions of different year-classes to future SSB are given in Table 11.5.4, while probability profiles for the forecast are shown in Figure 11.5.1.

11.6 Comments

- This assessment has been carried out with exactly the same parameters as last year
- Recruitment in 2003 (the 2002 year-class at age 1) is perceived as the weakest in the available time-series and is likely to have an adverse effect on spawning stock biomass in the near future.
- Two consecutive years of recruitment above average (yearclasses 2000 and 2001) have constituted the main component of the catches in 2003 but the total landings were 30% under the value predicted at $\mathbf{F}_{sq}$ from last year's assessment indicating a tendency of overestimating SSB in the recent years. Consequently, the perception of decreasing F in 2003 can be an artefact as the reference fleets have all shown an increase in effort.
- This assessment doesn't include discards.
- The EU regulation enforced in 2004 invoked a limitation of 22 days at sea per month for trawlers with mesh size less than 99 mm, and 14 days at sea for beam trawlers. Gill-netters have a derogation of 20 days at sea in the Eastern Channel provided that their mesh size is less than 110 mm. However these effort limitations from the cod recovery plan are not likely to decrease the effort on plaice in Division VIId and therefore the short-term prognosis was not modified in the intermediate year.

Suggested work plan for benchmark:

- Analyse the consistency and reliability of the tuning fleets (individual retrospective analysis, log catchabilities residuals, standardised CPUE, etc). Consider redefinition of the current tuning fleets (prior to the WG) and/or the integration of new ones. UK have provided beam-trawler data for this assessment but this new tuning fleet has not been used given that this was an update assessment.
- Integrate the ongoing discard estimation into the assessment.
- Investigate whether the problem of misreporting on sole could affect the reporting of plaice.
- Verify the consistency of the weights time series, with particular reference to the influence of an incorrect assumption about sex-ratios on mean weight calculations.

- Produce maps of catches per ICES rectangle for the recent years to investigate a possible shift in catch distribution.

The next benchmark assessment for this stock is scheduled for 2006.

Table 11.2.1 - Plaice in Division VIId. Nominal landings (tonnes) as officially reported to ICES , 1976-2003

Year	Belgium	Denmark	France	UK(E+W)	Others	Total reported	Un-allocated	Total as used by WG
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
1988	2165	-	5688 (2)	1250	-	9103	1317	10420
1989	2019	+	3265 (1)	1383	-	6667	2091	8758
1990	2149	-	4170 (1)	1479	-	7798	1249	9047
1991	2265	-	3606 (1)	1566	-	7437	376	7813
1992	1560	1	3099	1553	19	6232	105	6337
1993	877	+(2)	2792	1075	27	4771	560	5331
1994	1418	+	3199	993	23	5633	488	6121
1995	1157	-	2598 (2)	796	18	4569	561	5130
1996	1112	-	2630 (2)	856	+	4598	795	5393
1997	1161	-	3077	1078	+	5316	991	6307
1998	854	-	3276 (23)	700	+	4830	932	5762
1999	1306	-	3259 (23)	743	+	5437	889	6326
2000	1298	-	3183	752	+	5233	781	6014
2001	1346	-	2962	655	+	4963	303	5266
2002	1204	-	3454	841		5499	278	5777
2003	995	-	2783 (3)	756		4536	-	4536

1 Estimated by the Working Group from combined Division VIId+e
2 Includes Division VIIe
3 Preliminary

Table 11.2.2 - Plaice VIId. Length structure of discards and landings collected by observations on board (numbers raised to sampled trips)

(numbers raised to sampled trips)

	Fr Otter trawl		Fr Gillnet	
	Discards	Landings	Discards	Landings
	11 trips 196 hauls		10 trips	
3	9		0	
4	101		0	
5	214		0	
6	277		0	
7	209		0	
8	92		0	
9	5		0	
10	0		0	
11	0		0	
12	0		0	
13	0		0	
14	24		1	
15	0		0	
16	49		0	
17	24		5	
18	0	0	4	1
19	0	0	26	0
20	0	0	114	1
21	0	0	116	0
22	25	0	120	1
23	50	0	112	2
24	2	0	112	31
25	0	7	54	45
26	2	20	44	63
27	0	9	34	65
28	0	27	15	80
29	0	29	3	75
30	0	13	2	71
31	0	33	1	44
32	0	46	0	51
33	0	20	1	33
34	0	15	0	16
35	0	15	0	31
36	0	13	0	12
37	0	5	0	7
38	0	8	0	5
39	0	1	0	7
40	0	4	1	7
41		7		12
42		0		2
43		0		3
44		12		4
45		0		7
46		0		4
47		0		3
48		0		1
49		0		1
50		0		3
51		0		0
52		0		2
53		0		0
54		0		0
55		0		2
56		0		0
57		0		3
58		0		0
59		0		1
60		0		0

Table 11.2.3 - Plaice in Division VIId. Catch 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

Table 11.2.4 -Plaice in Division VIId. Weight in the catch

	1	2	3	4	5	6	7	8	9	10+
1980	0.309	0.312	0.499	0.627	0.787	1.139	1.179	1.293	1.475	1.557
1981	0.239	0.299	0.373	0.464	0.712	0.87	0.863	0.897	0.992	1.174
1982	0.245	0.271	0.353	0.431	0.64	0.795	1.153	1.067	1.504	1.355
1983	0.266	0.296	0.349	0.42	0.542	0.822	0.953	1.144	0.943	1.591
1984	0.233	0.295	0.336	0.402	0.508	0.689	0.703	0.945	1.028	1.427
1985	0.254	0.278	0.301	0.427	0.502	0.57	0.557	1.081	0.849	1.421
1986	0.226	0.306	0.331	0.406	0.546	0.486	0.629	0.871	1.446	1.579
1987	0.251	0.282	0.36	0.477	0.577	0.783	0.735	1.142	1.268	1.515
1988	0.292	0.268	0.321	0.432	0.56	0.657	0.77	0.908	1.218	1.328
1989	0.201	0.268	0.321	0.37	0.473	0.648	0.837	0.907	1.204	1.519
1990	0.201	0.256	0.326	0.378	0.483	0.61	0.781	0.963	1.159	1.31
1991	0.225	0.277	0.311	0.39	0.454	0.556	0.745	1.087	0.924	1.602
1992	0.182	0.277	0.352	0.429	0.509	0.585	0.701	0.837	0.85	1.195
1993	0.22	0.272	0.336	0.432	0.507	0.591	0.741	0.82	0.934	1.156
1994	0.243	0.27	0.288	0.356	0.466	0.576	0.686	0.928	0.969	1.287
1995	0.218	0.271	0.313	0.39	0.485	0.688	0.612	0.806	1.15	1.298
1996	0.221	0.3	0.29	0.396	0.475	0.643	0.764	0.934	1.057	1.312
1997	0.199	0.252	0.298	0.332	0.442	0.577	0.801	0.894	1.055	1.395
1998	0.159	0.244	0.267	0.381	0.502	0.762	0.839	0.981	0.986	1.379
1999	0.197	0.245	0.235	0.306	0.461	0.751	0.768	0.868	0.885	1.508
2000	0.182	0.256	0.314	0.37	0.44	0.607	0.768	0.972	0.975	1.193
2001	0.215	0.252	0.303	0.37	0.447	0.642	0.876	1.008	1.144	1.223
2002	0.254	0.256	0.309	0.376	0.438	0.562	0.627	0.880	0.909	1.330
2003	0.254	0.268	0.271	0.363	0.556	0.643	0.624	0.85	0.972	1.205

Table 11.2.5 -Plaice in Division VIId. Weight in the stock

	1	2	3	4	5	6	7	8	9	10+
1981	0.11	0.216	0.317	0.414	0.506	0.594	0.677	0.756	0.83	1.042
1982	0.105	0.208	0.308	0.406	0.502	0.596	0.687	0.776	0.862	1.118
1983	0.097	0.192	0.286	0.379	0.47	0.56	0.648	0.735	0.821	1.169
1984	0.082	0.164	0.248	0.333	0.42	0.507	0.596	0.686	0.777	1.086
1985	0.084	0.171	0.259	0.348	0.44	0.533	0.628	0.725	0.824	1.206
1986	0.101	0.205	0.311	0.42	0.532	0.646	0.763	0.882	1.004	1.313
1987	0.122	0.242	0.361	0.479	0.596	0.712	0.826	0.939	1.051	1.306
1988	0.084	0.168	0.254	0.34	0.427	0.514	0.603	0.692	0.783	0.952
1989	0.079	0.162	0.25	0.342	0.439	0.541	0.648	0.759	0.874	1.211
1990	0.085	0.23	0.322	0.346	0.465	0.549	0.748	0.899	0.979	1.766
1991	0.065	0.219	0.275	0.335	0.375	0.472	0.633	1.057	1.022	1.502
1992	0.088	0.241	0.336	0.421	0.477	0.521	0.634	0.713	0.741	1.229
1993	0.108	0.258	0.296	0.379	0.493	0.539	0.573	0.699	0.787	1.056
1994	0.165	0.198	0.276	0.331	0.383	0.493	0.603	0.903	0.781	1.15
1995	0.058	0.257	0.286	0.354	0.442	0.707	0.531	0.703	1.092	1.194
1996	0.178	0.229	0.263	0.347	0.354	0.474	0.536	0.907	0.958	1.126
1997	0.059	0.202	0.256	0.266	0.417	0.53	0.665	0.686	0.972	1.364
1998	0.072	0.203	0.273	0.361	0.53	0.67	0.629	0.656	0.915	1.107
1999	0.072	0.172	0.213	0.351	0.429	0.644	0.76	0.782	0.593	1.166
2000	0.068	0.184	0.204	0.246	0.355	0.554	0.693	0.817	0.89	1.131
2001	0.093	0.206	0.274	0.338	0.404	0.624	0.844	0.989	1.153	1.405
2002	0.102	0.206	0.281	0.379	0.467	0.558	0.610	0.759	1.053	1.250
2003	0.103	0.191	0.249	0.33	0.496	0.492	0.548	0.748	0.662	0.982

Table 11.2.6- Plaice in Division VIId. Tuning fleets. Data used in the assessment are highlighted in **bold**.

Plaice in Division VIId (Eastern English Channel) (run name: XSAEDB01) 106
FLT01: UK INSHORE TRAWL METIER <40 trawl lands all trawl age comps fleet (Catch: Unknown)
1985 2003
1 1 0.00 1.00
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
493	**29.5**	**21.4**	**13.8**	**17.6**	**3.3**	**0.9**	**0.6**	**0.2**	0.2
608	**36.4**	**120.3**	**77.2**	**17.2**	**8.5**	**14.7**	**2.2**	**1.5**	0.3
741	**228.3**	**48.9**	**26.2**	**5.3**	**4.4**	**7.3**	**5.4**	**0.3**	0.4

FLT02: BELGIAN BEAM TRAWL(HP corr) all gears age comp [rev: 05/08/04-WD] (Catch: Unknown)
1981 2003
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
41.11	**412.7**	**1361.3**	**641.0**	**578.0**	**138.7**	**62.7**	**9.6**	**5.0**	26.1
40.0	**407.2**	**1194.7**	**581.6**	**144.0**	**176.8**	**130.8**	**25.0**	**18.2**	24.9

FLT03: FRENCH TRAWLERS (EFFORT H*KW*10-4) 1989-90 DERAISED 1991> TRUE (Catch: Unknown)
1989 2003
1 1 0.00 1.00
2 10

6983	**1190.1**	**1635.9**	**1643.2**	**466.2**	**73.5**	**34.3**	**34.1**	**19.3**	16.1
8395	**698.2**	**1876.1**	**1289.5**	**728.3**	**153.7**	**42.6**	**33.1**	**46.5**	14.4
10689	**1938.7**	**1474.1**	**1430.0**	**399.5**	**255.2**	**41.0**	**17.6**	**11.9**	9.9
10519	**1802.9**	**1396.1**	**370.2**	**269.4**	**230.7**	**143.5**	**21.2**	**12.1**	11.6
10217	**2124.4**	**1118.2**	**268.4**	**56.0**	**73.4**	**48.7**	**32.3**	**14.3**	4.6
10609	**1034.2**	**2271.2**	**476.4**	**177.6**	**69.5**	**48.2**	**48.3**	**32.0**	25.0
12384	**1354.7**	**686.5**	**578.5**	**95.4**	**21.4**	**19.5**	**27.5**	**21.8**	28.2
14476	**1133.3**	**1283.9**	**352.7**	**317.5**	**98.8**	**43.6**	**33.3**	**34.6**	36.9
10921	**1396.2**	**3536.0**	**1155.4**	**139.0**	**170.7**	**88.3**	**50.8**	**22.4**	28.2
11707	**1446.0**	**3541.9**	**1534.4**	**205.4**	**29.8**	**20.2**	**17.8**	**6.9**	8.2
10625	**1139.1**	**5654.6**	**2456**	**254.4**	**36.1**	**24.8**	**23.5**	**4.4**	16.6
13779	**2757.4**	**1634**	**3110.4**	**781.5**	**130.9**	**21.2**	**6.1**	**12.9**	19.9
11376	**2113.6**	**1726.3**	**663.1**	**642.5**	**81.3**	**21.6**	**1.4**	**1.2**	16.4
13489	**3130.4**	**1134.9**	**336.6**	**230.9**	**186.2**	**36.7**	**9.5**	**2.9**	13.1
15934	**1984.9**	**2715.5**	**701.5**	**129.6**	**82.8**	**75.1**	**17.8**	**16.3**	11.2

Table 11.2.6-(continued) Plaice in Division VIId. Tuning fleets. Data used in the assessment are highlighted in **bold**.

FLT04: UK BEAM TRAWL SURVEY true age 6 [rev: 15/08/04-RM] (Catch: Unknown) (Effort: Unknown)
1988 2003
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**

FLT05: French GFS [option 2] true age 5 [rev: 01/09/04-JV] (Catch: Unknown) (Effort: Unknown)
1988 2003
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	1.0	**2.7**	**0.8**	**1.8**	**1.3**	**1.1**
1	1.0	**1.7**	**1.4**	**0.6**	**0.4**	**0.3**
1	6.6	**23.8**	**2.5**	**1.3**	**0.2**	**0.2**
1	43.8	**19.2**	**8.9**	**4.2**	**0.9**	**0.4**
1	36.2	**5.2**	**2.2**	**0.8**	**0.2**	**0.1**
1	13.6	**4.9**	**3.0**	**1.1**	**0.7**	**0.2**
1	**2**36.0	**4.5**	**2.6**	**0.3**	**0.1**	**0.2**
1	89.0	**35.5**	**8.4**	**4.5**	**0.3**	**0.1**
1	76.8	**12.5**	**14.0**	**3.1**	**0.5**	**0.0**
1	10.3	**8.5**	**4.6**	**7.6**	**1.3**	**0.2**
1	**1**59.0	**10.3**	**12.8**	**3.5**	**3.1**	**0.8**
1	46.1	**7.4**	**3.5**	**1.2**	**0.8**	**0.3**
1	5.4	**11.3**	**9.3**	**4.3**	**0.4**	**0.2**
1	91.2	**9.1**	**2.7**	**8.9**	**4.1**	**2.1**

FLT06: Intl YFS [rev: 01/09/04-JV] (Catch: Unknown) (Effort: Unknown)
1987 2003
1 1 0.50 0.75
0 1

1	11.68	**1.44**
1	5.56	**1.32**
1	3.97	**0.58**
1	3.42	**0.71**
1	4.36	**0.62**
1	4.04	**1.78**
1	3.70	**0.84**
1	8.69	**0.79**
1	6.87	**1.68**
1	4.07	**0.66**
1	2.23	**0.82**
1	5.30	**0.8**
1	3.81	**0.76**
1	5.14	**0.48**
1	3.74	**0.83**
1	0.67	**0.92**
1	4.92	**0.22**

Table 11.3.1 Plaice in Division VIId. Tuning diagnostics.

```
Lowestoft VPA Version 3.1

   8/09/2004  15:08

Extended Survivors Analysis

Plaice in Division VIId (run: XSAAEDB01/X01)

CPUE data from file fleet_Id.dat

Catch data for  24 years. 1980 to 2003. Ages  1 to  10.

     Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
FLT01: UK INSHORE TR,   1988, 2003,   2,     9,   .000,  1.000
FLT02: BELGIAN BEAM ,   1988, 2003,   2,     9,   .000,  1.000
FLT03: FRENCH TRAWLE,   1989, 2003,   2,     9,   .000,  1.000
FLT04: UK BEAM TRAWL,   1988, 2003,   1,     6,   .500,   .750
FLT05: French GFS [o,   1988, 2003,   1,     5,   .750,  1.000
FLT06: Intl YFS [rev,   1988, 2003,   1,     1,   .500,   .750

Time series weights :
     Tapered time weighting not applied

Catchability analysis :
     Catchability independent of stock size for all ages
     Catchability independent of age for ages >=    7

Terminal population estimation :

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

     S.E. of the mean to which the estimates  are shrunk =    .500

     Minimum standard error for population
     estimates derived from each fleet =    .300

     Prior weighting not applied

Tuning had not converged after   30 iterations


Total absolute residual between iterations
29 and  30 =     .00021

Final year F values
Age          ,      1,      2,      3,      4,      5,      6,      7,      8,      9
Iteration 29,  .0734,  .2441,  .6228,  .6166,  .5068,  .5104,  .4363,  .3087,  .5576
Iteration 30,  .0734,  .2441,  .6228,  .6165,  .5068,  .5104,  .4362,  .3087,  .5575
```

1

```
Regression weights
      , 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000
```

Fishing mortalities

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	.078	.115	.039	.015	.033	.044	.081	.111	.036	.073
2	.415	.378	.289	.184	.147	.150	.543	.329	.427	.244
3	.725	.613	.548	.796	.605	.657	.573	.826	.770	.623
4	.803	.682	.679	1.462	1.019	1.162	.952	.557	.962	.617
5	.649	.517	.755	1.389	.850	.909	.969	.658	.923	.507
6	.432	.316	.504	1.058	.580	.638	.658	.415	.617	.510
7	.376	.502	.389	1.169	.471	.740	.641	.345	.559	.436
8	.538	.452	.612	.879	.559	.504	.479	.309	.392	.309
9	.532	.446	.621	.925	.522	.492	.472	.396	.608	.558

Table 11.3.1 (continued) Plaice in Division VIId. Tuning diagnostic

1

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
1994	1.73E+04	1.13E+04	1.42E+04	5.92E+03	1.87E+03	1.26E+03	1.05E+03	6.75E+02	7.01E+02
1995	2.52E+04	1.45E+04	6.73E+03	6.23E+03	2.40E+03	8.85E+02	7.38E+02	6.51E+02	3.57E+02
1996	3.05E+04	2.03E+04	8.98E+03	3.30E+03	2.85E+03	1.29E+03	5.84E+02	4.04E+02	3.75E+02
1997	3.80E+04	2.66E+04	1.38E+04	4.70E+03	1.51E+03	1.21E+03	7.08E+02	3.58E+02	1.99E+02
1998	1.51E+04	3.38E+04	2.00E+04	5.62E+03	9.86E+02	3.41E+02	3.81E+02	1.99E+02	1.34E+02
1999	1.80E+04	1.33E+04	2.64E+04	9.88E+03	1.84E+03	3.81E+02	1.73E+02	2.15E+02	1.03E+02
2000	1.87E+04	1.56E+04	1.03E+04	1.24E+04	2.80E+03	6.69E+02	1.82E+02	7.46E+01	1.17E+02
2001	2.69E+04	1.56E+04	8.19E+03	5.27E+03	4.33E+03	9.60E+02	3.14E+02	8.69E+01	4.18E+01
2002	2.71E+04	2.18E+04	1.02E+04	3.24E+03	2.73E+03	2.03E+03	5.74E+02	2.01E+02	5.77E+01
2003	9.59E+03	2.37E+04	1.29E+04	4.26E+03	1.12E+03	9.81E+02	9.90E+02	2.97E+02	1.23E+02

Estimated population abundance at 1st Jan 2004

	0.00E+00	8.06E+03	1.68E+04	6.24E+03	2.08E+03	6.11E+02	5.33E+02	5.79E+02	1.97E+02

Taper weighted geometric mean of the VPA populations:

	2.25E+04	2.01E+04	1.34E+04	6.16E+03	2.43E+03	1.08E+03	5.52E+02	2.89E+02	1.36E+02

Standard error of the weighted Log(VPA populations) :

	.3897	.3568	.4457	.5200	.5232	.6435	.7014	.7371	1.0512

1

Log catchability residuals.

Fleet : FLT01: UK INSHORE TR

Age	1988	1989	1990	1991	1992	1993
1	No data for this fleet at this age					
2	.07	-1.70	-.80	.41	.37	.13
3	.18	-.43	-.40	.39	.47	-.11
4	-.28	.51	-.55	.28	.64	.01
5	.17	.41	-.07	-.05	.32	.05
6	.07	.70	.29	.05	.36	-.03
7	-.36	.28	.24	-.40	.22	.03
8	-.82	-.59	.27	-.58	.38	.17
9	-.12	-.88	.26	-.84	-.48	.42

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	No data for this fleet at this age									
2	.26	.19	.52	.15	-.31	-.10	.54	-.21	-.50	.97
3	-.06	-.05	-.55	.19	-.41	.33	-.07	-.21	1.06	-.33
4	-.06	-.22	-.84	-.89	-.03	-.61	.46	-.35	1.82	.12
5	.11	-.13	-.48	-.70	-.31	-.11	.23	.19	.53	-.14
6	-.14	-.20	-.41	-.29	-.10	-.59	.45	-.05	.03	-.15
7	-.22	-.49	-1.08	.02	.54	-.88	.31	-.29	1.79	.29
8	-.35	-.29	-.40	.10	.21	.05	.34	.57	.86	1.13
9	.31	-.04	-.53	.15	.43	-.25	.58	.25	1.82	-.76

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9
Mean Log q	-12.0521	-11.5075	-11.4827	-11.5373	-11.5785	-11.5515	-11.5515	-11.5515
S.E(Log q)	.6270	.4228	.6685	.3227	.3278	.6569	.5478	.6791

Table 11.3.1 (continued) Plaice in Division VIId. Tuning diagnostic

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	1.32,	-.457,	12.76,	.13,	16,	.85,	-12.05,
3,	1.08,	-.323,	11.67,	.53,	16,	.47,	-11.51,
4,	1.13,	-.354,	11.84,	.34,	16,	.78,	-11.48,
5,	.81,	1.639,	10.85,	.84,	16,	.25,	-11.54,
6,	.83,	1.544,	10.83,	.86,	16,	.26,	-11.58,
7,	.92,	.337,	11.14,	.55,	16,	.62,	-11.55,
8,	1.46,	-1.743,	14.08,	.51,	16,	.74,	-11.49,
9,	1.48,	-1.415,	14.53,	.38,	16,	.97,	-11.53,

1

Fleet : FLT02: BELGIAN BEAM

Age	1988	1989	1990	1991	1992	1993
1	No data for this fleet at this age					
2	.34,	-1.75,	.56,	1.22,	1.49,	.70
3	-.11,	-.32,	.49,	.83,	.57,	-.12
4	-.49,	-.12,	.05,	.12,	-.26,	-.45
5	-.96,	.13,	-.32,	.40,	-.47,	-.35
6	-.86,	.05,	-.20,	.53,	.23,	-.32
7	-.36,	-.06,	-.66,	-.05,	-.11,	-.26
8	-.35,	-.32,	-.18,	-.20,	.15,	-.44
9	-.36,	-.12,	-1.12,	.75,	.95,	-.89

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	No data for this fleet at this age									
2	1.15,	-1.45,	.02,	99.99,	-.69,	-1.31,	-1.18,	.58,	.25,	.09
3	.15,	.12,	-.07,	-1.46,	-.25,	-.04,	-.95,	.87,	.35,	-.05
4	.63,	.13,	.20,	.50,	.26,	.39,	-1.16,	.16,	.27,	-.22
5	-.01,	.11,	.25,	1.07,	.26,	.61,	-.53,	-.08,	.27,	-.38
6	-.07,	-.22,	-.03,	.84,	.40,	.71,	-.58,	-.12,	-.65,	.30
7	.01,	.70,	-.25,	.83,	.39,	.69,	-.44,	-.42,	-.08,	.08
8	.16,	.28,	.29,	.04,	.29,	-.26,	-.34,	-.20,	-.99,	-.43
9	.29,	-.28,	.11,	.35,	.68,	.50,	-.23,	.37,	-.29,	.25

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age ,	2,	3,	4,	5,	6,	7,	8,	9
Mean Log q,	-7.6754,	-5.6759,	-5.1226,	-5.0701,	-5.4106,	-5.5340,	-5.5340,	-5.5340,
S.E(Log q),	1.0386,	.5999,	.4444,	.4968,	.4844,	.4402,	.3809,	.5767,

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,	1.73,	-.458,	6.11,	.03,	15,	1.85,	-7.68,
3,	1.44,	-.952,	4.00,	.25,	16,	.87,	-5.68,
4,	1.30,	-1.081,	4.04,	.49,	16,	.57,	-5.12,
5,	1.21,	-.737,	4.49,	.47,	16,	.61,	-5.07,
6,	1.18,	-.759,	5.11,	.56,	16,	.58,	-5.41,
7,	1.10,	-.504,	5.44,	.66,	16,	.50,	-5.53,
8,	.90,	.912,	5.70,	.85,	16,	.31,	-5.69,
9,	1.16,	-.668,	5.51,	.56,	16,	.68,	-5.47,

1

Table 11.3.1 (continued) Plaice in Division VIId. Tuning diagnostic

Fleet : FLT03: FRENCH TRAWLE

Age	1988	1989	1990	1991	1992	1993
1	No data for this fleet at this age					
2	99.99	-.12	-.27	.53	.29	.20
3	99.99	-.25	-.05	.11	.24	-.32
4	99.99	.01	.04	.34	-.39	-.58
5	99.99	.51	.16	-.20	-.14	-1.32
6	99.99	.09	.40	-.09	.36	-.55
7	99.99	-.07	.18	-.33	.21	-.32
8	99.99	.29	.27	-.45	-.43	-.74
9	99.99	.95	1.02	-.38	-.24	-.23

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	No data for this fleet at this age									
2	.19	.04	-.68	-.51	-.80	.00	.64	.47	.40	-.39
3	.16	-.49	-.34	.63	.11	.42	-.18	.41	-.42	-.01
4	-.46	-.53	-.54	.89	.75	.81	.48	-.19	-.38	-.23
5	-.02	-1.10	-.12	.23	.76	.47	.94	.37	-.25	-.29
6	-.33	-1.37	-.29	.85	.09	.30	.77	.02	.02	-.28
7	-.33	-.98	-.15	.98	-.24	.97	.46	-.01	-.16	-.21
8	.19	-.53	.05	.99	.32	.59	.03	-1.48	-.54	-.50
9	-.27	-.17	.17	.78	-.25	-.35	.32	-.86	-.38	.41

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9
Mean Log q	-11.6003	-10.8778	-10.9082	-11.2575	-11.5797	-11.7914	-11.7914	-11.7914
S.E(Log q)	.4499	.3373	.5253	.6159	.5444	.5087	.6308	.5526

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	5.18	-2.361	18.99	.02	15	2.02	-11.60
3	.78	1.233	10.56	.71	15	.26	-10.88
4	.70	1.797	10.25	.73	15	.34	-10.91
5	.95	.187	11.08	.50	15	.61	-11.26
6	1.06	-.234	11.84	.56	15	.60	-11.58
7	1.48	-1.695	14.35	.49	15	.71	-11.79
8	.91	.464	11.35	.65	15	.57	-11.92
9	.82	1.153	10.58	.76	15	.45	-11.76

1

Fleet : FLT04: UK BEAM TRAWL

Age	1988	1989	1990	1991	1992	1993
1	.62	-1.30	-.61	.06	.13	-.76
2	.43	-.37	-.71	-.01	.10	-.11
3	.67	.24	-.53	.33	-.01	-.27
4	.00	.50	-.13	.10	.42	-.40
5	.59	-.12	.04	.21	.65	-.09
6	.02	.18	.13	-.05	.93	-.04
7	No data for this fleet at this age					
8	No data for this fleet at this age					
9	No data for this fleet at this age					

Table 11.3.1 (continued) Plaice in Division VIId. Tuning diagnostic

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-.07	-.11	-.19	.49	.36	.18	.32	.28	.37	.23
2	.05	-.83	-.15	-.36	.08	.36	.84	.22	.15	.32
3	.20	-.25	-1.41	-.51	-.49	.08	.87	.89	.38	-.19
4	.43	-.11	-1.14	-1.16	.03	-.52	.69	.63	.66	-.01
5	.14	-.42	-.59	-1.03	-.94	-.32	.55	1.06	-.12	.39
6	-.41	-.42	-.28	-.97	-.40	-.48	.48	.71	.70	-.11
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6
Mean Log q	-7.4645	-7.0458	-7.0254	-6.8321	-6.5686	-6.6167
S.E(Log q)	.5088	.4240	.5948	.5799	.5786	.5096

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	.66	1.408	8.30	.56	16	.33	-7.46
2	.91	.262	7.29	.40	16	.40	-7.05
3	.88	.426	7.33	.47	16	.54	-7.03
4	.77	1.071	7.27	.61	16	.45	-6.83
5	.70	1.726	6.96	.70	16	.38	-6.57
6	.77	1.434	6.72	.74	16	.38	-6.62

1

Fleet : FLT05: French GFS [o

Age	1988	1989	1990	1991	1992	1993
1	-.28	-.57	-.94	-1.56	.82	1.35
2	.86	.14	-1.51	-.80	-.44	.54
3	.33	-.48	-.54	-.93	.00	.66
4	.30	-.66	-.03	-.72	-.93	.64
5	.57	-1.52	.15	-.63	-.68	.31
6	No data for this fleet at this age					
7	No data for this fleet at this age					
8	No data for this fleet at this age					
9	No data for this fleet at this age					

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-.21	-.62	-.96	.87	.76	.21	.40	-.27	.08	.93
2	-.11	-.09	-.65	.17	.40	.23	1.43	-.05	.68	-.80
3	-1.08	-.11	-1.76	.74	-.17	.49	.58	-.04	.97	1.34
4	-1.16	-.06	-1.37	.05	.00	.52	.98	.13	.28	2.03
5	-.77	-.44	-.40	.09	99.99	.17	1.19	-.50	-.21	2.67
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Table 11.3.1 (continued) Plaice in Division VIId. Tuning diagnostic

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 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time


    Age ,         1,         2,         3,         4,         5
 Mean Log q,   -7.7410,   -7.9772,   -7.9833,   -8.3519,   -8.4173,
 S.E(Log q),     .8169,     .7308,     .8209,     .8553,     .9791,


 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,    3.17,   -1.158,      2.98,     .02,     16,    2.56,   -7.74,
  2,     .59,    1.180,      8.75,     .37,     16,     .42,   -7.98,
  3,     .85,     .405,      8.22,     .33,     16,     .71,   -7.98,
  4,     .98,     .048,      8.36,     .29,     16,     .87,   -8.35,
  5,   83.16,   -2.185,     48.72,     .00,     15,   72.26,   -8.42,
1
```

Fleet : FLT06: Intl YFS [rev

```
  Age  ,  1988,  1989,  1990,  1991,  1992,  1993
     1 ,   .25,  -.05,   .03,  -.26,   .53,   .53
     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



  Age  ,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003
     1 ,   .21,   .61,  -.56,  -.58,   .33,   .11,  -.37,  -.16,  -.11,  -.48
     2 , No data for this fleet at this age
     3 , No data for this fleet at this age
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age
     6 , No data for this fleet at this age
     7 , No data for this fleet at this age
     8 , No data for this fleet at this age
     9 , No data for this fleet at this age

 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time


    Age ,         1
 Mean Log q,  -10.0910,
 S.E(Log q),     .3908,


 Regression statistics :



 Ages with q independent of year class strength and constant w.r.t. time.

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  1,    1.18,    -.525,     10.12,     .37,     16,     .47,  -10.09,
1
```

Table 11.3.1 (continued) Plaice in Division VIId. Tuning diagnostic

Terminal year survivor and F summaries :

Age 1 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
FLT01: UK INSHORE TR,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT02: BELGIAN BEAM ,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT03: FRENCH TRAWLE,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT04: UK BEAM TRAWL,	10137.,	.524,	.000,	.00,	1,	.234,	.059
FLT05: French GFS [o,	20485.,	.842,	.000,	.00,	1,	.091,	.030
FLT06: Intl YFS [rev,	4973.,	.403,	.000,	.00,	1,	.397,	.117
F shrinkage mean ,	9783.,	.50,,,,				.277,	.061

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
8063.,	.26,	.26,	4,	1.006,	.073

1

Age 2 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
FLT01: UK INSHORE TR,	44256.,	.646,	.000,	.00,	1,	.078,	.100
FLT02: BELGIAN BEAM ,	18376.,	1.073,	.000,	.00,	1,	.028,	.225
FLT03: FRENCH TRAWLE,	11390.,	.465,	.000,	.00,	1,	.150,	.342
FLT04: UK BEAM TRAWL,	23526.,	.336,	.028,	.08,	2,	.284,	.180
FLT05: French GFS [o,	11042.,	.562,	.435,	.77,	2,	.101,	.351
FLT06: Intl YFS [rev,	14952.,	.403,	.000,	.00,	1,	.193,	.270
F shrinkage mean ,	12287.,	.50,,,,				.166,	.320

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
16767.,	.18,	.15,	9,	.837,	.244

Age 3 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
FLT01: UK INSHORE TR,	4306.,	.367,	.070,	.19,	2,	.156,	.812
FLT02: BELGIAN BEAM ,	6261.,	.543,	.113,	.21,	2,	.072,	.621
FLT03: FRENCH TRAWLE,	6884.,	.284,	.184,	.65,	2,	.257,	.578
FLT04: UK BEAM TRAWL,	6714.,	.302,	.136,	.45,	3,	.187,	.589
FLT05: French GFS [o,	12818.,	.481,	.447,	.93,	3,	.077,	.351
FLT06: Intl YFS [rev,	5300.,	.403,	.000,	.00,	1,	.082,	.702
F shrinkage mean ,	5435.,	.50,,,,				.170,	.689

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
6239.,	.15,	.10,	14,	.631,	.623

1

Table 11.3.1 (continued) Plaice in Division VIId. Tuning diagnostic

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 1999

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: UK INSHORE TR,	3435.,	.350,	.373,	1.06,	3,	.135,	.416
FLT02: BELGIAN BEAM ,	1935.,	.372,	.189,	.51,	3,	.159,	.650
FLT03: FRENCH TRAWLE,	1717.,	.272,	.224,	.82,	3,	.222,	.709
FLT04: UK BEAM TRAWL,	2469.,	.301,	.093,	.31,	4,	.174,	.541
FLT05: French GFS [o,	6544.,	.468,	.488,	1.04,	4,	.075,	.240
FLT06: Intl YFS [rev,	1442.,	.403,	.000,	.00,	1,	.048,	.802
F shrinkage mean ,	1145.,	.50,,,,				.188,	.936

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
2080.,	.15,	.14,	19,	.953,	.617

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1998

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: UK INSHORE TR,	620.,	.282,	.299,	1.06,	4,	.295,	.501
FLT02: BELGIAN BEAM ,	547.,	.348,	.240,	.69,	4,	.166,	.553
FLT03: FRENCH TRAWLE,	574.,	.322,	.217,	.67,	4,	.151,	.533
FLT04: UK BEAM TRAWL,	1030.,	.355,	.103,	.29,	5,	.139,	.330
FLT05: French GFS [o,	2741.,	.554,	.595,	1.07,	5,	.054,	.137
FLT06: Intl YFS [rev,	681.,	.403,	.000,	.00,	1,	.015,	.465
F shrinkage mean ,	293.,	.50,,,,				.179,	.866

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
611.,	.15,	.15,	24,	.949,	.507

1

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT01: UK INSHORE TR,	547.,	.234,	.150,	.64,	5,	.324,	.500
FLT02: BELGIAN BEAM ,	644.,	.315,	.158,	.50,	5,	.166,	.439
FLT03: FRENCH TRAWLE,	425.,	.305,	.038,	.13,	5,	.153,	.607
FLT04: UK BEAM TRAWL,	574.,	.312,	.141,	.45,	6,	.157,	.481
FLT05: French GFS [o,	639.,	.440,	.170,	.39,	5,	.028,	.441
FLT06: Intl YFS [rev,	738.,	.403,	.000,	.00,	1,	.015,	.393
F shrinkage mean ,	447.,	.50,,,,				.157,	.584

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
533.,	.14,	.06,	28,	.412,	.510

Table 11.3.1 (continued) Plaice in Division VIId. Tuning diagnostic

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	667.,	.233,	.058,	.25,	6,	.275,	.389
FLT02: BELGIAN BEAM ,	474.,	.288,	.173,	.60,	6,	.240,	.511
FLT03: FRENCH TRAWLE,	557.,	.310,	.124,	.40,	6,	.193,	.450
FLT04: UK BEAM TRAWL,	1164.,	.320,	.120,	.38,	6,	.099,	.241
FLT05: French GFS [o,	709.,	.500,	.316,	.63,	5,	.018,	.369
FLT06: Intl YFS [rev,	324.,	.403,	.000,	.00,	1,	.008,	.681
F shrinkage mean ,	429.,	.50,,,,				.169,	.553

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
579.,	.14,	.07,	31,	.501,	.436

1

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1995

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	370.,	.249,	.284,	1.14,	7,	.262,	.176
FLT02: BELGIAN BEAM ,	147.,	.255,	.085,	.33,	6,	.329,	.396
FLT03: FRENCH TRAWLE,	167.,	.313,	.154,	.49,	7,	.182,	.355
FLT04: UK BEAM TRAWL,	322.,	.358,	.186,	.52,	6,	.061,	.200
FLT05: French GFS [o,	351.,	.533,	.348,	.65,	5,	.008,	.185
FLT06: Intl YFS [rev,	112.,	.403,	.000,	.00,	1,	.003,	.492
F shrinkage mean ,	125.,	.50,,,,				.154,	.450

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
197.,	.14,	.11,	33,	.747,	.309

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1994

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	71.,	.253,	.233,	.92,	8,	.235,	.514
FLT02: BELGIAN BEAM ,	41.,	.241,	.203,	.84,	8,	.309,	.773
FLT03: FRENCH TRAWLE,	75.,	.295,	.163,	.55,	8,	.215,	.492
FLT04: UK BEAM TRAWL,	79.,	.355,	.159,	.45,	6,	.040,	.472
FLT05: French GFS [o,	67.,	.543,	.191,	.35,	5,	.006,	.536
FLT06: Intl YFS [rev,	117.,	.403,	.000,	.00,	1,	.002,	.340
F shrinkage mean ,	91.,	.50,,,,				.194,	.420

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
64.,	.15,	.10,	37,	.634,	.558

1
1

Table 11.3.2 - Plaice in Division VIId. Fishing mortality at age

Run title : Plaice in VIId (run: XSAAEDB01/X01)

At 8/09/2004 15:09

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR		1980	1981	1982	1983
AGE					
	1	0.0022	0.0013	0.0111	0.0049
	2	0.1674	0.1183	0.1342	0.1522
	3	0.2789	0.7287	0.4974	0.4533
	4	0.3371	0.8856	0.8578	0.939
	5	0.6174	0.2717	0.6936	0.5501
	6	0.4143	0.3657	0.2811	0.3976
	7	0.399	0.4874	0.349	0.1746
	8	0.2537	0.7046	1.8572	0.8832
	9	0.3567	0.5211	0.8332	0.4868
+gp		0.3567	0.5211	0.8332	0.4868
FBAR 2- 6		0.363	0.474	0.4928	0.4985

Table 8 Fishing mortality (F) at age

YEAR		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE											
	1	0.0148	0.005	0.0119	0.0008	0.0006	0.0548	0.0956	0.0776	0.0647	0.0607
	2	0.1159	0.3132	0.2137	0.1814	0.2064	0.1741	0.2207	0.5077	0.4433	0.4116
	3	0.5769	0.5974	0.6939	0.5189	0.6668	0.4547	0.7035	0.8338	0.8101	0.4781
	4	0.8154	0.8586	0.7638	0.7905	0.6746	0.7474	0.748	0.8761	0.6086	0.4947
	5	0.7895	0.2286	0.5955	0.5705	0.5597	0.8688	0.6315	0.695	0.5215	0.3439
	6	0.6238	0.569	0.4883	0.3083	0.4554	0.5727	0.6134	0.6051	0.6447	0.3542
	7	0.8291	0.3488	0.4333	0.7922	0.5232	0.4146	0.4355	0.4067	0.4805	0.3859
	8	0.2633	0.9128	0.2158	0.4516	0.484	0.3708	0.5112	0.3536	0.4907	0.329
	9	0.5743	0.6127	0.3802	0.5193	0.5623	0.5777	0.6798	0.5285	0.6037	0.4417
+gp		0.5743	0.6127	0.3802	0.5193	0.5623	0.5777	0.6798	0.5285	0.6037	0.4417
0 FBAR 2- 6		0.5843	0.5134	0.551	0.4739	0.5126	0.5635	0.5834	0.7035	0.6057	0.4165
	1										

Table 8 Fishing mortality (F) at age

YEAR		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	FBAR 01-03
AGE												
	1	0.0784	0.1145	0.0393	0.0153	0.0327	0.0442	0.0809	0.1108	0.0356	0.0734	0.0733
	2	0.4145	0.3781	0.2888	0.184	0.147	0.1501	0.5433	0.3288	0.4273	0.2441	0.3334
	3	0.725	0.613	0.5481	0.7957	0.6046	0.6569	0.573	0.8261	0.7699	0.6228	0.7396
	4	0.8033	0.682	0.6795	1.4618	1.0192	1.1619	0.9522	0.5574	0.9624	0.6165	0.7121
	5	0.6492	0.5172	0.7551	1.3886	0.8502	0.9091	0.9694	0.6581	0.9233	0.5068	0.696
	6	0.4317	0.316	0.5045	1.0578	0.5805	0.6379	0.658	0.4145	0.6168	0.5104	0.5139
	7	0.3757	0.5017	0.3893	1.1694	0.4712	0.7402	0.6405	0.3447	0.5595	0.4362	0.4468
	8	0.5379	0.4517	0.6115	0.8788	0.5591	0.5045	0.4787	0.3094	0.3917	0.3087	0.3366
	9	0.5318	0.4458	0.6213	0.9254	0.5219	0.4917	0.4716	0.3956	0.6077	0.5575	0.5203
+gp		0.5318	0.4458	0.6213	0.9254	0.5219	0.4917	0.4716	0.3956	0.6077	0.5575	
0 FBAR 2- 6		0.6047	0.5013	0.5552	0.9776	0.6403	0.7032	0.7392	0.557	0.7399	0.5001	

Table 11.3.3 - Plaice in Division VIId. Stocks numbers at age

Run title : Plaice in VIId (run: XSAAEDB01/X01)

At 8/09/2004 15:09

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

		1980	1981	1982	1983
YEAR		1980	1981	1982	1983
AGE					
	1	25536	12905	25210	19958
	2	18036	23056	11662	22559
	3	6267	13805	18535	9227
	4	1984	4291	6028	10199
	5	1118	1282	1601	2313
	6	232	546	884	724
	7	144	139	343	604
	8	206	87	77	219
	9	14	145	39	11
+gp		360	515	162	274
0 TOTAL		53899	56770	64541	66088

YEAR		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE											
	1	25056	29636	60228	31248	26474	16281	18816	21713	27938	13217
	2	17971	22339	26681	53850	28251	23940	13946	15473	18180	23696
	3	17530	14481	14778	19496	40641	20796	18201	10120	8426	10559
	4	5306	8909	7210	6681	10499	18878	11942	8150	3978	3392
	5	3609	2124	3416	3040	2742	4839	8090	5115	3071	1958
	6	1207	1483	1529	1704	1555	1418	1837	3893	2310	1649
	7	440	585	759	849	1133	892	724	900	1923	1097
	8	459	174	374	446	348	607	533	424	542	1076
	9	82	319	63	273	257	194	379	289	269	300
+gp		239	114	113	199	423	470	489	319	272	446
0 TOTAL		71900	80164	115151	117785	112323	88315	74957	66395	66910	57390
	1										

YEAR		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	GMST 80-01	AMST 80-01
AGE														
	1	17322	25178	30531	37964	15141	18001	18699	26889	27090	9590	23146(1)	23146	24725
	2	11255	14492	20317	26561	33828	13259	15584	15604	21779	23654	12676(2)	19913	21388
	3	14206	6728	8985	13773	19994	26424	10325	8190	10163	12854	16767	13544	15068
	4	5923	6226	3298	4700	5624	9884	12395	5267	3244	4258	6239	6449	7307
	5	1871	2400	2848	1513	986	1836	2798	4328	2729	1121	2080	2505	2859
	6	1256	885	1295	1211	341	381	669	960	2028	981	611	1056	1271
	7	1047	738	584	708	381	173	182	314	574	990	533	537	666
	8	675	651	404	358	199	215	75	87	201	297	579	294	374
	9	701	357	375	199	134	103	117	42	58	123	197	142	212
+gp		791	751	784	529	484	299	273	250	211	152	142		
0 TOTAL		55048	58406	69420	87514	77112	70575	61118	61931	68077	54020	35212		
	1													

(1) GM 80-01
(2) RCT3 estimates

Table 11.3.4 - Plaice in Division VIId. Stock summary

Run title : Plaice in VIId (run: XSAAEDB01/X01)

At 8/09/2004 15:09

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECR Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2- 6
1980	25536	16512	5586	2650	0.4744	0.363
1981	12905	14342	6562	4769	0.7268	0.474
1982	25210	15070	7580	4865	0.6418	0.4928
1983	19958	15146	8133	5043	0.62	0.4985
1984	25056	14145	7471	5161	0.6908	0.5843
1985	29636	15779	8156	6022	0.7383	0.5134
1986	60228	23102	10089	6834	0.6774	0.551
1987	31248	31773	13448	8366	0.6221	0.4739
1988	26474	24360	13108	10420	0.795	0.5126
1989	16281	21488	14204	8758	0.6166	0.5635
1990	18816	21826	14580	9047	0.6205	0.5834
1991	21713	17554	10151	7813	0.7697	0.7035
1992	27938	16154	8573	6337	0.7392	0.6057
1993	13217	15894	7750	5331	0.6879	0.4165
1994	17322	15002	8329	6121	0.7349	0.6047
1995	25178	14797	7516	5130	0.6825	0.5013
1996	30531	17138	6592	5393	0.8181	0.5552
1997	37964	15284	6776	6307	0.9307	0.9776
1998	15141	17225	7652	5762	0.753	0.6403
1999	18001	14416	8398	6326	0.7533	0.7032
2000	18699	11259	6438	6015	0.9343	0.7392
2001	26889	12837	6479	5266	0.8128	0.557
2002	27090	14569	6601	5777	0.8752	0.7399
2003	15053(1)	12128	5740	4536	0.7903	0.5001
2004	23146 (2)		7330(3)			
Arith. Mean	24193	16992	8580	6169	0.7294	0.5773
Units	(Thousands	(Tonnes)	(Tonnes)	(Tonnes)		

(1) RCT3 estimate
(2) GM 1980 - 2001
(3) Forecast

Table 11.4.1 - Plaice in Division VIId. Input to RCT3

7D PLAICE - VPA indices all * per 100
5 18 2

YEARCLASS	VPA age 1	VPA age 2	yfs0	yfs1	bts1	gfs0	gfs1
1986	31248	28251	-11	144	-11	-11	-11
1987	26474	23940	1168	132	2647	-11	1033
1988	16281	13946	556	58	231	19	408
1989	18816	15473	397	71	516	16	270
1990	21713	18180	342	62	1175	10	173
1991	27938	23696	436	178	1653	10	2379
1992	13217	11255	404	84	322	66	1916
1993	17322	14492	370	79	833	438	517
1994	25178	20317	869	168	1132	362	491
1995	30531	26561	687	66	1320	136	447
1996	37964	33828	407	82	3310	2360	3549
1997	15141	13259	223	80	1140	890	1253
1998	18001	15584	530	76	1130	768	848
1999	18699	15604	381	48	1319	103	1026
2000	26889	-11	514	83	1791	1590	738
2001	-11	-11	374	92	2066	461	1134
2002	-11	-11	67	23	618	54	266
2003	-11	-11	492	-11	-11	912	-11

Table 11.4.2 - Plaice in Division VIId. RCT3 output for 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   18 years :  1986 - 2003

 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 =   2001

         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      1.68   -.42    .65   .188     14   5.93    9.56     .740     .068
 yfs1      1.81   1.91    .66   .190     15   4.53   10.10     .729     .070
 bts1       .53   6.29    .25   .603     14   7.63   10.33     .293     .435
 gfs0       .70   6.48   1.36   .053     13   6.14   10.75    1.552     .016
 gfs1      1.77  -1.81   1.52   .041     14   7.03   10.64    1.710     .013

                                         VPA Mean =   10.00     .307     .398


 Yearclass =   2002

         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      1.68   -.42    .65   .188     14   4.22    6.69    1.178     .029
 yfs1      1.81   1.91    .66   .190     15   3.18    7.65     .964     .043
 bts1       .53   6.29    .25   .603     14   6.43    9.69     .291     .473
 gfs0       .70   6.48   1.36   .053     13   4.01    9.27    1.547     .017
 gfs1      1.77  -1.81   1.52   .041     14   5.59    8.08    1.794     .012

                                         VPA Mean =   10.00     .307     .425


 Yearclass =   2003

         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 yfs0      1.68   -.42    .65   .188     14   6.20   10.02     .731     .145
 yfs1
 bts1
 gfs0       .70   6.48   1.36   .053     13   6.82   11.23    1.584     .031
 gfs1

                                         VPA Mean =   10.00     .307     .824


 Year     Weighted      Log     Int     Ext     Var      VPA      Log
 Class     Average      WAP     Std     Std    Ratio              VPA
          Prediction           Error   Error

 2001       25301     10.14     .19     .10      .29
 2002       15053      9.62     .20     .32     2.55
 2003       22972     10.04     .28     .15      .29
```

Table 11.4.3- Plaice in Division VIId. RCT3 output for age 2

```
Analysis by RCT3 ver3.1 of data from file : recpl7d2.in

7D PLAICE - VPA AGE 2 / indices all * per 100

Data for    5 surveys over   18 years :  1986 - 2003

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 =   2001

         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      1.70   -.70    .69   .188     13   5.93    9.39     .786     .067
yfs1      1.83   1.65    .69   .198     14   4.53    9.92     .768     .070
bts1       .54   6.05    .26   .616     13   7.63   10.18     .306     .445
gfs0       .88   5.54   1.69   .038     12   6.14   10.96    1.970     .011
gfs1      1.42    .32   1.26   .065     13   7.03   10.33    1.430     .020

                                       VPA Mean =    9.83     .328     .386


Yearclass =   2002

         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      1.70   -.70    .69   .188     13   4.22    6.49    1.249     .028
yfs1      1.83   1.65    .69   .198     14   3.18    7.45    1.016     .043
bts1       .54   6.05    .26   .616     13   6.43    9.53     .301     .487
gfs0       .88   5.54   1.69   .038     12   4.01    9.08    1.943     .012
gfs1      1.42    .32   1.26   .065     13   5.59    8.27    1.500     .020

                                       VPA Mean =    9.83     .328     .410


Yearclass =   2003

         I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series           cept   Error          Pts  Value   Value    Error   Weights

yfs0      1.70   -.70    .69   .188     13   6.20    9.86     .777     .148
yfs1
bts1
gfs0       .88   5.54   1.69   .038     12   6.82   11.56    2.021     .022
gfs1

                                       VPA Mean =    9.83     .328     .830


Year     Weighted      Log     Int     Ext     Var     VPA      Log
Class     Average      WAP     Std     Std    Ratio             VPA
         Prediction           Error   Error

2001       21706      9.99     .20     .11     .30
2002       12676      9.45     .21     .32    2.32
2003       19418      9.87     .30     .18     .36
```

Table 11.5.1 – Plaice in Division VIId. Input for short term prediction

input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	23146	0.36	WS1	0.10	0.06
N2	12676	0.21	WS2	0.20	0.04
N3	16766	0.18	WS3	0.27	0.06
N4	6239	0.15	WS4	0.35	0.08
N5	2080	0.15	WS5	0.46	0.10
N6	610	0.15	WS6	0.56	0.12
N7	533	0.14	WS7	0.67	0.23
N8	579	0.14	WS8	0.83	0.16
N9	197	0.14	WS9	0.91	0.37
N10	141	0.15	WS10	1.21	0.18
H.cons selectivity			Weight in the HC catch		
sH1	0.07	0.58	WH1	0.24	0.09
sH2	0.33	0.10	WH2	0.26	0.03
sH3	0.74	0.18	WH3	0.29	0.07
sH4	0.71	0.13	WH4	0.37	0.02
sH5	0.70	0.11	WH5	0.48	0.14
sH6	0.51	0.16	WH6	0.62	0.08
sH7	0.45	0.17	WH7	0.71	0.20
sH8	0.34	0.08	WH8	0.91	0.09
sH9	0.52	0.24	WH9	0.88	0.32
sH10	0.52	0.24	WH10	1.25	0.05
Natural mortality			Proportion mature		
M1	0.10	0.10	MT1	0.00	0.10
M2	0.10	0.10	MT2	0.15	0.10
M3	0.10	0.10	MT3	0.53	0.10
M4	0.10	0.10	MT4	0.96	0.10
M5	0.10	0.10	MT5	1.00	0.10
M6	0.10	0.10	MT6	1.00	0.00
M7	0.10	0.10	MT7	1.00	0.00
M8	0.10	0.10	MT8	1.00	0.00
M9	0.10	0.10	MT9	1.00	0.00
M10	0.10	0.10	MT10	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF04	1.00	0.21	K04	1.00	0.10
HF05	1.00	0.21	K05	1.00	0.10
HF06	1.00	0.21	K06	1.00	0.10
Recruitment in 2005 and 2006					
R05	23146	0.36			
R06	23146	0.36			

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

Stock numbers in 2004 are VPA survivors.
These are overwritten at Age 2

Data from file:C:\forecasts\PLEVIID.SEN on 10/09/2004 at 12:27:35

Table 11.5.2 - Plaice in Division VIId. Short term prediction (management option table)

MFDP version 1a
Run: pl7d
Plaice in VIId (run: XSAAEDB01/X01)
Time and date: 11:27 10/09/2004
Fbar age range: 2-6

2004 Biomass	SSB	FMult	FBar	Landings
13995	7332	1.0000	0.5990	5891

2005 Biomass	SSB	FMult	FBar	Landings	2006 Biomass	SSB
13765	7004	0.0000	0.0000	0	19888	11688
.	7004	0.1000	0.0599	694	19139	11046
.	7004	0.2000	0.1198	1349	18434	10443
.	7004	0.3000	0.1797	1970	17768	9878
.	7004	0.4000	0.2396	2557	17140	9347
.	7004	0.5000	0.2995	3113	16546	8848
.	7004	0.6000	0.3594	3639	15986	8380
.	7004	0.7000	0.4193	4139	15457	7940
.	7004	0.8000	0.4792	4612	14957	7527
.	7004	0.9000	0.5391	5061	14484	7138
.	7004	1.0000	0.5990	5487	14036	6772
.	7004	1.1000	0.6589	5892	13612	6429
.	7004	1.2000	0.7188	6276	13211	6105
.	7004	1.3000	0.7787	6641	12831	5801
.	7004	1.4000	0.8386	6989	12471	5515
.	7004	1.5000	0.8985	7320	12130	5245
.	7004	1.6000	0.9584	7634	11806	4991
.	7004	1.7000	1.0183	7934	11498	4752
.	7004	1.8000	1.0782	8220	11206	4526
.	7004	1.9000	1.1381	8493	10929	4314
.	7004	2.0000	1.1980	8753	10665	4113

Input units are thousands and kg - output in tonnes

Table 11.5.3 - Plaice in Division VIId. Short term prediction (Detailed output)

MFDP version 1a
Run: pl7d
Time and date: 11:27 10/09/2004
Fbar age range: 2-6

Year: 2004 F multiplier: 1 Fbar: 0.599

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)
1	0.0733	1557	375	23146	2299	0	0
2	0.3334	3429	887	12676	2548	1901	382
3	0.7396	8391	2470	16767	4494	8887	2382
4	0.7121	3042	1125	6239	2177	5989	2090
5	0.6961	998	480	2080	948	2080	948
6	0.5139	235	144	611	341	611	341
7	0.4468	183	130	533	356	533	356
8	0.3366	158	144	579	482	579	482
9	0.5203	76	67	197	179	197	179
10	0.5203	55	69	142	172	142	172
Total		18125	5891	62970	13995	20919	7332

Year: 2005 F multiplier: 1 Fbar: 0.599

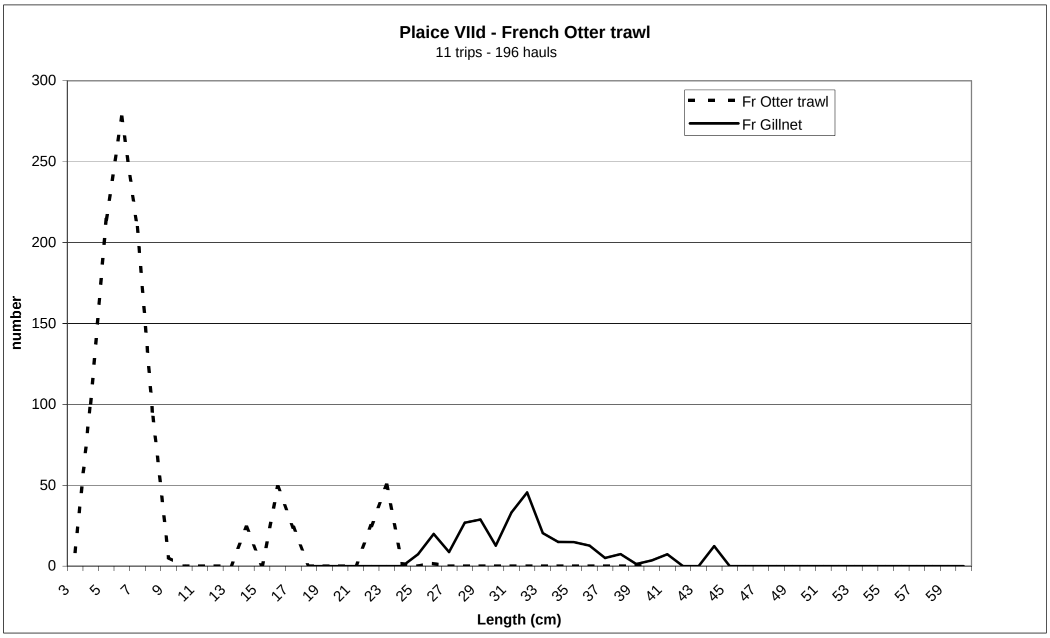
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)
1	0.0733	1557	375	23146	2299	0	0
2	0.3334	5266	1362	19464	3912	2920	587
3	0.7396	4113	1210	8218	2202	4355	1167
4	0.7121	3531	1305	7241	2527	6952	2426
5	0.6961	1329	639	2770	1262	2770	1262
6	0.5139	360	222	938	524	938	524
7	0.4468	114	81	331	221	331	221
8	0.3366	84	77	308	257	308	257
9	0.5203	145	127	374	340	374	340
10	0.5203	71	89	182	221	182	221
Total		16570	5487	62973	13765	19130	7004

Year: 2006 F multiplier: 1 Fbar: 0.599

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)
1	0.0733	1557	375	23146	2299	0	0
2	0.3334	5266	1362	19464	3912	2920	587
3	0.7396	6315	1859	12618	3382	6688	1792
4	0.7121	1731	640	3549	1239	3407	1189
5	0.6961	1543	741	3215	1465	3215	1465
6	0.5139	480	295	1249	697	1249	697
7	0.4468	175	124	508	339	508	339
8	0.3366	52	48	191	159	191	159
9	0.5203	77	68	199	181	199	181
10	0.5203	116	145	299	363	299	363
Total		17311	5657	64439	14036	18676	6772

Input units are thousands and kg - output in tonnes

Figure 11.2.1 - Plaice in Division VIId. Length structure of discards and landings collected by observations on board (numbers raised to sampled trips)



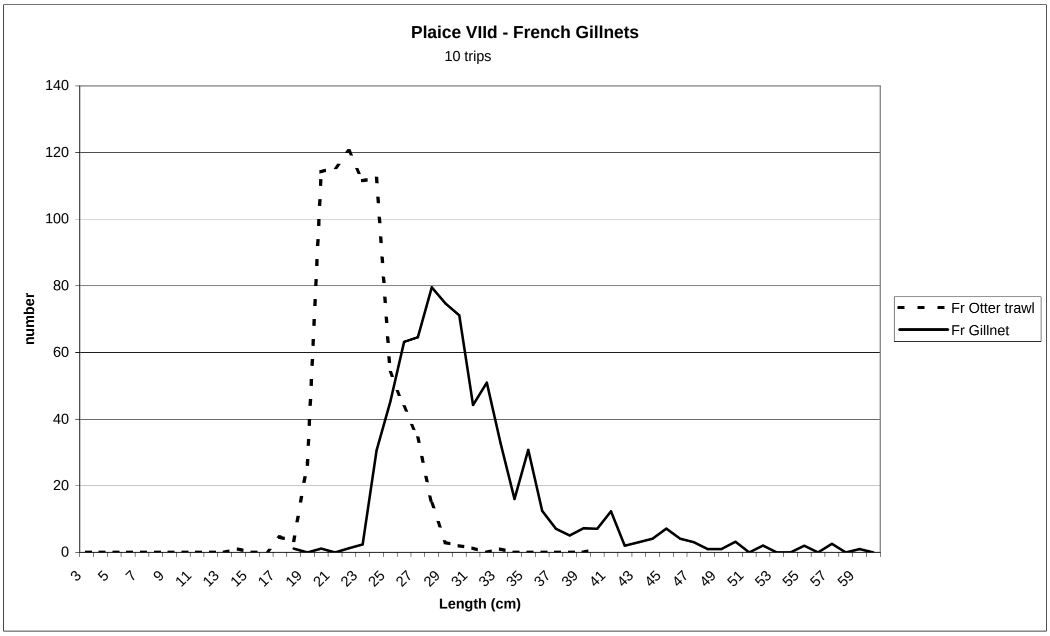


Figure 11.2.2 – Plaice in Division VIId. Commercial effort and CPUE.

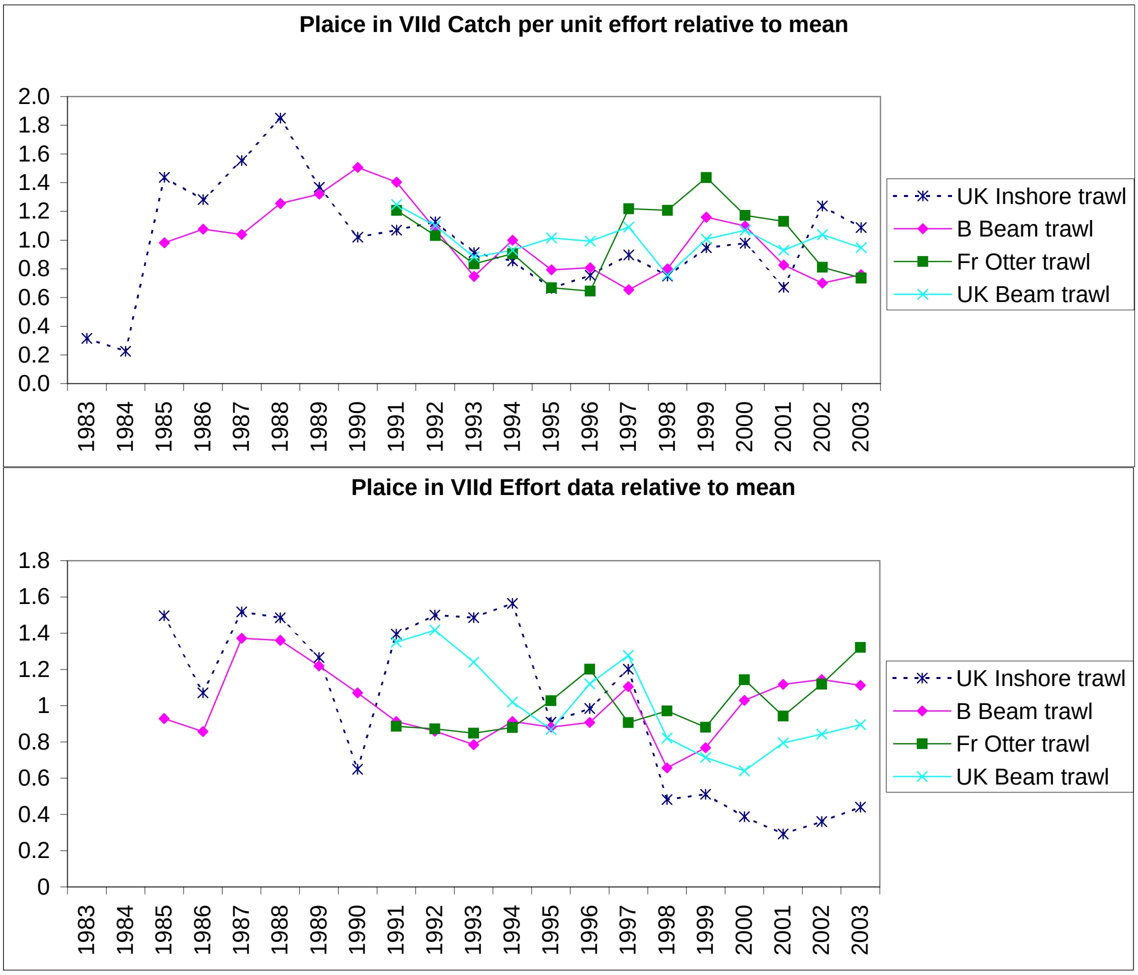


Figure 11.3.1 – Plaice in Division VIId. Stock summary. Estimated recruitment in 2004 (unshaded bar) is the long-term geometric mean used in short-term forecasts. SSB in 2004 (marked by a small square) are VPA survivors.

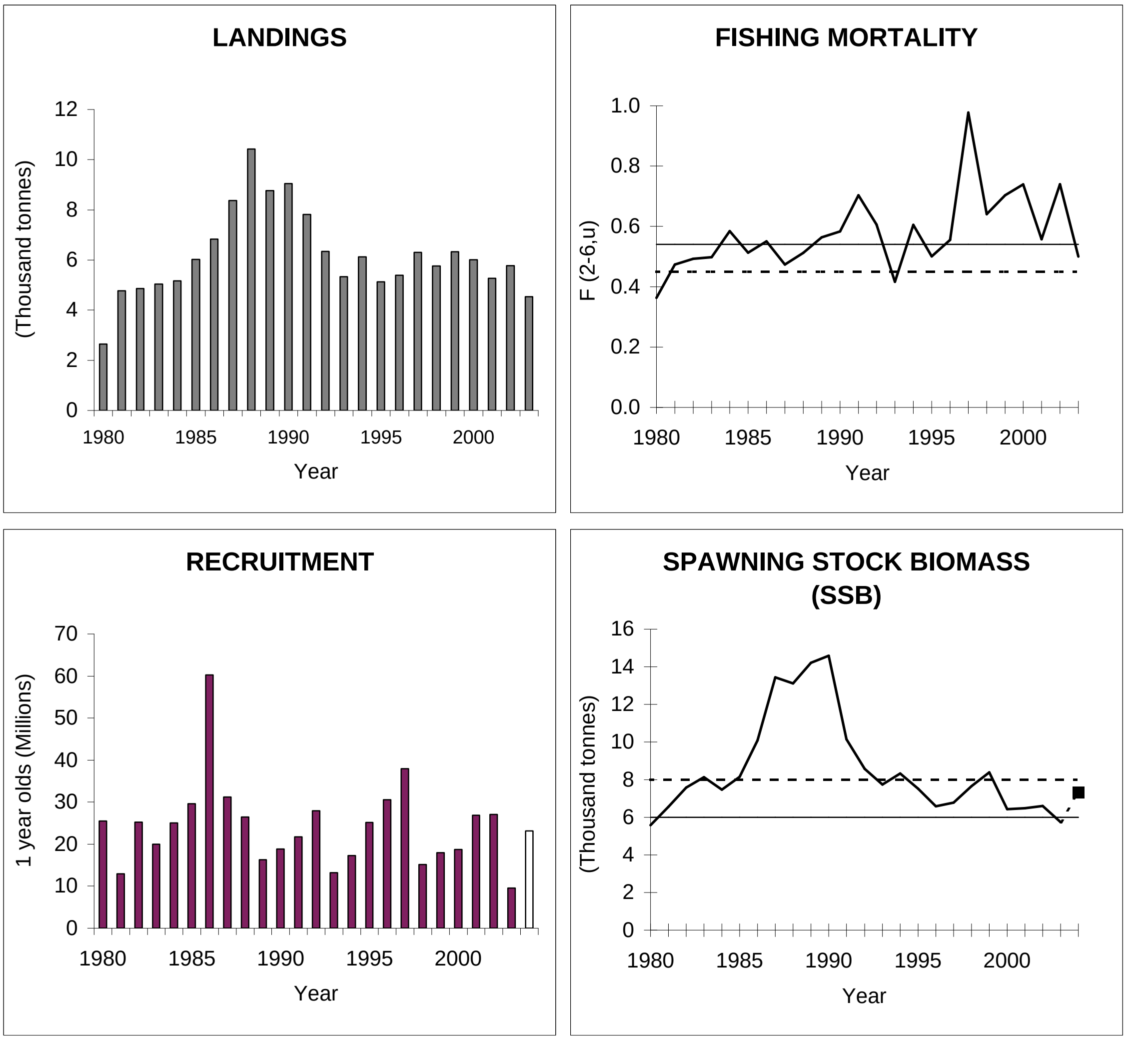


Figure 11.3.2 – Plaice in Division VIId. Quality control of assessments generated by successive Working Groups.

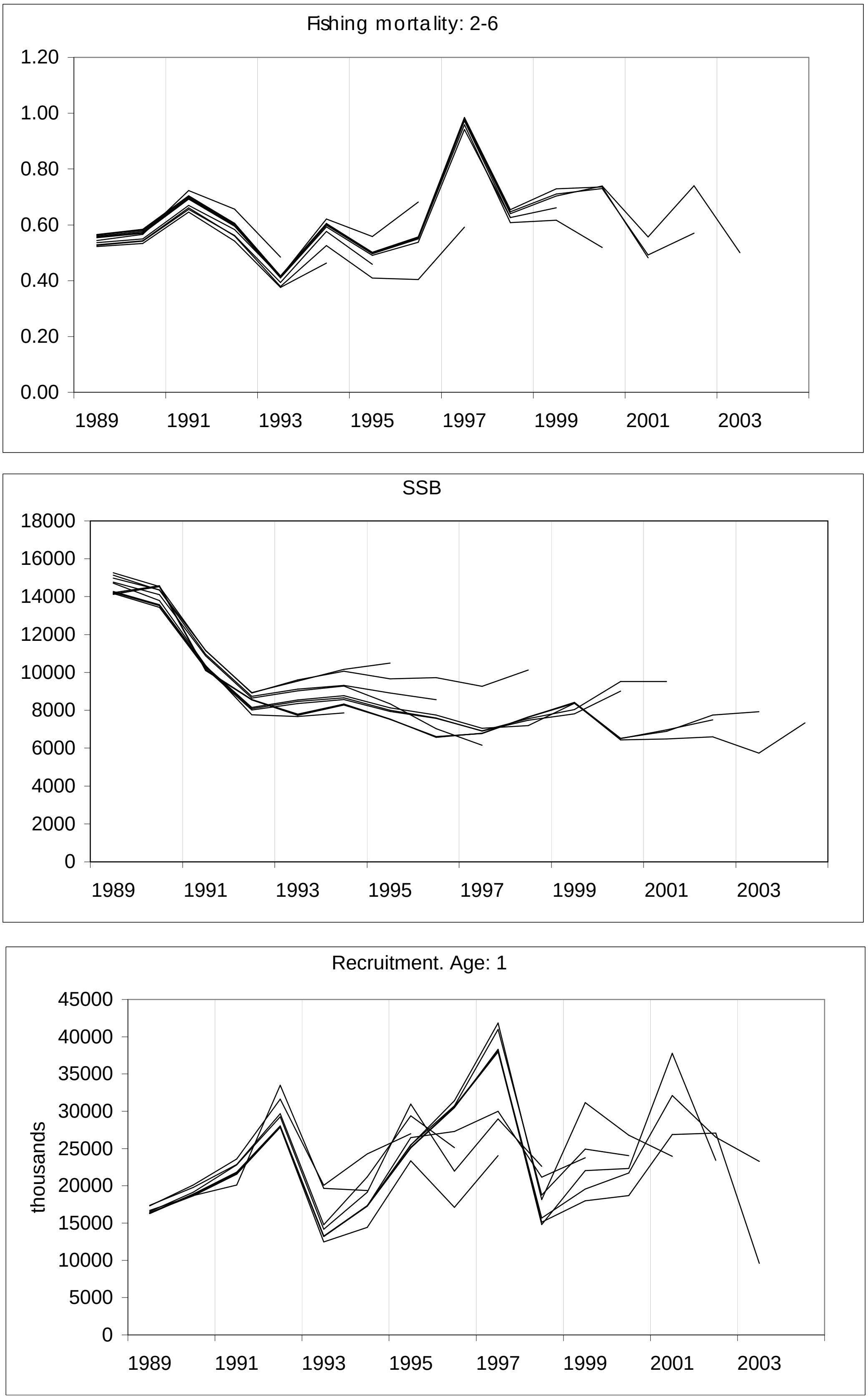
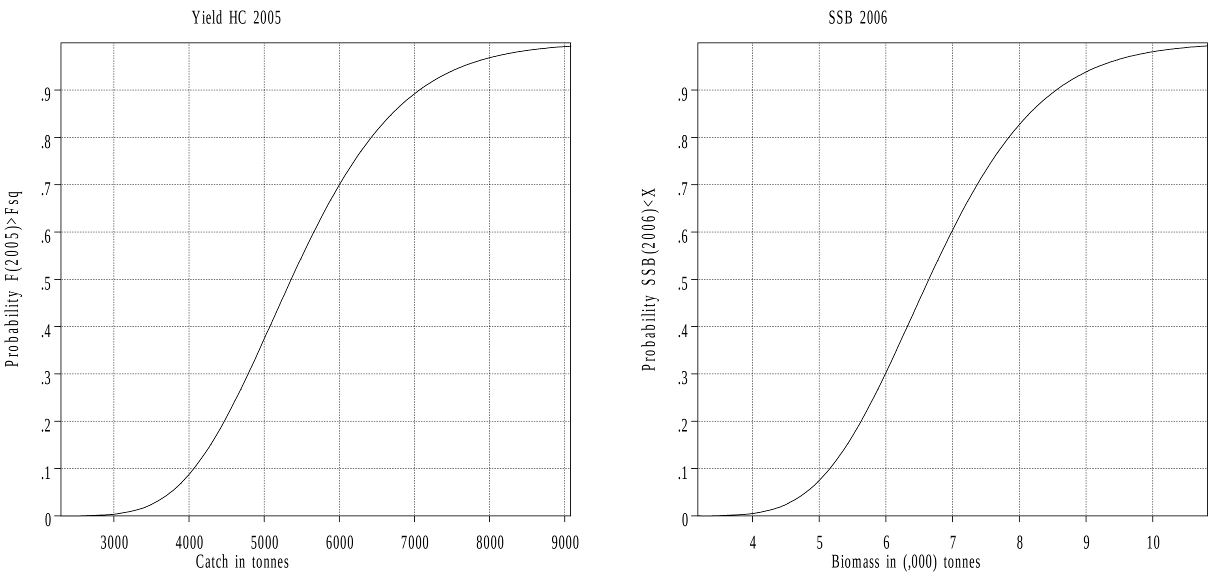


Figure 11.5.1 - Plaice VIId. Probability profiles for short term forecast.



Data from file:C:\forecasts\PLEVIID.SEN on 14/09/2004 at 17:41:31

12 NORWAY POUT IN ICES SUB-AREA IV AND DIVISION IIIa

The 2004 assessment of Norway pout in the North Sea and Skagerrak is a benchmark assessment. Exploratory assessment runs have been carried out using different assessment methods and different assessment tuning fleets including single tuning fleet runs. Input data to the tuning fleets have been analysed during benchmark assessment. The accepted assessment continues to use the seasonal assessment method (SXSA) with revised tuning fleets.

12.1 The fishery

The fishery is mainly performed by Danish and Norwegian (large) vessels using small mesh trawls in the north-western North Sea especially at the Fladden Ground and along the edge of the Norwegian Trench in the north-eastern part of the North Sea. Main fishing seasons are 3rd and 4th quarters of the year with also high catches in 1st quarter of the year especially previous to 1999.

12.1.1 ACFM advice applicable to 2003 and 2004

There is no management objective set for this stock. With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery. The ACFM advice for 2003 and 2004 was that the stock was considered to be within safe biological limits and the stock could on average sustain current fishing mortality. However, it can be expected that the SSB in the second half of 2003 and in 1st quarter of 2004 will decrease further from the 1st quarter 2003 level (172,000 t). Consequently, in the first half year 2003 the stock seems still to be within safe biological limits ($\mathbf{B}_{pa}$ = 150,000 t), however the stock are in risk of decreasing below $\mathbf{B}_{pa}$ in second half of 2003 and in 1st quarter of 2004.

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. By-catches of other species should also be taken into account in management of the fishery. Existing measures to protect other species should be maintained.

Biological reference points for the stock have been set by ICES at $\mathbf{B}_{lim}$ = 90,000 t as the lowest observed biomass and $\mathbf{B}_{pa}$ = 150,000 t which should be maintained. The advised TAC was 220,000 t.

12.1.2 Management applicable to 2003 and 2004

In 1996-2004 the TAC was set to 220,000 t. In managing this fishery by-catches of other species have been taken into account. Existing technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been maintained.

12.1.3 The Fishery in 2003 and 2004

Nominal landings of Norway pout as officially reported to ICES are given in **Table** 12.1.1. Annual landings as provided by Working Group members are shown in **Table**s 12.1.2-3 and trends in yield are shown in **Figure**s 12.3.2-3. Development in the fishery in catch in numbers by season (quarter of the year) is shown in **Table** 12.2.1 under Section 12.2. The spatial distribution of catches in tons by ICES statistical square and season of year for 2002 and 2003 from the Danish commercial fishery for Norway pout is shown in **Figure**s 12.1.1-2.

Landings in 2001 and 2002 were low, and the landings in 2003 and in the 1st and 2nd quarter of the year 2004 were historically low on the lowest level ever recorded since 1961. Especially in 1st quarter of the year 2003 catches have been relative low compared to previous years.

Effort in 2003 and the 1st and 2nd quarter of the year 2004 have been historically low and well below long term average of the 5 previous years (see **Table** 12.2.6 under Section 12.2). The effort in the Norway pout fishery was also relatively low in 2001, but nearly doubled in 2002 being at the same level as in the previous 8 years before 2001.

12.2 Data available

12.2.1 Landings

Data for annual nominal landings of Norway pout as officially reported to ICES are shown in **Table** 12.1.1. Data for annual landings as provided by Working Group members are presented in **Table** 12.1.2, and data for national landings by quarter of year and by geographical area are given in **Table** 12.1.3

12.2.2 Age compositions in Landings

Age compositions were available from Norway and Denmark. Catch at age by quarter of year is shown in **Table** 12.2.1.

12.2.3 Weight at age

Mean weight at age in the catch is shown in **Table** 12.2.2 and mean weight at age in the stock is given in **Table** 12.2.3. The estimation of mean weights at age in the catches and in the used mean weights in the stock in the assessment is described in the stock quality handbook.

Mean weight at age in the catch is estimated as a weighted average of Danish and Norwegian data. Historical levels and variation in mean weight at age in catch by quarter of year is shown in **Figure** 12.2.1. In general, the mean weights at age in the catches are variable between seasons of year. The same mean weight at age in the stock is used for all years. Mean weight at age in catch is not used as estimator of weight in the stock partly because the smallest 0-group fish are not fully recruited to the fishery in 3rd quarter of the year, i.e. because of likely effects of selectivity in the fishery.

12.2.4 Maturity and natural mortality

Proportion mature and natural mortality by age and quarter used in the assessment is given in **Table** 12.2.3. Maturity and natural mortality used in the assessment is described in the stock quality handbook.

In the 2001 and 2002 assessment exploratory runs were made with revised input data for natural mortality by age based on the results from two papers presented to the working group in 2001, (*both papers published in ICES J. Mar. Sci. in 2002, Sparholt, Larsen and Nielsen 2002a,b).* This was not explored further in the 2003 up-date assessment but this years benchmark assessment of the stock includes an exploratory run with revised natural mortalities. These revised natural mortalities are given in **Table** 12.2.3.

The resulting SSB (1st quarter of year), F and R for the final exploratory run was compared to those for the accepted run with standard settings (Figure 12.3.11). It appears that the implications of these revised input data are very significant (also for TSB (3rd quarter of year) – not shown). The working group in 2002 suggested that an assessment with partly the traditional settings (constant M) and a new assessment with the revised values for M were made for at least a 3 year period in order to compare the output and the performance of the assessments before the working group decided on final adoption of the revised values for M to be used in the assessment. This attitude was adopted by the working group again in the 2004 benchmark assessment where a exploratory run with revised values for M was performed as well. The results of the exploratory runs have been consistent throughout the 3 years of exploratory runs.

12.2.5 Catch, Effort and Research Vessel Data

Description of catch, effort and research vessel data used in the assessment is given in the stock quality control handbook. Data used in the present assessment is given in **Table**s 12.2.4-8 as described below.

Effort standardization:

The method for effort standardization of the commercial Norway pout fishery tuning fleet is described in the stock quality control handbook. In the 2004 benchmark assessment the same method of effort standardization as in previous years was used based on the below argumentation.

Results and parameter estimates by period from the yearly regression analysis on CPUE versus GRT for the different Danish vessel size categories is used in the effort standardization of both the Norwegian and Danish commercial fishery vessels included in the assessment tuning fleet.

Parameter estimates from regressions of ln(CPUE) versus ln(average GRT) by period together with estimates of standardized CPUE to the group of Danish 175 GRT industrial fishery trawlers is shown for the period 1994-2004 in the quality control handbook.

In 2002 the assessment was run both with and without the new standardization method (regression). The differences in results of output SSB, TSB and F between the two assessment runs were small.

With respect to further exploration of the effect of using effort standardization and using a combined Danish and Norwegian commercial fishery tuning fleet in the Norway pout assessment different analyses have been made in relation to the benchmark assessment in 2004. This was done to investigate alternative standardization methods and alternative division of the commercial fishery assessment tuning fleet used in the assessment. The results of these analyses were presented to the working group and were discussed here.

Analysis of variance (GLM-analyses) of catch, effort and log transformed CPUE data on trip basis for the Danish commercial fishery for Norway pout during the period 1986 to 2004 showed statistical significant differences in catch rates between different GT-groups, years, quarters of years (seasons), and fishing areas, as well as statistical significant first order interaction effects between all of these variables. The detailed patterns in this variation are not clear and straight forward to conclude on.

It has not yet been possible to obtain disaggregated effort and catch data by area and vessel size (GT-group) from the Norwegian Norway pout fishery to perform similar analyses for the Norwegian fishery.

Also it is not possible to regenerate the historical time series (before 1996) of catch numbers at age in the commercial fishery tuning fleet by nation which is only available for the combined Danish and Norwegian commercial tuning fleet. The reason for this is partly that there is no documentation of historical allocation of biological samples (mean weight at age data) to catch data (catch in weight) in the tuning fleet in order to calculate catch number at age for the period previous to 1996 for both nations, and partly because it seems impossible to obtain historical biological data for Norway pout (previous to 1996) from Norway. Alternative division of the commercial fishery tuning fleet would, thus, need new allocation of biological data to catch data for both the Danish and Norwegian fleet, and result in a significantly shorter Norwegian commercial fishery tuning fleet time series, and a historically revised Danish commercial fishery tuning fleet with new allocation of biological data to catch data. Revision of the tuning fleet would, furthermore, need analyses of possible variation in biological mean weight at age data to be applied to different fleets, as well as of the background for and effect of this possible variation.

The conclusion of the discussion in the working group of these preliminary analysis results was that further analysis and exploration of data is necessary before suggesting an alternative standardization method and alternative division of commercial fishery tuning fleets to be used in the assessment.

Accordingly, the same method of effort standardization as in previous years was used in the 2004 benchmark assessment.

Danish effort data

Table 12.2.4 shows CPUE data by vessel size category and year for the Danish commercial fishery in ICES area IVa. The basis for these data is described in the stock quality handbook.

Norwegian effort data

Observed average GRT and effort for the Norwegian commercial fleets are given in **Table** 12.2.5.

Standardized effort data

The resulting combined and standardized Danish and Norwegian effort for the commercial fishery used in the assessment is presented in **Table** 12.2.6.

Commercial fishery standardized CPUE data

Combined CPUE indices by age and quarter for the commercial fishery tuning fleet are shown in **Table** 12.2.7. Trends in CPUE (normalized) by quarterly commercial tuning fleet and survey tuning fleet for each age group and all age groups together are shown in **Figure** 12.2.2.

Research vessel data

Survey indices series of abundance of Norway pout by age and quarter are for the assessment period available from the IBTS (International Bottom Trawl Survey 1. and 3. quarter) and the EGFS (English Ground Fish Survey, 3. quarter) and SGFS (Scottish Ground Fish Survey, 3. quarter), **Table** 12.2.8. Surveys covering the Norway pout stock are described in the quality control handbook. Survey data time series used in tuning of the Norway pout stock assessment are described below.

Revision of assessment tuning fleets in the 2004 benchmark assessment:

Revision of the Norway pout assessment tuning fleets during benchmark assessment have been based partly on cohorte analyses and analyses of correlations within and between the different tuning fleet indices by age group, as well as on the results from a row of exploratory assessment runs described under Section 12.3 which analyses the performance of the different tuning fleets in the assessment. The exploratory assessment runs also give indications of possible catchability patterns and trends in the fishery over time within the assessment period. The analyses of the tuning fleet indices are presented in **Figure**s 12.2.3-12.2.8 and **Table**s 12.2.9-12.2.12.

The revision of the tuning fleets used in the assessment is summarised in **Table** 12.3.1.

Commercial fishery tuning fleets:

In addition to the analyses of the commercial fishery assessment tuning fleet as described above (effort standardization) the quarterly CPUE indices of the commercial fishery tuning fleet were analyzed during the 2004 benchmark assessment:

1. The indices for the 0-group in 3rd quarter of the year have been excluded from the commercial fishery tuning fleet. The main argumentation for doing that is that this age group indicate clear patterns in trends in catchability over the assessment period as shown in the single fleet/quarter assessment runs in Section 12.3 (**Figure** 12.3.7). Secondly, there is no correlation between the commercial fishery quarter 3 0-group index and the commercial fishery quarter 4 0-group index, and no correlation between the quarter 3 commercial fishery

0-group index in a given year with the 1-group index of the 3rd quarter commercial fishery 1-group index the following year.

2. The 2nd quarter indices for all age groups of the 2nd quarter have been excluded from the commercial fishery tuning fleet. This is mainly because of indications of strong trends in catchability over time in the assessment period for this part of the tuning fleet for all age groups as indicated by single fleet tuning runs in the Section 12.3 (**Figure** 12.3.7). Also, the within quarter and between quarter correlation indices are in general relatively poor. The cohorte analyses of the 2nd quarter commercial fishery indices indicate as well relative changes over time.

Survey tuning fleets:

Survey index series of abundance of Norway pout by age and quarter are for the assessment period available from the IBTS (Q1 and Q3) and the EGFS (Q3) and the SGFS (Q3) as given in **Table** 12.2.8. The SGFS data from 1998 onwards should be used with caution due to new survey design (new vessel from 1998 and new gear and extended survey area from 1999). The 0-group indices from this survey have accordingly not been used in the assessment tuning fleet for this survey previous to the 2004 benchmark assessment. It can be seen that the index for the 0-group from SGFS changed with an order of magnitude in the years after the change in survey design compared to previous years (**Table** 12.2.8). The EGFS data from previous to 1992 should be used with caution as the survey design shifted in 1992. This change in survey design has so far been accounted for by simply multiplying all indices with a factor 3.5 for all age groups in the years previous to 1992 in order to standardize it to the later indices. The EGFS survey indices for Norway pout has been revised in the 2004 assessment compared to the previous years assessment for the 1996, 2001, 2002, and 2003 indices. In previous years assessment the full EGFS survey time series for all age groups have been included as an assessment tuning fleet. Time series for IBTS Q3 are only available from 1991 and onwards. The 3rd quarter IBTS and the EFGS and SGFS are not independent of each other as the two latter is a part of the first.

1. The IBTS Q3 for the period 1991-2003 has been included in the assessment. This survey has a broader coverage of the Norway pout distribution area compared to the EGFS and SGFS isolated. However, as this survey index is not available for the most recent year to be used in the seasonal assessment it has been chosen to exclude the 0- and 1-group indices from the IBTS Q3 in order to allow inclusion of the 0- and 1-group indices from the SGFS and EGFS which are available for the most recent year in the assessment. Accordingly, the IBTS Q3 tuning fleet for age 2 and age 3 has been included in the assessment as a new tuning fleet. The SXSA demands at least two age groups in order to run which is the reason for including both age 0 and age 1 under the EGFS and SGFS tuning fleets and not including age 1 in the IBTS Q3 tuning fleet.

2. The SGFS for age group 0 and 1 for the period 1998 and onwards has been used as tuning fleet in the assessment. The short time series is due to the change in survey design for SGFS as explained above. The quarter 3 0-group survey index for SGFS is back-shifted to the final season of the assessment in the terminal year, i.e. to quarter 2 of the assessment year in order to include the most recent 0-group estimate in the assessment.

3. The EGFS for age group 0 and 1 for the period 1992 and onwards has been used as tuning fleet in the assessment. The shorter time series is due to the change in survey design for EGFS as explained above. Furthermore, there is a good argument for excluding the age 2-3 of the EGFS as the within survey correlation between the age groups 1-2 and 2-3 is very poor while the within correlation between age groups 0-1 is good. The quarter 3 0-group survey index for EGFS is back-shifted to the final season of the assessment in the terminal year, i.e. to quarter 2 of the assessment year in order to include the most recent 0-group estimate in the assessment.

4. The IBTS Q1 tuning fleet has remained unchanged compared to previous years assessment.

12.3 Catch at Age Analyses

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 2004. The catch at age analysis was carried out according to the specifications in the stock quality control handbook. The tuning fleets have been changed in this years assessment in accordance with the description in Section 12.2.5. An overview of indices used in this year assessment is provided in **Table** 12.3.1. The parameter settings of the SXSA have remained unchanged, except that recruitment season to the fishery has been backshifted from 3rd quarter of the year to 2nd quarter of the year in order to gain benefit from the most recent 0-group indices from the 3rd quarter surveys (SGFS and EGFS as explained above) in the assessment (**Table** 12.3.2).

Results of the analysis are presented in **Table** 12.3.3 (population numbers at age, SSB and TSB), **Table** 12.3.4 (partial fishing mortalities by quarter of year), **Table** 12.3.5 (diagnostics from the SXSA), and **Figure** 12.3.1 (log N residuals), as well as **Table** 12.3.7 (stock summary). The stock summary is also shown in **Figure**s 12.3.2-3, and the historical performance of the assessment is shown in **Figure** 12.3.4.

The tuning fleet data is provided in **Table**s 12.2.7-12.2.8. Fishing mortality has generally been lower than natural mortality and has decreased in recent decade below the long term average (0.7). Fishing mortality for the 1st and 2nd quarter has decreased to insignificant levels in recent years (F less than 0.05), while fishing mortality for 4th quarter, that historically constitutes the main part of the annual F, has not decreased in recent 3-4 years (**Fig**ure. 12.5.1). The main fishery is usually in 3rd and 4th quarter of the year therefore giving only little indication of total fishing mortality in 2003 and 2004 in **Figure** 12.5.1.

Stock biomass (SSB) has since 2001 decreased continuously from about 240 thousand tons to 90 thousand tons in 1st quarter of 2003 which is below $\mathbf{B}_{pa}$ and about $\mathbf{B}_{lim}$. Retrospective plots of F, SSB and recruitment is shown in **Figure** 12.3.5.

Exploratory catch at age analyses.

A number of exploratory runs were carried out as part of the benchmark assessment in 2004 in order to evaluate performance of stock indices as tuning fleets and also to compare performance of the seasonal XSA (SXSA) to the 'conventional' XSA. The exploratory runs are briefly described below as an addition to the final run presented above.

In **Figure** 12.3.6 a comparison of the revised 2004 assessment with new tuning fleets compared to the 2003 assessment is shown. The estimates of the SSB, recruitment and the average fishing mortality of the 1- and 2-group are in general consistent with the estimates of previous years assessment. Only historical F seems to slightly deviate from previous years assessment.

<u>Catchability trends:</u>

Previously a number of indices, commercial as well as surveys, have been used as tuning fleets in the assessment of Norway pout. In addition to the inspection of the tuning fleets as described in Section 12.2.5, the SXSA was used to explore trends in catchability over the time series within the single tuning series. Running SXSA by default assumes a constant catchability over the time series used. Applying a cosine function option allows catchability to change gradually over years, and allows to examine whether the single stock index has changed its catchability over time. The exploratory runs were based on the 2003 assessment data, due to late compilation of 2004 data and in order to test on basis of an accepted assessment by ACFM. **Figure** 12.3.7 provides inverse catchabilities for ages 0 – 3 from single runs of all indices previously used in the assessment of Norway pout. For catchability of ages 2 and 3 (q of the oldest and the second oldest age group in catches is assumed equal) for the commercial fleet, the 2nd quarter index, obviously displays a decrease in q (inverse catchability) over time for all age groups. Also q for age 0 in 3rd quarter of the commercial tuning fleet changes through time. In the survey indices changes in q is relatively smaller and is only considered a problem for the EGFS 3rd quarter. For both EGFS and SGFS 3rd quarter new survey gears were introduced in the 1990'ies, which might have affected catchability (see Section 12.2.5).

<u>SXSA performance of single indices:</u>

SXSA runs with single fleet tuning indices were run for the previous used fleets (2003 assessment): commercial fleets 1st – 4th quarter, IBTS 1st quarter, EGFS 3rd quarter, and SGFS 3rd quarter, in order to explore performance of the SXSA in relation to each series. For the estimation of survivors the SXSA weight the tuning indices by the inverse variance similar to XSA. Historical development in SSB, recruitment at age 0 and F (ages 1-2) are given in **Figure** 12.3.8 for all single runs. Most single fleet runs results in a stock and fishery perception markedly different from the 2003 assessment, however, the historical trends in stock dynamics of SSB, R and F mortality being the same. Some indices, e.g. the IBTS 3rd quarter (early period) and 3rd quarter commercial fleet, did not behave properly in SXSA (SXSA was not able to estimate population numbers for some years). Among the survey indices, IBTS Q1 showed the highest variations in history, high SSB and recruitment in periods and the lowest F in the entire time series. Contrary to this, EGFS Q3 performs with lowest SSB and recruitment and highest F in time series. Among the commercial indices, only the 2nd quarter index did perform markedly different from the remaining series, with high SSB and low F in the entire time series. The 2003 point estimates of SSB and F is also given in the **Figure** 12.3.8, showing the high variation in the present perception of SSB and F. In summary, using only single fleet stock indices as tuning fleets will result in a higher SSB except from the commercial fleet index from 1st and 4th quarter of the year giving the same SSB and F range as in the accepted 2003 assessment. Thus, those two commercial fleets mainly drive the behaviour of the SXSA. Runs with different combinations of tuning fleets confirmed this.

<u>XSA performance on the 2003 assessment data:</u>

The Working Group has in the past discussed the appropriate assessment models to use, both for the sandeel stock and for the Norway pout stock, partly due to questions in the interpretation of the SXSA model compared to the XSA. Thus, the comparison of the two models as carried out here, cannot be considered a verification of the SXSA performance but rather an informatory, comparison analysis of the performance of both models. A comparison between the seasonal and annual assessment have been conducted in 1998 by this Working Group (ICES CM 1998:Assess:7). In order to compare runs, XSA were run without any F and P shrinkage, as SXSA operate without shrinkage. The annual F derived from the

SXSA in the output is generated as a sum of the quarterly F's. This is an approximation of annual F which results in incomparable F levels between the two models, but a comparable F history between them. SSB, F and recruitment from the XSA run are presented in **Figure** 12.3.9. The XSA single fleet runs shows less variation in SBB for 2003 than did the SXSA, but the same or a higher variation in F for 2002. The two methods apparently weight the stock indices different in their estimation of survivors (**Fig**ure. 12.3.10), the XSA putting approximately equal weight to each of the fleets, while the SXSA puts more weight to the commercial fleet indices. However, the overall performance of the two methods is similar, so the group decided to continue using SXSA. Both methods did overall not show insensible to the tuning fleet indices used in the assessment.

Effect of new proposed natural mortalities.

Investigations on revised mortality rates of Norway pout (see Quality handbook and Section 12.2) suggests that the natural mortality due to spawning is significant higher for the old age groups and lower for the small age groups than the suggested values of 0.4 per quarter for all ages. Thus, for the younger ages (0 and 1) quarterly values of 0.25 is estimated, while for ages 2 and 3, M is estimated to 0.75 and 0.95 (**Table** 12.2.3). Stock summary from an SXSA run using these new M values is given in **Figure** 12.3.11. Stock trends remain the same, but levels differ significantly. The group decided not to use the suggested higher M values in present assessment but to present this also this year as an exploratory assessment run in accordance with the decisions put forward in the 2001 and 2002 assessments.

