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Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

6 - 15 September 2005

ICES Headquaters Copenhagen

International Council for the Exploration of the Sea

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0 Executive summary

The ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) met at ICES Headquarters in Copenhagen, Denmark, during 6-15 September 2005. There were 28 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; to evaluate stock recovery plans, to comment on the outcome of existing management measures, to consider environmental drivers of fish population dynamics and effects of fisheries on ecosystems, to update descriptions of fisheries, and to consider measurement and estimation of misreporting and discards.

0.1 Working procedures

The rates of change of fisheries and fish stocks in the areas covered by the Working Group (WG) are rapid. A consequence of this is that stock assessment methods that were applicable and appropriate in previous years may no longer be so, and the WG's previous practice of designating a number of stocks as **update** assessments was found to be problematic for this reason. Additionally, the addition of 10 *Nephrops* functional units and several new Terms of Reference to the workload of the WG meant that the detailed analyses of data and assessment methods required for **benchmark** assessments were difficult to achieve during the meeting itself. There was therefore no strict adherence to the benchmark/update timetable previously agreed by ACFM. To allow as full an exploration of data and methods as possible, much reliance was placed this year on preliminary analyses performed before the meeting, as well as on subgroup meetings held during the WG.

The **format** of each stock section was changed this year. The intention was to improve the readability of the report, and the consistency of approach between different stock sections. The new General section features four subsections: ecosystem aspects, fisheries, ICES advice, and management. These summarise the important and salient current features that the WG concluded would be useful and helpful for fisheries managers to be aware of. Some of this information was taken from the stock **Quality Handbooks**. These were not modified further in general, although there are exceptions. The Handbooks are intended as a repository of information which does not change from year to year, and (as mentioned above) this is often not applicable for this WG. Quality Handbooks will be edited intersessionally to remove excessive repetition of material now presented in the stock sections.

0.2 State of the stocks

The estimated yield (landings and discards) for **cod in Subarea IV and Divisions IIIa and VIId** was the lowest in the historical time-series (34,500 t). Exploratory analyses suggested that SSB and recruitment were also very low in 2004. However, estimates of mortality in 2004 were extremely sensitive to sparse data from research-vessel surveys, and the final assessment has been delayed pending the conclusion of the third-quarter English groundfish survey. The third-quarter Scottish groundfish survey indicated large numbers of juvenile cod in coastal waters off north-eat Scotland, but this perception is very uncertain and will need to be confirmed by subsequent surveys.

The strong 1999 year-class again dominated the catches of **haddock in Subarea IV and Division IIIa** in 2004 (66,500 t). However, the contribution of this year-class to the fishery appears to be drawing to a close, and this estimated yield was the lowest in the historical time-series. Recruitment following the 1999 year-class has been low, and SSB will decline further in the short-term. All sources of information agree that fishing mortality has declined rapidly in this fishery to at or near an historical minimum. Indications from the third-quarter Scottish groundfish survey are that the 2005 year-class may be stronger than those in recent years.

Catches of **whiting in Subarea IV and DivisionVIId** have continued to decline, and are now at their lowest-observed level (29,000 t). Recent information from both commercial fleets and research-vessel surveys indicate similar trends in mortality, biomass and recruitment, with all three being at their lowest-observed levels. This concordance in recent data has led the WG to present a final assessment for whiting in this year's report (there was no final assessment presented last year). However, stock trends are considerably different in earlier years depending on whether catch data (which indicate high abundance) or survey data (which indicate low abundance) are used, and the WG could not describe recent stock trends in terms of biological reference points.

The estimated SSB for **saithe in Subareas IV and VI and Division IIIa** is still above B_{pa} and is apparently increasing, which is consistent with last year's assessment. Fishing mortality is at or near the historic low, and recruitment remains just below 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, and in this year's assessment the recruiting age was increased to 3 to resolve this. Reported landings for 2004 (104,000 t) were around the recent mean.

Landings of **sole in Subarea IV** in 2004 (17,000 t) were at a similar level as in recent years. SSB has fluctuated around a moderate level for several years and for 2004 was estimated to be above B_{pa}. Fishing mortality appears to have declined rapidly in 2004 and, although uncertain, is now estimated to be below F_{pa}. After the strong 2001 year-class, recruitment has fallen back down to near the mean of the full time-series.

The yield of **sole in Division VIId** in 2004 was at or near the historic maximum. Fishing mortality is estimated to be around F_{pa}. SSB is above B_{pa} (8000t) following improved recruitment in recent years, particularly of the year classes 1998 to 2000 and 2003.

As last year, the assessment for **plaice in Subarea IV** included discards (based on sampling after 1999, growth modelling before 1999). Although reported landings for 2004 are at the lowest observed level (61,500 t), estimated total catches (120,000 t) are around the recent average. SSB is estimated to be stable, but low and fluctuating between B_{pa} and B_{lim}. Fishing mortality is fluctuating around a high level, when compared to historical estimates for this stock. Both the 2001 and 2003 year-classes are estimated to have been strong.

Plaice landings **in Division IIIa** have remained stable since 1997 with landings of 9,000 tonnes in 2004. Historically, the TAC has not been restrictive for this stock. About 82% of the landings were taken in Skagerrak. No final assessment could be produced for this stock.

Landings of **plaice in Division VIId** were below the recent mean, and near the historical minimum. Discrepancies between catch-at-age based analyses and surey-based analyses has prevented the WG from assessing the state of this stock.

Landings in 2004 for **sandeel in Subarea IV** (359,000 t) remained at or near the same low level as in 2003. Landings in 2005 have continued this trend, and following the implementation of a real-time management plan, the fishery was closed on the 2nd July 2005. Estimated SSB is at its lowest observed level. Fishing mortality has declined in recent years but is still high in comparison with the historical estimates, while recruitment remains low.

Landings for **Norway pout in Subarea IV** in 2004 (13,500 t) were the lowest observed. The directed Norway pout fishery remained closed during 2005, and only very limited bycatch was observed in other fisheries. Estimated SSB for this stock in 2004 was very near to B_{lim}, fishing mortality was the lowest in the historical time-series, and recruitment was at or near the historical minimum.

The yields for stocks of ***Nephrops*** are fairly stable from year to year. Reported landings for Functional Unit 3 (Skagerrak, 2200 t), FU 4 (Kattegat, 1600 t), FU 5 (Botney Gut, 1100 t), FU 6 (Farne Deeps, 2200 t), FU 8 (Firth of Forth, 1100 t), FU 9 (Moray Firth, 1300 t), FU 10 (Noup, 230 t), and FU 32 (Norwegian Deeps, 900 t) are all at or near the respective recent averages. Both FU 7 (Fladen, 8700 t) and FU 33 (Off Horn Reef) are at their highest-observed levels. Indications from TV surveys for FUs 6, 7, 8, and 9 are that stock densities are fluctuating about a long-term mean.

0.3 Mixed fisheries data collation

Data collation for the purposes of mixed-fisheries analysis has been continued this year (see Section 15), building on the work of previous meetings of WGNSSK, as well as SGDFF and more recent meetings under the auspices of EU STECF. Low levels of observer discard sampling limits the conclusions that can be drawn from this database about catch composition, and the results presented here are limited to extrapolations from Scottish and German sampling.

0.4 Environmental and ecosystem considerations

The WG was asked to “incorporate (where appropriate) existing knowledge on important environmental drivers for stock productivity and management into assessment and prediction, and important impacts of fisheries on the ecosystem.” This was addressed in each stock section, where information was available to the WG. However, due to a lack of firm conclusions in the literature on causative mechanisms linking fish stocks and the environment, and poorp predictability of ecosystems, no quantitative modifications were made to assessments or forecasts to account for environmental information. The report is limited to comments on potentially-important ecosystem impacts.

0.5 Long-term advice

Time constraints prevented the WG from expanding upon the analyses presented at the ICES *Ad Hoc* Group on Long-Term Advice (AGLTA) in April 2005. The stock sections, therefore, do not include evaluations of management plans, or long-term population projections..

0.6 Data-collation issues

The provision, exchange and raising of landings and discard data remains a serious problem for the WG, for both single-species and mixed-fisheries analyses. 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. The WG recognized the need to develop software that can be used to compile and aggregate the raw input data for assessment working groups. 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). Several initiatives are underway to develop such an approach, such as InterCatch and FishFrame, but so far these have not resulted in systems that are appropriate for assessment WGs and are designed to deal with data at a high level of aggregation. Any such system also relies completely on the timely and complete provision of data by national sources, and this cannot always be guaranteed. The WG believes that inputs from stock assessment data collators are essential for any such approach to be successful.

1 General

1.1 Terms of reference

The **Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak** [WGNSSK] (Chair: Coby Needle, UK) met in ICES Headquarters 6-15 September 2005 to:

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

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

c.) provide the data required to carry out multispecies assessments (quarterly catches and mean weights-at-age in the catch and stock for 2004 for all species in the multispecies model that are assessed by this Working Group).

WGNSSK will report by 17 September 2005 for the attention of ACFM.

WGNSSK, WGSSDS, WGHMM, WGMHSA, WGBFAS, WGNSDS, WGNPBW, AFWG, HAWG, NWWG, and WGPAND will, in addition to the tasks listed by individual group, in 2005:

1. for stocks where it is considered relevant, review limit reference points (and come forward with new ones where none exist) and develop proposals for management strategies including target reference points if management has not already agreed strategies or target reference points (or HCRs) following the guidelines from SGMAS (2005) and AMAWGC (2004 and 2005);
2. comment on the outcome of existing management measures including technical measures, TACs, effort control and management plans;
3. based on input from WGRED incorporate (where appropriate) existing knowledge on important environmental drivers for stock productivity and management into assessment and prediction, and important impacts of fisheries on the ecosystem;
4. update the description of fisheries exploiting the stocks, including major regulatory changes and their potential effects. The description of the fisheries should include an enumeration of the number, capacity and effort of vessels prosecuting the fishery by country;
5. where misreporting is considered significant provide information on its distribution on fisheries and the methods used to obtain the information;
6. provide for each stock information on discards (its distribution in time and space) and the method used to obtain it. Describe how it has been considered in the assessment;
7. provide on a national basis an overview of the sampling of the basic assessment data for the stocks considered;
8. provide specific information on possible deficiencies in the 2005 assessments including, at least, any major inadequacies in the data on landings, effort or discards; any major inadequacies in research vessel surveys data, and any major difficulties in model formulation; including inadequacies in available software. The

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

ToR a1 is addressed in Section 3, ToR a2 in Section 4, ToR a3 in Section 5, ToR a4 in Section 9, ToR a5 in Section 6, ToR a6 in Sections 7, 8, 12, and 13, and ToR a7 in Section 14. Section 1.5 (Data for other Working Groups) provides the information requested in ToRs b and c. Of the additional ToRs to be addressed by all assessment WGs, ToR 1 was not covered due to lack of time. ToRs 2 and 3 are addressed in each stock section (Sections 3 to 14), where information was available to the WG: however, no quantitative modifications were made to assessments or forecasts to account for environmental information and the report is limited to comments on potentially-important ecosystem impacts. Section 15 (Mixed fisheries data collation) presents progress made in addressing ToR 4. Misreporting, discarding or other sources of unaccounted removals (ToRs 5 and 6) are considered in several stock sections. An overview of sampling rates for basic assessment data (ToR 7) is given in Section 2.2.4, while sampling for the purposes of mixed fisheries data collation is discussed in Section 15. Discussions regarding the quality of each assessment, in terms of data and modelling (ToR 8), are given at the end of each stock section.