Data exploration with SMS

SMS (see **Section** 1.4.3) was applied to the SXSA data set including catches for the period 1974-2003 and first half-year of 2004. The CPUE time series beginning in 1983 were updated up to second half of 2004.

The SMS diagnostic (**Table** 12.3.6) shows that the negative log likelihood per observation is similar for catch and CPUE observations. The best fit for CPUE observations is obtained for fleet "Commercial Q1" and "IBTS Q1". SMS estimate a selection pattern (Fa) for age 2 and age 3 twice the value for age 1. Such difference seems difficult to explain from mesh selection alone.

The lowest CV, 44%, for the catch at age observation is estimated for age 1, followed by a CV at 60% for age 2 (**Table** 12.3.6). The CV is more than 125% for the 0- and 3 group. The residual plots for catch observation (**Figure** 12.3.12.1) shows accordingly the smallest residuals for age 1 and 2.

For the CPUE observations, the lowest CV is estimated for the 1-group in the commercial fishery in the third and fourth quarter. CV on CPUE data from IBTS Q1 are relatively low for the age 1 and 2. The same can be concluded from the CPUE residual plots (**Figure** 12.3.12.2). For the EGFS Q3, the pattern of the residuals indicates a shift in catchability around 1992. The SGFS Q4 has a similar shift for the 0-group around 1997.

Average F (age 1 and 2) and SSB for the period 1974-2004 (first half –year) is shown in **Figure** 12.3.12.3. There is as pronounced downward trend in F for the whole period, with the lowest estimated F at 0.024 in the first half year of 2004. SSB has been more variable through the time period and the lowest SSB in the time series, 58.000 t, is estimated for 2004. The CV of SSB for the 6 last years is estimated to be around 15% (**Figure** 12.3.12.4). CV of average F shows a steep increase to 33% in the last year, which only include the first half-year.

The results presented below have been made without input data from the first half –year of 2004. Retrospective runs using all CPUE fleets show surprisingly s**Table** estimates of both F and SSB (**Figure** 12.3.12.5). When individual set of CPUE data is applied, F is more variable (**Figure** 12.3.12.6), but all fleets' CPUE data estimate the same trend in F. The most variable retrospective pattern is found for the fleets "Commercial Q2" and "ENGF Q3" supporting the (above explained) decisions in relation to selection of new tuning fleets as used in the 2004 benchmark assessment for the Norway pout stock. The time series length used for CPUE seems to have limited influence on the estimate of SSB and F (**Figure** 12.3.12.7). Estimated SSB in 2003 varies however, in the range of 50.000-100.000 t supporting the output levels from SXSA and XSA.

To summarize the explorative runs: Catch and CPUE data for the assessment of Norway pout are very noisy, but internally consistent. The assessment, using SMS, gave very similar results irrespective of the CPUE time series used. Four of the seven CPUE series are data from the commercial fishery and these data are already included in the catch data. Therefore, these commercial fleets will not give a signal very different from the catch data. None of the scientific surveys had a clear signal different form the signal in the catch data.

SMS uses the build in functionality in the AD-Model builder package to carry out Markov Chain Monte Carlo simulations (Gilks et al. 1996), MCMC, to estimate the posterior distributions of the parameters. An example is shown for average F and SSB in **Figure** 12.3.12.8, where the variance is estimated using MCMC with 500.000 chains thinned by a factor 500 resulting in 1000 uncorrelated chains. Uniform priors were used for all parameters except for the recruitment, for which the Ricker function was assumed. The 95% confidence limits of the historical estimate of F and SSB are quite wide, and the very wide confidence limit for the predicted SSB highligth, that forecasts for this short-lived species is very uncertain in the SMS. The models predict a SSB in 2005 is far below $\mathbf{B}_{\text{lim}}$.

12.4 Recruitment Estimates

The long-term average recruitment (age 0, 2nd quarter) is 87 billions (arithmetic mean) and 72 billions (geometric mean) for the period 1983-2003 (**Table** 12.3.7). Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species.

No strong year-classes have appeared since the 1999 year-class. Recruitment has been well below the long-term average since 2000, and the 2003 and 2004 year-classes are the lowest in the time series. Both surveys in 3rd quarter of 2004 (EGFS and SGFS) have the lowest recruitment indices for a number of years (**Table** 12.2.8).

12.5 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 2005 without assuming anything about the recruitment in 2005 or taking unknown recruitment into consideration. A management **Table** is presented with forecast F being equal to last year (2003), i.e. with very low level of fishing mortality (**Table** 12.5). This F-level is not expected to increase as the recent reduction in effort targeting Norway pout most probably is caused by by-catch restrictions in the Norway pout fishery which is not expected to change during the next years fishery. Mean catch weight at age are averaged over the last three years. The low successive year-classes in 2002, 2003 and 2004 leads to a SSB estimate at $\mathbf{B}_{\mathrm{lim}}$ at start of 2004 (start of 1st quarter of 2004), and far below $\mathbf{B}_{\mathrm{lim}}$ at the start of 2005 (1st of January). Fishing at F status quo in the second half of 2004 (Landings around 12000 t) would lead to SSB in 2005 at 50% of $\mathbf{B}_{\mathrm{lim}}$, while no fishing would still lead to SSB being only 60% of $\mathbf{B}_{\mathrm{lim}}$.

<u>Short term developments in the stock</u>:

Recruitment has been low since 2000 and recent 2004 3rd quarter survey indices also indicate low recruitment of 0-group Norway pout in 2004 (**Table** 12.3.5 and **Table** 12.2.8). Stock biomass (SSB) is just about $\mathbf{B}_{\mathrm{lim}}$ in 1st quarter of 2004 (**Table** 12.3.5). Fishing mortality has decreased in 2003 to the lowest level in the time series. The fishing mortality of the first half year in 2004 has been lowest in time series in the first half year.

12.6 Management considerations

State of the stock and the exploitation: Stock biomass (SSB) is on $\mathbf{B}_{\mathrm{lim}}$ and below $\mathbf{B}_{\mathrm{pa}}$ in the 1st quarter of 2004. Recruitment has been historically low in 2003 and 2004, and was also relatively low in 2001-2002. Fishing mortality has generally been lower than the natural mortality for this stock and has decreased in recent years well below the long term average F (0.7). Fishing mortality was historically low in 2003 and in the two first quarters of the year in 2004. Fishing effort has in general decreased in recent years reaching a historically minimum in 2001 and in 2003 and in the first part of the year 2004, but increased in 2002 to the level of that in 1999-2000.

A forecast is given for this stock for the first time in this report. Catch predictions for 0- and 1-groups are important as the fishery target the 0-group already in 3rd and (especially in) 4th quarter of the year as well as the 1-group in the 1st quarter of the following year. The SSB is in the first part of 2004 on $\mathbf{B}_{\mathrm{lim}}$, and the stock projection indicate that the stock 1st of January 2005 will be around half of $\mathbf{B}_{\mathrm{lim}}$ (45.000 t) with present low level of fishing mortality. The forecast is based on the 3rd quarter 2004 survey estimates of the 0-group Norway pout in 2004. Survey indices in the 3rd quarter seems to predict strong 0-group year classes relatively well when comparing with 0-group indices from commercial fishery (4th quarter) and to 1-group survey indices the following spring. The 0-group is recruited to the 4th quarter commercial fishery which tends to predict strong year classes well as 0-group. (**Table**s 12.2.8-12, and **Fig**ures. 12.2.2-8). The deterministic forecast is off course affected by that: (a) the potential catches are largely dependent on the size of a few year classes, (b) the large dependence on the strength of the recruiting 0-group year classes, and (c) added uncertainty (in assessment and potential forecast) arising from variations in natural mortality. However, the forecast is not dependent on any assumption about the strength of the new year classes (2005 recruitment).

The population dynamics of Norway pout in the North Sea and Skagerrak are very dependent on changes caused by recruitment variation and variation in predation (or other natural) mortality, and less by the fishery. Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species. The forecasts indicate that total closure of fishery (i.e. F=0) will result in that the stock in the start of 2005 will still be below $\mathbf{B}_{\mathrm{lim}}$. The fishery targets both Norway pout and blue whiting. In managing this fishery, by-catches of haddock, whiting, herring, and blue whiting should be taken into account and existing measures to protect these by-catch species should be maintained.

<u>The assessment in relation to potential real time monitoring and management of the stock</u>:

ACFM has proposed that it may be more appropriate to formulate reference points based on total mortality, recruitment and stock biomass for use within management procedures using surveys and real time monitoring of catches. In that respect it has been questioned whether the 0-group is fully recruited to the 3rd quarter surveys in relation to forecast based on surveys alone. The assessment is considered appropriate to indicate trends in the stock and immediate changes in the stock because of the seasonal assessment taking into account the seasonality in fishery and using most recent information about recruitment. In real time monitoring of this stock it should be noted that both the 3rd quarter IBTS and the 4th quarter commercial fishery index seems in general for all ages in the stock to be relatively good indicators of the year class strengths and the size of the stock (**Table** 12.2.12, as well as **Table**s. 12.2.8-11, and **Fig**ures. 12.2.2-8).

12.7 Comments on the assessment and needs for future studies

It appears from the quality control diagrams made from the results of the assessment (**Figure** 12.3.4) as well as from **Figure** 12.3.6 with a comparison of the 2003 and 2004 assessment that the estimates of the SSB, recruitment and the average fishing mortality of the 1- and 2-group are consistent with the estimates of previous years assessment. Only historical F seems to slightly deviate from previous years assessment. Consequently, the revised assessment using new tuning fleets does not introduce a new perception of the stock, as well as of the stock dynamics in and development of the stock.

Potential workplan and suggestions for investigations in near future:

1. Further analysis and exploration of catch, effort and catch rate data of the commercial fishery is necessary before suggesting an alternative standardization method and alternative division of commercial fishery tuning fleets to be used in the assessment. This could include further investigation of disaggregation of Danish and Norwegian commercial tuning fleet time series taking into consideration their spatial behaviour.

2. Investigate further the potential for real time monitoring of the stock only based on catch rates indices from surveys and from commercial fishery on quarterly basis. It should among other be investigated whether these time series can estimate total mortality (slope of catch curve) and from this estimate both natural mortality and fishing mortality over years. This also include possible further exploration of whether it is more appropriate to formulate reference points based on total stock biomass (TSB) based on estimates of total mortality from surveys for use within management of this stock.

3. Evaluation of the Norway pout in Division VIa. ACFM (October 2001) asked the Working Group to verify the justification of treating Division VIa as a management area for Norway pout and sandeel separately from ICES area IV and IIIa. Preliminary results from an analysis of regionalized survey data on Norway pout maturity, presented in a Working Document to the 2000 meeting of the Working Group (*Larsen, Lassen, Nielsen and Sparholt,2001* in ICES C.M.2001/ACFM:07), gave no evidence for a stock separation in the whole northern area. However, this has to be explored further.

   Evaluation of availability of data necessary for performing assessment of the VIa stock should be performed.

12.8 Norway Pout in Division VIa

12.8.1 Catch trends and assessment

Landings of Norway pout from Division VIa as reported to ICES are given in **Table** 12.8.1 and **Figure** 12.8.1. Reported landings in 2003 were 6,400 t. This level of landings is well below the series average of nearly 11,000 t (1974-2003). No data are available on by-catches in this fishery. Since no age compositions are available, data are insufficient for an assessment of this stock.

12.8.2 Stock identity

ACFM (October 2001) asked the Working Group to verify the justification of treating Division VIa as a management area for Norway pout and sandeel separately from ICES area IV and IIIa. Preliminary results from an analysis of regionalized survey data on Norway pout maturity, presented in a Working Document to the 2000 meeting of the Working Group (*Larsen, Lassen, Nielsen and Sparholt,2001* in ICES C.M.2001/ACFM:07), gave no evidence for a stock separation in the whole northern area.

The WG considers that the extent of the data that is available on VIa Norway pout should be assessed before the discussion on the merging of the VIa stock with the North Sea stock is finalized.

Table 12.1.1 **NORWAY POUT nominal landings (tonnes) from the North Sea and Skagerrak / Kattegat, ICES areas IV and IIIa in the period 1997-2003, as officially reported to ICES.**

Norway pout ICES area IIIa

Country	1997	1998	1999	2000	2001	2002	2003
Denmark	34,746	11,080	7,194	14,545	13,619	3,780	4,235
Norway	-	-	-	-	- *	96 *	30 *
Sweden	2	-	-	133	780	-	-
Total	34,748	11,080	7,194	14,678	14,399	3,876	4,265

*Preliminary.

Norway pout ICES area IVa

Country	1997	1998	1999	2000	2001	2002	2003
Denmark	106,958	42,154	39,319	133,149	44,818	68,858	12,223
Faroe Islands	7,033	4,707	2,534				
Netherlands	35	-	-	-	-	-	-
Norway	39,006	22,213	44,841	48,061	17,158 *	23,657 *	11,357
Sweden	+	-	-	-	-	-	-
Total	153,032	69,074	86,694				

*Preliminary.

Norway pout ICES area IVb

Country	1997	1998	1999	2000	2001	2002	2003
Denmark	1,794	3,258	5,299	158	632	556	191
Germany	-	-	-	2	-	-	-
Netherlands	50	2	-	3	-	-	-
Norway	-	57	-	34	- *	- *	- *
UK (E/W/NI)	-	-	-	+	-	+	-
UK (Scotland)	+	-	-	-	-	-	-
Total	1,844	3,317	5,299	197	632	556	191

*Preliminary.

Norway pout ICES area IVc

Country	1997	1998	1999	2000	2001	2002	2003
Denmark	-	-	514	182	304	-	-
Netherlands	-	-	+	-	-	-	-
UK (E/W/NI)	-	-	-	-	+	-	-
Total	-	-	514	182	304	-	-

*Preliminary.

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

Country	1997	1998	1999	2000	2001	2002	2003
Denmark	143,498	56,492	51,812	147,852	59,069	73,194	16,649
Faroe Islands	7,033	4,707	2,534	0	0	0	0
Norway	39,006	22,270	44,841	48,095	17,158	23,753	11,387
Sweden	2	0	0	133	780	0	0
Netherlands	85	2	0	3	0	0	0
Germany	0	0	0	2	0	0	0
UK	0	0	0	0	0	0	0
Total nominal landings	189,624	83,471	99,187	196,085	77,007	96,947	28,036
By-catch of other species and other	-19,924	-3,671	-7,187	-11,685	-11,407	-20,247	-3,136
WG estimate of total landings (IV+IIIaN)	169700	79800	92000	184400	65600	76700	24900
Agreed TAC	220000	220000	220000	220000	220000	220000	220000

* provisional
** provisional
+ Landings less than 1
n/a not available

Table 12.1.2 **NORWAY POUT annual landings ('000 t) in the North Sea and Skagerrak (not incl. Kattegat, IIIaS) by country, for 1961-2003 (Data provided by Working Group members). (Norwegian landing data include landings of by-catch of other species).**

Year	Denmark		Faroes	Norway	Sweden	UK (Scotland)	Others	Total
	North Sea	Skagerrak						
1961	20.5	-	-	8.1	-	-	-	28.6
1962	121.8	-	-	27.9	-	-	-	149.7
1963	67.4	-	-	70.4	-	-	-	137.8
1964	10.4	-	-	51	-	-	-	61.4
1965	8.2	-	-	35	-	-	-	43.2
1966	35.2	-	-	17.8	-	-	+	53.0
1967	169.6	-	-	12.9	-	-	+	182.5
1968	410.8	-	-	40.9	-	-	+	451.7
1969	52.5	-	19.6	41.4	-	-	+	113.5
1970	142.1	-	32	63.5	-	0.2	0.2	238.0
1971	178.5	-	47.2	79.3	-	0.1	0.2	305.3
1972	259.6	-	56.8	120.5	6.8	0.9	0.2	444.8
1973	215.2	-	51.2	63	2.9	13	0.6	345.9
1974	464.5	-	85	154.2	2.1	26.7	3.3	735.8
1975	251.2	-	63.6	218.9	2.3	22.7	1	559.7
1976	244.9	-	64.6	108.9	+	17.3	1.7	437.4
1977	232.2	-	50.9	98.3	2.9	4.6	1	389.9
1978	163.4	-	19.7	80.8	0.7	5.5	-	270.1
1979	219.9	9	21.9	75.4	-	3	-	329.2
1980	366.2	11.6	34.1	70.2	-	0.6	-	482.7
1981	167.5	2.8	16.6	51.6	-	+	-	238.5
1982	256.3	35.6	15.4	88	-	-	-	395.3
1983	301.1	28.5	24.5	97.3	-	+	-	451.4
1984	251.9	38.1	19.11	83.8	-	0.1	-	393.0
1985	163.7	8.6	9.9	22.8	-	0.1	-	205.1
1986	146.3	4	6.6	21.5	-	-	-	178.4
1987	108.3	2.1	4.8	34.1	-	-	-	149.3
1988	79	7.9	1.5	21.1	-	-	-	109.5
1989	95.7	4.2	0.8	65.3	+	0.1	0.3	166.4
1990	61.5	23.8	0.9	77.1	+	-	-	163.3
1991	85	32	1.3	68.3	+	-	+	186.6
1992	146.9	41.7	2.6	105.5	+	-	0.1	296.8
1993	97.3	6.7	2.4	76.7	-	-	+	183.1
1994	97.9	6.3	3.6	74.2	-	-	+	182.0
1995	138.1	46.4	8.9	43.1	0.1	+	0.2	236.8
1996	74.3	33.8	7.6	47.8	0.2	0.1	+	163.8
1997	94.2	29.3	7	39.1	+	+	0.1	169.7
1998	39.8	13.2	4.7	22,1	-	-	+	79.8
1999	41	6.8	-	44.2	+	-	-	92.0
2000	127	9.3	-	48	0.1	-	+	184.4
2001	40.6	7.5	-	16.8	0.7	+	+	65.6
2002	50.2	2.8	-	23.6	-	-	-	76.7
2003	9.9	3.4	-	11.4	-	-	-	24.9

Table 12.1.3 **NORWAY POUT, North Sea and Skagerak. National landings (t) by quarter of year 1992-2004.**
(Data provided by Working Group members. Norwegian landing data include landings of by-catch of other species).

Year	Quarter	Denmark									Norway		Total
	Area	IIIaN	IIIaS	Div. IIIa	IVaE	IVaW	IVb	IVc	Div. IV	Div. IV + IIIaN	IVaE	Div. IV	Div. IV + IIIaN
1992	1	2,330	619	2,950	29,701	8,862	1,096	-	39,659	41,989			
	2	9,235	1,684	10,919	1,610	264	1,529	-	3,403	12,638			
	3	22,586	817	23,402	9,908	34,053	6,465	-	50,426	73,012			
	4	7,561	263	7,824	4,102	47,704	1,630	2	53,439	61,000			
	Total	41,713	3,383	45,095	45,321	90,883	10,720	2	146,926	188,639			
1993	1	319	30	350	16,471	6,581	151	-	23,203	23,522			
	2	1,052	77	1,129	594	102	802	-	1,498	2,550			
	3	3,629	531	4,161	7,461	25,072	409	-	32,941	36,570			
	4	1,728	406	2,133	10,685	28,994	9	-	39,688	41,416			
	Total	6,729	1,044	7,773	35,210	60,748	1,371	-	97,330	104,058			
1994	1	568	75	643	18,660	3,588	533	-	22,781	23,350			
	2	4	0	4	511	170	-	-	681	685			
	3	2,137	74	2,211	5,674	12,604	493	-	18,772	20,908			
	4	3,623	116	3,739	5,597	49,935	91	-	55,622	59,246			
	Total	6,332	265	6,598	30,442	66,298	1,117	-	97,857	104,189			
1995	1	576	9	585	19,421	1,336	7	-	20,764	21,339	15521	15521	36,860
	2	10,495	290	10,793	2,841	30	3,670	-	6,540	17,035	10639	10639	27,674
	3	20,563	976	21,540	13,316	17,681	11,445	-	42,442	63,004	5790	5790	68,794
	4	14,748	2,681	17,430	10,812	56,159	1,426	-	68,396	83,145	11131	11131	94,276
	Total	46,382	3,956	50,347	46,390	75,205	16,547	-	138,142	184,524	43,081	43081	227,605
1996	1	1,231	164	1,395	6,133	3,149	658	2	9,943	11,174	10604	10604	21,778
	2	7,323	970	8,293	1,018	452	1,476	-	2,946	10,269	4281	4281	14,550
	3	20,176	836	21,012	7,119	17,553	1,517	-	26,188	46,364	27466	27466	73,830
	4	5,028	500	5,528	9,640	25,498	42	-	35,180	40,208	5466	5466	45,674
	Total	33,758	2,470	36,228	23,910	46,652	3,692	2	74,257	108,015	47,817	47817	155,832
1997	1	2,707	460	3,167	6,203	2,219	7	-	8,429	11,137	4183	4183	15,320
	2	5,656	200	5,857	141	-	45		185	5,842	8466	8466	14,308
	3	16,432	649	17,081	19,054	21,024	740	-	40,818	57,250	21546	21546	78,796
	4	4,464	1,042	5,505	6,555	38,202	7		44,765	49,228	4884	4884	54,112
	Total	29,259	2,351	31,610	31,953	61,445	799	-	94,197	123,456	39,079	39079	162,535
1998	1	1,117	317	1,434	7,111	2,292	-	-	9,403	10,520	8913	8913	19,433
	2	3,881	103	3,984	131	5	124	-	259	4,140	7885	7885	12,025
	3	6,011	406	6,417	7,161	1,763	2,372	-	11,297	17,308	3559	3559	20,867
	4	2,161	677	2,838	1,051	17,752	77	-	18,880	21,041	1778	1778	22,819
	Total	13,171	1,503	14,673	15,454	21,811	2,573	-	39,838	53,009	22,135	22135	75,144
1999	1	4	12	15	2,769	1,246	1	-	4,016	4,020	3021	3021	7,041
	2	1,568	36	1,605	953	361	418	-	1,731	3,300	10321	10321	13,621
	3	3,094	109	3,203	7,500	3,710	2,584	-	13,794	16,887	24449	24449	41,336
	4	2,156	517	2,673	3,577	16,921	928	1	21,426	23,583	6385	6385	29,968
	Total	6,822	674	7,496	14,799	22,237	3,931	1	40,968	47,790	44,176	44176	91,966
2000	1	0	11	12	3,726	1,038	-	-	4,764	4,765	5440	5440	10,205
	2	929	15	944	684	22	227	-	933	1,862	9779	9779	11,641
	3	7,380	139	7,519	1,708	5,613	515	-	7,836	15,216	28428	28428	43,644
	4	947	209	1,157	1,656	111,732	76	-	113,464	114,411	4334	4334	118,745
	Total	9,257	375	9,631	7,774	118,406	818	-	126,998	136,255	47,981	47981	184,236
2001	1			302	7,341	9,734	103	72	17,250	17,250	3838	3838	21,088
	2			2,174	31	30	269	-	330	330	9268	9268	9,598
	3			2,006	15	154	191	-	360	360	2263	2263	2,623
	4			3,059	2,553	19,826	329	-	22,708	22,708	1426	1426	24,134
	Total			7,541	9,940	29,744	892	72	40,648	40,648	16,795	16795	57,443
2002	1	-	1	1	4,869	1,660	114	-	6,643	6,643	1896	1896	8,539
	2	883	161	1,045	56	9	22	-	87	970	5563	5563	6,533
	3	1,567	213	1,778	2,234	14,739	104	-	17,077	18,644	14147	14147	32,791
	4	393	100	492	1,787	24,273	335	-	26,395	26,788	2033	2033	28,821
	Total	2,843	475	3,316	8,946	40,681	575	-	50,202	53,045	23,639	23639	76,684
2003	1	-	1	1	615	581	22	-	1,218	1,218	1977	1977	3,195
	2	246	160	406	76	-	22	-	98	344	2773	2773	3,117
	3	2,984	1,005	3,989	172	1,613	89	-	1,874	4,858	5989	5989	10,847
	4	188	547	735	0	6270	457	-	6,727	6,915	644	644	7,559
	Total	3,418	1,713	5,131	863	8,464	590	-	9,917	13,335	11,383	11,383	24,718
2004	1	187	-	187	87	650	0	-	737	924	990	990	1,914
	2	0	-	-	0	0	7	-	7	7	660	660	667

Table 12.2.1 **NORWAY POUT in the North Sea and Skagerrak. Catch in numbers at age by quarter (millions). SOP is given in tons. Data for 1990 were estimated within the SXSA program used in the 1996 assessment.**

Age	Year	1984				1985				1986			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	1	2231	0	0	6	678	0	0	0	5572
1		2,759	2252	5290	3492	2,264	857	1400	2991	396	260	1186	1791
2		1,375	1165	1683	734	1,364	145	793	174	1,069	87	245	39
3		143	269	8	0	192	13	19	0	72	3	6	0
4+		0	0	0	0	1	0	0	0	3	0	0	0
SOP		56790	56532	152291	110942	57464	15509	62489	92017	37889	7657	45085	89993
Age	Year	1987				1988				1989			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	8	227	0	0	741	3146	0	0	151	4854
1		2687	1075	1627	2151	249	95	183	632	1736	678	1672	1741
2		401	60	171	233	700	73	250	405	48	133	266	93
3		12	0	0	5	20	0	0	0	6	6	5	13
4+		1	0	0	0	0	0	0	0	0	0	0	0
SOP		33894	15435	38729	60847	22181	3559	21793	61762	15379	13234	55066	82880
Age	Year	1990				1991				1992			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	20	993	0	0	734	3486	0	0	879	954
1		1840	1780	971	1181	1501	636	1519	1048	3556	1522	3457	2784
2		584	572	185	116	1336	404	215	187	1086	293	389	267
3		20	19	6	4	93	19	22	18	118	20	1	2
4+		10	0	0	0	6	0	0	0	3	0	0	0
SOP		28287	39713	26156	45242	42776	20786	62518	64380	64224	27973	114122	96177
Age	Year	1993				1994				1995			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	96	1175	0	0	647	4238	0	0	700	1692
1		1942	813	1147	1050	1975	372	1029	1148	3992	1905	2545	3348
2		699	473	912	445	591	285	421	134	240	256	47	59
3		15	58	19	2	56	29	71	0	6	32	3	3
4+		0	0	0	0	0	0	0	0	0	0	0	0
SOP		36206	29291	62290	53470	34575	15373	53799	79838	36942	28019	69763	97048
Age	Year	1996				1997				1998			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	724	2517	0	0	109	343	0	0	94	339
1		535	560	1043	650	672	99	3090	1922	261	210	411	531
2		772	201	1002	333	325	131	372	207	690	310	332	215
3		14	38	37	0	79	119	105	35	47	18	2	13
4+		0	0	0	0	0	0	0	0	8	24	0	0
SOP		21888	13366	74631	46194	15320	8708	78809	54100	19562	12026	20866	22830
Age	Year	1999				2000				2001			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	41	1127	0	0	73	302	0	0	32	368
1		202	318	1298	576	653	280	1368	4616	220	133	122	267
2		128	220	338	160	185	207	266	245	845	246	27	439
3		73	93	35	23	3	48	20	6	35	100	1	1
4+		1	0	0	0	0	0	0	0	0	0	0	0
SOP		7833	12535	41445	30497	10207	11589	44173	119001	21400	11778	4630	26565
Age	Year	2002				2003				2004			
	Quarter	1	2	3	4	1	2	3	4	1	2		
0		0	0	340	290	0	0	18	1	0	0		
1		485	351	621	473	57	64	223	54	10	4		
2		148	24	284	347	76	49	87	161	52	16		
3		17	5	24	26	22	25	7	32	9	6		
4+		0	0	0	0	0	0	0	0	0	0		
SOP		8553	6686	32922	28947	3190	3106	11613	7460	1934	667		

Table 12.2.2 **NORWAY POUT in the North Sea and Skagerrak. Mean weights (grams) at age in catch, by quarter 1983-2004, from Danish and Norwegian catches combined. Data for 1974 to 1982 are assumed to be the same as in 1983.**

Year	1983				1984				1985			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			4.00	6.00			6.54	6.54			8.37	6.23
1	7.00	15.00	25.00	23.00	6.55	8.97	17.83	20.22	7.86	12.56	23.10	26.97
2	22.00	34.00	43.00	42.00	24.04	22.66	34.28	35.07	22.7	28.81	36.52	40.90
3	40.00	50.00	60.00	58.00	39.54	37.00	34.10	46.23	45.26	43.38	58.99	
4									41.80			
Year	1986				1987				1988			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0				7.20			5.80	7.40			9.42	7.91
1	6.69	14.49	28.81	26.90	8.13	12.59	20.16	23.36	9.23	11.61	26.54	30.60
2	29.74	42.92	43.39	44.00	28.26	31.51	34.53	37.32	27.31	33.26	39.82	43.31
3	44.08	55.39	47.60		52.93			46.60	38.38			
4	82.51				63.09				69.48			
Year	1989				1990				1991			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			7.48	6.69			6.40	6.67			6.06	6.64
1	7.98	13.49	26.58	26.76	6.51	13.75	20.29	28.70	7.85	12.95	30.95	30.65
2	26.74	28.70	35.44	34.70	25.47	25.30	32.92	38.90	20.54	28.75	44.28	43.10
3	39.95	44.39		46.50	37.72	40.35	39.40	52.94	35.43	49.87	67.25	59.37
4					68.00				44.30			
Year	1992				1993				1994			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0		8.00	6.70	8.14			4.40	8.14			5.40	8.81
1	8.78	11.71	26.52	27.49	9.32	14.76	25.03	26.24	8.56	15.22	29.26	31.23
2	25.73	31.25	42.42	44.14	24.94	30.58	35.19	36.44	25.91	29.27	38.91	49.59
3	41.80	49.49	50.00	50.30	46.50	48.73	55.40	70.80	42.09	46.88	53.95	
4	43.90											
Year	1995				1996				1997			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			5.01	7.19			3.88	5.95			3.61	10.18
1	7.70	10.99	25.37	24.6	8.95	12.06	27.81	28.09	7.01	11.69	20.14	22.11
2	24.69	22.95	33.40	39.57	21.47	25.72	40.90	38.81	23.11	26.40	31.13	32.69
3	50.78	37.69	45.56	57.00	37.58	37.94	50.44	56.00	39.11	34.47	44.03	38.62
4												
Year	1998				1999				2000			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			4.82	8.32			2.84	7.56			7.21	13.86
1	8.76	12.55	23.82	24.33	8.98	12.40	22.16	25.60	10.05	15.65	23.76	22.98
2	22.16	25.27	31.73	30.93	25.84	24.15	32.66	37.74	19.21	25.14	38.90	34.48
3	34.84	32.18	44.92	33.24	36.66	35.24	43.98	51.63	32.10	41.30	39.61	50.04
4	42.40	40.00			46.57	46.57						
Year	2001				2002				2003			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			6.34	7.90			7.28	7.20			10.02	9.79
1	8.34	16.79	27.00	30.01	8.59	16.40	27.13	27.47	11.58	13.13	29.79	15.98
2	21.50	23.57	39.54	35.51	25.98	30.39	43.37	36.87	22.85	26.19	42.00	31.87
3	39.84	37.63	54.20	55.70	32.30	40.10	54.11	41.28	34.96	39.89	48.01	45.79
4												
Year	2004											
Quarter of year	1	2										
Age 0												
1	11.97	14.65										
2	27.90	26.24										
3	41.36	34.80										
4												

Table 12.2.3 **NORWAY POUT. Mean weight at age in the stock, proportion mature and natural mortality used in the assessment as well as revised natural mortality used in the exploratory assessment run.**

Age	Weight (g)				Proportion mature	M (quarterly)	Revised M (quarterly)
	Q1	Q2	Q3	Q4			(Exploratory run)
0	-	-	4	6	0	0.4	0.25
1	7	15	25	23	0.1	0.4	0.25
2	22	34	43	42	1	0.4	0.55
3	40	50	60	58	1	0.4	0.75

Table 12.2.4 **NORWAY POUT. Danish CPUE data (tonnes / fishing day) and fishing activities by vessel category for 1988-2003. Non-standardized CPUE-data for the Danish part of the commercial tuning fleet. (Logbook information).**

Vessel GRT	1988	1989	1990	1991	1992	1993	1994	1995
51-100	20.27	14.58	10.03	12.56	31.75	31	24.8	29.53
101-150	18.83	19.59	17.38	24.14	26.42	23.72	26.76	38.96
151-200	22.71	23.17	25.6	28.22	34.2	27.36	31.52	34.73
201-250	30.44	26.1	24.87	29.74	36	27.76	40.59	39.34
251-300	23.29	26.14	21.3	28.15	31.9	32.05	36.98	38.84
301-	38.81	28.58	24.96	36.48	42.6	34.89	44.91	57.9

Vessel GRT	1996	1997	1998	1999	2000	2001	2002	2003
51-100	-	20	-	-	-	-	-	-
101-150	20.48	22.68	-	-	-	-	-	-
151-200	22.05	27.45	16.85	12.43	29.13	-	20.45	-
201-250	24.96	30.59	19.68	26.69	48.55	25.35	17.09	12.94
251-300	31.43	32.55	17.48	23.98	45.92	20.02	21.73	10.8
301-	39.14	43.01	32.32	31	64.33	52.95	46.36	30.86

Table 12.2.5 **NORWAY POUT. Effort in days fishing and average GRT of Norwegian vessels fishing for Norway pout by quarter, 1983-2004.**

	Quarter 1		Quarter 2		Quarter 3		Quarter 4	
Year	Effort	Aver. GRT	Effort	Aver. GRT	Effort	Aver. GRT	Effort	Aver. GRT
1983	293	167.6	1168	168.4	2039	159.9	552	171.7
1984	509	178.5	1442	141.6	1576	161.2	315	212.4
1985	363	166.9	417	169.1	230	202.8	250	221.4
1986	429	184.3	598	148.2	195	197.4	222	226.0
1987	412	199.3	555	170.5	208	158.4	334	196.3
1988	296	216.4	152	146.5	73	191.1	590	202.9
1989	132	228.5	586	113.5	1054	192.1	1687	178.7
1990	369	211.0	2022	171.7	1102	193.9	1143	187.6
1991	774	196.1	820	180.0	1013	179.4	836	187.7
1992	847	206.3	352	181.3	1030	202.2	1133	199.8
1993	475	227.5	1045	206.6	1129	217.8	501	219.8
1994	436	226.5	450	223.5	1302	212.0	686	211.4
1995	545	223.6	237	233.8	155	221.7	297	218.1
1996	456	213.6	136	219.9	547	208.3	132	207.2
1997	132	202.4	193	218.9	601	194.8	218	182.3
1998	497	192.6	272	213.6	263	176.8	203	193.8
1999	267	173.0	735	180.1	1165	187.4	229	166.9
2000	294	197.1	348	180.7	929	205.3	196	219.3
2001	252	203.4	297	192.9	130	165.0	65	219.4
2002	90	208.6	246	189.1	1022	211.7	205	182.2
2003	162	219.1	320	215.3	550	252.8	75	208.4
2004	94	214.6	85	196.7				

Table 12.2.6 NORWAY POUT. Combined Danish and Norwegian fishing effort (standardised) to be used in the assessment.

	Quarter 1			Quarter 2			Quarter 3			Quarter 4			Year total		
Year	Norway	Denmark	Total	Norway	Denmark	Total	Norway	Denmark	Total	Norway	Denmark	Total	Norway	Denmark	Total
1987	441	1127	1568	547	31	578	197	1194	1391	355	1637	1992	1540	3989	5529
1988	315	883	1198	144	13	156	75	417	492	617	1894	2511	1150	3207	4357
1989	146	777	923	485	195	680	1093	1749	2841	1701	2284	3985	3424	5004	8428
1990	406	991	1397	2002	87	2089	1162	463	1625	1185	1653	2838	4754	3195	7949
1991	824	1319	2143	833	33	866	1027	484	1512	869	1724	2593	3553	3561	7113
1992	866	2092	2958	354	17	371	1051	1530	2581	1154	1242	2396	3424	4881	8306
1993	483	1234	1717	1056	37	1094	1145	1560	2705	508	1671	2179	3193	4502	7695
1994	464	1265	1728	477	74	551	1364	617	1981	718	1227	1945	3023	3183	6205
1995	578	809	1387	254	99	353	164	853	1017	313	1487	1800	1309	3248	4557
1996	478	579	1057	144	185	328	571	760	1330	138	1240	1378	1330	2763	4093
1997	137	394	531	204	17	220	617	1244	1861	220	1121	1341	1178	2775	3953
1998	509	446	955	285	34	319	264	562	825	208	457	665	1266	1498	2764
1999	266	305	571	740	56	796	1185	387	1572	226	733	959	2418	1481	3898
2000	303	303	606	351	75	426	966	221	1186	207	1903	2110	1826	2501	4327
2001	261	441	702	304	15	319	128	48	176	69	541	610	762	1045	1807
2002	94	388	481	251	21	272	1070	676	1746	207	551	758	1622	1636	3258
2003	171	212	383	336	15	352	600	79	679	78	101	179	1185	407	1593
2004	99	147	246	87	34	122									

Table 12.2.7 NORWAY POUT. CPUE indices (´000s per fishing day) by age and quarter from Danish and Norwegian commercial fishery (CF) in the North Sea (Area IV, commercial tuning fleet).

Year	CF, 1st quarter				CF, 2nd quarter				CF, 3rd quarter				CF, 4th quarter			
	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group
1982	.	2144.5	169.0	87.9	.	1705.7	144.3	12.1	30.3	1320.2	86.5	12.4	368.4	1050.5	16.0	0.0
1983	.	1524.2	470.0	5.4	.	1044.9	706.5	5.5	74.3	969.6	262.0	2.8	604.9	972.9	85.9	1.7
1984	.	1137.9	566.8	59.1	.	1518.0	784.9	181.1	0.2	990.2	314.9	1.5	462.0	723.1	152.1	0.0
1985	.	877.1	528.2	74.3	.	1310.5	221.5	20.3	2.6	599.0	339.0	8.3	183.6	809.5	47.2	0.0
1986	.	108.5	292.9	19.8	.	267.9	89.3	3.0	0.0	531.1	109.7	2.7	892.9	277.1	5.9	0.0
1987	.	1699.6	253.8	7.7	.	1856.4	103.8	0.0	5.8	1139.5	118.6	0.0	110.9	1073.3	115.5	2.5
1988	.	205.2	583.1	16.4	.	525.6	457.7	0.0	48.2	372.4	508.9	0.0	1173.6	251.6	161.3	0.0
1989	.	1860.8	52.1	7.6	.	1019.8	214.9	9.6	2.4	386.0	69.6	0.0	1184.7	488.1	22.6	3.2
1990	.	1063.6	450.8	25.7	.	865.0	258.2	14.7	9.5	571.0	126.6	7.2	444.1	394.5	39.7	2.3
1991	.	692.9	623.0	43.3	.	484.3	458.2	22.0	50.2	668.2	44.0	1.0	1005.4	397.3	71.5	6.6
1992	.	1129.0	360.7	39.6	.	2686.5	619.9	53.4	13.0	1010.4	144.0	0.4	190.3	1103.2	105.9	1.0
1993	.	1121.0	403.3	7.9	.	689.2	431.6	52.7	3.9	384.4	328.5	6.9	426.5	474.2	203.0	0.8
1994	.	1100.8	340.9	32.6	.	675.7	517.0	52.4	93.9	519.3	203.1	35.6	1950.6	590.1	68.9	0.0
1995	.	2846.0	171.0	4.0	.	3179.5	726.3	90.1	117.6	1860.5	38.5	2.9	198.3	1701.8	32.9	1.7
1996	.	365.0	730.6	13.2	.	121.1	408.5	115.7	121.8	346.2	714.4	27.4	1063.4	472.0	241.7	0.2
1997	.	988.8	479.3	146.6	.	435.0	593.0	540.5	1.9	1254.0	154.0	56.4	75.0	1344.0	152.5	25.8
1998	.	149.9	722.7	49.3	.	182.8	756.7	54.8	31.0	319.1	349.7	1.1	232.4	773.4	322.0	20.0
1999	.	351.0	224.6	128.0	.	280.3	230.0	116.8	0.0	725.5	213.5	21.9	1084.5	515.2	166.6	24.1
2000	.	1077.6	304.8	4.5	.	575.3	426.9	113.6	20.0	894.8	206.9	17.2	121.9	2174.1	114.5	2.8
2001	.	300.3	1196.9	50.0	.	216.0	662.1	312.0	30.5	369.2	142.7	6.3	557.3	321.6	718.4	1.5
2002	.	1008.8	307.7	34.7	.	1139.9	58.9	18.0	194.2	321.0	157.7	13.5	382.7	601.2	454.3	34.8
2003	.	153.2	199.6	57.0	.	165.9	134.6	70.3	20.2	220.9	106.0	11.0	3.9	276.4	893.3	178.2
2004	.	23.0	190.9	36.0	.	28.9	131.5	45.9								

Table 12.2.8 NORWAY POUT. Research vessel indices (CPUE in catch in number per trawl hour) of abundance for Norway pout.

Year	IBTS/IYFS[1] February			EGFS[2,3] August				SGFS[4] August				IBTS 3[rd] 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	2,331	663	9	6,067	1,558	114	0.4	13	490	91	1	-	-	-	-
1984	3,925	802	58	457	3,605	359	14	2	615	69	9	-	-	-	-
1985	2,109	1,423	71	362	1,201	307	0	5	636	173	5	-	-	-	-
1986	2,043	384	23	285	717	150	80	38	389	54	9	-	-	-	-
1987	3,023	469	65	8	552	122	0.9	7	338	23	1	-	-	-	-
1988	127	760	13	165	102	134	21	14	38	209	4	-	-	-	-
1989	2,079	260	178	1,530	1,274	621	20	2	382	21	14	-	-	-	-
1990	1,320	773	46	2,692	917	158	23	58	206	51	2	-	-	-	-
1991	2,497	677	129	1,509	683	399	6	10	732	42	6	7,383	1,105	222	3
1992	5,121	902	33	2,885	6,193	1,069	157	12	1,715	221	24	2,588	4,366	640	48
1993	2,681	2,644	259	5,699	3,278	1,715	0	2	580	329	20	3,953	1,861	597	53
1994	1,868	375	67	7,764	1,305	112	7	136	387	106	6	3,196	704	102	14
1995	5,941	785	77	7,546	6,174	387	14	37	2,438	234	21	1,762	4,527	317	42
1996	912	2,635	234	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	3,521	169	40
1998	1,006	5,343	300	2,684	411	248	0	2,628	938	1,027	5	2,931	806	743	11
1999	3,527	597	667	6,358	1,930	88	26	3,603	1,784	180	37	7,844	2,367	201	94
2000	8,091	1,538	65	2,005	6,261	141	2	2,094	6,656	207	23	1,643	7,872	278	11
2001	1,298	2,867	235	3,948	1,013	693	5	756	727	710	26	2,089	1,272	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	1,243	573	92	379	681	85	5	1,767	779	126	1	1,812	1,064	146	7
2004	909	362	35	564	542	90	7	731	719	175	19	n/a	n/a	n/a	n/a

[1]International Bottom Trawl Survey, arithmetic mean catch in no./h in standard area.
[2]English groundfish survey, arithmetic mean catch in no./h, 22 selected rectangles within Roundfish areas 1, 2, and 3.
[3]1982-91 EGFS numbers adjusted from Granton trawl to GOV trawl by multiplying by 3.5.
[4]Scottish groundfish surveys, arithmetic mean catch no./h. Survey design changed in 1998 and 2000. 0-group indices not used from this survey.
[5]English groundfish survey: Data for 1996, 2001, 2002, and 2003 have been revised compared to the 2003 assessment.

Table 12.2.9 Within tuning fleet consistency

	r^2 values		
	Age 0 vs 1	**Age 1 vs 2**	**Age 2 vs 3**
ibtsq1		0.57	0.43
ibtsq3	0.51	0.34	0.31
sgfs	0.31	0.63	0.40
egfs	0.40	0.05	0.00
commq1		0.33	0.14
commq2		0.02	0.24
commq3	0.02	0.42	0.06
commq4	0.38	0.17	0.18

Table 12.2.10 Between survey consistency

(Survey tuning fleet)

	r^2 values					
	EGFSq3 vs SGFSq3	**EGFSq3 vs IBTSq3**	**SGFSq3 vs IBTSq3**	**IBTSq1 vs SGFSq3**	**IBTSq1 vs EGFSq3**	**IBTSq1 vs IBTSq3**
Age 0	0.08	0.13	0.03			
Age 1	0.54	0.75	0.75	0.66	0.77	0.82
Age 2	0.04	0.62	0.51	0.68	0.14	0.53
Age 3	0.14	0.27	0.57	0.41	0.01	0.14

Table 12.2.11 Between quarter consistency
(Commercial Fishery tuning fleet)

	r^2 values					
	q1-q2	**q1-q3**	**q1-g4**	**q2-q3**	**q2-q4**	**q3-q4**
Age 0						0.01
Age 1	0.65	0.31	0.36	0.34	0.23	0.51
Age 2	0.17	0.24	0.30	0.02	0.07	0.22
Age 3	0.19	0.10	0.13	0.37	0.06	0.05

Table 12.2.12 Correlations (r^2) between the tuning fleet indices and assessment (SXSA) abundance estimates (2003 Assessment) by age.
(CF = Commercial Fishery tuning fleet).

Fleets	Age 0	Age 1	Age 2	Age 3
CF_Q1		0.50	0.57	0.45
CF_Q2		0.32	0.35	0.50
CF_Q3	0.05	0.69	0.45	0.37
CF_Q4	0.69	0.63	0.56	0.44
IBTS_1Q		0.64	0.48	0.62
EGFS_3Q	0.26	0.61	0.04	0.04
SGFS_3Q	0.04	0.41	0.43	0.66
IBTS_3Q	0.52	0.79	0.32	0.28

The correlation coefficients (r^2) are estimated from data covering the period 1983-2003 for the quarterly commercial tuning fleet indices.

Table 12.3.1. Norway pout. Stock indices used in final assessment compared to 2003 assessment.

		2003 ASSESSMENT	2004 ASSESSMENT
RECRUITING SEASON		3rd quarter	2nd quarter
FLT01: comm Q1			
	Year range	1982-2003	1982-2004
	Quarter	1	1
	Ages	1-3	1-3
FLT01: comm Q2			NOT USED
	Year range	1982-2003	
	Quarter	2	
	Ages	1-3	
FLT01: comm Q3			
	Year range	1982-2003	1982-2003
	Quarter	3	3
	Ages	0-3	1-3
FLT01: comm Q4			
	Year range	1982-2003	1982-2003
	Quarter	4	4
	Ages	0-3	0-3
FLT02: ibtsq1			
	Year range	1982-2003	1982-2004
	Quarter	1	1
	Ages	1-3	1-3
FLT03: egfs			
	Year range	1982-2003	1992-2004
	Quarter	3	Q3 -> Q2
	Ages	0-3	0-1
FLT05: sgfs			
	Year range	1982-2003	1998-2004
	Quarter	3	Q3 -> Q2
	Ages	0-3	0-1
FLT04: ibtsq3		NOT USED	
	Year range		1991-2003
	Quarter		3
	Ages		2-3

Table 12.3.2. Seasonal extended survivor analysis (SXSA) 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 2004

Run: npns2004_2 (Summary from NPNS2004_2)

The following parameters were used:

```
Year range:                         1983 - 2004
Seasons per year:                       4
The last season in the last year is season :         2
Youngest age:                           0
Oldest age:                         3
Plus age:                           4
Recruitment in season:                  2
Spawning in season:                     1
```

The following fleets were included:

```
Fleet  1:   (Q1: Age 1-3; Q2: None; Q3: Age 1-3)   commercial q134
Fleet  2:                           ibtsq1          (Age 1-3)
Fleet  3:                           egFsq2          (Age 0-1)
Fleet  4:                           sgFsq2          (Age 0-1)
Fleet  5:                           ibtsq3          (Age 2-3)
```

The following options were used:

```
1: Inv. catchability:                       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:                       canumr1.qrt
Weight in catch:                        weca.qrt
Weight in stock:                        west.qrt
Natural mortalities:                    natmor.qrt
Maturity ogive:                         matprop.qrt
Tuning data (CPUE):                     tun2004.xsa
Weighting for rhats:                    rweigh.xsa
```

Table 12.3.3. 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	*	221864.	148720.	99324.	*	119619.	80183.	53748.	*	85444.	57275.	38387.
1	109118.	69700.	45226.	25547.	64392.	40904.	25575.	12812.	34201.	21072.	13423.	7851.
2	13119.	7732.	4172.	1508.	13607.	7996.	4406.	1576.	5729.	2724.	1707.	496.
3	118.	67.	37.	11.	700.	352.	16.	4.	455.	148.	88.	43.
4+	6.	3.	0.	0.	1.	1.	1.	0.	3.	1.	1.	1.
SSN	24155.				20748.				9608.			
SSB	370068.				372501.				168363.			
TSN	122361.	299364.	198154.	126390.	78701.	168872.	110181.	68140.	40389.	109389.	72495.	46778.
TSB	1057515.	1311854.	1907134.	1247483.	778172.	903055.	1150527.	683585.	383832.	416182.	643410.	434241.

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	160015.	107261.	71899.	*	46805.	31374.	21024.	*	128728.	86289.	57234.
1	25176.	16552.	10882.	6323.	43634.	27048.	17251.	10232.	13907.	9119.	6035.	3895.
2	2814.	1011.	607.	206.	2773.	1530.	976.	515.	5098.	2844.	1846.	1033.
3	189.	68.	43.	24.	106.	61.	41.	27.	154.	87.	58.	39.
4+	30.	17.	12.	8.	21.	13.	9.	6.	18.	12.	8.	5.
SSN	5551.				7264.				6661.			
SSB	88771.				96985.				129078.			
TSN	28210.	177662.	118804.	78460.	46534.	75458.	49651.	31804.	19178.	140790.	94236.	62207.
TSB	247383.	287013.	729762.	586876.	371878.	461566.	601212.	384679.	216695.	238514.	578897.	478640.

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	136036.	91188.	60995.	*	127476.	85450.	57262.	*	245481.	164551.	109701.
1	35790.	22569.	14573.	8400.	36912.	23237.	14119.	8669.	37571.	23956.	15538.	9171.
2	2094.	1364.	806.	322.	4206.	2341.	1101.	586.	4844.	2154.	1113.	570.
3	361.	237.	154.	99.	140.	77.	36.	19.	298.	124.	67.	27.
4+	30.	20.	13.	9.	62.	33.	22.	15.	20.	8.	6.	4.
SSN	6063.				8098.				8919.			
SSB	87214.				127416.				145902.			
TSN	38274.	160226.	106734.	69825.	41320.	153164.	100728.	66552.	42733.	271722.	181275.	119472.
TSB	312691.	397882.	772949.	578447.	359964.	433870.	744275.	568716.	382600.	439212.	1098549.	894628.

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	103004.	69046.	45563.	*	72656.	48703.	32568.	*	313086.	209868.	140149.
1	70681.	44467.	28561.	16315.	29761.	18359.	11640.	6864.	20869.	12372.	7988.	4512.
2	5290.	2656.	1541.	714.	8657.	5231.	3119.	1344.	3741.	2024.	1123.	408.
3	229.	57.	22.	14.	260.	162.	61.	26.	537.	314.	187.	67.
4+	6.	1.	1.	1.	8.	5.	4.	2.	17.	11.	8.	5.
SSN	12592.				11901.				6382.			
SSB	175334.				222143.				119340.			
TSN	76205.	150186.	99170.	62606.	38686.	96414.	63528.	40804.	25164.	327807.	219174.	145142.
TSB	620623.	760262.	1057768.	679415.	409635.	461651.	623633.	411202.	250814.	270730.	1098677.	965719.

Year	1995				1996				1997			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	98492.	66021.	43682.	*	238709.	160012.	106666.	*	67837.	45472.	30392.
1	90475.	57379.	36902.	22653.	27896.	18261.	11782.	7044.	69440.	45996.	30751.	18084.
2	2085.	1201.	595.	361.	12443.	7709.	5003.	2533.	4189.	2541.	1597.	766.
3	164.	105.	45.	27.	193.	118.	48.	2.	1425.	891.	500.	249.
4+	48.	32.	22.	15.	26.	17.	12.	8.	7.	4.	3.	2.
SSN	11345.				15452.				12565.			
SSB	118470.				302455.				198151.			
TSN	92772.	157209.	103585.	66738.	40558.	264815.	176856.	116253.	75060.	117270.	78323.	49493.
TSB	688460.	908605.	1214916.	799856.	478198.	542894.	1152612.	908544.	635620.	821146.	1049310.	644890.

Year	1998				1999				2000			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	94065.	63054.	42189.	*	233146.	156282.	104726.	*	80731.	54116.	36215.
1	20092.	13254.	8712.	5503.	28003.	18605.	12211.	7122.	69277.	45903.	30541.	19352.
2	10548.	6506.	4107.	2481.	3254.	2076.	1212.	536.	4302.	2733.	1662.	897.
3	344.	192.	114.	75.	1487.	937.	552.	342.	228.	151.	61.	25.
4+	140.	87.	39.	26.	57.	38.	25.	17.	221.	148.	99.	67.
SSN	13041.				7598.				11680.			
SSB	267705.				153848.				164674.			
TSN	31124.	114104.	76025.	50274.	32801.	254802.	170283.	112742.	74029.	129666.	86479.	56555.
TSB	394284.	434477.	653449.	488258.	330267.	398629.	1015640.	834487.	601121.	797301.	1055129.	701461.

Table 12.3.3. (Continued)

Year	2001				2002				2003			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	77293.	51811.	34704.	*	51192.	34315.	22724.	*	16966.	11373.	7618.
1	24029.	15927.	10567.	6984.	22961.	14994.	9764.	6036.	14995.	10003.	6653.	4303.
2	9192.	5470.	3465.	2300.	4463.	2870.	1904.	1044.	3659.	2390.	1562.	948.
3	401.	240.	79.	52.	1182.	779.	518.	328.	416.	261.	155.	91.
4+	56.	38.	25.	17.	46.	31.	20.	14.	207.	139.	93.	62.
SSN	12052.				7987.				5782.			
SSB	238227.				164107.				119251.			
TSN	33678.	98968.	65948.	44058.	28652.	69866.	46521.	30146.	19277.	29759.	19835.	13021.
TSB	389608.	438986.	625185.	468496.	308763.	363164.	494324.	338044.	213717.	252147.	288267.	189755.

Year	2004	
Season	1	2
AGE		
0	*	19662.
1	5105.	3414.
2	2840.	1861.
3	504.	330.
4+	75.	51.
SSN	3930.	
SSB	90428.	
TSN	8525.	25319.
TSB	122592.	133846.

Table 12.3.4. 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	0.168	0.225	0.053	0.069	0.283	0.389	0.083	0.050	0.134	0.585
2	0.127	0.212	0.578	0.354	0.130	0.192	0.586	0.760	0.332	0.066	0.756	0.529
3	0.164	0.188	0.745	1.324	0.280	1.597	0.859	0.000	0.665	0.114	0.302	0.000
4+	0.000	1.807	*	*	0.000	0.000	0.000	0.000	0.341	0.000	0.000	0.000
F (1- 2)	0.087	0.122	0.373	0.290	0.092	0.130	0.435	0.574	0.208	0.058	0.445	0.557

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.000	0.098	*	0.000	0.000	0.013	*	0.000	0.010	0.069
1	0.019	0.019	0.141	0.407	0.077	0.049	0.121	0.288	0.022	0.013	0.037	0.216
2	0.583	0.109	0.630	0.256	0.191	0.049	0.234	0.731	0.180	0.032	0.178	0.607
3	0.585	0.053	0.183	0.000	0.147	0.000	0.010	0.247	0.170	0.000	0.000	0.000
4+	0.131	0.000	0.000	0.000	0.059	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.301	0.064	0.385	0.331	0.134	0.049	0.178	0.510	0.101	0.022	0.107	0.411

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	0.039
1	0.060	0.037	0.149	0.284	0.062	0.097	0.087	0.179	0.050	0.033	0.125	0.148
2	0.028	0.125	0.491	0.417	0.182	0.342	0.225	0.269	0.394	0.254	0.263	0.485
3	0.020	0.031	0.037	0.171	0.189	0.345	0.221	0.283	0.457	0.204	0.493	1.279
4+	0.000	0.000	0.000	0.000	0.215	0.000	0.000	0.000	0.443	0.000	0.000	0.000
F (1- 2)	0.044	0.081	0.320	0.350	0.122	0.220	0.156	0.224	0.222	0.143	0.194	0.317

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.016	0.026	*	0.000	0.002	0.045	*	0.000	0.004	0.037
1	0.063	0.042	0.157	0.228	0.082	0.055	0.126	0.203	0.121	0.037	0.168	0.359
2	0.281	0.142	0.356	0.571	0.102	0.115	0.423	0.491	0.210	0.185	0.572	0.486
3	0.869	0.526	0.057	0.190	0.071	0.539	0.453	0.099	0.134	0.118	0.583	0.000
4+	0.870	0.000	0.000	0.000	0.026	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.172	0.092	0.257	0.400	0.092	0.085	0.275	0.347	0.166	0.111	0.370	0.422

Year	1995				1996				1997			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.013	0.048	*	0.000	0.006	0.029	*	0.000	0.003	0.014
1	0.055	0.041	0.087	0.195	0.024	0.038	0.113	0.118	0.012	0.003	0.129	0.137
2	0.149	0.293	0.099	0.219	0.078	0.032	0.273	0.172	0.098	0.064	0.324	0.386
3	0.042	0.438	0.085	0.141	0.091	0.473	1.575	0.162	0.069	0.175	0.288	0.183
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.102	0.167	0.093	0.207	0.051	0.035	0.193	0.145	0.055	0.033	0.227	0.262

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	0.019	0.059	0.124	0.009	0.021	0.137	0.103	0.012	0.007	0.056	0.333
2	0.082	0.059	0.103	0.110	0.049	0.136	0.400	0.433	0.053	0.096	0.213	0.390
3	0.180	0.122	0.017	0.239	0.061	0.127	0.079	0.085	0.014	0.473	0.491	0.338
4+	0.072	0.399	0.000	0.000	0.011	0.006	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.049	0.039	0.081	0.117	0.029	0.079	0.268	0.268	0.032	0.052	0.134	0.361

Year	2001				2002				2003			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.001	0.013	*	0.000	0.012	0.016	*	0.000	0.001	0.000
1	0.011	0.010	0.014	0.047	0.026	0.029	0.080	0.099	0.005	0.008	0.035	0.015
2	0.117	0.056	0.010	0.259	0.041	0.010	0.197	0.493	0.026	0.025	0.098	0.227
3	0.112	0.655	0.017	0.021	0.017	0.008	0.057	0.102	0.066	0.121	0.131	0.529
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.025
F (1- 2)	0.064	0.033	0.012	0.153	0.033	0.020	0.139	0.296	0.015	0.016	0.067	0.121

Year	2004	
Season	1	2
AGE		
0	*	0.000
1	0.002	0.001
2	0.022	0.011
3	0.022	0.021
4+	0.000	0.000
F (1- 2)	0.012	0.006

Table 12.3.5. Seasonal extended survivor analysis (SXSA) of Norway pout in the North Sea and Skagerrak. Diagnostics from the SXSA.

Log inverse catchabilities, fleet no: 1 (commercial q134)

Year 1983-2004 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	11.631
1	10.728	*	9.890	9.277
2	9.268	*	8.861	8.505
3	9.268	*	8.861	8.505

Log inverse catchabilities, fleet no: 2 (ibtsq1)

Year 1983-2004 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	2.545	*	*	*
2	1.451	*	*	*
3	1.451	*	*	*

Log inverse catchabilities, fleet no: 3 (egFsq2**)**

Year 1992-2004 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	3.159	*	*
1	*	2.107	*	*
2	*	*	*	*
3	*	*	*	*

Log inverse catchabilities, fleet no: 4 (sgFsq2**)**

Year 1998-2004 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	3.318	*	*
1	*	2.180	*	*
2	*	*	*	*
3	*	*	*	*

Log inverse catchabilities, fleet no: 5 (ibtsq3)

Year 1991-2004 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	*	*	*	*
2	*	*	1.583	*
3	*	*	1.583	*

Table 12.3.5. (Continued)

Weighting factors for computing survivors:
Fleet no: 1 (commercial q134)

Year 1983-2004 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	1.141
1	1.363	*	3.202	2.504
2	2.138	*	1.797	1.270
3	1.271	*	0.812	0.845

Weighting factors for computing survivors:
Fleet no: 2 (ibtsq1)

Year 1983-2004 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	1.515	*	*	*
2	1.722	*	*	*
3	0.968	*	*	*

Weighting factors for computing survivors:
Fleet no: 3 (egFsq2**)**

Year 1992-2004 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	1.333	*	*
1	*	2.041	*	*
2	*	*	*	*
3	*	*	*	*

Weighting factors for computing survivors:
Fleet no: 4 (sgFsq2**)**

Year 1998-2004 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	1.211	*	*
1	*	1.876	*	*
2	*	*	*	*
3	*	*	*	*

Weighting factors for computing survivors:
Fleet no: 5 (ibtsq3)

Year 1991-2004 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	*	*	*	*
2	*	*	1.328	*
3	*	*	0.771	*

Table 12.3.6. Norway pout. SMS diagnostic.

```
objective function, negative log likelihood:  229.322

objective function contributions (total):
              Catch   CPUE     S/R
Species:1    105.94  116.99    6.40

objective function contributions (per observation):
           Catch   CPUE   S/R
Species:1   0.217 0.228 0.206


contribution by fleets:
-----------------------
Commercial Q1       obj conb.:-4.213   mean contb.:-0.064
Commercial Q2       obj conb.:15.054   mean contb.: 0.228
Commercial Q3       obj conb.:26.899   mean contb.: 0.320
Commercial Q4       obj conb.:17.622   mean contb.: 0.210
IBTS Q1             obj conb.:-4.076   mean contb.:-0.062
EGFS Q3             obj conb.:51.267   mean contb.: 0.610
SGFS Q3             obj conb.:14.436   mean contb.: 0.229

F, year effect:
---------------
 1.000 0.716 0.691 0.527 0.485 0.525 0.599 0.645 0.725 0.587 0.635 0.740 0.590
0.495 0.307 0.384 0.466 0.449 0.441 0.477 0.497 0.346 0.253 0.189 0.181 0.219
0.208 0.121 0.238 0.098 0.044

F, season effect:
-----------------
 age-season group:  age 0
    0.000 0.000 0.015 0.250
 age-season group: age 1
    0.052 0.045 0.155 0.250
 age-season group: age 2 & 3
    0.089 0.074 0.191 0.250

F, age effect:
--------------
  age 0    age 1    age 2    age 3
  0.282    2.445    5.152    5.152

sqrt(catch variance) ~ CV:
-------------------------
age 0   age 1   age 2   age 3
1.548   0.435   0.604   1.269

Survey catchability:
--------------------
              age 0    age 1       age 2        age 3
Commercial Q1             2.84e-002   1.26e-001   1.43e-001
Commercial Q2             4.15e-002   1.97e-001   3.93e-001
Commercial Q3 2.54e-002   6.51e-002   1.97e-001   8.88e-002
Commercial Q4 1.14e-002   1.23e-001   2.91e-001   7.82e-002
IBTS Q1                   1.02e-001   3.14e-001   5.62e-001
EGFS Q3       3.00e-002   1.45e-001   2.61e-001   1.43e-001
SGFS Q3                   7.52e-002   1.52e-001   1.74e-001
```

Table 12.3.6. cont. Norway pout. SMS diagnostic.

sqrt(CPUE variance) ~ CV:
----

	age 0	age 1	age 2	age 3
Commercial Q1		0.57	0.36	0.91
Commercial Q2		0.68	0.61	1.07
Commercial Q3	2.11	0.29	0.60	1.34
Commercial Q4	0.73	0.31	0.79	1.74
IBTS Q1		0.65	0.40	0.71
EGFS Q3	1.44	0.64	1.00	1.67
SGFS Q3		0.83	0.58	0.92

Average F:

1974:	2.171	
1975:	1.554	
1976:	1.500	
1977:	1.144	
1978:	1.053	
1979:	1.141	
1980:	1.299	
1981:	1.400	
1982:	1.573	
1983:	1.275	
1984:	1.377	
1985:	1.606	
1986:	1.282	
1987:	1.074	
1988:	0.667	
1989:	0.834	
1990:	1.012	
1991:	0.974	
1992:	0.957	
1993:	1.035	
1994:	1.078	
1995:	0.750	
1996:	0.549	
1997:	0.410	
1998:	0.392	
1999:	0.476	CV %
2000:	0.452	21
2001:	0.262	23
2002:	0.517	21
2003:	0.212	23
2004:	0.024	33

F in 2004 include first half-year only.

Recruit-SSB	alfa	beta	recruit s2	recruit s
Species 1: Ricker:	6.462e-001	1.313e-06	0.556	0.746

Table 12.3.7 Norway pout IIIa, IV. Stock summary table.
(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	221864	370068	1907134	451.40	0.872
1984	119619	372501	1150527	393.00	1.231
1985	85444	168363	643410	205.10	1.268
1986	160015	88771	729762	178.40	1.081
1987	46805	96985	601212	149.30	0.871
1988	128728	129078	578897	109.50	0.641
1989	136036	87214	772949	166.40	0.795
1990	127476	127416	744275	163.30	0.722
1991	245481	145902	1098549	186.60	0.876
1992	103004	175334	1057768	296.80	0.921
1993	72656	222143	623633	183.10	0.799
1994	313086	119340	1098677	182.00	1.069
1995	98492	118470	1214916	236.80	0.569
1996	238709	302455	1152612	163.80	0.424
1997	67837	198151	1049310	169.70	0.577
1998	94065	267705	653449	79.80	0.286
1999	233146	153848	1015640	92.00	0.644
2000	80731	164674	1055129	184.40	0.579
2001	77293	238227	625185	65.60	0.262
2002	51192	164107	494324	76.70	0.488
2003	16966	119251	288267	24.90	0.219
2004	19662	90428			
Arit mean	**129,459**	**178,201**	**883,601**		**0.724**
Geomean	**106,992**				

Table 12.5. Norway pout IIIa and IV. Short term forecast

Basis: F=F(2003).

F multiplier	0	0.2	0.4	0.6	0.8	1	1.2
Fbar : Q1	0.000	0.002	0.005	0.007	0.010	0.012	0.014
Fbar : Q2	0.000	0.001	0.002	0.004	0.005	0.006	0.007
Fbar : Q3	0.000	0.013	0.027	0.040	0.053	0.067	0.080
Fbar : Q4	0.000	0.024	0.048	0.073	0.097	0.121	0.145
SSB start of							
2004	90428	90428	90428	90428	90428	90428	90428
2005	55615	53092	50760	48601	46600	44742	43016
Yield							
2004 Q3+Q4	0	3040	5674	7966	9973	11738	13299
2005 Q1+Q2	0	273	525	759	976	1177	1365

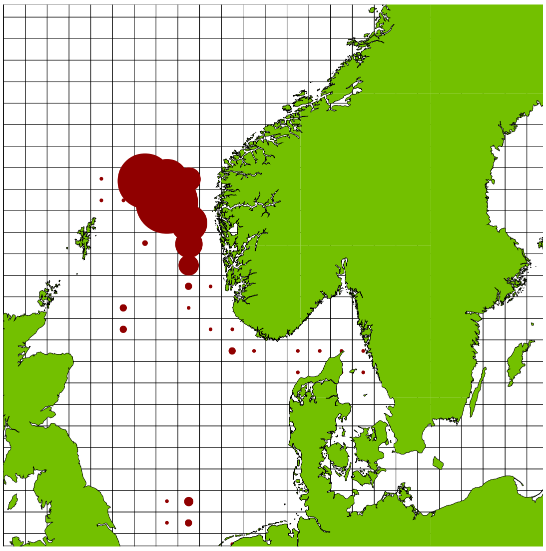
Table 12.8.1 Norway pout in Division VIa
Officially reported landings (tonnes)

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Denmark	5849	28180	3316	4348	5147	7338	14147	24431	6175	9549
Faroes	376	11	-	-	-	-	-	-	-	-
Germany	-	-	-	-	-	-	-	1	-	-
Netherlands	-	-	-	-	10	-	-	7	7	-
Norway	-	-	-	-	-	-	-	-	-	-
Poland	-	-	-	-	-	-	-	-	-	-
UK (E+W)	-	-	-	-	1	-	1	-	-	-
UK (Scotland)	517	5	-	-	-	-	+	-	140	13
Total	6742	28196	3316	4348	5158	7338	14148	24439	6322	9562

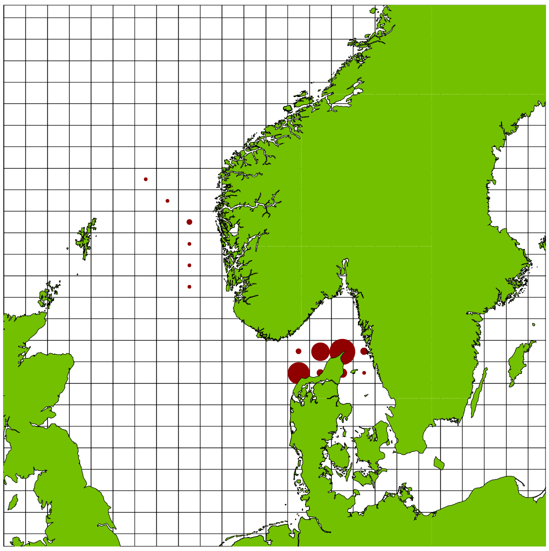
Country	1998	1999	2000	2001	2002	2003
Denmark	7186	4624	2005	3214	4815	6397
Faroes	-	-	-	-	-	-
Germany	-	-	-	-	-	-
Netherlands	-	1	-	-	-	-
Norway	-	-	-	-	-	-
Poland	-	-	-	-	-	-
UK (E+W)	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-
Total	7186	4625	2005	3214	4815	6397

Figure 12.1.1 Spatial distribution of Danish Norway pout fishery. Catch in tons by area (ICES Statistical square) and season (quarter of year) in 2002 from the Danish commercial fishery for Norway pout in the North Sea, Skagerrak and Kattegat areas. Large symbols indicate 1000 tonnes, medium 500 tonnes, small 100 tonnes.

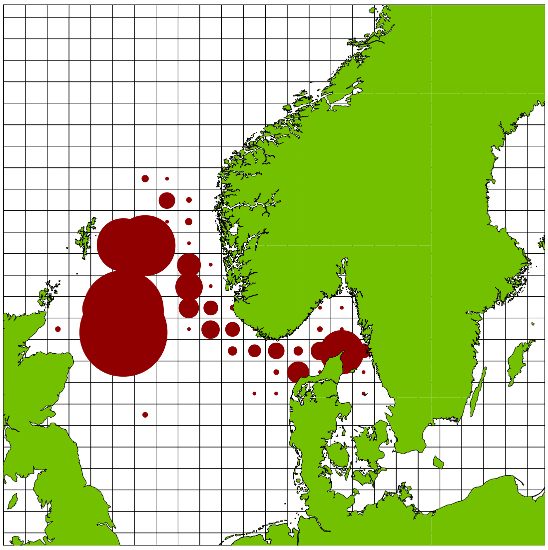
2002 first quarter:



2002 second quarter:



2002 third quarter:



2002 fourth quarter:

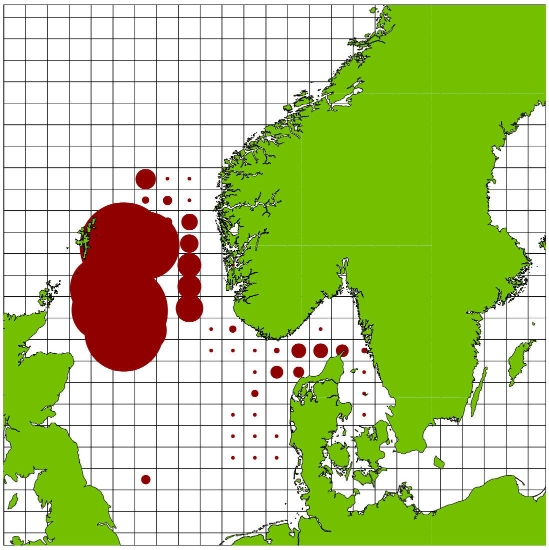
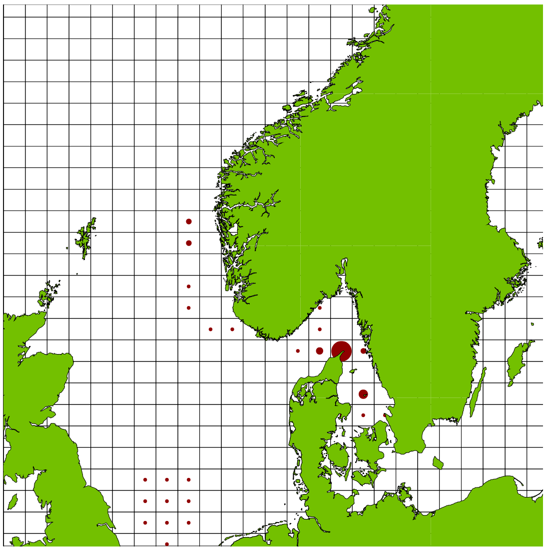
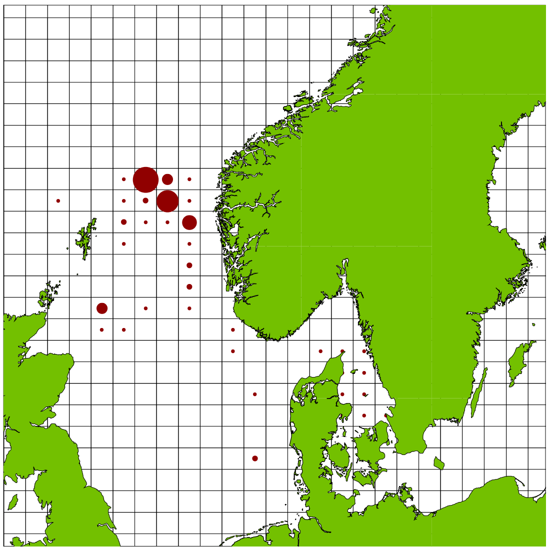


Figure 12.1.2 Spatial distribution of Danish Norway pout fishery. Catch in tons by area (ICES Statistical square) and season (quarter of year) in 2003 from the Danish commercial fishery for Norway pout in the North Sea, Skagerrak and Kattegat areas. Large symbols indicate 1000 tonnes, medium 500 tonnes, small 100 tonnes.

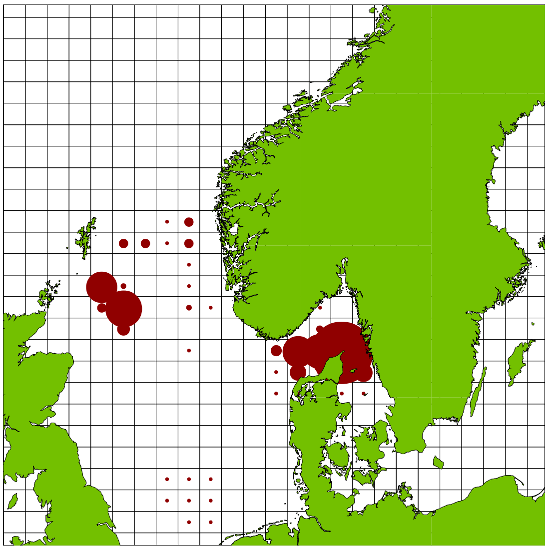
2003 first quarter:



2003 second quarter:



2003 third quarter:



2003 fourth quarter:

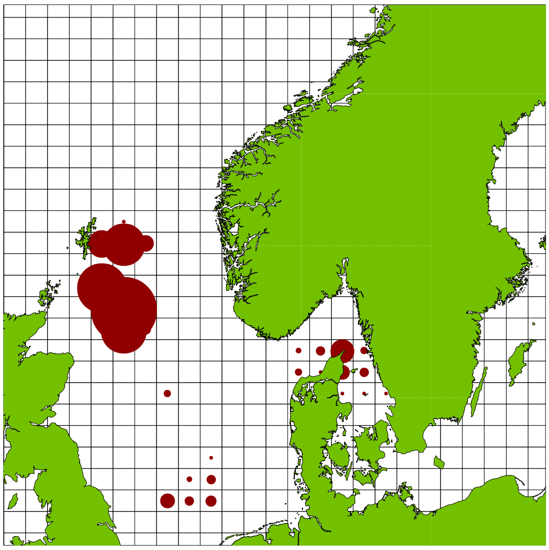


Figure 12.2.1. **NORWAY POUT. Weighted mean weights at age in catch of the Danish and Norwegian commercial fishery for Norway pout by quarter of year during the period 1982-2004.**

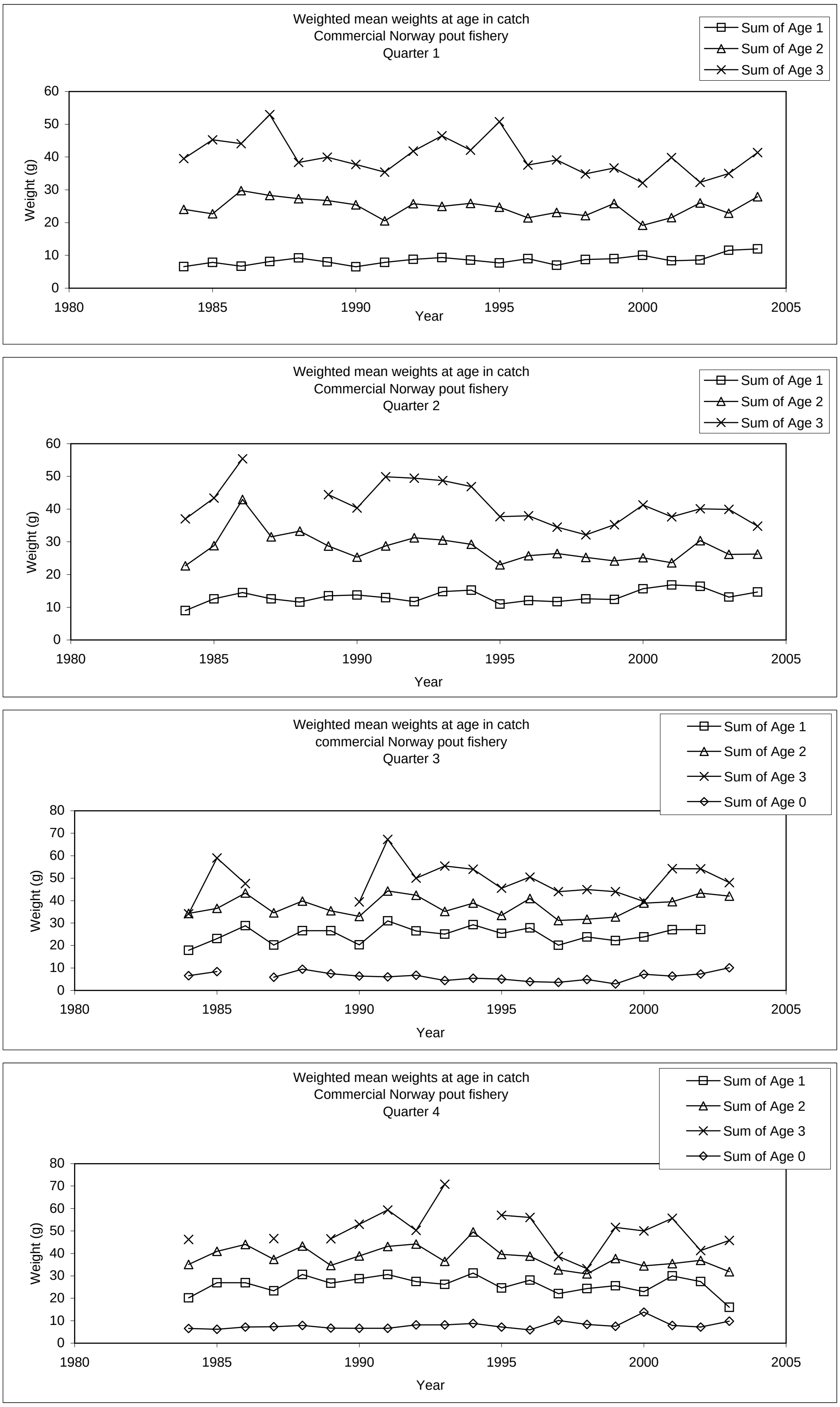
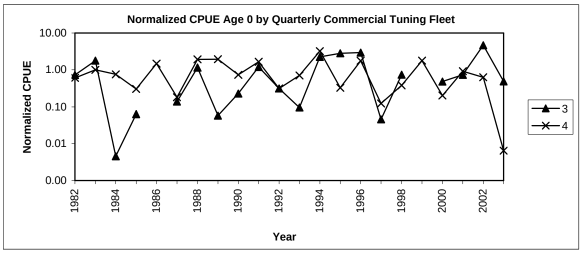
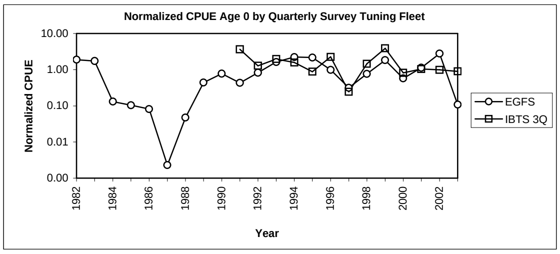
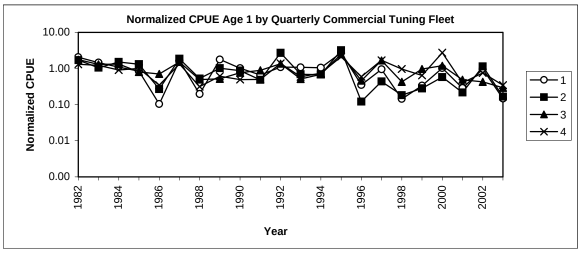
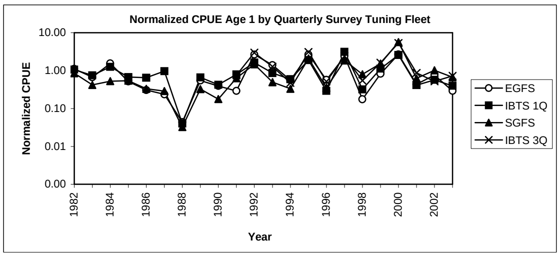


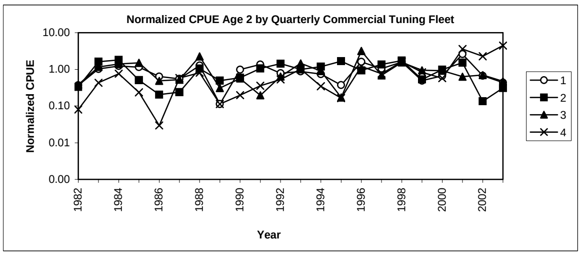
Figure 12.2.2 NORWAY POUT. Trends in CPUE (normalized) by quarterly commercial tuning fleet and survey tuning fleet used in the Norway pout SXSA Assessment for each age group and all age groups together.

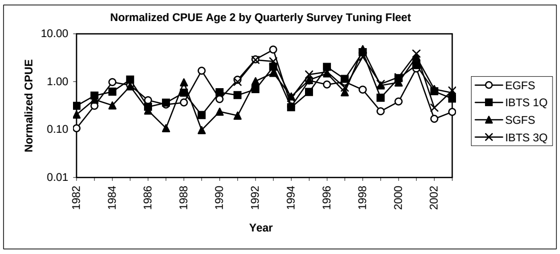


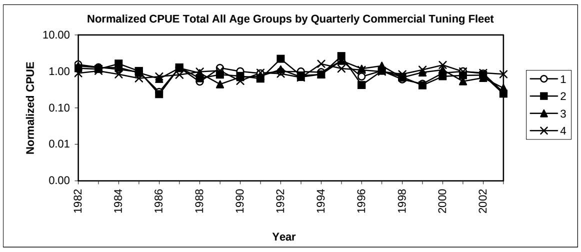












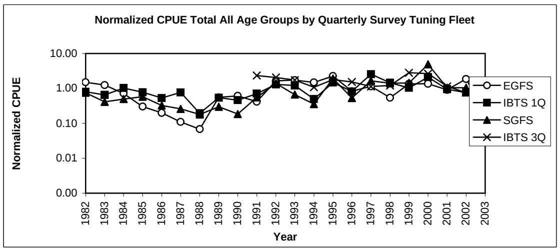


Figure 12.2.3 NORWAY POUT. Cohorte analysis of Norway pout survey CPUE indices: abundance indices by year class.

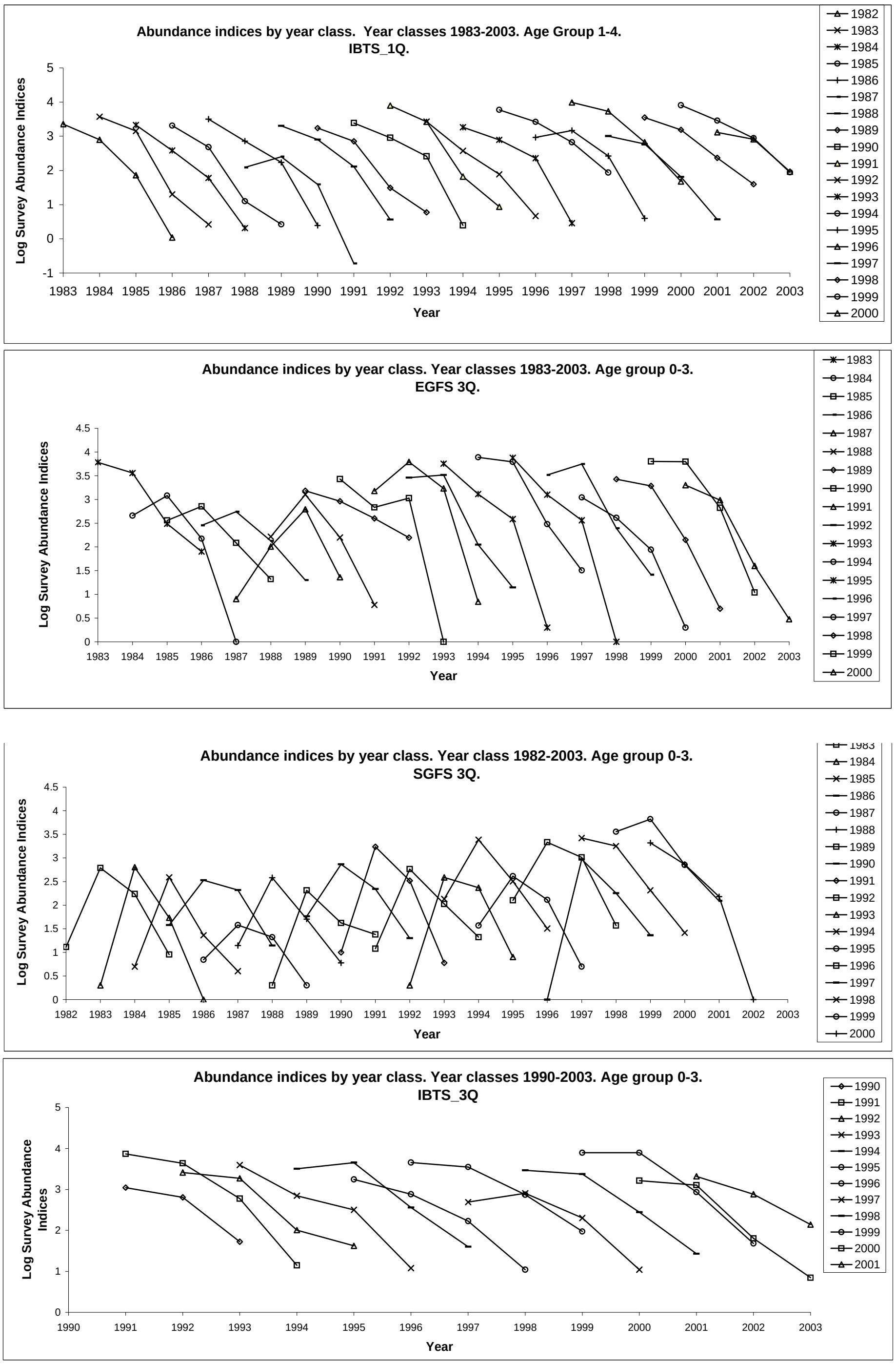
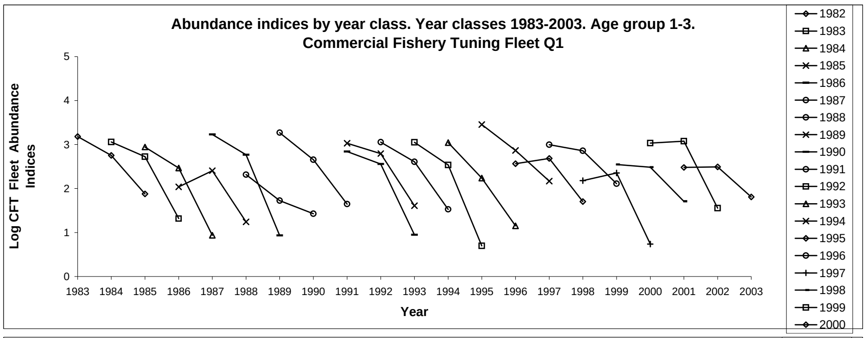
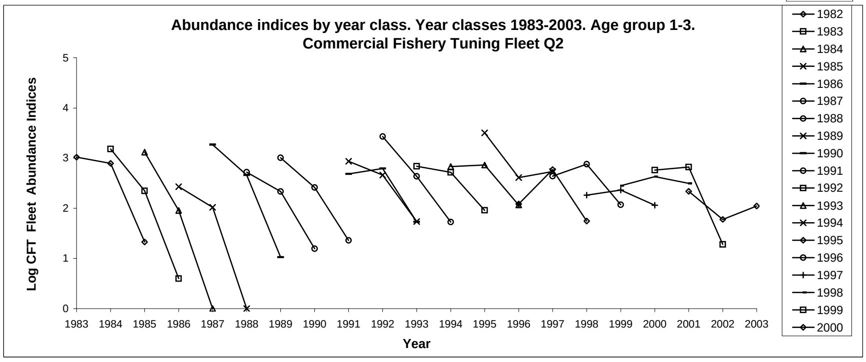
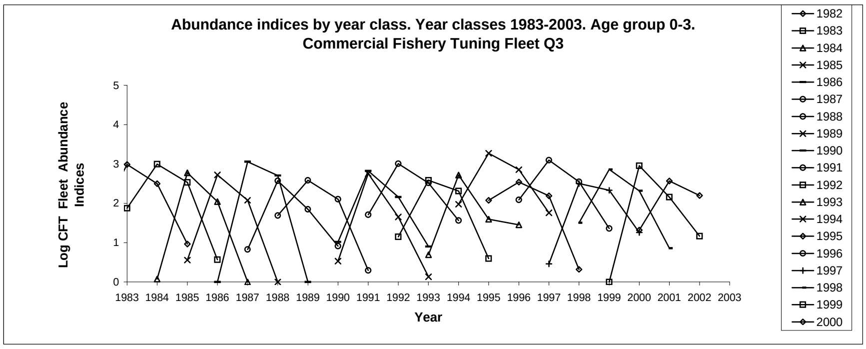


Figure 12.2.4 **NORWAY POUT. Cohorte analysis of Norway pout commercial fishery assessment tuning fleet (2003 assessment) CPUE indices: abundance indices by year class.**







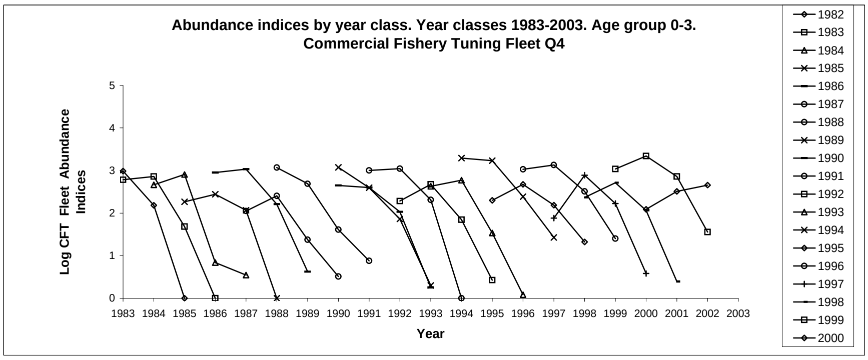
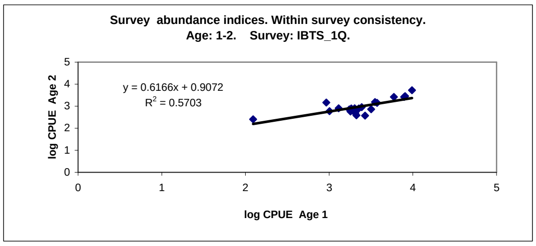
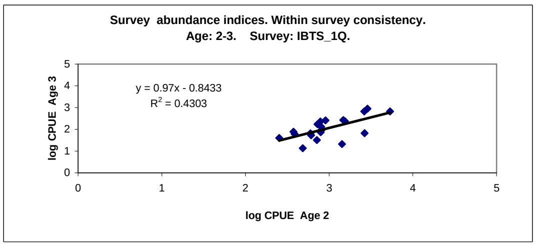


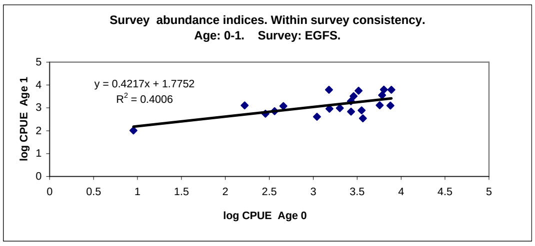
Figure 12.2.5 Within Survey Variability. Correlation between year class estimates by age.

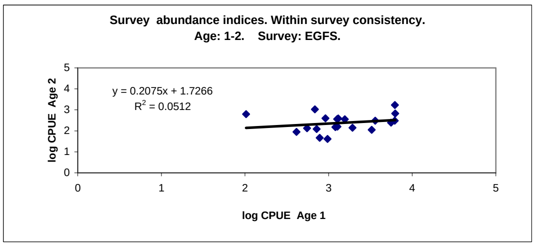
Survey: IBTS_Q1

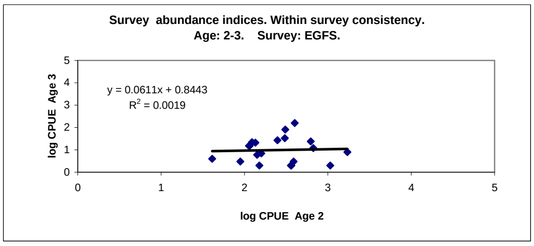




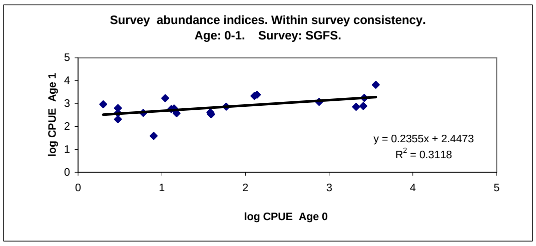
Survey: EGFS_Q3

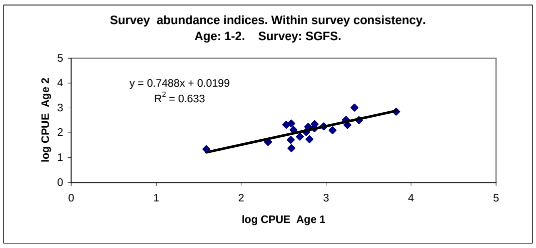


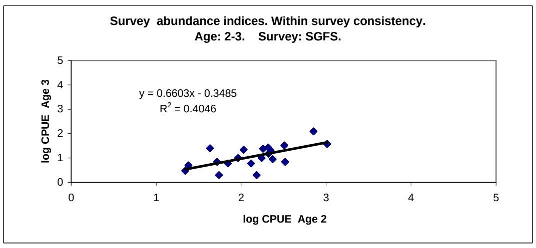




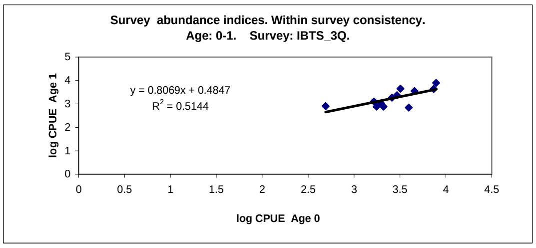
Survey: SGFS_Q3

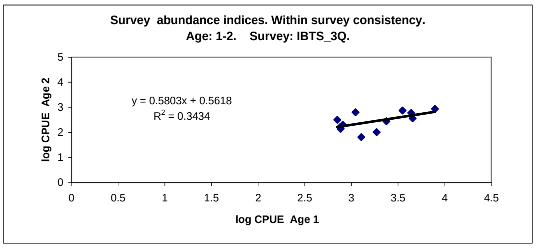






Survey: IBTS_Q3





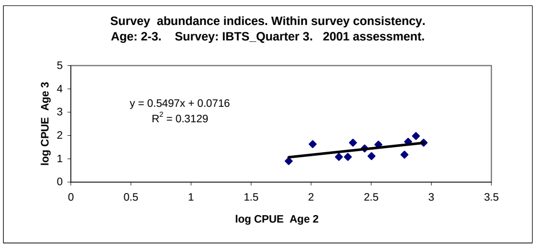
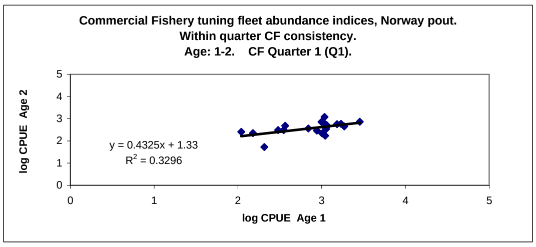
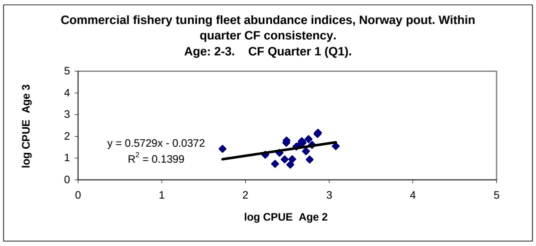


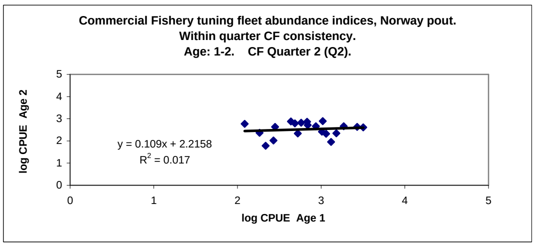
Figure 12.2.6 Within Quarter commercial fishery tuning fleet variability. Commercial Fishery (CF) assessment tuning fleet abundance indices. Correlation between year class estimates by age.

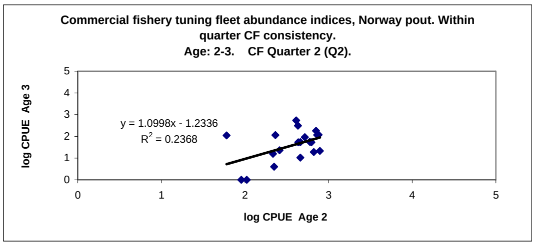
Quarter: CF Quarter 1 (Q1).



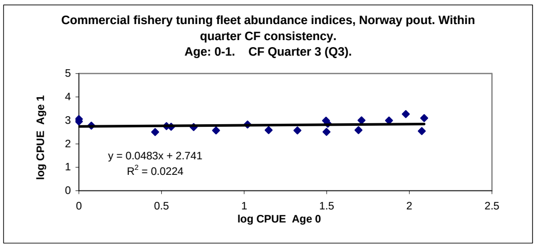


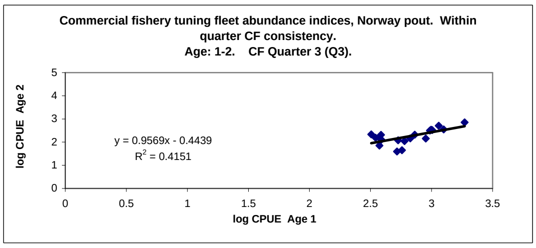
Quarter: CF Quarter 2 (Q2).

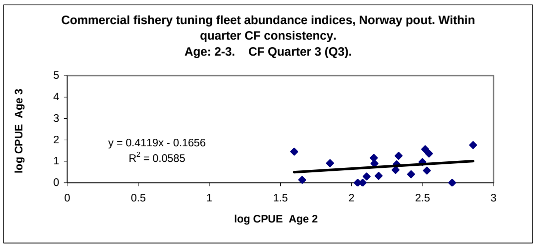




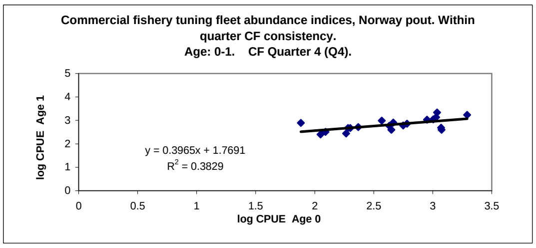
Quarter: CF Quarter 3 (Q3).

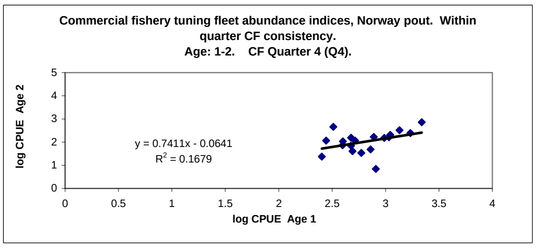






Quarter: CF Quarter 4 (Q4).





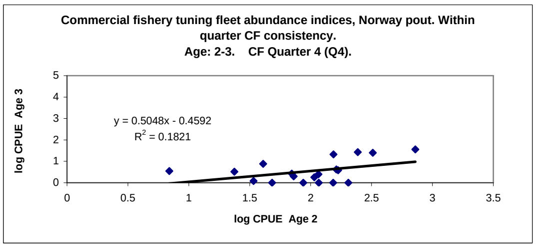


Figure 12.2.7 Between survey variability and consistency

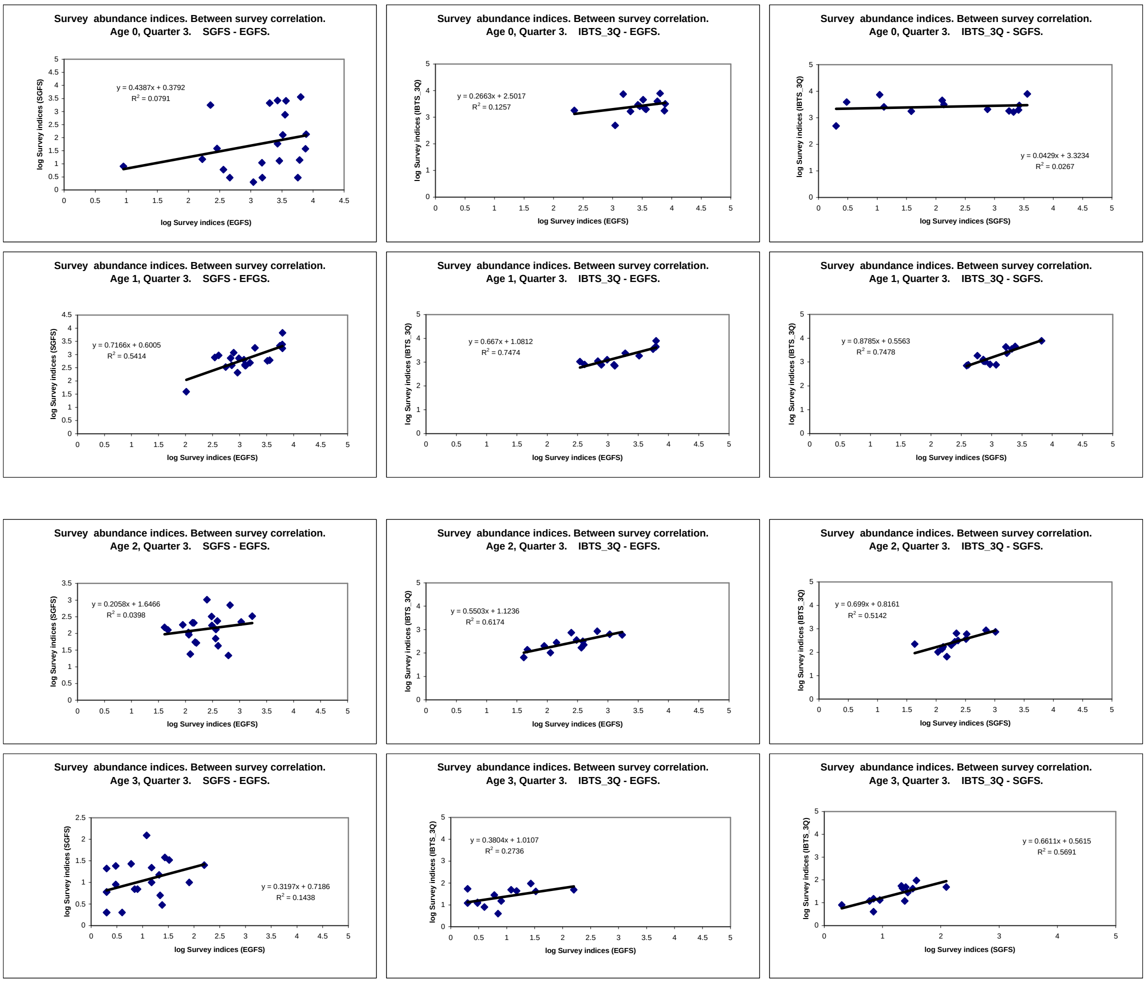


Figure 12.2.7 cont. Norway pout. Between survey variability and consistency.

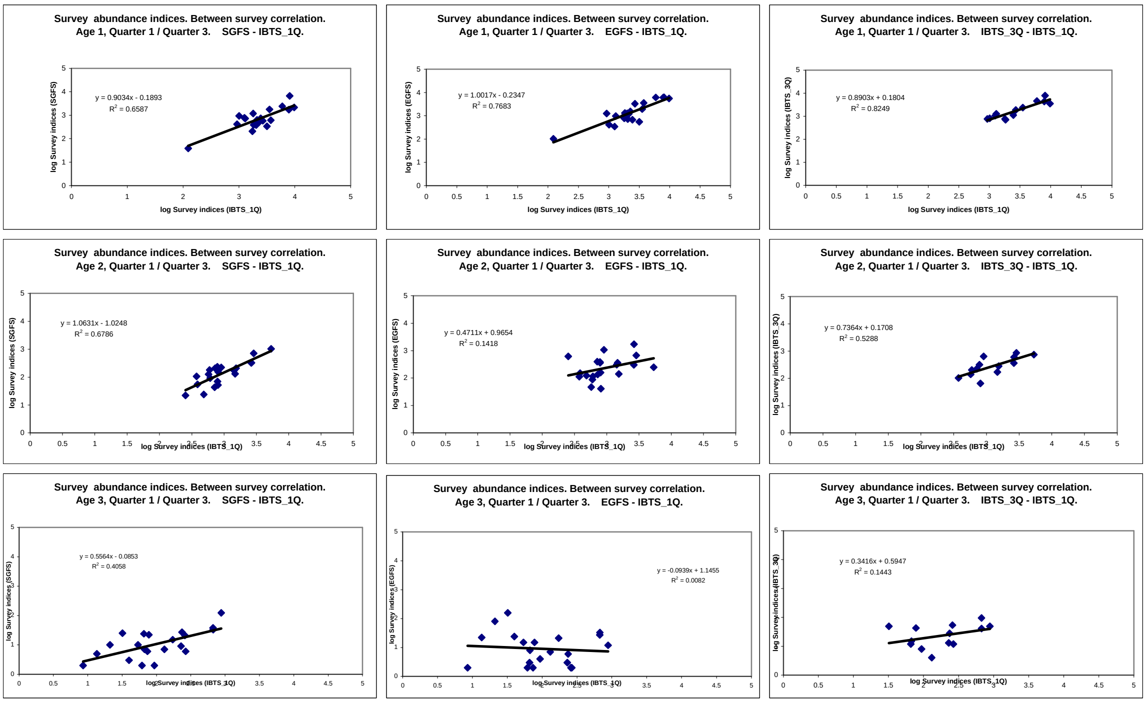


Figure 12.2.8 Norway pout. Between quarter variability. Commercial fishery assessment tuning fleet, Norway pout indices by age and quarter.

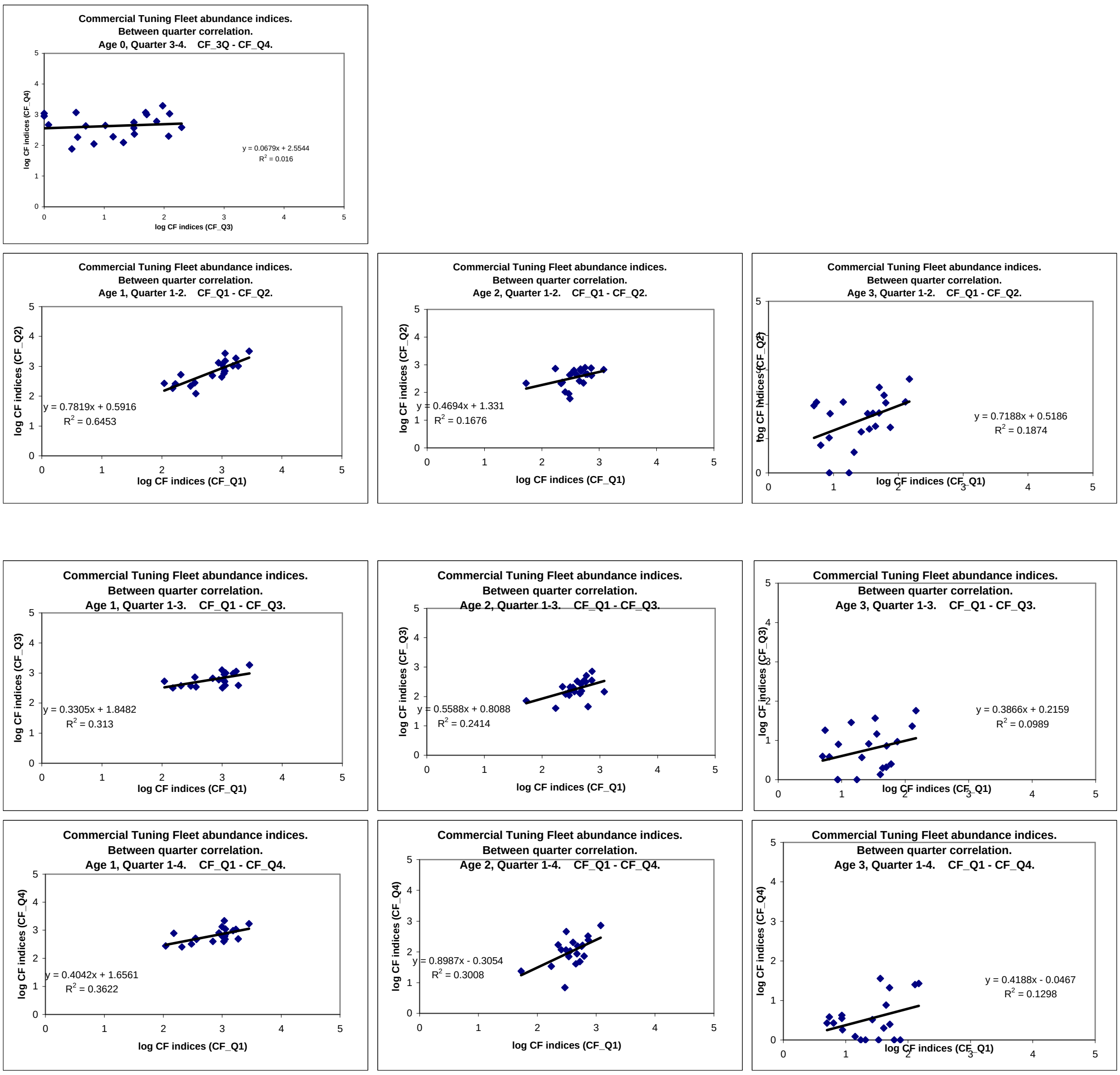


Figure 12.2.8. cont. Norway pout. Between quarter variability. Commercial fishery assessment tuning fleet, Norway pout indices by age and quarter.

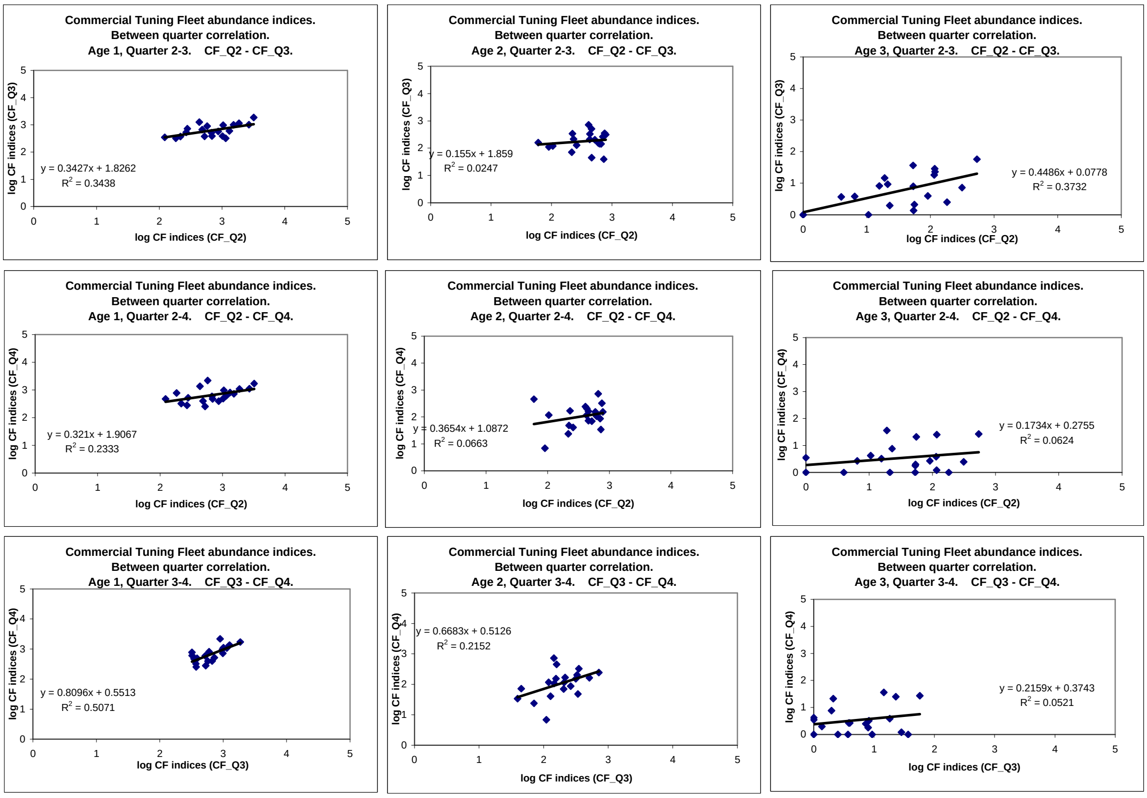


Figure 12.3.1 Log residual stock numbers (log (Nhat/N)) per age group divided by fleet and season.
SXSA-Norway pout in the North Sea and Skagerak.

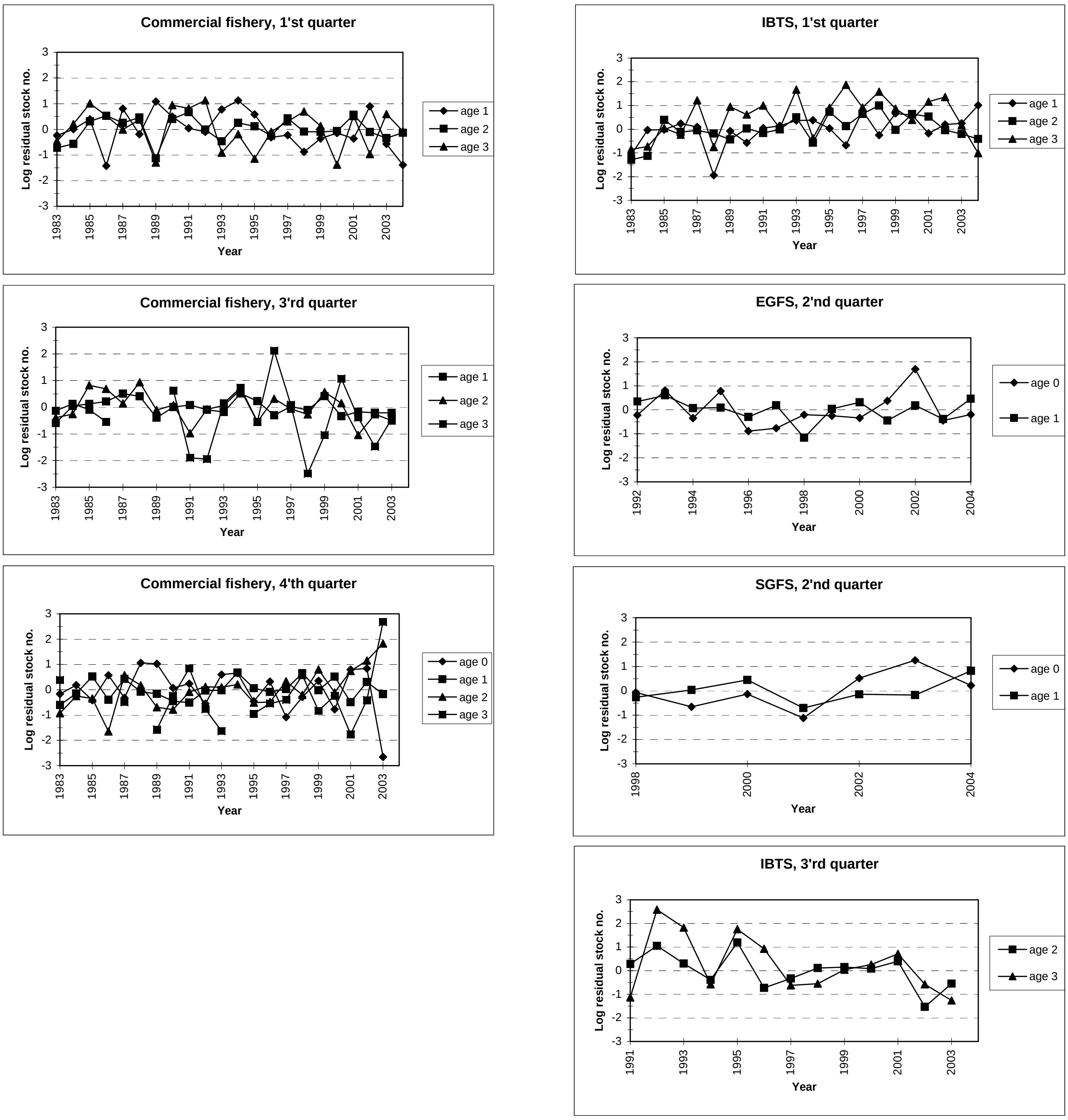


Figure 12.3.2. Norway pout. Stock summary plots.

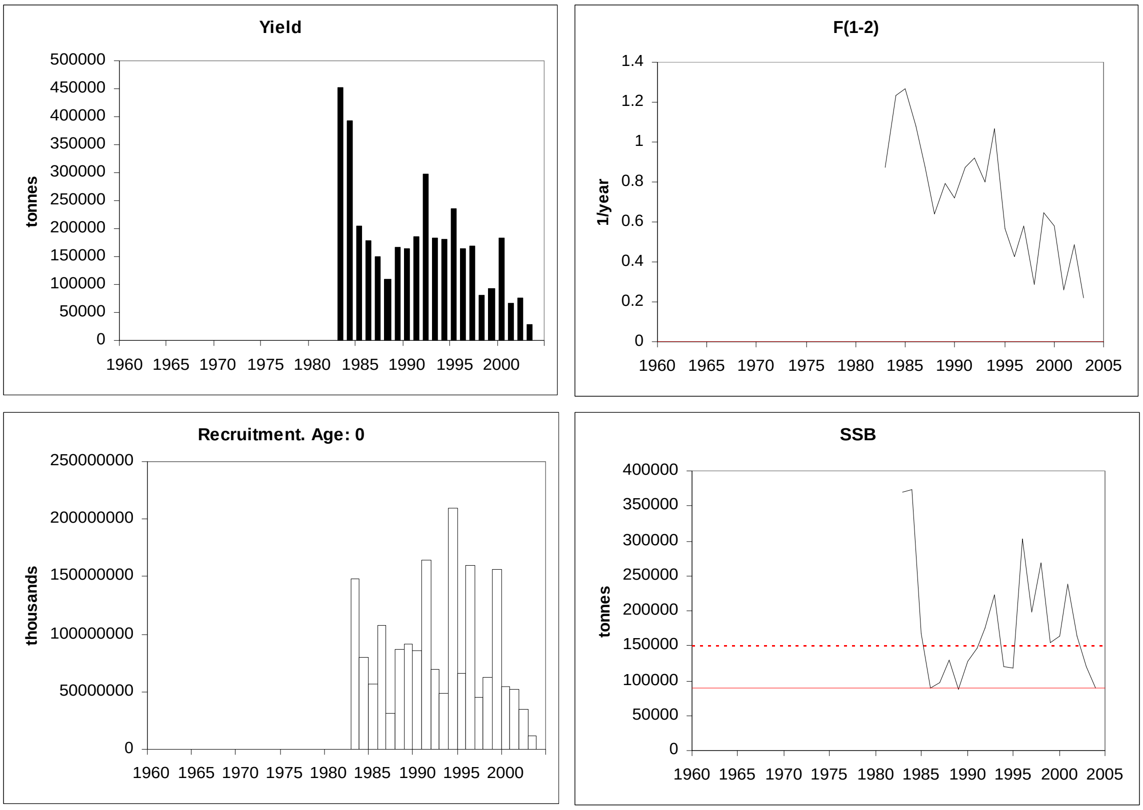


Figure 12.3.3 **Trends in yield, SSB and TSB for Norway pout in the North Sea and Skagerrak during the period 1983-2003.**

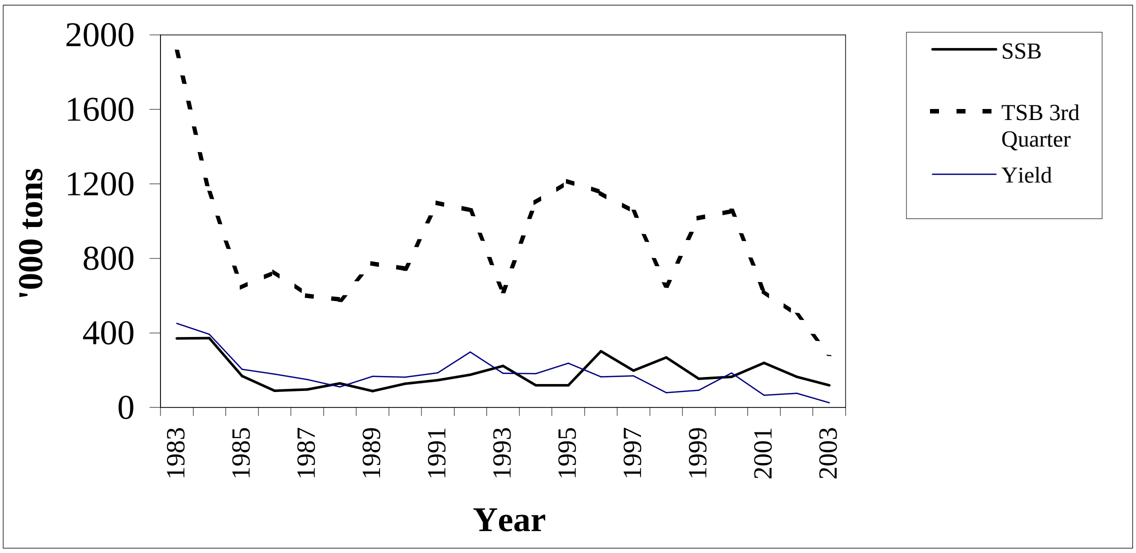


Figure 12.3.4 Norway pout. Historic performance of stock.

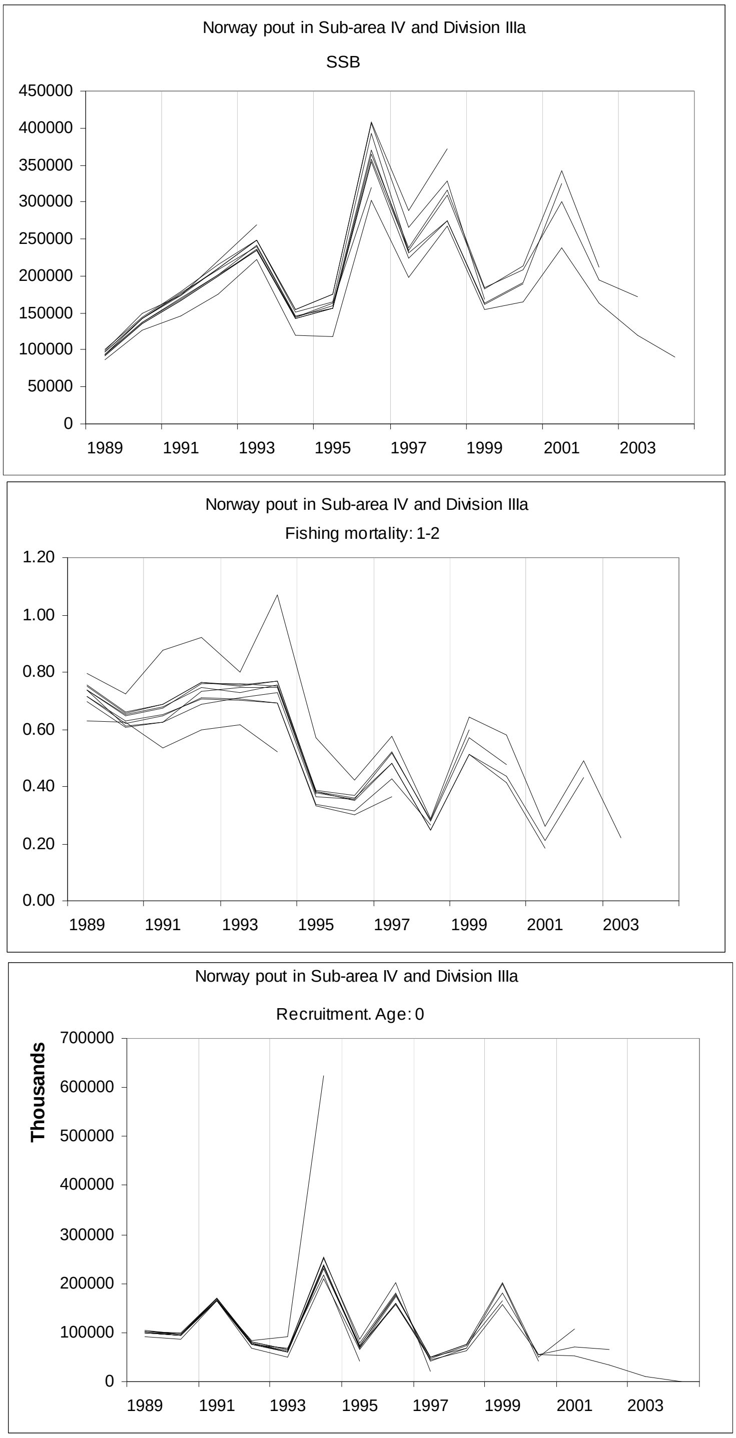


Figure 12.3.5. Norway pout IIIa and IV Retrospective plot of R, SSB and F from final assessment 2004.

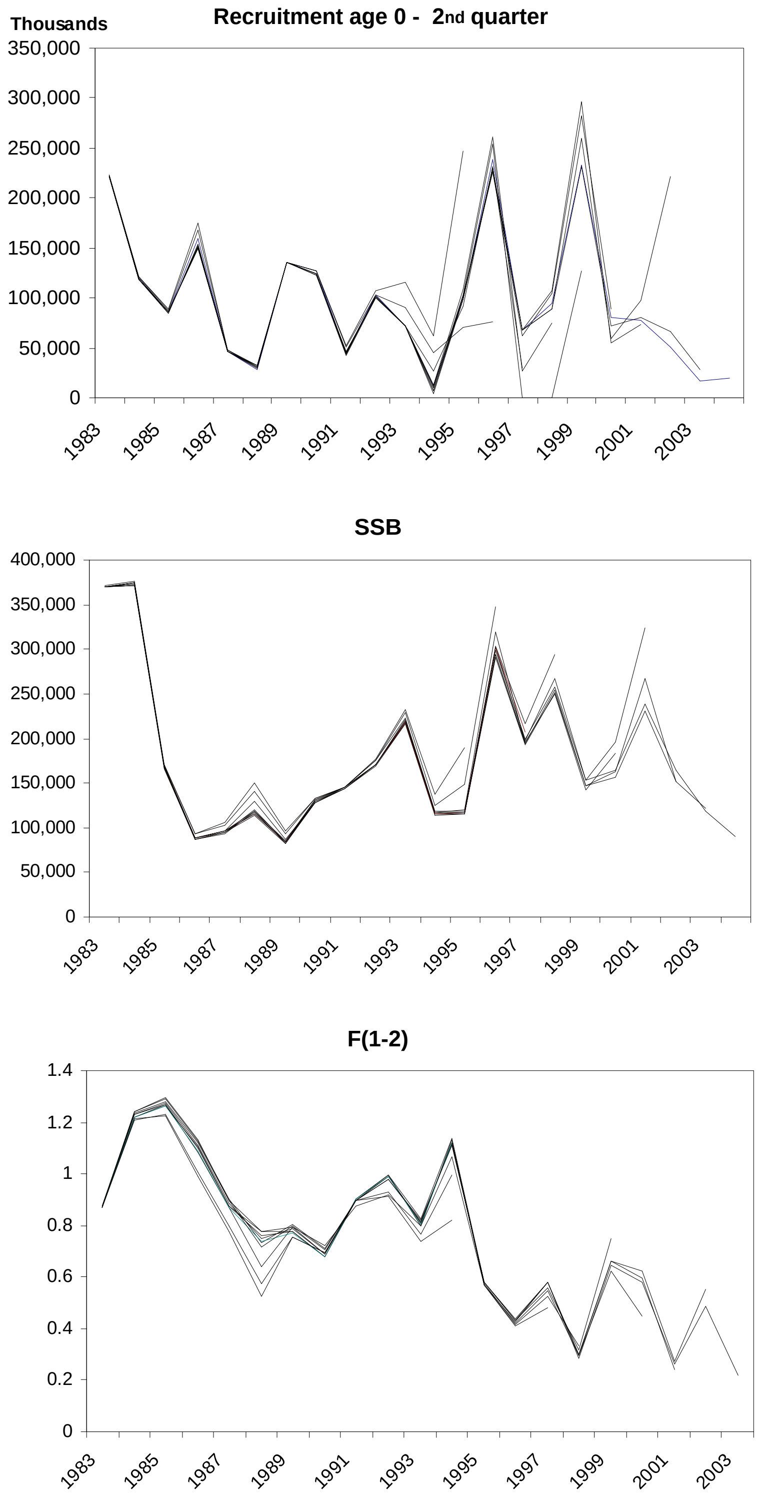


Figure 12.3.6. Norway pout IIIa and IV. Comparison of 2004 assessment to 2003 assessment.

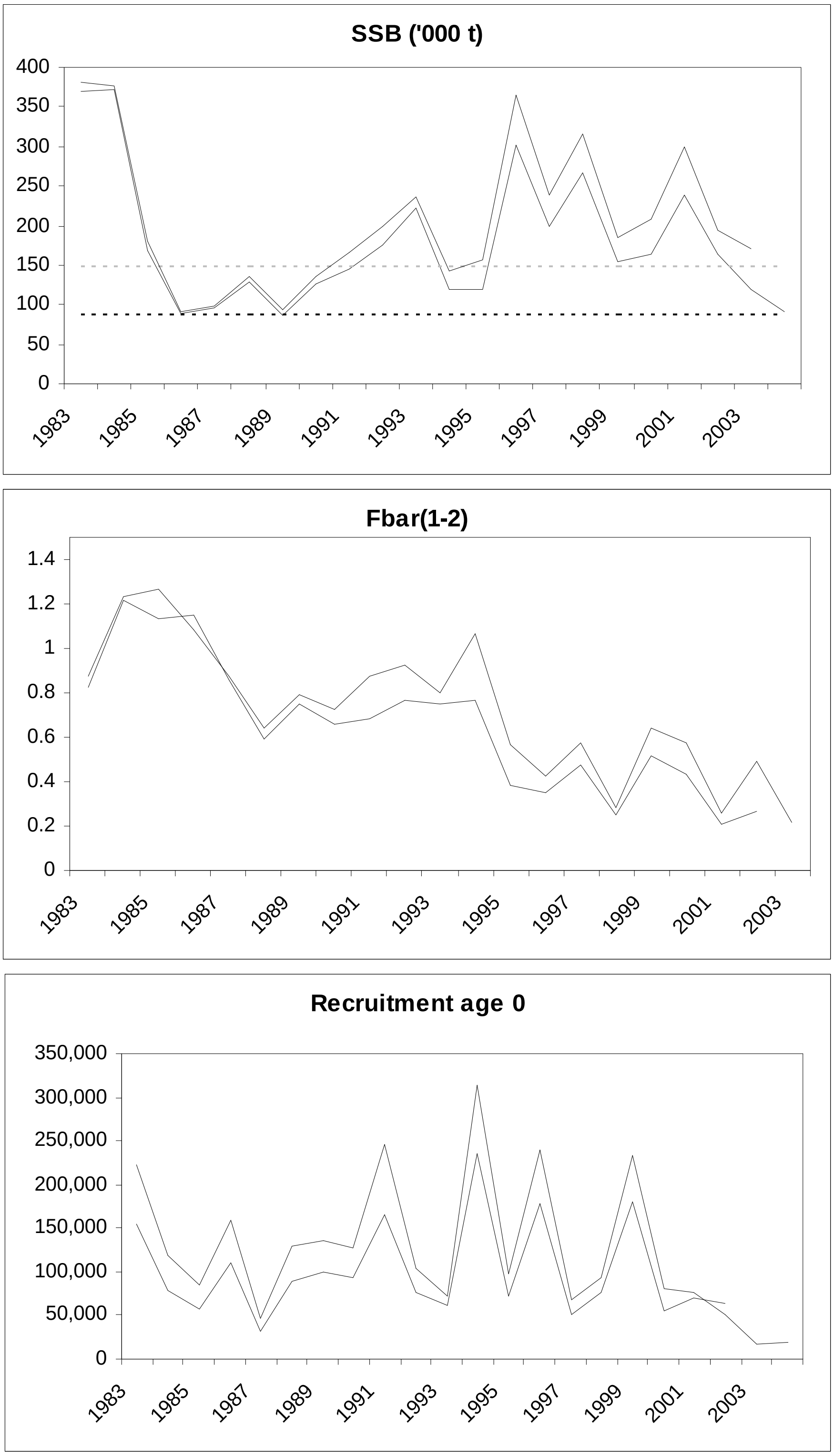


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Figure 12.3.7. Norway pout in IIIa and IV. Log inverse catchabilities, from SXSA using a cosine function option with a range of 10 cohorts. Tuning fleets previously used in SXSA tuning.

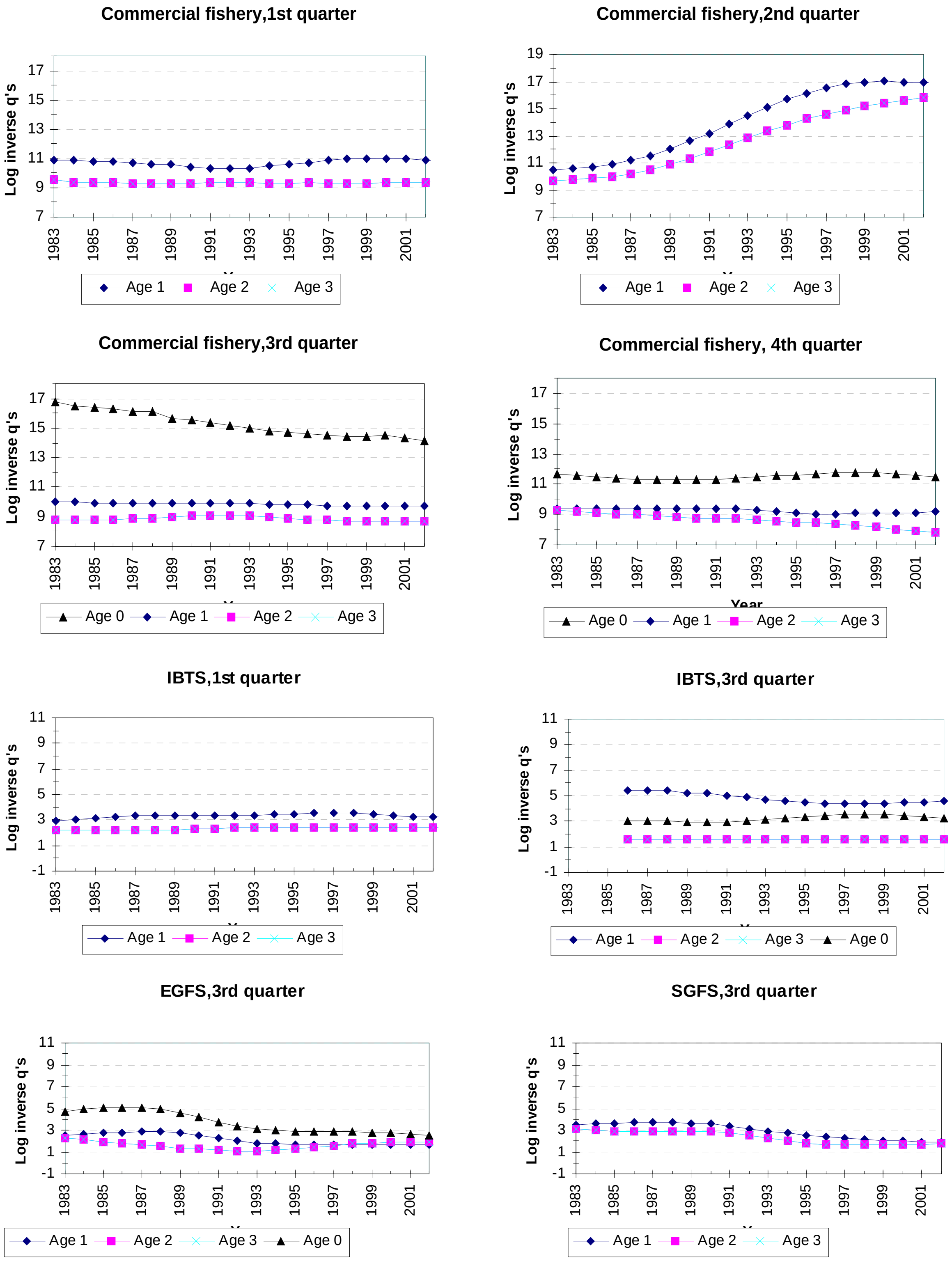


Figure.12.3.8. Norway pout IIIa and IV. Results of SXSA (Seasonal) runs with single tuning fleets compared to 2003 assessment. Upper: surveys, Lower: commercial fleet by quarter.

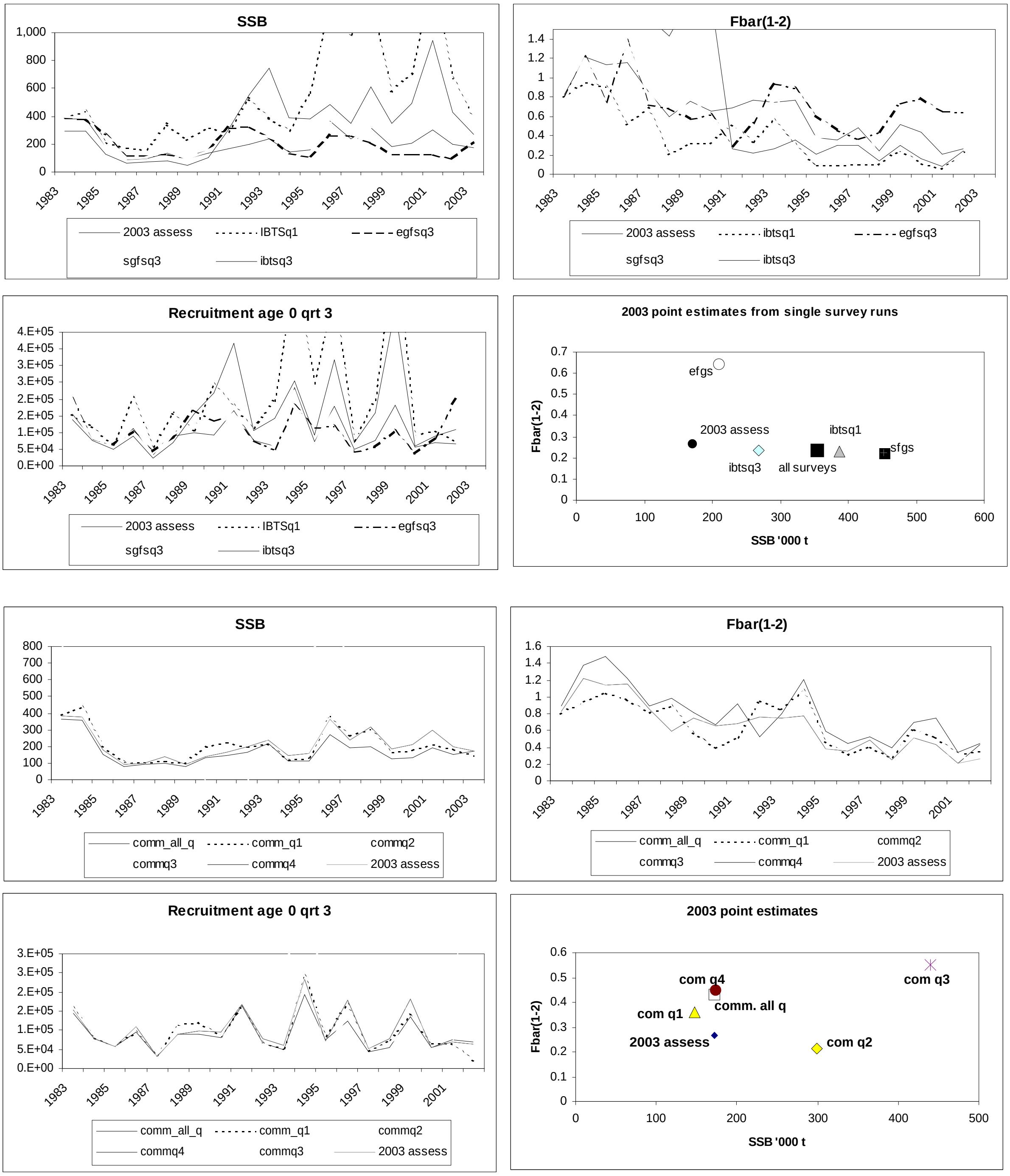


Figure 12.3.9. Norway pout IIIa and IV. Results of XSA (annual) run with 2003 assessment data; single fleet runs compared to 2003 assesment . Upper: single fleet runs; Lower: all fleets run XSA compared to 2003 assessment.

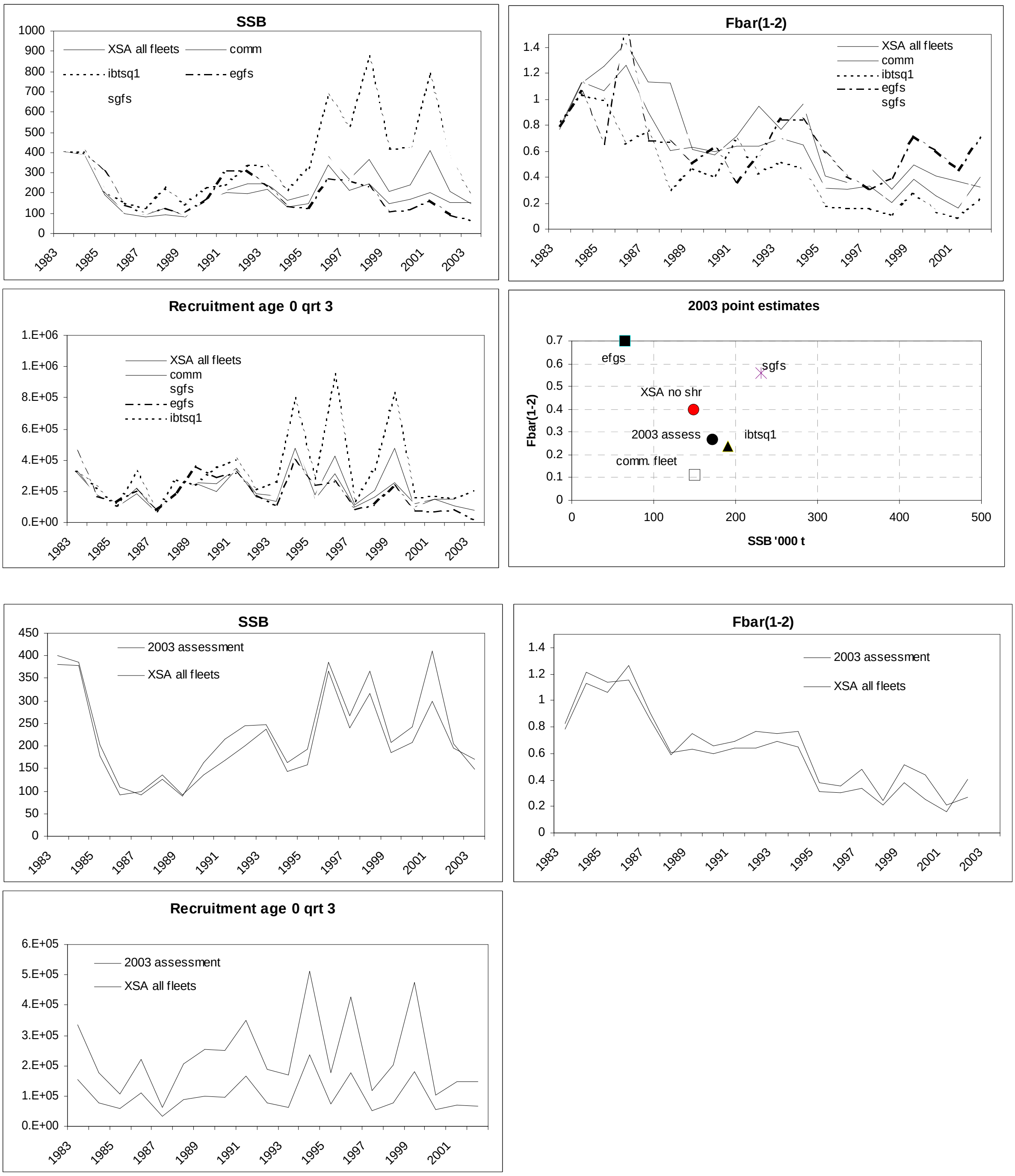
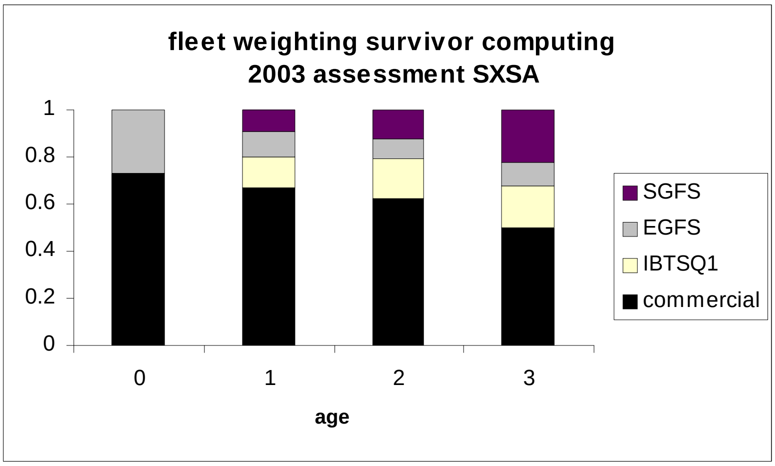


Figure 12.3.10. Norway pout IIIa and IV. Weighting of stock indices in SXSA versus XSA (both running on 2003 assessment data).



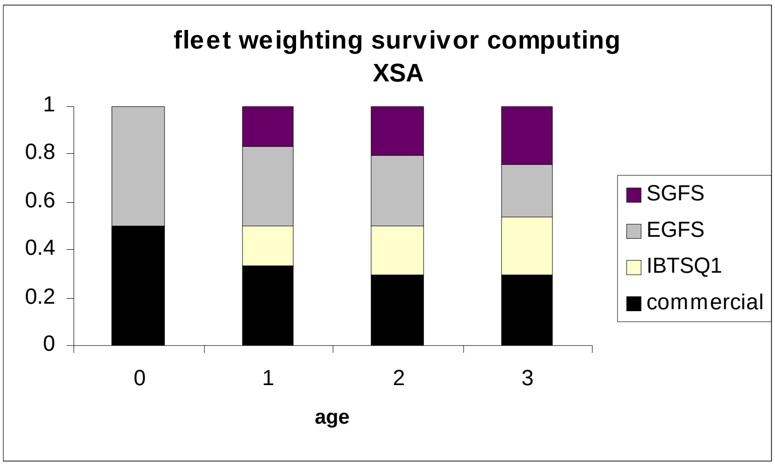


Figure. 12.3.11. Norway pout IIIA and IV. Stock summary using the new proposed natural mortalities. For the two uppermost plots, SSB and F, the new M series is associated with the right Y-axis.

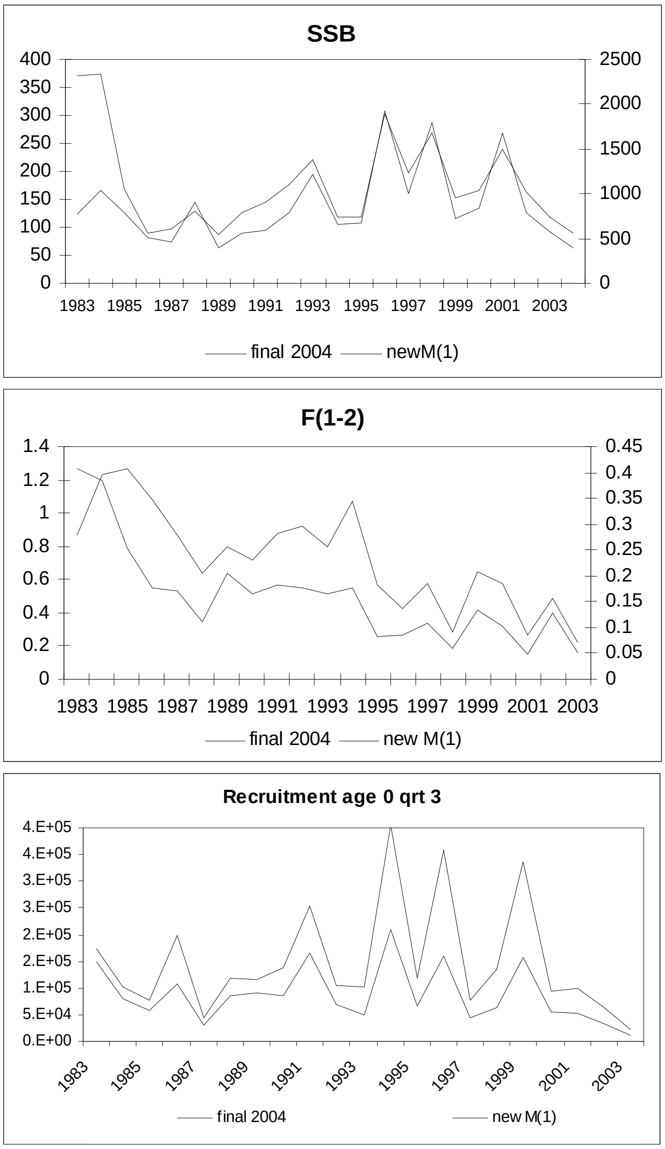


Figure 12.3.12.1. Norway pout. Catch residuals from SMS.

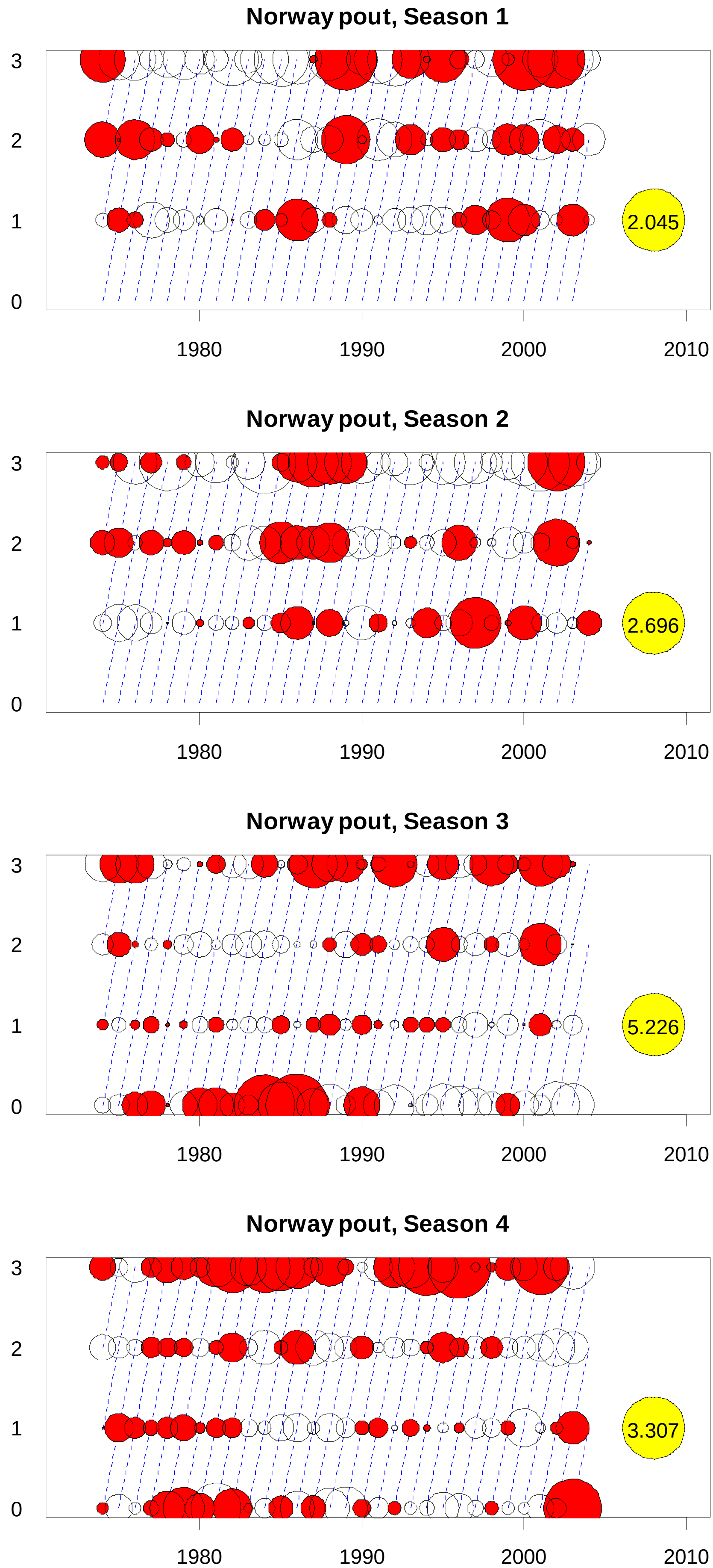


Figure 12.3.12.2. Norway pout. CPUE observation residuals from SMS.

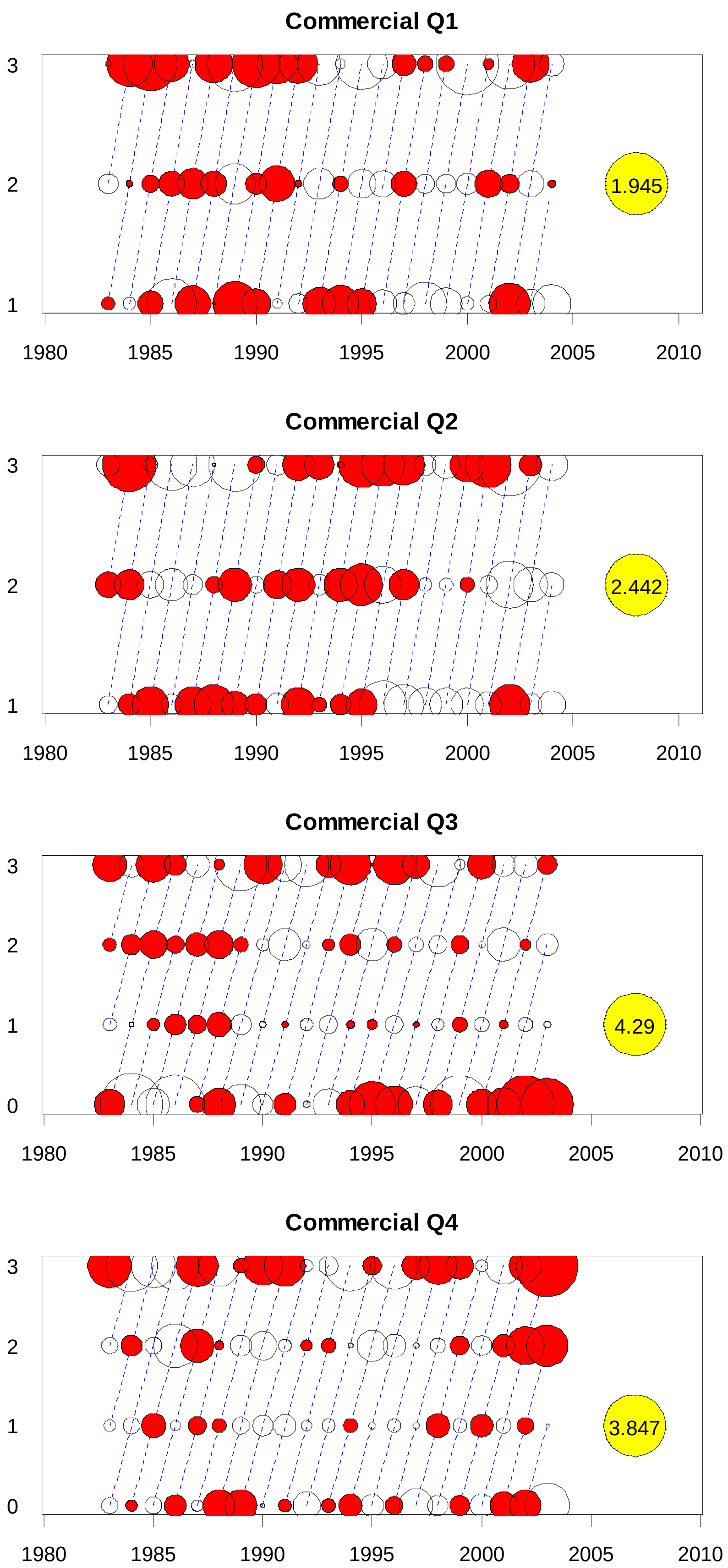


Figure 12.3.12.2. cont. Norway pout. CPUE observation residuals from SMS.

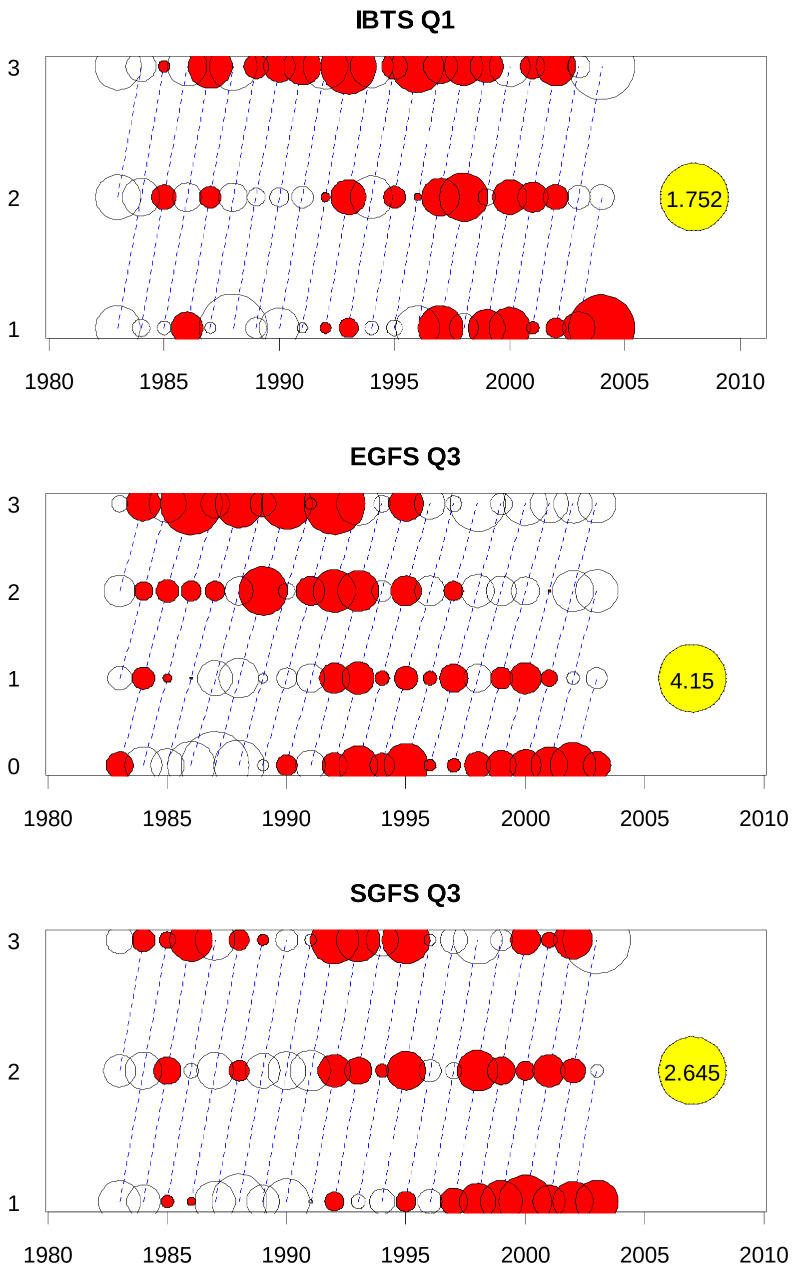


Figure 12.3.12.3. Norway pout. Mean F and SSB 1974-2004 from SMS runs (F in 2004 for first half year only)

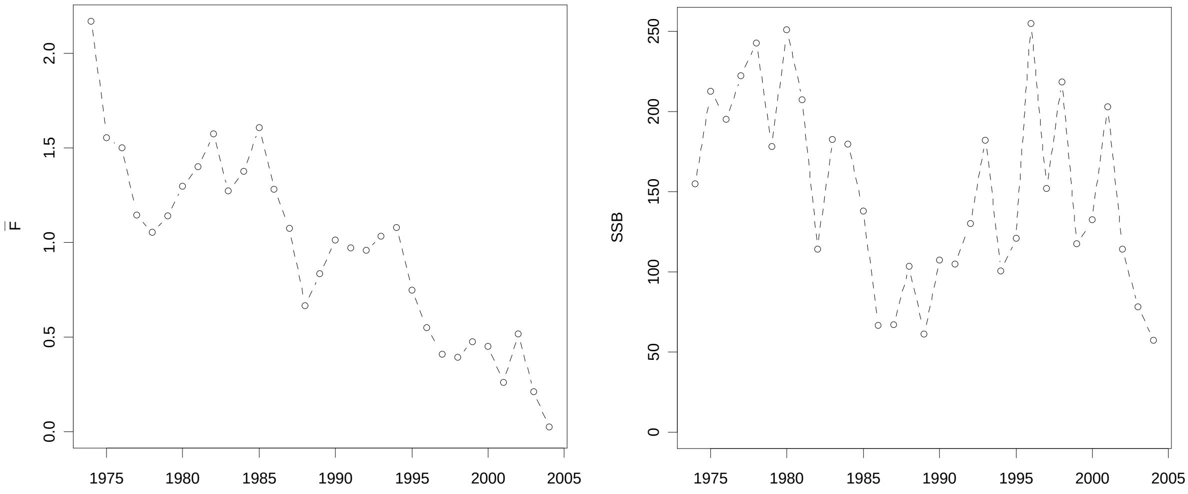


Figure 12.3.12.4. NORWAY POUT. Estimated variance on average F and SSB, (from the Hessian matrix). SMS model.

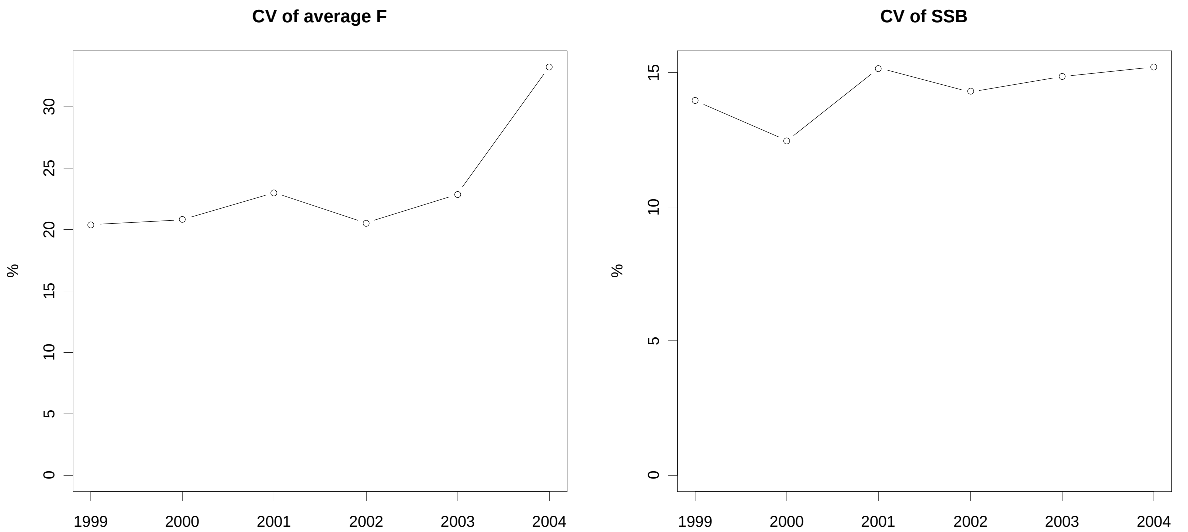
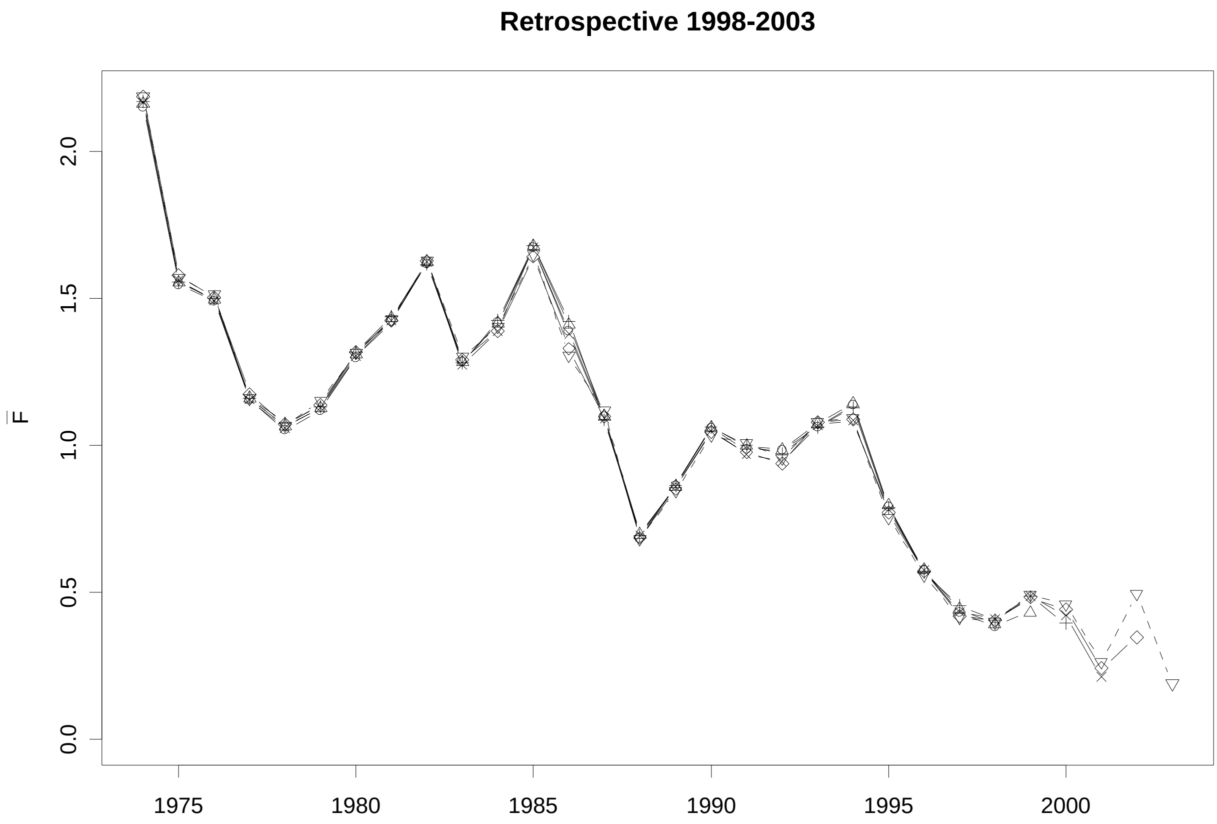


Figure 12.3.12.5. Norway pout. Retrospective runs, all fleets and full year data, SMS



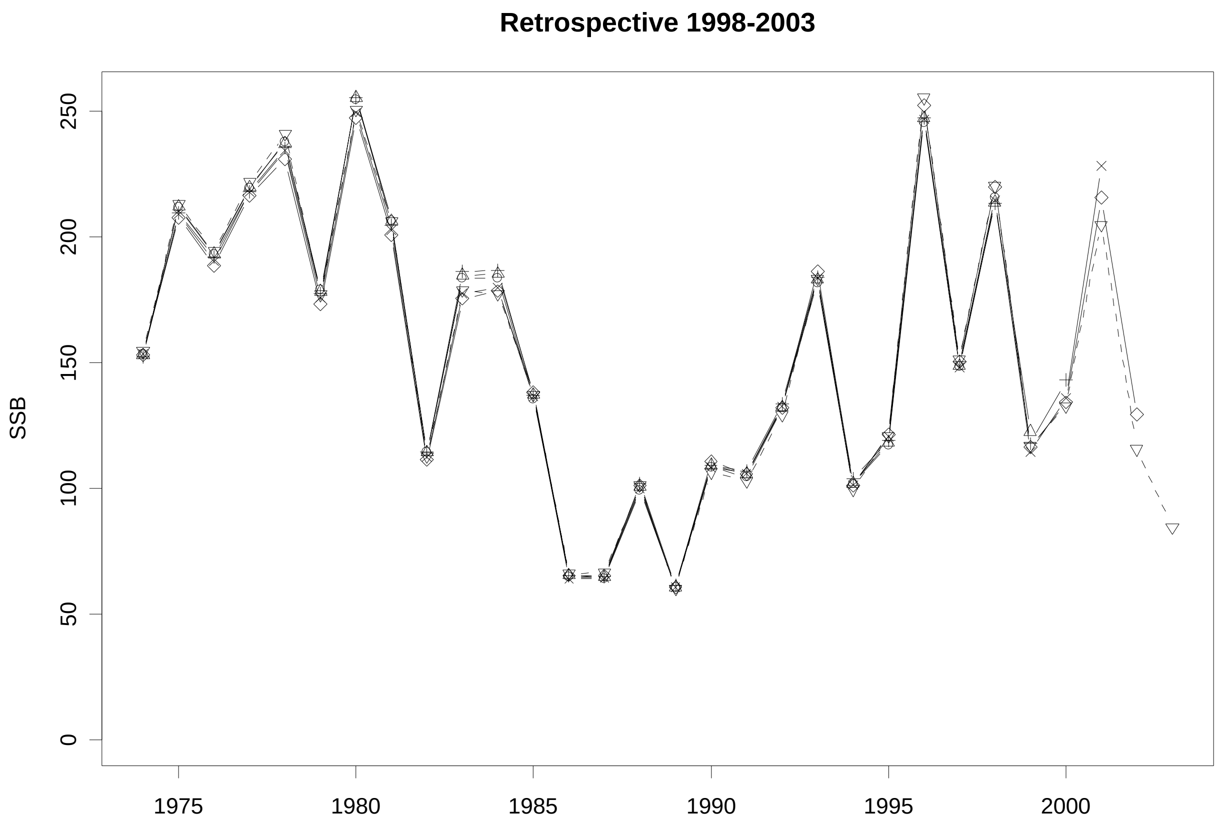


Figure 12.3.12.6. Norway pout Single fleet retrospective runs 1998-2003, full year, SMS

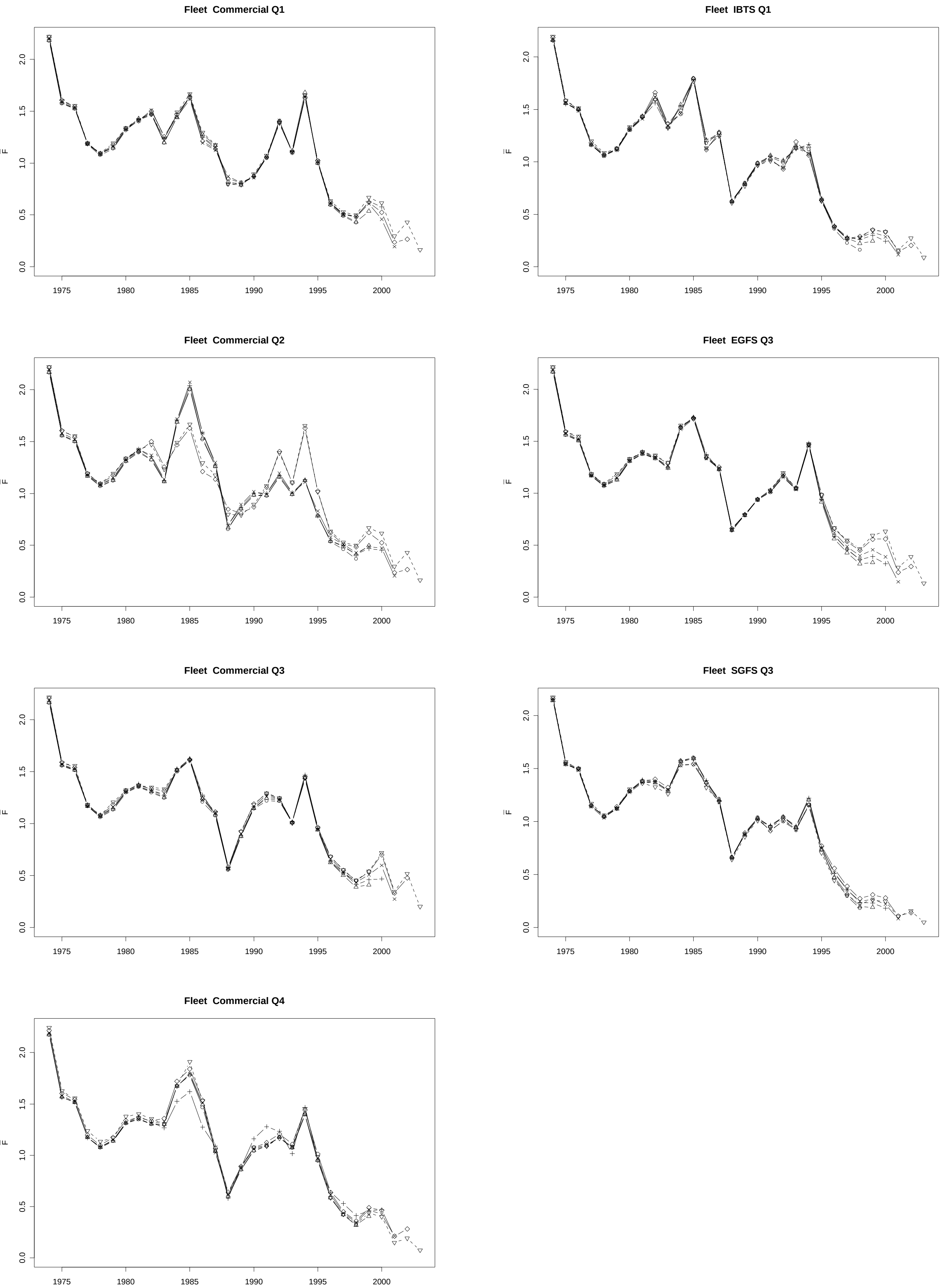


Figure 12.3.12.7. Norway pout. Tuning fleet window, all fleets data applied, assessment period 1974-2003, SMS

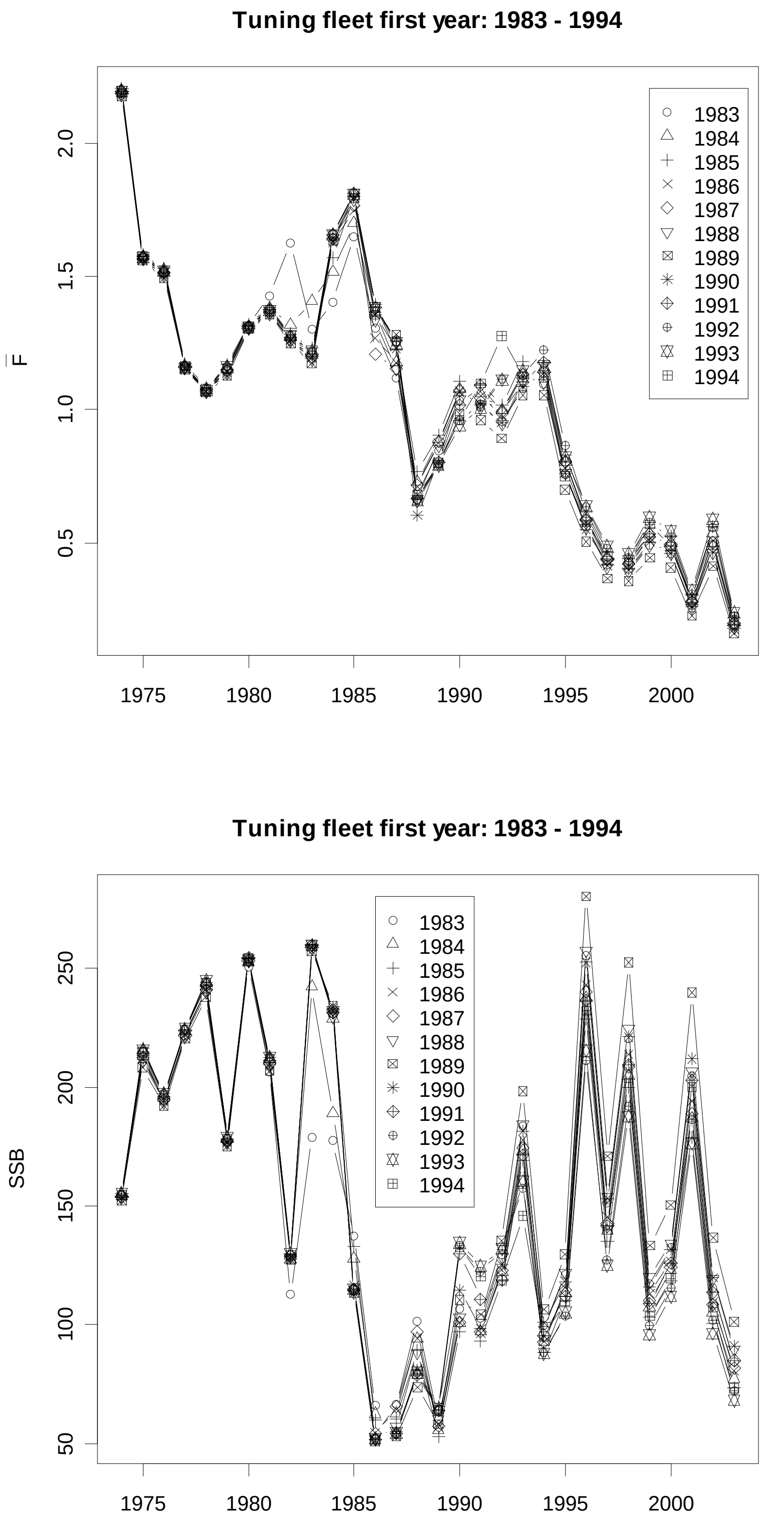
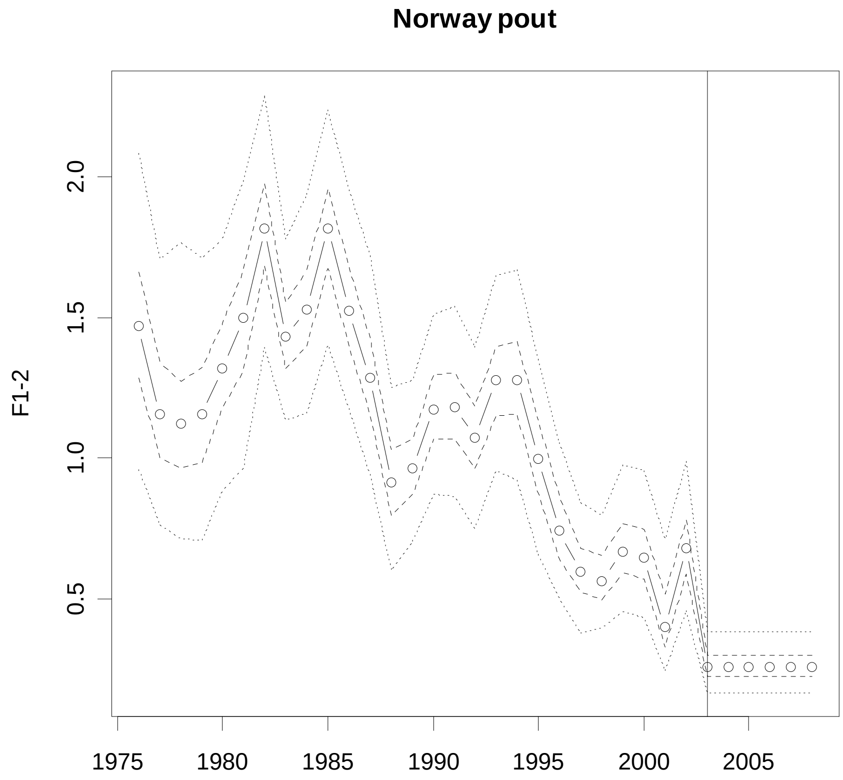


Figure 12.3.12.8. Norway pout. Posterior density of SSB, and average F estimated from 500000 Markov Chain Monte Carlo simulations. 2.5%, 25%, 50%, 75%, 97.5% quantiles are shown. SMS model.



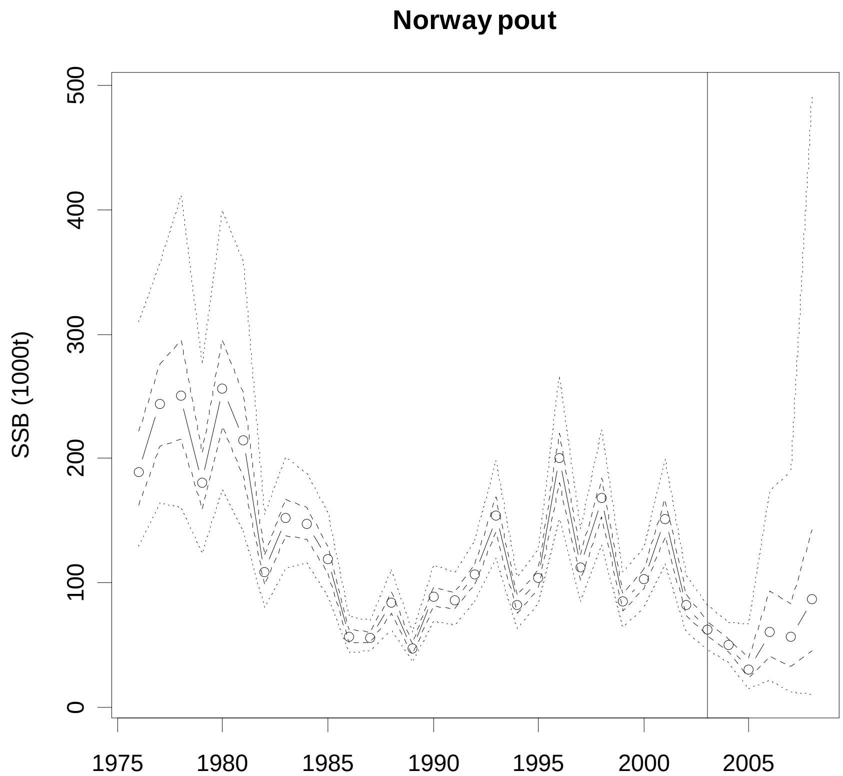
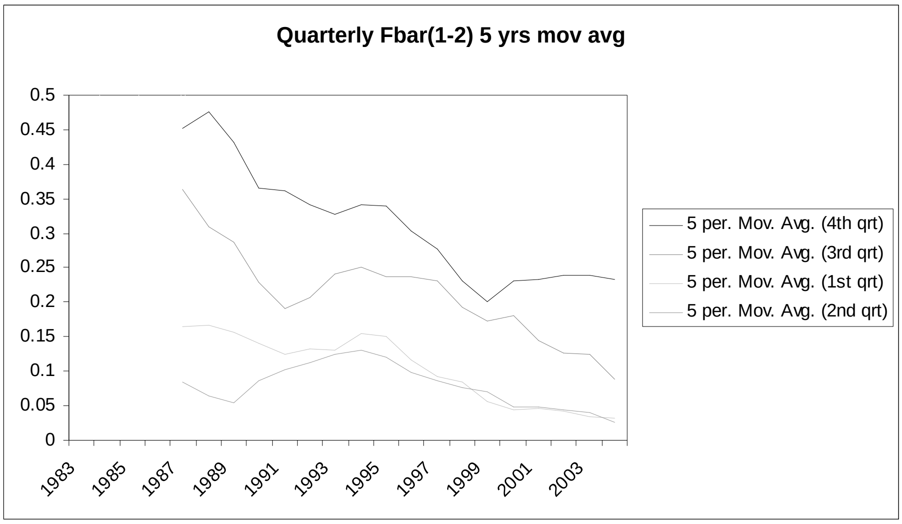


Figure 12.5.1. Norway pout IIIA and IV. Quarterly F(1-2) Upper: 5 years moving average, Lower: F(1-2) by quarter and year.



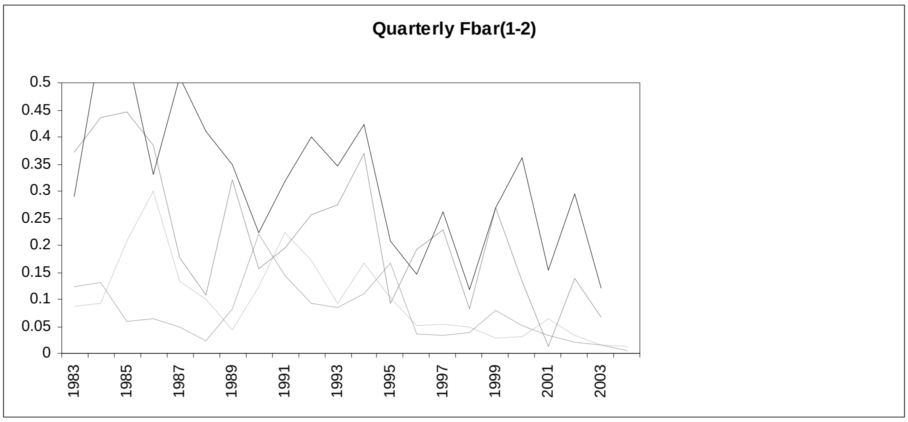
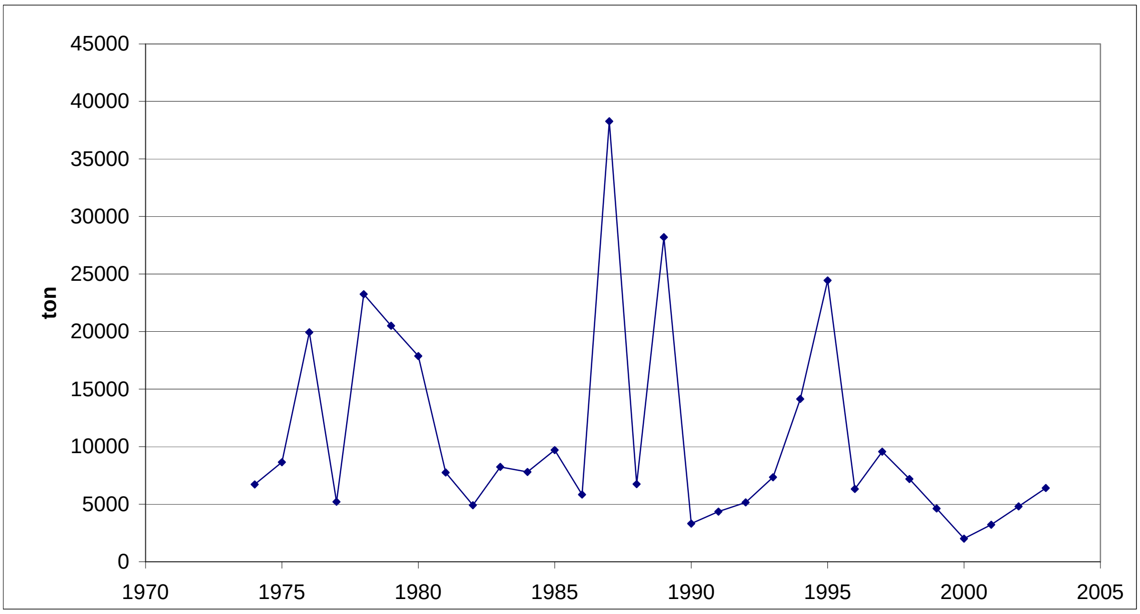


Figure 12.8.1 **Norway pout in Division VIa**
Catch trends



13 SANDEEL

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

13.1 Sandeel in sub-area IV

The assessment is classified as a benchmark assessment.

13.1.1 The Fishery

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

13.1.1.1 ICES advice applicable to 2003 and 2004

In 2003 the advice from ICES was that there is a need to develop management objectives to ensure that the stock remains high enough to provide food for a variety of predator species. The fishing mortality should not increase because of the consequences of removing a larger fraction of the food-biomass for other biota is unknown. Further, local depletion of sandeel aggregations should be prevented, particularly in areas where predators congregate.

The advice from ICES in 2003 was repeated in 2004. Further, based on the 2003 assessment ICES concluded that the state of the North Sea sandeel stock is uncertain (ICES 2003). The 2001 year-class still appeared to be abundant in 2002 but the 2002 year-class was estimated to be extremely weak. SSB in 2002 was estimated to be below B_{lim} and to increase to above B_{pa} in 2003. Due to the low recruitment in 2002 SSB was expected to be low in 2004. The scarcity of the 2002 year-class meant that the strength of the 2003 year-class was particularly important to the state of the stock in 2004. ICES advised that the fishery in 2004 should be managed through capacity control. Further, ICES advised that the exploitation in the beginning of the 2004 fishing season should be kept below the exploitation in 2003. This restriction should apply until the strength of the 2003 year class had been evaluated, at which time appropriate adjustment in management could be advised.

In the light of studies linking low sandeel availability to poor breeding success of kittiwake, ICES advised in 2000 for a closure of the sandeel fisheries in the Firth of Forth area east of Scotland (see Figure 13.1.1.1).

13.1.1.2 Management applicable in 2003 and 2004

The TAC was set to 918000 tonnes in 2003 and to 826200 tonnes in 2004.

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 and has been extended until 2006, with an increase in the effort of the monitoring fishery to 20 days, after which the effect of the closure will be evaluated.

The Council of the EU agreed in December 2003 that the Commission should implement a fishing effort regulation in 2004 for vessels fishing for sandeel in the North Sea and the Skagerrak. The Council of the EU adopted a harvest control rule based on the size of the 2003 year-class. For each member state the number of kilowatt-days in 2004 for vessels flying its flag or registered in the Community was not allowed to exceed the number in 2003. The maximum number of kilowatt-days was revised by the Commission, based on advice from the Scientific Technical and Economic Committee for Fisheries (STECF) on the size of the 2003 year class of North Sea sandeel, in accordance with the following rules:

- where STECF estimates the size of the 2003 year class of North Sea sandeel to be at or above 500 000 million individuals at age 0, no restrictions in kilowatt-days shall apply
- where STECF estimates the size of the 2003 year class of North Sea sandeel to be between 300 000 and 500 000 million individuals at age 0, the number of kilowatt-days shall not exceed the level in 2003 as calculated in total kilowatt-days

- where STECF estimates the size of the 2003 year class of North Sea sandeel to be below 300 000 million individuals at age 0, fishing with demersal trawl, seine or similar towed gears with a mesh size of less than 16mm shall be prohibited for the remaining of 2004. However, a limited fishery will be allowed in order to monitor the sandeel stocks in the North Sea and the Skagerrak and the effects of the closure. To this end the Member states concerned shall in cooperation with the Commission develop a plan for the monitoring of the fishery.

The Commission based this regulation on advice from STECF. An ad hoc working group was convened to establish a method for providing an estimate of the size of the 2003 year class by mid-April 2004 and to propose a procedure providing this estimate (STECF 2004, see Section 13.1.11).

From an estimate of the 2003 year-class and the uncertainty associated with that estimate STECF considered that continued fishing throughout 2004 with unrestricted effort carried the risk of overexploitation of the North Sea sandeel stock (STECF 2004a). The Council Regulation (EC) No 2287/2003 of 19 December 2003, in which it is stated that the number of kilowatt-days in 2004 must not exceed the level in 2003 as calculated in total kilowatt-days, was therefore maintained. This effort limit was reached for the Danish fleet in September and the Danish fishery for sandeels in the North Sea and Skagerrak (areas IV and IIIa) was closed from 13th September 2004. There is no information available about restrictions to be implemented on the Norwegian sandeel fishery for 2004.

13.1.1.3 The fishery in 2003 and 2004

Official landings statistics of sandeel by country and area of the North Sea are presented in **Table** 13.1.1.1. These are slightly higher than the landings provided by the Working Group members (**Table** 13.1.1.2). 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 catch history is shown in **Figure** 13.1.1.2. **Figure** 13.1.1.1 shows the areas for which catches are tabulated in **Tables** 13.1.1.3 and 13.1.1.4. **Figure** 13.1.1.3 shows the distribution of catches for 2003 by quarter and ICES statistical rectangle based on logbook data or sales slips from Danish, Norwegian, and Scottish vessels and for the first two quarters of 2004 based on logbook data or sales slips from Danish and Norwegian vessels. A catch of “0.0” in a rectangle indicates a very small catch or, for Danish data, that no sandeel were found in a sample from an industrial catch in the rectangle.