1.2 Data sources and sampling levels

1.2.1 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.

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

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

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

In a number of cases, uncertainties in the landing data can seriously affect the quality of the assessments and catch forecasts. In some cases, the WG estimates of the landings include specific corrections for misreported or unreported landings. These are discussed in the relevant stock annex sections of the Quality Control Handbook. There are signals that **unallocated removals** of various kinds occur in other stocks, especially in the stocks of valuable species: these removals may be due to fisheries (unrecorded discards, misreporting, or non-reporting) or to ecosystem changes. However, by their nature these these could not be verified or quantified. Continued concerns about the quality of North Sea cod landings data in particular have been addressed in this year's report (Section 3) by the use of an assessment method which estimates the magnitude of unallocated removals via research-vessel survey information.

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

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

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

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

1.2.1.2 Discards

Estimates of **discards** are used in the assessments for cod, haddock, whiting and plaice in the North Sea. All the discard data available for other species has been presented in the report (see the relevant stock sections). Some of these data are available in a form suitable for inclusion in the mixed-fisheries database, and these are discussed in Section 15. For the remaining species, the existing discard time-series appear to be based on sampling that is too sparse 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. Data from other sampling programmes were made available for this process, but not in a form that could be used in the roundfish discard collation procedure. Discard estimates for plaice in the North Sea were obtained by a combination of observations from the Dutch and English beam-trawl fisheries for recent years, and reconstructions based on observed growth for earlier years (see Section 9).

Problems with data collation procedures are discussed in Section 1.2.6.

1.2.1.3 Natural mortality

Natural mortality cannot readily be distinguished from fishing mortality by analyses of catch-at-age and research-vessel survey data. Therefore, unless stock analysis is conducted on the basis of total mortality (as is the case with the SURBA model, Section 1.3.3), natural mortality must be estimated separately from the assessment procedure. The estimates of natural mortality for cod, haddock and whiting are based on historical estimates of multispecies predation rates (ICES 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, and at 0.4 per quarter for all age groups of Norway pout. For sandeel, the natural mortalies used are derived from multispecies considerations, although they are not exactly the same (see the sandeel stock annex in the Quality Control Handbook).

New natural mortality estimates from the Study Group on Multispecies Assessments in the North Sea (SGMSNS, ICES CM 2005/D:06) were made available to the WG, and alternative assessments using them were explored for cod (Section 3) and sandeel (Section 12).

1.2.1.4 Commercial fleet and research vessel data

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

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

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

1.2.2 Norway pout and sandeel

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

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

- data on sandeel natural mortality from the MSVPA.

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

The sampling of Norway pout and sandeel landings are described in detail in the relevant Quality Control Handbooks (see Annex B). 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), and D12 (Norway pout, if not sandeel and catch taken east of 0°E). The samples are raised to total landings on the basis of sales slip information on landed categories. Effort is estimated from the total number of trips and an estimate of average days-at-sea per trip.

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

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

The maturity ogives for Norway pout and sandeel are kept constant over the whole period of assessment.

1.2.2.2 Natural mortality

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

1.2.2.3 Commercial fleet and research vessel data

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

For sandeel, only data from the Danish and Norwegian commercial fleets are available. Indices from research-vessel surveys are in development for sandeel, and are described in Section 13.1.12.

1.2.3 Nephrops

1.2.3.1 Landings, length frequencies

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

The differences in catchability between sexes have lead to the two sexes being assessed separately. And hence removals are raised separately for each sex. Trawl and creel fisheries are sampled separately.

In the absence of routine methods of direct age determination in *Nephrops*, age compositions of removals were inferred from length compositions by means of ‘slicing’. This procedure, introduced at the 1991 *Nephrops* WG, uses von Bertalanffy growth parameters to determine length boundaries between age classes. All animals in length classes between boundaries are assigned deterministically to the same age class. The method is implemented in the L2AGE programme which automatically generates the VPA input files. The programme was modified in 1992 to accommodate the two-stage growth pattern of female *Nephrops* and again in 2001 to separate ‘true’ as opposed to ‘nominal’ age classes). The age classes are ‘true’ to the extent that the first slicing boundary, i.e. lower length boundary for ‘age’ 0, is the *length-at-age* zero rather than the lowest length in the data. This ensures comparability of ‘age’ classes across stocks.

1.2.3.2 Discards

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

1.2.3.3 Natural mortality

A natural mortality rate of 0.3 is assumed for all age or length classes and years for males and immature females, with a value of 0.2 for mature females. The lower value for mature females reflects the reduced burrow emergence while ovigerous, and hence an assumed reduction in predation.

1.2.3.4 Commercial fleet and research vessel data

Landings at age and effort data for various national *Nephrops* trawl fleets are used to generate CPUE or LPUE indices. Catch at age are estimated from raising length sampling of discards and landings to officially recorded landings, and slicing into ages (knife edge slicing using growth parameters). CPUE is estimated using officially recorded effort (hours fished) although there are concerns over the accuracy of landings and effort for some stocks. There is no account taken of any technological creep in the indices.

Underwater TV survey: The burrowing nature of *Nephrops*, and variable emergence rates mean that trawl catch rates may bear little resemblance to population abundance. An underwater TV survey has been developed, estimating *Nephrops* population abundance form burrow density raised to stock area. A random stratified sampling design is used, on the basis of sediment strata and a regular grid. The survey provides a total abundance estimate, and is not age or length structured.

1.2.4 Sampling levels and 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 CM 1999/ACFM:3). Since 2002 an EU regulation (1639/2001) has been in place which has altered market sampling procedures. Firstly, each country is obliged to sample all fleet segments, including foreign vessels, landing in their country. Secondly, a minimum number of market samples per tonnes of landing are required. The national market sampling programmes have been adjusted accordingly.

Table 1.2.1 gives an overview of the sampling levels in 2004 for each stock, for both landed and discarded components of catch.

1.2.5 Problems with data collation

The provision, exchange and raising of landings and discard data remains a serious problem for the WG, for both single-species and mixed-fisheries analyses. 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. The WG recognized the need to develop software that can be used to compile and aggregate the raw input data for assessment working groups. 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). Several initiatives are underway to develop such an approach, such as InterCatch and FishFrame, but so far these have not resulted in systems that are appropriate for assessment WGs and are designed to deal with data at a high level of aggregation. Any such system also relies completely on the timely and complete provision of data by national sources, and this cannot always be guaranteed. The WG believes that inputs from stock assessment data collators are essential for any such approach to be successful. For example, no consistent data-exchange format has been agreed by ICES.

Table 1.2.2 gives a summary of data submitted to stock coordinators. As these tables were requested by the European Commission, only EU countries have been included (Norway is the principal omission).

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 an aggregation level to be useful for assessment WGs. Recent work by the Cod Recovery Subgroup of STECF (STECF 2005c) is a promising development, and is discussed in Section 15.

1.2.6 Developments in IBTS data collation

In the report of its 2004 meeting, the WG expressed concerns about the data collation procedure followed by ICES in the generation of the IBTS research-vessel survey indices. As some of these concerns remained in 2005, ICES were asked to provide the a statement on developments in IBTS data collation. This is reproduced below.

During 2005 the calculations of indices in the DATRAS database from the IBTS survey have been checked in detail.

The following checks where preformed:

1. Test that correct data are selected (correct use of e.g. validity codes)
2. Test that no data are lost in the ALK calculation (by comparing sum by age with sum by length)
3. Test that the hauls used before are equal to the hauls used now (done for Norway Pout only)
4. Test that the calculated age is equal before and now (done for Norway Pout only)
5. Test mean per statistical rectangle are equal to previous calculation (done for Norway Pout only)
6. Test that indices are equal to previously.

By running these checks a few mistakes was discovered and corrected. These errors were mainly found in the import routine.

It turned out to be too time-consuming to compare all new calculations for all species with the old calculations from the previous IBTS database and some of the differences in the results turn out to be changes in data. It was therefore decided to make a program that calculated the indices parallel with the DATRAS database. In this way it could be determined that the differences found between the old and the new indices were due to different data or problems in the calculations.

The test was done in two steps: firstly a test dataset was made by simulating an IBTS survey and thereby getting a complete dataset. Afterwards ALK where allocated to the CPUE data. The raw data was loaded into DATRAS and the two datasets with CPUE per age was compared. The two different programs got the same CPUE per age per haul.

Subsequently, the indices for Norway pout, haddock and cod based on 3 years of CPUE per age data from DATRAS were calculated both in DATRAS and externally. The comparison between the two indices calculations showed that the rounding of numbers in DATRAS had to be adjusted. The comparison after the rounding had been adjusted in DATRAS is shown in the table below. The differences are now on the 3. decimal.

Year	Q	Species	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Sum
2001	1	Cod	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2001	1	Haddock	0.000	0.001	0.000	0.000	0.000	0.000	0.001
2001	1	Norway pout	0.000	0.000	0.000	0.000			0.000
2002	1	Cod	0.001	0.000	0.001	0.000	0.000	0.000	0.001
2002	1	Haddock	0.001	0.000	0.001	0.000	0.000	0.001	0.003
2002	1	Norway pout	0.000	0.000	0.001	0.000			0.001
2003	1	Cod	0.000	0.001	0.000	0.000	0.000	0.000	0.001
2003	1	Haddock	0.000	0.001	0.001	0.001	0.001	0.000	0.003
2003	1	Norway pout	0.000	0.000	0.000	0.000			0.001
2004	1	Cod	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2004	1	Haddock	0.001	0.000	0.000	0.001	0.001	0.000	0.002
2004	1	Norway pout	0.001	0.000	0.000	0.000			0.000

The differences there still exist between the old indices and the indices calculated by DATRAS may thus be due to:

1. data have been updated in ICES but the WG indices have not been updated from year to year
2. data do not follow the standard specified in the manual

1.3 Methods and software

1.3.1 Update and benchmark assessments

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

1.3.2 Quality control handbooks

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

1.3.3 Assessment methods

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

XSA and SXSA

Extended Survivors' Analysis (XSA; Darby and Flatman 1994) has been used for catch-at-age analysis for most stocks, although it has not been selected as the final assessment in all cases. Three implementations were used. Version 3.1 of the Lowestoft VPA package was used for roundfish and flatfish stocks, while a separate implementation in the FLR package was used for plaice in the North Sea (Section 9). Seasonal XSA (Skagen 1993, 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. In some cases the level of shrinkage had a minimal effect on overall conclusions, and so was left unchanged from previous years.

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

Seasonal XSA (SXSA) was used in the sandeel and Norway pout assessments (Sections 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 user-defined weighting factors, where estimates of survivors are given a lower weighting in the second half of the year. This setting is used because the fishery inflicts the majority of 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.

B- ADAPT

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

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

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

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

and for the years with bias

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

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

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

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

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

Gavaris and Van Eeckhaute (1998) examined the potential for using a relatively simple ADAPT model structure to estimate the removals bias of Georges Bank haddock. Their model fitted a year effect for the bias in each year of the assessment time series under the assumption that bias does not distort the age composition of landings, only the overall total numbers. The authors determined that the model was over-parameterised and that it was necessary to introduce a constraint, that one year-class abundance was known exactly, in order to estimate the remaining catchability, bias and population abundance parameters. They concluded that, for the data sets to which they applied the model, the indices of abundance from trawl surveys were so highly variable that this resulted in estimates of bias with wide confidence intervals and therefore the model could only be used as a diagnostic tool.

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

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

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

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

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

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

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

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

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

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

Testing with simulated data (ICES CM 2005/ACFM:07, Appendix 4) established that increasing the uncertainty in the survey indices results in estimates of bias and the derived fishing mortality that are more variable from year to year. One solution to this problem is to introduce smoothing to the model estimates.

A constraint used frequently in stock assessment models is that of restricting the amount that fishing mortality can vary from year to year. This reflects limitations on the ability of fleets to rapidly increase capacity and the lack of historic effort regulation reducing catching opportunities. However, given the current 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:

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

Here $\mathrm{CW}_{a,y}$ 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 $\mathrm{SSQ}_{\mathrm{vpa}}$. λ is a user defined weight that allowed the effect of the smoothing constraint to be examined. The year range for the summation of the catch smoothing objective function was from the last year of the unbiased catches to the last year of the assessment.

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

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

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

TSA

An implementation (Time-Series Analysis or TSA) of the Kalman filter algorithm was used in comparative assessments for 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. It also has a tendency to generate strong retrospective patterns. 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. The version used this year assumed a constant CV on catch and survey estimates, and allowed for the separate modelling of industrial bycatch.

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. ICA was used in this report in comparative analyses for whiting.

CSA

Catch-Survey Analysis (CSA; Mesnil 2004) is an assessment method that aims to estimate absolute stock abundance given a time series of catches and of relative abundance indices, typically from research surveys. It does this by filtering measurement error in the latter through a simple two-stage population dynamics model known in the literature as the Collie-Sissenwine (1983) model. The underlying aim is to reduce the dependence on age-structured data inherent in most VPA-type assessment methods: CSA can be used with only 2 life-history stages (recruits and adults, for example), although simplifying assumptions have to be made. The application of the method and sensitivity tests of its settings are given in the text on whiting (Section 5).

SMS

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

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

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

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

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

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

with F-components defined as follows:

$F(a)$:

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

$F(q)$:

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

Age 3	$Fq_{3,1}$	$Fq_{3,2}$	$Fq_{3,3}$	0.25

F(*y*):

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

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

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

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

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

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

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

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

SURBA

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

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

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

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

SURBA is under continual development. The principal relevant changes since last year's WG are as follows:

- The model may now be fitted to several abundance indices at once, rather than one at a time. Catchability and SSQ weighting are set manually by the user.
- Smoothing down cohorts in abundance indices is no longer supported. Instead, a penalty term may be applied to penalize interannual variation in the fitted year effect.
- Uncertainty is now estimated directly from the Hessian matrix of the model parameters' variance-covariance matrix, rather than via a bootstrap as before. At the time of writing, this was implemented only for mortality and recruitment. Biomass estimates are therefore presented without confidence limits.

FLR

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

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

One of the potential applications of the FLR tool within a WG context is the modelling of different aspects of uncertainty. In this report an application of FLR was developed for North Sea plaice (Section 9) and sole (Section 7) in which this applicability was explored and tested. The application consisted of a number of steps:

- deterministic XSA analysis and short term forecast;
- deterministic XSA using different combinations of tuning fleets;
- structural uncertainty in XSA using different combinations of basic assumptions;
- data uncertainty in XSA using non-parametric bootstrapped tuning indices;
- data uncertainty in the short term forecast based on a bootstrapped XSA.

The combination of bootstrapping the assessment and taking the bootstrap results forward into a projection is promising, and would potentially lead to management which took more account of uncertainty than currently. However, a number of technical issues with regards to the bootstrapping still need to be resolved. It was found that for North Sea plaice, where a high shrinkage is used in the assessment, the bootstrapped assessments tended to be biased compared to the deterministic assessment. Furthermore, the resampling of residuals for ages where a power model was used for recruitment could not yet be carried out.

The general results of the explorations showed that the assessments are very sensitive to the assumptions about tuning fleets and the structural model configuration. This type of uncertainty has not yet been included in the bootstrap analysis, but it is envisioned that this could be included in a future version.

1.3.4 Recruitment estimation

For several stocks, recruitment estimates have been made using RCT3 (Shepherd 1997). This was the case when recruitment indices from 2005 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.

1.3.5 Short-term prognoses and sensitivity analyses

Short-term prognoses (forecasts) were made for all stocks for which a final assessment was presented. Half-year forecasts (to the start of 2006) 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 2005 from Seasonal XSA, rolled forwards to the start of the first quarter in 2006 using assumed mortality and weights-at-age.

Forecasts in all other cases were based on initial stock sizes as estimated by XSA (in a number of cases supplemented with separate recruitment estimates as described above), natural mortalities and maturity ogives as used in the XSA, and mean weights at age averaged over recent years (normally 3). For haddock, the mean weight-at-age of the large 1999 year-class in the forecast was modelled using a fitted growth curve. Fishing mortalities-at-age in forecasts were taken to be either the 2004 values, or a scaled or unscaled mean *F*-pattern over the most recent 3 years (depending on whether or not mean *F* showed a recent trend). Forecasts and corresponding sensitivity analyses were undertaken using either the Aberdeen suite of forecast programs or the MFDP/MFYPR software.

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

One of the potential applications of the FLR framework (see above) could be to generate probabilistic short term forecasts instead of the determistic forecasts which are now generally provided. This could circumvent lengthy discussions in WG meetings about the detailed settings of the deterministic short term forecasts, as the uncertainty that is associated with the model assumptions and the data appears to be far larger than the apparent precision which is suggested by the detailed forecasts. An example of this approach is presented in the sections of North Sea plaice (Section 9) and sole (Section 7).

1.3.6 Stock-recruit modelling and medium-term projections

Medium-term projections were not performed for any stock at this year's WG, as there was no specific requirement to do so.

1.3.7 Software versions

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

Software	**Purpose**	**Version**
B-ADAPT	Catch-at-age analysis with estimated misreporting	Compiled 03/10/2004.
CSA	Catch-at-stage analysis.	Compiled 21/09/2005.
FLR	Fisheries toolbox in R.	Core version 2.0 plus *ad hoc* additions.
ICA	Catch-at-age analysis (mixed separable and conventional VPA)	1.4 (compiled 09/09/1999).
INSENS	Generation of input files for Aberdeen Suite programmes.	Compiled 20/05/2002.
MFDP	Short-term forecast.	Unknown.
MFYPR	Yield-per-recruit analysis.	Unknown.
RCT3	Recruitment estimation.	Compiled 26/08/1996.
REFPOINT	Calculation of reference points and yield-per-recruit.	Compiled: 12/06/1997.
RETVPA00	Retrospective analysis for XSA.	Compiled 12/06/2002.
SMS	Catch-at-age analysis with a stochastic multi-species model	Unknown.
SURBA	Survey-based analysis.	3.0 (compiled 02/09/2005).
SXSA (Seasonal XSA)	Catch-at-age analysis for seasonal fisheries.	Compiled 01/09/2004.
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.
VPA95 (Lowestoft VPA suite)	Catch-at-age analysis (separable VPA, Laurec-Shepherd tuning, XSA).	Compiled 08/06/1998.
WGFRANSW	Short-term forecasts and sensitivity analysis.	1.0 (compiled 22/05/2001).

1.4 Working papers and relevant reports

1.4.1 Working papers

WD 1: Rätz, H.-J. German Otter Trawl Board Fleet as Tuning Series for the Assessment of Saithe in IV, VI and IIIa, 1995-2004

WD 2: Pastoors, M. A. and Poos, J.-J. Towards a new way of doing stock assessment

WD 3: Horwood, H. and Williamson, K. UK effort 1997-2004 and January-June 1997-2005 from the North Sea and West of Scotland

WD 4: Marrs, S. J. North Sea Stock Survey 2005

WD 5: Withdrawn.

WD 6: Rätz, H.-J. Mixed fisheries data

WD 7: Graham, N. Fishing technology issues for WGNSSK

WD 8: Williamson, K. Activity of UK vessels pair trawling with gears regulated by the cod recovery regime.

A further paper was available at the meeting but not presented:

Kraak, S.B.M. & Daan, N. The performance of XSA when exploitation varies between sub-areas.

1.4.2 Relevant reports

WGRED

The 2005 Report of the Working Group for Regional Ecosystem Description (WGRED, ICES CM 2005/ACE:01) reviewed the available ecosystem information on several ecoregions. The North Sea has been defined as one of the ecoregions. The report presents several important environmental trends which have been used in the overview section (2) of the WGNSSK report.

SGSIMUW

Report of the ICES Study Group on Stock Identity and Management Units of Whiting. ICES CM 2005/G:03.

This first meeting of SGSIMUW sought to define the intersessional work that is required to address the issue of stock structure and the definition of practical management units. Protocols based on survey data and commercial catch data were presented to illustrate the possible means to evaluate the impacts of population structuring on stock assessments. Some of them, e.g. Gadget, are outside the resource-base of the SG membership, but others that are also based on spatially disaggregated datasets (from both survey and commercial data) are likely to provide insight into the issue.