The sandeel fishery was developed in the beginning of the fifties and rose to a peak in 1997 (1.1 million t). The total landings of sandeels from the North Sea were at a historic low level in 2003. The landings of sandeel in the North Sea in 2003, as estimated by the Working Group members were 325,400 t, of which 84% were landed by the Danish fishery. Danish landings declined 60% from 2002 to 2003 and Norwegian landings declined by more than 80%. The distribution of landings in 2003 differed from the typical long-term pattern with generally low landings in the ICES rectangles most frequently exploited and higher landings from ICES rectangles that are usually less intensively fished (**Figure** 13.1.1.3, **Table** 13.1.1.3 and 13.1.1.4). Landings were particularly low in the north-eastern grounds (sampling area 2B, see **Table** 13.1.1.4). A relative increase in the importance of grounds close to the coast was observed. This change in fishing pattern is confirmed by the DIFRES monitoring programme, in which more detailed information about the catches of sandeels has been collected for a small number of vessels since 1999. The 2003 year-class appeared in the biological samples in mid-May, which is more early than usual, and fishing on this year-class continued through to November. The majority of these catches were taken in the areas where 0-group sandeels are most often targeted, i.e. off the Danish west coast (**Figure** 13.1.1.3).

The landings in the first half year of 2004 were at a similar low level as in 2003 (**Table** 13.1.1.5), and the same spatial trends in landings observed in 2003 was observed in 2004 (**Figure** 13.1.1.3). The tendency towards an increase in landings from grounds closer to the coast was more pronounced in 2004 than in 2003.

Total international standardized effort (see Section 13.1.3) peaked in 1989, decreased until 1994, and was followed by a small increase until 2001 (**Figure** 13.1.1.2). A decrease in effort is observed from 2001 to 2003. The landings in 2003 is 29% of the highest observed landings and the effort in 2003 45% of highest observed effort recorded in 1989. 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 large decrease from 2002 to 2003. The low levels of landings and effort seen in 2003 were carried forward into the first half year of 2004, whereas there seemed to have been a small increase in CPUE from 2003 to 2004.

13.1.2 Natural Mortality, Maturity, Age Composition and mean Weight at Age

Maturity and natural mortality are assumed at fixed values and are described in the stock annex.

The compilation of age-length-weight keys was carried out using the method described in the stock annex. The mean weights-at-age in the catch for the southern and northern North Sea in the time period 2000 to 2004 are given in **Tables** 13.1.2.3 and 13.1.2.4. Mean weight in the catch from 1983 to 2004 is given in **Table** 13.1.2.5 by half year and in **Table** 13.1.2.6 by year. Mean weight in the stock from 1983 to 2004 is given in **Table** 13.1.2.7 by half year and in **Table** 13.1.2.8 by year. The time series of mean weight in the stock and in the catch is shown in **Figure** 13.1.2.1 and 13.1.2.2. Mean weight at age show a large fluctuation over time. Most remarkable is a decrease in mean weight at age in age 2 and 3 sandeels in the first half year, the period where most of the catch is taken. Reasons for the variation in catch weight at age are discussed in the stock annex.

Catch numbers at age by half-year and year are given in **Tables** 13.1.2.1 and 13.1.2.2.

13.1.3 Catch, Effort and Research Vessel data

There are 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.

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 (see **Table** 13.1.3.1). These data for the first half year have been included in the tuning series since 2003. The effect of this on the assessment is analysed in this year's assessment (see Section 13.1.4.1.4). The reason for including the Norwegian effort data for first half year for the southern North Sea 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 the procedure for the generation of the tuning series more transparent. This issue should be addressed at the next benchmark assessment.

The vessel-size distribution of the fleet has changed through time (**Figure** 13.1.3.1). 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:

$$\text{CPUE}=a*\text{GR}^{b} \quad (1)$$

where a and b are constants and GR is vessel size in GR

Applying a logarithmic transform to (1) gives

$$\text{Ln(C/e)}=\ln(a)+b*\ln(\text{GR}) \quad (2)$$

where C = catch in tonnes, and e = effort in days spend fishing.

Since the 2003 WG meeting, 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:

$$\ln(\text{CPUE}) = d_{y}+ f_{y}*\ln(\text{GR}) \qquad (3)$$

where y = year, GR = vessel size in GR, 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 GR 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:

$$\text{CPUE}=e^{dy}*200^{fy} \qquad (4)$$

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 and used to estimate CPUE. Total standardised effort was afterwards estimated from the combined Danish and Norwegian CPUE and total international catches. The combined Norwegian and Danish effort is shown in **Tables** 13.1.3.3 and 13.1.3.4.

An additional analysis was carried out, to estimate the consequence of changing (3) to:

$$\ln(\text{CPUE}) = d_{y}+ \ln(\text{GR}) \quad (5)$$

Using (5) instead of (3) only changes the estimates of total effort slightly (**Table** 13.1.3.5). Total international effort was therefore estimated for each of the 4 fleets using the same method as during last assessment (ICES 2004).

The tuning fleets used in the assessments area given in **Table** 13.1.3.6. The CPUE for these fleets is summarised in **Figures** 13.1.3.2 and 13.1.3.3.

13.1.4 Catch at age analyses

The Seasonal XSA (SXSA) developed by Skagen (1993, 1994) has previously been used for stock assessment of sandeel. Annual XSA was tried in 2002 where it was concluded that the two approaches gave similar results (ICES 2003). For a standardization of methodology, it was decided to shift to XSA in 2002. Therefore, XSA has since 2002 been used for the final assessment. However, because data for the first half year of 2004 was available for this year's assessment SXSA is this year included as a comparison to XSA.

13.1.4.1 Exploration of data

13.1.4.1.1 A separable VPA of the North Sea sandeel catch at age data

A separable VPA was used to examine the catch at age data. The model constraints applied when fitting the model were F1(2003)=0.6 and S(1) = 1.0. These settings are based on the exploitation pattern from previous assessments.

Table 13.1.4.1 presents the log catch ratio residuals from the fitted separable VPA, the estimated selection at age and overall fishing mortality effects. **Figure** 13.1.4.1 illustrates the average selection pattern estimated for the last 6 years. **Figure** 13.1.4.2 shows the fitted year effects and **Figure** 13.1.4.3 the time series of log catch ratio residuals. Sandeels in IV are fully selected at age 1. The separable VPA suggest that the fishing mortality was at a relatively high level from 1988 to 1991. From 1992 until 1997 F was lower, compared to the previous period, but increased from 1998 to 2002. There is no consistent trend in the log catch residuals.

13.1.4.1.2 SMS

An exploratory run was generated for sandeel using SMS (see Section 1.4.3) the same input data as for SXSA (catch data by half-year). Exploratory runs showed a large variance of the catch at age observation, with minimum variance for age 1 and age 2 (CV at 60%). This high variance is mainly due to low landings (and sampling) in the second half-year. In SMS, catch at age observations have one common age specific variance and it is assumed that the variance for both half-years are evenly distributed over the year. This assumption seems not to be applicable to the half-yearly sandeel assessment.

The F at age estimated by XSA or SXSA shows highly variable age selection between the years. Therefore, the SMS assumption of constant age selection in catches is probably seriously violated. As an example of how SMS performs on half-yearly data, the retrospective pattern of F and SSB are shown in **Figure** 13.1.4.4. It is clear that the uncertainty of estimated F in the terminal year is very high, especially for the period since 2000. It is concluded that the basic assumption of a separable fishing mortality and one common variance for an age group is violated and no further runs were made with the SXSA data set.

To overcome the problem with different variance level of catch at age observation between the half-years, SMS was also tried on annual catch data (the input data for XSA analyses). Several configurations with different subsets of CPUE time series and ages included, and with different settings for variance and selectivity at age, were tried. The results from these SMS runs showed the same trend for the stock development, but e.g. F and SSB in the terminal years were highly dependant on the actual configuration of SMS. The overall conclusion of the explorative runs is that both catch and tuning data are noisy, and that the maximum likelihood method used by SMS weights the catch at age observation higher than the CPUE time series. The best fit for CPUE data is, not surprisingly, obtained for first half-year fleets that include most of the annual catch. The non-constant catchability is a problem, but is likewise a problem for XSA and SXSA that also assume a constant catchability for the tuning fleets.

13.1.4.1.3 Seasonal XSA

The Seasonal XSA (SXSA; Skagen 1994) was used to estimate fishing mortalities and stock numbers at age by half year, using data from 1983 to 2003 and first half year of 2004. The options used in run 01 were the same as in the 2002 report (**Table** 13.1.4.2). Weighting of estimated catchabilities (r_{hat}) was set manually, where the final year's data is down-weighted (**Table** 13.1.4.2).

The following 3 exploratory runs, in addition to run 01, were carried out, using the same settings as for run 01 except where indicated:

SXSA Run	Estimation of *r* (*r*=inverse catchability) Opt. 1 in **Table** 13.1.4.2	Weighting of r_{hat} (r_{hat}=estimated inverse catchability) Opt. 6 in **Table** 13.1.4.2	Weighting of s_{hats} (S_{hats}=estimated survivors) Opt. 7 in **Table** 13.1.4.2
01	Log	Manual	Manual
02	Cos. Filter Year range=5	Manual	Manual
03	Log	Manual	Log
04	Log	Manual No down weighting of r_{hat} of 2004	Log

The usual assumption in the SXSA assessments is that *r* (inverse catchability), for each commercial tuning fleet, is constant over years. In SXSA run 02 a cosine filter (option 1 in **Table** 13.1.4.2) is used in the estimation of the inverse catchability. Using this option inverse catchability is allowed to vary gradually over years, without assuming any particular model for the time dependence.

SXSA weights the estimated survivors from manually entered data or according to the variance of the estimated log catchability. The working group has used manual entered weighting factors for many years, and this setting was used in SXSA run 01 and 02, 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. The number of samples taken from the fisheries is related to the size of landings. In years with a limited fishery in the second half-year (like year 2002 and onwards) a smaller number of samples are taken which influence the accuracy of the catch at age data. To explore the effect of this weighting method two runs were made where the survivors were weighted by the inverse variance of the log catchability, instead of the manual weighting (SXSA run 03 and 04). Further, in SXSA run 04 the effect of down weighting last half years data in the estimation of the inverse catchability is explored, by giving data from first half year same weight as for data from 1993 to 2002.

The residuals of log stock number for run 01, 02, 03, and 04 are given in **Figures** 13.1.4.5, 13.1.4.6, 13.1.4.8. and 13.1.4.9. These residuals 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. There are large trends in the residuals from run 01, 03 and 04, which indicate changes in catchability over the year range of data used in the assessment. In **Figure** 13.1.4.7 log inverse catchability from run 02 (cosine filter used in the estimation of the inverse catchability) is plotted for each tuning fleet. The graph indicates that the assumption about constant catchability used in the assessment is violated. The residual plot from run 02 (**Figure** 13.1.4.6) seem to support this as the trends in the residuals does not appear in this plot (see also Section 13.1.4.1.2).

The fixed factors used in run 01 and 02 for weighting the survivor estimates from each fleet and weighting factors according to the inverse variance of log catchability (run 03) is given in **Table** 13.1.4.4. The weighting factors estimated in run 04 are almost identical to those estimated in run 03. The estimated weighting factors in run 03 show a relatively higher weighting of the first half-year fleets, but the difference between the two season is not that big as for the manually-set weighting factors. The weighting factors for run 03 are to a large extend comparable to those used in XSA (see Section 13.1.4.1.4 and **Figure** 13.1.4.14), i.e. for age-0 sandeel the fleet for the Northern North Sea in second half-year is given the highest weight, for age-1 sandeels the fleet for the southern North Sea in first half year is given the highest weight, and for age 2 sandeels the fleet for the southern North Sea in first half year is given the highest weight.

A comparison of the SXSA runs is shown in **Figure** 13.1.4.10. The 4 runs show similar trends of SSB, R and F. However SSB and F of run 02 deviate in absolute terms somewhat from the other 3 runs. Using the cosine filter in the estimation of the inverse catchability imply the addition of an extra parameter to be estimated. Further, no information is available to substantiate that catchability has changed in the latest years. Run 02 should thus be seen as exploratory with respect to catchability, and should not be considered in the evaluation of changes in stock dyamics. As the results from the other runs give similar results the choice of options has a limited effect on the assessment results. Therefore run 01 (using the same settings as those used in previous years where the SXSA was used as the assessment model) is chosen as the final assessment using the SXSA model.

The log inverse catchabilities for run 01 are given in **Table** 13.1.4.3. The stock summary plot is shown in **Figure** 13.1.4.11 and the assessment summary in **Table** 13.1.4.8. The retrospective plot is shown in **Figure** 13.1.4.12. Partial fishing mortalities by each of the commercial tuning fleets are shown in **Table** 13.1.4.5 and annual fishing mortalities in **Table** 13.1.4.6. The stock number at age is given in **Table** 13.1.4.7. As in the previous assessments (see e.g. ICES

2003) large variations in F are seen in recent years in the retrospective plot. This may be due to a violation in the assumption of constant catchability over years (see also Section 13.1.4.1.2).

A comparison between the final SXSA, the final XSA assessment (see Section 13.1.4.1.4), and previous assessments is given in Section 13.1.4.1.5.

13.1.4.1.4 XSA

An XSA analysis was carried out using data from 1983 to 2003 and the settings used in previous year's assessments (see ICES 2003 and 2004):

Settings used for tuning in XSA run 01:

Year of assessment	2004	
Assessment method	XSA	
Combined Northern 1st half-year	0-4+	1983-2003
Combined Northern 2nd half-year	0-4+	1983-2003
Combined Southern 1st half-year	0-4+	1983-2003
Combined Southern 2nd half-year	0-4+	1983-2003
Time series weights	None	
Power model used for catchability	Not used	
Catchability plateau age	2	
Surv. est. shrunk towards mean F	5 years / 2 ages	
s.e. of means	1.5	
Min. stand. Error for pop. estimates	0.3	
Prior weighting	None	
Number of iteration	28	
Convergence	Yes	

Two more exploratory runs were carried out using the same settings except where indicated in the **Table** below:

XSA Run	
2	Tapered time weighting: Power 3 over 10 years
3	Norwegian effort data not used in tuning fleets for the southern North Sea first half year

The residual plot of XSA run 01 (**Figure** 13.1.4.13) shows the same trends in the residuals as that of SXSA run 01 (**Figure** 13.1.4.5). The tuning weights estimated in run 01 with the XSA model are shown in **Figure** 13.1.4.14. The weighting of the fleets is comparable to those used in the final assessments of recent years, except for age-0 for which the fleet for the southern North Sea in the second half year is given a lower weight in this years assessment. No age-0 sandeels was found in the biological samples from the southern part of the North Sea (second half-year) in either 2002 or 2003 (**Table** 13.1.2.1).

To explore the effect of the change in the fishing pattern that seem to have taken place in the recent years (see Section 13.1.1.3) a run with the XSA was carried out using a tapered time weighting (XSA run 02). Further, the effect of including Norwegian catch and effort data in the tuning fleet for the southern North Sea in first half year was explored by an additional XSA run without Norwegian data included in this tuning fleet (XSA run 03).

The alternative settings used in XSA run 02 and 03 did not have any effect on the assessment, except for a slightly smaller estimate of recruitment in run 02 compared to run 01 and 03 (**Figure** 13.1.4.15). Further, the trends in the residual plot were the same but slightly smaller for XSA run 02 than for XSA run 01. XSA run 01 was chosen as the final assessment using the XSA model.

The diagnostic output from XSA run 01 is given in **Table** 13.1.4.9, fishing mortalities in **Table** 13.1.4.10, stock numbers in **Table** 13.1.4.11, and the assessment summary in **Table** 13.1.4.12. The stock summary plot is shown in **Figure** 13.1.4.17 and the results of the retrospective analysis in **Figure** 13.1.4.18.

13.1.4.2 Final Assessment

This year the Working Group decided to present two final assessments, one final assessment based on the SXSA model (SXSA run 01) and one final assessment based on the XSA model (XSA run 01). The WG has considerable experience in XSA. SXSA have been used for several years and recommended by ACFM, but the method does not give comprehensive diagnostics. The SXSA analysis use data from the first half year of 2004, which gives an indication of the size of the 2003 year-class. The XSA analysis estimates the 2003 year class from 0-group fishery data only, and retrospective analysis has shown that this estimate is highly unreliable.

Similar trends in both SSB, recruitment and F are estimated in the final assessments (**Figure** 13.1.4.20), the largest difference being the recruitment in 2003, where the SXSA estimate is higher than the XSA estimate. Further, the same large variations, in the recent years estimate of F observed in the last assessments is also seen in the retrospective plot of both XSA run 01 and SXSA run 01, although the tendency of underestimation of F is more consistent in the XSA result compared to the SXSA result.

The comparison of the exploratory assessments is shown in **Figure** 13.1.4.19 and a comparison between the final SXSA and the final XSA assessments to previous years assessments are shown in **Figure** 13.1.4.20. The 2001 year class is estimated to be lower in this years assessments than in previous years assessments. In 2002 the 2001 year class was estimated to be historic high, although the WG noted that this was a very uncertain estimate of the recruitment. In 2003 the 2001 year class was estimated to well above the average recruitment. The present assessments estimate the 2001 year class to be at the level of the 1983 year-class that is one of the highest recruitments in the time series.

SSB in 2004 was estimated to be at the historic low and under B_{lim} in both of the final assessments. The reason for such a low SSB is the recruitment in 2002 that is estimated to be historic low. SSB is in the final SXSA estimated to be below B_{pa} from 2001 and for the rest of the time series. In the final XSA assessment SSB is estimated to be below Bpa from 2000 and the rest of the time series. Also in 1996 and from 1989 to 1991 SSB was on a low level, but SSB has not previous to 2001 been below B_{pa} for two succeeding years.

13.1.5 Recruitment estimates

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 rather poor predictor of recruitment. Recruitment in 2003 is estimated in the final SXSA assessment to just below average and to well below average in the final XSA assessment. The retrospective pattern of the recruitment from the two final runs (the XSA and the SXSA) does not indicate a higher precision in one model over the other.

For the short term prognosis, recruitment in 2003 were taken both from the XSA and the SXSA model, to explore the sensitivity of the prognosis of the choice of model estimate. Besides several recruitment estimates for 2004 (0-group sandeels recruiting to the population in 3rd quarter of the year) were explored in the prognosis.

a) Maximum recruitment (1983-2003).

b) Geometric mean recruitment (1983-2003).

c) Minimum recruitment (1983-2003)

d) Modelled recruitment based on a relationship between the proportion of total landings made in the 2nd half year and log recruitment. The model formulation and result is in the following text table.

```
Call: lm(formula = ln.recr ~ ppn.2nd)
  Coefficients:
                    Value    Std. Error     t value       Pr(>|t|)
  (Intercept)  11.9307     0.4052      29.4418     0.0000
      ppn.2nd   5.6259      1.7179       3.2748      0.0113
  Residual standard error: 0.5971 on 8 degrees of freedom
  Multiple R-Squared: 0.5728
  F-statistic: 10.72 on 1 and 8 degrees of freedom, the p-value is 0.01127
```

13.1.6 Short term prognoses

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) have appeared in the fishery at the time of the WG, the biological samples from the fishery has not been processed to a stage where number of 0-sandeels caught can be estimated. Furthermore, 0-group CPUE is a poor predictor of recruitment (ICES C.M. 2003) and traditional deterministic forecasts are therefore not considered appropriate. Therefore the working group has previously not provided short term forecasts However, the critical state of the sandeel stock indicated by the current assessment compels us to provide at least some indicative forecasts for a range of scenarios for recruitment in the second half of 2004.

Stock and catch weights for 2004 were taken as 3-year averages of annual values. Stock numbers in 2004 were taken from the final SXSA assessment. Annual Fs at age for the forecasts were taken as the 2003 values because the terminal estimate of F in 2004 from SXSA is only for the first half year. The recruitment estimates used in the prognosis are described in Section 13.1.5.

In addition to exploring the variability in the forecasts as a result of uncertainty surrounding the 2004 recruitment, uncertainty in the terminal stock sizes and selection patterns were explored. Four scenarios were investigated, with combinations of SXSA population /F estimates, XSA population/F estimates, and the use of mean scaled vs terminal selection patterns. The following text table gives a summary of forecast SSBs under the assumption of geometric mean recruitment in 2004, all SSBs are in thousands of tonnes.

	SXSA F2003	SXSA Fscaled	XSA F2003	XSA Fscaled
SSB				
2004	238	238	285	285
2005	517	492	351	345
2006	579	536	480	461

Forecast SSBs are therefore highly influenced by the choice of input model and assumptions, with SXSA and F2003 being the most optimistic although even this fails to indicate a return to SSB above Bpa by 2006.

The forecast tables covering the full range recruitment scenarios for 2004 and input models are given in **Tables** 13.1.6.1-13.1.6.4. The range of SSB forecasts for 2004 is 238-285 kt, while SSB in 2005 ranges from 345-517 kt. SSB in 2006 is highly influenced by recruitment in 2004, with a range of 175 to 1769 kt using the extremes of historically observed recruitment. The GM recruitment and the modelled recruitment are of similar magnitude and consequently give similar estimates of SSB in 2006 at 401-579 kt. The modelled recruitment relies upon total catches for 2004 being known. At the time of the working group, the Danish fishery had been closed due to the European Commission's management regime for 2004, although the Norwegian fishery was continuing. This model may therefore underestimate recruitment. If recruitment in 2004 is at the same level as the minimum previously seen, SSB in 2006 is predicted to fall below B_{lim} again.

The SXSA assessment indicates F in 2004 to be lower than that observed in 2003, hence the forward projection of F2003 may lead to an overestimate of landings in 2004 and hence lower SSB in 2005. Terminal estimates of F in recent assessments have, however, been subject to major upwards revisions with the addition of more years data. There is therefore a large degree of uncertainty in the estimates of F used in the projections, as well as the uncertainty regarding the recruitment in 2004.

Despite the uncertainty in recruitment estimates for 2004, the SSB in 2005 is not projected to rise above B_{pa}, and recruitment in 2004 will have to be above average if the SSB is to rise above B_{pa} in 2006 under the assumption of a continued fishery at current levels.

13.1.7 Medium term prognoses

Medium term prognoses are not appropriate for sandeels, because of their short life-span.

13.1.8 Biological reference points

Information about biological reference points for sandeels in Sub-Area IV is included in the stock annex.

13.1.9 Quality of the assessment

The assessment of sandeels in IV is carried out without fisheries-independent indices of sandeel abundance. The tuning fleets used in the assessment are thought to be representative of the total landings of sandeels in the North Sea. Different sampling approaches have been tried during scientific surveys (see e.g. Jensen et al. 2001, STECF 2004b) but presently no scientific survey series exist that can be used for the assessment. The large decline in the stock size (Section 13.1.4.1) and landings (Section 13.1.1.3), and the change in fishing pattern seen in the latest years (Section 13.1.1.3) lead to a higher uncertainty in the assessment and seem to invalidate the assumptions of constant catchability that the assessment is based upon (see e.g. Section 13.1.4.1.3). Given the current dependency on the data from the commercial fishery and the potentially critically state of the stock, there is an urgent need to develop survey-based fishery-independent indicators of sandeel stock development.

13.1.10 Management considerations

There is a need to ensure that the sandeel 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.

No fishing mortality (*F*) reference points are given for sandeels in the North Sea because mortality appears to be determined mostly by natural causes rather than by fishing. The recruitment of sandeels seems more linked to environmental factors than to the size of the spawning stock biomass (Arnott and Ruxton 2002). Nevertheless, B_{lim} has been set to the historic lowest level of SSB that gave a recruitment about the average level. Until 2003 the sandeel stock has been considered to be within safe biological limits, and the stock has been able to sustain the fishing mortality. However, in the 2003 ICES assessment (ICES 2004) SSB was estimated to be below B_{lim} in 2003, and ICES reported that the state of the North Sea sandeel stock was uncertain.

The sandeel stock size shows large fluctuations over time, mainly due to large variations in the recruitment pattern. The scarcity of the 2002 year-class means that the strength of the 2003 year-class was particularly important to the state of the stock in 2004. The present assessment estimates the 2003 year-class from half the average (the XSA assessment) to just below the average recruitment (the SXSA assessment). The short-term prognosis, although uncertain, predicts SSB in 2005 to be below B_{pa} and possibly below B_{lim}.. SSB in 2006 is predicted to rise above B_{lim} in 2006 only if the recruitment in 2004 is at the average level. If recruitment in 2004 is low, SSB in 2006 is predicted to be below B_{lim}.

A close monitoring of a stock in 2005 is needed in order to get an early estimate the size of the 2004 year-class. In the case of low recruitment in 2004, fishing effort should be restricted to a level which will ensure that SSB in 2006 will be above B_{pa}. The real time monitoring system implemented in 2004 (see Section 13.1.11) could be implemented in 2005, with the expansion also to consider the effect of the fishery on the spawning biomass in 2006 (see comments below on the advantages and disadvantages of this approach).

Although the assessment is uncertain, all data available indicate that a drastic change in the stock development has taken place in recent years. The landings in 2003 and 2004 are at a historic low level, and both the XSA and the SXSA assessment estimate SSB in 2004 to be at an historic low and well below B_{lim}. Although SSB was also on a low level in 1996 and from 1989 to 1991, SSB has previous to 2001 not been below B_{pa} for two succeeding years. In this year's assessment, SSB is estimated to have been below B_{pa} from 2001 onwards. The decline in the North Sea stock abundance in 2003 seems to be linked to a decline in the density of sandeels in the entire North Sea, and is thus not only limited to the fished areas (see Section 13.1.12). If this change in the stock situation is caused by changes in the environment this may suggest that the reference points used for sandeels need to be revised. However, presently there is not data to quantify a link between changes in the environment and sandeel population dynamics, although sandeel recruitment is supposed to be influenced by e.g. climate changes. In case of a regime shift it is uncertain if the sandeel stock will be able to sustain the historic fishing effort.

In Section 13.1.12 the possible effect the implementation of different management tools on the sandeel population is discussed. The potential effects of implementing closed areas, closed seasons or a minimum landing size could not (yet) be assessed quantitatively.

A range of options for managing the fishery in 2005 could be considered. The following overview summarises the possible management measures and the qualitative effects that these measures are expected to achieve in terms of advantages (indicated by "+") and disadvantages (indicated by "-").

1 A total closure of the fishery

+ A closure will be the most effective way of reducing fishing mortality and promoting stock increase.

- In the absence of fishery-independent abundance indices, a closure of the fishery will mean that no information will be available to monitor changes in stock abundance.

2 Real time management/in year advice, based on monitoring of the fishery, with the following options:

2.1 Unrestricted fishery for the whole fleet in the start of the fishing season

+ A real time management system was carried out in 2004, and this approach has proven suitable for estimation of the year class strength of the previous year's recruitment.

- An unrestricted fishery during the start of the fishing season will carry the risk of recruitment and growth overfishing. The extent of this risk is unknown, but may be relatively small due to a tendency for fishing effort to be lighter at the start of the season (i.e. before a management decision can be implemented; see the text table in Section 13.1.11). However, fishing effort may become concentrated to the start of the year if real-time monitoring is continued, which would increase the risk of overfishing once more.

2.2 Unrestricted fishery for a selection of the fishing fleet ("sentinel" fishery)

+ A real-time management system will enable the monitoring of the changes in population size. The fishing mortality exerted on the sandeel population could effectively be adjusted (by delimiting the number of vessels) to reduce the risk of recruitment overfishing and local depletion of sandeels. Experience with an unrestricted sandeel fishery for a selection of the fishing fleet does not exist. However, since 2000 a small number of vessels have been allowed a restricted fishery in the Firth of Forth area that has otherwise been closed (see Section 13.1.1.3). The performance of this monitoring programme has yet to be evaluated.

- The information collected from a reduced monitoring programme could be more uncertain than the information from the whole fishery.

3 A fixed TAC restricted fishery

+ A TAC restricted fishery provides opportunities to monitor changes in the stock abundance and provide data for stock assessment.

- A fixed TAC restricted fishery carries the risk of recruitment and growth overfishing. This concern will be specially pronounced in case of a low 2004 year-class.

The WG highly recommends that fisheries-independent indices of sandeels should be generated for use in stock assessment. The experience from the latest years, when fisheries data are getting more noisy concurrent with a declining trend in stock abundance (see also Section 13.1.9), shows that a fishery-independent index of abundance would greatly improve the knowledge about the present stock situation and expand the options for managing the fishery.

The WG recommend that an additional XSA analysis will be carried out this year before the ACFM meeting, using data from the total Danish fishery for 2004 (the Danish sandeel fishery was closed 13th September, see Section 13.1.1.2), and Norwegian data up to October 2004, to present the most updated information about the stock situation.

13.1.11 Real time management of sandeels in the North Sea in 2004

The Council of the EU agreed a fishing effort regulation for vessels fishing for sandeel in the North Sea and the Skagerrak during its December 2003 meeting (Council Regulation (EC) No 2287/2003). The background for the implementation of this regulation is described in Section 13.1.1.1 and 13.1.1.2.

An *ad hoc* working group was convened in early 2004 to establish a method for providing an estimate of the size of the 2003 year class by mid-April 2004 and to propose a procedure for providing this estimate. The *ad hoc* group established a method for estimating the size of the 2003 year-class using data from the Danish fishery in March and April of 2004. This method generates weekly estimates of accumulated CPUE for 1-group sandeels from the Danish commercial fishery in the first part of the fishery season. Based on a regression of VPA population numbers of age-1 sandeels and the historical CPUE of 1-group sandeels the observed CPUE of 1-group sandeels in 2004 is used to quantify size of the 2003 year class. In this procedure historic values of fishing mortality and natural mortality were used to back calculate the abundance of 1-group sandeels 1st January 2004 to abundance of 0-group sandeels in 2003.

A four step process was used to estimate the size of the 2003 year class:

1. Forward calculation of 0-group abundance to the 1st January 2004 as 1-group.

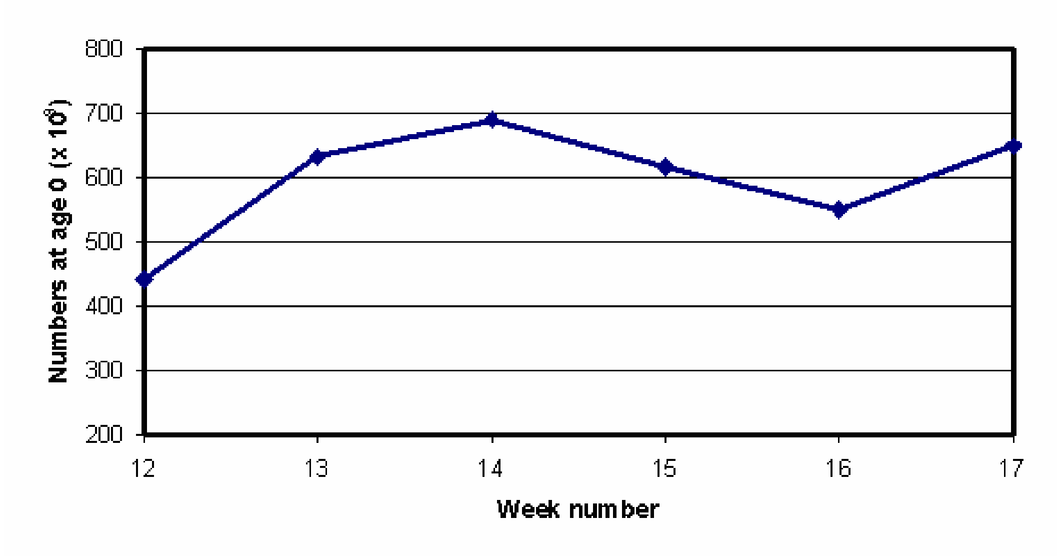
2. CPUE (tonnes per day absent) is standardised to a 200GT vessel. This is necessary due to changes over years in the size composition of the fleet.

3. Estimation of a standardised CPUE (numbers per day) for 1-group sandeels. In this step data from the biological sampling programme is used to determine the proportion of 1-group in the landings.

4. Conversion of standardised CPUE into a population estimate from a regression of historical CPUE against VPA population numbers at age 1, 1st January.

In order to determine the earliest time in the year at which year-class strength can be determined with reasonable accuracy, this procedure was performed on cumulative, weekly data for a range of weeks (12-26). For example in week 14, for each year, data from weeks 12-14 was used in each of the above steps. Week numbers were calculated starting from 1st January. The procedure thus requires weekly estimates of CPUE and the proportion of 1-group sandeels in the catches.

Using this procedure and data up to the end of April 2004, the *ad hoc* working group estimated the size of the 2003 year class to approximately 650 billions slightly less than the long-term average estimated by the XSA in 2003.



Abundance estimates of the 2003 year-class at age 0 sandeel by week 17 of 2004.

In the table below the estimate of the 2003 year class derived from the real time monitoring procedure is contrasted to the estimates from this years assessment using the SXSA (see Section 13.1.4.1.3) and the XSA (Section 13.1.4.1.4) models.

Method	Real time monitoring	XSA	SXSA
$N \cdot 10^9$ age-0 in 2003	650	354	561
Average recruitment ($N \cdot 10^9$) 1983-2003		656	620

The estimate of the 2003 year class estimated from the real time monitoring procedure is on about the average level of the recruitment estimated for the time series 1983 to 2003 of both the XSA and the SXSA model. The estimate is slightly higher than the SXSA estimate for 2003 and much higher than the XSA estimate for 2003.

An analysis of the performance of the model using historical data up to and including week 17 showed that the method misclassified (overestimated) year-class strength in 20% of cases, and underestimated year-class strength in 7% of cases. For year-classes less than 500 billion at age 0, over-classification occurred in 50% of cases and under-classification (below 300 billion) occurred in 17% of cases.

The real time monitoring system implemented in 2004 was only used for in-year assessment of the size of the 1-group population in relation to a pre-defined population size. No attempt was made to investigate the impact of implementing the management plan in terms of the subsequent effect on established spawning biomass reference points. It is therefore not clear if the restrictions on effort will reduce fishing mortality to a level that will ensure sufficient escapement of the 1-group sandeels to safeguard the level of SSB in 2005.

Because no recruitment index of sandeels exist, real time management is presently the only way to estimate year-class strength of sandeels in due time before the start of the main fishing season. Real time management in 2004 showed that the size of the year class in previous year can be estimated at week 17 approximate middle to end of April, and that this can be transferred into a management response in the middle of May. The **Table** below shows, that the percentage of the catches taken by the end of April in recent years has been on about 117000 t and about 240000 t by the end of May. As the largest part of the landings in May is known to be taken towards the end of that month average landings at the time when management can be made on the basis of a real time monitoring system will be between 117000 and 240000 t comprising 15 and 31% of the annual total catch.

The *ad hoc* STECF WG concluded that the variance of estimated CPUE of 1-group sandeels were relatively low. However the relationship between CPUE and XSA estimated stock numbers was more uncertain. Thus improving the precision of the stock assessment will also improve the performance of the real time monitoring. Alternatively it could be considered that a more robust measure of stock abundance, e.g. age independent CPUE (x ton landed per day) could be applied.

The real time monitoring system could be expanded to also consider the effect of the management on the spawning stock biomass, as well as including analyses of spatial effects of the fishery on the sandeel stock. Spatial effects may be considered through analyses of catches from smaller areas and CPUE data correspond to those areas.

Total landings by year and different time periods taken by Danish, Norwegian and Scottish vessels in the North Sea (from **Table** 13.1.1.3)

Year	Total landings	Total landings Jan-Apr	Total landings Jan-Apr + half of May	Percentage of landings taken from Jan-Apr	Percentage of annual landings taken from Jan to middle of May
1994	769279	116498	252204	15	33
1995	917959	18626	160913	2	18
1996	760737	44142	139566	6	18
1997	1102447	179680	319980	16	29
1998	961130	215541	351687	22	37
1999	695016	155864	288809	22	42
2000	666429	10850	135303	2	20
2001	813803	122810	230305	15	28
2002	809291	251634	420162	31	52
2003	303598	53921	107174	18	35
Average	779969	116957	240610	15	31

13.1.12 Norwegian request for advice on the effects of technical management measures

Rationale

This Section is the answer from the WG to a request from the Norwegian government to ICES for advice on "the uncertain situation for the sandeel stock in the North Sea" (7.7.04). The Section is based on two working documents presented for the WG (Wright and Jensen 2004, Johannessen et al. 2004) and input from the WG. The Norwegian request asks for advice on the effects of three possible technical measures; minimum landing sizes, closed areas or closed seasons. Clearly, any such measures should take account of the information on seasonal availability and population structure of North Sea sandeels. At present there is insufficient information to quantify the possible effect of such measures. Therefore, the following Sections will review the potential benefits of each measure in relation to our current understanding of the stock. The WG has also chosen to consider alternative management actions to those mentioned in the request from the Norwegian government. These additional management actions are: regional TACs and real time monitoring of the sandeel stock in 2005.

Background, biology and fishery

The sandeel landings from the North Sea consist almost entirely of the lesser sandeel (Ammodytes marinus; Popp-Madsen, 1994) and so only this species is described below.

Sandeels are characterised by bank affiliated resident juvenile and adult life stages (Kunzlik et al., 1986, Popp Madsen, 1994, unpubl. data, Wright et al., 1998) coupled to specific areas of sediment (Wright et al., 1998; Wright et al., 2000). The patchy distribution of this sediment is a key constraint on the distributional extent of sandeels, following settlement. The eggs are also demersal and are spawned directly onto the sandy areas they inhabit. Consequently, dispersal between patches of suitable sediment is confined to the pelagic larval stage (Berntsen, et al. 1994; Wright et al., 1998; Proctor et al., 1998; Munk et al., 2001; Jensen et al. 2003), which lasts between 1 and 3 months (Wright and Bailey, 1996; Jensen, 2001). Estimates of passive transport during this phase indicate varying levels of exchange between spawning grounds (Proctor et al., 1998). As a result inter-mixing across sandeel aggregations within the North Sea stock is limited. Furthermore, the relative geographic and hydrographic isolation of some sandeel aggregations, such as near the Firth of Forth, make them dependent on local spawning. Given the potential for differences in recruitment and mortality between local populations, the present management of the stock by a single TAC covering the whole North Sea makes these populations vulnerable to regional specific overexploitation.

There is considerable variation in size and maturity at age between regions and banks within the North Sea. Sandeels in coastal areas off Shetland (Wright, 1996), Norway (Bergstad et al. 2001) and off the Firth off Forth (Wanless et al., in press) have much lower growth rates than those from offshore banks (Macer. 1966; Bergstad et al. 2001) and as a result mature at older ages (Gauld & Hutcheon, 1990; Macer, 1966; Jensen et al., 2001). This regional difference in growth and reproductive potential has implications for the maximum fishing mortality an area will support and the duration of any recovery time resulting from a local collapse, but little information is available to test this. For example, although sandeels are very patchy distributed and that densities can be very high in the areas where they occur (see e.g. Jensen et al. 2003) density dependent effects on growth and mortality have not been analysed for sandeels in the North Sea.

The size of sandeels available to fishing fleets is influenced by the time when sandeels emerge and return to the sand (Winslade 1974) as well as their age (Reeves 1994) and growth rate. Because growth rates within the North Sea stock vary substantially between regions and between years the patterns of emergence and thus the availability of sandeels to the fishery is also highly variable. This has strong implications for analyses of the effect of management actions on the sandeel stock dynamics.

For other species of sandeels, with a similar life cycle and behaviour as that of A. marinus in the North Sea cannibalism of immature sandeels on the early life stages on sandeels have a major impact on the recruitment pattern (see e.g. Kimura et al. 1992, Kishi et al. 1991). A. marinus in the North Sea is also a fish predator (see e.g. Christensen

1983, Macer 1966), but no field investigations have been carried out to analyze the effect of cannibalism in A. marinus. Also the effect of other fish predators on the mortality of early life stages of sandeels is lacking. Only analyses of predation on juvenile and adult sandeels have been analyzed (see e.g. ICES 2003). Information about cannibalism and density dependent growth and mortality is important to include in an analysis of the effect of the fishery and of management measures on the sandeel stock.

Minimum landing sizes

Minimum landing sizes of sandeels could be implemented to increase the yield over a fishing season (due to the rapid growth of sandeel over the fishing season). It could also be implemented to decrease fishing mortality on 0-group sandeels, which appear in the catches from late in the summer and may dominate the catches towards the end of the fishing season. However, the adoption of a minimum landing size may have varying success since the implementation will most likely only be possible through the use of closed areas and seasons.

The economical low value of very small sandeels, in terms of their low oil content, is already a practical limiting factor for a directed fishery on small sandeels. Because of the quality constraint almost all fishing on 0-group takes place late in the year and is mostly limited to those areas where 0-group growth rates are very high, such as Fisher banks. The directed fishery for 0-group sandeels is carried out by a small number of vessels, which targets a small part of the areas which is inhabited by sandeels. A minimum landing size restriction late in the season could reduce mortality on 0-group sandeels in the areas where this fishery occur. This may be of value given the current low stock size. However, for any such measure to have a conservation value it would require that fishing effort is displaced rather than catches of undersized fish being discarded. A control rule of the type that fishing should cease in an area if catches are composed of x% sandeels < y cm in z hauls would be required.

Closed seasons

In the Shetland assessment area a closed season approach has been applied in the past to reduce fishing pressure on 0-group sandeels at times when they have been important to local seabird predators (Reeves, 1999). The protection of 0-group sandeels was considered important since historically the fishery took a large proportion of that age-class.

In contrast to Shetland, 0-group sandeels only comprise a small proportion of the North Sea landings (ICES 2004, and this WG report). However, given the small size of the 2002 year-class and the less than average size of the 2003 year-class (STECF, 2004a, this WG report) reducing 0-group mortality on the 2004 and 2005 year-class may help in stock recovery. The quantification of the effect on the sandeel stock by decreasing the mortality of 0-group sandeels would require a more detailed analysis, taking into account i.e. the high natural mortality that sandeel suffer, the likelihood of an increase in SSB, and the possible effect of an increase in cannibalism of immature 1-group sandeels on the early life stages on sandeels. Such an analysis is not possible at the present time.

1-group sandeel have a rapid increase in weight and oil content from April until June. Postponing the start of the fishery has the potential of increasing the yield in weight, and yield in the form of oil even more.

Closed areas

Closing an area to a fishery has the potential to conserve fish stocks if the area encompasses a large spawning congregation that provides a source of recruits for many surrounding areas or if it contains a resident and reproductively isolated population (Polunin, 2002). Wright et al. (1998) provided evidence for a resident and reproductively isolated sandeel population off the north east U.K. This information together with a decline in the breeding success of sandeel dependent seabirds and particularly kittiwakes (Wanless et al., 1999) in this region following the development of a fishery in the 1990s led to a precautionary closure in 2000. The concern was that any reduction of the local sandeel population below a level where it affected breeding success of sandeel dependent seabirds could potentially affect other top predators. The direct impact of the closure is still uncertain (Wright et al., 2002) and the decision rules for re-opening have yet to be agreed.

The precautionary closed area approach has also been applied to the small Shetland sandeel assessment area in the early 1990s and since re-opening in 1995 there has been a precautionary TAC and limit on the size of vessels operating (Reeves, 1999). The initial total closure in 1991 was in response to a succession of poor year-classes in the managed region which was associated with almost complete breeding failure in local seabird colonies. The stock did recover during the closure, but the primary reason for this appeared to be due to immigration of 0-group from outside the assessed region (Wright, 1996). The stock has suffered poor recruitment in recent years that cannot be explained by the very low fishing mortality.

These two examples of closed areas highlight the importance of understanding how different patches of sandeels are linked by larval dispersal. Identifying and protecting source populations and small reproductively isolated resident populations could help in achieving sustainable management of the North Sea stock. Closed areas could be permanent or rotated such that sufficient local spawning aggregations are protected to ensure sources of larval recruitment to nearby areas. Unfortunately, scientific knowledge is currently insufficient to identify and quantify how such a management regime would work. However, a FP6 project PROTECT FP6-2003-SSP-3, Priority 8 – Task 6 will be starting shortly to consider this issue.

Regional area TACs

In light of the changed perception of the geographical status of the North Sea sandeel stock (i.e. Wright et al. 1998) it might be more appropriate to set separate TACs to cover identified separate sandeel populations. In the first instance, such TACs would be intended to ensure the persistence of the sandeel populations and support a viable fishery in the identified regions. This proposal requires that assessments are disaggregated accordingly. Work has been done on assessing the three units separately (Pedersen et al. 1999) but more work is required to be confident that regional assessments can be done adequately. It is essential that appropriate fishery data on catch and effort are collected. It is also important that at least one fishery independent data set is initiated for stock assessment purposes. Further, it is essential that the population units to be assessed separately can be defined based upon knowledge on sandeel biology and distribution pattern.

Real time monitoring in 2005

A Danish real time monitoring system was established in 2004, to estimate the strength of the 2003 year-class based on catches of 1-group sandeels in the start of the 2004 sandeel fishing season (STECF 2004b). This approach was found to be suitable for estimating the size of the year-class, and the uncertainties associated with this method have been described (STECF 2004a). This approach may be broadened to include estimation of the total stock biomass and the spawning stock biomass, to supplement the information from the routine assessment. The method may be developed further to consider spatial differences in distribution and abundance of sandeels, e.g. for larger aggregations of fishing grounds.

Summary

The effect of implementing closed areas is not possible to assess, due to a lack of knowledge about sandeel biology. Collation of existing knowledge on the geographical distribution of catches and effort would also be needed. Further knowledge about the variability in local reproduction and the exchange of larvae between spawning grounds is especially needed. This lack of information is also hindering the implementation of regional area TACs, as more detailed information about the population structure of sandeels is needed to define the areas which will have to be assessed separately. Having said this, the implementation of regional TACs could lead to a more detailed monitoring of the stock development in sandeels and decrease the possibility of a local stock collapse caused by overexploitation.

The implementation of a minimum landing size, to decrease fishing mortality on 0-group sandeels, is most likely to require the implementation of closed seasons and areas. The effect of such a management measure is likely to be restricted to the areas where 0-group sandeels are targeted by the fleet. The effect is thus more likely to be at a regional than at a North Sea level. The same conclusions may also apply to the effect of closed seasons.

In an evaluation of the effect of implementing the above described management measures it should also be considered that the effect of the fishery on the sandeel population is influenced by sandeel population density and the economical value of the catch. Effort reduces in years and areas with a low abundance of sandeels, as seen in 2003 and 2004. A reduction in effort is also occurring in seasons and areas where the oil content of the fish is small.

Table 13.1.1.1 Sandeel in IV. Official landings reported to ICES

SANDEELS IVa

Country	1997	1998	1999	2000	2001	2002	2003
Denmark	26,498	23,138	3,388	4,742	1,058	111	399
Faroe Islands	11,221	11,000	6,582				
Norway	98,386	172,887	44,620	11,522*	4,121*	185*	280*
Sweden	-	55	495	55	-	-	73
UK (E/W/NI)	-	-	-	-	-	-	-
UK (Scotland)	3,463	5,742	4,195	4,781	970	543	186
Total	139,568	212,822	59,280	21,100	6,149	839	938

*Preliminary.

SANDEELS IVb

Country	1997	1998	1999	2000	2001	2002	2003
Denmark	731,184	603,491	503,572	533,905	638,657	627,097	245,096
Faroe Islands	-	-	-				
Germany	-	-	-	-	-	-	534
Ireland	-	-	389	-	-	-	
Norway	252,177	170,737	142,969	107,493*	183,329*	175,799*	29,336*
Sweden	-	8,465	21,920	27,867	47,080	36,842	21,444
UK (E/W/NI)	2,575	-	-	-	-	-	-
UK (Scotland)	20,554	18,008	7,280	5,978	-	2,442	115
Total	1,006,490	800,701	676,130	675243	869066	842180	296525

*Preliminary.

SANDEELS IVc

Country	1997	1998	1999	2000	2001	2002	2003
Denmark	3,163	9,674	10,356	11,993	7,177	4,996	28,646
France	-	-	-	1	-	-	-*
Netherlands	-	+	+	-	-	+	-*
Sweden	-	-	-	-	-	-	160
UK (E/W/NI)	-	-	-	+	-	-	+
Total	3,163	9,674	10,356	11,994	7,177	4,996	28,806

*Preliminary.

Summary table official landings

	1997	1998	1999	2000	2001	2002	2003
Total IV tonnes	1,149,221	1,023,197	745,766	708,337	882,392	848,015	326,269
TAC		1,000,000	1,000,000	1,020,000	1,020,000	1,020,000	918,000

By-catch and other landings

	1997	1998	1999	2000	2001	2002	2003
Area IV tonnes: official-WG	11,439	18,797	10,628	9,188	20,781	37,315	00,849

Summary table - landing data provided by Working Group members

	1997	1998	1999	2000	2001	2002	2003
Total IV - tonnes	1,137,782	1,004,400	735,138	699,149	861,611	810,700	325,420

Table 13.1.1.2. Sandeel in IV. Landings ('000 t), 1952-2003 (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	0.3	325.4

+ = less than half unit.
- = no information or no catch.

Table 13.1.1.3 Sandeel in IV. Monthly landings (ton) by Denmark, Norway and Scotland from each area defined in Fig 13.1.1.1

	1A	1B	1C	2A	2B	2C	3	4	5	6	Shetland	Total
1999												0
Mar	1448	2587	136	1047	9371	0	466	73	218	0	479	15826
Apr	52710	3030	0	64860	17779	0	644	80	55	1360	1080	141598
May	151806	15520	0	42635	45709	0	7299	1567	82	1271	461	266351
Jun	52943	9427	0	6199	8224	0	3304	12744	1097	18254	6	112198
Jul	7816	1883	0	15142	13918	0	14841	2434	1270	5274	0	62578
Aug	1	0	0	1770	29621	0	15376	0	0	99	2043	48909
Sept	1	155	0	930	26486	0	4129	0	0	883	88	32672
Oct	0	0	0	42	16440	0	1754	0	0	68	0	18305
Dec	0	0	0	181	358	0	198	0	0	0	0	737
Total	266725	32603	136	132807	167905	0	48011	16898	2722	27208	4157	699174
2000												0
Mar	800	42	0	3257	5618	0	739	0	0	393	687	11536
Apr	30931	19012	0	15259	71384	281	33583	479	0	595	1436	172959
May	110128	6843	0	24941	42647	0	53911	6685	3089	662	1651	250558
Jun	73632	3262	26	18564	16440	0	17287	11240	2503	29205	0	172160
Jul	10610	33	4	25193	3286	11	5996	2024	2692	12201	0	62049
Aug	0	0	0	3	113	0	117	0	1	127	560	921
Sept	0	0	0	21	393	0	18	0	0	145	0	577
Oct	0	0	0	0	0	0	2	0	0	1	0	3
Total	226102	29192	30	87238	139882	292	111652	20428	8285	43329	4334	670763
2001												0
Mar	3205	0	0	5235	2078	0	915	218	334	180	144	12309
Apr	60040	10891	0	19956	16609	0	1968	916	0	265	295	110940
May	96489	2014	0	71446	20668	0	15266	4829	510	3767	589	215578
Jun	72384	0	1556	15160	8103	120	8265	4790	4291	22748	0	137417
Jul	6703	90	0	67814	24065	0	8769	1664	2204	13747	0	125056
Aug	473	0	0	51965	61169	0	8679	0	0	2927	236	125449
Sep	578	0	0	24926	31178	0	4802	0	0	4840	0	66324
Oct	0	0	0	6464	14027	0	972	0	0	500	0	21963
Total	239872	13026	1556	262966	177898	120	49635	12417	7339	48974	1264	815067
2002												
Mar	3077	0	0	3911	2715	0	928	322	0	0	0	10953
Apr	104033	1745	0	66992	51007	0	15466	904	59	475	109	240790
May	176437	3341	0	78497	37385	0	37058	915	151	3272	12	337068
Jun	118879	125	0	27386	19380	10	10561	8673	2531	12498	0	200043
Jul	1128	0	0	90	48	0	193	2744	204	9869	0	14276
Aug	0	0	0	109	261	0	397	0	0	5146	422	6335
Sept	0	0	0	0	74	0	290	0	0	0	0	364
Oct	0	0	0	1	0	0	0	0	0	2	0	3
Dec	0	0	0	0	0	0	0	0	2	0	0	2
Total	403554	5211	0	176986	110870	10	64893	13558	2947	31262	543	809834
2003												
Mar	1947	52	0	97	380	7	225	325	0	0		3033
Apr	28806	5026	0	8341	6072	0	1900	81	0	662	49	50937
May	59890	1812	24	8884	9357	0	4532	10995	1020	9991	16	106521
Jun	11737	49	0	11906	398	10	2140	20891	13318	21639		82088
Jul	3604	0	0	9857	2013	0	3272	2738	1697	5790		28971
Aug	960	6	0	4381	4687	0	11293	16	175	687	121	22326
Sept	0	255	73	35	1551	0	2955	0	0	1094		5963
Oct	0	0	0	114	0	0	1589	0	0	127		1830
Nov	0	0	0	0	0	0	2070	0	0	0		2070
Dec	0	0	0	0	0	0	45	0	0	0		45
Total	106944	7200	97	43615	24458	17	30021	35046	16210	39990	186	303784
%	35%	2%	0%	14%	8%	0%	10%	12%	5%	13%	0%	100%
Average 1998-2008												
	36%	3%	0%	19%	24%	0%	8%	3%	1%	6%	0%	100%
2004*												
Feb	0	0	0	0	0	0	0	0	0	7		7
Mar	326	0	0	1000		0	37		260	2		1625
Apr	15893	627	0	15824	4847	0	10732	471	322	834		49550
May	46631	1044	0	21607	5495	0	22628	20484	233	8578		126700
Jun	21842	146	0	5076	1800	0	13821	13680	4789	35909		97063
Total	84692	1817	0	43507	12142	0	47218	34635	5604	45330	0	274945
%	31%	1%	0%	16%	4%	0%	17%	13%	2%	16%	0%	100%

*) Only landings by Denmark and Norway

Table 13.1.1.4 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

Sampling areas: Northern - Areas 1B, 1C, 2B, 2C, 3.
Southern - Areas 1A, 2A, 4, 5, 6.

Table 13.1.1.5 Sandeel in IV. Monthly landings (t) by Denmark, Norway and Scotland (Data provided by Working Group members).

Year	Month	Denmark	Norway	Scotland	Total
1998	Mar	14,729	9,332		24,061
	Apr	130,629	60,852	2,359	193,840
	May	191,407	80,885	8,246	280,538
	Jun	204,102	77,929	7,933	289,964
	Jul	56,586	29,457		86,043
	Aug	17,894	43,084		60,978
	Sept	2,395	37,331		39,726
	Oct	17	4,503		4,520
	Nov				0
	Total	617,759	343,373	18,538	979,670
1999	Mar	6,851	8,496	479	15,826
	Apr	115,596	24,149	1,854	141,599
	May	202,813	56,961	6,578	266,352
	Jun	97,284	14,478	434	112,197
	Jul	49,333	13,245	0	62,578
	Aug	19,044	27,823	2,043	48,910
	Sept	6,217	26,366	88	32,672
	Oct	2,567	15,738	0	18,305
	Nov	405	332		737
	Total	500,110	187,589	11,476	699,175
2000	Mar	7,524	3,325	687	11,536
	Apr	126,644	44,879	1,436	172,959
	May	195,866	48,292	6,400	250,558
	Jun	150,394	20,089	1,677	172,160
	Jul	60,126	1,923		62,049
	Aug	247	113	560	921
	Sept	184	393		577
	Oct	3			3
	Total	540,988	119,015	10,759	670,763
2001	Mar	10,684	1,481	144	12,310
	Apr	95,723	14,922	295	110,940
	May	183,757	31,231	589	215,577
	Jun	127,292	10,124	0	137,416
	Jul	106,654	18,403	0	125,057
	Aug	65,021	60,192	236	125,449
	Sep	33,741	32,583	0	66,324
	Oct	7,910	14,054	0	21,963
	Nov	30	0	0	30
	Total	630,811	182,991	1,264	815,066
2002	Mar	10,236	717	0	10,953
	Apr	177,597	63,083	109	240,789
	May	247,494	86,942	2,898	337,334
	Jun	174,467	24,568	1,448	200,483
	Jul	14,228	48	0	14,276
	Aug	5,652	261	422	6,335
	Sep	0	364	0	364
	Oct	3	0	0	3
	Dec	2	0	0	2
	Total	629,679	175,983	4,877	810,539
2003	Mar	2,802	231		3,033
	Apr	42,885	8,003		50,888
	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		22,204
	Sep	4,407	1,555		5,962
	Oct	1,831	0		1,831
	Nov	2,070	0		
	Dec	45	0		45
	Total	273,982	29,615	0	301,527
2004	Feb	7	0	*	
	Mar	1,444	182	*	
	Apr	42,664	6,886	*	
	May	100,715	25,984	*	
	Jun	89,369	7,696	*	
	Total	234,199	40,748		274,947

* No data available

Table 13.1.2.1 Sandeel in IV. Catch numbers at age (numbers · 10^{-5}) by half year.

Catch in numbers for fleet: 1
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
Season	1	2	1	2	1	2	1
AGE							
0	*	46385.	*	0.	*	7510.	*
1	6434.	771.	21719.	157.	888.	118.	6819.
2	2408.	73.	2649.	6.	308.	164.	542.
3	472.	134.	402.	0.	90.	0.	375.
4+	1035.	0.	219.	0.	284.	0.	213.
SOP	88280.	153698.	179581.	1263.	14116.	29772.	59587.

Catch in numbers for fleet: 2
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
Season	1	2	1	2	1	2	1
AGE							
0	*	73443.	*	0.	*	0.	*
1	64084.	819.	84858.	1370.	4982.	35.	29030.
2	13531.	15.	8667.	472.	15588.	31.	952.
3	1158.	0.	1060.	0.	3593.	0.	3683.
4+	2389.	0.	250.	0.	1204.	0.	231.
SOP	432330.	184311.	608649.	17428.	197210.	1055.	213507.

Table 13.1.2.2 Sandeel in IV. Catch numbers at age (numbers $\cdot$ 10^{-5}) by year.

Catch numbers at age Numbers*10**-5

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
0,	0,	122890,	72170,	7530,	131960,	33810,	127040,	257310,	69310,	277980,
1,	848389,	124830,	799900,	394500,	134870,	1067620,	363880,	741900,	741590,	213900,
2,	41160,	460610,	106990,	404880,	365700,	71830,	213960,	119380,	144620,	183590,
3,	140443,	58150,	20450,	17040,	214360,	43770,	31670,	23470,	16450,	50300,
+gp,	4904,	10540,	480,	3710,	28800,	34910,	9560,	7750,	9600,	17670,
TOTALNUM,	1034896,	777020,	999990,	827660,	875690,	1251940,	746110,	1149810,	981570,	743440,
TONSLAND,	750040,	707105,	685950,	791050,	1007304,	826835,	584912,	898959,	820140,	576932,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
0,	4569,	40460,	339055,	26290,	363618,	349749,	66590,	1198280,	0,	75098,
1,	581087,	823630,	254537,	1459804,	269557,	349646,	625678,	721083,	1081042,	60220,
2,	113528,	130940,	272518,	84569,	772782,	105984,	153626,	160264,	117943,	160914,
3,	92017,	29790,	78361,	80900,	55151,	196854,	36079,	17643,	14614,	36824,
+gp,	30324,	15300,	25481,	20265,	27362,	21358,	53733,	34237,	4692,	14881,
TOTALNUM,	821526,	1040120,	969952,	1671828,	1488470,	1023591,	935706,	2131507,	1218291,	347937,
TONSLAND,	770747,	915043,	776126,	1114044,	1000375,	718668,	692498,	858619,	806921,	242153,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

Table 13.1.2.3 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
2000	0	-	-	-	-	-	-
	1	6.41	14.92	8.46	-	6.78	14.92
	2	7.44	17.95	8.05	-	7.90	17.95
	3	12.68	19.18	11.17	-	11.86	19.18
	4	18.49	22.62	-	-	18.49	22.62
	4+	-	-	21.92	-	21.92	-
	5	19.37	25.37	-	-	19.37	25.37
	6	18.41	18.41	-	-	18.41	18.41
	4++	18.60	22.67	21.92	-	19.66	22.67
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	5.06	12.13	5.33	13.00
	2	13.03	17.90	14.24		13.09	17.90
	3	11.86		18.77		12.17	
	4	14.47				14.47	
	5	17.24				17.24	
	5+						
	6						
	4++	14.82		28.30		14.98	
2004	0			1.73		1.73	
	1	6.07		7.36		6.27	
	2	11.10		10.07		10.64	
	3	11.23		15.78		13.40	
	4	25.01				25.01	
	5	33.17				33.17	
	5+						
	6						
	4++	30.69		27.53		28.39	

Table 13.1.2.4 Sandeel in IV. Southern North Sea mean weight (g) in the catch (Denmark). Age group 4++ is the 4-plus group used in assessment

		Half-year	
Year	Age	1	2
2000	0	1.72	1.66
	1	6.16	6.61
	2	9.56	13.68
	3	14.42	15.74
	4	15.41	18.06
	5	16.66	19.60
	6	19.82	19.75
	7	18.69	19.75
	8+	19.88	-
	4++	15.93	18.34
2001	0	1.75	2.40
	1	4.22	9.51
	2	7.93	17.00
	3	12.57	-
	4	16.19	-
	5	16.71	-
	6	17.73	-
	7	21.56	-
	8+	-	-
	4++	16.76	-
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	-
	1	5.25	15.57
	2	7.86	16.59
	3	9.33	-
	4	11.65	-
	5	15.27	-
	6	24.43	-
	7	15.05	-
	8+	15.90	-
	4++	12.47	-
2004	0		-
	1	5.49	-
	2	10.49	-
	3	11.34	-
	4	10.27	-
	5		-
	6		-
	7		-
	8+		-
	4++	10.27	-

Table 13.1.2.5 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	5.33	13.09	12.17	14.98
2004	6.27	10.64	13.40	28.39

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		

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

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		15.57	16.59		

Table 13.1.2.6 Sandeel in IV. Mean weight (kg) in the catch by year.

Run title : Sandeel in IV

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Catch weights at age (kg)

YEAR,	1983,
AGE	
0,	.0027,
1,	.0059,
2,	.0103,
3,	.0149,
+gp,	.0177,
SOPCOFAC,	.9997,

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
0,	.0000,	.0024,	.0030,	.0023,	.0030,	.0050,	.0029,	.0030,	.0054,	.0027,
1,	.0059,	.0059,	.0064,	.0070,	.0061,	.0055,	.0053,	.0077,	.0073,	.0064,
2,	.0117,	.0103,	.0115,	.0116,	.0130,	.0131,	.0129,	.0159,	.0131,	.0131,
3,	.0140,	.0166,	.0151,	.0187,	.0165,	.0161,	.0180,	.0188,	.0180,	.0172,
+gp,	.0172,	.0297,	.0172,	.0291,	.0191,	.0181,	.0243,	.0229,	.0249,	.0211,
SOPCOFAC,	.9999,	.9998,	.9995,	1.0001,	1.0000,	1.0002,	1.0001,	1.0005,	.9999,	1.0000,

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
0,	.0066,	.0051,	.0029,	.0019,	.0025,	.0032,	.0017,	.0027,	.0000,	.0034,
1,	.0067,	.0074,	.0073,	.0061,	.0045,	.0057,	.0065,	.0045,	.0062,	.0055,
2,	.0149,	.0150,	.0113,	.0098,	.0087,	.0089,	.0088,	.0086,	.0091,	.0081,
3,	.0166,	.0198,	.0150,	.0120,	.0121,	.0137,	.0136,	.0132,	.0141,	.0094,
+gp,	.0194,	.0210,	.0261,	.0214,	.0164,	.0216,	.0172,	.0152,	.0238,	.0130,
SOPCOFAC,	1.0000,	1.0002,	1.0000,	1.0002,	1.0004,	1.0000,	.9997,	1.0004,	.9995,	1.0000,

Table 13.1.2.7 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	7.96	9.40	12.95
2004	5.64	10.55	11.53	18.95

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	18.87
2002		8.29	12.60		
2003	3.37	13.58	17.69		

Table 13.1.2.8 Sandeel in IV. Mean weight (kg) in the stock by year.

```
Run title : Sandeel in IV

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   Stock weights at age (kg)

   YEAR,       1983,
   AGE
     0,        .0010,
     1,        .0050,
     2,        .0129,
     3,        .0169,
   +gp,        .0248,


   Table  3    Stock weights at age (kg)
   YEAR,       1984,    1985,    1986,    1987,    1988,    1989,    1990,    1991,    1992,    1993,
   AGE
     0,        .0010,   .0010,   .0010,   .0010,   .0010,   .0010,   .0010,   .0010,   .0010,   .0010,
     1,        .0041,   .0042,   .0042,   .0047,   .0044,   .0044,   .0043,   .0043,   .0041,   .0045,
     2,        .0138,   .0128,   .0131,   .0128,   .0148,   .0135,   .0133,   .0132,   .0131,   .0127,
     3,        .0163,   .0188,   .0163,   .0160,   .0158,   .0196,   .0176,   .0170,   .0172,   .0164,
   +gp,        .0210,   .0221,   .0278,   .0212,   .0192,   .0183,   .0193,   .0206,   .0212,   .0213,


   YEAR,       1994,    1995,    1996,    1997,    1998,    1999,    2000,    2001,    2002,    2003,
   AGE
     0,        .0010,   .0010,   .0010,   .0010,   .0010,   .0010,   .0010,   .0010,   .0010,   .0010,
     1,        .0063,   .0071,   .0068,   .0056,   .0050,   .0056,   .0064,   .0044,   .0061,   .0053,
     2,        .0130,   .0154,   .0100,   .0094,   .0085,   .0088,   .0086,   .0085,   .0090,   .0080,
     3,        .0146,   .0200,   .0145,   .0118,   .0120,   .0134,   .0133,   .0135,   .0141,   .0094,
   +gp,        .0187,   .0209,   .0211,   .0216,   .0163,   .0222,   .0170,   .0152,   .0238,   .0130,
```

Table 13.1.3.1 Sandeel in IV. Norwegian effort data.

Northern area

Year	Fishing days		Mean gross register tonnage (Av. GRT pr. trip)	
	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec
1976	595		199	
1977	2212	457	172	185
1978	1747	806	203	204
1979	1407	1720	214	189
1980	2642	1099	216	210
1981	1740	404	217	191
1982	1206		209	
1983	304	66	255	191
1984	145		183	
1985	366		220	
1986	1562	567	201	187
1987	2123	1584	219	201
1988	3571	925	203	198
1989	4292	588	192	202
1990	2275	731	208	189
1991	1749	958	200	194
1992	1202	23	205	213
1993	1462	971	231	201
1994	2559	742	222	227
1995	3305	980	216	218
1996	1935	724	224	219
1997	3354	1484	218	221
1998	2479	2176	222	219
1999	2030	1540	240	241
2000	2045	n/a (very low)	254	n/a
2001	579	1371	281	256
2002	859		269	n/a (very low)
2003	683		322	291
2004	493		390	

Southern area

Year	Fishing days		Mean gross register tonnage (Av. GRT pr. trip)	
	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec
1999	521	10	262	316
2000	111	n/a	259	n/a
2001	138	n/a	295	n/a
2002	276	n/a	282	n/a
2003	187	44	288	282
2004	621		378	

Table 13.1.3.2 Sandeel in IV. Danish CPUE data. Regression summary and parameter estimates from the regression $CPUE=e^{dy}*GR^{fy}$ and estimates of standardised CPUE (200 GR).

Area	Half year	N	DF	Sum of squares	F value	Pr>F	R-square
North	1	28321	46	732810	16382	<0.0001	0.32
North	2	12751	46	280132	7469	<0.0001	0.27
South	1	58204	46	2030942	47718	<0.0001	0.34
South	2	18706	46	459537	13170	<0.0001	0.31

North Jan-Jun

Year	d^y	f^y	CPUE
1982	0.91	0.46	28.21
1983	0.78	0.47	26.03
1984	1.01	0.46	31.19
1985	-0.17	0.72	39.12
1986	1.45	0.44	42.99
1987	1.34	0.49	51.81
1988	1.02	0.50	39.02
1989	0.97	0.49	35.09
1990	1.75	0.27	24.72
1991	1.01	0.50	39.04
1992	1.19	0.44	33.55
1993	1.00	0.48	33.62
1994	1.22	0.53	56.38
1995	1.21	0.49	44.72
1996	1.03	0.45	30.76
1997	1.50	0.46	50.95
1998	0.77	0.54	37.05
1999	0.95	0.48	32.94
2000	0.80	0.55	40.62
2001	1.22	0.44	34.31
2002	1.04	0.52	44.84
2003	-0.46	0.61	15.96
2004	0.51	0.51	24.52

North Jul-Dec

Year	d^y	f^y	CPUE
1982	5.76	-0.49	23.81
1983	1.33	0.43	37.17
1984	0.90	0.47	29.36
1985	2.15	0.20	24.27
1986	0.45	0.65	48.61
1987	1.50	0.32	24.68
1988	1.51	0.35	29.42
1989	1.68	0.30	25.64
1990	2.11	0.25	31.15
1991	0.96	0.51	38.73
1992	1.60	0.37	34.83
1993	1.60	0.33	28.39
1994	1.80	0.37	43.56
1995	1.96	0.35	44.85
1996	1.60	0.38	36.51
1997	1.29	0.38	27.46
1998	1.09	0.40	24.59
1999	1.16	0.42	29.31
2000	1.33	0.41	33.31
2001	1.59	0.38	36.92
2002	2.09	0.05	10.63
2003	0.72	0.44	20.99

South Jan-Jun

Year	d^y	f^y	CPUE
1982	1.19	0.49	43.25
1983	0.63	0.58	41.05
1984	0.82	0.56	44.95
1985	0.29	0.64	39.38
1986	1.36	0.46	45.60
1987	1.10	0.56	57.37
1988	1.03	0.53	46.70
1989	0.96	0.53	43.84
1990	1.46	0.37	31.01
1991	1.33	0.48	47.04
1992	0.24	0.71	54.89
1993	0.59	0.58	38.64
1994	1.19	0.53	53.36
1995	0.89	0.59	56.77
1996	0.47	0.62	41.65
1997	1.15	0.57	64.15
1998	0.73	0.59	46.64
1999	1.27	0.46	40.69
2000	0.95	0.53	42.78
2001	0.70	0.55	37.35
2002	0.20	0.71	52.80
2003	0.18	0.56	22.69
2004	0.80	0.46	25.12

South Jul-Dec

Year	d^y	f^y	CPUE
1982	4.63	-0.22	32.68
1983	1.21	0.40	28.68
1984	0.51	0.55	31.10
1985	0.79	0.50	30.35
1986	1.43	0.41	36.83
1987	1.02	0.49	37.13
1988	1.93	0.28	30.19
1989	2.10	0.24	29.48
1990	2.50	0.20	35.59
1991	1.13	0.51	46.61
1992	1.78	0.34	36.17
1993	1.92	0.29	31.96
1994	2.18	0.32	48.91
1995	2.06	0.36	51.97
1996	0.98	0.55	50.14
1997	1.34	0.45	41.13
1998	0.78	0.47	26.18
1999	3.63	-0.03	31.89
2000	1.08	0.46	33.42
2001	1.32	0.48	46.39
2002	1.97	0.21	22.37
2003	0.12	0.54	19.60

Table 13.1.3.3 Sandeel in IV. Fishing effort in the Northern North Sea (days fishing times scaling factor for each vessel category to represent days fishing for a vessel of 200 GR)

Year	Norweigian Standardized Fishing days	Norweigian Catch sampled for fishing effort ('000t)	Norweigian 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	214.2	51.8	53.1	360.9	6.79
1988	3600	143.8	39.9	156.0	39.0	39.5	332.0	8.41
1989	4211	146.9	34.9	240.8	35.1	35.0	435.2	12.43
1990	2299	58.6	25.5	87.0	24.7	25.0	148.7	5.94
1991	1748	67.7	38.7	190.9	39.0	39.0	282.2	7.24
1992	1214	53.7	44.2	102.6	33.6	37.2	151.2	4.06
1993	1565	70.7	45.2	134.3	33.6	37.6	189.0	5.03
1994	2707	130.1	48.1	283.3	56.4	53.8	413.4	7.69
1995	3429	208.6	60.8	143.3	44.7	54.3	348.5	6.42
1996	2036	100.9	49.6	99.0	30.8	40.2	203.1	5.05
1997	3489	254.9	73.1	183.1	50.9	63.8	456.5	7.15
1998	2622	220.8	84.2	125.1	37.1	67.1	364.8	5.43
1999	2217	77.4	34.9	46.4	32.9	34.2	137.2	4.01
2000	2328	104.5	44.9	152.2	40.6	42.4	271.1	6.40
2001	672	44.6	66.4	42.1	34.3	50.8	88.5	1.74
2002	1003	119.5	119.2	57.3	44.8	95.1	179.7	1.89
2003	914	17.1	18.7	15.275	15.96	17.41	32	1.84
2004	692	19.3	27.9	38.652	24.52	25.64	61.2	2.39
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	3.0	24.7	42.1	76.9	1.82
1988	922	26.9	29.2	61.7	29.4	29.3	71.4	2.43
1989	590	11.5	19.5	40.8	25.6	24.3	57.2	2.36
1990	721	22.8	31.6	60.4	31.1	31.3	70.8	2.26
1991	943	30.3	32.1	70.0	38.7	36.7	90.7	2.47
1992	24	1.5	63.8	42.5	34.8	35.8	25.5	0.71
1993	972	30.7	31.6	58.0	28.4	29.5	87.0	2.95
1994	777	35.7	45.9	80.5	43.6	44.3	76.4	1.73
1995	1009	53.3	52.8	54.5	44.8	48.8	72.6	1.49
1996	749	42.9	57.3	89.2	36.5	43.3	140.7	3.25
1997	1542	95.7	62.1	21.8	27.5	55.6	121.5	2.18
1998	2257	114.4	50.7	35.4	24.6	44.5	148.5	3.34
1999	1665	77.8	46.7	34.3	29.3	41.4	125.2	3.02
2000	0	0.0	0.0	6.5	33.3	33.3	10.0	0.30
2001	1508	122.2	81.0	26.9	36.9	73.1	153.8	2.10
2002	0	0.7	0.0	0.4	10.6	3.8	1.3	0.34
2003	295	7.5	25.4	17.5	21.0	22.33	29.8	1.33
2004								

Table 13.1.3.4 Sandeel in IV. Fishing effort in the Southern North Sea (days fishing times scaling factor for each vessel category to represent days fishing for a vessel of 200 GR), 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	214	8.48			

Table 13.1.3.5 Sandeel in IV. Comparison of effort estimated using regression model 3: ln(CPUE) = d_y+ f_y*ln(GR) and regression model 5: ln(CPUE) = d_y+ ln(GR) on logbook data for the Danish industrial fleet for the years 1984 to 2003.

	Effort estimated using model 3	Effort estimated using model 5	Effort estimated using model 3	Effort estimated using model 5
North Jan-Jun			South Jan-Jun	
1987	6.79	6.79	5.19	5.19
1988	8.41	8.43	9.89	9.84
1989	12.43	12.44	11.54	11.47
1990	5.94	5.80	11.03	10.96
1991	7.24	7.27	6.95	6.94
1992	4.06	3.98	11.31	11.60
1993	5.03	5.02	6.94	6.95
1994	7.69	7.72	4.24	4.24
1995	6.42	6.42	7.56	7.50
1996	5.05	5.05	7.05	6.94
1997	7.15	7.16	6.55	6.54
1998	5.43	5.40	9.61	9.54
1999	4.01	4.02	10.56	11.03
2000	6.40	6.31	8.36	8.46
2001	1.74	1.76	11.20	11.22
2002	1.89	1.88	9.79	9.19
2003	1.84	1.75	9.33	9.33
2004	2.39	2.38	8.48	8.79
North Jul-Dec			South Jul-Dec	
1987	1.82	1.82	2.83	2.83
1988	2.43	2.41	1.11	1.07
1989	2.36	2.23	0.63	0.57
1990	2.26	2.18	0.67	0.62
1991	2.47	2.56	2.84	3.00
1992	0.71	0.70	2.02	1.97
1993	2.95	2.90	1.07	0.99
1994	1.73	1.72	0.97	0.95
1995	1.49	1.47	1.30	1.29
1996	3.25	3.25	2.77	2.84
1997	2.18	2.18	3.36	3.36
1998	3.34	3.33	1.64	1.60
1999	3.02	3.01	1.13	1.37
2000	0.30	0.30	1.59	1.57
2001	2.10	2.11	3.98	3.83
2002	0.34	0.25	0.86	0.83
2003	1.33	1.33	1.53	1.48

Table 13.1.3.6 Sandeel in IV. Tuning fleets. Total international standardised effort and catch at age in numbers (millions).

```
Sandeel IV
104
North IV 1.half year
1976  2004
1 1 0.25 0.50
1 4
      5.90   5697.20   1130.00    445.00    155.10
     11.30  24306.50   2350.50    516.30    144.00
      4.30   6126.90   2337.80    572.50    143.50
      2.30   2335.20   1327.60    242.20     11.80
      5.40  13394.10   8865.00   1049.60    827.30
      3.90   5505.00   4109.00    904.00    174.00
      2.40   3518.00   2132.00    556.00     85.00
      2.00   5684.00   1215.00     89.00     12.00
      1.80  11692.20   1646.70    152.70      4.50
      1.60   2688.00   3292.00   1002.00    480.00
      4.40  23934.00   2600.00    200.00      0.00
      6.79  26236.00  10855.00    350.00    155.00
      8.41   9855.00  25922.00   1319.00     26.00
     12.43  56661.00   2219.00   3385.00      0.00
      5.94  13101.00   3907.00    578.00    175.00
      7.24  41855.00   2342.00    908.00    318.00
      4.06   9871.00   4056.00    486.00    305.00
      5.03  15768.00   2635.00   1023.00    646.00
      7.69  28490.20   7225.30   5953.50   2155.50
      6.42  36140.00   3360.00   1091.00    145.00
      5.05  11523.60   5384.60    760.80    300.70
      7.15  67037.80   3640.30   5254.30   1205.70
      5.43   6667.10  33215.80   2038.90    410.10
      4.01   2117.70   3490.80   5086.00   1022.70
      6.40  22887.20   8809.90   1419.80   1469.70
      1.74   6433.80   2407.80    472.00   1034.60
      1.89  21718.80   2649.00    401.50    219.20
      1.84    887.60    308.20     89.70    284.30
      2.39   6819.00    541.50    375.30    212.80
South IV 1.half year
1982  2004
1 1 0.25 0.50
1 4
      8.90  56545.00   6224.00   3277.00   1939.00
      8.40   2232.00  35029.00    934.00    387.00
      9.10  62517.00   2257.10  13271.70    442.10
     10.00   7790.00  39301.00   2490.00    265.00
      7.20  43629.00   7333.00   1604.00     30.00
      5.19   4351.00  22771.00   1158.00    165.00
      8.89   2349.00  10074.00  17914.00   2769.00
     11.54  44444.00   4525.00    957.00   3368.00
     11.03  20179.00  16670.00   2467.00    745.00
      6.95  20058.00   9224.00   1320.00    454.00
     11.31  60337.00  10021.00   1002.00    621.00
      6.94   3581.00  14659.00   3707.00   1012.00
      4.24  24697.10   2594.20   2654.40    715.30
      7.56  39060.00   6503.00   1531.00   1226.00
      7.05  10193.90  16015.30   6403.40   1169.10
      6.55  52358.70   3647.90   2404.60    683.30
      9.61   9545.80  39552.90   3188.00   2260.30
     10.56  31950.90   6498.70  13149.80    946.70
      8.36  35612.80   5972.90   1825.30   3528.00
     11.20  64084.00  13530.70   1158.00   2389.10
      9.79  84858.00   8666.70   1059.90    250.00
      9.33   4981.90  15588.30   3592.70   1203.80
      8.48  29029.60    952.40   3683.20    231.40
```

```
North IV 2.half year
1976  2003
1 1 0.5 0.75
0 4
      2.40   6125.60    648.00     83.50    367.80     36.60
      4.20   3067.20   2855.70    913.30    141.90    141.10
      1.90   7820.20   1001.00    307.30     38.90      1.90
      4.80  44202.90   1310.10    433.10     66.20      9.50
      2.40   8348.80   1172.70    213.90     19.40      7.50
      2.30   9128.00    346.00     94.00     14.00      6.00
      0.40   6530.00     65.00      0.00      0.00      0.00
      0.60   7911.00    303.00    316.00     19.00      0.00
      0.60      0.00   1207.20    120.60     42.60      0.00
      0.40    349.00    109.00    239.00     89.00     11.00
      2.70   7105.00   7077.00    473.00      0.00      0.00
      1.82    455.00   5768.00    198.00      0.00      0.00
      2.43  13196.00   1283.00    340.00    119.00     17.00
      2.36   3380.00   4038.00    274.00      0.00      0.00
      2.26  12107.00   1670.00    342.00     51.00     15.00
      2.47  13616.00    866.00     28.00      8.00      3.00
      0.71   6797.00     48.00      3.00      0.00      0.00
      2.95  26960.00   1004.00    112.00     34.00     22.00
      1.73    457.00    828.60   1211.00    396.30     24.70
      1.49   4046.00   3374.00    338.00     26.00      2.00
      3.25  31817.40   1705.70   1771.50    135.80     55.30
      2.18   2431.00  11345.60    633.20     24.90      1.90
      3.34  35220.00  10005.30   1837.00     78.80      0.60
      3.02  33652.80    693.50    550.70     57.80      0.00
      0.30      0.00    467.20     83.90     23.60     46.10
      2.10  46385.40    771.20     72.80    134.30      0.00
      0.34      0.00    157.00      6.40      0.00      0.00
      1.33   7509.80    118.00    163.70      0.00      0.00
South IV 2.half year
1982  2003
1 1 0.5 0.75
0 4
      1.50   5039.00   4718.00    490.00    344.00     40.00
      1.80   9298.00    240.00   2806.00    513.00      2.00
      2.20      0.00   9422.50     91.60    577.30     43.80
      3.30  11940.00   1896.00   3229.00   2234.00    298.00
      1.70    112.00   5350.00    293.00    241.00     18.00
      2.83    298.00   3095.00   6664.00    196.00     51.00
      1.11      0.00      0.00    234.00   2084.00     68.00
      0.63      1.00   1619.00    165.00     35.00    123.00
      0.67    597.00   1438.00    477.00     71.00     21.00
      2.84  12115.00  11411.00    344.00    111.00      0.00
      2.02    134.00   3903.00    382.00    157.00     34.00
      1.07    838.00   1037.00    953.00    266.00     87.00
      0.97      0.00   4092.90    322.30    197.60    136.90
      1.30      0.00   3166.00   2789.00    307.00    157.00
      2.77   2088.10   2030.50   4080.40    536.10   1023.00
      3.36    198.00  15238.30    535.50    406.20    135.60
      1.64   1141.80    737.50   2672.50    209.40     65.20
      1.13   1322.10    202.50     58.20   1391.80    166.40
      1.59   6659.00   3600.60    495.90    339.20    329.50
      3.98  73442.60    819.30     15.10      0.00      0.00
      0.86      0.00   1370.40    472.20      0.00      0.00
      1.53      0.00     34.50     31.20      0.00      0.00
```

Table 13.1.4.1 Sandeel in IV. Separable VPA diagnostic output.

```
Title : Sandeel in IV

At  3/09/2004  14:57

Separable analysis
from 1983 to 2003 on ages  0 to  3
with Terminal F of .600 on age 1 and Terminal S of 1.000

Initial sum of squared residuals was   333.028 and
  final sum of squared residuals is     42.315 after 113 iterations



Matrix of Residuals

 Years,    1983/84,1984/85,1985/86,1986/87,1987/88,1988/89,1989/90,1990/91,1991/92,1992/93,
  Ages

  0/ 1,      .469, -2.114,  -.458,   .068,  -.123,  -.267,  -.121,  -.123,   .320,   .708,
  1/ 2,     -.083,  1.157, -1.592,  -.547,  -.163,  -.699,   .723,  -.455,  -.054,   .299,
  2/ 3,     -.085,  -.046,  1.003,   .282,   .124,   .458,  -.364,   .284,  -.060,  -.362,
  TOT ,      .000,   .000,   .000,   .000,   .000,   .000,   .000,   .000,   .000,   .000,
  WTS ,     1.000,  1.000,  1.000,  1.000,  1.000,  1.000,  1.000,  1.000,  1.000,  1.000,

 Years,    1993/94,1994/95,1995/96,1996/97,1997/98,1998/99,1999/00,2000/01,2001/02,2002/03,

  0/ 1,     1.441, -2.934,   .507,   .494,   .339,  1.933,  1.606,  -.519,  1.315, -2.540,
  1/ 2,     -.097,   .824,   .485,   .045,   .248,  -.412,  -.259,  -.199,  -.345,  1.123,
  2/ 3,     -.349,   .365,  -.408,  -.162,  -.231,  -.313,  -.305,   .254,  -.177,   .091,
  TOT ,      .000,   .000,   .000,   .000,   .000,   .000,   .000,   .000,   .000,   .000,
  WTS ,     1.000,  1.000,  1.000,  1.000,  1.000,  1.000,  1.000,  1.000,  1.000,  1.000,



Fishing Mortalities (F)

        ,    1983,
F-values,   .1213,

        ,    1984,   1985,   1986,   1987,   1988,   1989,   1990,   1991,   1992,   1993,
F-values,   .1163,  .5491,  .2981,  .2219,  .4950,  .4234,  .5916,  .4227,  .2135,  .1663,

        ,    1994,   1995,   1996,   1997,   1998,   1999,   2000,   2001,   2002,   2003,
F-values,   .1835,  .2234,  .3062,  .2814,  .5911,  .5743,  .8138,  .8494,  .3932,  .6000,



 Selection-at-age (S)

        ,       0,      1,      2,      3,
S-values,   .0440, 1.0000, 1.3881, 1.0000,
```

Table 13.1.4.2 Sandeel in IV. Options for Seasonal survivor analysis (SXSA 01).

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

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:
 10: *Unknown catches:


The following fleets were used:
Fleet:  1: Fishery in the Northern North Sea
Fleet:  2: Fishery in the Southern North Sea

The following values was used:
 1: First VPA year                  1983
 2: Last VPA year                   2004
 3: Youngest age                       0
 4: Oldest true age                    3
 5: Number of seasons                  2
 6: Recruiting season                  2
 7: Last season in last year           1
 8: Spawning season                    1
 9: Number of fleets                   2

The following options were used:
  1: Inv. catchability:                            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 r                                0
   (0: Manual; (1: not available at present).)
 7: *Weighting of shats                            0
   (0: Manual; 1: Linear; 2: Log.)
 8: Handling of the plus group                     1
   (1: Dynamic; 2: Extra age group)

 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 1983-2003                    Year 2004
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 13.1.4.3 Sandeel in IV. SXSA (Run 01), log inverse catchability

```
Log inverse catchabilities, fleet no: 1
Fishery in the Northern North Sea

Season           1        2
AGE
      0          *    4.671
      1      3.664    4.198
      2      3.464    4.634
      3      3.464    4.634


Log inverse catchabilities, fleet no: 2
Fishery in the Southern North Sea

Season           1        2
AGE
      0          *    6.571
      1      3.963    3.793
      2      3.147    3.791
      3      3.147    3.791
```

Table 13.1.4.4 Sandeel in IV. SXSA (run 01). Factors for weighting of the survivor estimated from each fleet set manually, or estimated from the inverse variance of the log catchability.

Fixed weights (SXSA run 01 and 02)

	Northern and Southern	
Age	1st half-year	2nd half-year
0		0.02
1	1	0.1
2	1	0.1
3	1	0.1

Weighting according to the inverse variance of log catchability (SXSA run 03)

	Northern		Southern	
Age	1st half-year	2nd half-year	1st half-year	2nd half-year
0		0.77		0.46
1	1.87	1.09	1.25	0.99
2	1.33	0.79	1.87	0.74
3	1.05	0.90	2.12	0.94

Table 13.1.4.5 Sandeel in IV. SXSA (run 01) fishing mortality at age.

Partial fishing mortality for fleet: 1
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	*	0.013	*	0.000	*	0.000	*	0.017	*	0.003	*	0.027
1	0.093	0.010	0.055	0.015	0.046	0.004	0.077	0.053	0.163	0.082	0.194	0.058
2	0.021	0.012	0.083	0.009	0.089	0.029	0.181	0.076	0.136	0.005	0.796	0.038
3	0.036	0.016	0.013	0.013	0.127	0.027	0.050	0.000	0.097	0.000	0.067	0.021
4+	0.051	0.000	0.010	0.000	0.253	0.012	0.000	0.000	0.063	0.000	0.028	*
F (1- 2)	0.057	0.011	0.069	0.012	0.067	0.016	0.129	0.065	0.150	0.043	0.495	0.048

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	*	0.026	*	0.032	*	0.066	*	0.001
1	0.361	0.089	0.171	0.061	0.283	0.017	0.053	0.001	0.199	0.029	0.201	0.015
2	0.173	0.042	0.175	0.045	0.167	0.005	0.151	0.000	0.060	0.004	0.358	0.119
3	0.744	0.000	0.176	0.045	0.207	0.004	0.151	0.000	0.128	0.009	0.417	0.059
4+	0.000	*	0.238	0.101	0.595	0.039	0.238	0.000	0.938	*	1.993	*
F (1- 2)	0.267	0.065	0.173	0.053	0.225	0.011	0.102	0.000	0.129	0.017	0.279	0.067

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.017	*	0.023	*	0.010	*	0.128	*	0.095	*	0.000
1	0.170	0.040	0.130	0.045	0.130	0.052	0.072	0.262	0.023	0.019	0.202	0.012
2	0.099	0.017	0.108	0.070	0.156	0.046	0.277	0.032	0.177	0.054	0.448	0.010
3	0.190	0.009	0.076	0.033	0.404	0.004	0.278	0.025	0.158	0.004	0.242	0.008
4+	0.035	0.001	0.094	0.045	0.491	0.002	0.104	0.000	0.388	0.000	0.155	0.010
F (1- 2)	0.134	0.029	0.119	0.058	0.143	0.049	0.174	0.147	0.100	0.037	0.325	0.011

Year	2001		2002		2003		2004
Season	1	2	1	2	1	2	1
AGE							
0	*	0.086	*	0.000	*	0.020	*
1	0.058	0.023	0.143	0.004	0.050	0.016	0.048
2	0.124	0.009	0.138	0.001	0.013	0.015	0.115
3	0.092	0.044	0.079	0.000	0.018	0.000	0.059
4+	0.272	0.000	0.072	0.000	0.088	0.000	0.077
F (1- 2)	0.091	0.016	0.141	0.002	0.031	0.015	0.082

Partial fishing mortality for fleet: 2
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	*	0.016	*	0.000	*	0.015	*	0.000	*	0.002	*	0.000
1	0.037	0.008	0.295	0.116	0.133	0.072	0.141	0.040	0.027	0.044	0.046	0.000
2	0.608	0.107	0.114	0.007	1.059	0.388	0.510	0.047	0.286	0.160	0.309	0.026
3	0.373	0.437	1.089	0.180	0.315	0.678	0.399	0.114	0.319	0.100	0.912	0.373
4+	1.654	0.477	0.948	0.311	0.140	0.315	0.014	0.012	0.067	0.031	3.023	*
F (1- 2)	0.322	0.058	0.205	0.061	0.596	0.230	0.325	0.044	0.157	0.102	0.178	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	*	0.023	*	0.001	*	0.002	*	0.000
1	0.283	0.036	0.264	0.052	0.136	0.224	0.326	0.054	0.045	0.030	0.174	0.075
2	0.353	0.025	0.746	0.062	0.659	0.063	0.374	0.028	0.332	0.038	0.129	0.032
3	0.210	0.022	0.751	0.063	0.301	0.049	0.311	0.093	0.464	0.070	0.186	0.029
4+	2.142	*	1.014	0.141	0.850	0.000	0.486	0.062	1.470	*	0.661	*
F (1- 2)	0.318	0.030	0.505	0.057	0.397	0.144	0.350	0.041	0.189	0.034	0.151	0.054

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.000	*	0.002	*	0.001	*	0.004	*	0.004	*	0.020
1	0.186	0.038	0.115	0.054	0.101	0.069	0.103	0.019	0.351	0.006	0.314	0.095
2	0.195	0.143	0.321	0.162	0.157	0.039	0.330	0.047	0.330	0.006	0.304	0.061
3	0.270	0.102	0.640	0.130	0.185	0.065	0.435	0.067	0.409	0.090	0.311	0.120
4+	0.295	0.065	0.367	0.830	0.278	0.139	0.572	0.036	0.359	0.157	0.373	0.069
F (1- 2)	0.190	0.091	0.218	0.108	0.129	0.054	0.216	0.033	0.341	0.006	0.309	0.078

Year	2001		2002		2003		2004
Season	1	2	1	2	1	2	1
AGE							
0	*	0.135	*	0.000	*	0.000	*
1	0.579	0.024	0.560	0.032	0.280	0.005	0.204
2	0.696	0.002	0.451	0.051	0.650	0.003	0.203
3	0.226	0.000	0.208	0.000	0.708	0.000	0.580
4+	0.628	0.000	0.082	0.000	0.375	0.000	0.083
F (1- 2)	0.637	0.013	0.506	0.041	0.465	0.004	0.203

Table 13.1.4.6 Sandeel in IV. SXSA (run 01) annual fishing mortality at age.

Annual F at age (second half-year only for age 0)

Year/age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	0.029	0.000	0.015	0.017	0.006	0.027	0.015	0.030	0.048	0.032	0.068
1	0.152	0.459	0.238	0.292	0.280	0.296	0.785	0.543	0.600	0.447	0.301
2	0.798	0.231	1.646	0.872	0.601	1.314	0.638	1.128	0.985	0.606	0.467
3	0.822	1.413	1.070	0.589	0.541	1.428	1.100	1.136	0.606	0.587	0.723
4	4.184	1.413	0.706	0.025	0.167	0.000	0.000	1.850	2.122	0.885	0.000
F (1-2)	0.475	0.345	0.942	0.582	0.440	0.805	0.712	0.836	0.792	0.526	0.384

Year/age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	0.001	0.017	0.024	0.011	0.133	0.099	0.020	0.222	0.000	0.020	0.000
1	0.464	0.435	0.324	0.322	0.352	0.425	0.629	0.731	0.800	0.373	0.254
2	0.662	0.454	0.664	0.414	0.740	0.610	0.900	0.932	0.697	0.754	0.321
3	0.743	0.599	0.933	0.711	0.872	0.707	0.720	0.386	0.315	0.812	0.657
4	0.000	0.419	1.284	1.010	0.803	0.993	0.659	1.068	0.169	0.517	0.161
F (1-2)	0.563	0.445	0.494	0.368	0.546	0.518	0.765	0.832	0.749	0.563	0.288

Table 13.1.4.7 Sandeel in IV. SXSA (Run 01) 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	*	874709.	*	221210.	*	1199641.	*	620569.	*	196916.	*	712338.
1	101278.	32457.	381496.	95335.	99396.	30211.	530796.	154290.	274002.	82248.	87975.	24962.
2	89801.	30521.	26082.	14287.	68435.	11001.	22920.	7231.	115077.	49608.	59319.	10292.
3	3600.	1576.	22164.	3866.	11505.	4853.	5869.	2457.	5227.	2269.	34407.	7317.
4+	498.	6.	812.	178.	2711.	1207.	2580.	1705.	3173.	1865.	3161.	0.
SSN	93900.		49058.		82651.		31369.		123478.		96887.	
SSB	1230791.		738074.		1150859.		467735.		1626297.		1484869.	
TSN	195178.	939268.	430554.	334876.	182047.	1246913.	562165.	786252.	397480.	332906.	184862.	754909.
TSB	1740220.	1834771.	2302209.	1588208.	1567329.	2050955.	2686461.	2911712.	2914106.	1988186.	1871960.	1607357.

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	320474.	*	625432.	*	788276.	*	315843.	*	614117.	*	856279.
1	311229.	53171.	141732.	31955.	272509.	62698.	336947.	81373.	137271.	38764.	257307.	62398.
2	19276.	7400.	38414.	8903.	23350.	6183.	40224.	15438.	63047.	28103.	29890.	11996.
3	7907.	1745.	5661.	1302.	6548.	2565.	4725.	1949.	12291.	4366.	22045.	7730.
4+	3997.	0.	1397.	183.	1073.	87.	2061.	623.	1933.	0.	3303.	0.
SSN	31180.		45473.		30971.		47011.		77272.		55238.	
SSB	487916.		637784.		441834.		650504.		1043287.		771491.	
TSN	342409.	382791.	187205.	667775.	303480.	859809.	383958.	415226.	214543.	685349.	312545.	938404.
TSB	1857322.	1129003.	1241562.	1360101.	1610897.	1679777.	2025248.	1624893.	1661007.	1784594.	2382232.	6996687.

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	349174.	*	2037738.	*	352593.	*	421559.	*	533064.	*	497460.
1	384445.	95440.	154182.	43548.	892887.	256057.	156668.	47801.	165045.	40053.	216077.	44008.
2	46634.	23100.	72222.	30891.	32273.	15666.	185588.	64825.	29416.	11539.	31982.	9335.
3	8434.	3487.	16083.	4915.	19997.	7134.	11769.	3610.	48994.	17911.	8897.	3307.
4+	5791.	2759.	4669.	1926.	4017.	1146.	6264.	2013.	4283.	1258.	14232.	5448.
SSN	60859.		92974.		56288.		203621.		82693.		55111.	
SSB	1008692.		1053541.		626840.		1828861.		1012695.		634782.	
TSN	445304.	473961.	247156.	2119019.	949175.	632597.	360289.	539808.	247738.	603826.	271187.	559558.
TSB	3749784.	3178212.	2094269.	7021767.	5653795.	3056580.	2613768.	2097772.	1935295.	2458973.	2017673.	1447465.