Nine working documents were presented at the meeting. Six of these were provided by non-attending contributors and focused on the analysis of various survey series, predominantly the first-quarter International Bottom Trawl Survey (IBTS Q1). The evaluations of the IBTS Q1 indices show the whiting indices to be sensitive to the spatial coverage of the survey and that since 1983, when consistent spatial coverage was first established, a generally coherent set of indices has been produced that is consistent with the corresponding results from catch-at-age analyses. The exception is that for younger ages in particular there are distinct relationships between indices and catch-at-age estimates during two separate periods (1983-1990 and 1991-to date).

Two of the working documents reviewed published information on aspects of North Sea whiting biology relevant to the evaluation of its population structure. Historical information suggests that whiting to the north and south of the Dogger Bank frontal system comprise functionally separate units with only limited movement across the boundary. Although insufficient information exists to confirm any genetic differentiation, the Study Group concluded that there was sufficient information available to support the view of separate stocks for stock assessment and management units but did not, at this meeting, define their boundaries. Current work within one research institute is directed towards resolving the population structure of whiting within the North Sea and between the North Sea and waters to the west of Scotland, but this will not report for two years.

IBTS indices were available to the SG at the start of its meeting. The ICES DATRAS data download format was adopted for distribution of the additional English and Scottish survey series to SG members for the intersessional work. The SG Chair will provide a data exchange format to North Sea coastal state institutes for the exchange of commercial catch data with rectangle-based spatial resolution. Relevant survey-based analyses are discussed in Section 5 of this WGNSSK report, but the completion of analyses based on spatially-resolved commercial catch data will depend on the availability of those data from national institutes.

SGMSNS

Report of the ICES Study Group on Multispecies Assessment in the North Sea. ICES CM 2005/D:06.

The main task of this second meeting of SGMSNS was the production an updated key run of the North Sea MSVPA and the identification of the future direction of multispecies assessment and advice in ICES.

The MSVPA key run suffers from the same problems of inaccurate catch data and methodology as the corresponding single-species assessment. Data requested from the ICES Working Groups on Seabird Ecology (WGSE) and Marine Mammal Ecology (WGMME), on sea bird and marine mammal population numbers, diet and consumption rations were not available to SGMSNS and therefore could not be included in the new key run. New estimates of consumption rates for the main predator fish species were presented and used in the key run. Compared to the previous used values the rations have increased for cod and mackerel and decreased for saithe and especially whiting.

The main difference between the 2003 and 2005 key run results is due to the re-introduction of grey gurnard and changes in predator rations. Gurnard mainly affects the predation mortalities of 0-group cod and whiting, which are two- to three-fold higher in this year’s key run. The predation mortality on the main prey species (sandeel, herring, sprat and Norway pout) have increased in this year’s key run, mainly due to the increase in mackerel and cod rations.

The key run results are considered more uncertain in the most recent years for various reasons. There has been a shift of dominance between the “traditional” MSVPA predators (cod, whiting, saithe and haddock) towards “other predators” (mainly mackerel, horse mackerel and grey gurnards), for which only rather uncertain stock abundance estimates exist. Stomach sampling has historically been focused on the “traditional” MSVPA predators and for some “other predators” the number of stomach samples is quite low. The predation mortality for the whole assessment period 1963–2003 is based on stomachs sampled for the years 1981–1991. This dataset might not reflect the diet and stock distributions today, and this could bias the estimation of predation mortality. SGMSNS concluded that there is still a long way to go until 0-group fish dynamics can be reliably modelled in multispecies models.

The future of Multispecies modelling in ICES was discussed. It is clear that ICES cannot neglect multispecies interactions in its future work where the ecosystem approach to management, stock recovery and definition of long-term goals and management will be in focus. In addition, most of the scientific work on multispecies interactions takes place in projects outside ICES and therefore ICES needs a forum for the integration of this external research into its advisory procedures.

SGMSNS proposed that a new Working Group on Multispecies Assessment should be established. The research in the WG should not be confined to a single modelling approach but should cover alternative models of multispecies interactions and in a wider geographical area. The new WG should meet annually. Every third meeting should be dedicated to constructing an updated key run with new catch data. The intervening years should be used to work on specific themes, drawing in expertise from other scientific disciplines and from out-side the ICES community. Alternatively, the WG could meet annually for key run updates in conjunction with a series of themed workshops.

New estimates of natural mortality from SGMSNS for a number of stocks were made available to WGNSSK, and were used in exploratory analyses for cod (Section 3) and sandeel (Section 13).

PGEGGS

Report of the Planning Group on North Sea Cod and Plaice Egg Surveys in the North Sea (PGEGGS), 10–12 May 2005, Lowestoft, UK (ICES CM 2005/G:11, REF. D)

The 2004 ichthyoplankton surveys covered the whole North Sea and mapped the occurrence of early stage eggs of cod and plaice. In addition new data on the spawning locations of haddock have been produced. The dataset contains additional information on hydrography and the distribution of eggs and larvae of non-target species. As well as progressing the analysis of the data beyond the initial stages presented here, the November meeting of PGEGGS will consider whether repeating the surveys in the future is justified and produce recommendations for the planning of any such survey.

AGLTA

Report of the ICES *Ad Hoc* Meeting on Long Term Advice. ICES CM 2005/ACFM:25.

The WG did not have time to review this report as planned. The WG had also intended to present a new approach to evaluating management plans for sandeel and Norway pout, but this also proved impossible.

SGMAS

Report of the ICES Study Group on Management Strategies. ICES CM 2005 /ACFM:09.

SGMAS dealt with the general approach to evaluating management plans. The report provides a check-list of issues to be addressed when evaluating management plans and an inventory of the available software for carrying out numerical parts of the evaluation process. It is recognized that not all parts of an evaluation will be amendable to numerical treatment.

The report appears to document the current state of development with regards to evaluation of management plans. There are as yet no directly useable issues or techniques which could be applied by a working group like WGNSSK.

STECF-SGRST Subgroup "Evaluating the cod recovery plan"

The Subgroup met in Ispra, Italy during June 2005 to address a Commission request to evaluate the cod recovery plan. Prior to the meeting an extensive call for data had been made. However, in attempting to collate the broad scope of data requested, the data required to consider catch-composition issues were not made available in sufficient detail. The Subgroup therefore decided to convene a second meeting in Ispra during the week following WGNSSK, following which their report would be finalised. Work has proceeded in the meantime in compiling data, and this is presented and summarised in Section 15 of the present report. Due caution must be taken in interpreting catch-composition results from these data, as discard information is very sparse and may not yet be representative.

1.5 Data for other Working Groups

1.5.1 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 commercial roundfish species from these bycatches are provided for the Norwegian fisheries (cod, haddock, saithe, whiting: Table 2.1.9) fisheries. Sample sizes were too low in the Danish fisheries in 2004 for age compositions to be determined.

1.5.2 SGMSNS

Tables 1.5.2.1 to 1.5.2.6 give quarterly catch-at-age data for Subarea IV (North Sea). These data are provided for the years 2002—2004, and for all available catch components of cod, haddock, whiting, and saithe. 2004 values only are given for plaice and sole, while data for 2002—2005 are presented for sandeel.

1.6 Recommendations

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

The WG **recommends** that its 2006 meeting be held at ICES headquarters, during dates set with regard to the previous recommendation.

Comment from the Chair

It has become more difficult over recent years for the WG to address its ToRs satisfactorily. The tasks requested of the WG have increased in number, scope and complexity. At the same time, the amount of people and time available have both remained roughly the same. The quality of the data on which to base analyses has declined: landings data are thought to be increasingly unreliable, and the ability of surveys to track very sparse stocks is also in doubt. This makes assessments more difficult, and therefore time-consuming. It is now very difficult for the WG as a whole to perform the required quality checks on the assessments and subsequent text: it is impossible for the Chair to keep an overview of the entire output of the WG. This trend has been evident for a number of years, but the inclusion of *Nephrops* stocks in the remit of the WG has exacerbated the problems. This new workload has slowed the existing work of the WG, without greatly facilitating mixed-fisheries modelling and forecasting as intended.

The WG did not formulate a specific recommendation on this matter. Instead, the Chair **requests** that ACFM give the issue of the structure of the WG due consideration. There are several possible alternatives to the current practice. Splitting the stocks assessed by the WG into two or more smaller WGs is not thought to be appropriate as the mixed-fisheries dimension would be lost. The further use of subgroups with appointed vice-chairs is a possibility. A more radical departure from the current practice would be for the WG to only review assessments completed intersessionally, and focus during the meeting on forecasting, management evaluation, ecosystem issues, fishery aspects and mixed-fishery data-collation and analyses. Although this would improve the consideration of these aspects, it would require careful thought before implementation. Tools for mixed-fisheries analysis would have to be developed. Given that the WG meeting follows immediately after the summer-holiday period, it seems likely that at least three months would be required before the meeting to work on assessments (via virtual subgroups if appropriate). There would therefore have to be a strict cut-off point (perhaps the end of June) after which new data could not be accepted, which leaves open the question of how to treat the autumn surveys. This method would also rely heavily on staff availability during the summer months, which may be problematic in institutes for which stock assessment is not the first priority.

These are suggestions only, and it is unlikely that any one approach will solve all problems. However, without change of some kind, the quality of the work done by the WG is unlikely to improve.

Table 1.2.1. Biological sampling levels by stock and country. Preliminary official landings, numbers of vessels/trips/hauls sampled, and numbers of fish measured and aged to analyses commercial catches in 2004.

Stock	Cod
Type	Landings

	Data				
Country	No. trips	No.hauls	Landings	Lengths	Ages
England	545		1989.3	25953	2774
Scotland	293		6644	35622	11857
Netherlands			1765		
Belgium	4		1661.9	2070	
Denmark	80		9772	5254	5210
France			880	0	0
Germany		131	2311.3	1849	1936
Ireland			0		
Norway			4057	4897	634
Poland			0		
Spain			0		
Sweden	22		1169.7	755	755
Grand Total	944	131	30250.2	76400	23166

Stock	Cod
Type	Discards

	Data				
Country	No. trips	No.hauls	Landings	Lengths	Ages
England			1989.3		
Scotland	46		6644	3050	1702
Netherlands			1765		
Belgium			1661.9		
Denmark			9772		
France	12	64	880	147	
Germany		47	2311.3	352	1936
Ireland			0		
Norway			4057		
Poland			0		
Spain			0		
Sweden		26	1169.7	11022	450
Grand Total	58	137	30250.2	14571	4088

Stock	Haddock
Type	Landings

	Data				
Country	No. trips	No.hauls	Landings	Lengths	Ages
England	193		1158	14610	1164
Scotland	278		39337	84054	7778
Netherlands			105		
Belgium			373.3		
Denmark	25		3190	2828	2704
France			505	253	549
Germany		81	1309.4	1884	1209
Ireland			0		
Norway			2360	13739	366
Poland			0		
Spain			0		
Sweden	0		344.9	0	0
Grand Total	496	81	48682.6	117368	13770

Stock	Haddock
Type	Discards

	Data				
Country	No. trips	No.hauls	Landings	Lengths	Ages
England			1158		
Scotland	46		39337	31610	2850
Netherlands			105		
Belgium			373.3		
Denmark			3190		
France	15	250	505	207	
Germany		17	1309.4	338	327
Ireland			0		
Norway			2360		
Poland			0		
Spain			0		
Sweden		23	344.9	828	0
Grand Total	61	290	48682.6	32983	3177

Stock	Nephrops
Type	Landings

	Data				
Country	No. trips	No.hauls	Landings	Lengths	Ages
England	30		2232.7	6535	0
Scotland	139		12916	94194	0
Netherlands			919		
Belgium			213.3		
Denmark			5187		
France			0		
Germany			62.2		
Ireland			0		
Norway			188		
Poland			0		
Spain			0		
Sweden	32		903.8	12458	0
Grand Total	201		22622	113187	0

Stock	Nephrops
Type	Discards

	Data				
Country	No. trips	No.hauls	Landings	Lengths	Ages
England			2232.7		
Scotland		64	12916	9977	0
Netherlands			919		
Belgium	11	22	213.3		
Denmark			5187		
France			0		
Germany			62.2		
Ireland			0		
Norway			188		
Poland			0		
Spain			0		
Sweden		20	903.8	7629	0
Grand Total	11	106	22622	17606	0

Table 1.2.1. cont. Biological sampling levels by stock and country. Preliminary official landings, numbers of vessels/trips/hauls sampled, and numbers of fish measured and aged to analyses commercial catches in 2004.

Stock	Norway pout
Type	Landings

	Data				
Country	No. trips	No.hauls	Landings	Lengths	Ages
England			0		
Scotland			0		
Netherlands			0		
Belgium			0		
Denmark			11345		
France			0		
Germany			106.7		
Ireland			0		
Norway			4999	509	1727
Poland			0		
Spain			0		
Sweden			2.5		
Grand Total			16453.2	509	1727

Stock	Norway pout
Type	Discards

	Data				
Country	No. trips	No.hauls	Landings	Lengths	Ages
England			0		
Scotland			0		
Netherlands			0		
Belgium			0		
Denmark			11345		
France			0		
Germany			106.7		
Ireland			0		
Norway			4999		
Poland			0		
Spain			0		
Sweden			2.5		
Grand Total			16453.2		

Stock	Plaice IIIa
Type	Landings

	Data				
Country	No. trips	No.hauls	Landings	Lengths	Ages
England			0		
Scotland			0		
Netherlands			1455		
Belgium			0		
Denmark	30		7133	4771	4232
France			0		
Germany			76.7		
Ireland			0		
Norway			80		
Poland			0		
Spain			0		
Sweden	11		316.5	911	911
Grand Total	41		9061.2	5682	5143

Stock	Plaice IIIa
Type	Discards

	Data				
Country	No. trips	No.hauls	Landings	Lengths	Ages
England			0		
Scotland			0		
Netherlands			1455		
Belgium			0		
Denmark			7133		
France			0		
Germany			76.7		
Ireland			0		
Norway			80		
Poland			0		
Spain			0		
Sweden		61	316.5	10547	366
Grand Total		61	9061.2	10547	366

Stock	Plaice IV
Type	Landings

	Data				
Country	No. trips	No.hauls	Landings	Lengths	Ages
England			7541.85		
Scotland	63		7741.65	3081	0
Netherlands			23662	4660	4660
Belgium	10		4314.4	6520	350
Denmark	13		12123	2588	2537
France			0		
Germany		119	3648.8	5055	4803
Ireland			0		
Norway			1744	232	0
Poland			0		
Spain			0		
Sweden			1.3		
Grand Total	86	119	60777	22136	12350

Stock	Plaice IV
Type	Discards

	Data				
Country	No. trips	No.hauls	Landings	Lengths	Ages
England			7541.85		
Scotland			7741.65		
Netherlands	10	310	23662	9676	310
Belgium	2	35	4314.4		
Denmark			12123		
France			0		
Germany		93	3648.8	4391	4803
Ireland			0		
Norway			1744		
Poland			0		
Spain			0		
Sweden			1.3		
Grand Total	12	438	60777	14067	5113

Table 1.2.1. cont. Biological sampling levels by stock and country. Preliminary official landings, numbers of vessels/trips/hauls sampled, and numbers of fish measured and aged to analyses commercial catches in 2004.

Stock	Plaice VIId
Type	Landings

Country	No. trips	No.hauls	Landings	Lengths	Ages
England	273		577.1	14624	1878
Scotland			0		
Netherlands			9		
Belgium	11		926.2	11900	300
Denmark			0		
France			2439	7790	1843
Germany			0		
Ireland			0		
Norway			0		
Poland			0		
Spain			0		
Sweden			0		
Grand Total	284		3951.3	34314	4021

Stock	Plaice VIId
Type	Discards

Country	No. trips	No.hauls	Landings	Lengths	Ages
England			577.1		
Scotland			0		
Netherlands			9		
Belgium	7	161	926.2		
Denmark			0		
France	12	64	2439	1021	
Germany			0		
Ireland			0		
Norway			0		
Poland			0		
Spain			0		
Sweden			0		
Grand Total	19	225	3951.3	1021	

Stock	Saithe
Type	Landings

Country	No. trips	No.hauls	Landings	Lengths	Ages
England	0		484.9	0	0
Scotland	196		7475.2	13029	5228
Netherlands			3		
Belgium			21.4		
Denmark	34		7983	5035	4994
France			11854	2628	883
Germany		57	9593.3	10505	2673
Ireland			0		
Norway			61144	30932	1990
Poland			0		
Spain			0		
Sweden			2244.9		
Grand Total	230	57	100803.7	62129	15768

Stock	Saithe
Type	Discards

Country	No. trips	No.hauls	Landings	Lengths	Ages
England			484.9		
Scotland	46		7475.2	6675	1126
Netherlands			3		
Belgium			21.4		
Denmark			7983		
France	0	0	11854	0	0
Germany		0	9593.3	0	0
Ireland			0		
Norway			61144		
Poland			0		
Spain			0		
Sweden			2244.9		
Grand Total	46	0	100803.7	6675	1126

Stock	Sandeel
Type	Landings

Country	No. trips	No.hauls	Landings	Lengths	Ages
England			0		
Scotland			29		
Netherlands			0		
Belgium			0		
Denmark	713		287743	21050	35086
France			0		
Germany			2657.8		
Ireland			0		
Norway			48667	327	1841
Poland			0		
Spain			0		
Sweden			33246		
Grand Total	713		372342.8	21377	36927

Stock	Sandeel
Type	Discards

Country	No. trips	No.hauls	Landings	Lengths	Ages
England			0		
Scotland			29		
Netherlands			0		
Belgium			0		
Denmark			287743		
France			0		
Germany			2657.8		
Ireland			0		
Norway			48667		
Poland			0		
Spain			0		
Sweden			33246		
Grand Total			372342.8		

Table 1.2.1. cont. Biological sampling levels by stock and country. Preliminary official landings, numbers of vessels/trips/hauls sampled, and numbers of fish measured and aged to analyses commercial catches in 2004.

Stock	Sole IV
Type	Landings

Country	No. trips	No.hauls	Landings	Lengths	Ages
England			534		
Scotland	144		356	7111	976
Netherlands			12869	3446	3446
Belgium	5		1451	4790	275
Denmark	1		805	86	0
France			0		
Germany		85	949	3129	143
Ireland			0		
Norway			185		
Poland			0		
Spain			0		
Sweden			0		
Grand Total	150	85	17149	18562	4840

Stock	Sole IV
Type	Discards

Country	No. trips	No.hauls	Landings	Lengths	Ages
England			534		
Scotland			356		
Netherlands	10	310	12869	920	109
Belgium			1451		
Denmark			805		
France			0		
Germany		43	949	490	143
Ireland			0		
Norway			185		
Poland			0		
Spain			0		
Sweden			0		
Grand Total	10	353	17149	1410	252

Stock	Sole VIId
Type	Landings

Country	No. trips	No.hauls	Landings	Lengths	Ages
England	287		1102	18248	2512
Scotland			0		
Netherlands			0		
Belgium	11		1465	12130	310
Denmark			0		
France			2734	7200	1567
Germany			0		
Ireland			0		
Norway			0		
Poland			0		
Spain			0		
Sweden			0		
Grand Total	298		5301	37578	4389

Stock	Sole VIId
Type	Discards

Country	No. trips	No.hauls	Landings	Lengths	Ages
England			1102		
Scotland			0		
Netherlands			0		
Belgium			1465		
Denmark			0		
France	27	314	2734	87	
Germany			0		
Ireland			0		
Norway			0		
Poland			0		
Spain			0		
Sweden			0		
Grand Total	27	314	5301	87	

Stock	Whiting
Type	Landings

Country	No. trips	No.hauls	Landings	Lengths	Ages
England	242		1304.7	17632	1626
Scotland	294		5059.6	59072	6368
Netherlands			1110		
Belgium			185.1		
Denmark			62		
France			5567	3578	2932
Germany		68	296.4	152	793
Ireland			0		
Norway			23	577	0
Poland			0		
Spain			0		
Sweden			1.8		
Grand Total	536	68	13609.6	81011	11719

Stock	Whiting
Type	Discards

Country	No. trips	No.hauls	Landings	Lengths	Ages
England			1304.7		
Scotland	46		5059.6	17290	2481
Netherlands			1110		
Belgium			185.1		
Denmark			62		
France	20	275	5567	524	
Germany		45	296.4	261	793
Ireland			0		
Norway			23		
Poland			0		
Spain			0		
Sweden			1.8		
Grand Total	66	320	13609.6	18075	3274

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

Cod in IV

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

Cod in IIIa

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

Haddock in IV

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

Haddock in IIIa

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

Whiting in IV

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

Whiting in VIId

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

Saithe in IV

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

Saithe in VI

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

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

Cod in VIId

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

Plaice in VIId

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

Nephrops FU 6 (Farne Deeps)

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

Nephrops FU 7 (Fladen)

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

Nephrops FU 8 (Firth of Forth)

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

Nephrops FU 9 (Moray Firth)

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

Nephrops FU 10 (Noup)

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

Nephrops FU 3 & 4 (Skagerrak and Kattegat)

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

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

Nephrops FU 32 (Norwegian Deeps)

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

Nephrops FU 33 (Off Horn Reef)

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

Nephrops FU 5 (Botney Gut)