Year	2001		2002		2003		2004
Season	1	2	1	2	1	2	1
AGE							
0	*	859656.	*	70763.	*	561357.	*
1	219059.	37816.	305945.	47909.	31796.	8137.	247200.
2	32350.	8636.	29522.	10525.	37842.	12352.	6524.
3	7118.	3437.	6991.	3489.	8184.	2471.	9936.
4+	6500.	1554.	3964.	2273.	4718.	1944.	3615.
SSN	45968.		40477.		50744.		20075.
SSB	470197.		457709.		439253.		251892.
TSN	265027.	911098.	346422.	134959.	82540.	586260.	267275.
TSB	1436249.	2867729.	2336212.	529776.	606499.	2220771.	1646099.

Table 13.1.4.8 Sandeel in IV. SXSA (run 01) assessment summary

Year	Recruits Age 0	Totalbio	SSB	Landings	Yield/SSB	Mean F Ages 1-2
1983	874709000	1740220	1230791	530640	0.4311	0.4753
1984	221210000	2302209	738074	750040	1.0162	0.3450
1985	1199641000	1567329	1150859	707105	0.6144	0.9421
1986	620569000	2686461	467735	685950	1.4665	0.5822
1987	196916000	2914106	1626297	791050	0.4864	0.4403
1988	712338000	1871960	1484869	1007304	0.6784	0.8051
1989	320474000	1857322	487916	826835	1.6946	0.7115
1990	625432000	1241562	637784	584912	0.9171	0.8358
1991	788276000	1610897	441834	898959	2.0346	0.7924
1992	315843000	2025248	650504	820140	1.2608	0.5264
1993	614117000	1661007	1043287	576932	0.5530	0.3843
1994	856279000	2382232	771491	770747	0.9990	0.5630
1995	349174000	3749784	1008692	915043	0.9072	0.4447
1996	2037738000	2094269	1053541	776126	0.7367	0.4941
1997	352593000	5653795	626840	1114044	1.7772	0.3681
1998	421559000	2613768	1828861	1000375	0.5470	0.5461
1999	533064000	1935295	1012695	718668	0.7097	0.5175
2000	497460000	2017673	634782	692498	1.0909	0.7650
2001	859656000	1436249	470197	858619	1.8261	0.8316
2002	70763000	2336212	457709	806921	1.7630	0.7488
2003	561357000	606499	439253	242153	0.5513	0.5634
2004		1646099	251892			
Average	620436571.4	2179554	841632	765479	1.0505	0.6039
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 13.1.4.9 Sandeel in IV. XSA (run 01) diagnostics

```
Lowestoft VPA Version 3.1

   31/08/2004  11:46

 Extended Survivors Analysis

 Sandeel in IV

 CPUE data from file fleet.dat

 Catch data for  21 years. 1983 to 2003. Ages  0 to   4.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                     ,    year, year,  age ,  age
 North IV 1.half year,   1983, 2003,   1,     3,   .250,   .500
 South IV 1.half year,   1983, 2003,   1,     3,   .250,   .500
 North IV 2.half year,   1983, 2003,   0,     3,   .500,   .750
 South IV 2.half year,   1983, 2003,   0,     3,   .500,   .750


 Time series weights :
      Tapered time weighting not applied


 Catchability analysis :
      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    2


 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   2 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =   1.500

      Minimum standard error for population
      estimates derived from each fleet =    .300

      Prior weighting not applied

 Tuning converged after   28 iterations

 Regression weights
       , 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000

 Fishing mortalities
    Age,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003

      0,  .001,  .017,  .025,  .012,  .142,  .104,  .017,  .211,  .000,  .032
      1,  .404,  .495,  .335,  .343,  .394,  .507,  .763,  .713,  .859,  .512
      2,  .668,  .323,  .737,  .394,  .760,  .630, 1.248, 1.278,  .542,  .689
      3,  .762,  .606,  .538,  .890,  .854,  .753,  .785,  .733,  .563,  .527

1
 XSA population numbers (Thousands)

                                AGE
 YEAR ,           0,            1,            2,            3,

 1994 ,    8.56E+08, 3.18E+08, 3.14E+07, 2.33E+07,
 1995 ,    3.68E+08, 3.84E+08, 6.40E+07, 8.84E+06,
 1996 ,    2.09E+09, 1.63E+08, 7.06E+07, 2.54E+07,
 1997 ,    3.40E+08, 9.16E+08, 3.50E+07, 1.85E+07,
 1998 ,    4.11E+08, 1.51E+08, 1.96E+08, 1.30E+07,
 1999 ,    5.27E+08, 1.60E+08, 3.06E+07, 5.02E+07,
 2000 ,    5.83E+08, 2.14E+08, 2.91E+07, 8.95E+06,
 2001 ,    9.39E+08, 2.58E+08, 3.00E+07, 4.58E+06,
 2002 ,    6.09E+07, 3.42E+08, 3.80E+07, 4.58E+06,
 2003 ,    3.54E+08, 2.74E+07, 4.36E+07, 1.21E+07,

 Estimated population abundance at 1st Jan 2004

    ,     0.00E+00, 1.54E+08, 4.94E+06, 1.20E+07,

 Taper weighted geometric mean of the VPA populations:

    ,     5.19E+08, 2.20E+08, 4.84E+07, 1.18E+07,

 Standard error of the weighted Log(VPA populations) :

    ,        .7528,    .7577,    .6213,    .7878,
```

```
 Log catchability residuals.

 Fleet : North IV 1.half year

  Age  ,  1983
     0 , No data for this fleet at this age
     1 ,   .60
     2 , -1.44
     3 ,  -.72

  Age  ,  1984,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992,  1993
     0 , No data for this fleet at this age
     1 ,   .17,  -.01,  -.57,  -.03,  -.22,   .17,   .17,   .41,  -.68,   .43
     2 ,   .46,   .72,   .16,  -.67,  1.31,  -.91,   .04,  -.15,   .03,  -.94
     3 , -2.27,  1.25, -1.31, -1.08, -1.85,  1.09,  -.25,  -.03,   .43,  -.45

  Age  ,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003
     0 , No data for this fleet at this age
     1 ,  -.16,   .10,   .00,  -.32,  -.53, -1.39,   .33,   .16,  1.06,   .29
     2 ,   .48,  -.94,  -.17,  -.34,   .56,   .42,  1.16,  1.14,   .65, -1.56
     3 ,   .62,   .02, -1.18,   .85,   .52,   .34,   .34,  1.19,   .88, -1.58


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time


   Age ,        1,         2,         3
 Mean Log q,  -10.6019,  -10.4296,  -10.4296,
 S.E(Log q),     .5163,     .8361,    1.0695,



 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,    1.11,    -.641,      9.66,     .64,     21,     .58,  -10.60,
  2,    1.46,   -1.043,      7.12,     .22,     21,    1.21,  -10.43,
  3,    2.23,   -1.965,      3.56,     .12,     21,    2.21,  -10.58,
1


 Fleet : South IV 1.half year

  Age  ,  1983
     0 , No data for this fleet at this age
     1 , -1.47
     2 ,   .13
     3 ,  -.15


  Age  ,  1984,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992,  1993
     0 , No data for this fleet at this age
     1 ,   .52,  -.47,  -.16, -1.26, -1.40,   .31,   .29,   .02,   .41, -1.07
     2 , -1.19,  1.02,   .36,  -.01,  -.04,  -.48,   .52,   .91,  -.44,   .11
     3 ,   .22,  -.02,  -.07,   .04,   .36,  -.45,   .23,   .03,  -.22,   .16


  Age  ,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003
     0 , No data for this fleet at this age
     1 ,   .59,   .32,  -.16,  -.17,  -.44,   .66,   .81,   .90,  1.08,   .69
     2 ,  -.30,  -.79,   .23,  -.60,  -.19,  -.28,   .15,   .66,  -.16,   .39
     3 ,   .06,  -.16,   .26,  -.20,   .05,  -.02,  -.03,  -.12,  -.14,   .14


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time


   Age ,        1,         2,         3
 Mean Log q,  -10.9040,  -10.0797,  -10.0797,
 S.E(Log q),     .7726,     .5484,     .1913,
```

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,	.83,	.882,	12.30,	.59,	21,	.65,	-10.90,
2,	.95,	.271,	10.48,	.59,	21,	.53,	-10.08,
3,	.87,	3.231,	10.86,	.97,	21,	.14,	-10.08,

1

Fleet : North IV 2.half year

Age	1983
0 ,	.81
1 ,	.23
2 ,	.23
3 ,	.77

Age	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993
0 ,	99.99,	-2.37,	-.41,	-1.74,	.14,	-.36,	.23,	.07,	1.55,	.69
1 ,	.43,	-.45,	.08,	1.16,	.37,	.73,	.55,	-.92,	-2.83,	-.39
2 ,	.69,	1.58,	.82,	-1.56,	.29,	.48,	.56,	-1.53,	-3.63,	-1.76
3 ,	-.62,	2.19,	99.99,	99.99,	-1.14,	99.99,	.19,	-1.85,	99.99,	-1.50

Age	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003
0 ,	-3.02,	.17,	-.28,	-.65,	1.49,	1.27,	99.99,	1.45,	99.99,	.95
1 ,	-.79,	.63,	-.07,	.50,	1.78,	-.78,	1.01,	-.66,	-.62,	.04
2 ,	2.04,	-.01,	1.03,	.88,	.03,	.70,	1.56,	-.54,	-1.84,	-.01
3 ,	1.28,	-.42,	-.64,	-1.41,	-.35,	-1.97,	1.18,	1.61,	99.99,	99.99

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age ,	0,	1,	2,	3
Mean Log q,	-11.4751,	-11.6189,	-11.9661,	-11.9661,
S.E(Log q),	1.3066,	.9656,	1.3778,	1.3371,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
0,	1.65,	-.720,	5.75,	.07,	18,	2.19,	-11.48,
1,	1.10,	-.324,	10.83,	.34,	21,	1.09,	-11.62,
2,	1.58,	-.729,	8.66,	.08,	21,	2.20,	-11.97,
3,	4.55,	-1.967,	-3.32,	.02,	15,	5.49,	-12.14,

1

Fleet : South IV 2.half year

Age	1983
0 ,	1.82
1 ,	-1.46
2 ,	.54
3 ,	2.19

Age	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993
0 ,	99.99,	.99,	-2.15,	-.66,	99.99,	-5.23,	.38,	1.76,	-1.48,	.18
1 ,	.82,	-.07,	-.10,	-.26,	99.99,	.78,	1.25,	1.16,	.17,	.30
2 ,	-1.66,	1.29,	.02,	.73,	-.08,	.51,	1.33,	.06,	-.60,	.62
3 ,	-.09,	2.52,	.83,	.22,	1.73,	.84,	.96,	-.14,	1.09,	.79

Age	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003
0 ,	99.99,	99.99,	-.91,	-1.65,	.71,	.96,	2.08,	3.21,	99.99,	99.99
1 ,	1.02,	.34,	-.10,	.00,	-.47,	-1.39,	1.02,	-1.59,	.26,	-1.69
2 ,	.52,	1.46,	1.24,	-.49,	.34,	-1.34,	.89,	-3.53,	.75,	-2.59
3 ,	.39,	1.41,	.11,	.17,	.56,	1.41,	1.40,	99.99,	99.99,	99.99

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age ,	0,	1,	2,	3
Mean Log q,	-13.4154,	-11.2593,	-11.1876,	-11.1876,
S.E(Log q),	2.1000,	.9275,	1.3161,	1.2073,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
0,	.40,	1.746,	17.53,	.39,	15,	.78,	-13.42,
1,	.64,	2.219,	14.16,	.68,	20,	.54,	-11.26,
2,	.57,	1.635,	13.96,	.44,	21,	.72,	-11.19,
3,	1.15,	-.554,	9.34,	.45,	18,	.90,	-10.28,

1

Terminal year survivor and F summaries :

Age 0 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
North IV 1.half year,	1.,	.000,	.000,	.00,	0,	.000,	.000
South IV 1.half year,	1.,	.000,	.000,	.00,	0,	.000,	.000
North IV 2.half year,	397223100.,	1.342,	.000,	.00,	1,	.547,	.000
South IV 2.half year,	1.,	.000,	.000,	.00,	0,	.000,	.000
F shrinkage mean ,	48995190.,	1.50,,,,				.453,	.098

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
154029000.,	1.00,	1.41,	2,	1.407,	.032

Age 1 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
North IV 1.half year,	6602955.,	.528,	.000,	.00,	1,	.445,	.406
South IV 1.half year,	9887020.,	.791,	.000,	.00,	1,	.199,	.288
North IV 2.half year,	5151369.,	.988,	.000,	.00,	1,	.127,	.496
South IV 2.half year,	913839.,	.950,	.000,	.00,	1,	.137,	1.530
F shrinkage mean ,	3217578.,	1.50,,,,				.092,	.707

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
4943270.,	.36,	.37,	5,	1.015,	.512

1

Age 2 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
North IV 1.half year,	10034140.,	.492,	1.310,	2.66,	2,	.293,	.783
South IV 1.half year,	20029400.,	.483,	.264,	.55,	2,	.391,	.467
North IV 2.half year,	12027560.,	.769,	.501,	.65,	3,	.115,	.689
South IV 2.half year,	4514033.,	.805,	1.251,	1.55,	3,	.111,	1.292
F shrinkage mean ,	7815343.,	1.50,,,,				.090,	.926

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
12013900.,	.30,	.34,	11,	1.138,	.689

Age 3 Catchability constant w.r.t. time and age (fixed at the value for age) 2

Year class = 2000

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
North IV 1.half year,	3087014.,	.476,	.655,	1.38,	3,	.146,	.633
South IV 1.half year,	4454288.,	.262,	.126,	.48,	3,	.741,	.478
North IV 2.half year,	1126928.,	.861,	.593,	.69,	2,	.032,	1.230
South IV 2.half year,	3224311.,	.778,	.934,	1.20,	3,	.038,	.613
F shrinkage mean ,	3170065.,	1.50,,,,				.042,	.621

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
3932398.,	.22,	.17,	12,	.756,	.527

1
1

Table 13.1.4.10 Sandeel in IV. XSA (run 01) fishing mortality at age.

Run title : Sandeel in IV

At 31/08/2004 11:46

Terminal Fs derived using XSA (With F shrinkage)

Fishing mortality (F) at age

YEAR / AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	0.0277	0.0000	0.0124	0.0172	0.0050	0.0263	0.0154	0.0280	0.0470	0.0319	0.0569
1	0.1609	0.4713	0.2198	0.2486	0.2973	0.2783	0.8810	0.6060	0.6000	0.4734	0.3173
2	0.5165	0.2344	1.6301	0.7302	0.4329	1.5578	0.5453	1.1929	1.1154	0.5012	0.4600
3	0.5758	0.5791	1.1393	0.4035	0.3741	0.7395	1.7008	0.8734	0.6143	0.7235	0.5317
+gp	0.5758	0.5791	1.1393	0.4035	0.3741	0.7395	1.7008	0.8734	0.6143	0.7235	0.5317
FBAR 1-2	0.3387	0.3529	0.9250	0.4894	0.3651	0.9181	0.7132	0.8995	0.8577	0.4873	0.3887

YEAR / AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	0.0008	0.0165	0.0245	0.0116	0.1416	0.1042	0.0172	0.2111	0.0000	0.0322
1	0.4044	0.4951	0.3355	0.3429	0.3941	0.5066	0.7632	0.7132	0.8588	0.5120
2	0.6684	0.3233	0.7369	0.3942	0.7605	0.6296	1.2479	1.2780	0.5423	0.6892
3	0.7623	0.6065	0.5382	0.8898	0.8536	0.7525	0.7849	0.7332	0.5626	0.5269
+gp	0.7623	0.6065	0.5382	0.8898	0.8536	0.7525	0.7849	0.7332	0.5626	0.5269
FBAR 1-2	0.5364	0.4092	0.5362	0.3686	0.5773	0.5681	1.0056	0.9956	0.7006	0.6006

Table 13.1.4.11 Sandeel in IV. XSA (run 01) stock numbers at age (millions)

Run title : Sandeel in IV

At 31/08/2004 11:46

Terminal Fs derived using XSA (With F shrinkage)

Stock number at age (start of year) Numbers*10**-6

YEAR / AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	941060	256560	1491950	632810	226274	758964	329736	685734	835764	329379	749899
1	103696	411310	115280	662139	279502	101167	332179	145893	299605	358285	143354
2	131723	26590	77324	27871	155533	62534	23069	41458	23972	49523	67214
3	4795	43128	11544	8313	7370	55364	7228	7339	6902	4312	16465
+gp	1184	1442	1952	188	1552	7069	5248	2092	2179	2393	5551
0 TOTAL	1182459	739030	1698049	1331322	670231	985097	697459	882517	1168421	743892	982483

YEAR / AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	GMST 83-03	AMST 83-03
0	856012	368190	2089891	339511	410971	527482	583387	939410	60947	354005	Na	592865	702789
1	318318	384325	162726	916321	150790	160287	213569	257669	341781	27385	154029	239929	290338
2	31438	63985	70555	35043	195875	30623	29089	29988	38035	43614	4943	49298	61758
3	23287	8843	25415	18533	12967	50249	8955	4583	4585	12136	12014	12343	17136
+gp	7285	4344	7929	4380	6081	5178	12647	8454	1411	4708	5458		
0 TOTAL	1236340	829686	2356517	1313788	776683	773820	847646	1240104	446759	441849	176444		
1													

Table 13.1.4.12 Sandeel in IV. XSA (run 01) assessment summary.

Run title : Sandeel in IV

At 31/08/2004 11:46

Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

Year	Recruits Age 0	Totalbio	SSB	Landings	Yield/SSB	Mean F Ages 1-2
1983	941060160	3271018	1808364	530640	0.2934	0.3387
1984	256559984	3042566	1099634	750040	0.6821	0.3529
1985	1491949824	3223488	1248515	707105	0.5664	0.9250
1986	632810432	3906568	506017	685950	1.3556	0.4894
1987	226273776	3684730	2144795	791050	0.3688	0.3651
1988	758963584	3142909	1938812	1007304	0.5195	0.9181
1989	329735584	2339977	548655	826835	1.5070	0.7132
1990	685734336	2028438	721198	584912	0.8110	0.8995
1991	835763584	2599962	478894	898959	1.8772	0.8577
1992	329378944	2563147	771966	820140	1.0624	0.4873
1993	749898688	2636770	1241780	576932	0.4646	0.3887
1994	856012224	3732887	884206	770747	0.8717	0.5364
1995	368189536	4362382	1253956	915043	0.7297	0.4092
1996	2089891072	4429476	1241183	776126	0.6253	0.5362
1997	339510848	6141995	643595	1114044	1.7310	0.3686
1998	410970976	3094550	1928122	1000375	0.5188	0.5773
1999	527482432	2483536	1060048	718668	0.6780	0.5681
2000	583386944	2533990	583763	692498	1.1863	1.0056
2001	939409728	2521268	445538	858619	1.9272	0.9956
2002	60947416	2598612	439130	806921	1.8375	0.7006
2003	354005376	1020271	522218	242153	0.4637	0.6006
2004			223430*			
Average	655616000	3112311	1024304	765479	0.9561	0.6206
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

*Calculated using the 2003 weight in the stock

Table 13.1.6.1 Sandeel in IV. Short term forecast based upon SXSA, forecasting with 2003 F.

	Terminal population from SXSA, 2003F				
	Recruitment basis for 2004				
		Historic max	Geometric mean	Regression of proportion of landings from 2nd half year on log recruitment (rsq=0.573)	Historic min
Fmult	2004	1	1	1	1
F	2004	0.564	0.564	0.564	0.564
SSB	2004	238	238	238	238
SSB	2005	**517**	**517**	**517**	**517**
SSB	2006	1769	579	532	245
TSB	2004	3579	2043	1982	1612
TSB	2005	5748	2183	2043	1183
TSB	2006	3434	2245	2198	1911
Landings	2004	401	359	357	347
Landings	2005	1133	448	421	255
Recruitment	2004	2037738	501500	441176	70763
Recruitment	2005	501500	501500	501500	501500
Recruitment	2006	501500	501500	501500	501500

Table 13.1.6.2 Sandeel in IV. Short term forecast based upon SXSA, forecasting with average selection pattern scaled to 2003 F.

	Terminal population from SXSA, scaled F				
	Recruitment basis for 2004				
		Historic max	Geometric mean	Regression of proportion of landings from 2nd half year on log recruitment (rsq=0.573)	Historic min
Fmult	2004	1	1	1	1
F	2004	0.564	0.564	0.564	0.564
SSB	2004	238	238	238	238
SSB	2005	**492**	**492**	**492**	**492**
SSB	2006	1556	536	496	251
TSB	2004	3579	2043	1982	1612
TSB	2005	5552	2115	1980	1152
TSB	2006	3180	2160	2120	1874
Landings	2004	542	424	420	391
Landings	2005	1314	482	450	249
Recruitment	2004	2037738	501500	441176	70763
Recruitment	2005	501500	501500	501500	501500
Recruitment	2006	501500	501500	501500	501500

Table 13.1.6.3 Sandeel in IV. Short term forecast based upon SXSA, forecasting with 2003 F.

	Terminal population from XSA, 2003F				
	Recruitment basis for 2004				
		Historic max	Geometric mean	Regression of proportion of landings from 2nd half year on log recruitment (rsq=0.553)	Historic min
Fmult	2004	1	1	1	1
F	2004	0.600	0.600	0.600	0.600
SSB	2004	285	285	285	285
SSB	2005	**351**	**351**	**351**	**351**
SSB	2006	1528	480	416	175
TSB	2004	3187	1616	1519	1158
TSB	2005	5663	2061	1839	1010
TSB	2006	3238	2190	2126	1884
Landings	2004	387	318	314	298
Landings	2005	1350	449	394	187
Recruitment	2004	2089891	519091	422471	60947
Recruitment	2005	519091	519091	519091	519091
Recruitment	2006	519091	519091	519091	519091

Table 13.1.6.4 Sandeel in IV. Short term forecast based upon XSA, forecasting with average selection pattern scaled to 2003 F.

	Terminal population from XSA, scaled F				
	Recruitment basis for 2004				
		Historic max	Geometric mean	Regression of proportion of landings from 2nd half year on log recruitment (rsq=0.597)	Historic min
Fmult	2004	1	1	1	1
F	2004	0.600	0.600	0.600	0.600
SSB	2004	285	285	285	285
SSB	2005	**345**	**345**	**345**	**345**
SSB	2006	1439	461	401	176
TSB	2004	3187	1616	1519	1158
TSB	2005	5557	2030	1813	1001
TSB	2006	3123	2146	2086	1860
Landings	2004	455	342	335	309
Landings	2005	1418	470	411	193
Recruitment	2004	2089891	519091	422471	60947
Recruitment	2005	519091	519091	519091	519091
Recruitment	2006	519091	519091	519091	519091

Figure 13.1.1.1 Sandeel in IV. Danish sandeel sampling areas.

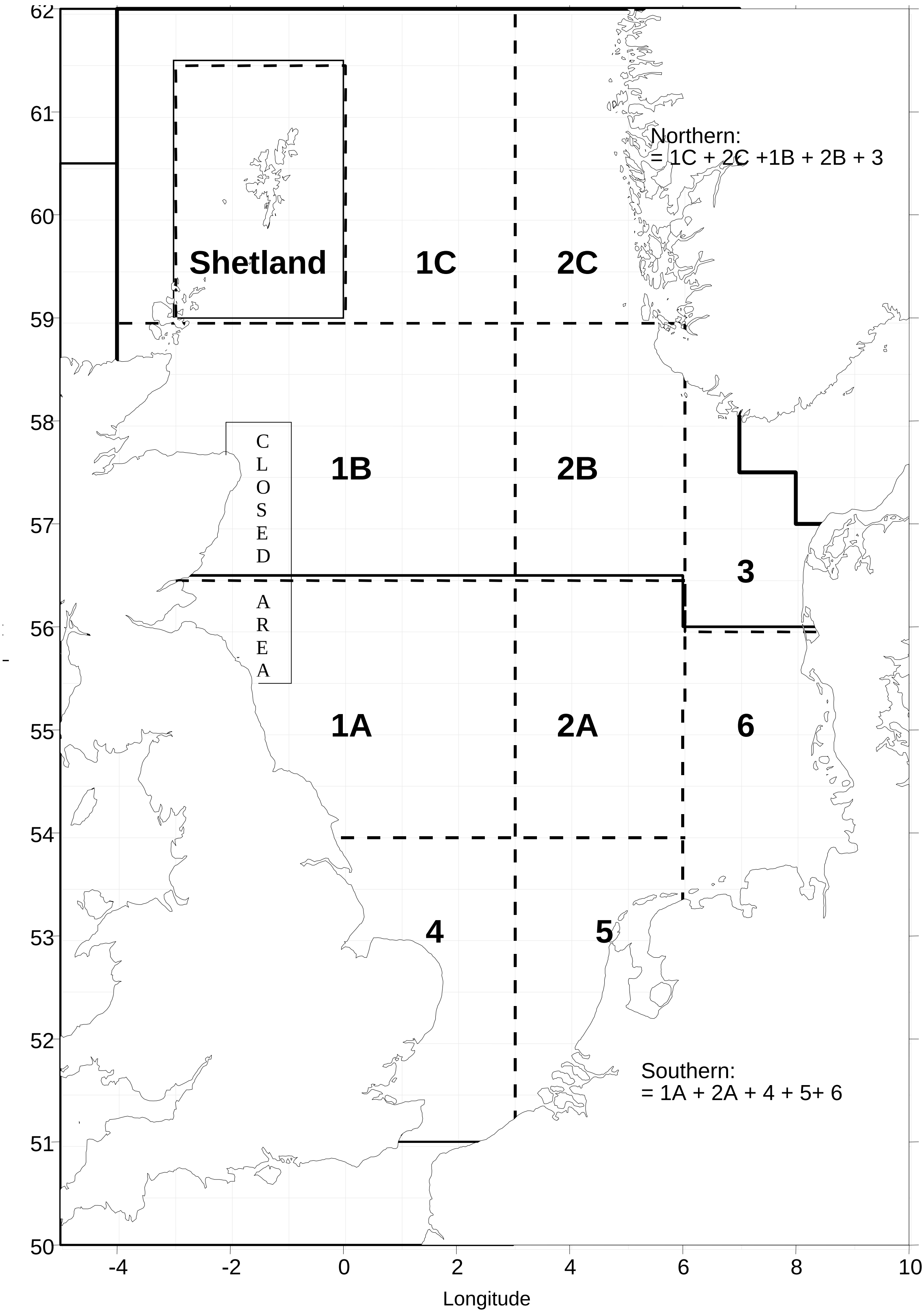
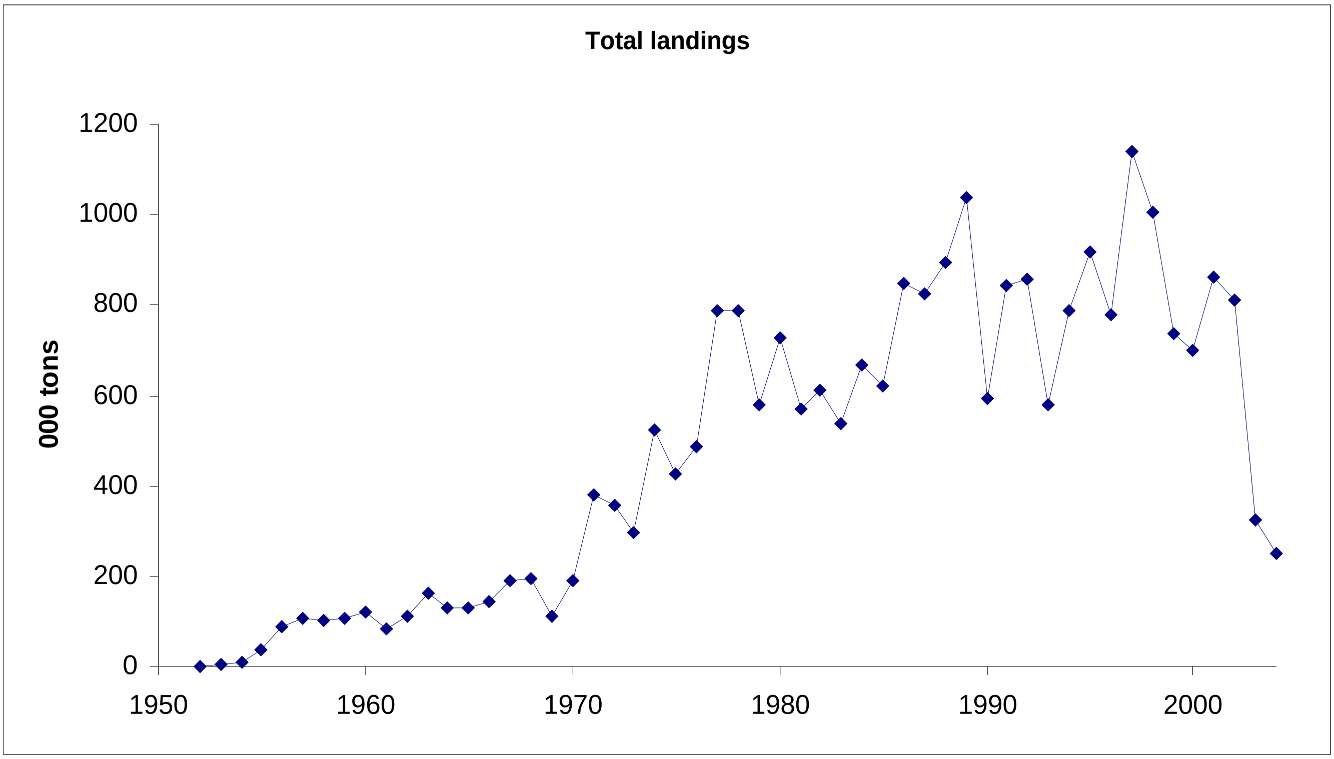


Figure 13.1.1.2 Sandeel in IV. Total international landings, effort and CPU. 2004 only represent first half year.



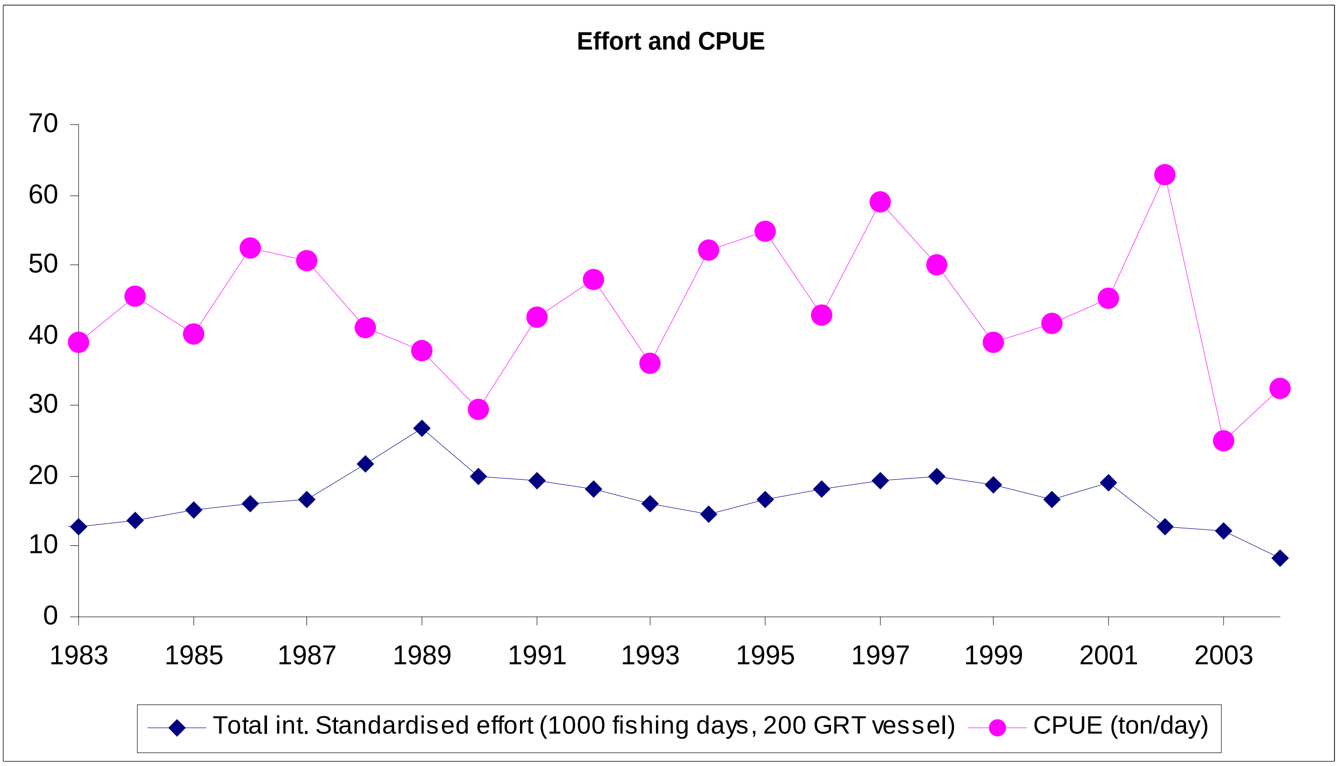
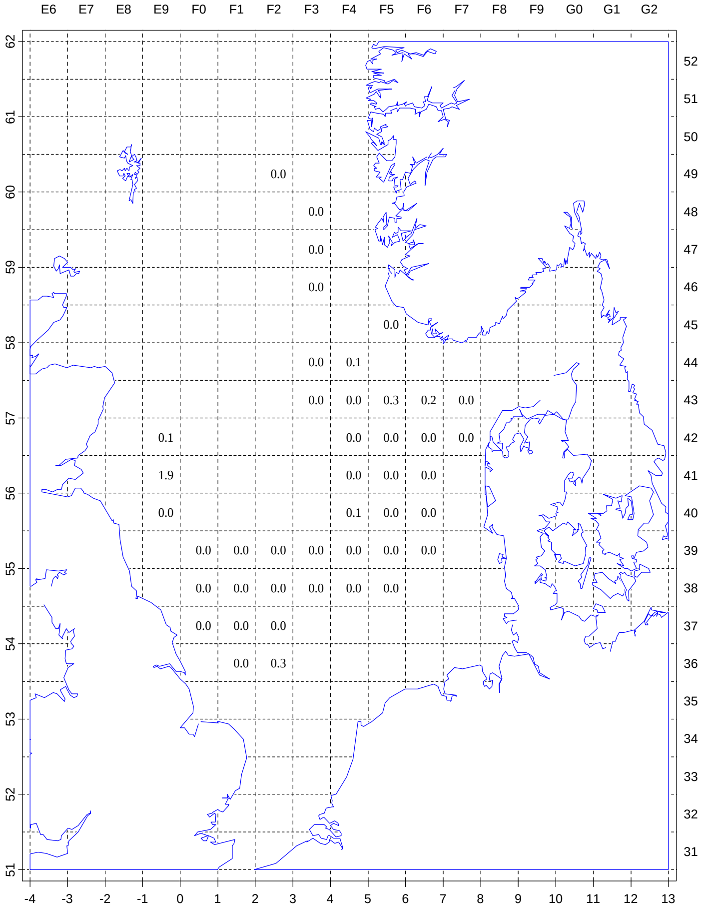


Figure 13.1.1.3 Sandeel in IV. Quarterly catches of sandeels by Denmark, Norway and Scotland in 2003 and by Denmark and Norway in 2004 by ICES rectangle **(**‘000 tonnes).

North Sea sandeel landings in 2003 quarter 1

Total landings: 3033 ton

Max landings per rectangle: 1900 ton



North Sea sandeel landings in 2003 quarter 2

Total landings: 260498 ton

Max landings per rectangle: 39250 ton

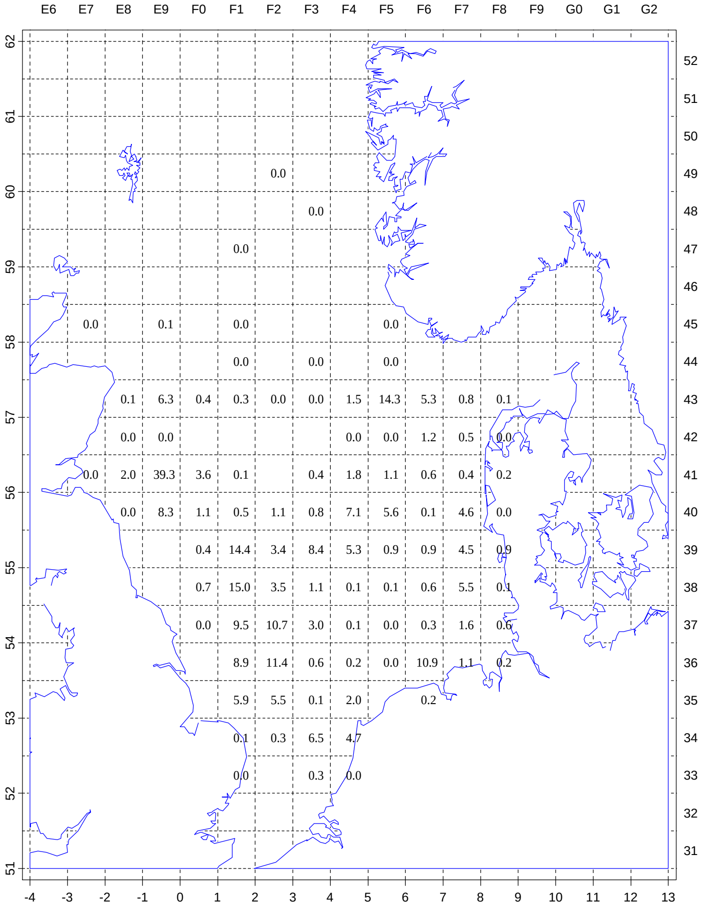
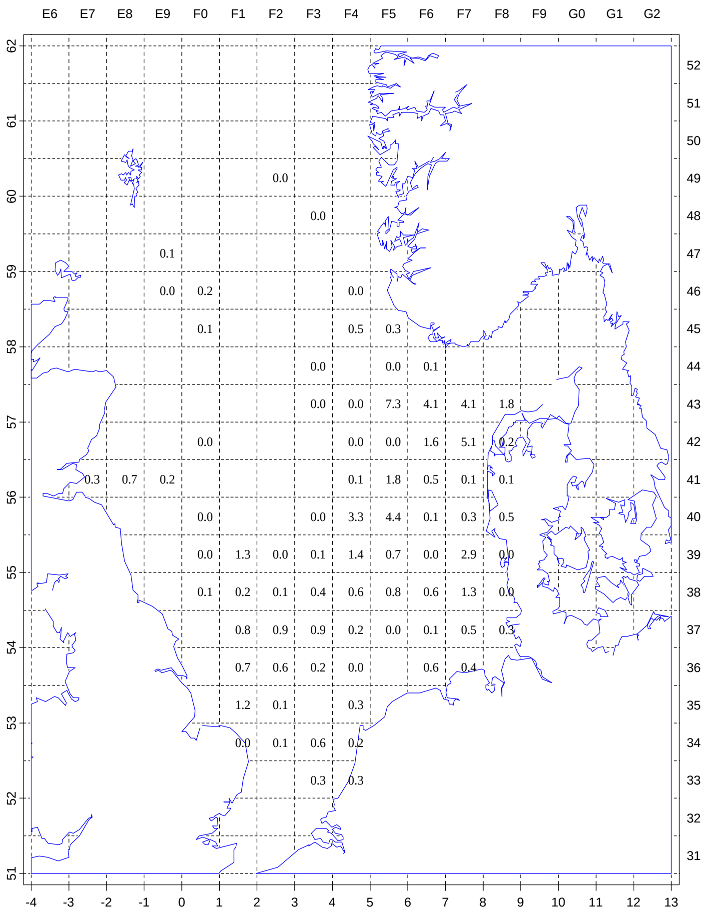


Figure 13.1.1.3 (continued) Quarterly catches of Sandeel by ICES rectangle ('000 tonnes).

North Sea sandeel landings in 2003 quarter 3

Total landings: 57822 ton

Max landings per rectangle: 7320 ton



North Sea sandeel landings in 2003 quarter 4

Total landings: 3945 ton

Max landings per rectangle: 2173 ton

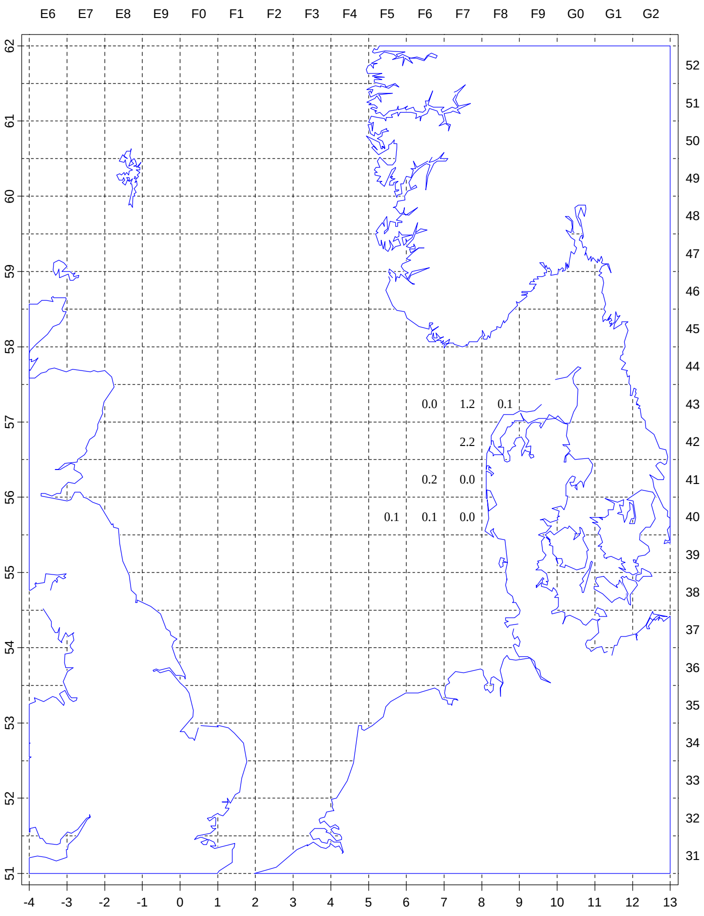
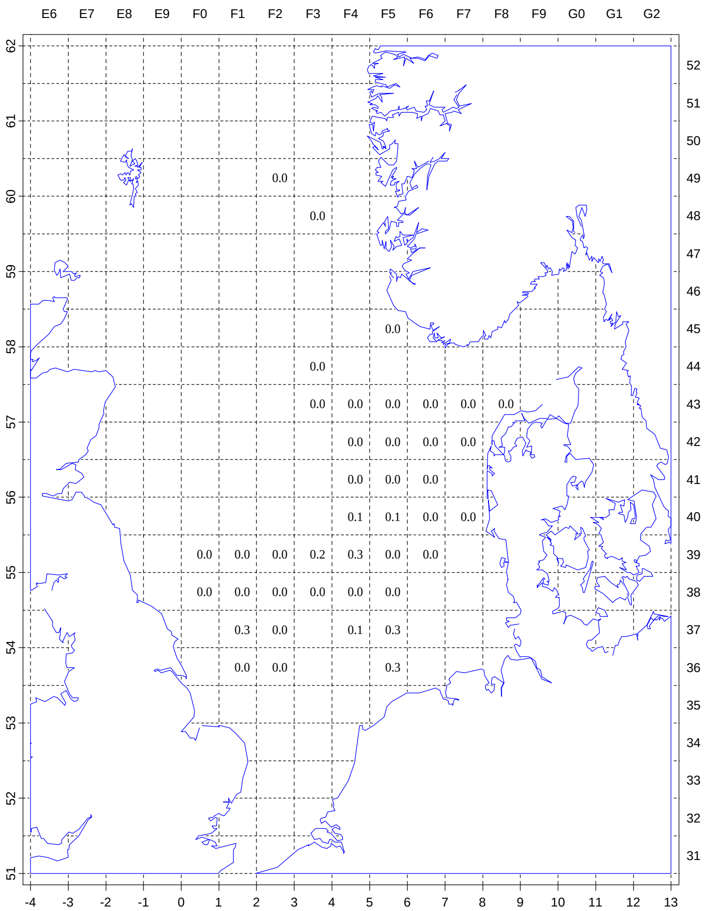


Figure 13.1.1.3 (continued) Quarterly catches of Sandeel by ICES rectangle ('000 tonnes).

North Sea sandeel landings in 2004 quarter 1

Total landings: 1633 ton

Max landings per rectangle: 343 ton



North Sea sandeel landings in 2004 quarter 2

Total landings: 273314 ton

Max landings per rectangle: 27853 ton

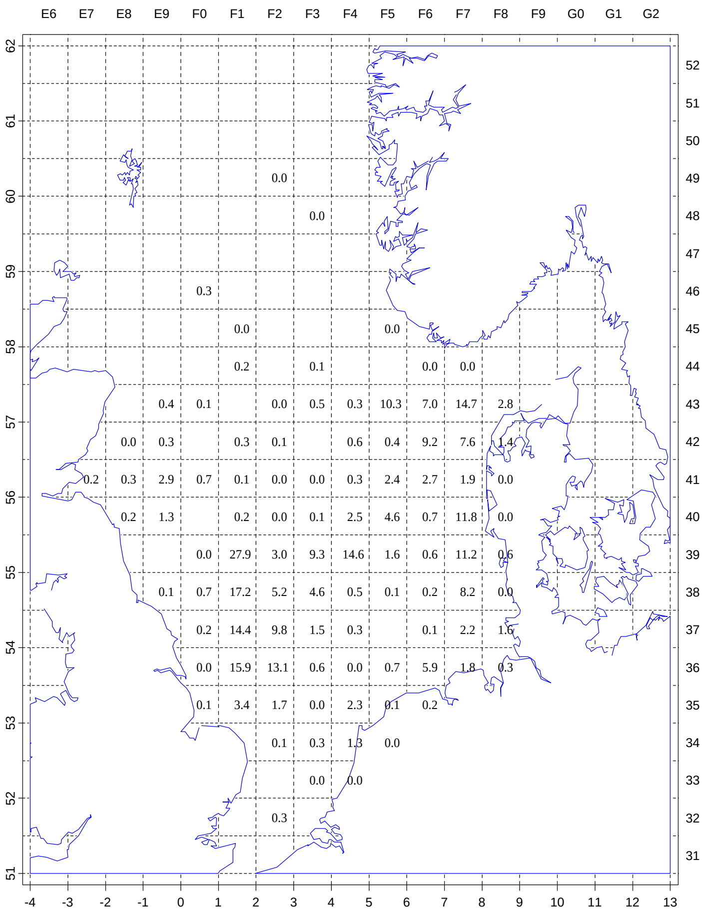
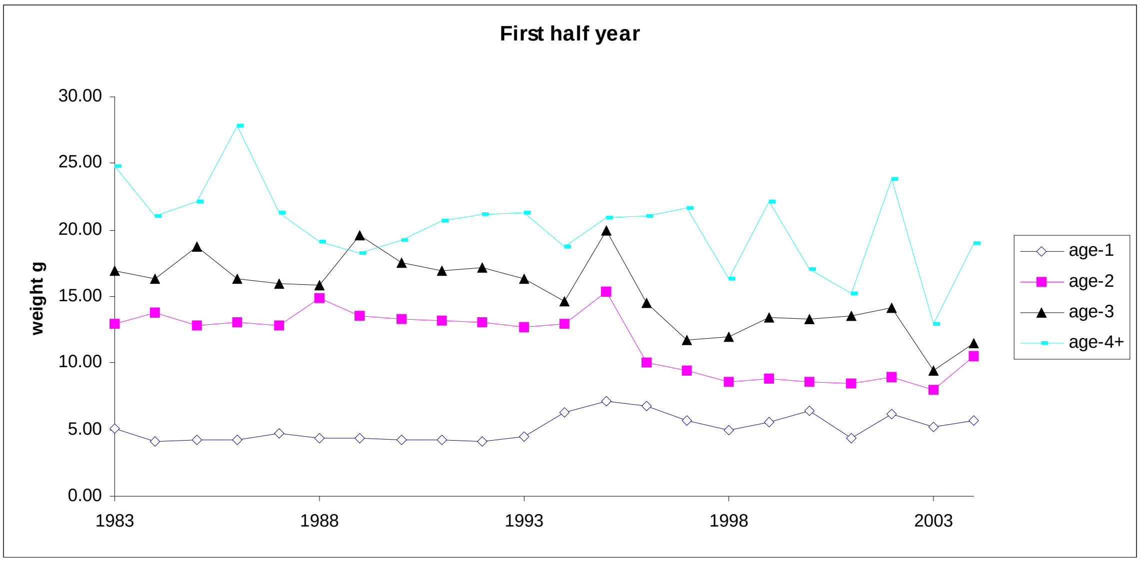


Figure 13.1.2.1 Sandeel in IV. Mean weight at age in the stock, by half year.



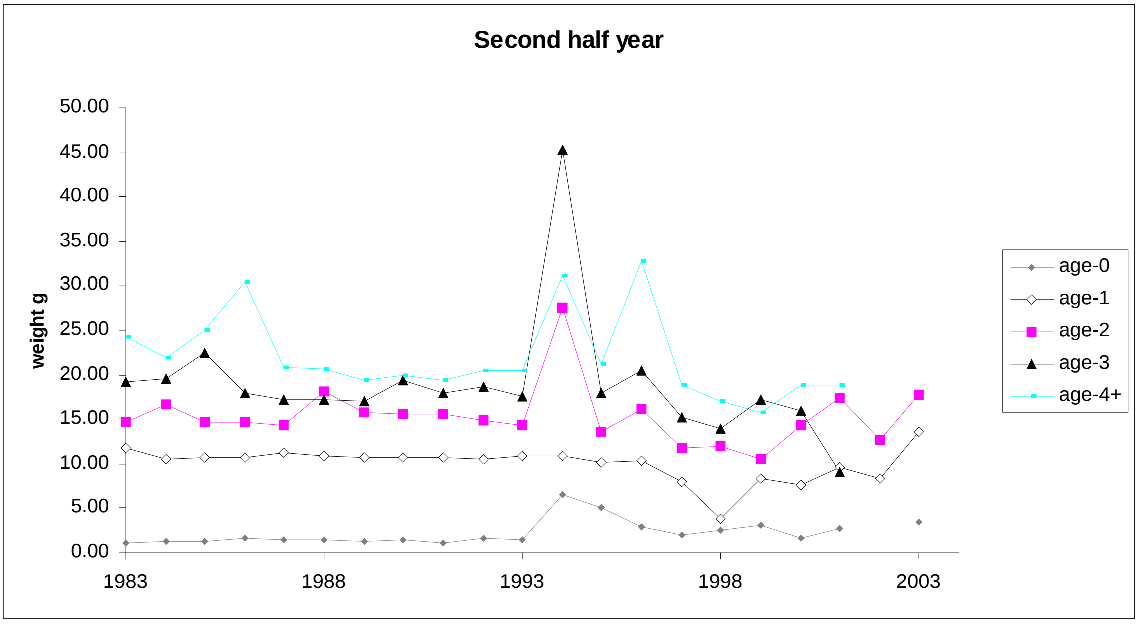
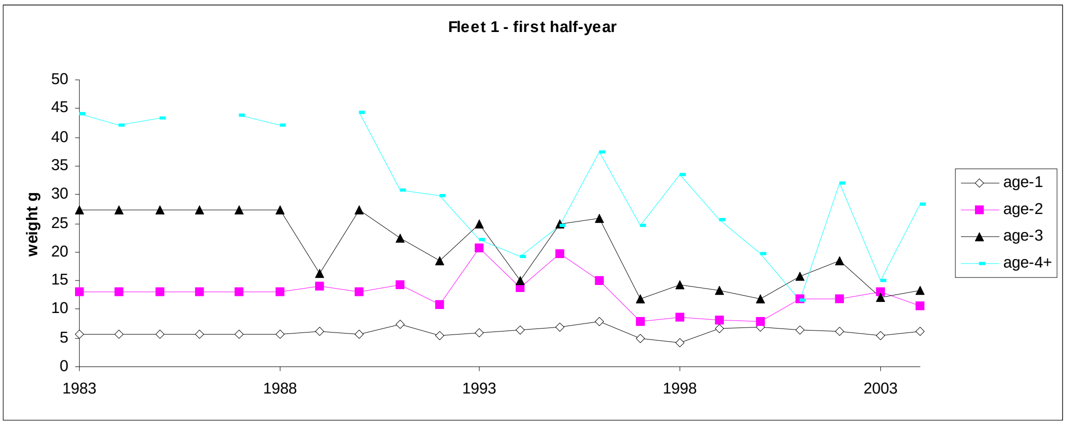
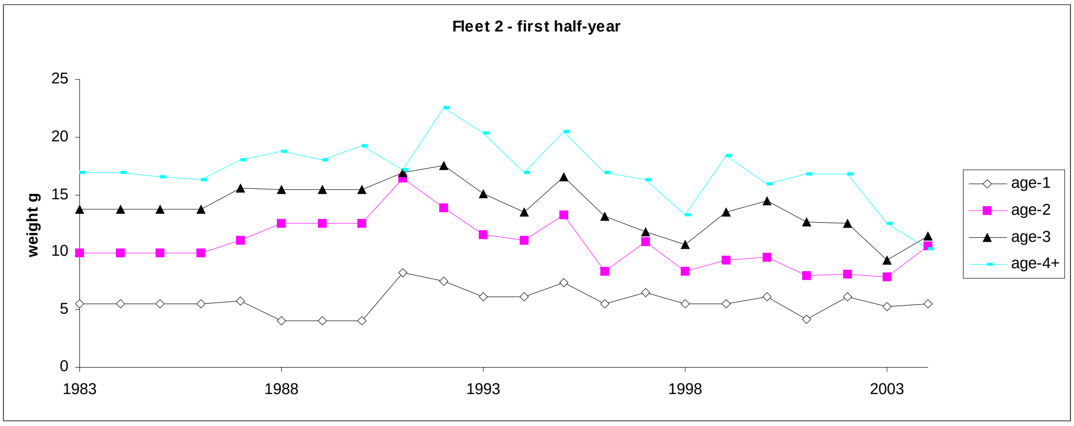
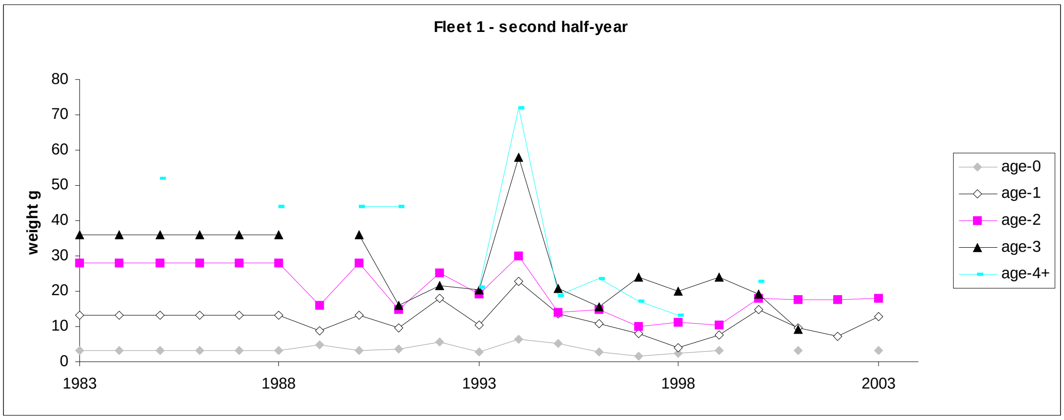


Figure 13.1.2.2 Sandeel in IV. Mean weight at age in the catch by fleet and half year.







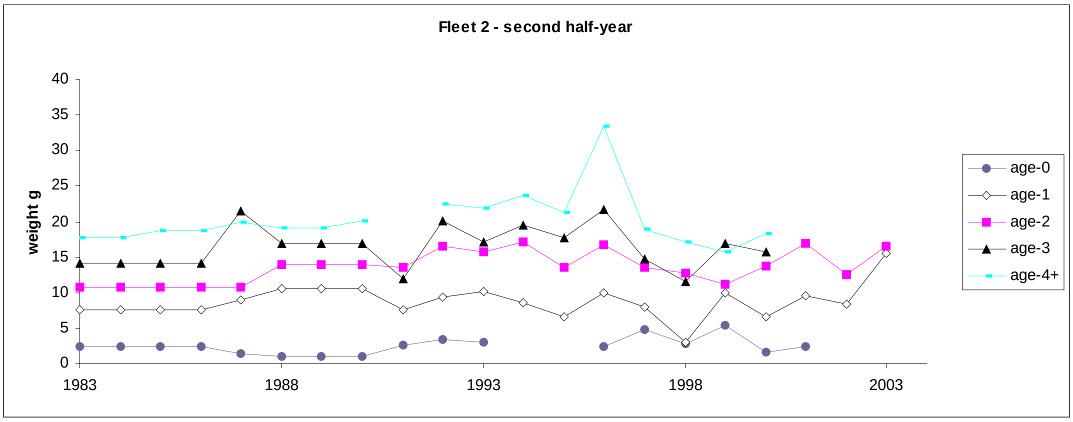


Figure 13.1.3.1. Sandeel in IV. Total effort by the Danish fleet by GT class for the years 1987 to 2003.

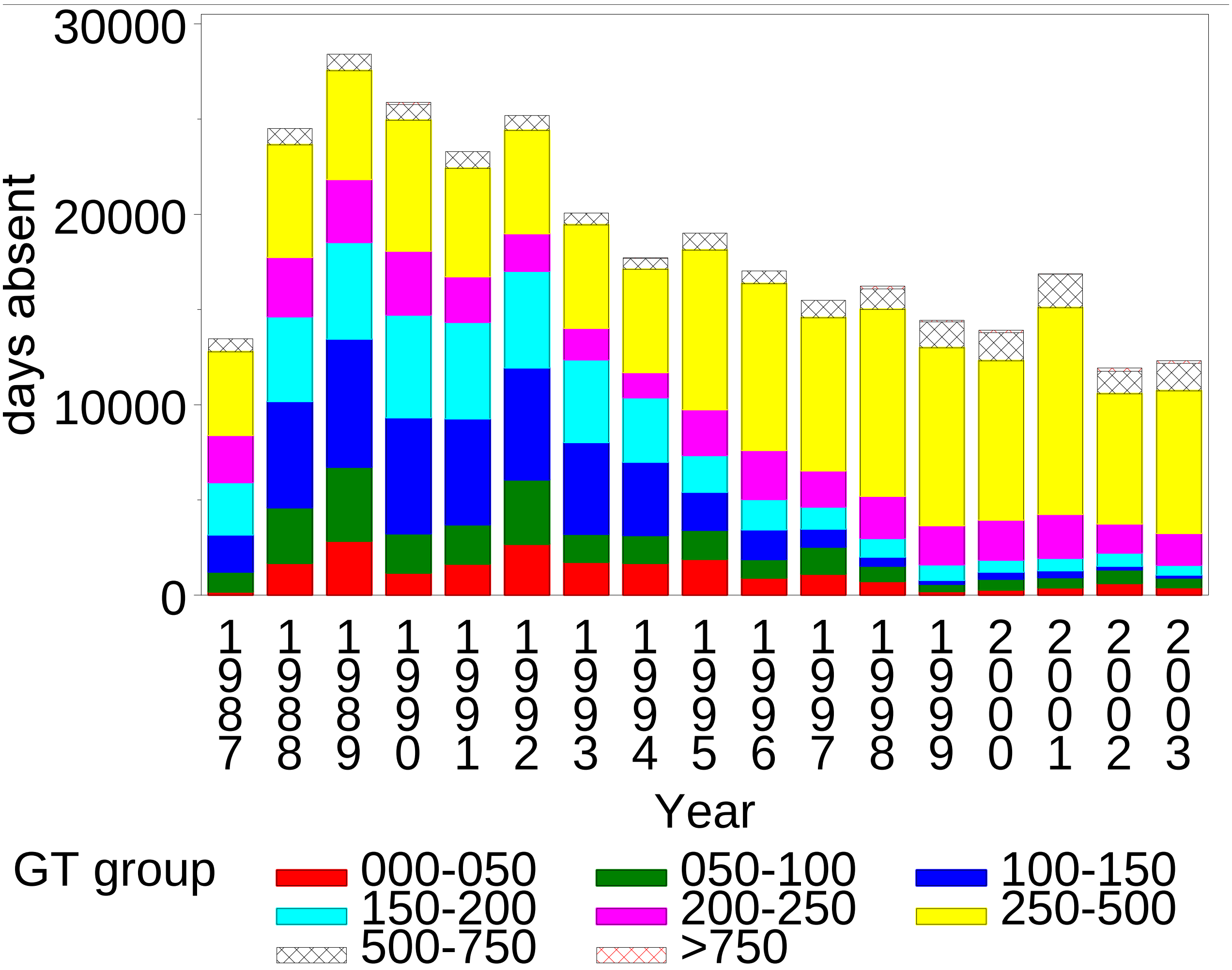


Figure 13.1.3.2 Sandeel in IV. CPUE (ton/day) by fleet.

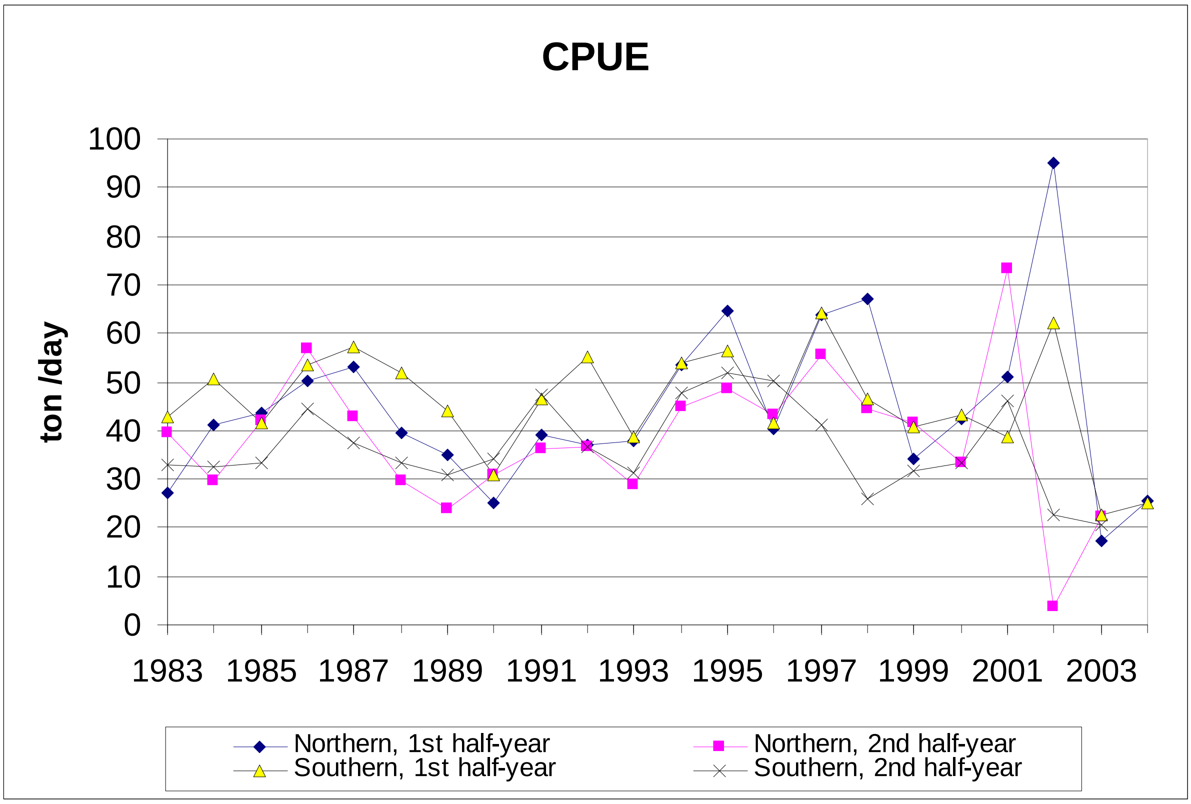


Figure 13.1.3.3 Sandeel in IV. Normalized CPUE by age group and year.

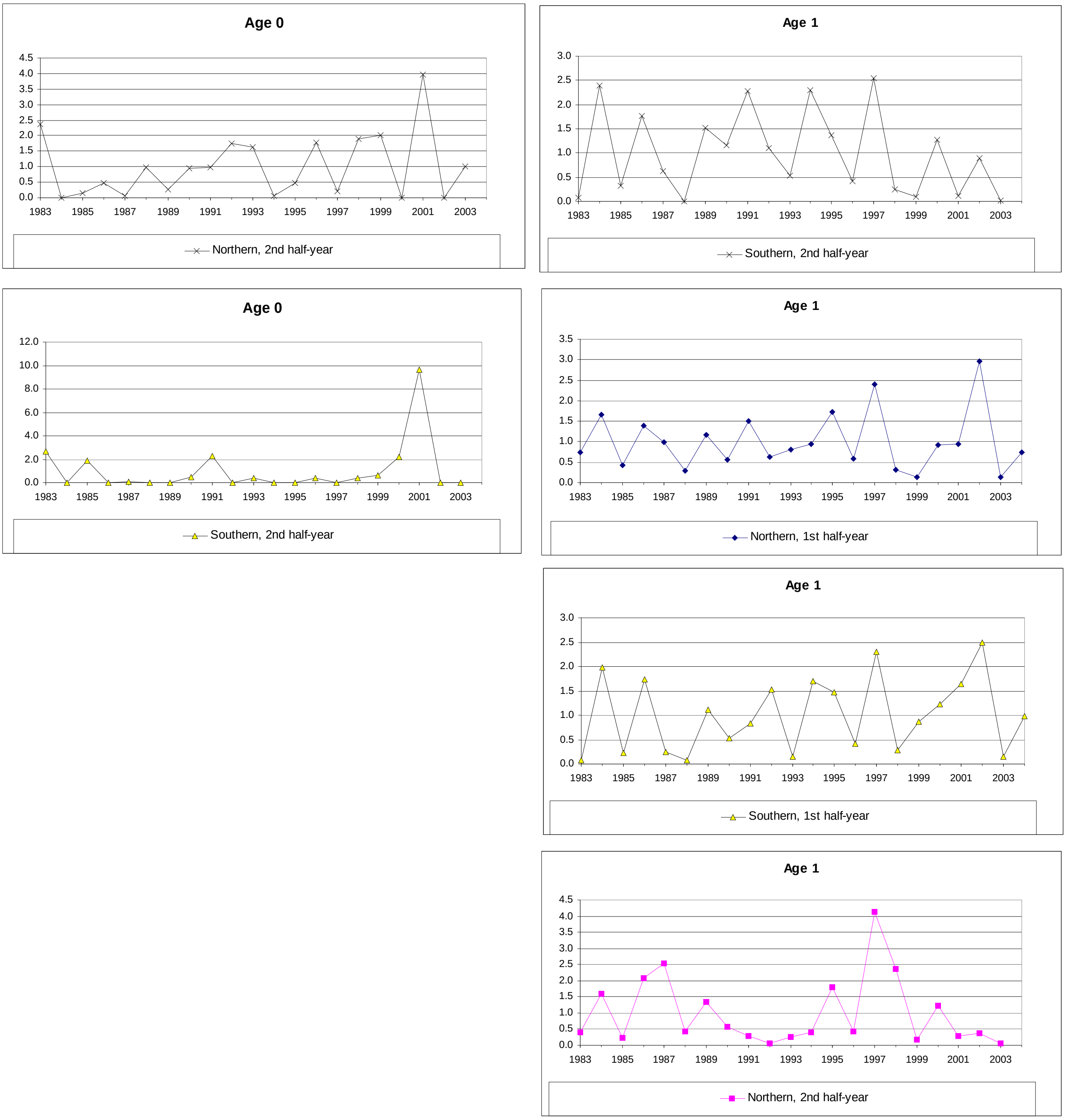


Figure 13.1.3.3 Sandeel in IV. Continued

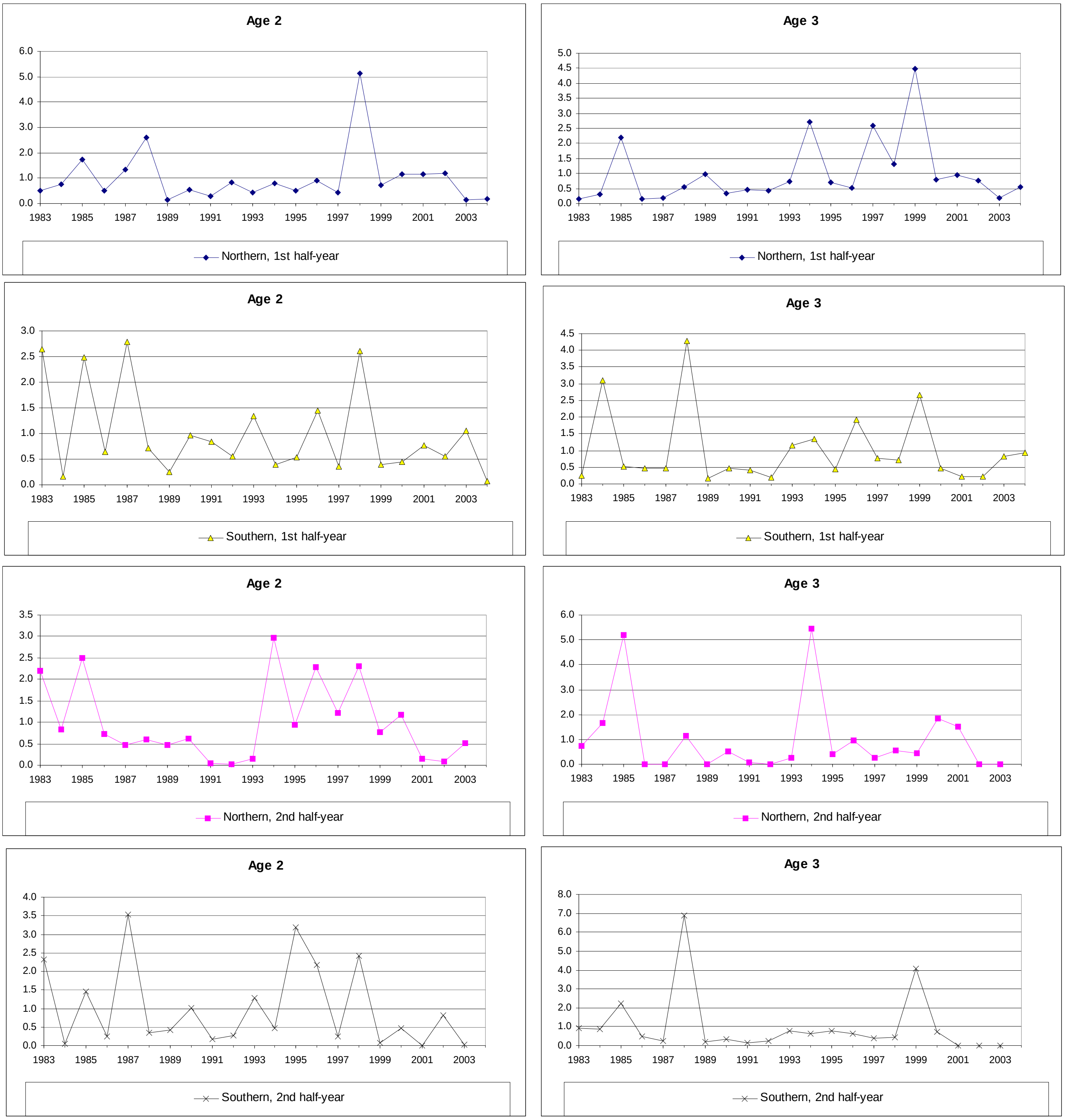


Figure 13.1.4.1 Sandeel in IV. Selection at age estimated from catch data for the years 1983 to 2003. The year weights were set to estimate the selection pattern from the log catch ratios of the last 6 years.

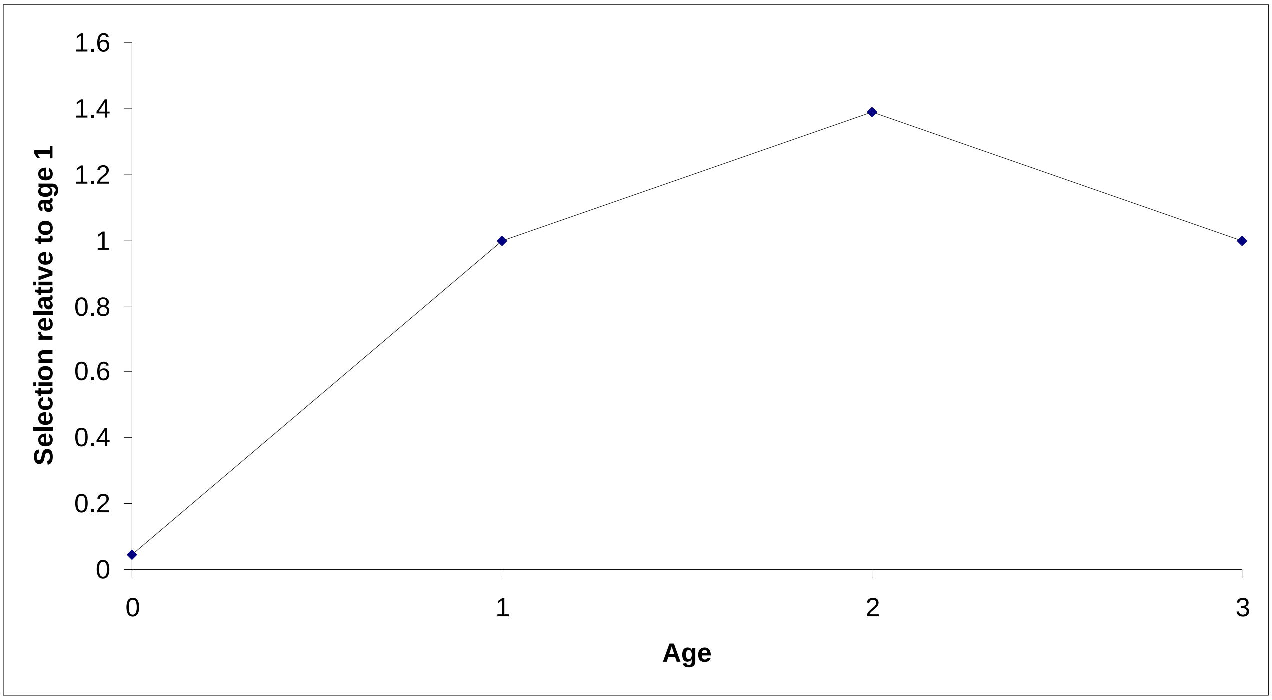


Figure 13.1.4.2 Sandeel in IV. Overall fishing mortality estimated from the catch data for the years 1983 to 2003. Fishing mortality in 2003 is user defined. Fishing mortalities for the years prior to 2003 are model estimates.

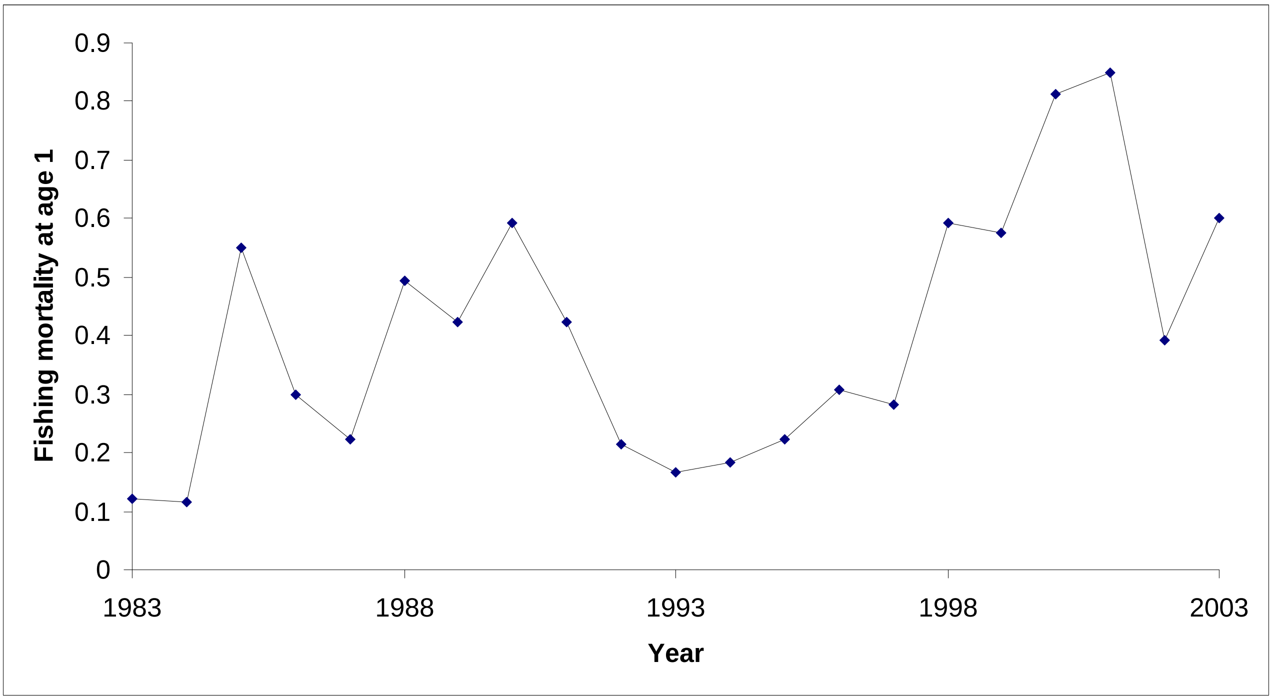
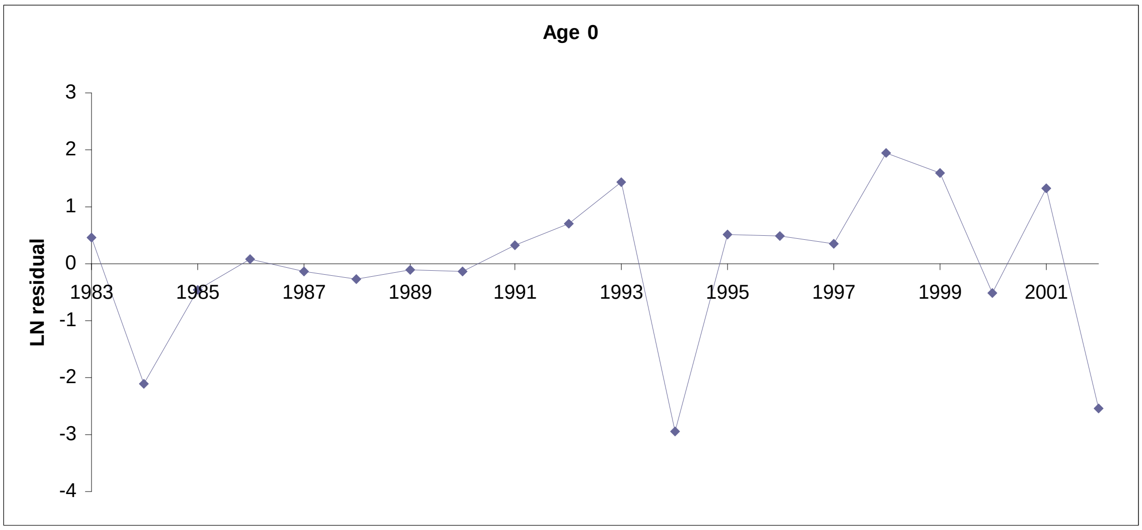
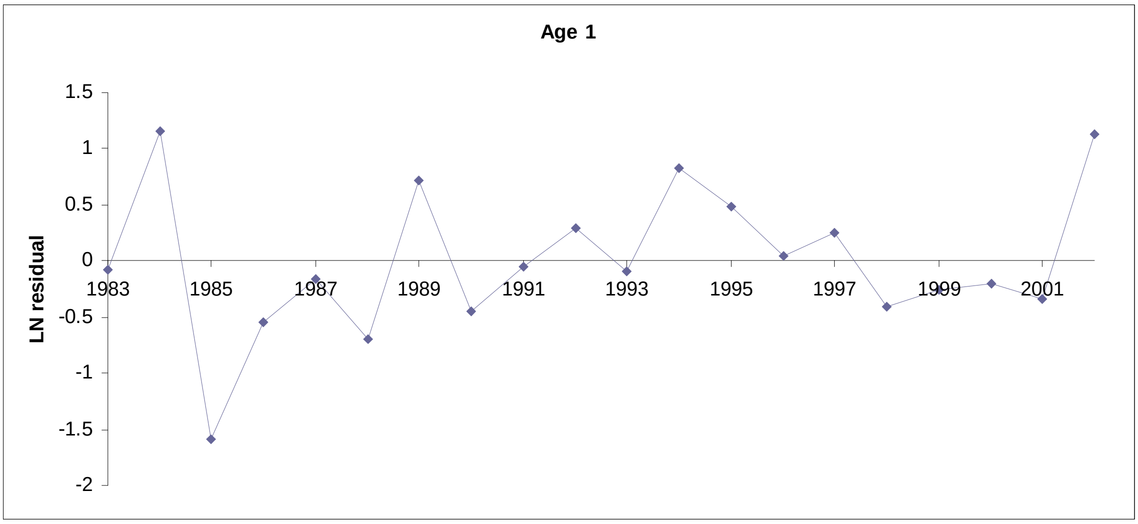


Figure 13.1.4.3 Sandeel in IV. Separable VPA log catch ratio residuals for the years 1983 to 2003.





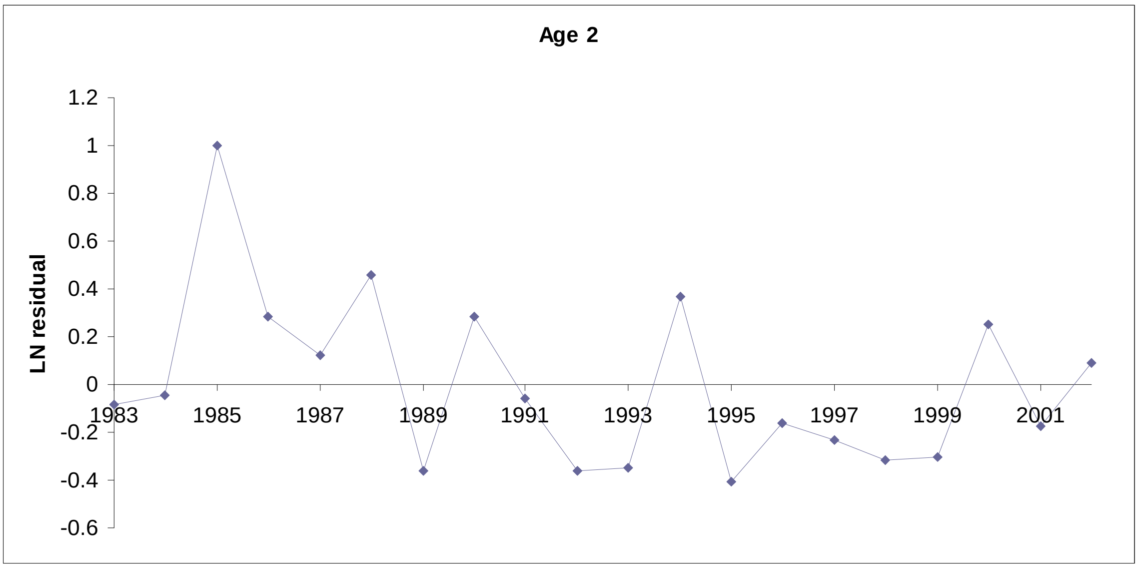
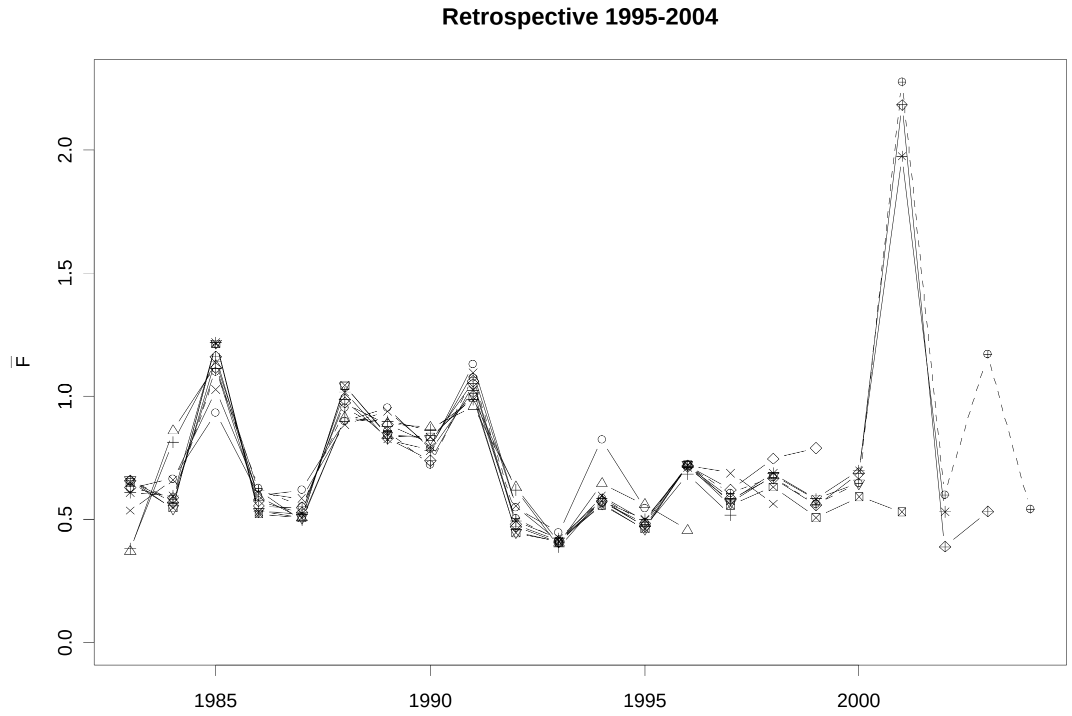


Figure 13.1.4.4 Sandeel in IV. Retrospective pattern of F and SSB from a SMS run using input data as for SXSA (half-yearly catch at age data). (F in 2004 is for first half year only)



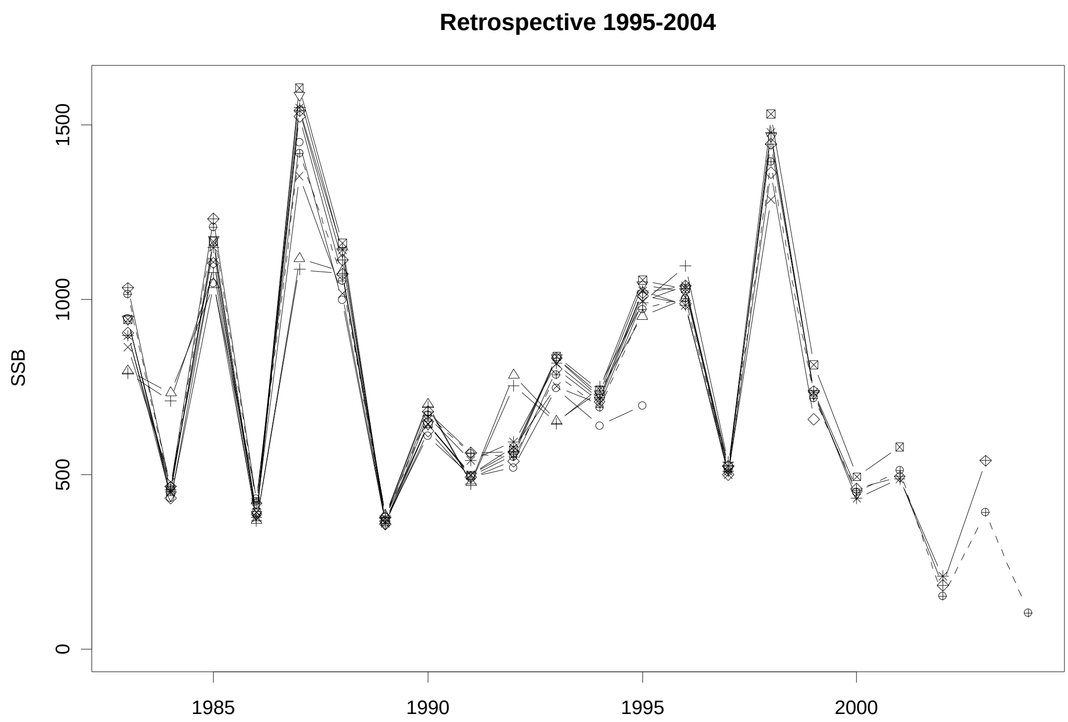


Figure 13.1.4.5 Sandeel in IV. Log residual stocknr. (nhat/n) by fleet. SXSA Run 01.