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

Norway pout

	BE	DK	EE	FI	FR	DE	IE	LV	NL	PL	PT	ES	SE	UK
Landings		#				#			#				#	#
Yearly Age & Length Composition		#												
Quarterly Age composition (Landings)		#												
Discards		(#)												
Quarterly Age composition (Discards)		(#)												
CPUE		#												
Surveys: IBTS Q1		#			#	#			#				#	#
Surveys: IBTS Q3		#			#	#			#				#	#
Surveys: EGFS Q3		-			-	-			-				-	#
Surveys: SGFS Q3		-			-	-			-				-	#
Maturity Information		#											#	
Sex ratio		#											#	

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

Stock	Area	Stock numbers	Mean wt catch	Mean wt stock	Natural mort.	Proportion mature	Ages
Cod	3a47d	AC from DK, DE, NL, UK. Discard AC from DE and UK. SOP corrected.	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 DK and UK. Discard AC from UK. IBC AC from N.	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 FR, DE, NL, UK. Discard AC from DE and UK. IBC AC from DE.	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 DK, DE, FR, N, UK. Discard AC from UK (not used). IBC AC from N (not used).	Based on AC. No smoothing.	Same as mean weight in 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.	Second quarter catch weights at age	M= 0.1 (0.9 in 1963)	Mat= (0.0, 0.0, 1.0, …, 1.0)	1–10+
Sole	7d	AC from B, FR and EW (since 1985). No discards included. No SOP correction.	Based on AC. No smoothing.	Second quarter catch weights at age	M= 0.1	Mat= (0.0, 0.0, 1.0, …, 1.0)	1–11+
Plaice	4	AC from NL, EW, DK, FR, B. Discards from UK and NL. SOP corrections applied by EW and B	Based on AC. No smoothing. Calculated separately for different catch components	1st quarter catch weight	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	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.	Based on AC. No smoothing.	Same as mean weight in the catch	First half year: M1–3= (1.0, 0.4, 0.4) Second half year: M0-3= (0.0, 0.2, …, 0.2)	Mat= (0.0, 0.0, 1.0, …, 1.0)	0–4+
Nephrops	3-10, 32, 33	Relative abundance from UK surveys.	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Not applicable.

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

Stock	Area	Assessment Method	Assessment Age Range	Assessment year range	Fbar Age Range	Time taper	Catchability dependent on stock size for ages	Catchability independent of age for ages >=	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	3a47d	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	N/A
Haddock	3a4	XSA	0-7+	1963–2004	2–4	None	0	3	5 years, 3 ages	2	0.3	No	S	EngGFS	1977-2004	0-5	0.5-0.75
													S	ScoGFS	1982-2004	0-5	0.5-0.75
													S	IBTS_Q1	1982–2004	0-4	0.99-1
Whiting	47d	XSA	1–8+	1980–2004	2–6	15 yr tricubic	None	4	3 years, 4 ages	0.5	0.3	No	S	IBTS Q1	1990–2004	0–4	0.99–1
													S	ScoGFS	1990–2004	1–6	0.5–0.75
													S	EngGFS	1992–2004	1–6	0.5–0.75
Saithe	3a46	XSA	3-10+	1967-2004	3–6	20 yr tricubic	None	7	5 years, 3 ages	1	0.3	No	C	FraTRB	1990–2004	3–9	0–1
													C	NorTRL	1980–2004	3–9	0–1
													C	GerOTB	1995–2004	3–9	0–1
													S	NORACU	1995–2004	3–6	0.5–0.75
													S	IBTS Q3	1991–2004	3–6	0.5–0.75
Sole	4	XSA	1-10+	1957-2004	2–6	None	1	7	5 years, 5 ages	2	0.3	No	S	BTS-Isis	1985–2004	1–9	0.66–0.75
													S	SNS	1970–2004	1–4	0.66–0.75
													C	NL beam	1990–2004	2–9	0–1
Sole	7d	XSA	1-11+	1982-2004	3–8	None	None	7	5 years, 5 ages	2	0.3	No	C	Bel beam	1986–2004	2–10	0–1
													C	UK beam	1986–2004	2–10	0–1
													S	UK BTS	1988–2004	1–6	0.5–0.75
													S	YFS	1987–2004	1	0.5–0.75
Plaice	4	XSA	1-10+	1957-2004	2–6	None	None	6	5 years, 2 ages	0.5	0.3	No	S	BTS-Isis	1985-2004	1–9	0.66-0.75
													S	BTS-Tri	1996-2004	2–9	0.66-0.75
													S	SNS	1982-2004	1–3	0.66-0.75
Plaice	3a	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	N/A
Plaice	7d	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
N. pout	4	SXSA	0-4+	1983-2005	1–2	None	N/A	N/A	N/A	N/A	N/A	N/A	C	Comm	1982-2004	1–3	Q1
													C	Comm	1982-2004	1–3	Q3
													C	Comm	1982-2004	0–3	Q4
													S	IBTS Q1	1982-2005	1–3	Q1
													S	EngGFS	1992-2004	0–1	Q2
													S	ScoGFS	1998-2005	0–1	Q2
													S	IBTS Q3	1991-2003	2–3	Q3
Sandeel	4	SXSA	0-4+	1983-2005	1–2	None	N/A	N/A	N/A	N/A	N/A	N/A	C	North 1	1983-2005	1–3	0.25-0.5
													C	North 2	1983-2005	1–3	0.5-0.75
													C	South 1	1983-2005	0-3	0.25-0.5
													C	South 2	1983-2005	0-3	0.5-0.75

Table 1.5.2.1. Quaterly catch-at-age data for cod in subarea IV.

Cod catch numbers (1000)

		1		2		3		4		All		
		Disc.	H.cons	Disc.	H.cons	Disc.	H.cons	Disc.	H.cons	Disc.	H.cons	All
year	age											
2002	1	.	7	.	266	.	1425	.	4441	.	6139	6139
	2	.	1091	.	1501	.	1980	.	1599	.	6170	6170
	3	.	2795	.	3191	.	2870	.	1953	.	10810	10810
	4	.	665	.	596	.	344	.	244	.	1849	1849
	5	.	93	.	74	.	31	.	15	.	213	213
	6	.	90	.	99	.	58	.	26	.	273	273
	7	.	21	.	11	.	7	.	4	.	43	43
	8	.	19	.	5	.	1	.	3	.	29	29
	9	.	9	.	1	.	0	.	2	.	12	12
	10	.	1	.	2	.	0	.	2	.	5	5
	11	.	0	.	.	.	0	.	0	.	0	0
2003	0	.	.	1	.	39	.	737	.	777	.	777
	1	1106	12	1094	3	3621	66	1507	283	7328	364	7692
	2	3124	2075	3331	1686	1366	2701	634	1409	8454	7871	16325
	3	748	750	239	900	70	958	9	316	1065	2923	3988
	4	27	928	41	944	2	455	1	294	70	2620	2690
	5	13	145	0	230	0	46	0	21	14	442	456
	6	1	16	0	24	.	7	0	2	2	50	51
	7	0	28	.	14	.	3	0	5	1	49	50
	8	0	4	.	5	.	1	0	3	0	13	13
	9	.	1	.	4	.	1	.	0	.	7	7
	10	.	3	.	0	.	.	.	.	.	3	3
	11	0	0	.	1	.	.	.	.	0	1	1
2004	0	.	.	.	.	36	.	953	.	989	.	989
	1	888	.	1324	93	855	245	5839	1158	8907	1496	10403
	2	3053	483	488	694	165	1079	379	1344	4086	3602	7687
	3	875	1331	16	996	6	1154	14	793	911	4274	5185
	4	.	393	.	346	.	257	.	283	.	1279	1279
	5	.	228	.	313	.	203	.	115	.	858	858
	6	.	42	.	42	.	22	.	16	.	121	121
	7	.	10	.	13	.	2	.	6	.	31	31
	8	.	6	.	8	.	5	.	0	.	19	19
	9	.	2	.	3	.	0	.	1	.	7	7
	10	.	1	.	0	.	0	.	.	.	2	2
	11	.	0	.	0	.	0	.	0	.	0	0

Table 1.5.2.1. cont. Quaterly catch-at-age data for cod in subarea IV.

Cod Mean weight (kg)

		1		2		3		4		All		
		Disc.	H.cons	Disc.	H.cons	Disc.	H.cons	Disc.	H.cons	Disc.	H.cons	All
year	age											
2002	1	.	0.453	.	0.610	.	0.643	.	0.797	.	0.753	0.753
	2	.	0.931	.	0.943	.	0.901	.	1.477	.	1.066	1.066
	3	.	1.674	.	1.788	.	2.180	.	2.346	.	1.963	1.963
	4	.	3.593	.	3.597	.	4.443	.	5.372	.	3.987	3.987
	5	.	5.093	.	6.299	.	7.985	.	8.327	.	6.162	6.162
	6	.	7.628	.	8.156	.	9.600	.	8.373	.	8.306	8.306
	7	.	9.080	.	9.505	.	12.923	.	10.552	.	9.975	9.975
	8	.	9.018	.	13.549	.	13.076	.	12.463	.	10.348	10.348
	9	.	10.840	.	12.465	.	13.382	.	10.180	.	10.908	10.908
	10	.	13.584	.	11.227	.	14.262	.	14.050	.	12.971	12.971
	11	.	12.974	.	.	.	15.302	.	12.629	.	13.221	13.221
2003	0	.	.	0.000	.	0.046	.	0.064	.	0.063	.	0.063
	1	0.154	0.702	0.197	0.497	0.269	0.548	0.332	0.617	0.254	0.606	0.271
	2	0.324	1.026	0.285	0.993	0.366	0.984	0.643	1.389	0.339	1.070	0.691
	3	0.525	1.746	0.547	1.549	0.538	1.652	1.318	2.284	0.538	1.713	1.399
	4	0.976	2.926	0.511	2.964	0.463	3.564	1.918	3.642	0.705	3.131	3.067
	5	2.228	5.439	2.512	3.893	3.387	6.430	3.147	7.348	2.265	4.827	4.750
	6	2.699	7.775	3.192	7.228	.	8.919	3.903	8.242	2.827	7.690	7.530
	7	2.745	8.074	.	9.120	.	10.367	4.443	9.850	3.500	8.676	8.595
	8	4.371	11.456	.	10.147	.	9.032	6.474	14.245	4.948	11.429	11.301
	9	.	12.963	.	10.559	.	15.077	.	13.375	.	11.704	11.704
	10	.	10.708	.	12.228	.	.	.	.	.	10.796	10.796
	11	5.778	14.813	.	14.256	.	.	.	.	5.778	14.339	14.209
2004	0	.	.	.	.	0.043	.	0.101	.	0.099	.	0.099
	1	0.114	.	0.170	0.514	0.287	0.606	0.372	0.682	0.308	0.659	0.359
	2	0.351	0.727	0.430	0.780	0.428	1.010	0.542	1.215	0.381	1.004	0.673
	3	0.413	1.866	0.910	1.761	0.431	2.082	0.456	2.668	0.423	2.049	1.763
	4	.	2.936	.	2.941	.	3.309	.	3.968	.	3.241	3.241
	5	.	4.803	.	5.249	.	5.318	.	6.337	.	5.292	5.292
	6	.	7.546	.	7.014	.	8.805	.	8.929	.	7.772	7.772
	7	.	9.192	.	7.824	.	10.938	.	9.427	.	8.756	8.756
	8	.	9.724	.	9.835	.	9.143	.	12.332	.	9.690	9.690
	9	.	11.900	.	11.213	.	13.703	.	13.162	.	11.873	11.873
	10	.	11.919	.	12.083	.	11.759	.	.	.	11.957	11.957
	11	.	11.898	.	16.714	.	13.000	.	15.716	.	14.137	14.137

Table 1.5.2.2. Quaterly catch-at-age data for haddock in subarea IV.