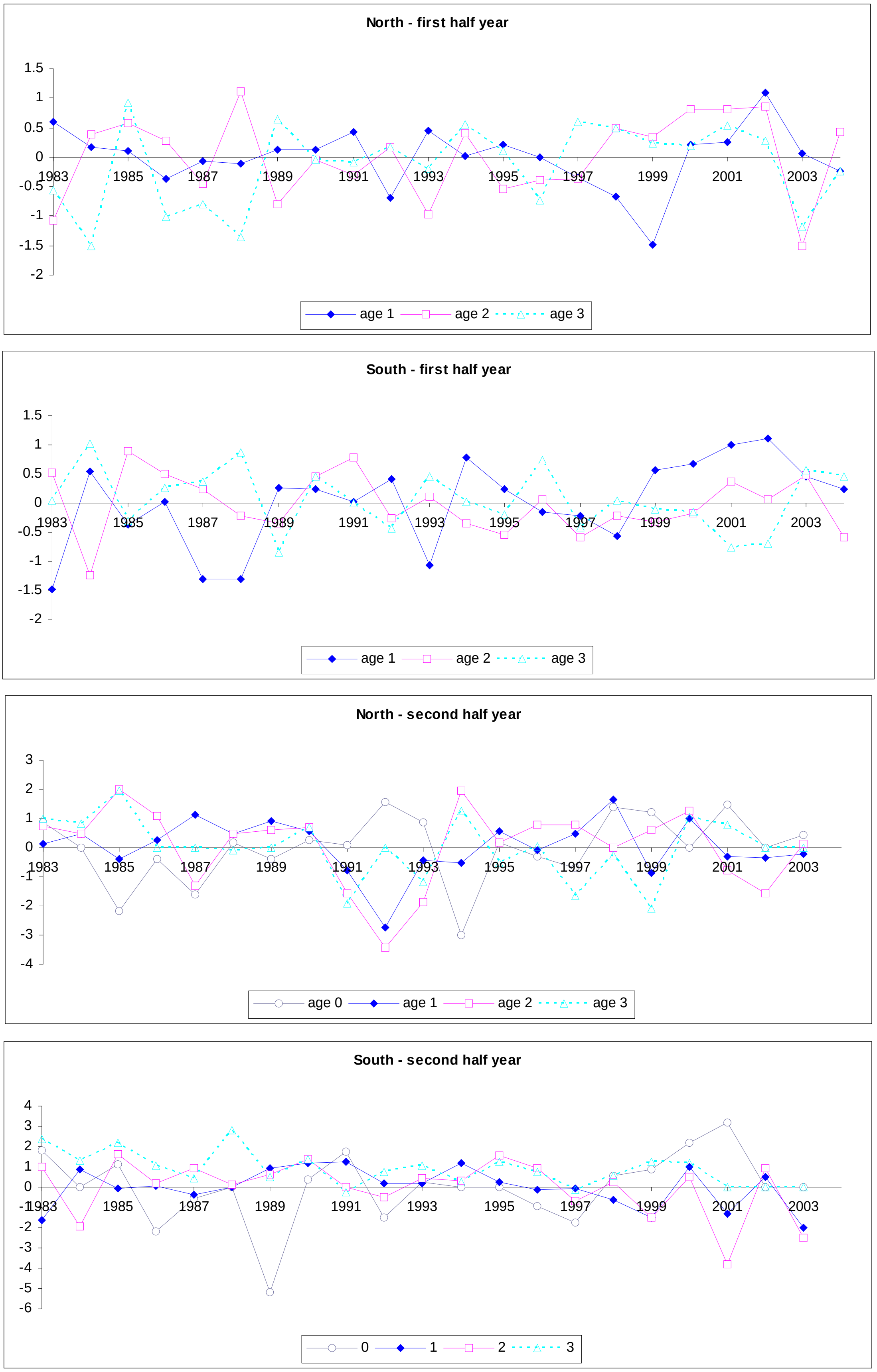


Figure 13.1.4.6 Sandeel in IV. Log residual stocknr. (nhat/n) by fleet. SXSA Run 02

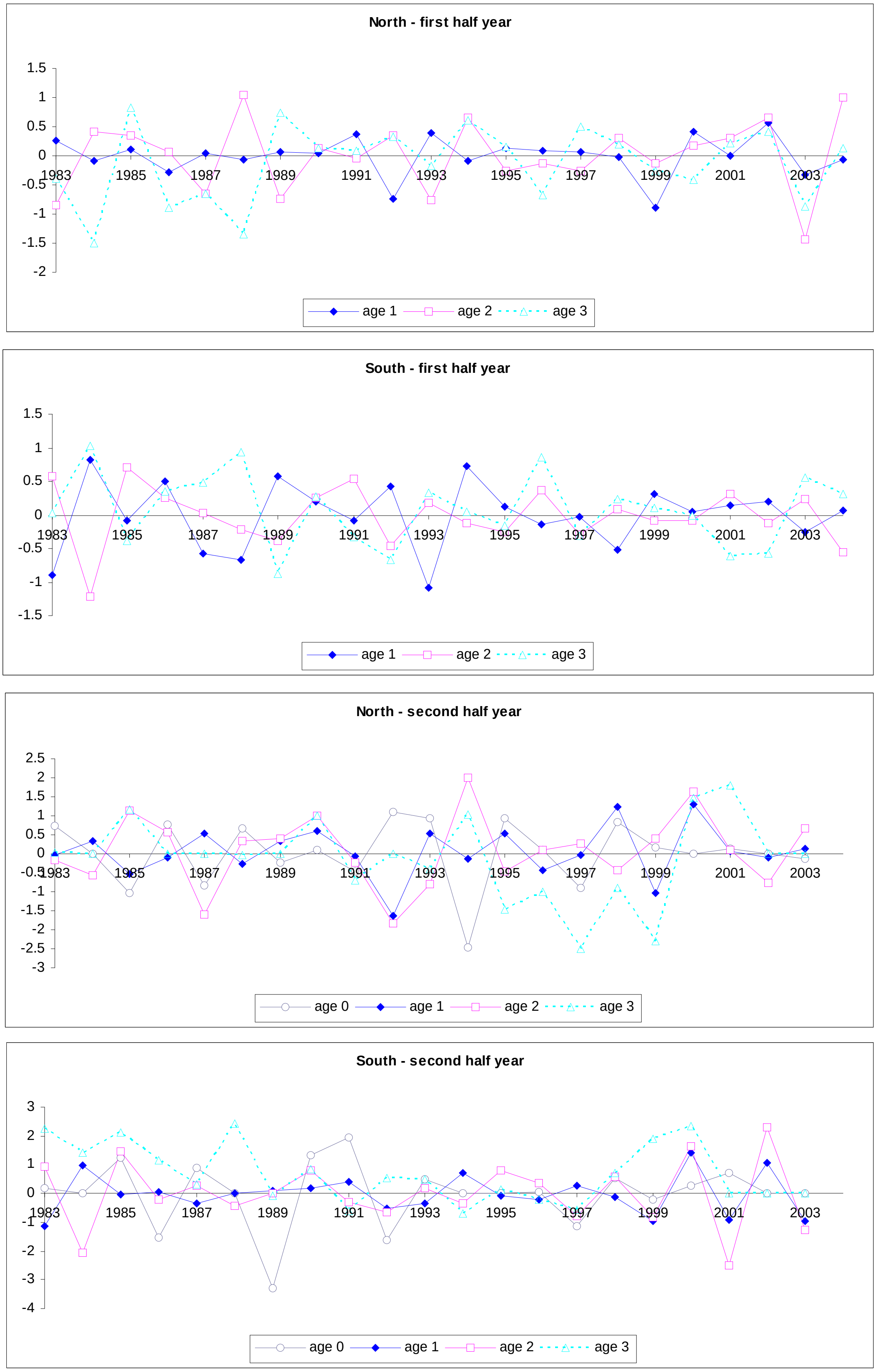


Figure 13.1.4.7 Sandeel in IV. Log inverse catchability by fleet and half-year. SXSA Run 02

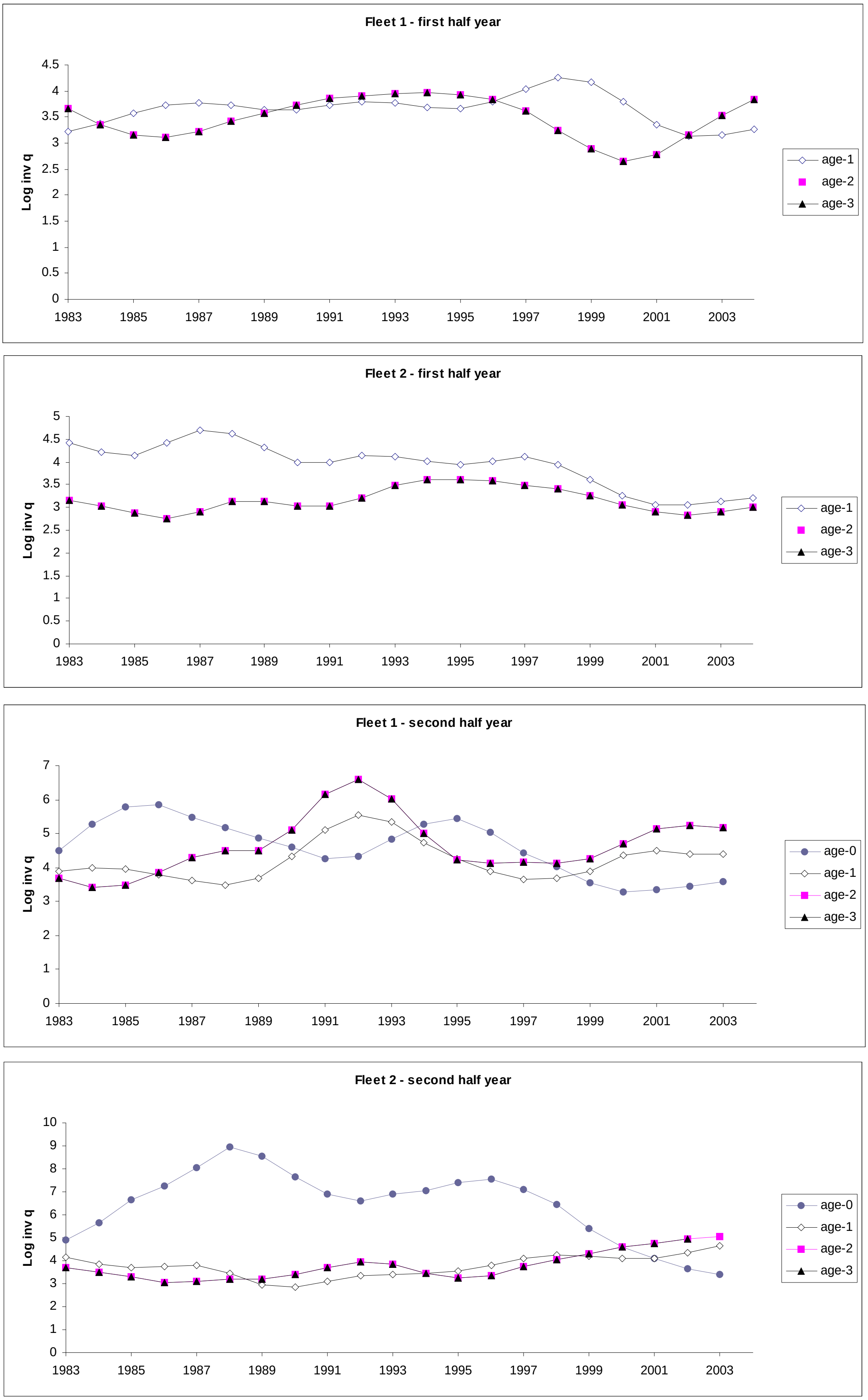


Figure 13.1.4.8 Sandeel in IV. Log residual stocknr. (nhat/n) by fleet. SXSA Run 03

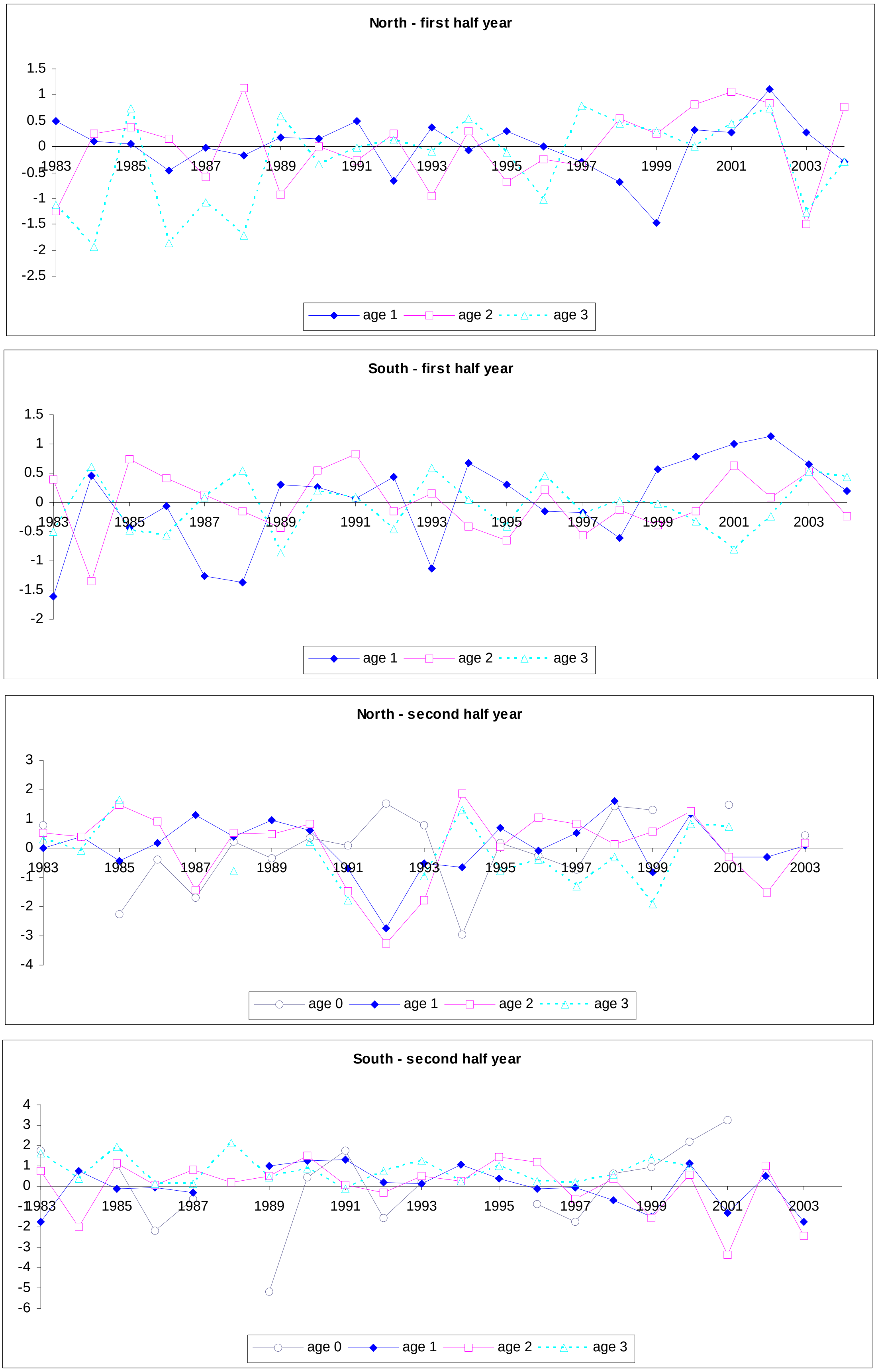


Figure 13.1.4.9 Sandeel in IV. Log residual stocknr. (nhat/n) by fleet. SXSA Run 04

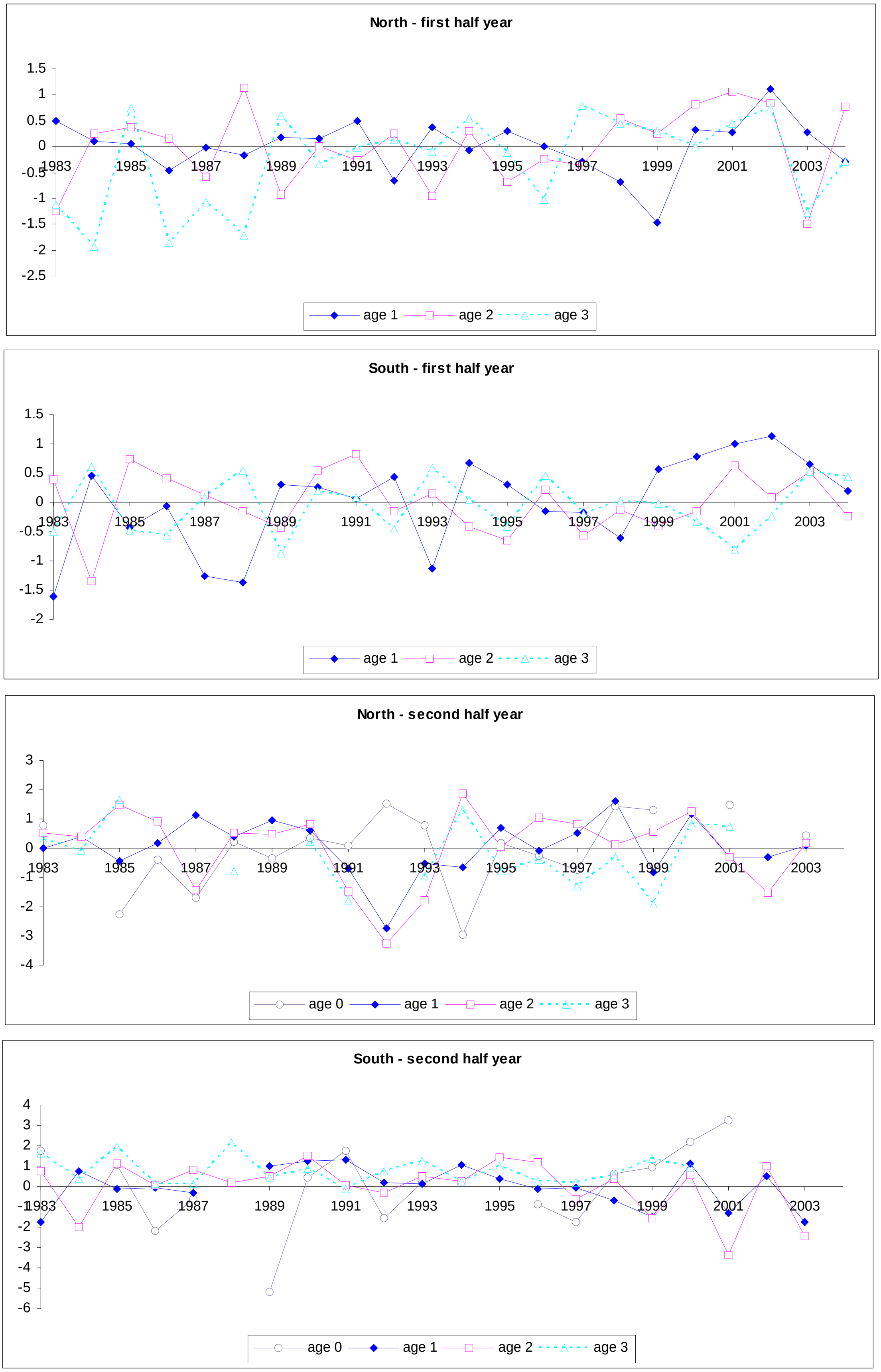
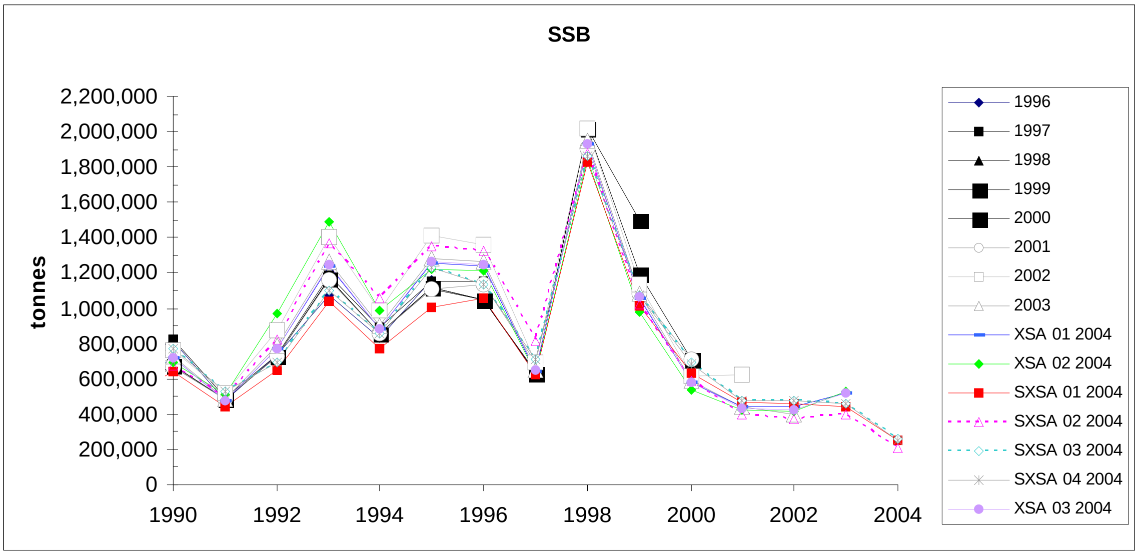
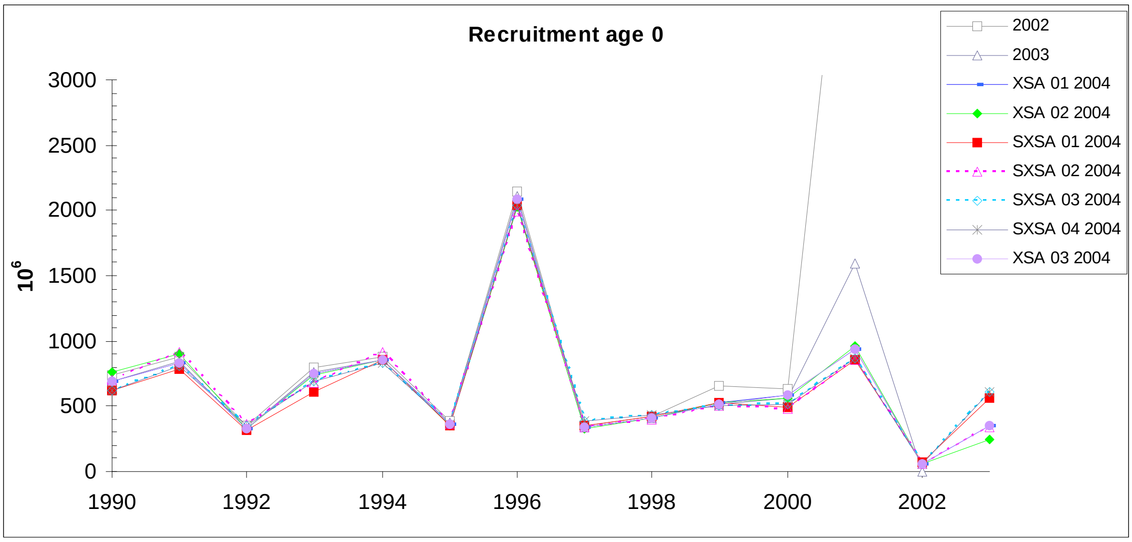


Figure 13.1.4.10 Sandeel in IV. Comparison of historical performances of exploratory assessments in 2004 using the SXSA. F_{bar} in 2004 only represent first half year.





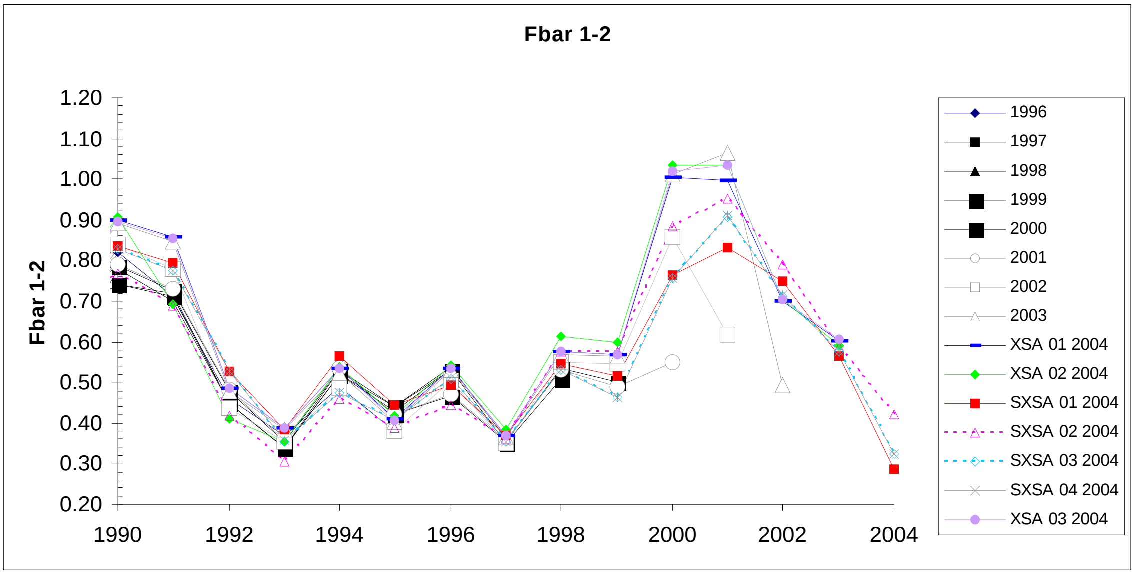


Figure 13.1.4.11 Sandeel in IV. Stock summary for SXSA run 01.

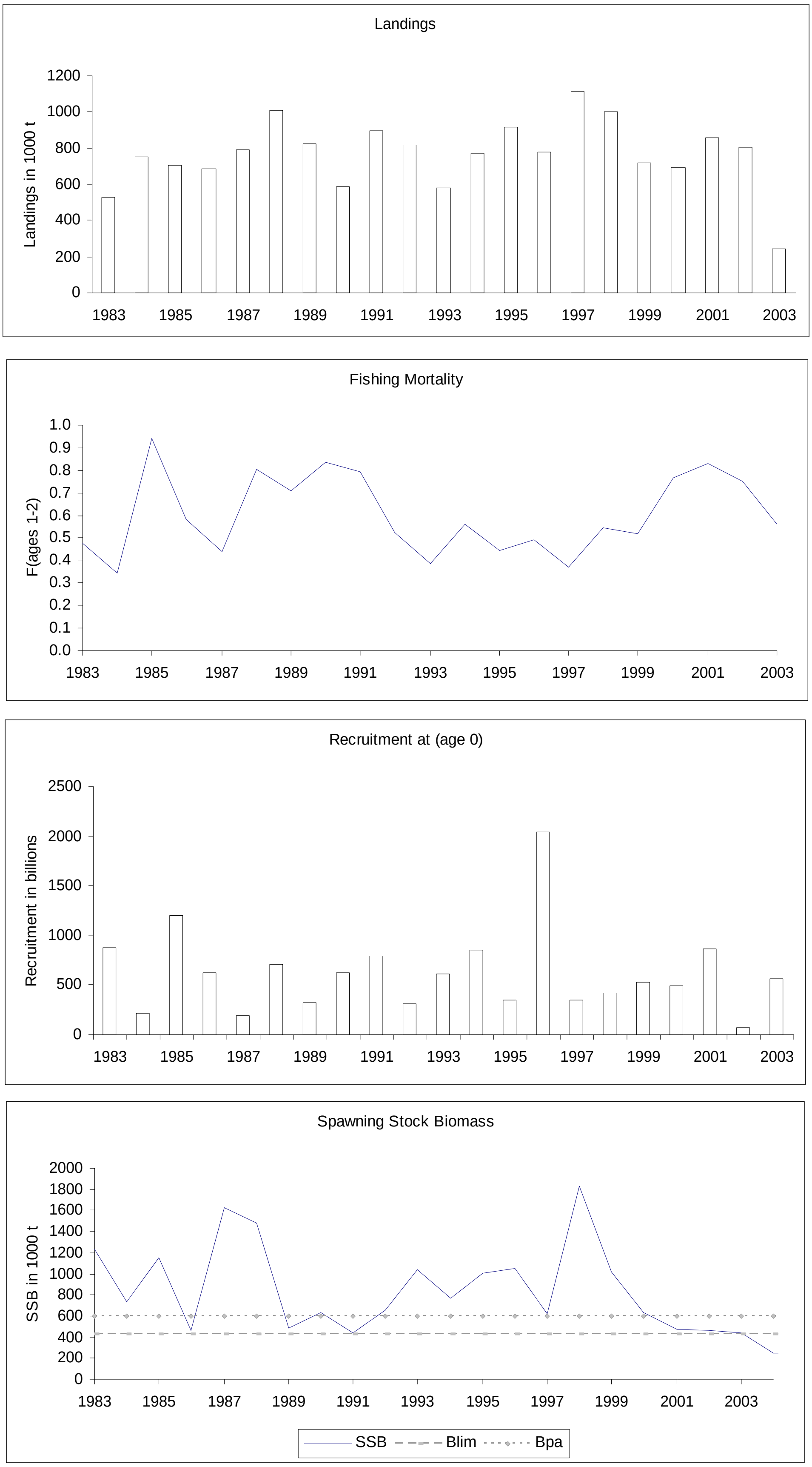


Figure 13.1.4.12 Sandeel IV. Retrospective analysis of SSB, recruitment, and Fbar 1983-2004 for SXSA run 01.

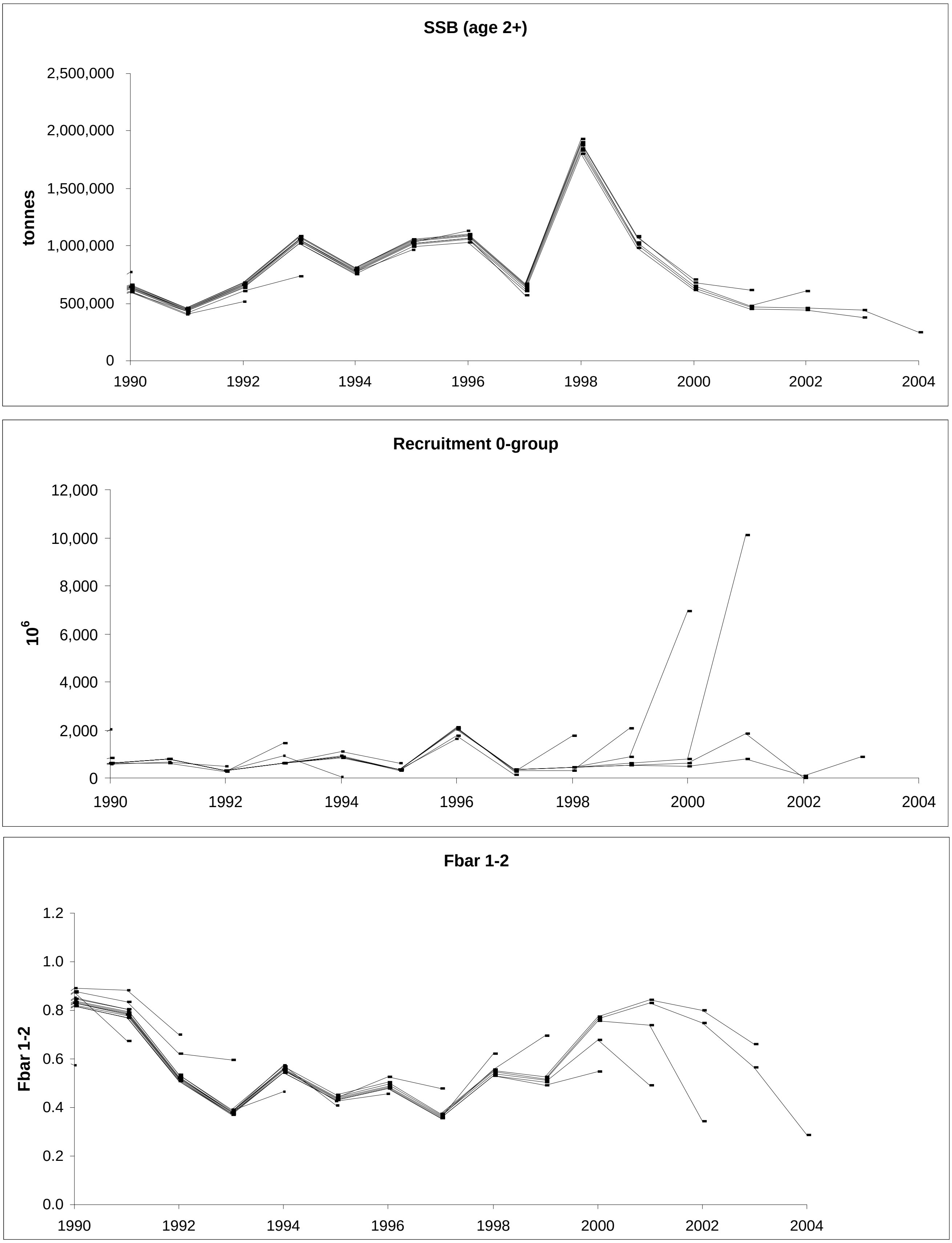


Figure 13.1.4.13 Sandeel in IV. Log catchability residuals by fleet. XSA Run 01.

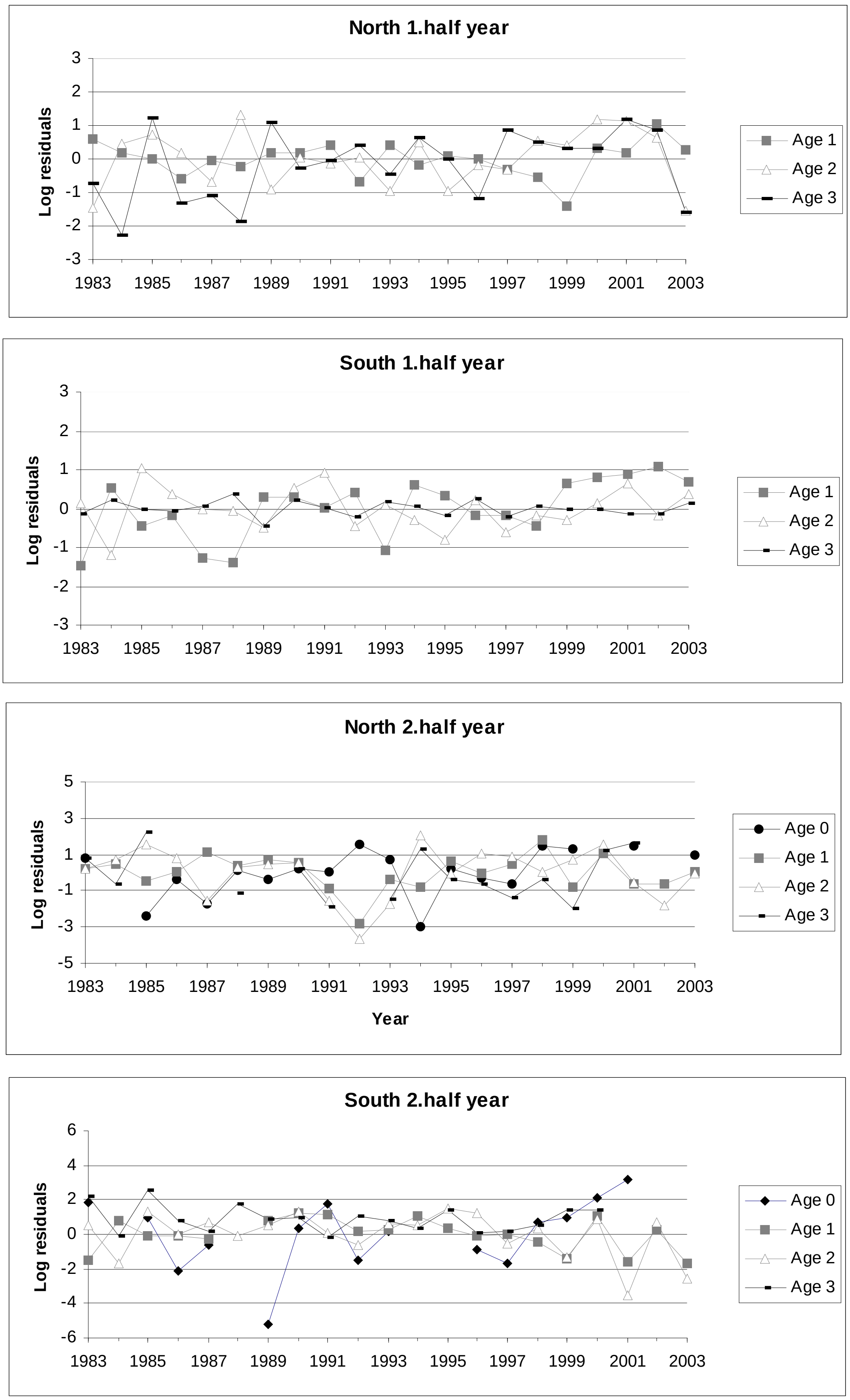


Figure 13.1.4.14 Sandeel in IV. XSA (run 01) tuning weights.

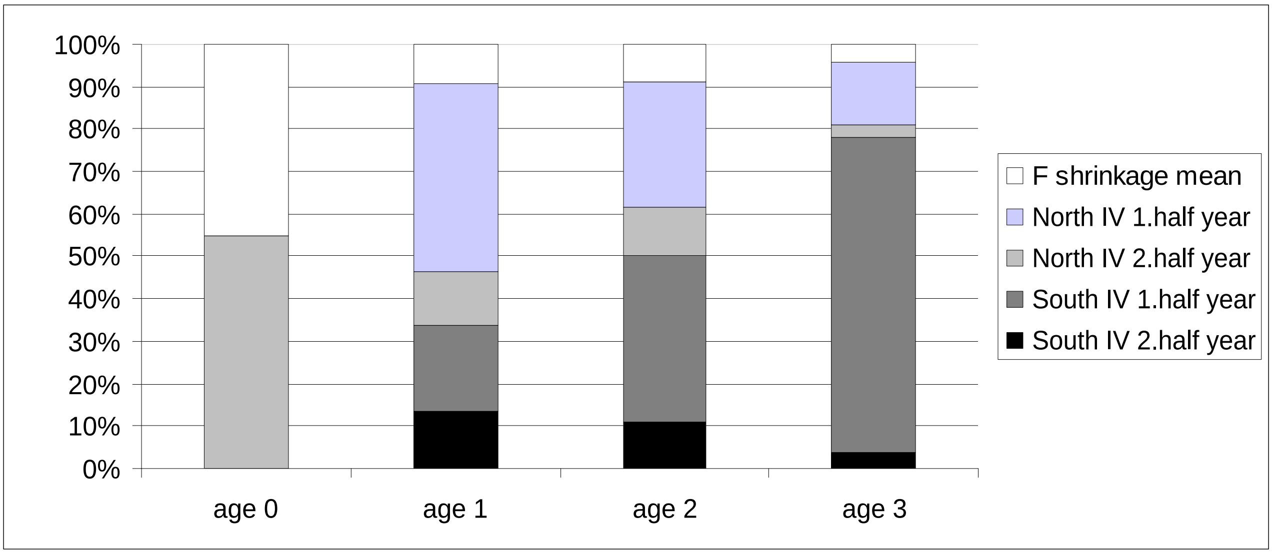


Figure 13.1.4.15 Sandeel in IV. Comparison of exploratory assessments in 2004 using the XSA.

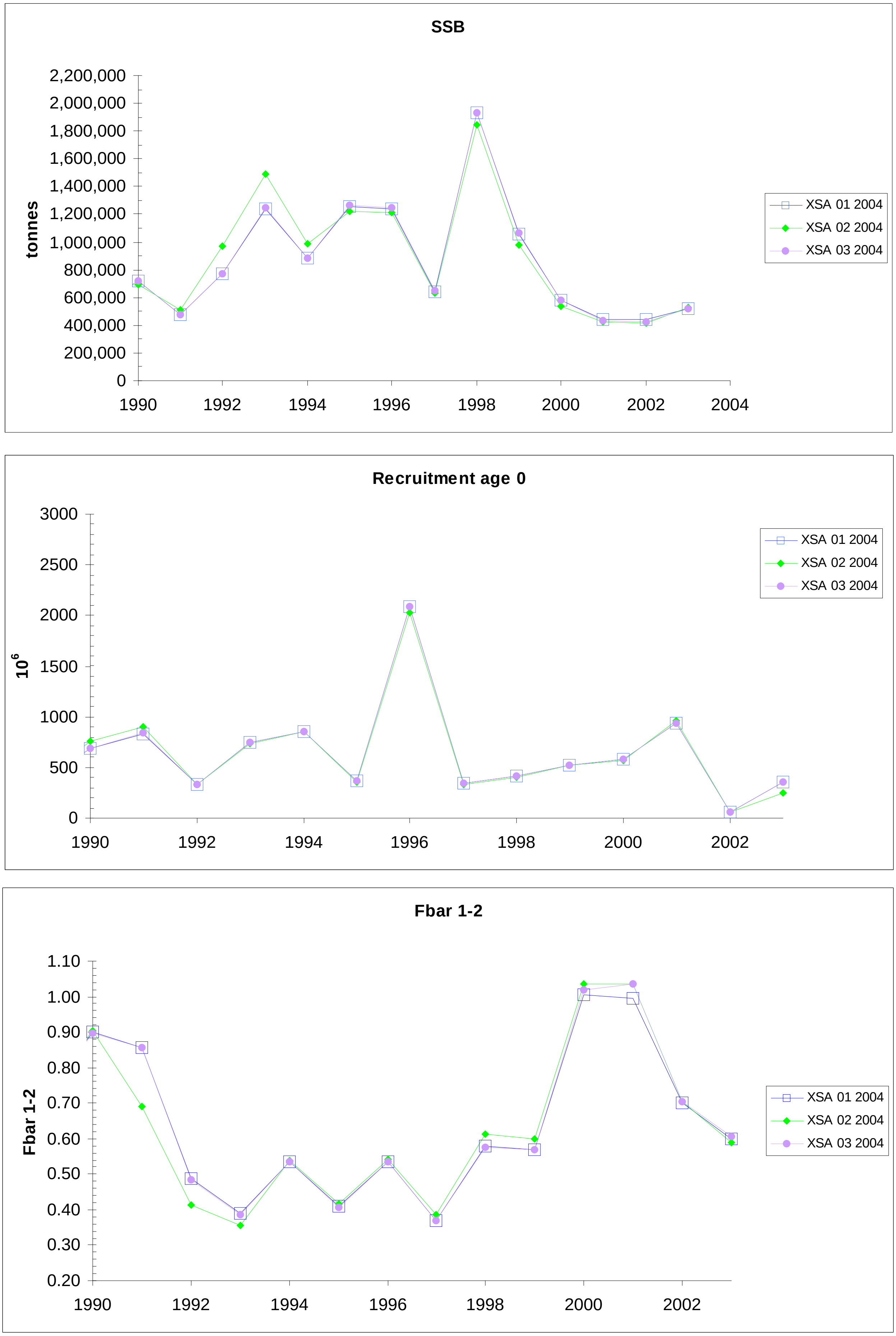
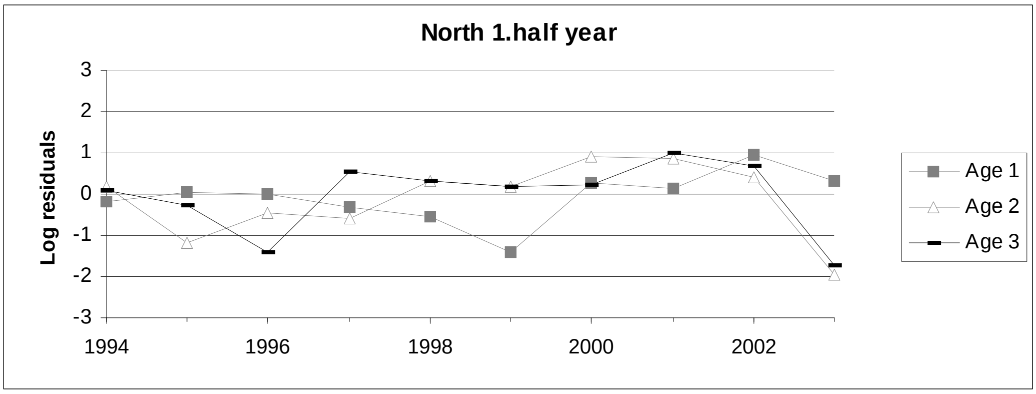
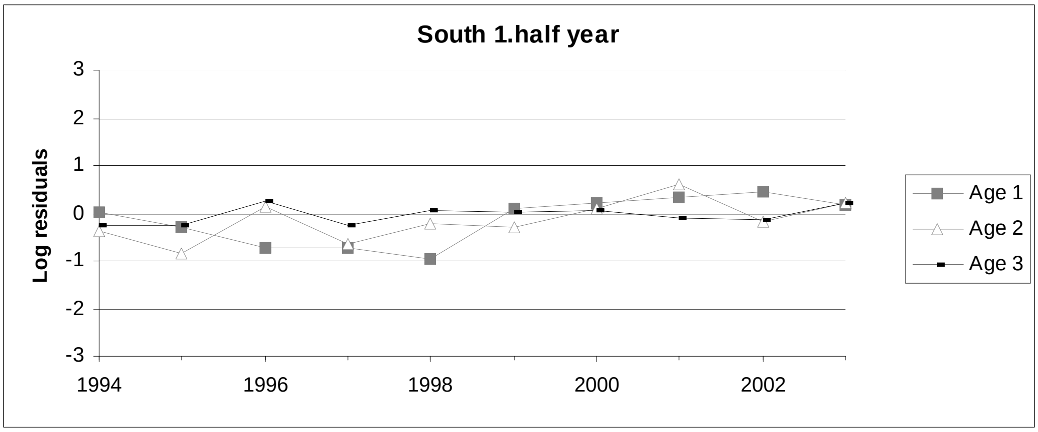
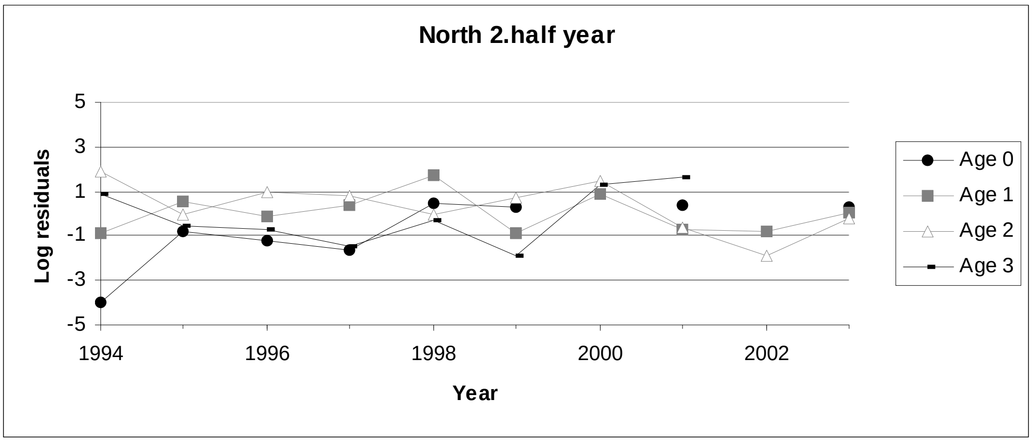


Figure 13.1.4.16 Sandeel in IV. Log catchability residuals by fleet. XSA Run 02







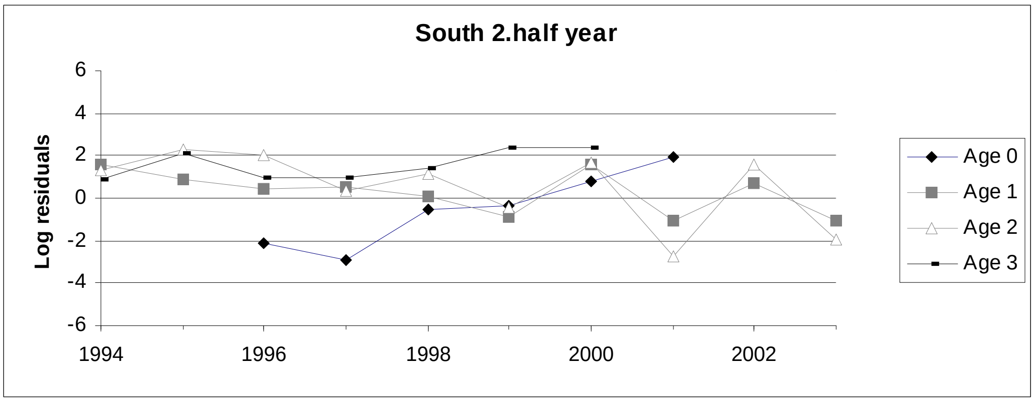


Figure 13.1.4.17 Sandeel in IV. Stock summary for XSA run 01.

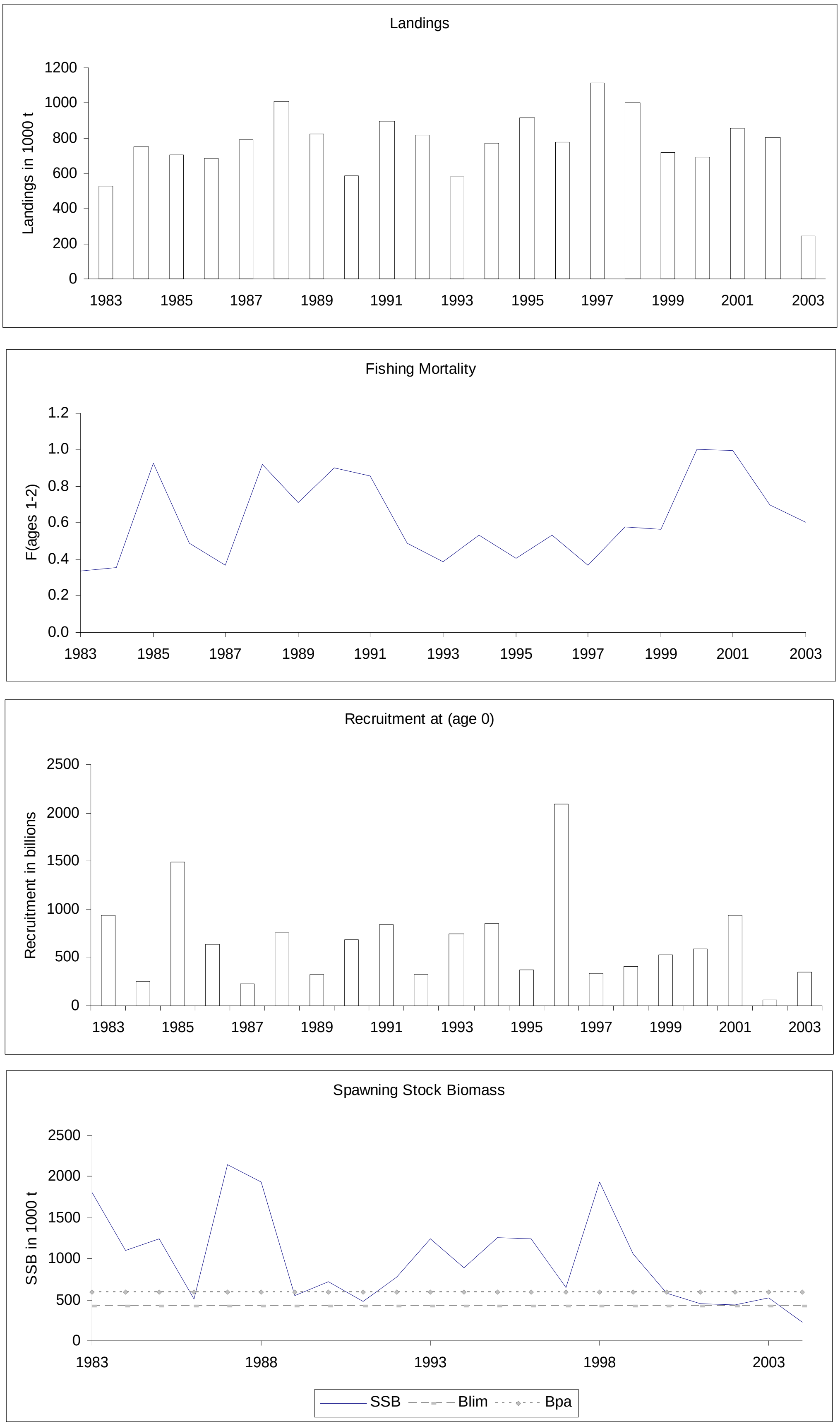


Figure 13.1.4.18 Sandeel in IV. Retrospective analysis of SSB, recruitment, and Fbar 1983-2003 for XSA run 01.

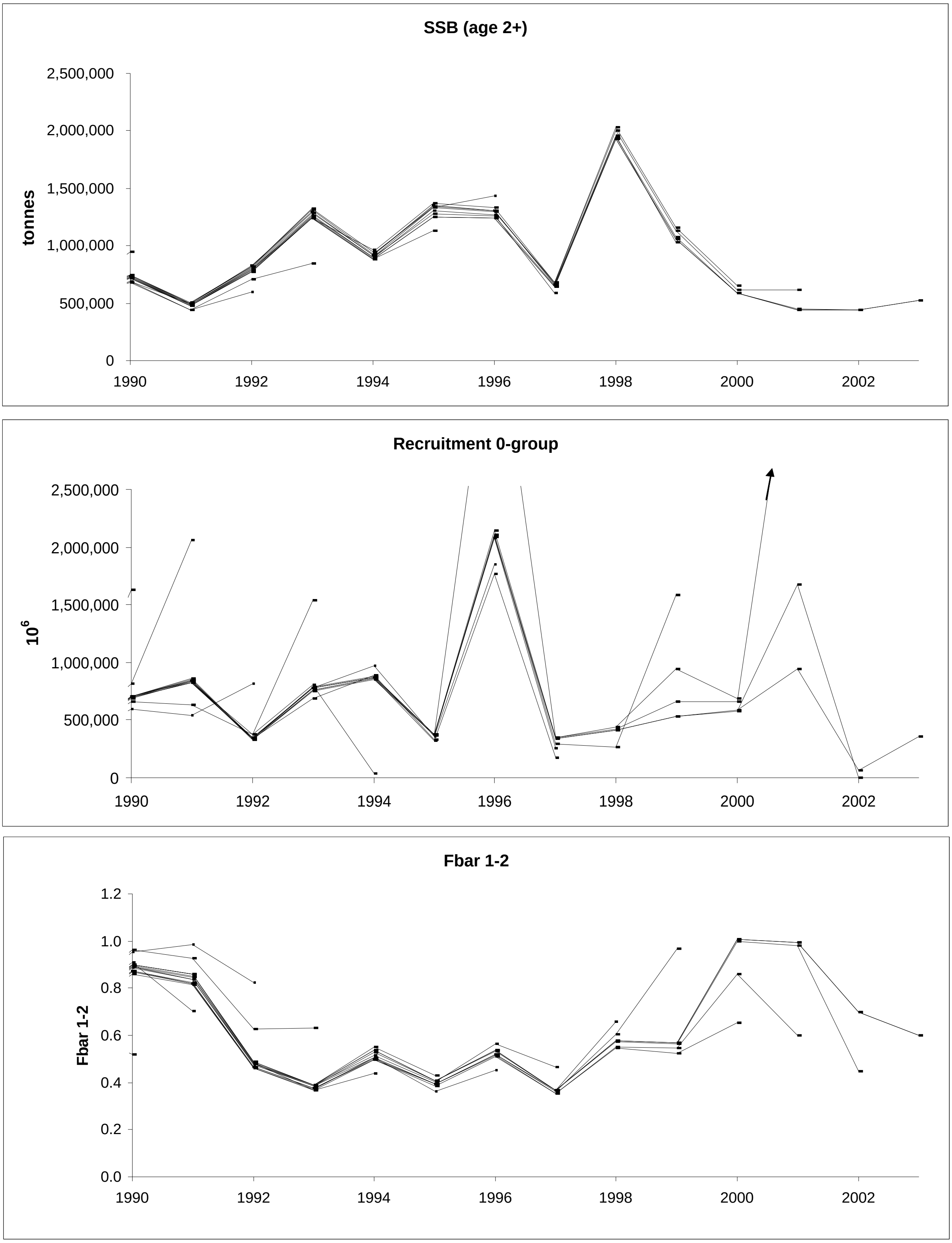


Figure 13.1.4.19 Sandeel in IV. Overview of exploratory runs.

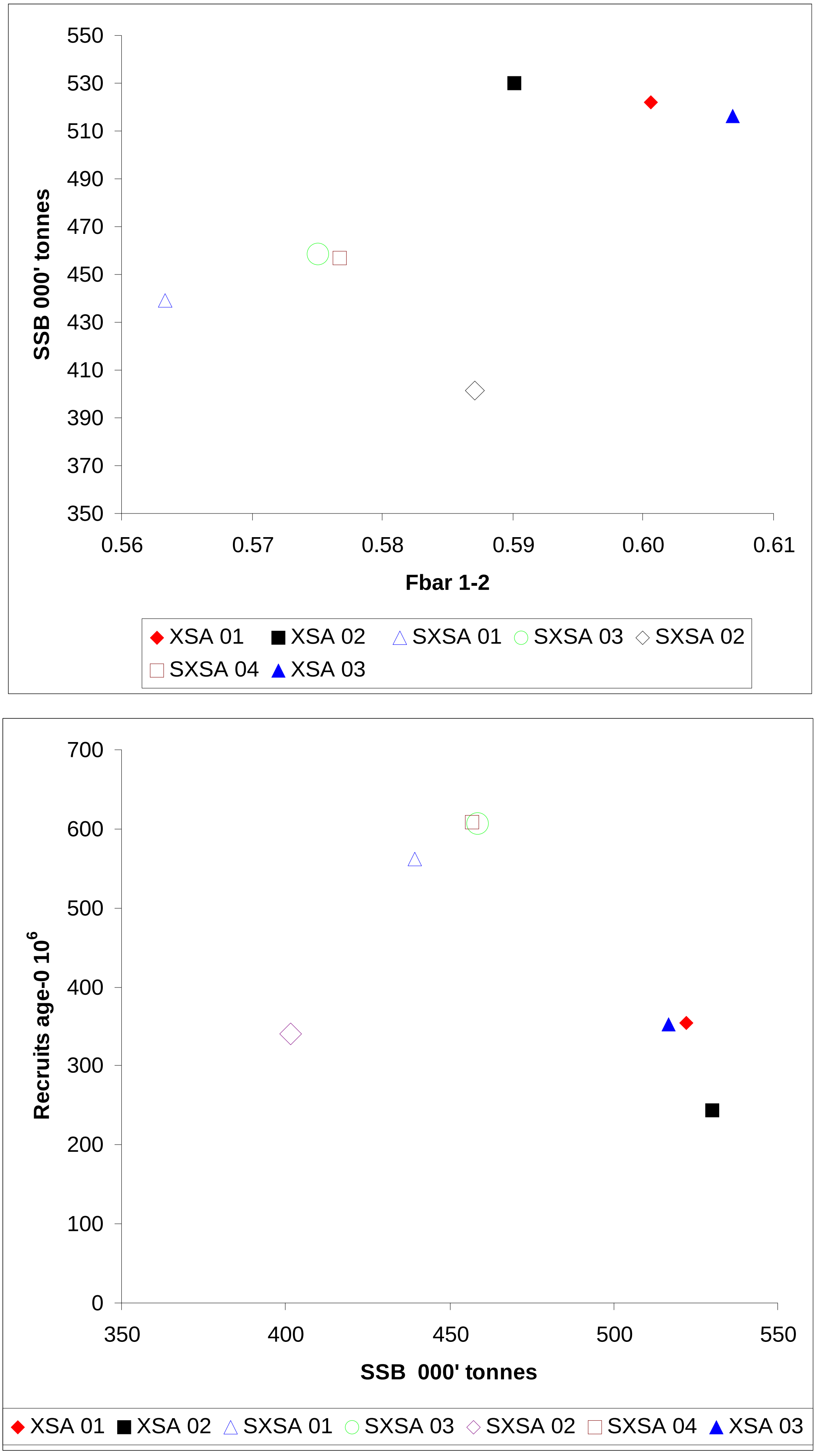
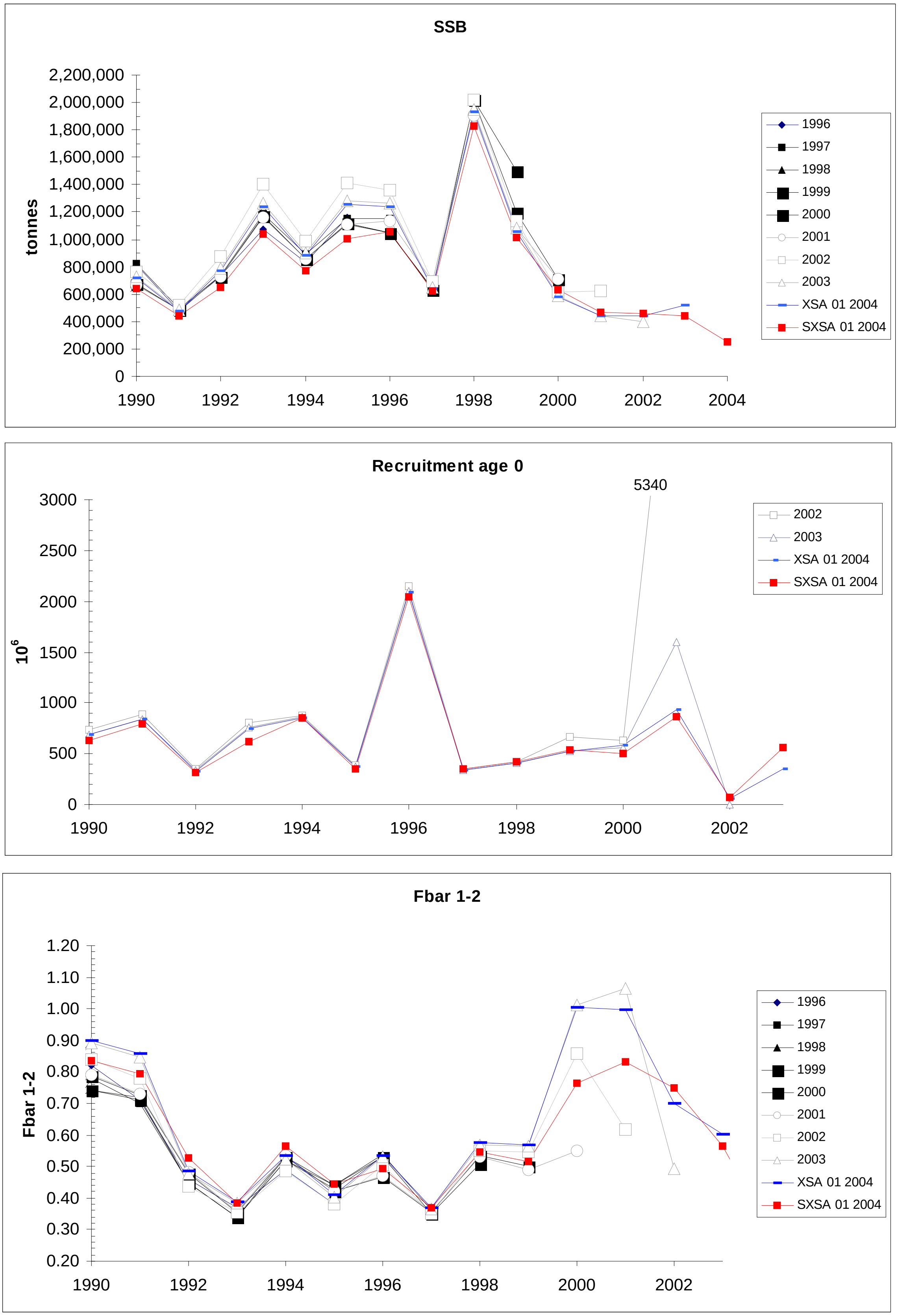


Figure 13.1.4.20 Sandeel in IV. Comparison of historical performances of SXSA run 01 and XSA run 01.



14 Mixed fisheries investigations

14.1 State of the art

14.1.1 WGNSSK03 conclusions

WGNSSK03 has investigated mixed-fisheries issues by compiling mixed fisheries data over the period 2000-2002 and also by applying the mixed fisheries forecast model MTAC to these data. WGNSSK03 considered that this approach be considered as a step forward towards providing routine, fishery-based, advice. However, the group expressed concern and made recommendations on, (i) the quality of the mixed-fisheries database, (ii) the capacity of MTAC to provide suitable mixed-fisheries forecasts and, (iii) the ability of assessment working groups to accommodate more fully fishery interactions.

Regarding (i), WGNSSK03 recognised that discard data were provided by only one nation and that landings or catch at age data were country- and not fishery-disaggregated. WGNSSK03 recommended that future collation of mixed-fisheries data should be made according to the framework proposed by SGDFF, and that the SGDFF should initiate the compilation of these data.

Regarding (ii), WGNSSK03 noted that a critical assumption underlying MTAC is that the fishery-, species- and age-dependent exploitation pattern used in the forecasts is estimated from the last years average. However, this assumption is likely to be violated in the case of shifts in fishing tactics, as a result of e.g. changes in management regulations. There are a number of on-going approaches aiming at modeling fishermen's adaptation to management changes, which could at a later stage be incorporated in the mixed-fisheries model. Nevertheless, MTAC was seen as a step further towards providing mixed-fisheries forecasts.

Regarding (iii), WGNSSK03 noted that within the current working group framework, stock assessments (including forecasts) are undertaken on a stock by stock basis with little consideration of fisheries and the linkage between the two. ICES groups that are currently considering the working practices and structure of the assessment and advisory process need to consider these points when considering the appropriate framework under which fishery-based forecasts are to be undertaken. WGNNSSK03 suggested that maintaining the current working group structure whilst improving interchanges between working groups was the easiest to implement in the short term.

14.1.2 ACFM03 conclusions

During its 2003 autumn meeting, ACFM commented the work carried out by WGNSSK03 on mixed-fisheries based advice. ACFM concluded that the mixed fisheries forecasts provided by MTAC are not yet adequate to provide an analytical basis for fishery-based advice, due to a number of limitations. The different concerns raised by ACFM are summarized below.

- ACFM identified two management problems which are related to technical interactions. First, managers must keep catches of all stocks within their TACs without foregoing catches of stocks whose TACs are taken up more slowly. Second, when several fisheries all take a species in common, managers may also allocate the safe harvest of the shared species among those fisheries in ways that allow the fisheries to take their allowable harvest of their various target species, without exceeding the total allowable catch of the shared species.

- ACFM noted that "*experience of fisheries-based advice in other parts of the world indicate that such provision is possible, but that it requires well-defined fisheries that are based on complete and reliable catch data. In the ICES case, model development has outstripped the provision of appropriate data both for defining fisheries and providing mixed fishery advice. Specifically, the lack of data on discards for most species is a principal concern. Although this is a weakness of many single-stock forecasts it is accentuated in a mixed fisheries context and may lead to inappropriate advice being given to the extent of mis-informing managers*". ACFM recommended more work be done on data collation (e.g. through better catch monitoring) and fishery definitions.

- ACFM was concerned "*that any approach to managing mixed fisheries that assumes constant species composition over time implicitly discourages adaptive behaviour*".

- ACFM recommended that managers take action in two ways. First, managers should specify the level of fishery desegregation at which they intend to operate. Second, managers should supply policy parameters, such as the tolerance for exceeding the sustainable catches of each individual species.

- ACFM expressed the concern that "*many of the single-stock assessments that are used as a basis for mixed fishery projections currently cannot provide a reliable basis for single-species catch projections; hence the initial single species TAC constraints cannot be set to start the computations*".

14.1.3 STECF03 investigations

The STECF sub-group on mixed-fisheries met in 2003, after ACFM, with the mandate of calculating mixed-fisheries forecasts to the intention of managers. The SG overall shared the concerns expressed by ACFM and the group treated these in two different ways. Regarding the lack of management inputs and the lack of single-stock assessments and projections, the group took action in obtaining management inputs from the Commission and in carrying out exploratory sensitivity analyses. Regarding data inadequacies, fishery definitions, and fleet adaptive behavior, the group was of the opinion that, as long as the advice derived from MTAC is mixed-species rather than mixed-fisheries, these concerns would not be more critical than those applicable to traditional short-term forecasts. Overall, the group acknowledged that the scientific basis underlying the mixed-species projections derived from MTAC and related datasets was not the best one, but only the best available at the time of the meeting. The group was of the opinion that, despite its numerous limitations, it would be more appropriate to provide advice based on evidence for the mixed-species nature of the different fisheries than advice that would completely ignore the effects of technical interactions on the implementation success of TAC-based management.

14.1.4 SGDFF04 conclusions

Although the compilation of fishery- and age-disaggregated catch and effort data was initially one of the task allotted to SGDFF04, the SG felt that the ideal approach would be for assessment WGs to modify the way in which they compile data in order that it is available on a fleet or fishery basis. The role of this SG would then be to act as technical support to the WGs in relation to fleet and fishery issues. The SG first recognised that market sampling by national institutes is designed to provide species-based rather than fishery-based information. The SG finalised the data exchange format required to collate inputs to mixed-fisheries forecasts. In addition, the SG defined fleets and fisheries for the North Sea, the Northern Shelf and the Southern Shelf areas. Finally, the SG considered that the MTAC model was an appropriate short-term fix. However, the group also recognised that models should be developed in the medium-term to accommodate several processes including biological interactions, fleet adaptation, recruitment dynamics, in the provision of mixed-species forecasts.

14.2 WGNSSK04 contribution to mixed-fisheries forecasts

14.2.1 Database and data available

WGNSSK04 acknowledged the different comments and concerns raised by the different groups that have recently been involved in the development and provision of mixed-fisheries forecasts. The WG recognized that the main obstacle to the routine provision of such advice was the quality of the underlying catch and effort data. The WG therefore decided to focus effort in improving the quality of the MF database. The common exchange format used by the WG was that developed by SGDFF04. The progress made compared to last year is summarized in the text table below.

	WGNSSK03	WGNSSK04
Fishery-based landings	8 nations / 6 stocks	9 nations / 15 stocks
Fishery-based discards	1 nation / 3 stocks	5 nations / 8 stocks
Fishery- and age-disaggregated information	0 nation / 0 stock	9 nations / 8 stocks

A detailed overview of the 2003 fishery-based data submissions by country is given in the text table below.

Country	Landings total/ by age	Discard total/ by age	Effort
Belgium[1]	Yes / No	No / No	No
Denmark	Yes / Yes	No / No	Yes
France	Yes / Yes	Yes / No	Yes
Germany	Yes / Yes	Yes / Yes	Yes
Netherlands	Yes / Yes	Yes / Yes	No[2]
Norway	Yes / No	No / No	No
Sweden	Yes / Yes	Yes / Yes	No
UK England[1]	Yes / Yes	No / No	No
UK Scotland	Yes / Yes	Yes / Yes	Yes

The SGDFF requirements for landings and effort data was to report by country, year, quarter, gear, mesh size range, fishery, area and species. The number of these strata for each country is presented in the text table below, which highlights the fact that different procedures were carried out to define fisheries in different countries.

Country	Landings or discards	Effort
Belgium	398	-
Denmark	1072	210
France	666	221
Germany	687	275
Netherlands	30	-
Norway	319	-
Sweden	168	-
UK England	424	-
UK Scotland	1504	188

The stocks assessed by this WG, for which fishery- and age-disaggregated information was available, are given in the following text table, and the landings from the documented fisheries, as reported in the MF database, have been compared to official landings. The examination of the table indicates that the coverage in the MF database is reasonable.

Stock	Official landings	MF database landings	Percentage
Cod 3an, 4, 7d	34105	31246	92%
Haddock 3a, 4	44262	43661	99%
Plaice 3a	8843	7256	82%
Plaice 4	65688	66492	101%
Plaice 7d	4537	3386	75%
Saithe 3a, 4, 6a	110518	107520	97%
Sole 4	16692	18008	108%
Whiting 4, 7d	17817	17345	97%

Finally, fishery-disaggregated (but not age-disaggregated) data were also provided for Sole (Division VIId), *Nephrops* (Sub-Area IV and Division IIIa), Sandeel (Sub-Area IV) and Norway pout (Sub-Area IV).

[1] Mesh size not available
[2] NL effort is available but has accidentally not been included in the exchange files.

14.2.2 Data treatments

The mandatory SGDFF-formatted landings, discard, numbers and weights at age data submissions by country given in a one-dimensional vector are imported into a SAS data base in a tabular format. The mandatory SGDFF formatted effort data submissions by country are provided and treated similar to the catch data. The large number of strata (i.e. combinations of "country", "fishery", "area", "quarter", "gear", "mesh size range" and "species") used by the WG resulted in numerous missing entries. The WG implemented a coarse procedure to fill in such missing entries

- Missing discards for a given stratum were estimated by multiplying the landings of that stratum by the ratio of total international discards to total international landings

- Missing landings at age for a given stratum were estimated by multiplying the landings of that stratum by the overall landings at age ogive estimated for the species under consideration

- Missing discards at age for a given stratum were estimated by multiplying the discards of that stratum by the overall discards at age ogive estimated for the species under consideration. The species for which some age-disaggregated information was available were cod, haddock, plaice, saithe, sole and whiting. The selected fishing areas were Sub-Area 4, and Divisions IIIA, IVa and VIId.

14.2.2.1 Results

The database is now recorded in the WG's directory and some results are presented in Table 14.1. A striking feature is the high level of saithe discards. The general perception is that the Norwegian, French and German vessels, which are the major contributors to the saithe fishery, have discarded relatively few fish in 2003. However, the Scottish have reported substantial amounts of discards. Given that only Scotland provided discards-at-age information for saithe, the discard ogive for the other countries is derived from that of Scotland. The inconsistency generated by this assumption illustrates some limitations of the current interpolation procedure, but it also stresses that countries should be encouraged to provide complete discard information.

14.2.3 Conclusions and recommendations

The WG has made progress in compiling fishery- and age-disaggregated landings, discards and effort data. Future developments would nevertheless be required to further develop the quality of that database, as detailed below.

- The data coverage is still not comprehensive. This situation could lead to a distortion between calculated landings and/or discards and their perceived level, especially when the major countries contributing to a fishery do not provide appropriate data. The WG recommends that all nations provide the complete age-structured information for the stocks and fisheries they are sampling.

- Missing information was eventually completed with a coarse procedure (missing discard and landing ogives were estimated over all available information) in order to generate the database required by ACFM and others. This procedure is only a first proxy, and any results derived from the current MF database should be interpreted cautiously.

- The WG felt unable to provide an acceptable way to derive catch at age information for those fishing units where information was missing and could not be interpolated using the filter detailed in section 14.2.3.

- The WG endorsed the views of SGDFF04 that current market sampling of all participating nations is undesirably designed to provide stock-based catch at age. The WG strongly recommends that the move towards fishery-based data provision must be accompanied by a reconfiguration of market sampling procedures by national institutes. The WG was of the opinion that the PGCCDBS and the WKSCMFD have the widest expertise to make recommendations on the design of market sampling within the ICES community.

- Mixed-fisheries data were compiled under the SGDFF format during the WG. This task was considered as demanding, given the general overload of the WG. Furthermore, there is a risk of both redundancy and duplication if individuals compile data and if this task is repeated by those coordinating stock assessments. The WG was therefore of the opinion that such MF data should be compiled under the agreed format prior to the WG. The MF database could then be used to provide input data not only to MF forecasts, but also to stock assessments.

- The WG suggested that current assessment working groups could be restructured to accommodate more fully the fishery interactions. This could involve for example to create a permanent ICES fishery-based forecast group.

Table 14.1. Summary of the raw and estimated MF data.

Stocks	Official landings	MF database landings	Landings (t) by fleets with total discard information available	Landings (t) by fleets with landings at age ogive available	Landings (t) by fleets with discards at age ogive available	Estimated total discard
Cod 3an, 4, 7d	34105	31246	8651	2031	116	1492
Haddock 3a, 4	44262	43661	31852	2616	971	19542
Plaice 3a	8843	7256	88	878	25	3679
Plaice 4	65688	66492	29722	3728	5148	25945
Plaice 7d	4537	3386	0	73	0	499
Saithe 3a, 4, 6a	110518	107520	7195	2404	329	6575
Sole 4	16692	18008	13506	1037	307	1552
Whiting 4, 7d	17817	17345	5698	1131	387	7658

15 THE INTEGRATED APPROACH

In conjunction with client commissions, ICES are moving towards a new system whereby advice from traditionally disaparate areas is to be combined. The intention is that this integrated approach will combine the separate outputs from ACFM, ACE and ACME into one overall body of advice. This theme was developed by Jake Rice (chair of the Consultative Committee) in an recent letter to all chairs of ICES Working Groups and Study Groups. ICES are intending to augment the ToRs of assessment (and other) Working Groups to attempt to encourage more efficient working practices in pursuit of the integrated approach. Chairs were asked to pose the following question to their Groups: "What do we need to augment our advice to fisheries (and other) managers on the effects of the environment on their fisheries, or the effects of their fisheries on the ecosystem?"

The WG included two plenary sessions on this issue during the meeting. The first introduced the issue to the WG in general terms. The second centred on a presentation by Einar Svendsen (IMR Norway), chair of the Oceanography Committee, on the integrated approach in general, and some possible uses of oceanographic and ecosystem models currently under development in Bergen and elsewhere. The overall conclusion of the WG was that we needed to encourage environmental scientists and ecosystem modellers to become more involved in the annual round of assessments, for without this involvement it is hard to see how the integrated approach will ever become reality. Members of assessments WGs simply do not have the time, either at their meetings or intersessionally, to consider adequately environmental effects on fisheries, or fishery effects on ecosystems.

The sort of questions that we need to ask of the environmental science community might include:

- Given current and projected environmental conditions, is the aim of trying to achieve precautionary biomass levels realistic?

- Can information on hydrography and primary production help us to answer questions on sandeel biology and ecology? This is particularly important now when the North Sea sandeel stock abundance is estimated to be very low.

- Are apparent shifts in recruitment "regimes" caused by actual changes in productivity (survival of juveniles), or by reduced numbers of spawners?

Process models and data on environmental influences may be particularly useful for stocks that recruit to the fishery at ages older than one year. In these cases there is a lag between hatching and recruitment during which environmental conditions can be measured, which may lead to improved estimates of year-class strength. Shorter time-scales may also be useful: Einar Svendsen highlighted the example of the strong linkage between Atlantic water in$\mathbf{F}_{low}$ to the North Sea, and horse mackerel recruitment. On the other hand there is the case of Bay of Biscay anchovy, for which an upwelling index (with a strong historical relationship to recruitment) was used to forecast recruitment in the exact year that the relationship failed.

The view of the WG was that the integrated approach was a valid idea to promote, but that the ability of assessment WGs to address these issues was limited by their current membership. WG practice would have to change considerably for the integrated approach to become a reality. There are also some dangers to be aware of: complex models do not always improve understanding of natural systems, some current models are far more complicated that justified by the quality of the data to which they are fitted, and correlational analyses without good hypotheses of causation are unlikely to be reliable. However, although there are problems, there is also a clear requirement for assessment WGs to evolve to fit the new focus. One possible model is that of the NAFO scientific meeting, at which environmental scientists present information to stock assessors to help them in their deliberations. Such integration would necessarily require a reduction in the time available for the type of population analysis done currently. There would have to be a tradeoff between integration, the ability to carry out in-depth analyses of stocks, and the time available.

Appendix 1: Discard reconstruction of North Sea plaice

The approach builds on the concept that during its life a cohort will grow through the discard size range. Dependent on the growth rate of plaice, mesh size, minimum landing size, and the availability of the fish to the fishery, the cohort size distribution may be broken up in different components: fish that are unavailable or escape through the meshes; undersized-fish that are retained in the cod-end; and markeTable fish that are retained in the cod-end (Figure 1). To reconstruct the number of plaice discards at age, catch numbers at age are calculated from corrected levels of fishing mortality at age, using a reconstructed population and selection and distribution ogives. This method is a further development of the approach of Casey (1996), and is a follow up of earlier work on the effects of area closures on the exploitation (ICES, 1987; Rijnsdorp & Van Beek, 1991).

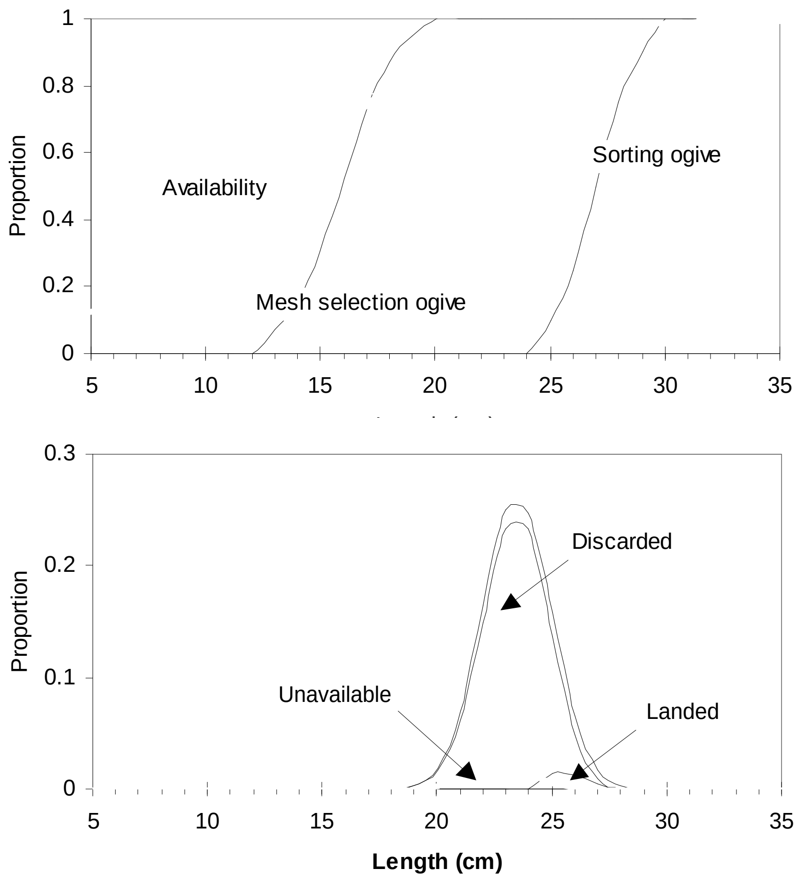


Figure 1. Factors determining the proportion of the population that will be retained in the cod-end and will be landed by the fishery (upper panel) and the resulting size distributions of the discarded and landed fraction. The heavy line in the bottom panel shows the reconstructed length distribution of the cohort.

Following the analysis of Rijnsdorp et al. (2004), the mean length of age groups 1 – 6 were estimated using a GLM model of the length at age (Li) estimated in surveys (SNS and BTS survey) and otolith back-calculations. The model was estimated for each age separately*:*

Li = Year + Survey + □

The class variable *Year* extracts the signal of inter-annual variations in length at age, whereas the class variable *Survey* estimates the differences in length observed between surveys. Differences in length estimates between the surveys do occur due to differences in timing (BTS: August-September; SNS: September-October) and differences in survey area. The otolith back-calculation time series comprise of female data only and will give higher length at age estimates for older age groups (2 plus) because of the sexual dimorphism in growth. With the fitted model, the length at age was predicted for the BTS survey for the whole time period (Figure 2), as the BTS length will most closely match the mean length of the population during the year. Length distributions (proportion of a length class at age) were modeled as a normal distribution with the mean length at age from the above analysis and the average coefficient of variation (9%) observed in the BTS survey.

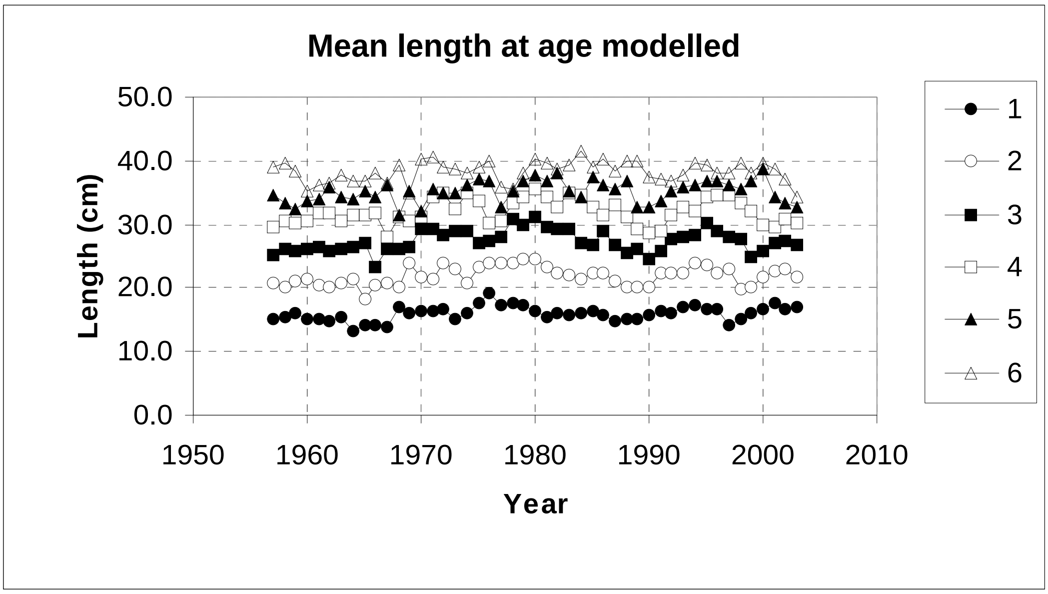


Figure 2. Variations in the mean length at age in summer as estimated from the BTS and SNS surveys and the time series of otolith back-calculations.

The mesh selection and sorting ogives were assumed to be constant throughout the time period and corresponds to a selection factor of 2.2, a selection range of 3cm, a cod end mesh of 80mm and a minimum landing size of 27cm.

The availability curves were estimated from survey data for individual years assuming that only those size classes that occur outside the coastal zone (12 nm zone and since 1989 the plaice box) are available to the fisheries. The availability was estimated for each cm-class as the proportion of the population numbers outside the coastal zone of the area between 52°N-55°30'N and east of 3°E. The population numbers were estimated as the sum of the catch rates per stratum (ICES rectangle) times the surface area of the stratum. In the next step a logistic regression was calculated over the proportion of fish outside the coastal waters per cm-class. In order to smooth the relationships, the availability ogive was estimated from the pooled survey data of the year (i) and two neighbouring years (i-1, i+1), analogous to a three-year running mean. Availability ogives were thus estimated for individual years since 1980. For the period 1957 – 1979, a mean availability ogive was used based on the survey data from 1970-1979. With these regressions, the proportions availability were estimated for the size range up to 30 cm, and rescaled to an availability of 1 for 30 cm fish (Figure 3).

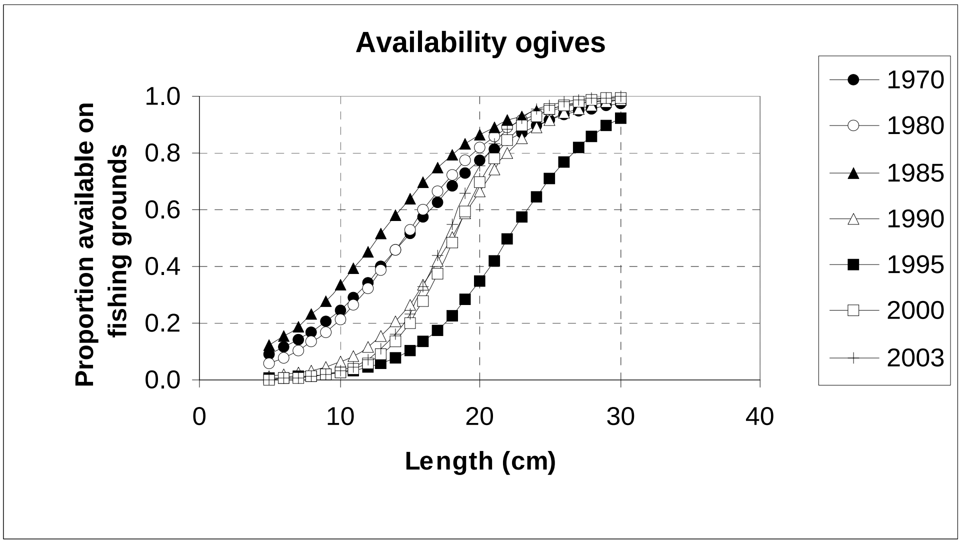


Figure 3. Variation in the availability ogives for different years illustrating the effect of changes in distribution pattern of plaice and the establishment of the plaice box in 1989.

The proportion of the population at age available at the fishing ground and retained in the net (Figure 4) was calculated from the proportion of a length class at age using the mesh selection ogive and the availability ogives. This proportion was divided into a discarded and a landed part (Figure 5). The level of fishing mortality on the pre-recruit age groups 1-4 was set relative to the level of mean F on the ages 5 and 6, since these age groups are almost completely recruited to the fishery. For these age groups the F was available from the VPA of landings data and was corrected for the simulated proportion of discards calculated.

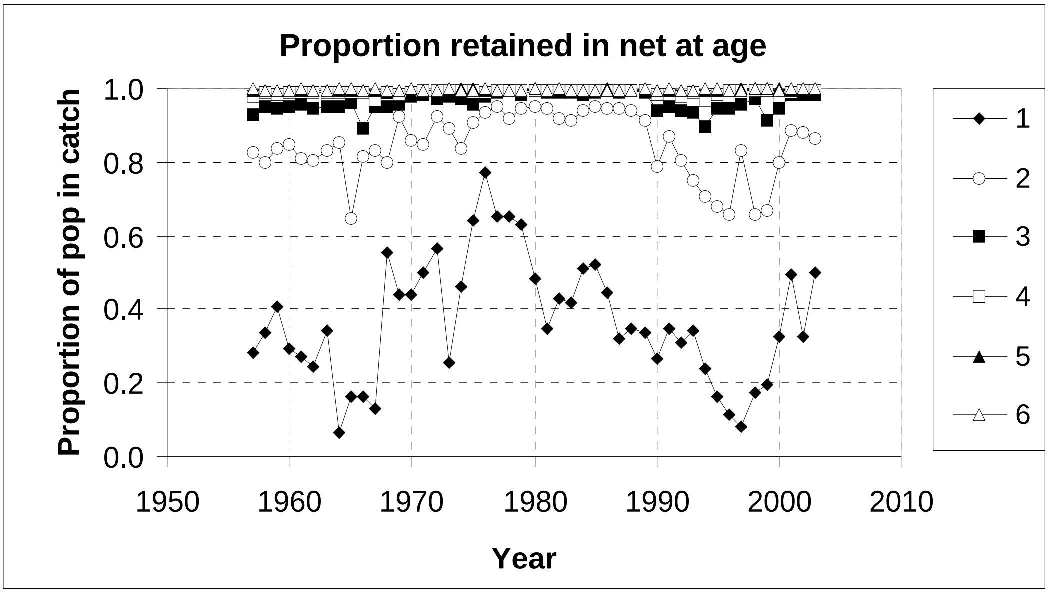


Figure 4. Proportion of the population by age retained by the cod-end and available on the fishing grounds.

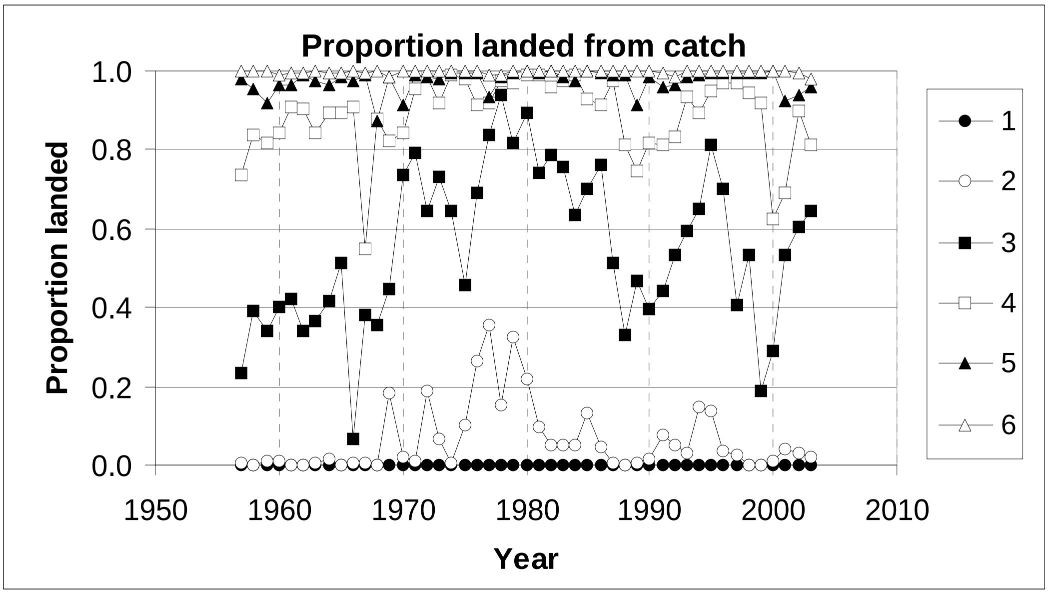


Figure 5. Proportion of the catch by age that is landed.

Stock numbers at age were calculated using the newly calculated F's. However for this calculation procedure the stock numbers in the final year for ages 1-6, from which population numbers at younger ages in earlier years are calculated, were missing. For ages 1-4 the stock numbers in the final year were estimated using RCT3, and were taken from the VPA of landings data for ages 5-6. The population numbers at age were calculated backwards from the stock numbers in the final year or from stock numbers at age 7 in earlier years:

$N_{i-1} = N_i * e^{(M+F)}$

Catch numbers at age including discards were calculated using the newly calculated population numbers and F at age:

$C_i = F/(F+M)*N_i - N_{i+1}$

Discards numbers at age were calculated by subtracting landings numbers at age from the newly calculated catch numbers at age. Discard percentages by number compared to the catch from this reconstruction for 1957-1998 are presented in Figure 6.

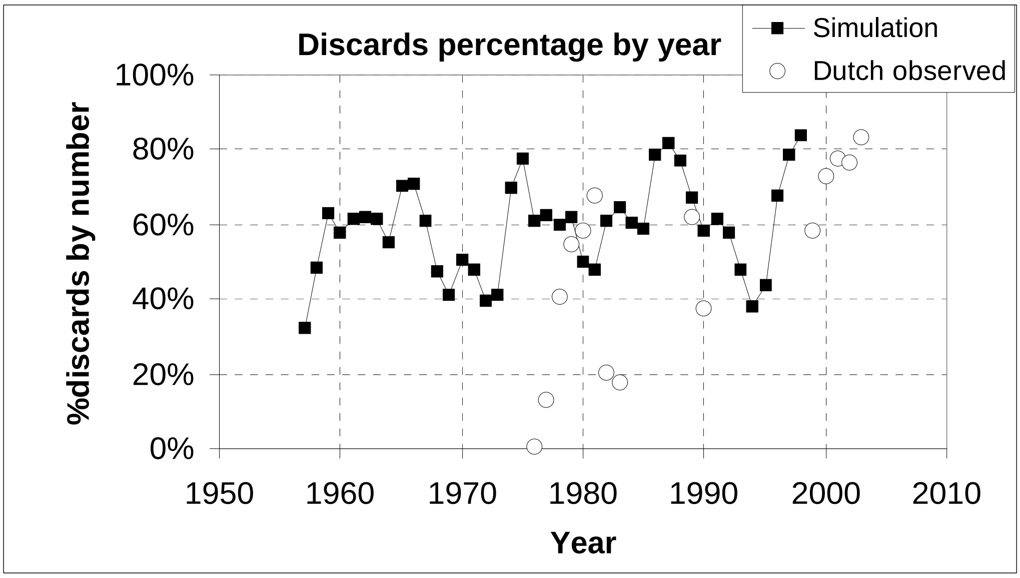


Figure 6. North Sea plaice. Discard percentage by year estimated from the discards numbers over all ages divided by the catch numbers over all ages (simulated), compared to observations from the Dutch discard sampling program (Van Beek, 1998; Van Keeken et al. 2004).

Appendix 2: Recruitment estimates, predictions and biological reference points for an assessment without discards

Recruitment estimates

Input to the RCT3 analysis is presented in Table 9.5.1b. Results for age 1 and 2 are presented in Table 9.5.2b and 9.5.3b respectively. The geometric mean (GM) recruitment is 388 million and the arithmetic mean is 427 million.

The 2002 year-class in 2004 (at age 2) is estimated at 107 million in XSA and 210 in RCT3. All indices estimate this year-class to be below average (350 million), and the RCT3 estimate was used for further analysis.

The 2003 year-class in 2004 (at age 1) is poorly estimated by the RCT3 analysis (only one survey index available). The long term GM for this year-class was used for further analysis.

For the 2004 and subsequent year-classes, the long term GM was used as there were no RCT3 estimates.

The text Table below summarises the year-class strength estimates.

Yearclass	At age in 2004	XSA	RCT3	GM 57-01	Accepted estimate
2002	2	107002	**210233**	350452	RCT3
2003	1	-	412008	**388164**	GM 1957-2001
2004 & subsequent	Recruits	-		**388164**	GM 1957-2001

Short term prognoses

The input for the short term prognoses is given in Table 9.7.1b, the management option Table is presented in Table 9.7.2b. F in 2004 is set at the status quo level. The detailed Table for F status quo is given in Table 9.7.3b. At status quo fishing mortality in 2004 and 2005 the SSB is expected to be at around 175,000 tonnes in 2005 and 173,000 tonnes in 2006.

The yield at status quo F is expected to be at 80,000 tonnes in 2004. The landings in 2005 are predicted to be around 77,000 tonnes at status quo F.

A sensitivity analysis has been carried out to identify the different sources of uncertainty underlying the predictions and is presented in Figure 9.7.2b.

The probability profiles relative to the short term forecast is given in Figure 9.7.3b. At the current yield of around 66,000 tonnes, the probability that F is higher that $\mathbf{F}_{sq}$ is around 20%. The probability that SSB will stay below 210,000 tonnes is predicted to be about 90%.

Medium term prognoses

Figure 9.8.1b shows the stock-recruitment fit and the medium term forecasts at $\mathbf{F}_{sq}$. There is a high probability (>90%) that the SSB remains under 240,000 tonnes over the medium time period.

Figure 9.8.2b shows the probability of SSB to remain below 300,000 tonnes over the next 10 years with discards included. At F=0.3, the probability of remaining below 300,000 tonnes is around 40% in 2013.

Long term prognoses

The results show that the maximum human consumption yield calculated is around 90,000 t (Figure 9.9.1b) and can be reached at F=0.27 (Figure 9.9.2b).

Biological reference points

The estimated biological reference points are presented in Table 9.10.1b and Figure 9.10.1b.

$\mathbf{B}_{loss}$ (SSB in 1997) is now estimated to be 134 200 tonnes, whereas in last year's assessment it was estimated at 134 383 tonnes.

$\mathbf{F}_{max}$ is revised upwards from 0.23 to 0.27. $\mathbf{F}_{med}$ is revised downwards from 0.33 to 0.32. $\mathbf{F}_{high}$ is revised upwards from 0.53 to 0.58.

Table 9.5.1b. North Sea plaice. Inputs to RCT3 analysis, no discards included.

'yc'	'VPA-1'	'VPA-2'	'SNS-0'	'SNS-1'	'SNS-2'	'SNS-3'	'SNS-4'	'BTS-1'	'BTS-2'	'BTS-3'	'BTS-4'	'comb DFS/YFS-0'	'comb DFS/YFS-1'
1967	237191	214619	-11	-11	-11	2813	156	-11	-11	-11	-11	-11	-11
1968	319312	288923	-11	-11	9450	1008	70	-11	-11	-11	-11	-11	-11
1969	363584	328912	-11	8032	23848	4484	795	-11	-11	-11	-11	-11	-11
1970	267735	242239	3678	18101	9584	1631	258	-11	-11	-11	-11	-11	-11
1971	224206	200746	6705	6437	4191	1261	33	-11	-11	-11	-11	-11	-11
1972	531150	479398	9242	57238	17985	10744	185	-11	-11	-11	-11	-11	-11
1973	447146	402480	5451	15648	9171	791	591	-11	-11	-11	-11	-11	-11
1974	327713	295593	2193	9781	2274	1720	136	-11	-11	-11	-11	-11	-11
1975	317705	284789	1151	9037	2900	435	159	-11	-11	-11	-11	-11	-11
1976	463106	415973	11544	19119	12714	1577	110	-11	-11	-11	-11	-11	-11
1977	420668	379549	4378	13924	9540	456	34	-11	-11	-11	-11	-11	-11
1978	435425	392735	3252	21681	12084	785	93	-11	-11	-11	-11	-11	-11
1979	654712	591477	27835	58049	16106	1146	78	-11	-11	-11	-11	-11	-11
1980	417218	377274	4039	19611	8503	308	16	-11	-11	-11	-11	-11	-11
1981	1021353	920987	31542	70108	14708	2480	351	-11	-11	-11	12	634	287
1982	582671	526068	23987	34884	10413	1584	145	-11	-11	39	9	457	160
1983	600866	543584	36722	44667	13789	1155	198	-11	180	51	5	432	117
1984	523565	473626	7958	27832	7558	1232	1357	116	132	33	9	263	101
1985	1247428	1127127	47385	93573	33021	13140	4034	660	764	174	47	718	269
1986	539766	488401	8818	33426	14429	3709	828	226	140	39	23	345	189
1987	560481	507145	21270	36672	14952	3248	1161	577	319	56	12	465	105
1988	403903	364267	15598	37238	7287	1507	612	429	103	29	6	331	135
1989	392584	353750	24198	24903	11149	2257	98	112	122	27	6	463	129
1990	399309	359920	9559	57349	13742	988	78	185	126	38	11	468	151
1991	401054	359645	17120	48223	9484	884	96	172	179	35	8	496	131
1992	285642	255167	5398	22184	4866	415	42	125	64	14	5	357	74
1993	239160	215075	9226	18225	2786	1189	34	145	44	23	3	263	31
1994	322002	283986	27901	24900	10377	1393	41	252	212	20	9	445	38
1995	249542	224745	13029	24663	-11	5739	1040	218	-11	47	4	184	117
1996	749963	677746	91713	-11	29431	14347	982	-11	436	183	24	572	153
1997	255267	230789	15363	33391	9235	905	196	338	130	32	10	157	-11
1998	249774	225483	22720	35188	2489	356	58	305	75	20	6	-11	-11
1999	271104	242800	39201	23028	2416	263	-11	279	79	15	6	-11	14
2000	-11	-11	24185	10193	1047	-11	-11	226	45	11	-11	185	5
2001	-11	-11	101291	30265	-11	-11	-11	569	170	-11	-11	500	19
2002	-11	-11	29905	-11	-11	-11	-11	126	-11	-11	-11	213	11
2003	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	363	-11

Table 9.5.2b. North Sea plaice. RCT3 output for 1 year olds, no discards included.

```
Analysis by RCT3 ver3.1 of data from file :

p4rct1.csv

Plaice North Sea - 1-Y-Rcr.,,,,,,,,,,,,

Data for   11 surveys over   37 years :  1967 - 2003

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as    .20
Minimum of   3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass =   2000

        I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series           cept   Error          Pts  Value   Value    Error   Weights

SNS-0      .96   3.95    .87   .200     30  10.09   13.63     .922     .031
SNS-1     1.00   2.80    .51   .405     30   9.23   11.99     .554     .086
SNS-2      .79   5.74    .39   .536     31   6.95   11.24     .467     .121
SNS-3
SNS-4
BTS-1     1.92   2.31   1.00   .174     15   5.42   12.75    1.112     .021
BTS-2      .73   9.31    .27   .752     16   3.83   12.09     .321     .256
BTS-3      .82   9.96    .33   .662     18   2.48   11.99     .390     .173
BTS-4
comb D    1.53   3.91    .42   .579     17   5.23   11.92     .503     .104
comb D     .84   9.10    .45   .547     17   1.79   10.62     .663     .060

                                       VPA Mean =   12.91     .420     .149


Yearclass =   2001

        I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series           cept   Error          Pts  Value   Value    Error   Weights

SNS-0      .96   3.95    .87   .200     30  11.53   15.00     .982     .035
SNS-1     1.00   2.80    .51   .405     30  10.32   13.07     .536     .116
SNS-2
SNS-3
SNS-4
BTS-1     1.92   2.31   1.00   .174     15   6.35   14.52    1.201     .023
BTS-2      .73   9.31    .27   .752     16   5.14   13.05     .298     .376
BTS-3
BTS-4
comb D    1.53   3.91    .42   .579     17   6.22   13.44     .467     .153
comb D     .84   9.10    .45   .547     17   3.00   11.63     .554     .109

                                       VPA Mean =   12.91     .420     .189


Yearclass =   2002

        I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series           cept   Error          Pts  Value   Value    Error   Weights

SNS-0      .96   3.95    .87   .200     30  10.31   13.83     .927     .080
SNS-1
SNS-2
SNS-3
SNS-4
BTS-1     1.92   2.31   1.00   .174     15   4.84   11.63    1.160     .051
BTS-2
BTS-3
BTS-4
comb D    1.53   3.91    .42   .579     17   5.37   12.13     .489     .287
comb D     .84   9.10    .45   .547     17   2.48   11.20     .595     .194

                                       VPA Mean =   12.91     .420     .389


Yearclass =   2003

        I-----------Regression----------I  I-----------Prediction---------I
```

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
SNS-0									
SNS-1									
SNS-2									
SNS-3									
SNS-4									
BTS-1									
BTS-2									
BTS-3									
BTS-4									
comb D	1.53	3.91	.42	.579	17	5.90	12.95	.462	.453
comb D									
					VPA Mean =		12.91	.420	.547

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	169564	12.04	.16	.22	1.92		
2001	456838	13.03	.18	.27	2.13		
2002	234684	12.37	.26	.39	2.16		
2003	412008	12.93	.31	.02	.00		

Table 9.5.3b. North Sea plaice. RCT3 output for 2 year olds, no discards included.

```
Analysis by RCT3 ver3.1 of data from file :

p4rct2.csv

Plaice North Sea - 2-Y-Rcr.,,,,,,,,,,,,

Data for   11 surveys over   37 years :  1967 - 2003

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as    .20
Minimum of   3 points used for regression

Forecast/Hindcast variance correction used.
```

Yearclass = 2000

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------				I	I-----------Prediction---------			I
SNS-0	.97	3.77	.88	.198	30	10.09	13.53	.931	.031
SNS-1	1.00	2.65	.51	.405	30	9.23	11.88	.557	.086
SNS-2	.79	5.61	.39	.537	31	6.95	11.13	.468	.122
SNS-3									
SNS-4									
BTS-1	1.93	2.18	1.00	.175	15	5.42	12.64	1.115	.022
BTS-2	.73	9.17	.28	.748	16	3.83	11.98	.327	.250
BTS-3	.82	9.85	.33	.666	18	2.48	11.89	.390	.176
BTS-4									
comb D	1.55	3.69	.43	.571	17	5.23	11.80	.514	.101
comb D	.85	8.98	.45	.551	17	1.79	10.50	.663	.061
					VPA Mean =		12.81	.422	.150

Yearclass = 2001

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------				I	I-----------Prediction---------			I
SNS-0	.97	3.77	.88	.198	30	11.53	14.91	.992	.035
SNS-1	1.00	2.65	.51	.405	30	10.32	12.97	.539	.118
SNS-2									
SNS-3									
SNS-4									
BTS-1	1.93	2.18	1.00	.175	15	6.35	14.42	1.203	.024
BTS-2	.73	9.17	.28	.748	16	5.14	12.94	.304	.371
BTS-3									
BTS-4									
comb D	1.55	3.69	.43	.571	17	6.22	13.34	.477	.150
comb D	.85	8.98	.45	.551	17	3.00	11.52	.553	.112
					VPA Mean =		12.81	.422	.192

Yearclass = 2002

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------				I	I-----------Prediction---------			I
SNS-0	.97	3.77	.88	.198	30	10.31	13.74	.936	.080
SNS-1									
SNS-2									
SNS-3									
SNS-4									
BTS-1	1.93	2.18	1.00	.175	15	4.84	11.52	1.162	.052
BTS-2									
BTS-3									
BTS-4									
comb D	1.55	3.69	.43	.571	17	5.37	12.02	.500	.279
comb D	.85	8.98	.45	.551	17	2.48	11.09	.595	.197
					VPA Mean =		12.81	.422	.392

Yearclass = 2003

```
        I-----------Regression----------I  I-----------Prediction---------I
```

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
SNS-0									
SNS-1									
SNS-2									
SNS-3									
SNS-4									
BTS-1									
BTS-2									
BTS-3									
BTS-4									
comb D	1.55	3.69	.43	.571	17	5.90	12.84	.472	.444
comb D									
					VPA Mean =		12.81	.422	.556

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	151604	11.93	.16	.23	1.92		
2001	410083	12.92	.18	.27	2.13		
2002	210233	12.26	.26	.39	2.17		
2003	370870	12.82	.31	.02	.00		

Table 9.7.1b. North Sea plaice. Short term forecast input data, no discards included.

```
Table_____plaice,North Sea - no disca
 input data for catch forecast and linear sensitivity analysis


 Label     Value     CV     Label     Value     CV

 Number at age               Weight in the stock
 N1       388165   0.42     WS1        0.12   0.00
 N2       210233   0.56     WS2        0.22   0.03
 N3       386227   0.19     WS3        0.25   0.02
 N4        70335   0.21     WS4        0.29   0.04
 N5        55266   0.14     WS5        0.34   0.02
 N6        31699   0.13     WS6        0.43   0.07
 N7        22324   0.13     WS7        0.50   0.11
 N8        20272   0.17     WS8        0.63   0.04
 N9         2639   0.19     WS9        0.74   0.07
 N10        4828   0.18     WS10       0.84   0.07

 H.cons selectivity          Weight in the HC catch
 sH1        0.01   1.14     WH1        0.24   0.01
 sH2        0.13   0.34     WH2        0.26   0.03
 sH3        0.43   0.15     WH3        0.29   0.01
 sH4        0.55   0.13     WH4        0.32   0.03
 sH5        0.65   0.13     WH5        0.36   0.03
 sH6        0.57   0.12     WH6        0.45   0.08
 sH7        0.64   0.07     WH7        0.53   0.10
 sH8        0.43   0.13     WH8        0.69   0.04
 sH9        0.32   0.17     WH9        0.77   0.02
 sH10       0.32   0.17     WH10       0.85   0.06

 Natural mortality           Proportion mature
 M1         0.10   0.10     MT1        0.00   0.10
 M2         0.10   0.10     MT2        0.50   0.10
 M3         0.10   0.10     MT3        0.50   0.10
 M4         0.10   0.10     MT4        1.00   0.10
 M5         0.10   0.10     MT5        1.00   0.00
 M6         0.10   0.10     MT6        1.00   0.00
 M7         0.10   0.10     MT7        1.00   0.00
 M8         0.10   0.10     MT8        1.00   0.00
 M9         0.10   0.10     MT9        1.00   0.00
 M10        0.10   0.10     MT10       1.00   0.00

 Relative effort             Year effect for natural mortality
 in HC fishery
 HF04       1.00   0.04     K04        1.00   0.10
 HF05       1.00   0.04     K05        1.00   0.10
 HF06       1.00   0.04     K06        1.00   0.10

 Recruitment in 2005 and 2006
 R05      388165   0.42
 R06      388165   0.42



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

  Stock numbers in 2004 are VPA survivors.
  These are overwritten at   Age  2

Data from file:C:\CLARA\TEMP3\TEMP.SEN on 14/09/2004 at 11:47:58
```

Table 9.7.2b. North Sea plaice. Management option table, no discards included.

Table_____.plaice,North Sea - no disca
Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 2004	Year 2005						
Mean F Ages								
H.cons 2 to 6	0.46	0.00	0.09	0.19	0.30	0.37	0.46	0.56
Effort relative to 2003								
H.cons	1.00	0.00	0.20	0.40	0.64	0.80	1.00	1.20
Biomass								
Total 1 January	271	281	281	281	281	281	281	281
SSB at spawning time	153	175	175	175	175	175	175	175
Catch weight (,000t)								
H.cons	80.0	0.0	18.4	35.2	53.4	64.5	77.4	89.1
Biomass in year.... 2006								
Total 1 January		370	352	335	317	306	293	282
SSB at spawning time		245	228	212	195	185	173	163

	Year 2004	Year 2005						
Effort relative to 2003								
H.cons	1.00	0.00	0.20	0.40	0.64	0.80	1.00	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.14	0.17	0.17	0.17	0.17	0.17	0.17	0.17
SSB at spawning time	0.12	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Catch weight								
H.cons	0.13	0.00	0.25	0.18	0.17	0.16	0.16	0.16
Biomass in year.... 2006								
Total 1 January		0.16	0.16	0.16	0.17	0.17	0.17	0.18
SSB at spawning time		0.15	0.16	0.16	0.16	0.17	0.17	0.17

Table 9.7.3b. North Sea plaice. Detailed forecast table, no discards included.

```
Table_____.plaice,North Sea - no disca
           Detailed forecast tables.


Forecast for year 2004
F multiplier H.cons=1.00

      Populations     Catch number
+----+-----------+   +--------+-------+
| Age| Stock No. |   | H.Cons |  Total|
+----+-----------+   +--------+-------+
|   1|     388165|   |    4407|   4407|
|   2|     210233|   |   24415|  24415|
|   3|     386227|   |  128188| 128188|
|   4|      70335|   |   28249|  28249|
|   5|      55266|   |   25355|  25355|
|   6|      31699|   |   13151|  13151|
|   7|      22324|   |   10050|  10050|
|   8|      20272|   |    6703|   6703|
|   9|       2639|   |     690|    690|
|  10|       4828|   |    1262|   1262|
+----+-----------+   +--------+-------+
|  Wt|        271|   |      80|     80|
+----+-----------+   +--------+-------+


Forecast for year 2005
F multiplier H.cons=1.00

      Populations     Catch number
+----+-----------+   +--------+-------+
| Age| Stock No. |   | H.Cons |  Total|
+----+-----------+   +--------+-------+
|   1|     388165|   |    4407|   4407|
|   2|     347037|   |   40302|  40302|
|   3|     167037|   |   55439|  55439|
|   4|     228018|   |   91582|  91582|
|   5|      36902|   |   16930|  16930|
|   6|      26028|   |   10798|  10798|
|   7|      16237|   |    7310|   7310|
|   8|      10694|   |    3536|   3536|
|   9|      11992|   |    3133|   3133|
|  10|       4906|   |    1282|   1282|
+----+-----------+   +--------+-------+
|  Wt|        281|   |      77|     77|
+----+-----------+   +--------+-------+
```

Table 9.10.1b. North Sea plaice. Biological reference points, no discards included.

Reference point	Deterministic	Median	75th percentile	95th percentile	Hist SSB < ref pt %
MedianRecruits	381000	381000	401000	404650	
MBAL	0				0.00
B_{loss}	134200				
SSB90%R90%Surv	255524	284973	307737	337022	23.40
SPR%ofVirgin	9.28	9.20	9.97	11.84	
VirginSPR	5.40	5.35	5.92	7.22	
SPRloss	0.59	0.54	0.59	0.65	

	Deterministic	Median	25th percentile	5th percentile	Hist F > ref pt %
FBar	0.46	0.46	0.45	0.42	36.17
F_{max}	0.27	0.28	0.25	0.22	76.60
$F_{0.1}$	0.13	0.13	0.12	0.10	100.00
F_{low}	0.19	0.20	0.19	0.18	100.00
F_{med}	0.32	0.31	0.29	0.26	68.09
F_{high}	0.58	0.59	0.49	0.44	6.38
F35%SPR	0.12	0.12	0.11	0.10	100.00
F_{loss}	0.40	0.43	0.40	0.37	57.45

For estimation of Gloss and F_{loss}:

A LOWESS smoother with a span of 1 was used.

Stock recruit data were log-transformed

A point representing the origin was included in the stock recruit data.

For estimation of the stock recruitment relationship used in equilibrium calculations:

A LOWESS smoother with a span of 1 was used.

Stock recruit data were log-transformed

A point representing the origin was included in the stock recruit data.

North Sea - no disca plaice

Steady state selection provided as input

FBar averaged from age 2 to 6

Number of iterations = 100

Random number seed = -99

Stock recruitment data Monte Carloed using residuals from the equilibrium LOWESS fit

Data source:

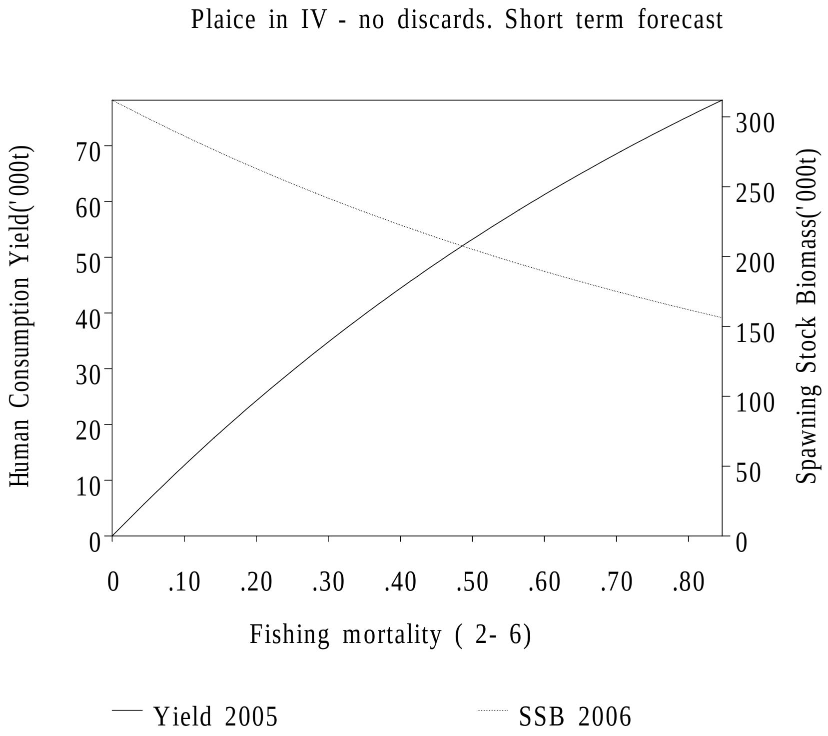
D:\Groups\Working_groups\WGNSSK\2004\at_wg\ple\longterm\without_discards\PLE_NOD.SEN

D:\Groups\Working_groups\WGNSSK\2004\at_wg\ple\longterm\without_discards\PLE_NOD.SUM

FishLab DLL used FLVB32.DLL built on Jun 14 1999 at 11:53:37

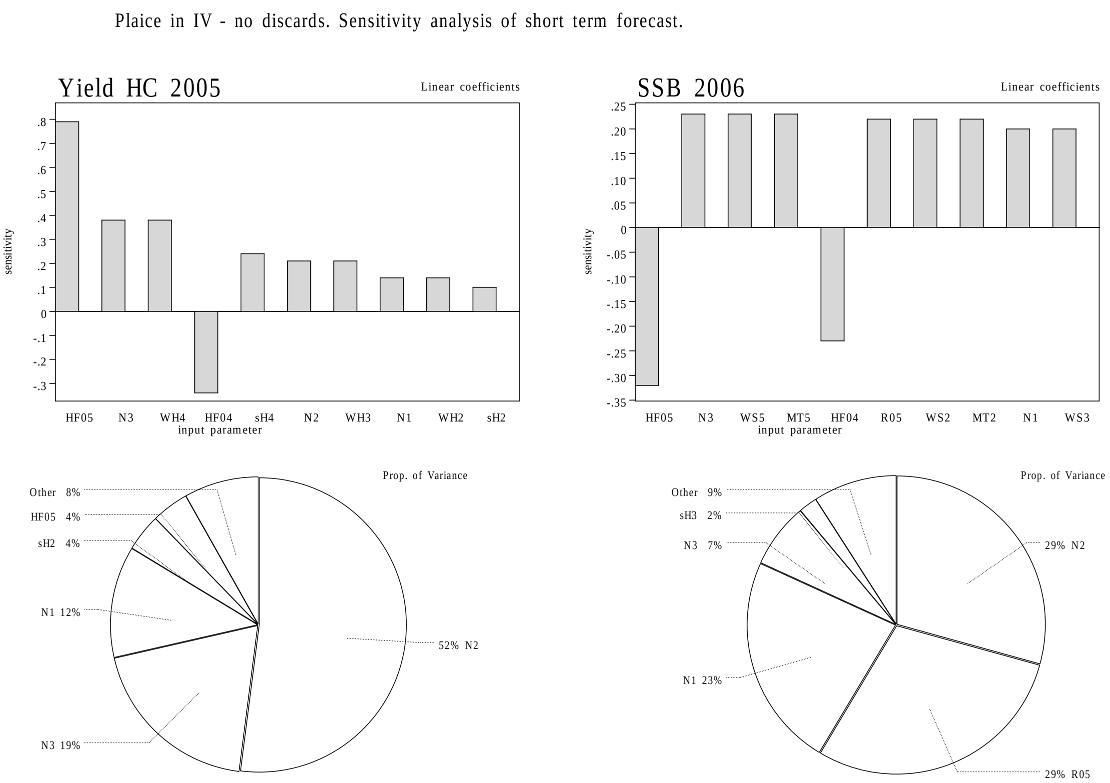
PASoft 4 October 1999 14/09/2004 13:28:59

Figure 9.7.1b. North Sea plaice. Short term forecast, no discards included.



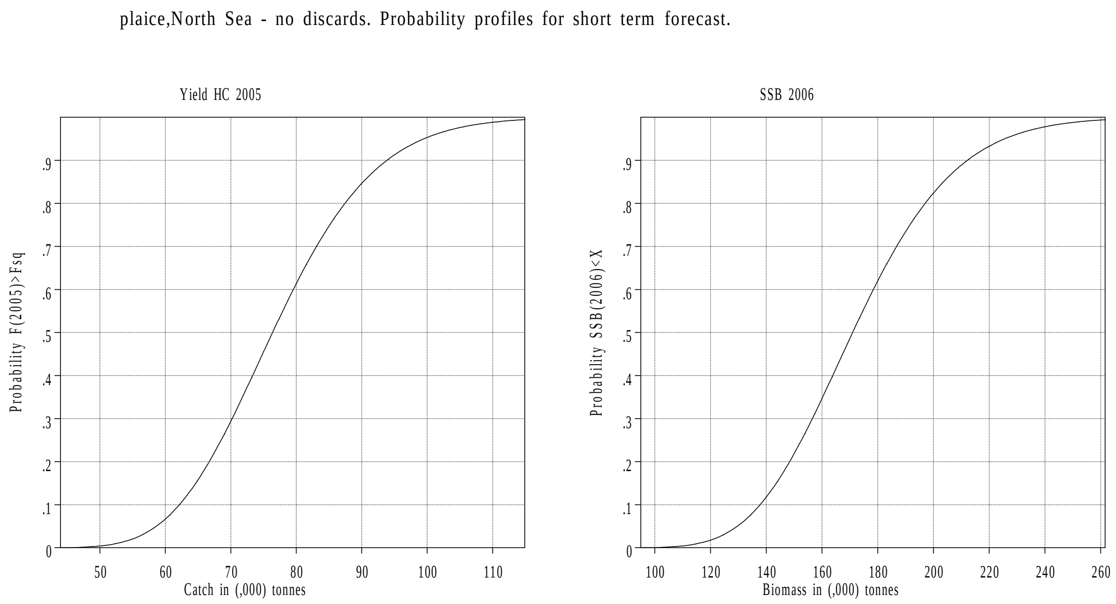
Data from file:C:\CLARA\TEMP3\PLE_NOD.SEN on 14/09/2004 at 19:20:24

Figure 9.7.2b. North Sea plaice. Sensitivity analysis of the short term forecast, no discards included.



Data from file:C:\CLARA\TEMP3\PLE_NOD.SEN on 14/09/2004 at 19:19:49

Figure 9.7.3b. North Sea plaice. Probability profiles for short term forecast, no discards included.



Data from file:C:\CLARA\TEMP3\TEMP.SEN on 14/09/2004 at 11:53:03

Figure 9.8.1b. North Sea Plaice. Medium term analysis, no discards included.

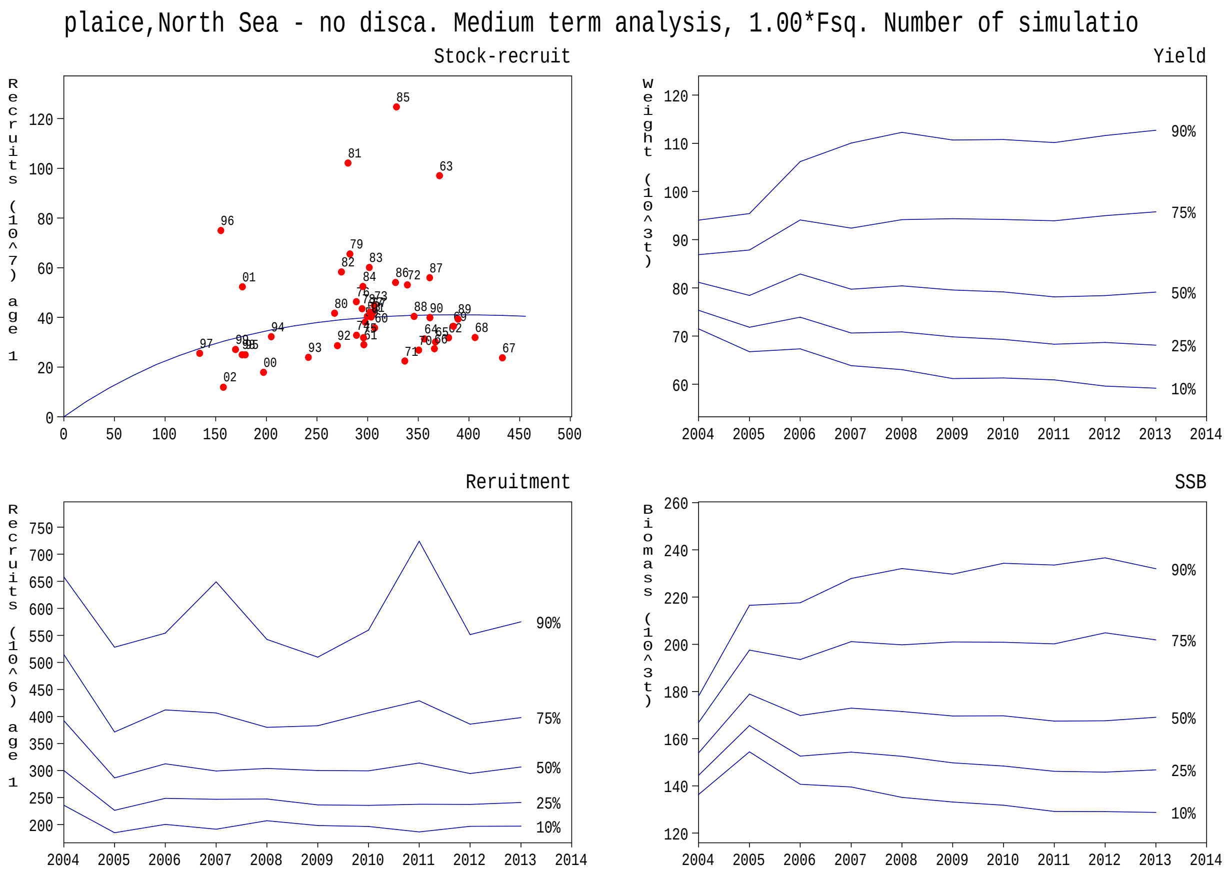


Figure 9.8.2b. North Sea plaice. Summary of medium-term analysis, no discards included. Contours show the probability that SSB will be below $\mathbf{B}_{pa}$ for any combination of year and fishing mortality.

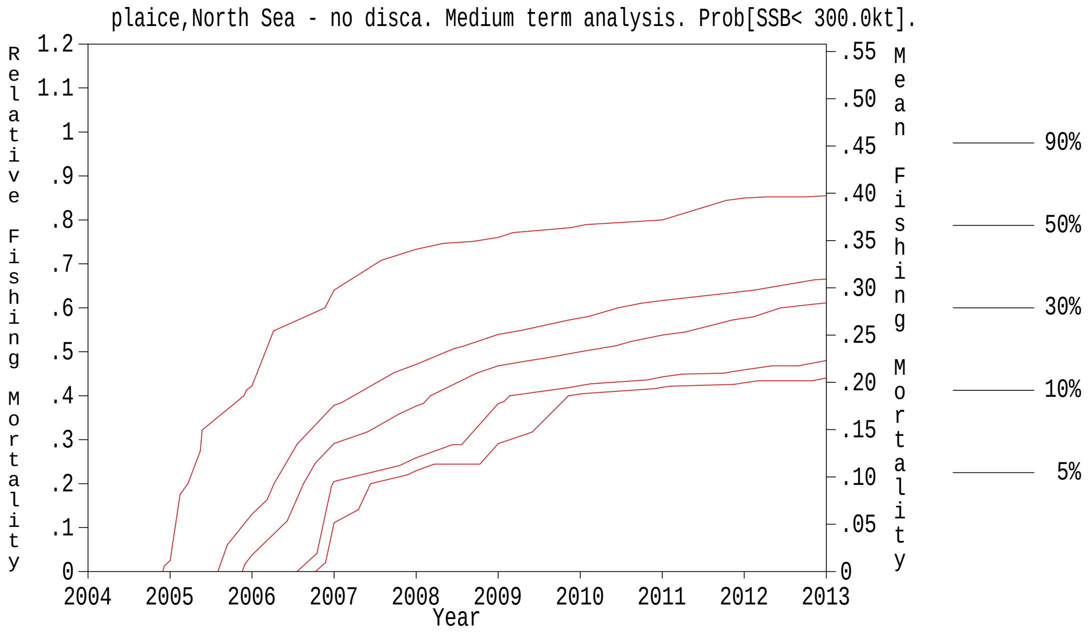


Figure 9.9.1b. North Sea plaice. Long term yield, no discards included.

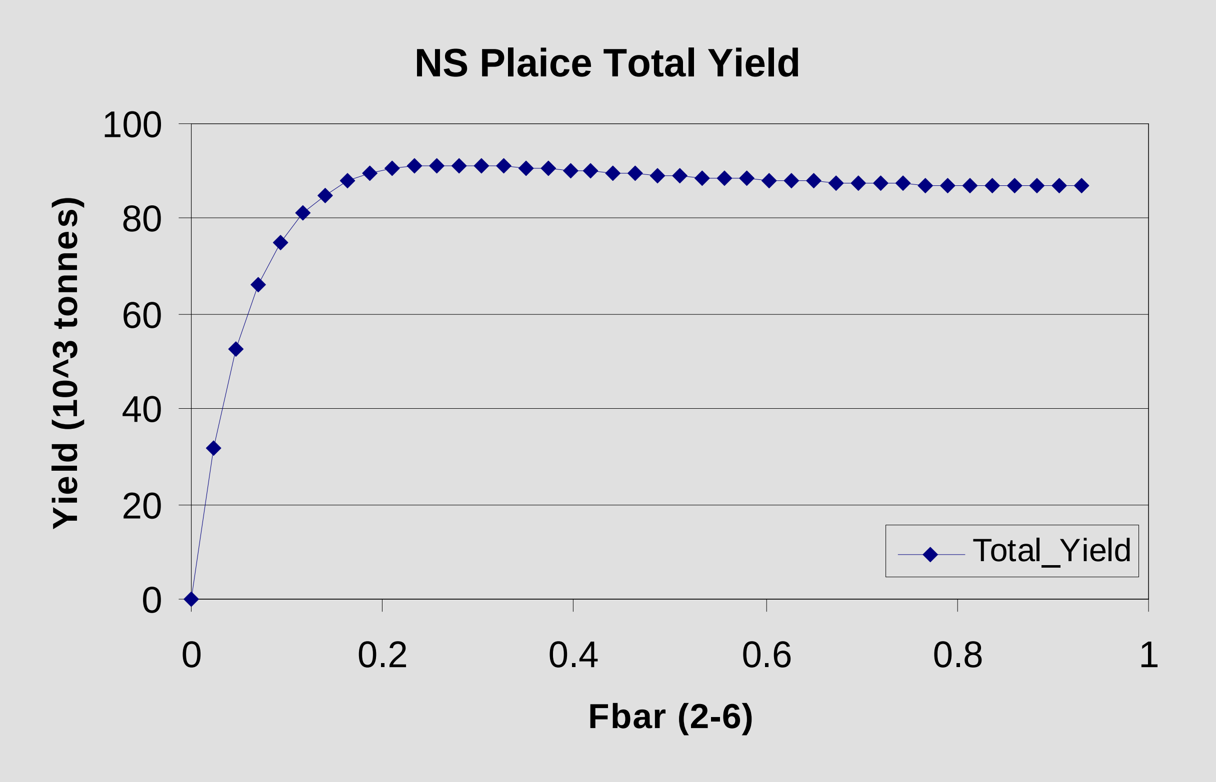
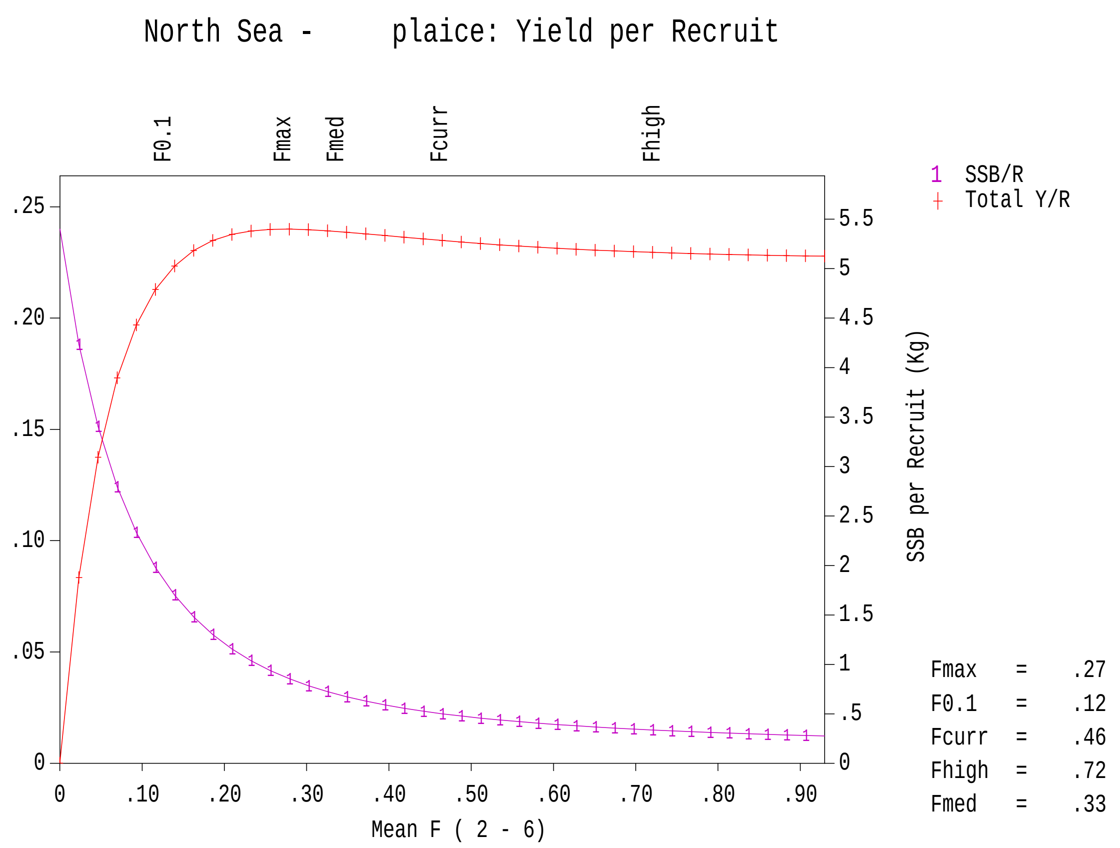


Figure 9.9.2b. North Sea plaice. Long term yield and stock recruitment, no discards included.



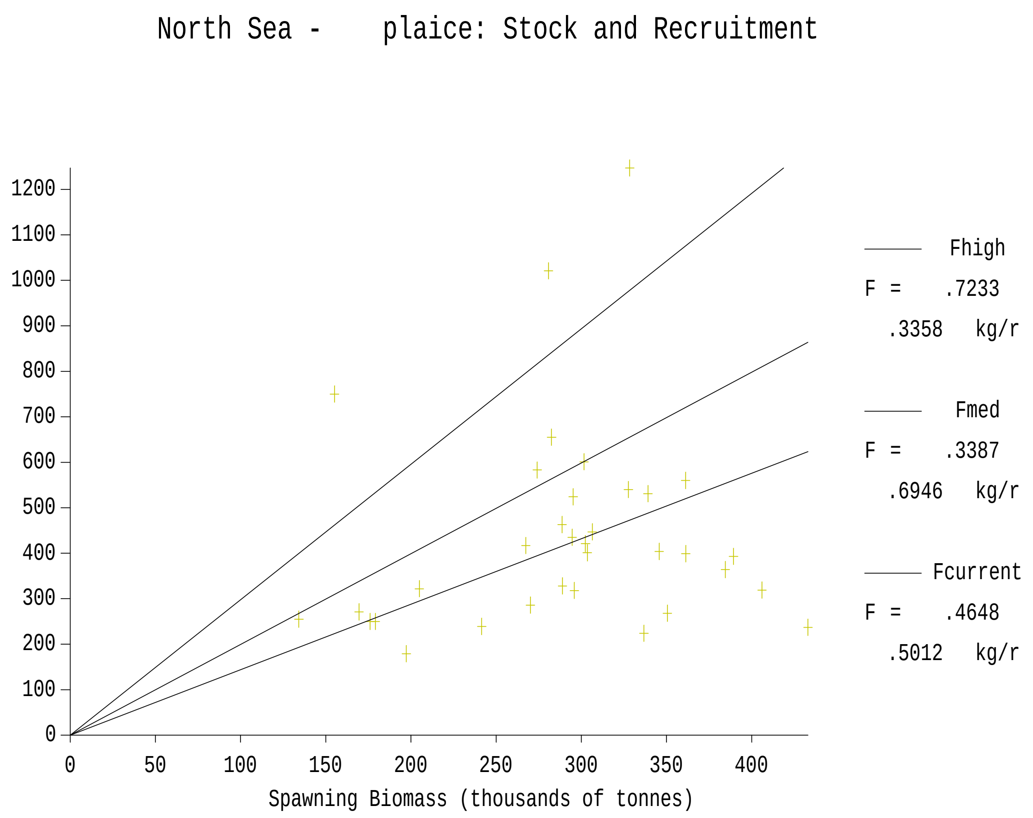
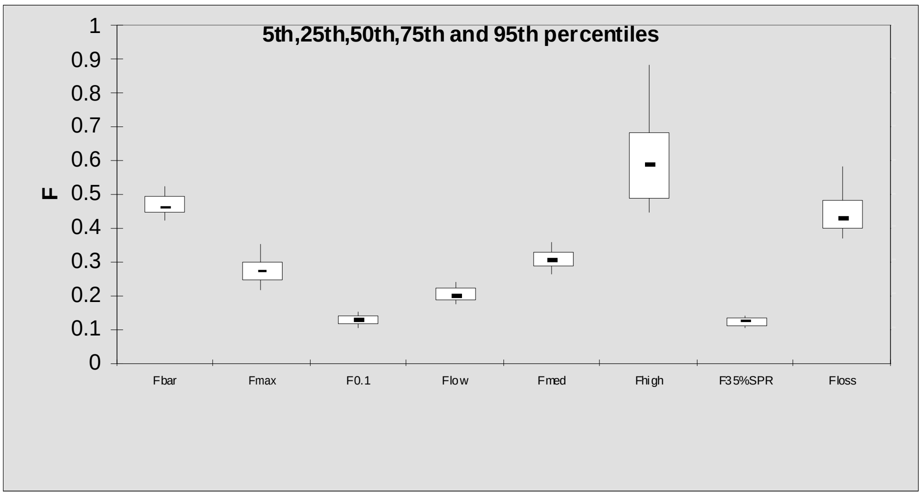


Figure 9.10.1b. North Sea plaice. Biological reference points, no discards included.



Appendix 3: Precautionary reference points

Background

The ICES approach is that in order to have stocks and fisheries within safe biological limits, the probability should be high that

1. the spawning stock biomass (SSB) is above a limit value (called $\mathbf{B}_{lim}$) below which recruitment (R) becomes impaired or the dynamics of the stock are unknown, and

2. the fishing mortality (F) is below a limit value (called $\mathbf{F}_{lim}$) that will drive the spawning stock to that biomass limit $\mathbf{B}_{lim}$.

Because of uncertainty in the annual estimation of SSB and F, ICES defines the more conservative operational reference points, $\mathbf{B}_{pa}$ and $\mathbf{F}_{pa}$ (the subscripts pa stand for precautionary approach). When a stock is estimated to be at $\mathbf{B}_{pa}$ the probability should be high that in reality it is above $\mathbf{B}_{lim}$. Similarly, when F is estimated to be at $\mathbf{F}_{pa}$ the probability should be high that in reality it is below $\mathbf{F}_{lim}$. In other words, if the assessed F is at or below $\mathbf{F}_{pa}$, the risk is low – taking assessment uncertainty into account – that the real exploitation will lead to impaired recruitment. Thus $\mathbf{B}_{pa}$ and $\mathbf{F}_{pa}$ are operational values that ensure with high probability that exploitation is sustainable.

The values of $\mathbf{B}_{lim}$, $\mathbf{F}_{lim}$, $\mathbf{B}_{pa}$, and $\mathbf{F}_{pa}$ are estimated based on the history of the stock and the fishery. $\mathbf{B}_{lim}$ and $\mathbf{F}_{lim}$ may be considered estimates of properties of nature, reflecting the reproductive capacity of a fish stock under the current natural regime. The distances between $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$ and between $\mathbf{F}_{lim}$ and $\mathbf{F}_{pa}$ reflect our ability to measure the present SSB and F, and are thus related to data quality, estimation methodology, and the perception of accepTable risk.

Determination of reference points

From the above it can be understood that $\mathbf{B}_{lim}$ has to be defined first, because $\mathbf{F}_{lim}$ is defined with reference to $\mathbf{B}_{lim}$, $\mathbf{B}_{pa}$ with reference to $\mathbf{B}_{lim}$, and $\mathbf{F}_{pa}$ with reference to $\mathbf{F}_{lim}$.

$\mathbf{B}_{lim}$ can be defined after inspection of the R-SSB plot. If an SSB has been observed below which recruitment is impaired, this SSB should be taken as the value of $\mathbf{B}_{lim}$. If no SSB has been observed below which recruitment is impaired, the lowest observed value of SSB ($\mathbf{B}_{loss}$) should be taken as the value of $\mathbf{B}_{lim}$ (as the SSB below which the dynamics of the stock are unknown). $\mathbf{F}_{lim}$ should be estimated by measuring the slope of the replacement line at $\mathbf{B}_{lim}$, i.e. R/$\mathbf{B}_{lim}$, and calculate the inverse $\mathbf{B}_{lim}$/R. The equivalent fishing mortality derived from a curve of SSB/R against F will therefore be $\mathbf{F}_{lim}$. If $\mathbf{B}_{loss}$ is used as $\mathbf{B}_{lim}$ then $\mathbf{F}_{loss}$ should be used as $\mathbf{F}_{lim}$. The pa values are determined from the lim values by fixed multipliers (ICES 1997; ICES 1998).

As a method to determine $\mathbf{B}_{lim}$ from an R-SSB plot, the SGPA (ICES 2003a) proposed to use the "segmented regression" or "hockey-stick method" (O'Brien & Maxwell 2002a, 2002b). With this method a breakpoint SSB, labeled S*, can be identified below which recruitment declines linearly to zero at SSB = 0, and above which recruitment is assumed to be independent of SSB

SGPRP (ICES 2003b) classified North Sea plaice as having no S/R signal and a distinct plateau (wide range of SSB), and it was suggested that $\mathbf{B}_{lim}$ should be estimated according to standard method. The segmented regression was not significant, and SGPRP requested from the WGNSSK "to evaluate a change in reference points for North Sea plaice based on an updated version of $\mathbf{B}_{loss}$".

The technical basis and the values of the current reference points for plaice are:

Reference point	Value	Technical basis
$\mathbf{B}_{lim}$	210,000 t	$\mathbf{B}_{loss}$
$\mathbf{B}_{pa}$	300,000 t	1.43 * $\mathbf{B}_{lim}$
$\mathbf{F}_{lim}$	0.6	$\mathbf{F}_{loss}$
$\mathbf{F}_{pa}$	0.3	The 5^{th} percentile of $\mathbf{F}_{loss}$ or lower, such that it implies Beq > $\mathbf{B}_{pa}$ and a less than 10% probability that SSB_{MT} < $\mathbf{B}_{pa}$.

Appendix 4

Estimating systematic bias in the North Sea cod landings data

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Introduction

For many years reported North Sea cod landings have followed the Total Allowable Catch (TAC), which in 2001, 2002 and 2003 implied severe reductions in order to significantly reduce exploitation rates. Assessment models subsequently fitted to the reported landings at age data, estimate that the fishing mortality rate declined strongly in line with the reductions in the TAC.

In contrast, the 2003 Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) noted that, while decommissioning and effort regulation may have reduced exploitation rates, there have been frequent reports from the fishing industry that the TAC has not limited landings. The WGNSSK concluded that whilst the perception of the low level of current stock biomass is robust to the biased landings data, fishing mortality had not been reduced to the extent estimated. As a direct consequence of the uncertainty in the true level of landings, estimates of the current stock abundance and fishing mortality rate could not be reliably determined and the WGNSSK was unable to provide management advice on the response of the stock to exploitation

Under the management regime adopted for this stock by the European Union and Norway, an inability to provide advice for a stock that is considered to be well below safe Precautionary Approach reference levels, is unacceptable. Therefore, in this paper a model structure that, theoretically, could be used to estimate the bias in reported landings is tested with simulated data to evaluate its potential for recovering unbiased abundance and exploitation rate estimates for the provision of management advice. The model is applied to the North Sea cod assessment data sets in order to determine the level of potential bias in the reported landings from that stock.

An ADAPT model structure for the estimation of bias in landings data

In recent years indices of North Sea cod population abundance (N) and fishing mortality (F) calculated from groundfish survey catch per unit effort (cpue) have indicated higher levels of abundance and mortality rates than those estimated by catch at age analysis (ICES WGNSSK 2003). 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 are 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 (Figure 1). Although the patterns could result from a variety of causes, for instance, changes in natural mortality, survey catchability or discarding, the most probable cause is bias in the reported landings. Residual patterns that show systematic bias indicate model mis-specification which may be addressed by defining a more appropriate model.

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

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

and for the years with bias

$$N'_{(a,y)} = B_{(y)}\ C_{(a,y)}\ Z_{(a,y)}\ (1-\exp(-Z_{(a,y)}))\ /\ F_{(a,y)} \qquad (2)$$

Survey catch per unit effort ($u_{(a,y,f)}$, f – 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

$$N_{(a,y)} = u_{(a,y,f)} / q_{(y,f)} \qquad (3)$$

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

$$B_{(y)} = N'_{(a,y)} / (u_{(a,y,f)} / q_{(y,f)}) \qquad (4)$$

Gavaris and Van Eeckhaute (1998) examined the potential for using a relatively simple ADAPT model structure to estimate the bias in declared landings of Georges Bank haddock. Their model fitted a year effect for the bias in landings in each year of the assessment times series under the assumption that landings bias does not distort the age composition 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 ADAPT model can be made by assuming that the time series of landings can be divided into two periods; a historic time series in which landings were relatively unbiased and a recent period during which landings at age were biased by a common factor across all ages.
The fit of the model to the early period of unbiased data provides estimates of appropriately scaled population abundance and survey catchability, thereby removing the indeterminacy noted by Gavaris and Van Eeckhaute.

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

Within the modified ADAPT VPA model population numbers were estimated from the VPA equations

$$N_{(a,y)} = B_{(y)}\, C_{(a,y)}\, Z_{(a,y)}\, (1-\exp(-Z_{(a,y)})) / F_{(a,y)} \qquad (5)$$

$$N_{(a,y)} = N_{(a+1,y+1)}\, e^{\,Z(a,y)} \qquad (6)$$

Where $B_{(y)}$ was estimated for years in which bias was considered to have occurred and defined as 1.0 for years without bias. Selection was 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

$$F_{(o)} = s\ [(F_{(o-1)} + F_{(o-2)} \ldots..+F_{(o-n)}] / n \qquad (7)$$

The parameters estimated to fit the population model to the cpue calibration data were 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 was

$$SSQvpa = \Sigma_{a,y,f} \{ Ln(u_{(a,y,f)}) - [Ln(q_{(a,f)}) + Ln(N_{(a,y)})]\}^{2} \qquad (8)$$

The year range of the summation extended 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 working group meeting.

Testing with simulated data (described later) 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:

$$SSQcatches = \lambda\, \Sigma\, \{Ln(B_{(y)}\, \Sigma_a [C_{(a,y)}\, CW_{(a,y)}]) - Ln(B_{(y+1)}\, \Sigma_a [C_{(a,y+1)}\, CW_{(a,y+1)}])\}^2 \qquad (9)$$

$CW_{(a,y)}$ 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 SSQvpa. 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

$$SSQ = SSQvpa + SSQcatches \qquad (10)$$

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.

Simulation testing of the ADAPT model

A data set derived from a simulated population and fishery was used to test the ADAPT model. The population consisted of 25 years and 15 ages with recruitment generated from a Beverton and Holt stock and recruit model with random noise. The fishery was simulated at constant annual fishing mortality (0.5) and a constant selection at age pattern throughout the time period used for extracting the fishery test data. Catch data was generated without error and a cpue data series for all ages and years generated with log-normal random noise at a standard error of 0.3; similar to the values estimated for the North Sea cod survey indices (ICES WGNSSK 2003).

CPUE data collected from the North Sea survey is available in the year of the assessment (one year after the final catch data year). Therefore in order to test the model with the inclusion of an extra survey year, the ADAPT model was fitted to 24 years of catch at age data and 25 years of survey data from the simulated series. Catch under-reporting biases of 17, 33, 0, 33, 50% were applied to the catches in years 20 – 24, the multipliers on catch required for recovery of the true landings were therefore 1.2, 1.5, 1.0, 1.5 and 2.0.

The ADAPT model was applied to the unbiased data set in order to test its ability to reconstruct the true population values in the absence of bias and then to the biased data sets with and without the smoothing of catches.

Results of testing with simulated data

Unbiased catch data

The estimates of population abundance and fishing mortality calculated using the unbiased test data set were consistent with the simulated populations. Only minor, unbiased differences between model estimates and true values were recorded. They result from the noise in the simulated cpue series.

Biased catch data with no catch smoothing, $\lambda = 0.0$

Tables 1 and 2 present the parameter estimates, their standard log errors and the variance covariance matrix of the parameter estimates. Note that the parameters are estimated on a log scale so that the standard errors are approximate coefficients of variation on the un-transformed scale. Figures 2 – 5 present the bootstrap percentile distributions for total landings, fishing mortality, SSB and bias with the true values and the values estimated without bias correction.

Biased catch data with catch smoothing, $\lambda = 1.0$

Tables 3 and 4 present the parameter estimates, their standard log errors and the variance covariance matrix of the logarithms of the estimates. Figures 6 – 9 present the bootstrap percentile distributions for total landings, fishing mortality, SSB and bias with the true values and the values estimated using the biased landings data. Figures 10 and 11 illustrate the log catchability residual pattern before and after fitting of the smoothed model, demonstrating the improvement in the model fit in the final five years.

Discussion of the simulation test results

The bias parameter estimates, plotted in Figures 5 and 9, have the correct trajectory as the simulated series and the true values lie within the bootstrap percentiles. Of the two most important management metrics, spawning stock biomass is the least affected by the under-reported landings. The assessment without bias correction estimates the terminal year SSB to be close to the true value; years behind the terminal year are underestimated. Fishing mortality is severely affected by underreported landings and if used with the relatively unbiased population numbers estimates would result in biased stock projections. Fitting the bias parameter within the model recovers the trajectory of the simulated fishing mortality time series and would result in projections that have more uncertainty and substantially less bias.

The Figures and Tables illustrate that under an assumption of constant catchability there is sufficient information within structure of the survey indices and the landings at age data to estimate the bias in the total landings. The models ability to estimate the parameters will be dependent on the level of random noise in the survey cpue series to which the model is fitted and the number of years in which the unbiased catch data coincides with the survey series. If the survey series only covers years with biased data the estimates of bias and catchability will be confounded and the model will be indeterminate.

Smoothing the total catch estimates results in an improved fit of the model to the simulated data. For this series of tests, the cpue data series were generated with random noise without structure. If simulated year effects in the survey data had been generated they would be confounded with the bias estimate and unless multiple survey series with independent year effects were available the estimation of bias may be more problematic and require a greater weight to applied to smoothing.

Fitting the model to the North Sea cod data

The ADAPT model was fitted to North Sea cod landings data for the years 1963 – 2003 and ages 1-7+. Survey data from the English groundfish survey (1992 – 2004, ages 1 – 6), the International Bottom Trawl Survey (1976 – 2004, ages 1 – 5) and the Scottish groundfish survey (1982 – 2004, 1ges 1 – 6). Surviving population numbers at ages 1 - 5 were estimated in 2004 with fishing mortality at age 6 in all years calculated as the average of ages 3 – 5.

Based on information from the commercial fishing industry bias parameters were estimated in the years 1993 – 2003. A smoothing weight of 1.0 was applied to the residuals between year of the log of total landings in tonnes, catchability residuals from each survey were given equal eight in the analysis. Catchability was assumed to be constant in time and independent of age for ages 1 – 5. Catchability at age 6 constrained to be equal to that at age 5.

Two of the survey series have a sufficient number of years in their time series of observations to enable catchabilities to be estimated during a period in which the landings were considered to be relatively unbiased, the IBTS and Scottish groundfish surveys. The majority of the time series of English groundfish survey indices lies within the time period in which bias is considered to have occurred. Therefore the EGFS will only provide information on the trends in the population abundance in recent years; its catchability estimates will be confounded with the estimates of bias.

Single survey runs

Figures 12 and 13 present the estimated bias and landings from a fit of the smoothed model to the Scottish groundfish survey data series and Figures 14 and 15 to the estimates from fitting to the IBTS survey series. The patterns in estimated bias are very similar, increasing after 1993 until 1997/1998 when the last strong year class arrived in the fishery, and then increasing again until 2003. Fits to both data series indicate that the latest reduction in TAC is unlikely to have been effective in reducing landings.

Fitting the model to all survey series simultaneously

Figures 16 – 18 present the reported and ADAPT estimated landings, the estimates of average fishing mortality at ages 2 – 4 and SSB from fits of the model with and without estimation of bias. Bootstrap percentiles are plotted for each times series. Figure 19 plots the estimates of bias with bootstrap percentiles.

Sensitivity to the smoothing constraint

Figure 20 illustrates the sensitivity of the time series of estimates of spawning stock biomass, average fishing mortality at ages 2 – 4 and estimated landings to the weight applied to the constraint in the year to year variation in landings within the smoothed objective function. The first row of figures illustrates the estimated values when no smoothing is applied, the second a smoothing weight of 1.0 and the final row a weight of 10.0. The smoothing parameter has the desired effect of reducing variation in the estimates between years with only a minor effect on the overall trends in the time series.

Retrospective analysis

Figures 21 - 23 present the retrospective analysis estimates of landings, SSB and average fishing mortality from retrospective runs back to the year 2000. There is no retrospective bias in the model results. Fishing mortality is more variable than the other estimated series.

Discussion of the application to the North sea cod data

The single and multi-fleet model fits are consistent in estimating increasing bias in the reported North Sea cod landings data from 1993. The landings were more consistent with the model estimates in 1997/98 a time when the strong 1996 year class recruited to the fishery. The estimates of bias and their trend in time are consistent with anecdotal reports from the commercial industry. There is no external information that can be used to validate the magnitude of the estimated bias.

Population estimates and hence spawning stock biomass in the final assessment year are relatively less biased than the preceding years. The difference is consistent with the findings of the simulation experiment and also with the known retrospective bias in SBB, that is a characteristic of the assessments of this stock that have been fitted to reported landings.

Fishing mortality is estimated to be severely biased in the most recent years. This is consistent with the WGNSSK's perception of the validity of fishing mortalities obtained from assessment models fitted to reported landings, which led to the rejection of the 2003 assessment estimates by that group.

The analysis of the sensitivity to the weight given to smoothing and the retrospective analysis demonstrate that the model estimates are robust to the assumption of smoothing and are consistent between assessment years with the addition of more data.

The simulation studies have established that an estimate of the level of the unbiased exploitation rate can be recovered from biased data using the modified ADAPT model. The estimates of bias are based on survey indices that can be affected by year effects and therefore confounded with the estimated bias. However, the estimates of bias are consistent between surveys, giving more credibility to the results.

The method provides a procedure by which, in the absence of information from other sources, potentially unbiased estimates of exploitation levels can be derived to make stock projections for the North Sea cod. There is greater uncertainty associated with the estimates but for management of the stock this is an improvement on the current uncertainty resulting from bias in the reported landings.

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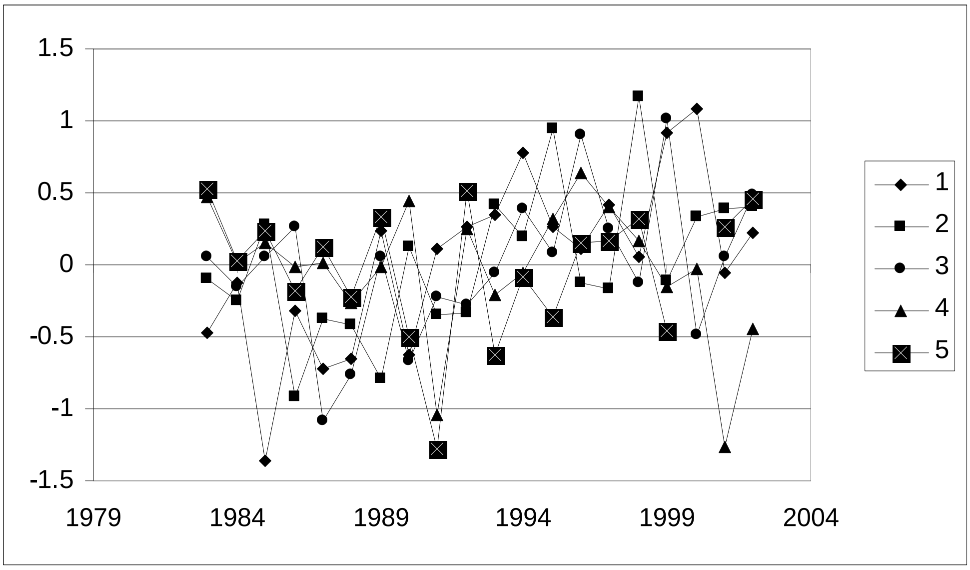

Figure 1a The log catchability residuals resulting from a fit of the Laurec-Shepherd VPA calibration model to the North Sea cod reported landings at age data set and the Scottish groundfish survey data for 1983 – 2003.

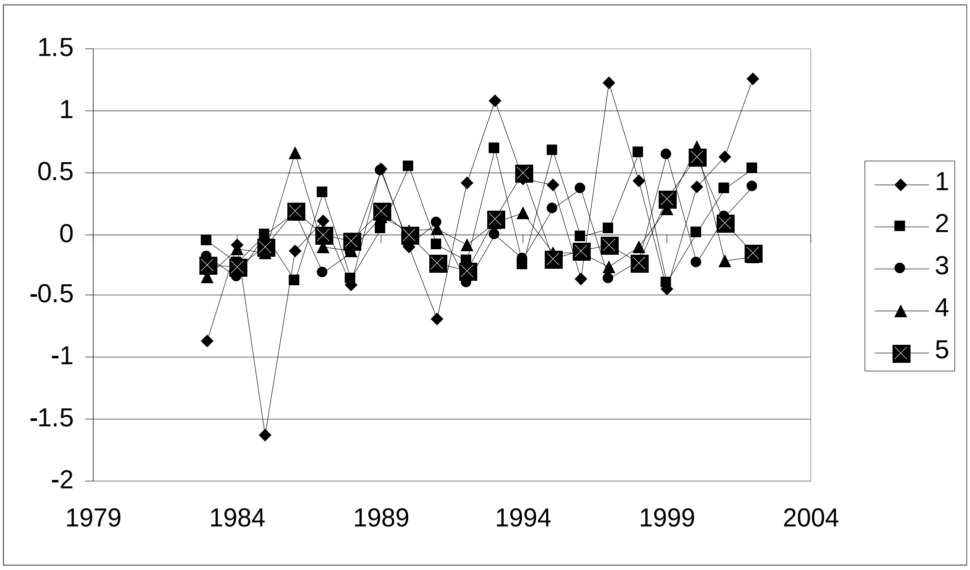

Figure 1b The log catchability residuals resulting from a fit of the Laurec-Shepherd VPA calibration model to the North Sea cod reported landings at age data set and the IBTS groundfish survey data for 1983 – 2003.

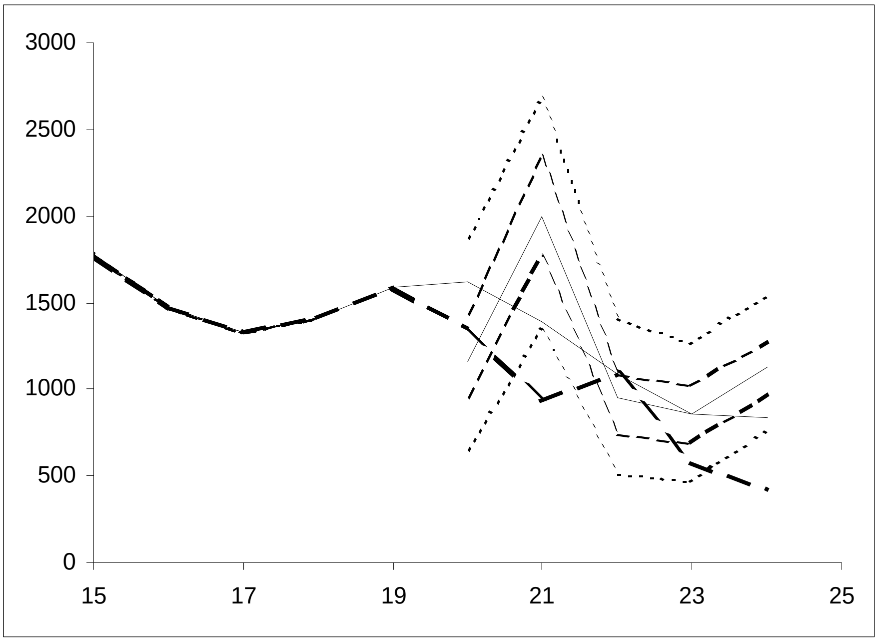

Figure 2 The percentiles (5,25,50,75,95) of estimated total catch from the ADAPT model applied without catch smoothing to the simulated data set. The solid line represents the true catch, the dashed solid line the reported biased catch.

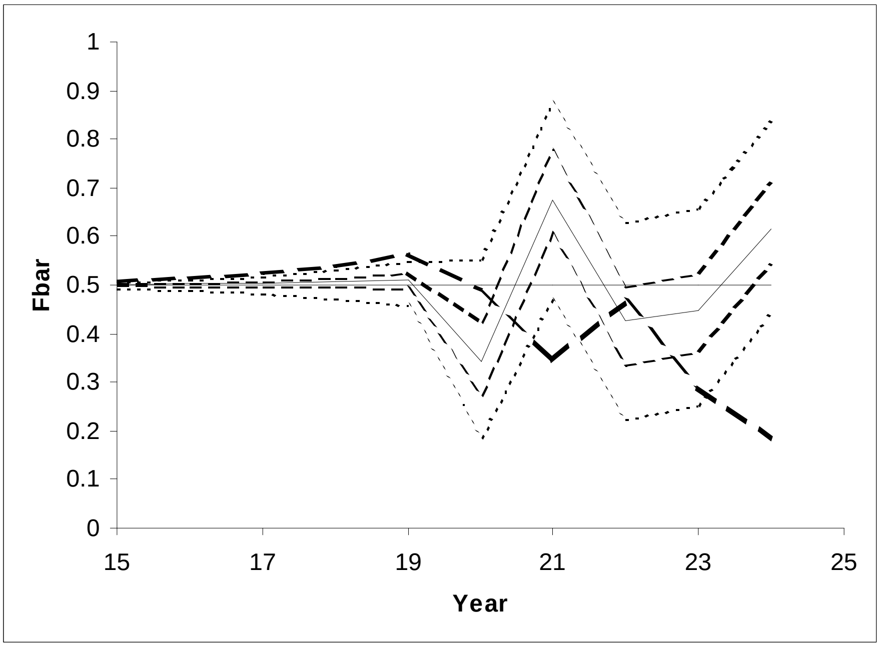

Figure 3 The percentiles (5,25,50,75,95) of the average fishing mortality estimates from the ADAPT model applied without catch smoothing to the simulated data set. The solid horizontal line represents the true mortality rate the descending dashed solid line the estimate of average mortality without assuming bias in the catch data.

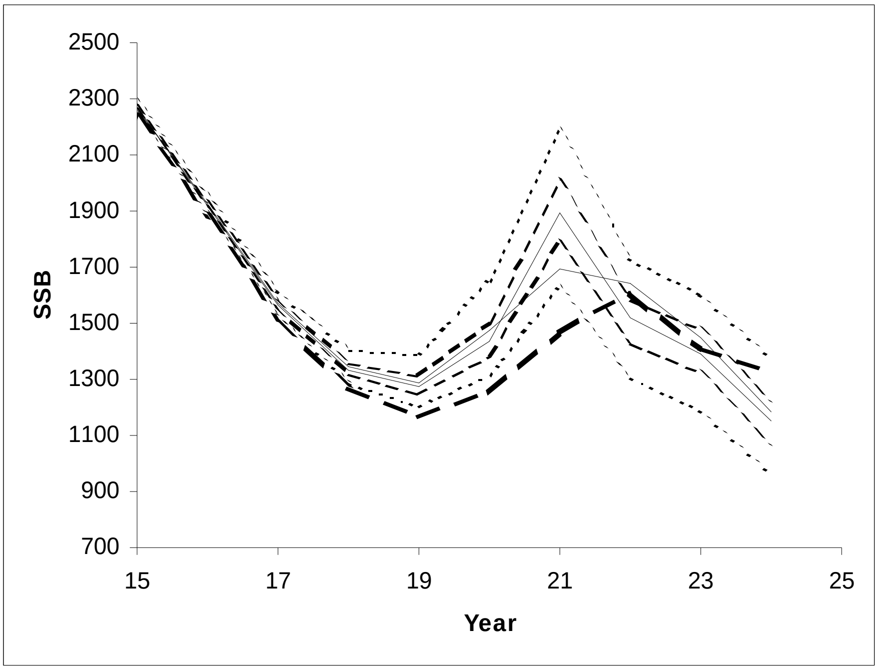

Figure 4 The percentiles (5,25,50,75,95) of the SSB estimates from the ADAPT model applied without catch smoothing to the simulated data set. The solid line represents the true SSB the dashed solid line the estimate SSB without assuming bias in the catch data.

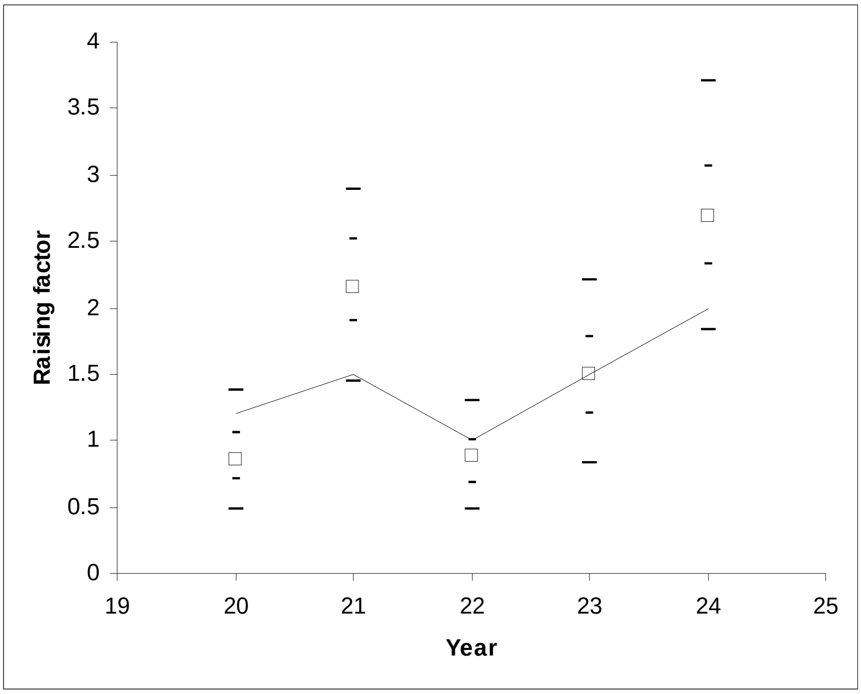

Figure 5 The percentiles (5,25,50,75,95) of the catch raising factor estimates from the ADAPT model applied without catch smoothing to the simulated data set. The solid line represents the true raising factor.

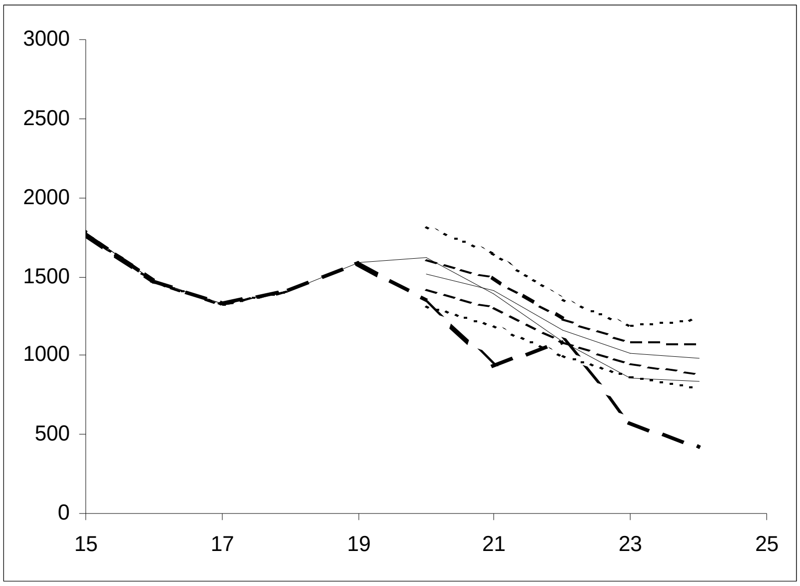

Figure 6 The percentiles (5,25,50,75,95) of estimated total catch from the ADAPT model applied with catch smoothing to the simulated data set. The solid line represents the true catch, the dashed solid line the reported biased catch.

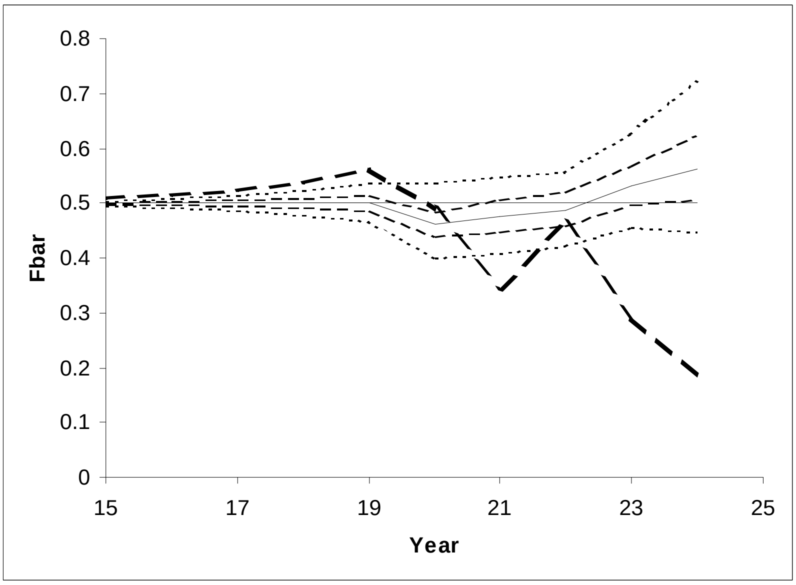

Figure 7 The percentiles (5,25,50,75,95) of the average fishing mortality estimates from the ADAPT model applied with catch smoothing to the simulated data set. The solid horizontal line represents the true mortality rate the descending dashed solid line the estimate of average mortality without assuming bias in the catch data.

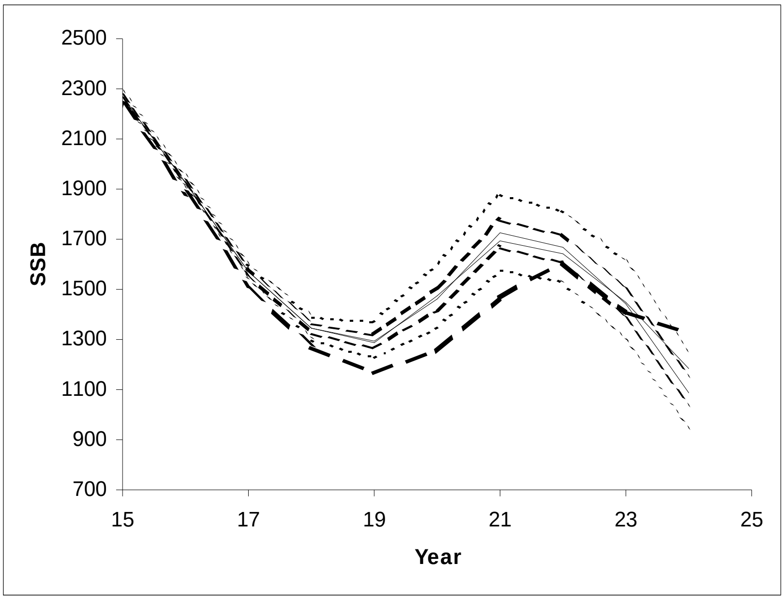

Figure 8 The percentiles (5,25,50,75,95) of the SSB estimates from the ADAPT model applied with catch smoothing to the simulated data set. The solid line represents the true SSB the dashed solid line the estimate SSB without assuming bias in the catch data.

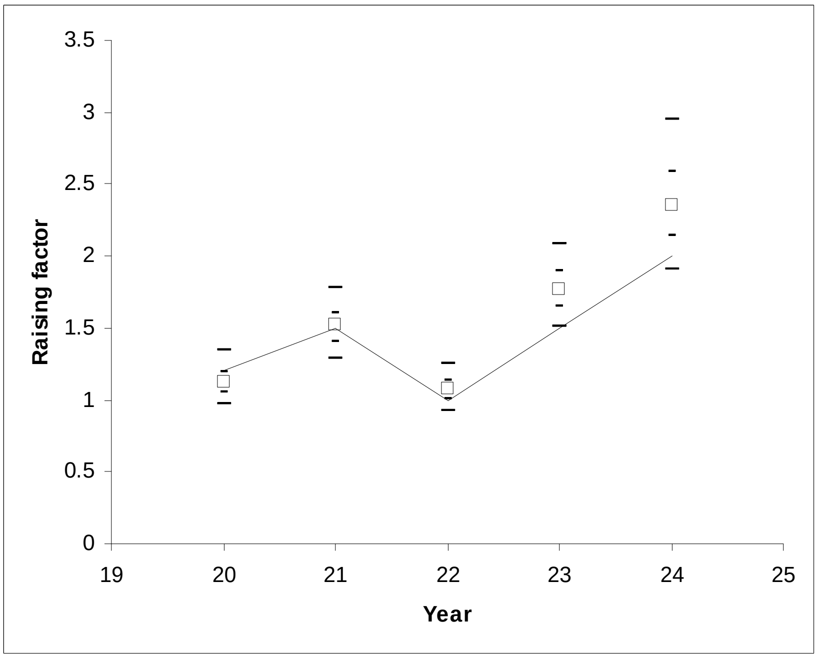

Figure 9 The percentiles (5,25,50,75,95) of the catch raising factor estimates from the ADAPT model applied with catch smoothing to the simulated data set. The solid line represents the true raising factor.

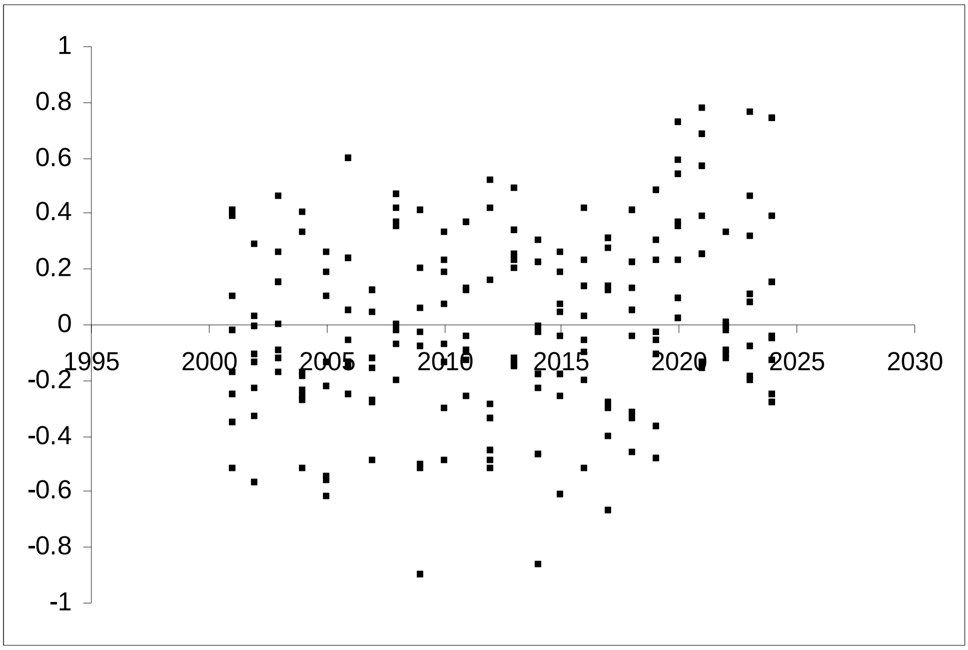

Figure 10 The log catchabilty residuals resulting from the fit of the ADAPT model, applied with catch smoothing, to simulated biased landings data (years 2020,21,23,24) without estimation of bias.

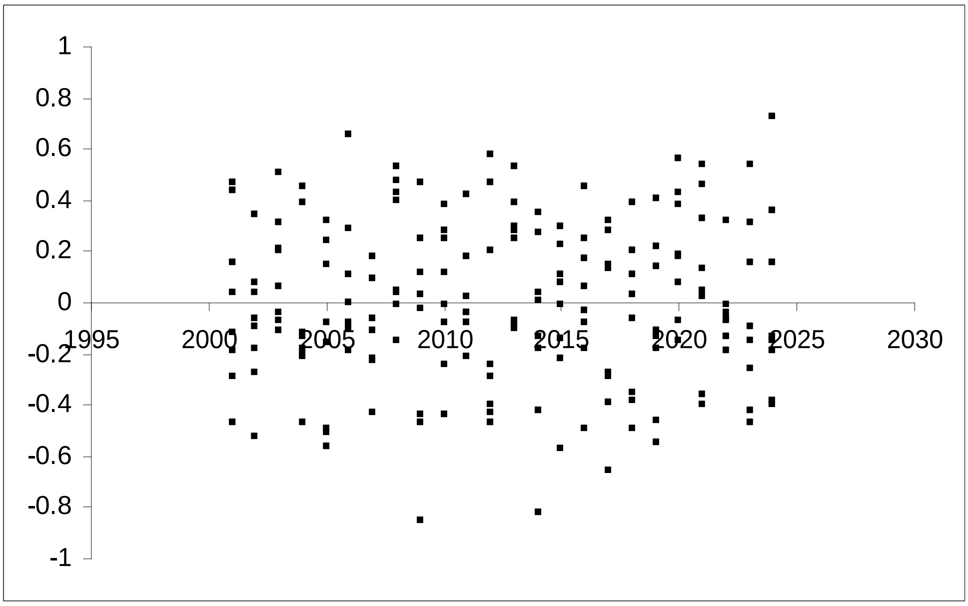

Figure 11 The log catchabilty residuals resulting from the fit of the ADAPT model to the simulated data set, applied with catch smoothing, to simulated biased landings data (years 2020,21,23,24) with estimation of bias.

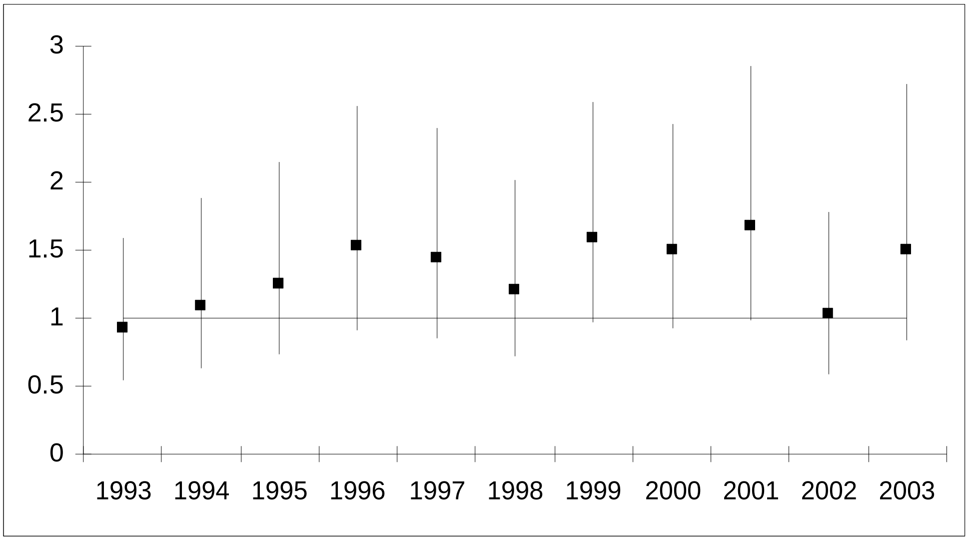

Figure 12 The bias (+/- 2 standard errors) in landings data for the North Sea cod (Ices areas 347d) as estimated by a modified ADAPT model fitted to reported landings at age and the Scottish groundfish survey cpue series.

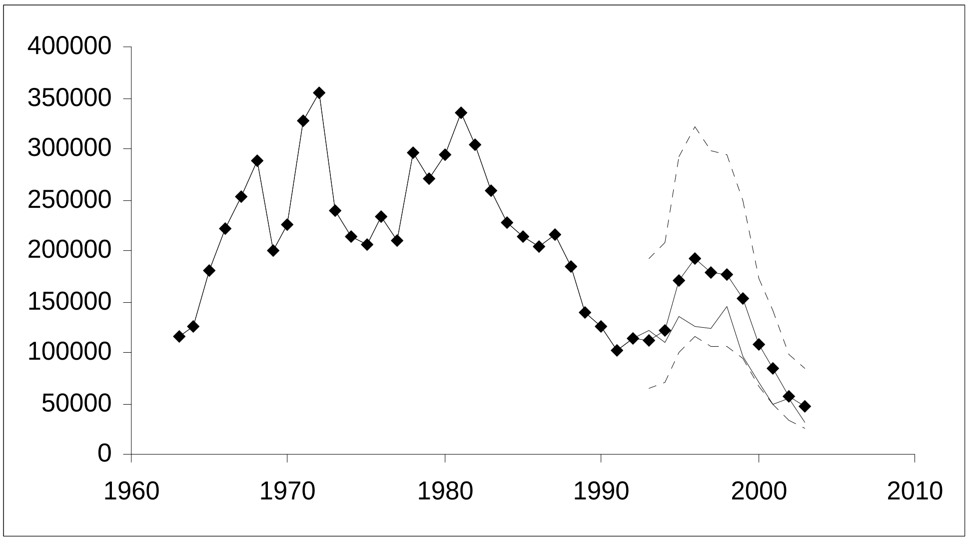

Figure 13 The reported landings data for the North Sea cod (Ices areas 347d, solid line) and landings as estimated (fine line, +/- 2 standardr errors) by a modified ADAPT model fitted to reported landings at age and the Scottish groundfish survey cpue series.

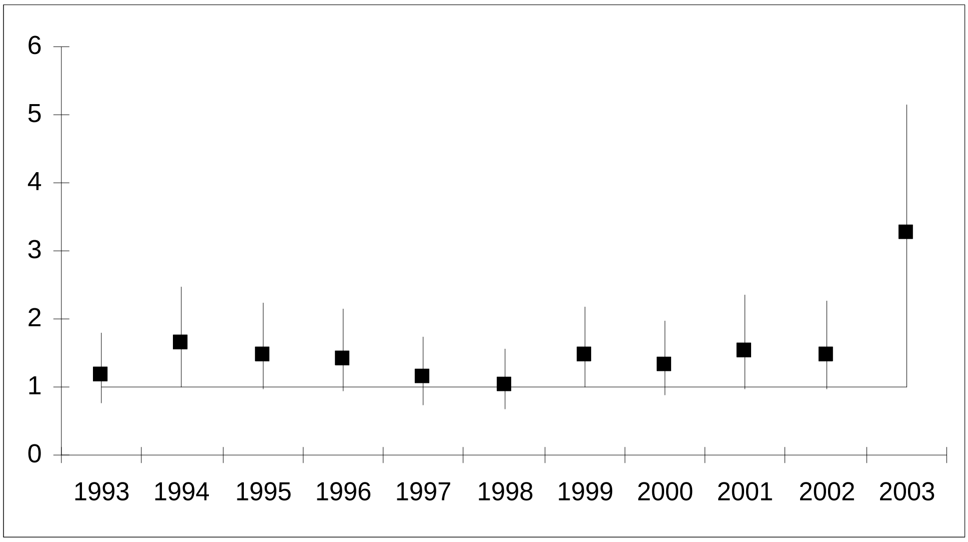

Figure 14 The bias (+/- 2 standard errors) in landings data for the North Sea cod (Ices areas 347d) as estimated by a modified ADAPT model fitted to reported landings at age and the IBTS groundfish survey cpue series.

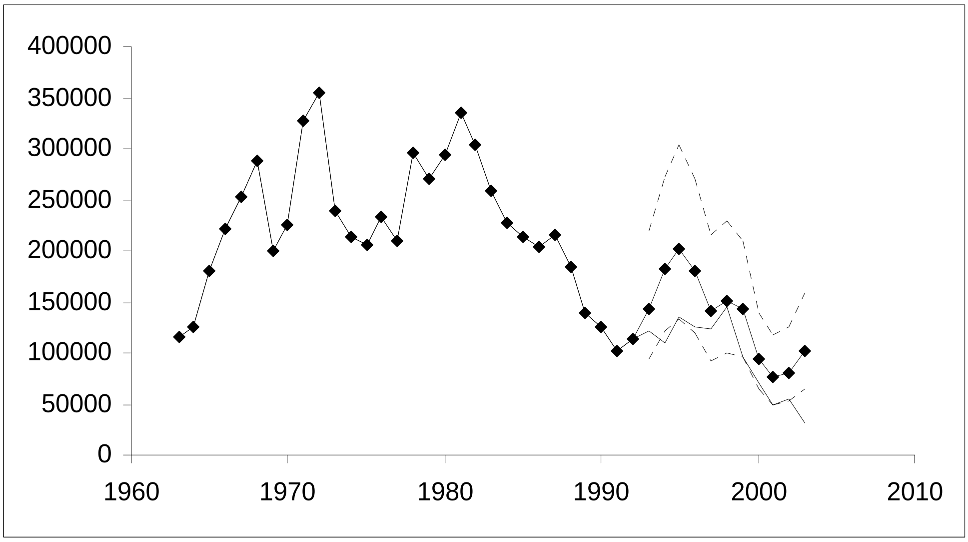

Figure 15 The reported landings data for the North Sea cod (Ices areas 347d, solid line) and landings as estimated (fine line, +/- 2 standardr errors) by a modified ADAPT model fitted to reported landings at age and the IBTS groundfish survey cpue series.

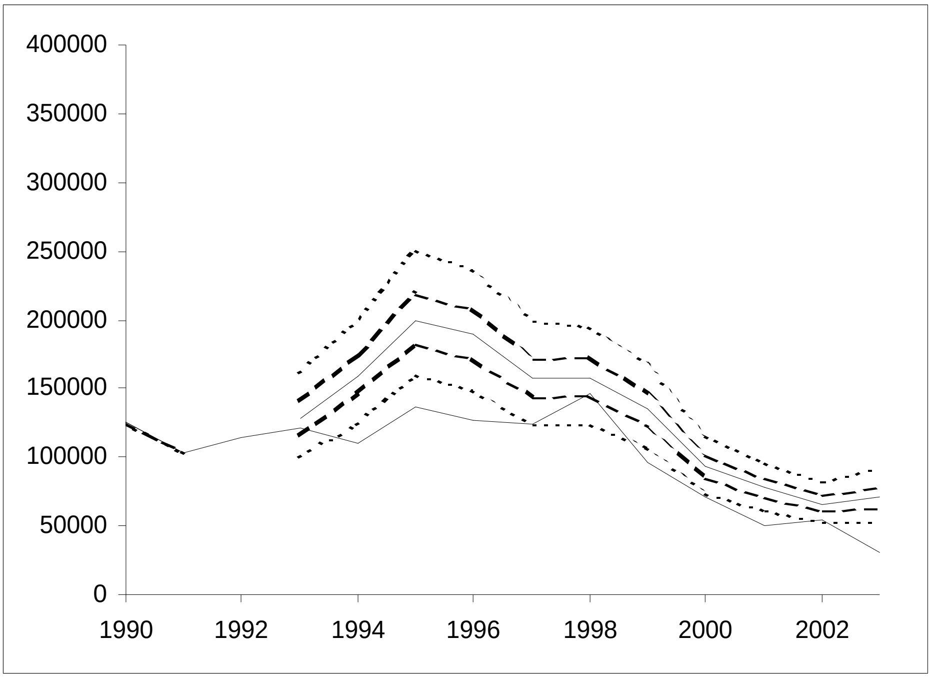

Figure 16 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The percentiles (5,25,50,75,95) of estimated cod in 347d total catch from the ADAPT model applied with catch smoothing to all survey series. The solid line represents the reported catch.

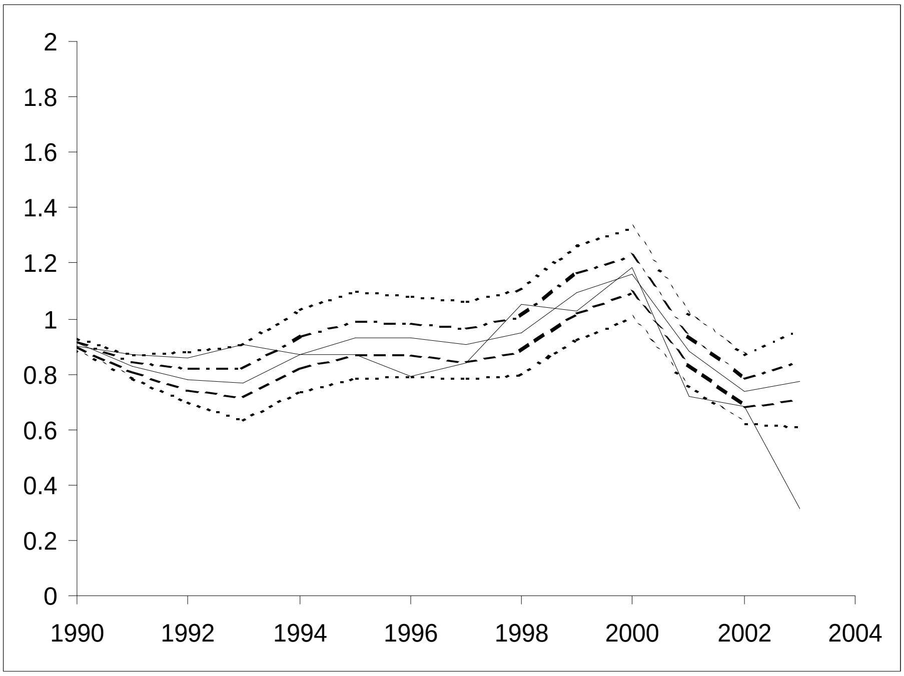

Figure 17 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The percentiles (5,25,50,75,95) of the cod in 347d average fishing mortality estimates from the ADAPT model applied with catch smoothing to all survey series. The solid horizontal line represents the estimate of average mortality without assuming bias in the catch data.

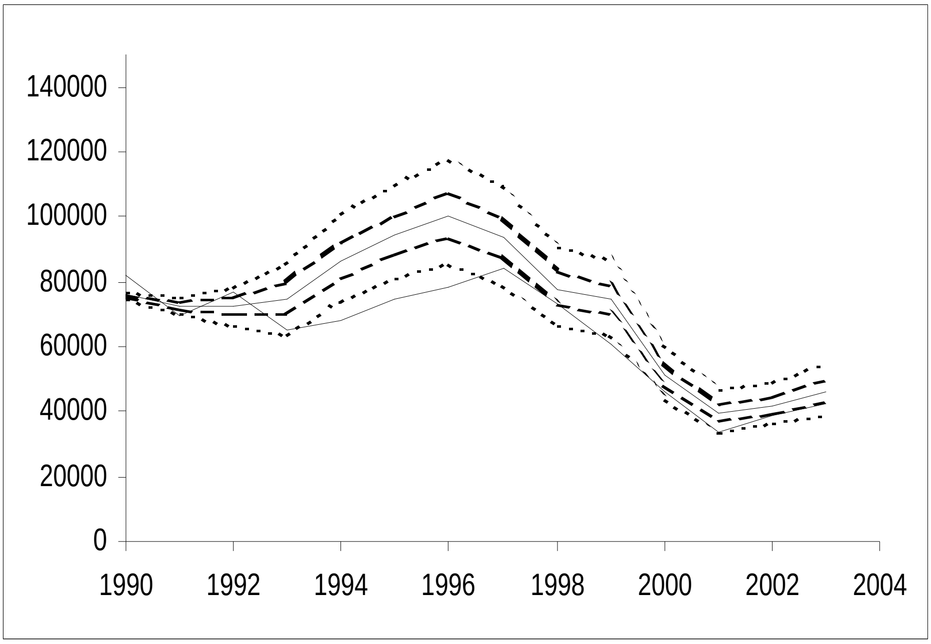

Figure 18 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The percentiles (5,25,50,75,95) of the cod347d SSB estimates from the ADAPT model applied with catch smoothing to all survey series. The solid line represents the estimate SSB without assuming bias in the catch data.

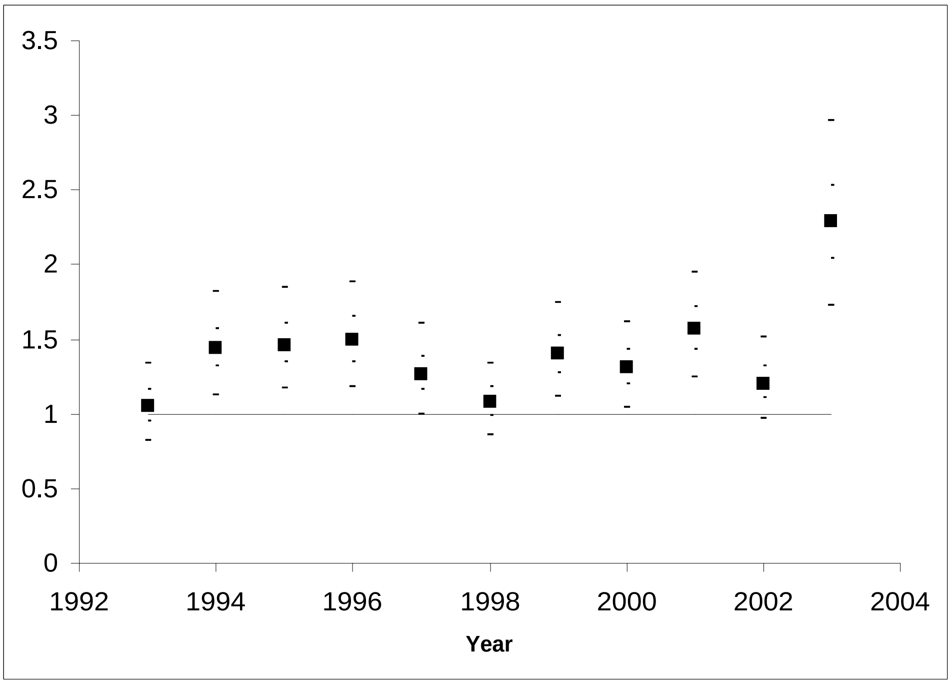

Figure 19 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The percentiles (5,25,50,75,95) of the cod 347d catch raising factor estimates from the ADAPT model applied with catch smoothing to all survey series. The solid line represents no bias.

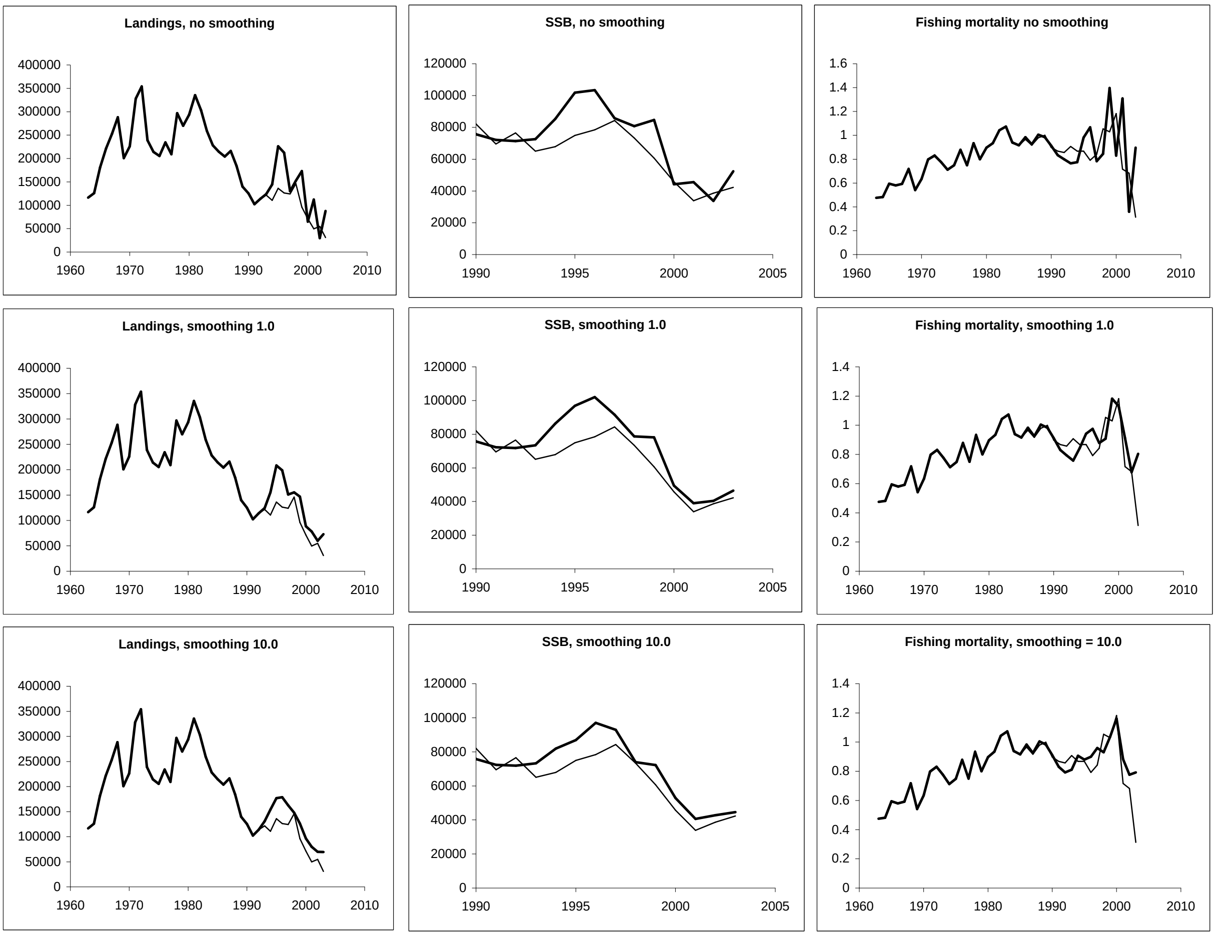

Figure 20 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The sensitivity of the estimates of landings, SSB and average fishing mortality (ages 2 – 4) to the weight given to the smoothing constraint on year to year variation on total landings. Solid line – estimates with estimation of missing landings, fine line - estimates without estimation of missing landings.

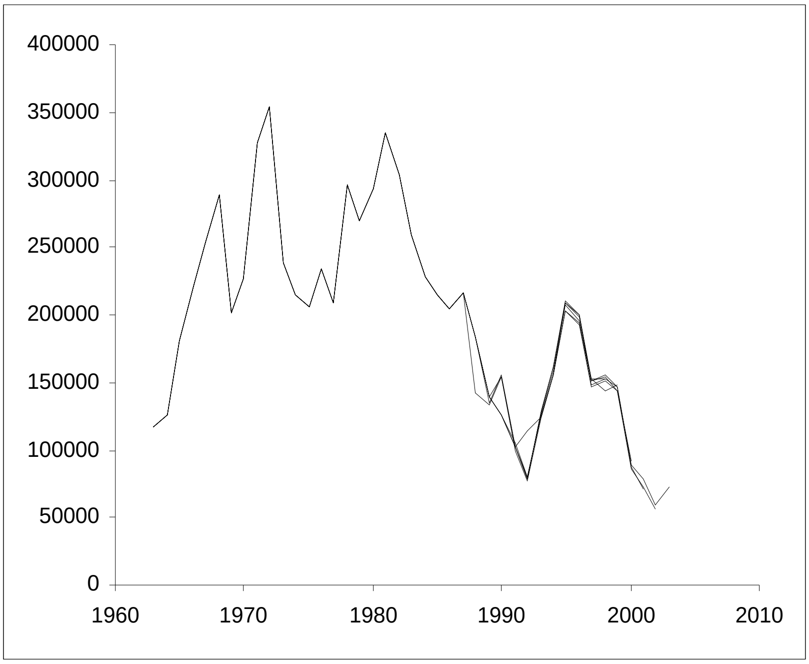

Figure 21 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Retrospective series of the total landings as estimated using the modified ADAPT model for assessment years finishing in 1998 – 2003 (without discards).