Haddock Catch numbers (1000)

year	age	1 Disc.	1 H.cons	1 Ind b.	2 Disc.	2 H.cons	2 Ind.b.	3 Disc.	3 H.cons	3 Ind b.	4 Disc.	4 H.cons	4 Ind b.
2002	0	.	.	.	.	.	.	752	.	13408	244	.	35587
	1	57	.	2844	716	.	5834	1053	54	1185	2126	61	3874
	2	8128	175	779	7761	688	1259	13799	4349	1085	18832	4923	1331
	3	48076	20908	119	19839	18706	724	37818	32405	2303	20130	36711	491
	4	92	2098	6	29	1422	48	228	917	369	62	899	81
	5	1	673	3	5	485	24	2	551	.	.	262	.
	6	.	424	.	.	269	.	.	255	.	.	115	.
	7	.	92	.	.	152	.	104	130	.	33	50	.
	8	.	123	.	.	111	.	.	150	.	.	77	.
	9	.	130	.	.	59	.	.	73	.	.	7	.
	10	.	3	.	.	15	.	.	11	.	.	1	.
2003	0	.	.	.	14	.	18	290	.	3450	1729	.	765
	1	4161	.	4766	1050	.	620	5488	.	393	1729	33	161
	2	2100	133	1541	2008	80	485	5362	215	78	1349	456	6
	3	11671	1939	650	8553	1997	416	6948	4215	213	2497	4230	13
	4	18152	19967	458	9442	15863	467	4590	22769	500	2539	13802	98
	5	13	685	.	15	612	.	3	419	7	7	186	5
	6	22	188	.	3	176	.	2	132	.	4	62	.
	7	0	101	.	0	59	.	0	72	.	0	36	.
	8	0	38	.	0	38	.	0	21	.	.	12	.
	9	0	33	.	.	23	.	.	22	.	.	8	.
	10	.	19	.	.	10	.	.	14	.	.	2	.
2004	0	.	.	.	.	.	.	430	.	.	486	.	.
	1	214	.	154	2223	.	50	3112	74	352	3252	211	58
	2	1127	20	111	4614	271	64	5136	922	85	4053	1350	20
	3	588	426	21	610	622	34	791	1244	14	404	1362	15
	4	5050	4195	67	1407	3248	88	4294	6489	50	1783	7538	53
	5	6120	20149	124	3085	15076	229	4993	19568	193	2979	18461	191
	6	5	188	2	.	208	5	.	184	.	.	118	1
	7	3	43	.	.	27	4	.	28	.	.	39	.
	8	.	19	.	.	12	.	.	12	.	.	13	.
	9	.	8	.	.	8	.	.	13	.	.	6	.
	10	.	5	.	.	8	.	.	17	.	.	16	.

year	age	All Disc.	All H.cons	All Ind b.	All
2002	0	996	.	48996	49991
	1	3953	115	13737	17804
	2	48520	10136	4454	63109
	3	125863	108729	3637	238230
	4	411	5336	504	6250
	5	8	1970	27	2005
	6	.	1064	.	1064
	7	136	424	.	560
	8	.	461	.	461
	9	.	269	.	269
	10	.	29	.	29
2003	0	2032	.	4233	6265
	1	12428	33	5940	18400
	2	10819	883	2110	13813
	3	29669	12382	1291	43341
	4	34723	72402	1523	108648
	5	38	1902	12	1952
	6	31	559	.	590
	7	1	268	.	269
	8	0	109	.	110
	9	0	87	.	87
	10	.	45	.	45
2004	0	916	.	.	916
	1	8801	285	615	9701
	2	14930	2564	281	17775
	3	2392	3654	85	6131
	4	12534	21470	258	34262
	5	17178	73253	737	91167
	6	5	698	8	712
	7	3	136	4	144
	8	.	56	.	56
	9	.	35	.	35
	10	.	45	.	45

Table 1.5.2.2. cont. Quaterly catch-at-age data for haddock in subarea IV.

Haddock Catch mean weight (kg)

		1			2			3			4		
		Disc.	H.cons	Ind b.	Disc.	H.cons	Ind b.	Disc.	H.cons	Ind b.	Disc.	H.cons	Ind b.
year	age												
2002	0	.	.	.	.	.	.	0.035	.	0.021	0.062	.	0.015
	1	0.080	.	0.055	0.092	.	0.030	0.162	0.347	0.121	0.192	0.364	0.103
	2	0.150	0.345	0.121	0.184	0.367	0.130	0.234	0.465	0.221	0.271	0.406	0.224
	3	0.234	0.331	0.243	0.251	0.357	0.252	0.301	0.430	0.292	0.318	0.413	0.297
	4	0.307	0.481	0.398	0.445	0.506	0.407	0.349	0.746	0.372	0.394	0.615	0.361
	5	0.320	0.667	0.431	0.374	0.671	0.431	0.436	0.880	.	.	0.777	.
	6	.	0.828	.	.	0.976	.	.	1.027	.	.	0.936	.
	7	.	1.137	.	.	0.917	.	0.357	0.985	.	0.356	1.010	.
	8	.	1.471	.	.	1.545	.	.	1.542	.	.	0.963	.
	9	.	1.950	.	.	2.017	.	.	1.830	.	.	2.204	.
	10	.	1.913	.	.	2.227	.	.	2.298	.	.	1.936	.
2003	0	.	.	.	0.031	.	0.005	0.042	.	0.011	0.072	.	0.015
	1	0.054	.	0.024	0.124	.	0.049	0.162	.	0.093	0.196	0.315	0.029
	2	0.154	0.447	0.049	0.217	0.322	0.056	0.235	0.442	0.194	0.286	0.429	0.104
	3	0.275	0.412	0.233	0.227	0.385	0.225	0.272	0.471	0.223	0.309	0.476	0.345
	4	0.346	0.410	0.290	0.282	0.408	0.389	0.338	0.456	0.278	0.360	0.486	0.447
	5	0.560	0.647	.	0.414	0.620	.	0.455	0.789	0.287	0.580	0.735	0.420
	6	0.632	0.878	.	0.529	0.724	.	0.469	0.716	.	0.718	0.751	.
	7	0.819	1.249	.	0.789	1.199	.	0.536	1.047	.	0.845	1.048	.
	8	0.947	1.503	.	0.693	1.043	.	1.034	1.609	.	.	1.640	.
	9	1.154	1.782	.	.	1.283	.	.	1.580	.	.	2.354	.
	10	.	2.210	.	.	2.021	.	.	2.245	.	.	2.641	.
2004	0	.	.	.	.	.	.	0.039	.	.	0.068	.	.
	1	0.122	.	0.102	0.119	.	0.102	0.180	0.329	0.126	0.207	0.356	0.108
	2	0.196	0.306	0.161	0.197	0.294	0.169	0.235	0.373	0.189	0.278	0.388	0.287
	3	0.255	0.366	0.222	0.277	0.475	0.260	0.286	0.475	0.223	0.308	0.471	0.299
	4	0.285	0.397	0.243	0.297	0.428	0.296	0.323	0.467	0.214	0.345	0.455	0.325
	5	0.326	0.417	0.317	0.326	0.437	0.411	0.370	0.507	0.672	0.345	0.499	0.360
	6	0.639	0.714	0.431	.	0.632	0.596	.	0.757	.	.	0.869	0.431
	7	0.716	0.867	.	.	1.068	0.840	.	1.322	.	.	1.057	.
	8	.	1.474	.	.	1.529	.	.	1.383	.	.	1.097	.
	9	.	1.617	.	.	1.697	.	.	1.780	.	.	1.860	.
	10	.	1.875	.	.	2.170	.	.	2.254	.	.	1.414	.

		All			
		Disc.	H.cons	Ind b.	All
year	age				
2002	0	0.042	.	0.017	0.017
	1	0.164	0.356	0.064	0.088
	2	0.226	0.428	0.179	0.255
	3	0.270	0.393	0.283	0.326
	4	0.353	0.556	0.374	0.528
	5	0.380	0.742	0.431	0.737
	6	.	0.925	.	0.925
	7	0.357	0.997	.	0.841
	8	.	1.427	.	1.427
	9	.	1.939	.	1.939
	10	.	2.217	.	2.217
2003	0	0.067	.	0.012	0.030
	1	0.127	0.315	0.031	0.097
	2	0.222	0.425	0.056	0.210
	3	0.263	0.450	0.230	0.316
	4	0.329	0.439	0.327	0.402
	5	0.497	0.678	0.339	0.673
	6	0.620	0.777	.	0.769
	7	0.685	1.157	.	1.155
	8	0.947	1.380	.	1.378
	9	1.154	1.651	.	1.650
	10	.	2.200	.	2.200
2004	0	0.054	.	.	0.054
	1	0.173	0.349	0.116	0.175
	2	0.232	0.372	0.180	0.251
	3	0.280	0.461	0.251	0.387
	4	0.308	0.443	0.272	0.392
	5	0.342	0.466	0.450	0.442
	6	0.639	0.727	0.539	0.724
	7	0.716	1.053	0.840	1.039
	8	.	1.377	.	1.377
	9	.	1.740	.	1.740
	10	.	1.903	.	1.903

Table 1.5.2.3. Quaterly catch-at-age data for whiting in subarea IV.