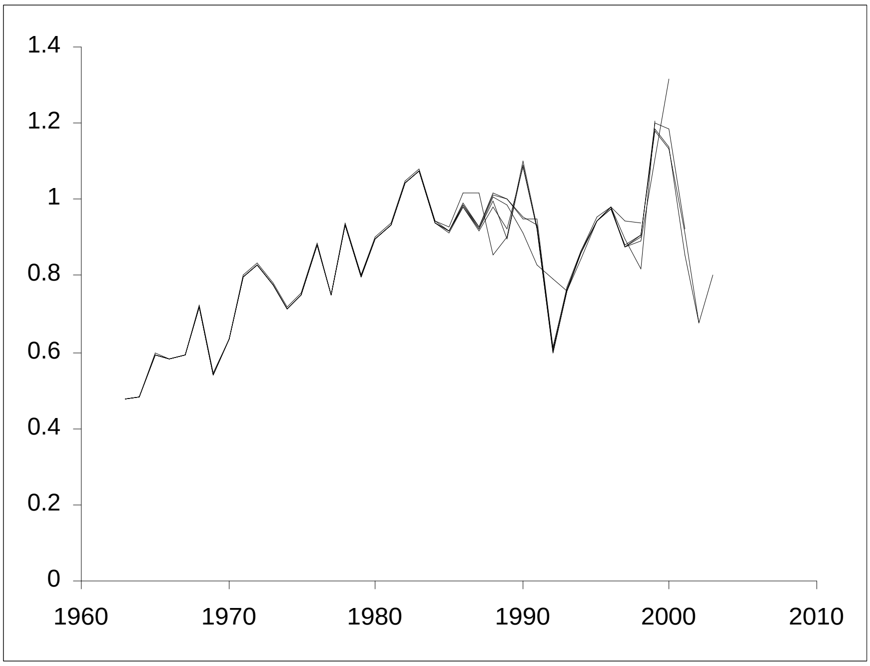

Figure 22 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Retrospective series of average fishing mortality as estimated using the modified ADAPT model for assessment years finising in 1998 - 2003 (without discards).

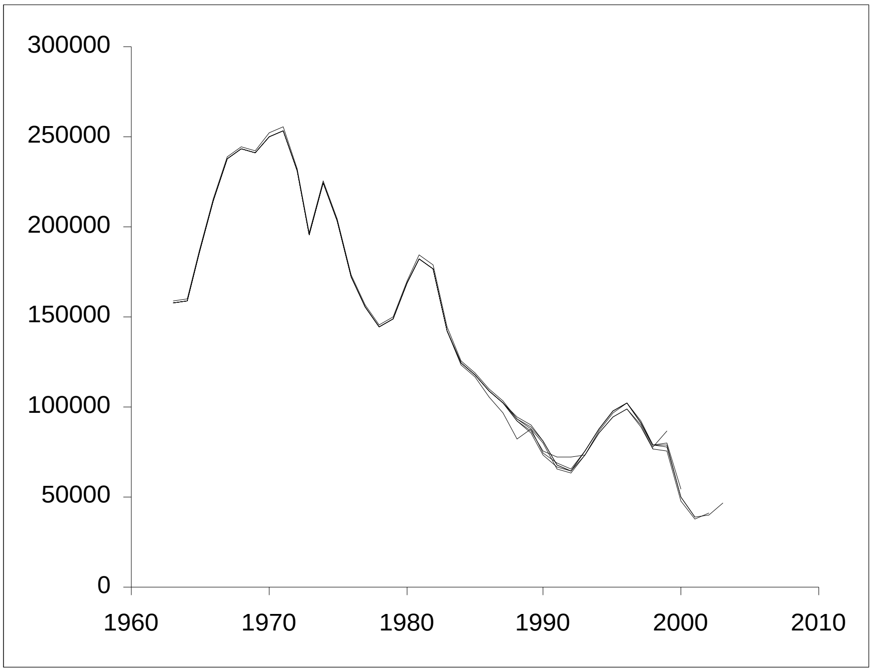

Figure 23 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Retrospective series of spawning stock biomass as estimated using the modified ADAPT model for assessment years finising in 1998 - 2003 (without discards).

Table 1 The estimated population numbers at age in the final year and catch data raising factors for the final 5 years of the simulated data with bias. The simulated raising factors were 1.2, 1.5, 1.0, 1.5, 2.0. The ADAPT model was applied without catch smoothing.

Parameter	Age	Survivors	s.e.log est
1	1	813.0	0.22
2	2	1267.5	0.19
3	3	762.9	0.19
4	4	349.1	0.21
5	5	48.8	0.24
6	6	42.9	0.24
7	7	23.1	0.26
8	8	67.0	0.24
9	9	32.4	0.25
10	10	8.5	0.26
11	11	3.1	0.26
12	12	0.6	0.27
13	13	0.6	0.26
14	14	0.8	0.26
Parameter	Year	Factor	s.e.log est
15	20	0.89	0.32
16	21	2.15	0.21
17	22	0.87	0.30
18	23	1.52	0.27
19	24	2.65	0.20

Table 2 The variance co-variance estimates from the ADAPT model applied without catch smoothing, parameter numbers refer to the parameters listed in Table 1.

Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	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	0.00	0.00
2	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	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	-0.01
5	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
6	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
7	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	-0.01
14	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	0.07	0.00	0.00	0.00	0.00	-0.01
15	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	0.10	-0.04	0.00	0.00	0.00
16	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	-0.04	0.04	-0.03	0.00	0.00
17	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	-0.03	0.09	-0.04	0.00
18	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	-0.04	0.08	-0.03
19	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	-0.03	0.04

Table 3 The estimated population numbers at age in the final year and catch data raising factors for the final 5 years of the simulated data with bias. The simulated raising factors were 1.2, 1.5, 1.0, 1.5, 2.0. The ADAPT model was applied with catch smoothing.

Parameter	Age	Survivors	s.e.log est
1	1	815.17	0.22
2	2	1272.92	0.19
3	3	770.62	0.18
4	4	357.43	0.21
5	5	48.86	0.24
6	6	42.76	0.24
7	7	23.26	0.26
8	8	66.84	0.24
9	9	32.79	0.25
10	10	8.56	0.26
11	11	3.16	0.26
12	12	0.65	0.27
13	13	0.57	0.26
14	14	0.84	0.26
Parameter	Year	Factor	s.e.log est
15	20	1.10	0.15
16	21	1.63	0.14
17	22	1.04	0.15
18	23	1.69	0.14
19	24	2.44	0.16

Table 4 The variance co-variance estimates from the ADAPT model applied with catch smoothing, parameter numbers refer to the parameters listed in Table 3.

Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	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	0.00	0.00
2	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
5	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
6	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
7	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	-0.01
14	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	0.07	0.00	0.00	0.00	0.00	-0.01
15	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	0.02	0.00	0.00	0.00	0.00
16	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	0.02	0.00	0.00	0.00
17	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	0.02	0.00	0.00
18	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	0.00	0.02	0.00
19	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.03

Table 5 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The estimated population numbers at age in the final year and landings data raising factors for the final 11 years. The ADAPT model was fitted with catch smoothing.

Parameter	Age	Survivors	s.e.log est
1	1	21854.38	0.21
2	2	25430.52	0.21
3	3	3659.71	0.23
4	4	5027.72	0.23
5	5	305.95	0.42
Parameter	**Year**	**Factor**	**s.e.log est**
6	1993	1.02	0.22
7	1994	1.40	0.20
8	1995	1.53	0.20
9	1996	1.57	0.20
10	1997	1.22	0.21
11	1998	1.06	0.20
12	1999	1.53	0.18
13	2000	1.24	0.19
14	2001	1.57	0.21
15	2002	1.09	0.23
16	2003	2.36	0.19

Table 6 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The variance co-variance estimates from the ADAPT model applied with catch smoothing, parameter numbers refer to the parameters listed in Table 5.

Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
2	0.00	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
3	0.00	0.00	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.06	-0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
5	0.00	0.00	0.01	-0.03	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
6	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
7	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
8	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
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.03	-0.01	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.05	-0.01
16	0.01	0.00	0.00	0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04

WORKING GROUP ON THE ASSESSMENT OF DEMERSAL STOCKS IN THE NORTH SEA AND SKAGERRAK

ICES Headquarters, 7 – 16 September 2004

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WORKING GROUP ON THE ASSESSMENT OF DEMERSAL STOCKS IN THE NORTH SEA AND SKAGERRAK

11-20 JUNE 2002

WORKING GROUP ON THE ASSESSMENT OF DEMERSAL STOCKS IN THE NORTH SEA AND SKAGERRAK

FINAL REPORT

WORKING GROUP ON THE ASSESSMENT OF DEMERSAL STOCKS IN THE NORTH SEA AND SKAGERRAK

TABLES AND FIGURES

WORKING GROUP ON THE ASSESSMENT OF DEMERSAL STOCKS IN THE NORTH SEA AND SKAGERRAK

WORKING DOCUMENTS

WGNSSK Quality Handbook

Stock specific documentation of standard assessment procedures used by the ICES WGNSSK.

1. HADDOCK IN THE NORTH SEA AND IIIA

Working group: WGNSSK

Version: 1.0

Updated: 10/09/2004, by: Martin Pastoors (martin.pastoors@wur.nl), Ewen Bell (ewen.d.bell@cefas.co.uk).

1.1 GENERAL

1.1.1 Stock definition

Haddock occur in many areas of the central and Northern North Sea and Skagerrak, and are prevalent as far south as the Humber estuary. They usually inhabit depths less than 200 metres. Results from tagging experiments and particle-tracking simulations suggest that there may also be links between the stocks of North Sea haddock and those to the north-west of Scotland. Spawning occurs from March until May and takes place in almost any area around the Scottish coasts to the Norwegian Deeps

1.1.2 Fishery

In the North Sea, haddock is taken as part of a mixed demersal fishery, with the large majority of the catch being taken by Scottish light trawlers, seiners and pair trawlers. Until 2001, these gears had a minimum legal mesh size of 100 mm, and smaller quantities were taken by other Scottish vessels, including *Nephrops* trawlers which used mesh sizes between 70 and 100mm mesh and hence may have had higher discard rates. New gear regulations were brought in for 2002 as a part of the North Sea cod recovery plan (Commission Regulation (EC) No 2056/2001). Vessels from other countries including England, Denmark and Norway also participate in the fishery, and haddock are also taken as a by-catch by Danish and Norwegian vessels fishing for industrial species. In Division IIIa, haddock are taken as a by catch in a mixed demersal fishery, and in the industrial fishery. Landings from Division IIIa are small compared to those the North Sea.

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

1.1.3 Ecosystem aspects

To be done

1.2 DATA

1.2.1 Commercial catch

Quarterly age composition data for the North Sea (Sub-area IV) human consumption landings were supplied by Denmark, England and Wales, France and Scotland. These nations accounted for 90% of the total human consumption landings. Sampling levels are given in Table 1.3.3.1**.** The procedures used to aggregate national data sets into total international landings are given in Section 1.3. Germany, Norway and Sweden provided quarterly landings, Belgium supplied annual age compositions, and the Faroe Islands, Poland and the Netherlands provided official landings statistics only. Industrial bycatch age compositions for the North Sea were supplied by Denmark and Norway. Age composition data for the human consumption and industrial catches in the Skagerrak (Division IIIa) in 2002 were supplied by Denmark, which accounts for most of the human consumption landings and all of the industrial bycatch in this area.

Discard estimates are derived by raising a mean discard proportion ogive from the Scottish sampling programme to the level of the international fleet landings. The Scottish discard programme follows a stratified random design, with fishing trips stratified by area, gear and quarter. Discards are estimated independently in each stratum and total discards are then estimated by summing across strata. Raising to landings is done for each individual trip. However, when there are few trips per stratum (often there is only one trip per stratum), this *traditional* estimator can be both biased and imprecise. Stratoudakis *et al* (1999) developed an alternative *ratio* estimator that collapses the stratification (i.e. combines strata with similar discard properties) and then estimates discards independently in each collapsed stratum. Total discards are then estimated by summing across collapsed strata. Collapsing strata has the effect of increasing the sample size in each stratum, and results in a collapsed ratio estimator that has negligible bias and greater precision than the traditional estimator. Work is underway to estimate cod, haddock and whiting discards in Sub-Area IV and Divisions VIId and IIIa using the collapsed ratio estimator, to compare these estimates with the traditional estimates, and to compare stock assessments using the two sets of discard estimates. It should also be noted that the method assumes that the Scottish fleet characteristics for haddock are applicable to the international fleet, which may be more tenable for haddock than for other species (given the large Scottish share of the catches). However, further evaluation work on this discard series will be beneficial. No estimates of discards are available for Division IIIa.

North Sea

Country	HC	Disc	Ind BC
Belgium	QL		-
Denmark	AC	AC	AC
France	QL		-
Germany	QL	AC	-
Netherlands	QL		-
Norway	QL		AC
Poland	OS		-
Sweden	QL		-
UK E+W	AC		-
UK Scotland	AC	AC	-

Skagerrak

Nation	HC	Disc	Ind BC
Belgium	QL		
Denmark	AC		
Germany	included in IV		
Norway	QL		
Sweden	QL	AC	

AC - Quarterly Age compositions *QL - Quarterly landings*
OS - Official statistics.

How are data aggregated; describe the Aberdeen programs.

1.2.2 Biological

Natural mortality

The values of natural mortality and proportion mature at age used in the assessment are unchanged from last year's meeting (**Table** 4.2.1). The estimates of natural mortality originate from MSVPA (ICES CM 1989/Assess:20). For roundfish, values of M are based on predation mortality estimated from MSVPA. They were first adopted by the Roundfish Working Group for the assessment of North Sea Cod, Haddock and Whiting in 1986 (ICES 1986b/Assess:??). The values adopted were means at age over 1980–1982 as given by the MSWG (Section 3.1.1, ICES 1986a/Assess:??).

Subsequently, the Roundfish Working Group reviewed the values in use at its 1987 meeting (ICES 1987b), based on the results of a key run in the 1986 MSWG (Table 2.8.2, ICES 1987a/Assess:??). These used mean total Ms over the years 1978– 1982. This review resulted in slight changes to the values used for Haddock and Whiting, but the values used for Cod were unchanged.

There was a further review by the Roundfish Working Group at its 1989 meeting (ICES 1990/Assess:??) which considered the values given by the 1989 MSWG (Table 2.8.2, ICES 1989). This used means over 1981–1986. As these values did not differ greatly from the values already in use by the Roundfish WG, the values were not changed.

Maturity

The estimates of proportion mature are based on IBTS data. Both natural mortality and maturity are assumed constant with time. Biomass totals are calculated as at the beginning of the year.

Weight at age

The mean weight-at-age data for the Division IIIa catches do not cover all years and for earlier years are not split by catch category, so only North Sea weight-at-age data have been used. Weight-at-age data from the total catch is calculated as a weighted average of the human consumption, discards and industrial bycatch in the North Sea. Weight at age in the stock is assumed to be the same as weight at age in the catch.

Proportion mortality before spawning

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

1.2.3 Surveys

Three research vessel survey series are available:

- Scottish third-quarter groundfish survey (ScoGFS): ages 0–8, years 1982–2003. Only ages 0–5 are used for tuning, as there are several missing data points at older ages and very low catch rates. This survey is undertaken during August each year using a fixed station design and the GOV trawl. Coverage was restricted to the northern part of the North Sea corresponding to the more northerly distribution of haddock, but since 1998 it has been extended into the central North Sea. There are two versions of the series available, the first with the new areas ignored to ensure consistent coverage, the second with the new areas included. The catch rates as presented are corrected for the change in vessel and gear, on the basis of comparative trawl haul data (Zuur *et al* 2001). Nevertheless, the series with consistent area definitions are used for the assessment.

- English third-quarter groundfish survey (EngGFS): ages 0–7, years 1977–2002. Only ages 0–5 are used for tuning, as catch rates for older ages are low. This survey covers the whole of the North Sea in August-September each year to about 200m depth, using a fixed station design of 75 standard tows and the GOV trawl from 1992 onwards. Prior to 1992 a different gear was used (WHICH) and therefore the series used in the assessment is truncated in 1992.

- International bottom-trawl survey (IBTS Q1): ages 1–6+, years 1967–2003. This survey covers the whole of the North Sea using fixed stations of at least two tows per rectangle with the GOV trawl. Previously this series covered only the years from 1982 onwards for ages 3–6+, and from 1973 onwards for ages 1–2. However, the methodology of the historical extension of the series has not been evaluated and is therefore not used in the assessment. The series is backshifted to the previous year and age so that the information collected in the spring of the current year can be used in the assessment.

1.2.4 Commercial CPUE

Two commercial Scottish CPUE series have been available in recent years for use in assessments of this stock, specifically light trawlers (ScoLTR) and seiners (ScoSEI). However, none have been used in the final assessment presented by the WG during any of its last three meetings, although they have been used in exploratory and comparative analyses. During preparations for the 2000 round of assessment WG meetings it became apparent that the 1999 effort data for the Scottish commercial fleets were not in accord with the historical series and specific concerns were outlined in the 2000 report of WGNSSK (ICES CM 2001/ACFM:07). Effort recording is still not mandatory for these fleets, and concerns remain about the validity of the historical and current estimates.

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

- Scottish seiners (ScoSEI): ages 0–13, years 1978–2002.

- Scottish light trawlers (ScoLTR): ages 0–13, years 1978–2002.

The definitions of these commercial fleets are the same as those given for the equivalent vessels fishing in Division VIa, which are given in the Report of the 1998 Working Group on the Assessment of Northern Shelf Demersal Stocks (ICES CM 1999/ACFM:1, Appendix 2).

1.2.5 Other relevant data

None.

1.3 HISTORICAL STOCK DEVELOPMENT

1.3.1 Deterministic modelling

Model used: XSA

Software used: Lowestoft VPA suite

Model Options chosen:

```
Tapered time weighting not applied

Catchability dependent on stock size for ages <    1
Regression type = C
Minimum of   5 points used for regression
Survivor estimates shrunk to the population mean for ages <  1
Catchability independent of age for ages >=    2

Survivor estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages.
S.E. of the mean to which the estimates  are shrunk =   2.000

Minimum standard error for population estimates derived from each fleet =    .300

Input data types and characteristics:
```

Type	Name	Year range	Age range	Variable from year to year Yes/No

Caton	Catch in tonnes	1963 – last data year	0-7+	Yes
Canum	Catch at age in numbers	1963 – last data year	0-7+	Yes
Weca	Weight at age in the commercial catch	1963 – last data year	0-7+	Yes (except for IIIa)
West	Weight at age of the spawning stock at spawning time.	1963 – last data year	0-7+	Yes. assumed to be the same as weight at age in the catch
Mprop	Proportion of natural mortality before spawning	1963 – last data year	0-7+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1963 – last data year	0-7+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1963 – last data year	0-7+	No – the same ogive for all years
Natmor	Natural mortality	1963 – last data year	0-7+	No – fixed values at age for all ages in all years

Tuning data:

Fleet	First,	Last,	First,	Last,	Alpha,	Beta
ENGGFS_	1992,	year-1,	0,	5,	.500,	.750
SCOGFS consistent area	1982,	year-1,	0,	5,	.500,	.750
IBTS_Q1 backshifted	1975,	year-1,	0,	4,	.990,	1.000

Fbar is calculated over ages 2-4.

1.3.2 uncertainty analysis

Scenario analysis using Fishlab excel spreadsheet where alternative structural model assumptions can be explored.

1.3.3 Retrospective analysis

Retrospective analysis using Fishlab excel spreadsheet with diminishing tuning series (cut off final years)

1.4 SHORT-TERM PROJECTION

Model used: Age structured

Software used: Excel.

Initial stock size. Taken from the XSA survivors for age 1 and older.

Recruitment: The short-term geometric mean recruitment for the years 2000 and beyond. The GM is used for all recruitments in the forecast.

Natural mortality: same vector as in assessment.

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Determined as the average from the three catch components (human consumption, discard and industrial by-catch, weighted by their proportions in the catch.

Weight at age in the catch: The relatively slow growth of the large 1999 yearclass is highly inflential to the short term forecast. Reduced weight at age remains an issue only in the human consumption landings. Catch weights for the '99 year class in the discard and industrial by-catch components remain within the bounds of previously observed weights. Weight at age in the human consumption fishery was modelled as an exponential function of age. The formulation is as follows.

$y = 1 / (1 + \exp(a - bx))$

where y is weight in kg at age x for the '99 yearclass.

Exploitation pattern: Average of the three last years, scaled by the Fbar (2-4) to the level of the last year. Exploitation patterns for the different catch components (human consumption, discards and industrial bycatch) calculated based on the relative catch by component (partial F at age).

Intermediate year assumptions: 0.9*Fstatus quo to reflect reductions in the main fleets targetting haddock and the restrictive management measures in 2004. Multipliers on $\mathbf{F}_{sq}$ refer to human consumption and discard partial fishing mortality only. By-catch F is assumed constant at 0.017.

Stock recruitment model used: Not used

Procedures used for splitting projected catches: The landings in Division IIIa are calculated the long-term average of the Division IIIa (human consumption) landings expressed as a percentage of the combined IIIa–IV (human consumption) landings (1963-last year). The percentage of 1963-2003 was 3.4%.

1.5 MEDIUM-TERM PROJECTIONS

The recruitment dynamics of haddock (with occasional large year-classes) are very uncertain, and future recruitment cannot be projected with any confidence. This means that a medium-term projection for haddock on the basis of the current assessment is unlikely to be informative, and no such projection is presented.

If a stock recruitment curve is used, the Beverton-Holt type is applied.

1.6 LONG-TERM PROJECTIONS, YIELD PER RECRUIT

to be specified

1.7 BIOLOGICAL REFERENCE POINTS

1.8 OTHER ISSUES

None.

1.9 REFERENCES

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Zuur, A.F., Fryer, R.J. and Newton, A.W. 2001. The comparative fishing trial between *Scotia* II and *Scotia* III. FRS Marine Laboratory, Report No 03/01.

ICES 1999. Report of the Working Group on the Assessment of Northern Shelf Demersal Stocks, 1998. ICES CM 1999/ACFM:1

ICES 2001. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, October 2000. ICES CM 2001/ACFM:7.

WGNSSK Quality Handbook

Stock specific documentation of standard assessment procedures used by the ICES WGNSSK.

1. PLAICE IIIA

Working group: North Sea Demersal Working Group

Updated: 15/09/2003

By: Clara Ulrich-Rescan

1.1 General

1.1.1 STOCK DEFINITION

The stock boundaries are arbitrary and more for management purposes than based on a biological recognised stock separation. Electrophoresis and meristic character indicated that the plaice in IIIa is a mixed population of the Kattegat and the Skagerrak component, which is dominating and a Belt Sea component (Simonsen et al., 1988).

The influence of the North Sea stock component, especially via the transport of eggs or larvae could also contribute to the IIIa plaice stock abundance (see Ecosystem aspects).

1.1.2 FISHERY

The fishery is dominated by Denmark, with Danish landings usually accounting for more than 90% of the total. from spring to autumn by Danish seiners, flatfish gillnetters and beam trawlers. Plaice is also caught within a mixed cod-plaice fishery by otter trawlers, and is a bycatch of other gillnet fisheries .Plaice is also caught as by-catch in the directed Nephrops fishery. Since 1978, landings have declined from 27 000 to 9 000 tonnes in the late nineties. However, landings in 2001 were the highest since 1992. The fishery exploits traditionally three age classes (ages 4 to 6). The TAC is usually not restrictive.

The use of beam trawl in the Kattegat is prohibited, but allowed in the Skagerrak. Minimum mesh size is 90 mm for towed gears, and 100 mm for fixed gears. The minimum landing size is 27 cm. Danish fleets are prohibited to land females in area IIIa from january 15th to april 30th.

1.1.3 ECOSYSTEM ASPECTS

The large scale circulation pattern in the Northern Kattegat depends mainly on interaction between Baltic runoffs and local variation due to wind stress. Nielsen et al., (1998) demonstrated that the abundance of settled 0-group plaice along the Danish coast of the Kattegat depends on transport from the Skagerrak. The 0-group abundance measured in July-August was significantly higher in years when wind conditions during the larval development period (March-April) were moderate to strong. This might imply that larval plaice are food-limited in years when calm conditions prevail during the larval drift period (Nielsen et al., 1998).

1.2 Data

1.2.1 COMMERCIAL CATCH

ICES official landings are available from Belgien, Norway and Germany, and national statistics are available from Denamrk, Sweden and the Netherlands. The age-disaggregated indices were derived by merging logbook statistics supplying catch weight per market category with the age distribution within these categories available from the market sampling. Catch-at-age and mean weight-at-age in the catch information were traditionally provided by Denmark only. For 2003 data were also provided by Sweden.The sampling scheme is broken down by quarter, landing harbours, and fishing area. The total international catches-at-age have been estimated for Kattegat and Skagerrak separately since 1984.

1.2.2 BIOLOGICAL

Weights-at-age in the stock were assumed equal to those of the catch.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

A fixed natural mortality of 0.1 per year was assumed for all years and ages.

A knife-edge maturity distribution was employed: age group 2 was assumed to be immature, whereas age 3 and older plaice were assumed mature.

1.2.3 SURVEYS

Data from four surveys are available. IBTS survey data for Kattegat and Skagerrak for the first and third quarter are provided by Sweden as numbers-per-age and hour on a haul-by-haul basis for the period 1991–2004and 1995-2003 respectively (no survey was performed in third quarter 2000). Two Danish bottom trawl surveys (‘KASU’) are conducted by the vessel ‘Havfisken’ in Kattegat, Belt Sea, and Western Baltic in the first and fourth quarter of each year. The indices available from these surveys cover the period 1996-2004 for the first quarter survey (except 1998), and 1994-2003 for the fourth quarter survey. The survey indices of the IBTS and KASU surveys first quarter is shifted from February to the preceding December to allow for full use of the available data.

Very few plaice aged 7 9 are caught during the surveys and these ages are removed from the analysis.

1.2.4 COMMERCIAL CPUE

Three Danish fleets, i.e., trawlers, gillnetters, and Danish seiners, are available. The age-disaggregated indices were derived by merging logbook statistics supplying catch weight per market category with the age distribution within these categories available from the market sampling. Fishing effort has been defined as standardised days fishing. The standardisation of effort by vessel length is obtained by modelling Log-CPUE using a GLM approach, with (Log-) vessel length (continuous variable), year (discrete variable) and quarter (discrete variable) taken as external factors. A 15 m vessel is used as the reference fishing unit. The fishing effort appears to have been fairly stable over the last decade. There has been a decrease in the fishing effort of towed-geared fleets since 1990, but this trend has been reversing since 1998. The fishing effort of gillnetters has steeply increased over 1990-1994, and steadily decreased since then. All commercial fleets show increase in both the yield and the CPUE in 2001. Highest values and increases are observed for the Danish seiners.

1.2.5 OTHER RELEVANT DATA

None.

1.3 Historical Stock Development

1.3.1 DETERMINISTIC MODELLING

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting applied, power = 3 over 20 years

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 8

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

S.E. of the mean to which the estimate are shrunk = 0.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1978 – last data year	2 – 11+	Yes
Canum	Catch at age in numbers	1978 – last data year	2 – 11+	Yes
Weca	Weight at age in the commercial catch	1978 – last data year	2 – 11+	Yes
West	Weight at age of the spawning stock at spawning time.	1978 – last data year	2 – 11+	Yes/No - assumed to be the same as weight at age in the catch
Mprop	Proportion of natural mortality before spawning	1978 – last data year	2 – 11+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1978 – last data year	2 – 11+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1978 – last data year	2 – 11+	No – the same ogive for all years
Natmor	Natural mortality	1978 – last data year	2 – 11+	No – set to 0.1 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Danish Gillnetters	1987 – last data year	2 – 11+
Tuning fleet 2	Danish Trawlers	1987 – last data year	2 – 11+
Tuning fleet 3	Danish seiners	1987 – last data year	2 – 11+
Tuning fleet 4	IBTS Q1	1991 – last data year	1 – 6
Tuning fleet 5	KASU Q4	1994 – last data year	1 – 6
Tuning fleet 6	KASU Q1	1995 – last data year	1 – 5
Tuning fleet 6	IBTS Q3	1995 – last data year	1 – 6

1.3.2 UNCERTAINTY ANALYSIS

1.3.3 RETROSPECTIVE ANALYSIS??

1.4 Short-Term Projection

Model used: Age structured

Software used: WGFRANSW

Initial stock size. Stock sizes for age 3 and older are taken from the estimated number of survivors from the XSA. The age 2 recruitments are taken as the geometric average over the entire period.

Natural mortality: Set to 0.1 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Assumed to be the same as weight at age in the catch

Weight at age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years, scaled by the Fbar (3-6) to the level of the last year

Intermediate year assumptions: TAC constraint

Stock recruitment model used: None, the long term geometric mean recruitment at age 2 is used

Procedures used for splitting projected catches: Not relevant

WGNSSK Quality Handbook

Stock specific documentation of standard assessment procedures used by the ICES WGNSSK.

1. EASTERN CHANNEL PLAICE (PLE-ECHE)

Working group: North Sea Demersal Working Group

Updated: 5/9//2003

By: Richard Millner (r.s.millner@cefas.cu.uk) and Joel Vigneau (joel.vigneau@ifremer.fr)

1.1 General

1.1.1 STOCK DEFINITION

There is mixing of plaice between the North Sea and VIId both as adults and juveniles. Analysis of tagging data shows that around 40% of the juvenile plaice in VIId come from nursery grounds in the North Sea. The eastern Channel supplies very few recruits to the North Sea. There is also an adult migration between the North Sea and Channel with 20-30% of the plaice caught in the winter in VIId were from migratory North Sea fish. Separation between VIId and the western Channel (VIIe) is much clearer. VIId does not receive significant numbers of juvenile plaice from VIIe but contributes around 20% of the recruits to VIIe. Similarly, around 20% of the adult plaice spawning in VIId may have spent part of the year in VIIe but few plaice tagged in VIIe during the spawning period are recaptured in VIId. It can be concluded that there is considerable interchange of plaice from the North Sea into VIId but a much smaller interchange between VIId and VIIe. Since the exploitation patterns between the three areas are very different, it has been concluded that separate assessments should be carried out.

The management area for channel plaice is a combined one between VIId and VIIe. TACs are obtained by combining the agreed TAC from each area.

1.1.2 FISHERY

Plaice is mainly caught in beam trawl fisheries for sole or in mixed demersal fisheries using otter trawls. There is also a directed fishery during parts of the year by inshore trawlers and netters on the English and French coasts. The main fleet segments are the English and Belgian beam trawlers. The Belgian beam trawlers fish mainly in the 1st and 4th quarters and their area of activity covers almost the whole of VIId south of the 6 mile contour from the English coast. There is only light activity by this fleet between April and September. The second offshore fleet is mainly large otter trawlers from Boulogne, Dieppe and Fecamp. The target species of these vessels are cod, whiting, plaice mackerel, gurnards and cuttlefish and the fleet operates throughout VIId. The inshore trawlers and netters are mainly vessels <10m operating on a daily basis within 6 miles of the coast. There are a large number of these vessels (in excess of 400) operating from small ports along the French and English coast. These vessels target sole, plaice, cod and cuttlefish.

The minimum landing size for plaice is 27cm. Demersal gears permitted to catch plaice are 80mm for beam trawling and 100mm for otter trawlers. Fixed nets are required to use 100mm mesh since 2002 although an exemption to permit 90mm has been in force since that time.

There is widespread discarding of plaice, especially from beam trawlers. The 25 and 50% retention lengths for plaice in an 80mm beam trawl are16.4cm and 17.6cm respectively which are substantially below the

MLS. Routine data on discarding is not available but comparison with the North Sea suggests that discarding levels in excess of 40% by weight are likely. Discard survival from small otter trawlers can be in excess of 50% (Millner et al., 1993). In comparison discard mortality from large beam trawlers has been found to be between less than 20% after a 2h haul and up to 40% for a one-hour tow (van Beek et al 1989).

1.1.3 ECOSYSTEM ASPECTS

No information is available.

1.2 Data

1.2.1 COMMERCIAL CATCH

The landings are taken by three countries France (55% of combined TAC), England (29%) and Belgium (16%). Quarterly catch numbers and weights were available for a range of years depending on country; the availability is presented in the text table below. Levels of sampling prior to 1985 were poor and these data are considered to be less reliable. In 2001 international landings covered by market sampling schemes represented the majority of the total landings.

1.2.1.1 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.

1.2.1.2 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.

1.2.1.3 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.

1.2.1.4 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**.

1.2.2 BIOLOGICAL

Natural mortality was assumed constant over ages and years at 0.1 as in the North Sea. 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.

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.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

1.2.3 SURVEYS

A dedicated 4m beam trawl survey for plaice and sole has been carried out by England using the RV Corystes since 1988. The survey covers the whole of VIId and is a depth stratified survey with most samples allocated to the shallower inshore stations where the abundance of sole is highest. In addition, inshore small boat surveys using 2m beam trawls are undertaken along the English coast and in a restricted area of the Baie de Somme on the French coast. In 2002, The English and French Young Fish Surveys were combined into an International Young Fish Survey. The dataset was revised for the period back to 1987. The two surveys operate with the same gear (beam trawl) during the same period (September) in two different nursery areas. Previous analysis (Riou *et al*, 2001) has shown that asynchronous spawning occurs for flatfish in Division VIId. Therefore both surveys were combined based on weighting of the individual index with the area nursery surface sampled. Taking into account the low, medium, and high potential area of recruitment, the French YFS got a weight index of 55% and the English YFS of 45%.

A third survey consists of the French otter trawl groundfish survey (FR GFS) in October. Prior to 2002, the abundance indices were calculated by splitting the survey area into five zones, calculating a separate index for each zone each zone, and then averaging to obtain the final GFS index. This procedure was not thought to be entirely satisfactory, as the level of sampling was inconsistent across geographical strata. A new procedure was developed based on raising abundance indices to the level of ICES rectangles, and then by averaging those to calculate the final abundance index. Although there are only minor differences between the two indices, the revised method was used in 2002 and subsequently.

1.2.4 COMMERCIAL CPUE

Three commercial fleets have been used in tuning. UK inshore trawlers, Belgian beam trawl fleet and French otter trawlers as well as three survey fleets.
The effort of the French otter trawlers is obtained by the log-books information on the duration of the fishing time weighted by the engine power (in KW) of the vessel. Only trips where sole and/or plaice have been caught is accounted for.

1.2.5 OTHER RELEVANT DATA

None.

1.3 Historical Stock Development

1.3.1 DETERMINISTIC MODELLING

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:
Tapered time weighting not applied
Catchability independent of stock size for all ages
Catchability independent of age for ages >= 7
Survivor estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages
S.E. of the mean to which the estimate are shrunk = 0.500
Minimum standard error for population estimates derived from each fleet = 0.300
Prior weighting not applied

Input data types and characteristics:

Catch data available for 1982-present year. However, there was no French age compositions before 1986 and large catchability residuals were observed in the commercial data before 1986. In the final analyses only data from 1986-present were used in tuning

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1980 – last data year	2 – 10+	Yes
Canum	Catch at age in numbers	1980 – last data year	2 – 10+	Yes
Weca	Weight at age in the commercial catch	1980 – last data year	2 – 10+	Yes
West	Weight at age of the spawning stock at spawning time.	1980 – last data year	2 – 10+	Yes - assumed to be the weight at age in the Q1 catch
Mprop	Proportion of natural mortality before spawning	1980 – last data year	2 – 10+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1980 – last data year	2 – 10+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1980 – last data year	2 – 10+	No – the same ogive for all years
Natmor	Natural mortality	1980 – last data year	2 – 10+	No – set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	English commercial Inshore trawl	1985 – last data year	2 – 10
Tuning fleet 2	Belgian commercial Beam trawl	1981 – last data year	2-10
Tuning fleet 3	French trawlers	1989 – last data year	2 - 10
Tuning fleet 4	English BT survey	1988 – last data year	1 – 6
Tuning fleet 5	French GFS	1988 – last data year	1 - 5
Tuning fleet 6	International YFS	1987 – last data year	1 - 1

1.3.2 UNCERTAINTY ANALYSIS

1.3.3 RETROSPECTIVE ANALYSIS

1.4 Short-Term Projection

Model used: Age structured

Software used: IFAP prediction with management option table and yield per recruit routines

Initial stock size: Taken from XSA for age 3 and older. The number at age 2 in the last data year is estimated using RCT3. The recruitment at age 1 in the last data year is estimated using the geometric mean over a long period (1980 – last data year)

Natural mortality: Set to 0.1 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Average weight of the three last years

Weight at age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years, scaled by the Fbar (2-6) to the level of the last year

Intermediate year assumptions:

Stock recruitment model used: None, the long term geometric mean recruitment at age 1 is used

Procedures used for splitting projected catches: Not relevant

1.5 Medium-Term Projections

The segmented stock/recruitment relationship is considered not significant (ICES, 2003a). There is therefore no consistent basis to build a medium term projection

1.6 Biological Reference Points

$\mathbf{B}_{lim}$ =	5400 t.
$\mathbf{B}_{pa}$ =	8000 t.
$\mathbf{F}_{lim}$ =	0.54
$\mathbf{F}_{pa}$ =	0.45

1.7 Other Issues

None.

1.8 References

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Quality Handbook ANNEX: WGNSSK – Norway pout

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Norway pout in North Sea and Skagerrak (ICES Area IV and IIIa)

Working Group: WG on the Assessment of Demersal Stocks in the North Sea and Skagerrak

Date: 15.9.04

A. General

A.1. Stock definition

Norway pout is a small, short-lived gadoid species, which rarely gets older than 5 years (Sparholt, Larsen and Nielsen 2002a). It is mainly distributed in the northern North Sea (>57°N) and in Skagerrak at depths between 50 and 250 m (Raitt 1968; Sparholt, Larsen and Nielsen 2002b).

ICES ACFM (October 2001) asked the ICES WGNSSK to verify the justification of treating ICES Division VIa as a management area for Norway pout (and sandeel) separately from ICES areas IV and IIIa. Preliminary results from an analysis of regionalized survey data on Norway pout maturity, presented in a Working Document to the 2000 meeting of the WGNSSK (*Larsen, Lassen, Nielsen and Sparholt,2001* in ICES C.M.2001/ACFM:07), gave no evidence for a stock separation in the whole northern area.

A.2. Fishery

The fishery is mainly by Danish and Norwegian (large) vessels using small mesh trawls in the northern North Sea at Fladen Ground and along the edge of the Norwegian Trench. Main fishing seasons are 1st, 3rd, and 4th quarters of the year. Norway pout is caught in small meshed trawls (16-31 mm) in a mixed fishery with blue whiting. The fishery is mainly carried out by Denmark (~70-80%) and Norway (~20-30%) at fishing grounds in the northern North Sea especially at Fladen Ground and along the edge of the Norwegian Trench. Norway pout is landed for reduction purposes (fish meal and fish oil).

With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery. The Norway pout fishery is regulated by minimum mesh size in the trawls, fishing area closure in the Norway pout box in the North-Western part of the North Sea, and by-catch regulations to protect other species.

A.3. Ecosystem aspects

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. By-catches of other species should also be taken into account in management of the fishery. Existing technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been maintained.

Recruitment in Norway pout is highly variable and influences spawning stock biomass (SSB) and total stock biomass (TSB) rapidly due to the short life span of the species. The fishing mortality is lower than the natural mortality, and this stock is important as food source for other species, which means that the population dynamics for Norway pout in the North Sea and in Skagerrak are very dependent on changes caused by recruitment variation and predation mortality (or other natural mortality causes) and less by the fishery

B. Data

B.1. Commercial catch and effort data

The assessment uses the combined catch and effort data from the commercial Danish and Norwegian small meshed trawler fleets fishing mainly in the northern North Sea.

For the Danish and Norwegian commercial landings sampling procedures of the commercial landings, which vary between the countries, were described in detail in the report of the WGNSSK meeting in 2004 (ICES 2005).

From 2002 onwards, an EU regulation (1639/2001) was endorsed which affects the market sampling procedures. First, each country is obliged to sample all fleet segments, including foreign vessels landing in their country. Second, a minimum number of market samples per tonnes of landing are required. The national market sampling programmes have been adjusted accordingly.

Method of effort standardization of the commercial fishery tuning fleet

Background descriptions of the commercial fishery tuning series used and methods of effort standardization of the commercial fishery between different vessel size categories and national commercial fleets are given in the 2004 working group report (ICES 2005) and the 1996 working group report (ICES CM 1997/Assess:6). Previous to the 2001 assessment the effort has been standardized by vessel category (to a standard 175 GRT vessel) only using the catch rate proportions between vessel size categories within the actual year.

In the 2004 (as well as in the 2001-2003) assessments the output of the regression analyses using time series from 1987-2004 has been applied to the Danish and Norwegian commercial fishery as well. Effort standardization of both the Danish and the Norwegian part of the commercial fishery tuning series is performed by applying standardization factors to reported catch and effort data for the different vessel size categories. The standardization factors are obtained from regression of CPUE indices by vessel size category over years of the Danish commercial fishery tuning fleet. The number of small vessels in the Danish Norway pout fishing fleet has decreased significantly and the relative number of large vessels has increased in the latest years. Furthermore, there was found no trends in CPUE between vessel categories over time. For these reasons the CPUE indices used in the regression has been obtained from pooled catch and effort data over the years 1994-present assessment year by vessel category in order to obtain and include estimates for all vessel categories also for the latest years where no observations exists for the smallest vessels groups. Results and parameter estimates from the yearly regression analyses on CPUE versus GRT for the different Danish vessel size categories used in the effort standardization of both the Norwegian and Danish commercial fishery are yearly updated to the yearly performed assessment.

The regression model used in effort standardisation is the following:

Regression models: $CPUE=b*GRT^a$ => $\ln(CPUE)=\ln(b)+a*\ln((GRT-50))$

Parameter estimates from regressions of ln(CPUE) versus ln(average GRT) by period together with estimates of standardized CPUE to the group of Danish 175 GRT industrial fishery trawlers is used to standardize effort in the commercial fishery tuning fleet used in the Norway pout assessment. Parameter estimates for the period 1994-2004 is the following:

Year	Slope	Intercept	R-Square	CPUE(175 tonnes)
1994-2004	0.18	18.88	0.77	32.86

In 2002 the assessment was run both with and without the new standardization method (regression). The differences in results of output SSB, TSB and F between the two assessment runs were small.

Norwegian effort data

In 1997, Norwegian effort data were revised as described in sections 13.1.3.1 and 1.3.2 of the 1997 working group report (ICES CM 1998/Assess:7). Furthermore, in the 2000 assessment Norwegian average GRT and Effort data for 1998-99 were corrected because data from ICES area IIa were included for these years in the 1998-99 assessments. Observed average GRT and effort for the Norwegian commercial fleets are given in the input data to the yearly performed assessment. This information has been put together in the report of the ICES WGNSSK meeting in 2004 (ICES 2005).

Danish effort data

In each yearly assessment the input data as CPUE data by vessel size category and year for the Danish commercial fishery in area IVa is given. This is based on fishing trips where total catch included at least 70 % Norway pout and blue whiting per trip, and where Norway pout was reported as main species in catch in the logbook per fishing day and fishing trip. There has been a relative reduction in the number and effort of small vessels and an increase for the larger vessels in the fleet in the latest years. Furthermore, it appears clearly that there is big difference in CPUE (as an indicator of fishing power) between different vessel size categories (BRT). Accordingly, standardization of effort is necessary when using a combined commercial fishery tuning fleet in the assessment including several vessel categories. Minor revisions (up-dating) of the Danish effort and catch data used in the effort standardization and as input to the tuning fleets have been made for the 2001 assessment.

Standardized effort data

The resulting combined and standardized Danish and Norwegian effort for the commercial fishery used in the assessment is presented in the input data to the yearly performed assessment, as well as the combined CPUE indices by age and quarter for the commercial fishery tuning fleet.

The seasonal variation in effort data is one reason for performing a seasonal VPA.

B.2. Biological data

Age reading
There are no reports of age reading problems of Norway pout otoliths, no indications of low quality of the age length keys used in the assessment of this stock.

Weight at age
Mean weight at age in the catch is estimated as a weighted average of Danish and Norwegian data. Historical levels and variation in mean weight at age in catch by quarter of year is shown in Figure 12.2.1 in the 2004 benchmark assessment in the 2004 ICES WGNSSK Report (ICES 2005). In general, the mean weights at age in the catches are variable between seasons of year. The same mean weight at age in the stock is used for all years. Mean weight in catch is not used as estimator of weight in the stock partly because the smallest 0-group fish are not fully recruited to the fishery in 3rd quarter of the year.

Maturity and natural mortality
The same proportion mature and natural mortality are used for all years in the assessment. The natural mortality is set to 0.4 for all age groups in all seasons that result in an annual natural mortality of 1.6 for all age groups. The proportion mature used is 0% for the 0-group, 10% of the 1-group and 100% of the 2+-group independent of sex.

In the 2001 and 2002 assessment exploratory runs were made with revised input data for natural mortality based on the results from two papers presented to the working group in 2001, (*both papers published in ICES J. Mar. Sci. in 2002, Sparholt, Larsen and Nielsen 2002a,b).* This was not explored further in the 2003 up-date assessment but this year benchmark assessment of the stock includes an exploratory run with revised natural mortalities. These revised natural mortalities are given in Table 12.2.3 in the 2004 ICES WGNSSK Report (ICES 2005).

The resulting SSB, TSB (3rd quarter of year), TSB (1st quarter of year) and F for the final exploratory run was compared to those for the accepted run with standard settings. It appears that the implications of these revised input data are very significant. The working group in 2002 suggested that an assessment with partly the traditional settings (constant M) and a new assessment with the revised values for M were made for at least a 3 year period in order to compare the output and the performance of the assessments before the working group decided on final adoption of the revised values for M to be used in the assessment. This attitude was adopted by the Working Group again in the 2004 benchmark assessment where a exploratory run with revised values for M was performed as well. The results of the exploratory runs have been consistent throughout the 3 years of exploratory runs.

Research results on population dynamics parameters (e.g. natural mortality and maturity)
Investigations on population dynamics (natural mortality, distribution, and spawning and maturity as well as growth patterns) of Norway pout in the North Sea are ongoing. Exploratory runs of the SXSA model was presented in the 2001 and 2002 assessment reports as well as in the 2004 assessment (Norway pout benchmark assessment) with revised input data for natural mortality by age based on the results from two papers presented to the working group in 2001, (later published in *Sparholt, Larsen and Nielsen, 2002a,b*). The resulting SSB, TSB (3rd quarter of year), TSB (1st quarter of year) and F for the final exploratory run was compared to those for the accepted run with standard settings. It appears that the implications of these revised input data are very significant. The working group in 2002 suggested that an assessment with partly the traditional settings (constant M) and a new assessment with the revised values for M were made for at least a 3 year period in order to compare the output and the performance of the assessments before the working group decided on final adoption of the revised values for M to be used in the assessment. This attitude was adopted by the working group again in the 2004 benchmark assessment where a exploratory run with revised values for M was performed as well. The results of the exploratory runs have been consistent throughout the 3 years of exploratory runs.

Preliminary results from an analysis of regionalized survey data on Norway pout maturity is presented in a Working Document to the 2000 meeting of the Working Group (*Larsen, Lassen, Nielsen and Sparholt,2001* in ICES C.M.2001/ACFM:07).

B.3. Survey data

Survey index series of abundance of Norway pout by age and quarter are for the assessment period available from the IBTS (Q1 and Q3) and the EGFS (Q3) and the SGFS (Q3) as given in Table 12.2.8. The SGFS data from 1998 onwards should be used with caution due to new survey design (new vessel from 1998 and new gear and extended survey area from 1999). The 0-group indices from this survey have accordingly not been used in the assessment tuning fleet for this survey previous to the 2004 benchmark assessment. It can be seen that the index for the 0-group from SGFS changed with an order of magnitude in the years after the change in survey design compared to previous years (Table 12.2.8). The EGFS data from previous to 1992 should be used with caution as the survey design shifted in 1992. This change in survey design has so far been accounted for by simply multiplying all indices with a factor 3.5 for all age groups in the years previous to 1992 in order to standardize it to the later indices. The EGFS survey indices for Norway pout has been revised in the 2004 assessment compared to the previous years assessment for the 1996, 2001, 2002, and 2003 indices. In previous years assessment the full EGFS survey time series for all age groups have been included as an assessment tuning fleet. Time series for IBTS Q3 are only available from 1991 and onwards. The 3rd quarter IBTS and the EFGS and SGFS are not independent of each other as the two latter is a part of the first.

B.4. Commercial CPUE data

Combined CPUE indices by age and quarter for the Danish and Norwegian commercial fishery tuning fleet is calculated from effort data obtained from the method of effort standardization of the commercial fishery tuning fleet described under section B.1 and vessel category specific catches by area. CPUE is estimated on a quarterly basis for the Danish and Norwegian commercial fleets.

The resulting combined, commercial fishery CPUE data by age and quarter used in tuning of the assessment based on the combined and standardized Danish and Norwegian effort data and on catch data for the commercial fishery is presented in the input data to the yearly performed assessment.

Revision of assessment tuning fleets (survey CPUE data and commercial fishery CPUE data) in the 2004 benchmark assessment:
Revision of the Norway pout assessment tuning fleets during benchmark assessment have been based partly on cohorte analyses and analyses of correlations within and between the different tuning fleet indices by age group, as well as on the results from a row of exploratory assessment runs described under section 12.3 which analyses the performance of the different tuning fleets in the assessment. The exploratory assessment runs also give indications of possible catchability patterns and trends in the fishery over time within the assessment period. The analyses of the tuning fleet indices are presented in Figures 12.2.3-12.2.8 and Tables 12.2.9-12.2.12.

The revision of the tuning fleets used in the assessment is summarised in Table 12.3.1.

Commercial fishery tuning fleets:

In addition to the analyses of the commercial fishery assessment tuning fleet as described above (effort standardization) the quarterly CPUE indices of the commercial fishery tuning fleet were analyzed during the 2004 benchmark assessment:

1. The indices for the 0-group in 3rd quarter of the year have been excluded from the commercial fishery tuning fleet. The main argumentation for doing that is that this age group indicate clear patterns in trends in catchability over the assessment period as shown in the single fleet/quarter assessment runs in section 12.3 (Figure 12.3.7). Secondly, there is no correlation between the commercial fishery quarter 3 0-group index and the commercial fishery quarter 4 0-group index, and no correlation between the quarter 3 commercial fishery 0-group index in a given year with the 1-group index of the 3rd quarter commercial fishery 1-group index the following year.
2. The 2nd quarter indices for all age groups of the 2nd quarter have been excluded from the commercial fishery tuning fleet. This is mainly because of indications of strong trends in catchability over time in the assessment period for this part of the tuning fleet for all age groups as indicated by single fleet tuning runs in the section 12.3 (Figure 12.3.7). Also, the within quarter and between quarter correlation indices are in general relatively poor. The cohorte analyses of the 2nd quarter commercial fishery indices indicate as well relative changes over time.

Survey tuning fleets:

Survey index series of abundance of Norway pout by age and quarter are for the assessment period available from the IBTS (Q1 and Q3) and the EGFS (Q3) and the SGFS (Q3) as given in Table 12.2.8. The SGFS data from 1998 onwards should be used with caution due to new survey design (new vessel from 1998 and new gear and extended survey area from 1999). The 0-group indices from this survey have accordingly not been used in the assessment tuning fleet for this survey previous to the 2004 benchmark assessment. It can be seen that the index for the 0-group from SGFS changed with an order of magnitude in the years after the change in survey design compared to previous years (Table 12.2.8). The EGFS data from previous to 1992 should be used with caution as the survey design shifted in 1992. This change in survey design has so far been accounted for by simply multiplying all indices with a factor 3.5 for all age groups in the years previous to 1992 in order to standardize it to the later indices. The EGFS survey indices for Norway pout has been revised in the 2004 assessment compared to the previous years assessment for the 1996, 2001, 2002, and 2003 indices. In previous years assessment the full EGFS survey time series for all age groups have been included as an assessment tuning fleet. Time series for IBTS Q3 are only available from 1991 and onwards. The 3rd quarter IBTS and the EFGS and SGFS are not independent of each other as the two latter is a part of the first.

1. The IBTS Q3 for the period 1991-2003 has been included in the assessment. This survey has a broader coverage of the Norway pout distribution area compared to the EGFS and SGFS isolated. However, as this survey index is not available for the most recent year to be used in the seasonal assessment it has been chosen to exclude the 0- and 1-group indices from the IBTS Q3 in order to allow inclusion of the 0- and 1-group indices from the SGFS and EGFS which are available for the most recent year in the assessment. Accordingly, the IBTS Q3 tuning fleet for age 2 and age 3 has been included in the assessment as a new tuning fleet. The SXSA demands at least two age groups in order to run which is the reason for including both age 0 and age 1 under the EGFS and SGFS tuning fleets and not including age 1 in the IBTS Q3 tuning fleet.
2. The SGFS for age group 0 and 1 for the period 1998 and onwards has been used as tuning fleet in the assessment. The short time series is due to the change in survey design for SGFS as explained above. The quarter 3 0-group survey index for SGFS is back-shifted to the final season of the assessment in the terminal year, i.e. to quarter 2 of the assessment year in order to include the most recent 0-group estimate in the assessment.
3. The EGFS for age group 0 and 1 for the period 1992 and onwards has been used as tuning fleet in the assessment. The shorter time series is due to the change in survey design for EGFS as explained above. Furthermore, there is a good argument for excluding the age 2-3 of the EGFS as the within survey correlation between the age groups 1-2 and 2-3 is very poor while the within correlation between age groups 0-1 is good. The quarter 3 0-group survey index for EGFS is back-shifted to the final season of the assessment in the terminal year, i.e. to quarter 2 of the assessment year in order to include the most recent 0-group estimate in the assessment.
4. The IBTS Q1 tuning fleet has remained unchanged compared to previous years assessment.

C. Historical Stock Development

The SXSA (Seasonal Extended Survivors Analysis: Skagen (1993)) was used to estimate quarterly stock numbers and fishing mortalities for Norway pout in the North Sea and Skagerrak. The catch at age analysis is carried out according to the specifications given in the present stock quality handbook.

Model used: SXSA
The SXSA (Seasonal Extended Survivors Analysis: Skagen (1993)) is used to estimate quarterly stock numbers and fishing mortalities for Norway pout in the North Sea and Skagerrak. The assessment is analytical using catch-at-age analysis based on quarterly catch and CPUE data. The assessment is considered appropriate to indicate trends in the stock and immediate changes in the stock because of the seasonal assessment taking into account the seasonality in fishery. The seasonal model makes it possible to include and use the most recent information from the fishery and from the surveys at the assessment in , and provides a gives at the assessment time an The seasonal variation in effort data is one reason for performing a seasonal VPA.

In the options chosen in the SXSA for the Norway pout assessment the catchability, r, per age and quarter and fleet is assumed to be constant within the period 1983-2004 where the estimated catchability, rhat, is a geometric mean over years by age, quarter and tuning fleet. In the 2004 benchmark assessment exploration of trends in tuning fleet catchabilities was investigated by single fleet runs with the SXSA. The accepted assessment with revised tuning fleets in the 2004 benchmark assessment assume constant catchability. Tuning is performed over the period 1983 to present producing log residual (log(Nhat/N)) stock numbers and survivor estimates by year, quarter, age and tuning fleet. The contributions from the various age groups to the survivor estimates by year and quarter and fleet are in the SXSA combined to an overall survivors estimate, shat, estimated as the geometric mean over years of log(shat) weighted by the exponential of the inverse cumulated fishing mortality as described in Skagen (1993).

Comparison of output from a seasonal based assessment model (the SXSA model) and a annual based (the XSA model):

In the 2004 benchmark assessment of the Norway pout stock a comparison of the output, performance and weighting of tuning tuning fleets of the seasonal based SXSA model and the annual based XSA model was performed. The results are in detail presented in the 2004 ICES WGNSSK Report (ICES 2005). The differences in results of output SSB, TSB and F between the two assessment runs were small. Both model runs gave in general similar weighting to the different tuning fleets used. This was based on comparison of runs of the accepted assessment (by the WG and ACFM) in 2003.

Software used:
SXSA program available from ICES.
(XSA program available from ICES; Exploratory run).

Model Options chosen:
The parameter settings and options of the SXSA has been the same in all recent years assessments. No time taper or shrinkage is used in the catch at age analysis. The three surveys and the seasonally (by quarter) divided commercial fleets are all used in the tuning.

```
The following parameters were used:
Year range:                                               1983 - present
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

Fleet  1:    (Q1: Age 1-3; Q2: None; Q3: Age 1-3)    commercial q134
Fleet  2:                                            ibtsq1
       (Age 1-3)
Fleet  3:                                            egFsq2
       (Age 0-1)
Fleet  4:                                            sgFsq2
       (Age 0-1)
Fleet  5:                                            ibtsq3
       (Age 2-3)


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

Factor (between 0 and 1) for weighting the inverse catchabilities
at the oldest age versus the second oldest age (factor 1 means that
the catchabilities for the oldest age are used as they are):          0

Specification of minimum value for the survivor number (this is
Used instead of the estimate if the estimate becomes very low):       0

Iteration until convergence (setting 0):                               0
```

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1983-present	0-3+	Yes

Canum	Catch at age in numbers	1983-present|	0-3+	Yes
Weca	Weight at age in the commercial catch	1983-present|	0-3+	Yes
West	Weight at age of the spawning stock at spawning time.	1983-present|	0-3+	No
Mprop	Proportion of natural mortality before spawning	Not relevant in SXSA|		
Fprop	Proportion of fishing mortality before spawning	1983-present|	0-1	Yes
Matprop	Proportion mature at age	1983-present|	1-3+	No, 10%age 1, 100% 2+
Natmor	Natural mortality	1983-present|	0-3+	No, 0.4 per quarter per age group

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Commercial fleet, Q1,3,4	1983-present	0-3+
Tuning fleet 2	IBTS Q1	1983-present	0-3+
Tuning fleet 3	EGFS	1992-present	0-1
Tuning fleet 4	SGFS	1998-present	0-1
Tuning fleet 5	IBTS Q3	1991-present	2-3+

D. Short-Term Projection

Deterministic short-term forecasts was performed for the Norway pout stock in 2004. The forecast was calculated as a stock projection up to 1st of January 2005 without assuming anything about the recruitment in 2005 or taking unknown recruitment into consideration. A management table is presented with forecast F being equal to last year (2003), i.e. with very low level of fishing mortality (ICES 2005, Table 12.5). This F-level is not expected to increase as the recent reduction in effort targeting Norway pout most probably is caused by by-catch restrictions in the Norway pout fishery which is not expected to change during the next years fishery. Mean catch weight at age are averaged over the last three years. The low successive year-classes in 2002, 2003 and 2004 leads to a SSB estimate at $\mathbf{B}_{lim}$ at start of 2004 (start of 2nd quarter of 2004), and far below $\mathbf{B}_{lim}$ at the start of 2005 (1st of January). Fishing at F status quo in the second half of 2004 (Landings around 12000 t) would lead to SSB in 2005 at 50% of $\mathbf{B}_{lim}$, while no fishing would still lead to SSB being only 60% of $\mathbf{B}_{lim}$.

E. Biological Reference Points

$\mathbf{B}_{lim}$ is 90 000 t
$\mathbf{B}_{pa}$= 150 000 t
$\mathbf{F}_{low}$ =0.23
$\mathbf{F}_{med}$ =0.67
$\mathbf{F}_{high}$ =1.21

$\mathbf{B}_{lim}$ is 90.000 t, the lowest observed biomass

$\mathbf{B}_{pa}$ be established at 150,000 t. This affords a high probability of maintaining SSB above $\mathbf{B}_{lim}$, taking into account the uncertainty of assessments. Below this value the probability of below average recruitment increases.

$\mathbf{F}_{lim}$ None advised.

$\mathbf{F}_{pa}$ None advised.

F. Other Issues

There is no management objective set for this stock. With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery. There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. In managing this fishery by-catches of other species have been taken into account. Technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been used in managing this stock and the fishery.

G. References

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STOCK ANNEX: SAITHE IN SUB-AREAS IV AND VI AND DIVISION IIIa

1. General

1.1 STOCK DEFINITION

The geographical distribution of juveniles (< age 3) and adults differs. Typical for all saithe stocks are the inshore nursery grounds. Juveniles are therefore mainly distributed along the west and south coast of Norway, the coast of Shetland and the coast of Scotland. Around age 3 the individuals gradually migrate from the costal areas to the northern part of the North Sea (57°N - 62°N), where the feeding grounds of the adult part of the stock are situated. The age at maturity is between 4 and 6 years, and spawning takes place in January-March at about 200 m depth along the Northern Shelf edge and the western edge of the Norwegian deeps. Mature fish migrate during the season between the feeding grounds (summer) and spawning grounds (winter).

Before 1999 saithe in Sub-area IV and Division IIIa and saithe in Sub-area VI was treated as a separate stock units. These stock boundaries were more for management purposes than a biological basis for stock separation. Present biological knowledge shows no evidence that saithe in Division IVa and Via belong to separate stock units. There seems to be a similar recruitment pattern and the spawning areas in these divisions are not separated (ICES 1995).

Tagging experiments by various countries have shown that exchange between all saithe stock components in the north-east Atlantic takes place to a variable extent (ICES 1995). For example, a substantial migration of immature saithe from the Norwegian coast between 62°N and 66°N to the North Sea has been shown to occur (Jakobsen 1981). 0-group saithe, on the other hand, drifts from the northern North Sea to the coast of Norway north of 62°N.

1.2 FISHERY

Saithe in the North Sea are mainly taken in a direct trawl fishery in deep water near the Northern Shelf edge and the Norwegian deeps. The majority of the catches are taken by Norwegian, French, and German trawlers. In the first half of the year the fishery are directed towards mature fish, while immature fish dominate in the catches the rest of the year. In recent years the French fishery deployed less effort along the Norwegian deeps, while the German and Norwegian fisheries have maintained their effort there. The main fishery developed in the beginning of the 1970s. Recently trawlers have also been targeting deep sea fish, and it is necessary to take account of that when tuning series are established. The fishery in Area VI consists largely of a directed French, German, and Norwegian deep-water fishery operating on the shelf edge, and a Scottish fishery operating inshore. In both areas most of the saithe do not enter the main fishery before age 3, because the younger ages are staying in inshore waters. A small proportion of the total catch is taken in a limited purse seine fishery along the west coast of Norway targeting juveniles (age 2 and 3). Minimum landing size for saithe is currently 35 cm in the EU zone and 32 cm in the Norwegian zone (south of 62°N). Since the fish are distributed inshore until they are 2-3 years old, discarding of young fish is assumed to be a small problem in this fishery. Problems with by-catches in other fisheries when saithe quotas are exceeded may cause discarding. Data from SGDBI and Scotland indicate that the discard in the UK fleets in 2000 and 2001 was about 22 000 t and 15 000 t, respectively, mainly age 3 and age 4. French and German trawlers are targeting saithe and they have larger quotas, so the problem may be less in these fleets. The Norwegian trawlers move out of the area when the boat quotas are reached, and in addition the fishery is closed if the seasonal quota is reached.

1.3 ECOSYSTEM ASPECTS

Saithe in the North Sea mainly preys on krill and Norway pout.

2 Data

2.1 COMMERCIAL CATCH

Catch at age data by fleet are supplied by Denmark, Germany, France, Norway, UK (England), and UK (Scotland) for Area IV and only UK(Scotland) for Area VI. Aberdeen (FRS) is responsible for the database with catch at age data from the different countries.

2.2 BIOLOGICAL

Average weights at age in the stock are assumed to be equal to average weights at age in the catches. Average weights at age by fleet are supplied by Denmark, Germany, France, Norway, UK (England), and UK (Scotland) for Area IV and only UK(Scotland) for Area VI.

Aberdeen (FRS) is responsible for the database with weights at age in the catches from the different countries.

A natural mortality rate of 0.2 is used for all ages in all years. A constant maturity ogive based on historic biological sampling is used for all years:

Age	1	2	3	4	5	6	7+
Proportion mature	0.0	0.0	0.0	0.15	0.7	0.9	1.0

2.3 SURVEYS

A Norwegian acoustic survey is conducted in conjunction with the IBTS Q3 survey, covering the area north of 56°30′ N up to 62° N and directed towards saithe. The time series of indices from this survey is the only survey data used for tuning, and it extends back to 1995.

Time series from the English and Scottish Groundfish surveys are also available for tuning but since saithe is not well represented they are, at the time being, excluded.

A survey along the Norwegian coast targeting saithe larvae (0-group) started in 1999. The time series from this survey is currently too short to evaluate its potential as a year class strength predictor (i.e. to investigate the correlation between the 0-group indices and the corresponding VPA numbers at age 3).

2.4 COMMERCIAL CPUE

Three time series of CPUE are used in the tuning: Norwegian bottom trawl, German bottom trawl and French fresh fish trawlers. All fleets are targeting saithe along the Northern Shelf edge and along the western edge of the Norwegian deep, primarily at depths between 150 - 250 m. A more detailed description of the CPUE time series follows.

Norwegian bottom trawl: This time series extends back to 1980. The resolution of the logbook data is day-by-day (i.e. a record comprises total daily catch and total hours trawled for each vessel). Only records where the weight proportion of saithe exceeds 50 % and records from vessels larger than 30 m are used to calculate CPUE (kg/h). Samples of age compositions in commercial trawl catches are used to age disaggregated the CPUE time series.

German bottom trawl: This age disaggregated CPUE time series extends back to 1995, and it is described in (Rätz et al. 2002)

French fresh fish trawlers: This time series extends back to 1990. The French saithe fishery has developed in the seventies, during the gadoid outburst. At the beginning of the nineties, the saithe stock reached its lowest historical level. Part of the French vessels reacted by fishing in different areas and in deeper waters. The remaining vessels have been harvesting saithe, almost exclusively in the North Sea, and with by-catches of deep-water species (blue ling) west of Scotland. The French fleet targeting saithe is now made up of large trawlers and freezer trawlers over 50 m. The vessels are registered in Boulogne and Lorient.

Series of CPUE (kg/h) at age were not supplied for the French freezers after 2002, as the landings from this fleet were neither length- nor age-sampled. The French tuning fleet is therefore made up of the non-freezer trawlers. Data are restricted to the fishing trips with more than 10% of saithe landings.

2.5 OTHER RELEVANT DATA

None.

3 Historical Stock Development

3.1 DETERMINISTIC MODELLING

Modell used: XSA (Darby and Flatman 1994)

Software used: Lowstoft VPA suite.

The settings of the final run in 2003 are given in the following table.

Year of assessment	**2003**	
Assessment model	XSA	
French trawlers (TRB) IV	1990-2002	**3-9**
Norwegian trawlers IV	1980-2002	3-9

German trawlers IV	1995-2002	3-9
SGFS	not used	
EGFS	not used	
Norwegian acoustic survey IV	**1995-2002**	**3-7**
Time-series weights	tricubic over 20 yrs	
Power model used for catchability	1-2	
Catchability plateau age	7	
Surv. est. shrunk towards mean F	5 years / 3 ages	
s.e. of the means	1.0	
Min. stand. error for pop. estimates	0.3	
Prior weighting	none	

3.2 UNCERTAINTY ANALYSIS

Nothing here yet.

3.3 RETROSPECTIVE ANALYSIS

4 Short-Term Projection

Model used:

WGFRANSW (Reeves and Cook 1994)

Recruitment at age 1:

The geometric mean of historic XSA numbers at age 1 (in 2003 the geometric mean from the period 1985-00 was used).

Initial stock structure:

The number at age 2 are found by applying natural mortality (0.2) and XSA fishing mortality at age 1 from the last year to the number of recruits at age 1 (geometric mean). The number at age 3 are found by first applying natural mortality (0.2) and XSA fishing mortality at age 1 from the second last year (i.e. for the 2003-assessment F_1 from 2001) to the number of recruits at age 1 (geometric mean) and, second, apply natural mortality (0.2) and XSA fishing mortality at age 2 from the last year to this number (i.e. for the 2003-assessment F_2 from 2002). For ages older than 3, XSA-numbers for the current year are used.

Mortality:

Natural mortality is 0.2 for all ages. Fishing mortalities at age is the mean of the XSA fishing mortalities at age for the 3 last years. (The fishing pattern is not scaled to F_{3-6} for the last year.)

Maturity:

The constant maturity ogive used (see section 2.2).

Mean weights at age in the stock and catch:

The average of mean weights at age for the last three years.

5 Medium-Term Projections

Initial stock size, maturity at age, natural mortality, fishing mortality and mean weights at age in the stock/catch are the same as in the short-term projection.

Recruitment:

A Ricker stock-recruitment curve is fitted to the historic data (SSB and age 1 from XSA).

6 Long-Term Projections, yield per recruit

Nothing here yet.

7 Biological reference points

$F_{0.1}$	0.09	F_{lim}	0.60
F_{max}	0.17	F_{pa}	0.40
F_{med}	0.49	B_{lim}	106 000 t
F_{high}	>0.49	B_{pa}	200 000 t

8 Other Issues

None

9 References

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Quality Handbook ANNEX:__xxxx

Stock specific documentation of standard assessment procedures used by ICES.

Working group: North Sea Demersal Working Group

Updated: 15/9//2004 by: Henrik Jensen (hj@dfu.min.dk)

1 Sandeel in IV

1.1 General

1.1.1 Stock definition

For assessment purposes, the European continental shelf was divided into four regions for sandeel assessment purposes up to 1995: Division IIIa (Skagerrak), northern North Sea, southern North Sea, and Shetland Islands and Division VIa. These divisions were based on regional differences in growth rate and evidence for a limited movement of adults between divisions (e.g. ICES CM 1977/F:7, ICES CM 1991/Assess:14.). The two North Sea divisions were revised in 1995, and it was decided to amalgamate the two stocks into a single stock unit with two fleets, one fleet in the northern North Sea and one in the southern North Sea. The Shetland sandeel stock is assessed separately. ICES assessments have used these stock definitions since 1995.

Sandeels are largely stationary after settlement and the North Sea sandeel fishery must be considered as exploiting a complex of local populations. Recruitment to local areas may not only be related to the local stock, as interchange between areas seems to take place during the early phases of life before settlement.

Based on the distribution and simulated dispersal of larval stages, Wright et al. (1998) suggest that the North Sea stock could be split into six areas, including the Shetland as a separate population. Assessments have tentatively been made for some of these areas (Pedersen et al. 1999) and there was high correlation between the results from the study and the assessment made by the WG for the whole North Sea. Presently there are insufficient information about sandeel biology, especially about the intermixing of the early life stages between spawning aggregations, to allow for and alternative separation of the North Sea into separate population units to be assessed.

1.1.2 Fishery

Sandeel is taken by trawlers using small meshed trawls with mesh sizes < 16 mm. The fishery is seasonal. The geographical distribution of the sandeel fishery varies seasonally and annually, taking place mostly in the spring and summer. In the third quarter of the year the distribution of catches generally changes from a dominance of the west Dogger Bank area back to the more easterly fishing grounds.

Most of the sandeel catch consists of the lesser sandeel *Ammodytes marinus*, although small quantities of other Ammodytoidei spp. are caught as well. There is little by-catch of protected species (ICES 2004).

In most years and particularly prior to 1998, most landings of sandeels in March were taken from the eastern North Sea banks whilst sandeel landings in April-June were mainly from the west Dogger Bank. As there can be regional differences in the age composition this seasonal expansion of the fishery can result in a change in the age composition in the fishery. In some years a relatively large part of the sandeel landings are taken from the central and eastern North Sea along the Danish west coast. From 1991, grounds off the Scottish east coast have been targeted particularly in June. However, since 2000 the banks in the Firth of Forth area have been closed to fishing.

Technical measures for the sandeel fishery include a minimum percentage of the target species at 95% for meshes < 16 mm, or a minimum of 90% target species and maximum 5% of the mixture of cod, haddock, and saithe for 16 to 31 mm meshes.

1.1.3 Ecosystem aspects

ACFM consider that there is a need to ensure that the sandeel stock remains high enough to provide food for a variety of predator species.

In 1999 the U.K called for a moratorium on sandeel fishing adjacent to seabird colonies along the U.K. coast and in response the EU requested advice from ICES. An ICES Study Group, was convened in 1999 to assess whether removal of sandeel by fisheries has a measurable effect on sandeel, whether establishment of closed areas and seasons for sandeel fisheries could ameliorate any effects, and to identify possible spatial and/or temporal restrictions of the fishery as specifically as possible. The ICES Advisory committees (ACFM and ACE) accepted the advice from the study group. STECF (1999) agreed with this ICES advice and the EU advised to close the fishery whilst maintaining a commercial monitoring. A 3-year closure, from 2000 to 2002, was decided. All commercial fishing was excluded, except for a maximum of 10 boat days in each of May and June for stock monitoring purposes. The closure was maintained for three years (see e.g. Wright et *al.* 2002) and has been extended until 2006, with a small increase in the effort of the monitoring fishery, after which the effect of the closure will be evaluated.

1.2 Data

1.2.1 Commercial catch

In the last 20 years the landings of sandeels in IV have been taken by 5 countries: Denmark (78%), Norway (19%) UK/Scotland (1%), Sweden (1%) and Faroes Isl. (1%). In the 1950's also Germany and the Netherlands participated in this fishery, but since the start of the 1970's no landings have been recorded for these countries.

Age, length and weight at age data are available for Denmark and Norway to estimate numbers by age in the landings. Prior to 1996, the Norwegian age composition data were based on Danish ALK's. Catch numbers and weight at age for the southern North Sea are based only on Danish age compositions.

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. Excel spreadsheet files can be found with the Danish stock co-ordinator and in the ICES computer system under **w:\acfm\WGNSSK****.

The result files can be found at ICES and with the stock co-ordinator as ASCII files on the Lowestoft format under **w:\acfm\WGNSSK****.

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). MSVPA (ICES CM 2002/D:04) estimates of natural mortalities are relatively stable in the period covered by this assessment. The values used in this assessment are quite similar to the MSVPA M, except for the 0-group where MSVPA estimates a value of approximately 1.2 for the second half of the year. The assessment uses a value of 0.8 for the whole year for the 0-group, 1.2 for the 1-group, and 0.6 for the 3-group and 4+-group.

The proportion mature is assumed constant over the whole period with 100% mature from age 2 and 0% of age 0 and 1. Recent research indicates however, that there are large regional variations in age at maturity of *Ammodytes marinus* in the North Sea (see e.g. Jensen et al. 2001). Whilst sandeels in some areas seem to spawn at age 2 or older, sandeels in other regions seem to mature and spawn at age 1. As the decision to spawn at age 1 or 2 is an annual event, it is likely that there are large regional and annual variations in the fraction of the populations of the sandeels that contribute to the spawning. The age at maturity keys used in the assessment might thus considerably underestimate the spawning biomass of sandeels in the North Sea.

The fishing fleet catch sandeels in different parts of the North Sea during the year, and the fishing pattern changes from year to year. Because sandeels, *Ammodytes marinus*, in the North Sea possibly consist of a number of sub populations (see section **) the industrial fishery target different part of the sandeel populations during the year and between years. There seem to be significant spatial and temporal variations in emergence behaviour (e.g. Rindorf *et al*. 2000) and growth (e.g. Pedersen et al. 1999; Wright et al. 1998) of sandeels in the North Sea. Further, there are age/length dependent variations in the burrowing behaviour of sandeels (Kvist et al. 2001). The information about age compositions in the catches and the age and weight relationships thus represent average values over time and space and reflect the variability in emergence behaviour and growth. For example, weight at age of sandeels seems to vary both between years and between Danish and Norwegian catches.

The effect of variations in the biological data on the performance of the assessments has not yet been analysed. Such an analysis requires information about spatial and temporal variations in emergence and growth. A new sampling programme for such data for the Danish industrial fleet was initiated in 1999 in which a part of the fleet is monitored in detail (Jensen *et al*. 2001). In 1999, information about catches of sandeel was collected on a trawl haul basis from 17 Danish vessels. In total 231 samples was taken from 49 grounds, corresponding to 2.6% of the Danish landings of sandeel in the North Sea in 1999. This sampling programme was continued in 2000 to 2003 with about the same sampling level. Basic analysis of the data from 1999-2003 is not completed. However, the data have been used for estimation of assessment catch at age numbers. Due to the new sampling program, the number of fish measured and aged has since 1999 increased by a factor of around 10 compared to previous years.

1.2.3 Surveys

There are no survey time series available for this stock.

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.

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:

$$CPUE = a * GR^{b} \qquad (1)$$

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:

$$\mathrm{Ln}(C/e)=\ln(a)+b*\ln(GR) \quad (2)$$

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:

$$\ln(CPUE) = d_y + f_y*\ln(GR) \quad (3)$$

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:

$$CPUE=e^{dy}*200^{fy} \quad (4)$$

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. For analysis of alternative procedures see WG reports from previous years (ICES 1986, … 2003 **to be updated with references prior to 1986). In 2004 SXSA was used again, as a supplement to the XSA, the reason being that data were available for the first half year of 2004 for the assessment.

The assessment of sandeels in IV now use the XSA method with the following settings for tuning:

stock	Sandeel
area	IV
Assessment model	**XSA**
Combined Northern 1st half year	1983-2001 0-4+
Combined Northern 2nd half year	1983-2001 0-4+
Combined Southern 1st half year	1983-2001 0-4+
Combined Southern 2nd half year	1983-2001 0-4+
Time series weights	**none**
Power model used for catchability	**not used**
Catchability plateau age	**2**
Surv. est. shrunk towards mean F	**5 years / 2 ages**
s.e. of the means	**1.5**
Min. stand. error for pop. estimates	**0.3**
Prior weighting	**none**

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1974 – last data year	0 – 4+	Yes
Canum	Catch at age in numbers	1974 – last data year	0 – 4+	Yes
Weca	Weight at age in the commercial catch	1974 – last data year	0 – 4+	Yes
West	Weight at age of the spawning stock at spawning time.	1974 – last data year	0 – 4+	Yes
Mprop	Proportion of natural mortality before spawning	1974 – last data year	0 – 4+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1974 – last data year	0 – 4+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1974 – last data year	0 – 4+	No (see section **)
Natmor	Natural mortality	1974 – last data year	0 – 4+	No (see section **)

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Northern North Sea first half year	1976 – last data year	1 – 4+
Tuning fleet 2	Northern North Sea	1976 – last data year	0 – 4+

	second half year		
Tuning fleet 3	Southern North Sea first half year	1982 – last data year	1 – 4+
Tuning fleet 4	Southern North Sea second half year	1982 – last data year	0 – 4+

The low number of age groups makes the assessment highly sensitive to estimated terminal fishing mortalities for the oldest age (age 3). This in combination with an assumed constant and poorly determined proportion mature makes the SSB estimate highly uncertain.

1.4 Short-Term Projection

Not done

The high natural mortality of sandeel and the few year classes in the fishery make the stock size and catch opportunities largely dependent on the size of the incoming year classes. Quantitative estimates of recruits (age 0) in the year of the assessment are not available at the time of the WG. Traditional deterministic forecasts are therefore not considered appropriate.

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). Due to the few age-groups, SSB is highly dependent on the terminal F and thereby tuning method. Even though the previously used SXSA and XSA give similar results, an update of the reference points is needed.

The TAC was set to 1,020,000 tonnes for 2002 and 918.000 t for 2003. The ACFM advice for 2003 was that the stock can sustain the current fishing mortality and that the fishing mortality should not be allowed to increase because the consequences of removing a larger fraction of the food-biomass for other biota are unknown.

1.8 Other Issues

None

1.9 References

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WGNSSK Stock Annex

Stock specific documentation of standard assessment procedures used by the ICES WGNSSK.

1. EASTERN CHANNEL SOLE (SOLE_ECHE)

Working group: North Sea Demersal Working Group

Updated: 3/9//2003

By: Richard Millner (r.s.millner@cefas.cu.uk) and Wim Demaré (wim.demare@dvz.be)

1.1 General

1.1.1 STOCK DEFINITION

The sole in the eastern English Channel (VIId) are considered to be a separate stock from the larger North Sea stock to the east and the smaller geographically separate stock to the west in VIIe. There is some movement of juvenile sole from the North Sea into VIId (ICES CM 1989/G:21) and from VIId into the western Channel (VIIe) and into the North Sea. Adult sole appear to largely isolated from other regions except during the winter, when sole from the southern North Sea may enter the Channel temporarily (Pawson, 1995).

1.1.2 FISHERY

There is a directed fishery for sole by small inshore vessels using trammel nets and trawls, who fish mainly along the English and French coasts and possibly exploit different coastal populations. Sole represents the most important species for these vessels in terms of the annual value to the fishery. The fishery for sole by these boats occurs throughout the year with small peaks in landings in spring and autumn. There is also a directed fishery by English and Belgian beam trawlers who are able to direct effort to different ICES divisions. These vessels are able to fish for sole in the winter before the fish move inshore and become accessible to the local fleets. In cold winters, sole are particularly vulnerable to the offshore beamers when they aggregate in localised areas of deeper water. Effort from the beam trawl fleet can change considerably depending on whether the fleet moves to other areas or directs effort at other species such as scallops and cuttlefish. A third fleet is made up of French offshore trawlers fishing for mixed demersal species and taking sole as a by-catch.

The minimum landing size for sole is 24cm. Demersal gears permitted to catch sole are 80mm for beam trawling and 90mm for otter trawlers. Fixed nets are required to use 100mm mesh since 2002 although an exemption to permit 90mm has been in force since that time.

1.1.3 ECOSYSTEM ASPECTS

No information is available.

1.2 Data

1.2.1 COMMERCIAL CATCH

The landings are taken by three countries France (50%), Belgium (30%) and England (20%). Age sampling for the period before 1980 was poor, but between 1981 and 1984 quarterly samples were provided by both Belgium and England. Since 1985, quarterly catch and weight-at-age compositions were available from Belgium, France, and England.

1.2.1.1 Belgium text to be inserted by Belgium

1.2.1.2 France text to be inserted by France

1.2.1.3 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

1.2.1.4 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**.

1.2.2 BIOLOGICAL

Natural mortality was assumed constant over ages and years at 0.1, and the maturity ogive used was knife-edged with sole regarded as fully mature at age 3 and older as in the North Sea.

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.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

1.2.3 SURVEYS

A dedicated 4m beam trawl survey for plaice and sole has been carried out by England using the RV Corystes since 1988. The survey covers the whole of VIId and is a depth stratified survey with most samples allocated to the shallower inshore stations where the abundance of sole is highest. In addition, inshore small boat surveys using 2m beam trawls are undertaken along the English coast and in a restricted area of the Baie de Somme on the French coast. In 2002, The English and French Young Fish Surveys were combined into an International Young Fish Survey. The dataset was revised for the full period back to 1981. The two surveys operate with the same gear (beam trawl) during the same period (September) in two different nursery areas. Previous analysis (Riou *et al*, 2001) has shown that asynchronous spawning occurs for flatfish in Division VIId. Therefore both surveys were combined based on weighting of the individual index with the area nursery surface sampled. Taking into account the low, medium, and high potential area of recruitment, the French YFS got a weight index of 55% and the English YFS of 45%.

1.2.4 COMMERCIAL CPUE

Three commercial fleets have been used in tuning. The Belgian beam trawl fleet (BEL BT), the UK Beam Trawl fleet (UK BT) and a French otter trawl fleet (FR OT). The two beam trawl fleets carry out fishing directed towards sole but can switch effort between ICES areas. The UK BT CPUE data is derived from trips where landings of sole from VIId exceeded 10% of the total demersal catch by weight on a trip basis. Effort from both the BT fleets is corrected for HP. The French otter trawl fleet is description needed.

1.2.5 OTHER RELEVANT DATA

None.

1.3 Historical Stock Development

1.3.1 DETERMINISTIC MODELLING

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

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

S.E. of the mean to which the estimate are shrunk = 0.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Catch data available for 1982-present year. However, there was no French age compositions before 1986 and large catchability residuals were observed in the commercial data before 1986. In the final analyses only data from 1986-present were used in tuning

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1982 – last data year	2 – 11+	Yes
Canum	Catch at age in numbers	1982 – last data year	2 – 11+	Yes
Weca	Weight at age in the commercial catch	1982 – last data year	2 – 11+	Yes
West	Weight at age of the spawning stock at spawning time.	19682 – last data year	2 – 11+	Yes - assumed to be the same as weight at age in the Q2 catch
Mprop	Proportion of natural mortality before spawning	1982 – last data year	2 – 11+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1982 – last data year	2 – 11+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1982 – last data year	2 – 11+	No – the same ogive for all years
Natmor	Natural mortality	1982 – last data year	2 – 11+	No – set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Belgian commercial BT	1986 – last data year	2-10
Tuning fleet 2	English commercial BT	1986 – last data year	2-10
Tuning fleet 3	English BT survey	1988 – last data year	1-6
Tuning fleet 4	International YFS	1994 – last data year	1-1

1.3.2 UNCERTAINTY ANALYSIS

1.3.3 RETROSPECTIVE ANALYSIS

1.4 Short-Term Projection

Model used: Age structured

Software used: WGFRANSW

Initial stock size is taken from the XSA for age 3 and older and from RCT3 for age 2. The long-term geometric mean recruitment is used for age 1 in all projection years.

Natural mortality: Set to 0.1 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Average weight over the last three years

Weight at age in the catch: Average weight over the three last years

Exploitation pattern: Average of the three last years, scaled to the level of Fbar (3-8) in the last year

Intermediate year assumptions: F *status quo*

Stock recruitment model used: None, the long term geometric mean recruitment at age 1 is used

Procedures used for splitting projected catches: Not relevant

1.5 Medium-Term Projections

Model used: Age structured

Software used: WGMTERMc

Settings as in short term projection except for the weights in the catch and in the stock which are averaged over the last 10 years

1.6 Long-Term Projections, yield per recruit

Model used: Age structured

Software used: WGMTERMc

Settings as in short term projection except for the weights in the catch and in the stock which are averaged over the last 10 years

1.7 Biological Reference Points

Biological reference points

$\mathbf{B}_{pa}$	$\mathbf{F}_{pa}$	$\mathbf{F}_{lim}$
8,000 t	0.4	0.55

1.8 Other Issues

None.

1.9 References

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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:	16 September 2004

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 no 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 35 m to 200 m in the North Sea to the north of the Dogger Bank. It samples at most one survey station per statistical rectangle. In 1998 the coverage of this survey was extended into the central North Sea, but the index available to the Working Group has been modified so as to cover a consistent area throughout the time-series.

The English Groundfish Survey (ENGGFS) is carried out in August each year, and samples at most one station per rectangle. It covers depths of roughly 35 m to 200 m in the whole of the North Sea basin.

The time-series of the survey indices of whiting supplied by the French Channel Groundfish Survey (FRAGFS) was revised in 2002. In 2001, the Eastern Channel was split into five zones. Abundance indices were first calculated for each zone, and then averaged to obtain the final FRAGFS index. This procedure was not thought to be entirely satisfactory, as the level of sampling was inconsistent across geographical strata. In 2002, it was thought more appropriate first to raise abundance indices to the level of ICES rectangles, and then to average those to calculate the final abundance index. Previous to the 2002 WG, only the hauls in which whiting were caught were used to derive abundance indices. This procedure biased estimates, and therefore, the indices supplied from 2002 are calculated on the basis of all hauls.

The first quarter International Bottom Trawl Survey (IBTS Q1) is undertaken in February and March of each year, and covers depths of roughly 35 m to 200 m in the whole of the North Sea basin. It uses a higher density of survey stations than either the SCOGFS or the ENGGFS, with several hauls per statistical rectangle.

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:

$\mathbf{B}_{lim}$ = 225,000 t; $\mathbf{B}_{pa}$ = 315,000 t; $\mathbf{F}_{lim}$ = 0.90; $\mathbf{F}_{pa}$ = 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.

Appendix 1 Stock Annex template.

Quality Handbook ANNEX:____

Stock specific documentation of standard assessment procedures used by ICES.

Stock:… North Sea sole…………………………………………………….

Working Group:… WGNSSK…………………………………

Date: 09-09-2004

A. General

A.1. Stock definition

The sole in the North Sea (IV) are considered to be a separate stock from the smaller stock in VIId. There is some movement of juvenile sole from the North Sea into VIId (ICES CM 1989/G:21) and from VIId 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.

A.2. Fishery

Sole is mainly taken by beam trawlers in a mixed fishery with plaice in the southern part of the North Sea. Fishing by different countries is described below:

Belgium: The Belgian fleet operates out of 2 main ports: Oostende and Zeebrugge. The majority of the fleet use beam trawl exclusively and fish for sole an plaice. The fishing grounds change throughout the year depending on catch rates, although the central and southern North Sea (IVb,c) are the preferred fishing area of the Belgian fleet.

Denmark: The main Danish fishery is a directed one for sole using fixed nets although there is also a little effort using beam trawling, and some by-catch in otter trawlers.

Germany: The German sole fishery can be divided into three segments: 7 large beam-trawl vessels >30m, 20-30 Euro-cutters and a varying number of small shrimp beam-trawl vessels catching sole during Q2 & Q3.

The Netherlands: A high proportion of the fishing effort in the North Sea is by Dutch beam trawlers fishing for plaice and sole. The introduction of the Plaice Box in 1989 resulted in a change in the distribution pattern of beam trawl vessels > 300 HP with an increase in activity outside and to the north of the Box.

UK: The English fleet consists of a large number of small otter trawlers fishing in the southern North Sea for sole mainly in the 2 nd and 3 rd quarters of the year. Prior to 2002, Sole was also taken as by-catch in the English beam trawl fishery (9 vessels) which fished mainly for plaice with 120mm mesh. Since 2002, these vessels do not participate in the fishery any more. These vessels landed the majority of the catch in The Netherlands.

Technical measures applicable to the sole fishery before 2000 were an exemption to use 80 mm mesh codend when fishing south of 55° North. From January 2000, the exemption area extends from 55° North to 56° North, East of 5° E latitude. Fishing with this mesh size is permitted within that area providing that the landings comprise at least 70% of a mix of species which are defined in the new technical measures of the EU [EU 850/98]. Some additional protection is given to sole fron the closure of the plaice box along the Dutch and danish coast. in the year 1989 to 1993 the box was closed in the second and the third quarters of the year to all vessels using towed gears and with engine power larger than 300 HP. Since 1994 the box has been closed during all quarter.

A.3. Ecosystem aspects

Rijnsdorp et al. (ICES CM2004/K:13) describes the changes in growth of plaice *Pleuronectes platessa* L. and sole *Soleasolea* (L.). The changes are analysed to explore changes in the productivity of the North Sea.. Based on market sampling data it was concluded that both length at age and condition factor increased since the mid 1960s to reach a highest level in the mid 1970s. Since the mid 1980s, length at age and condition decreased to a level intermediate between the low level around 1960 and the high level around 1975. Growth rate of the juvenile age groups was negatively affected by intra-specific competition. Length of 0-group fish attained in autumn showed a positive relationship with the temperature in the 2 nd and 3 rd quarter, but for the older fish no temperature effect could be detected. Also, no correlation could be detected with the NAO-index. 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. It is concluded that the productivity of the southeastern North Sea for flatfish has decreased over the last two decades, possibly in relation to a decrease in the in$\mathbf{F}_{low}$ of nutrients and an overall change in the

North Sea ecosystem.

A.4 Management reference points

The management reference points for this stock are presented in the text table below:

$\mathbf{F}_{lim}$	$\mathbf{F}_{pa}$	$\mathbf{B}_{lim}$	$\mathbf{B}_{pa}$
undefined	0.40	25000t	35000t

B. Data

B.1. Commercial catch

The text table below show the countries and the kind of data they provide to the Working Group.

Country	**Catch weights**	**Catch numbers at age**	**Weight in catch**	**Length composition**
The Netherlands	X	X (by sex)	X (by sex)	X (by sex)
Scotland	X			
UK (England,Wales)	X	X	X	X
UK (Northern Ireland)	X			
Germany	X	X	X	
Belgium	X	X	X	X
France	X	X	X	
Denmark	X	X	X	
Norway	X			

The catch weights are based on official logbookdata corrected with unallocated landings which represent the difference between official landings and the figures supplied by the WG members. Catch numbers ata age are derived from market sampling programmes. The age compositions were combined on a quarterly basis and then raised to the annual international total.

Data are supplied as FISHBASE files containing quarterly numbers at age, weight at age, length at age and total landings. The files are aggregated by the stock coordinator to derive the input VPA files in the Lowestoft format. No SOP corrections are applied to the data because individual country SOPs are usually better than 95%. The quarterly data files by country as well as the input files can be found with the stock co-ordinator (Sieto Verver, RIVO, The Netherlands, sieto.verver@wur.nl).

Despite the data regulation that came into action in 2002, no structural sampling takes place to collect samples from national vessels which land abroad and this constitutes for an substatial part of the total landings by some countries. Some samples are taken but there is no international exchange system for this information available.

Discarding is not considered to be a problem in the sole fishery.

B.2. Biological data

Weights

Weight at age in the catch are measured weights from the various national market sampling programmes of the landings. Weight at age in the stock are those of the 2nd quarter in the landings.

No clear trends in weights are evident over the last years, although age 7 to 13 and older show a slight decline in stock weight at age. This decline is supported by the average decline in length for these ages for the most important fleets over the last years. The sexratio for quarter 2 over the period 1986 to 2002 do not show an evident change, at most a small increase in the number of males at the older ages that could support the decrease in the stock weight. This increase is not further explored during the benchmark assessment in 2003 (ICES CM 2004/ACFM:07) (check the year).

Maturity

A knife-edged maturity was used in all years, assuming full maturation at age 3. This maturity-ogive is based on market samples of females in the sixties and seventies. A working document was presented to the WG in 2003 describing an international collaboration (COMPASS) to explore how to determine annually varying maturity ogives for North Sea flatfish from market and research samples and the consequences of such ogives on the stock assessment and the biological reference points. The explorations have so far not produced results that can be used for the assessment.

Natural mortality

Natural mortality has been assumed constant over all ages at 0.1, except for 1963 where a value of 0.9 is used to take into account the effect of the severe winter (ICES CM 1979/G:10). In 1996 additional natural mortality was observed in the cold winter of 1995/1996, but in the absence of precise estimates, the standard value of 0.1 has been retained (ICES 1997e/Assess:6).

B.3. Surveys

The SNS (Sole Net Survey) is a coastal survey with a 6- m beam trawl carried out in the 3 th quarter. 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 BTS survey indices were revised in 1998 (ICES CM 2000/ACFM:07) and again examined this year. The procedure to convert length distribution into age distribution was improved and database corrections were carried out. These changes resulted in minimal changes. Figure 9.3.1 (Section North Sea plaice) shows a map of the distribution of the surveys.

The Demersal Young Fish Survey (DFS) is an international survey (The Netherlands, England, Belgium and Germany), which covers the coastal and estuarine areas of the southern North Sea. This survey is directed to 0 and 1-group plaice and sole. The combined international DFS index is only used for RCT3 analysis and not for tuning the VPA.

B.4. Commercial CPUE

Effort data is available from Belgium, UK and The Netherlands. Only the latter is used for tuning. Effort in the Netherlands commercial beam trawl is total HP effort days and this has nearly doubled between 1978 and 1994. Since 1996 the effort show a decline and the effort is around the same level as it was in the early 1980's.

The English effort is based on the effort from otter trawlers mainly fishing for sole in area IVc. Effort is in HP*hrs and excludes trips directed at cod or shrimps.

The Belgium effort is based on fishing hours corrected for fishing power.

B.5. Other relevant data

None.

C. Historical Stock Development

Model used: XSA

Software used: Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability dependent on stock size for ages < 2

Regression type = C

Minimum of 5 points used for regression

Survivor estimates shrunk to the population mean for ages < 2

Catchability independent of age for ages >= 7

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

S.E. of the mean to which the estimates are shrunk = 2.000

Minimum standard error for population estimates derived from each fleet = .300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1957 -2003	1-10+	Yes
Canum	Catch at age in numbers	1957 -2003	1-10+	Yes

Weca	Weight at age in the commercial catch	1957 -2003	1-10+	Yes
West	Weight at age of the spawning stock at spawning time.	1957 -2003	1-10+	Yes
Mprop	Proportion of natural mortality before spawning	1957 -2003	1-10+	No
Fprop	Proportion of fishing mortality before spawning	1957 -2003	1-10+	No
Matprop	Proportion mature at age	1957 -2003	1-10+	No
Natmor	Natural mortality	1957 -2003	1-10+	No

Tuning data:

Type	Name	Year range	Age range
Survey fleet	NL-BTS ISIS	1985-2003	1 - 9
Tuning fleet 2	NL-SNS	1970 - 2002 (no 2003 survey)	0 - 4
Tuning fleet 3	NL Comm BT	1990 - 2003	2 - 9

D. Short-Term Projection

Fishing mortality at age were the average over the last 3 years, scaled to the reference F(2-6). Weight at age in the catch and in the stock are averages for the last 3 years. The maturity ogive and natural mortality were the same as XSA.

Model used: Age structured.

Software used: WGFRANSW.

Initial stock size: Taken from XSA for age 3 and older. The number at age 1&2 in the last data year is estimated using the geometric mean over a long period (1957 –last data year).

Maturity: Set to 1 for age 3 and older in all years, same as in XSA.

F and M before spawning: Set to 0 for al ages in all years.

Weight at age in the stock: Average weight over the last 3 years.

Weight at age in the catch: Average weight over the last 3 years.

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used: Long term geometric mean for age 1 is used

Procedures used for splitting projected catches: none.

E. Medium-Term Projections

Not carried out during WG2004

Model used: (WG2003) Age structured

Software used: (WG2003) WGMTERMc

Settings used a in short term projections

F. Long-Term Projections

Not carried out.

Model used:

Software used:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

G. Biological Reference Points

The biological reference points and the basis for the management reference point are:

B_{lim}=B_{loss}=25 000 t. B_{pa} = 1.4 *B_{lim}.

F_{pa} = 5th percentile (0.49) of F_{loss} implies $B_{eq} < \sim B_{pa}$,

F=0.4 implies $B_{eq} > B_{pa}$ and P(SSBMT < B_{pa}) < 10%.

H. Other Issues

I. References

ICES 1979. Report of the Flatfish Working Group. ICES CM 1979/G:10

ICES 1997. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, October 1996. ICES CM 1997/Assess :6

ICES 2000. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, October 1999. ICES CM 2000/ACFM:7