Whiting Catch numbers (1000)

		1			2			3			4		
		Disc.	H.cons	Ind. b	Disc.	H.cons	Ind. b	Disc.	H.cons	Ind. b	Disc.	H.cons	Ind. b
year	age												
2002	0	.	.	.	.	.	.	74	.	118401	1251	.	16590
	1	722	36	170	795	13	12508	1191	208	15825	6626	1352	9698
	2	10365	445	340	4816	1082	12566	2782	2201	2027	14524	4628	3842
	3	18921	4880	340	11551	6678	5167	3688	5000	1474	7737	7879	1612
	4	2968	4323	118	2715	4184	406	1701	3137	738	1729	3966	910
	5	447	1654	8	242	1207	139	143	650	46	227	836	12
	6	151	419	.	20	356	.	18	210	.	5	231	120
	7	64	331	.	15	215	.	36	168	.	2	122	.
	8	4	127	.	9	94	.	87	117	.	.	74	.
2003	0	.	.	.	1	.	.	155	.	54375	5614	11	3600
	1	39916	.	157	716	16	5928	4423	83	8924	6897	131	2586
	2	66866	385	286	3451	1300	3289	5516	1171	650	4274	1092	823
	3	22714	1801	604	4042	1916	1209	4793	1800	294	5029	2578	474
	4	13399	3877	353	2313	3860	252	2832	2620	378	3111	2638	233
	5	1817	1487	125	845	2201	62	963	1638	170	1162	1630	34
	6	102	443	.	299	558	.	62	232	25	55	294	24
	7	2	168	.	7	96	.	4	38	.	29	72	.
	8	.	104	.	.	50	.	2	63	.	.	61	.
2004	0	.	.	.	.	.	.	91	.	21846	3167	.	1898
	1	3172	.	59	582	731	7818	868	341	3585	4746	287	1363
	2	3522	84	70	1817	387	3743	944	496	257	3389	868	430
	3	5226	1091	48	2856	1509	679	2712	1650	77	3620	2098	244
	4	4638	2760	27	3335	2233	.	1791	2096	24	3182	2299	95
	5	3003	2955	.	1563	2315	.	1474	1272	.	1526	1818	.
	6	1448	981	.	599	896	.	377	544	.	481	795	11
	7	307	164	.	44	158	.	12	138	.	70	145	.
	8	1	70	.	6	82	.	3	35	.	19	56	.

		All			
		Disc.	H.cons	Ind. b	All
year	age				
2002	0	1325	.	134991	136316
	1	9335	1609	38201	49145
	2	32487	8356	18775	59618
	3	41896	24437	8593	74926
	4	9112	15609	2172	26894
	5	1059	4346	205	5610
	6	194	1216	120	1530
	7	116	837	.	953
	8	100	412	.	512
2003	0	5770	11	57975	63755
	1	51953	230	17594	69777
	2	80107	3948	5048	89103
	3	36577	8095	2580	47253
	4	21655	12995	1215	35864
	5	4788	6956	391	12134
	6	518	1526	49	2094
	7	43	374	.	417
	8	2	278	.	280
2004	0	3258	.	23745	27003
	1	9367	1359	12825	23552
	2	9672	1836	4500	16008
	3	14413	6348	1048	21809
	4	12945	9389	146	22480
	5	7566	8360	.	15926
	6	2905	3216	11	6131
	7	433	606	.	1039
	8	29	244	.	273

Table 1.5.2.3. cont. Quaterly catch-at-age data for whiting in subarea IV.

Whiting Catch mean weight (kg)

		1			2			3			4		
		Disc.	H.cons	Ind. b	Disc.	H.cons	Ind. b	Disc.	H.cons	Ind. b	Disc.	H.cons	Ind. b
year	age												
2002	0	.	.	.	.	.	.	0.013	.	0.009	0.041	.	0.021
	1	0.045	0.291	0.031	0.065	0.149	0.039	0.092	0.172	0.036	0.161	0.189	0.061
	2	0.125	0.222	0.158	0.142	0.197	0.066	0.199	0.196	0.154	0.207	0.221	0.183
	3	0.169	0.286	0.229	0.201	0.245	0.161	0.245	0.277	0.238	0.238	0.274	0.203
	4	0.189	0.347	0.224	0.212	0.291	0.327	0.268	0.307	0.280	0.261	0.298	0.298
	5	0.220	0.383	0.461	0.188	0.315	0.415	0.290	0.329	0.407	0.222	0.294	0.407
	6	0.218	0.412	.	0.210	0.396	.	0.268	0.381	.	0.349	0.330	0.380
	7	0.264	0.423	.	0.221	0.329	.	0.296	0.354	.	0.513	0.341	.
	8	0.281	0.397	.	0.197	0.347	.	0.369	0.357	.	.	0.373	.
2003	0	.	.	.	0.000	.	.	0.017	.	0.009	0.049	0.128	0.021
	1	0.044	.	0.062	0.058	0.159	0.028	0.117	0.196	0.033	0.138	0.233	0.061
	2	0.086	0.216	0.143	0.127	0.212	0.075	0.161	0.243	0.118	0.189	0.249	0.179
	3	0.150	0.260	0.220	0.200	0.241	0.161	0.203	0.274	0.224	0.225	0.281	0.198
	4	0.201	0.358	0.288	0.230	0.305	0.271	0.243	0.319	0.341	0.260	0.308	0.293
	5	0.293	0.354	0.392	0.228	0.305	0.381	0.240	0.317	0.446	0.233	0.304	0.435
	6	0.347	0.469	.	0.223	0.352	.	0.218	0.357	0.522	0.260	0.324	0.401
	7	0.400	0.385	.	0.282	0.418	.	0.527	0.464	.	0.233	0.302	.
	8	.	0.425	.	.	0.423	.	0.055	0.364	.	.	0.304	.
2004	0	.	.	.	.	.	.	0.015	.	0.009	0.045	.	0.021
	1	0.087	.	0.065	0.063	0.211	0.027	0.113	0.181	0.033	0.134	0.253	0.061
	2	0.165	0.218	0.151	0.165	0.193	0.068	0.188	0.198	0.116	0.184	0.251	0.180
	3	0.203	0.259	0.251	0.202	0.225	0.111	0.218	0.227	0.194	0.212	0.268	0.196
	4	0.223	0.315	0.204	0.222	0.287	.	0.246	0.281	0.304	0.219	0.308	0.270
	5	0.246	0.337	.	0.232	0.327	.	0.246	0.337	.	0.236	0.340	.
	6	0.223	0.352	.	0.236	0.319	.	0.273	0.327	.	0.254	0.332	0.380
	7	0.213	0.363	.	0.344	0.329	.	0.255	0.313	.	0.254	0.330	.
	8	0.342	0.396	.	0.331	0.358	.	0.306	0.357	.	0.196	0.335	.

		All			
		Disc.	H.cons	Ind. b	All
year	age				
2002	0	0.039	.	0.010	0.011
	1	0.135	0.189	0.043	0.065
	2	0.171	0.211	0.101	0.154
	3	0.197	0.269	0.185	0.219
	4	0.224	0.312	0.293	0.280
	5	0.223	0.339	0.415	0.320
	6	0.225	0.386	0.380	0.365
	7	0.272	0.373	.	0.361
	8	0.349	0.370	.	0.366
2003	0	0.048	0.128	0.010	0.013
	1	0.063	0.214	0.036	0.057
	2	0.098	0.232	0.101	0.105
	3	0.173	0.265	0.189	0.190
	4	0.218	0.324	0.302	0.259
	5	0.256	0.318	0.418	0.297
	6	0.251	0.381	0.462	0.351
	7	0.280	0.386	.	0.375
	8	0.055	0.384	.	0.382
2004	0	0.044	.	0.010	0.014
	1	0.112	0.212	0.032	0.074
	2	0.174	0.223	0.083	0.154
	3	0.208	0.246	0.143	0.216
	4	0.225	0.299	0.263	0.256
	5	0.241	0.335	.	0.290
	6	0.237	0.334	0.380	0.288
	7	0.234	0.335	.	0.293
	8	0.240	0.363	.	0.351

Table 1.5.2.4. Quaterly catch-at-age data for saithe in subarea IV.

Species Saithe

		Catch numbers (1000)						Catch mean weight (kg)					
		1	2	3	4	All		1	2	3	4	All	
		H.cons	H.cons	H.cons	H.cons	H.cons	All	H.cons	H.cons	H.cons	H.cons	H.cons	All
year	age												
2002	0	.	13	4	9	26	26	.	0.454	0.563	0.452	0.469	0.469
	1	42	181	527	176	926	926	0.938	0.652	0.769	0.644	0.730	0.730
	2	753	2008	2221	1694	6676	6676	0.858	0.691	0.854	0.758	0.781	0.781
	3	3678	5300	4690	5070	18738	18738	1.047	0.573	0.833	0.809	0.795	0.795
	4	8075	11044	9995	12118	41233	41233	0.845	0.700	0.961	0.906	0.852	0.852
	5	3493	1567	1589	2011	8659	8659	1.240	1.222	1.440	1.389	1.308	1.308
	6	4767	1362	901	1713	8743	8743	1.628	1.691	2.071	1.939	1.744	1.744
	7	1270	507	287	317	2381	2381	2.328	1.303	3.102	2.600	2.239	2.239
	8	2225	175	168	282	2850	2850	3.005	3.199	3.917	3.127	3.083	3.083
	9	1450	74	58	212	1794	1794	3.778	4.033	5.213	4.297	3.896	3.896
	10	1676	105	103	129	2013	2013	4.250	5.348	5.691	6.203	4.506	4.506
2003	1	.	.	9	.	9	9	.	.	0.451	.	0.451	0.451
	2	430	1043	558	779	2810	2810	0.296	0.335	0.737	0.480	0.449	0.449
	3	372	3636	2989	4676	11672	11672	0.712	0.558	0.866	0.721	0.707	0.707
	4	3547	4491	4598	7260	19897	19897	0.934	0.841	1.065	0.896	0.929	0.929
	5	9485	6438	3172	5807	24901	24901	1.050	0.961	1.273	1.106	1.068	1.068
	6	4119	966	344	384	5813	5813	1.598	1.475	2.286	1.906	1.639	1.639
	7	5371	715	330	278	6694	6694	2.180	2.242	2.907	2.477	2.235	2.235
	8	1157	116	97	59	1429	1429	3.160	3.490	4.491	4.222	3.321	3.321
	9	1647	152	59	36	1895	1895	3.706	3.853	4.417	4.595	3.757	3.757
	10	1704	160	89	105	2058	2058	4.865	6.213	6.696	6.598	5.138	5.138
2004	2	67	1	126	112	307	307	0.603	0.551	0.691	0.700	0.674	0.674
	3	612	337	1917	1665	4530	4530	0.830	0.953	0.833	0.856	0.850	0.850
	4	2730	4351	4357	3063	14501	14501	0.971	0.974	1.041	1.060	1.012	1.012
	5	6042	4131	3435	3290	16899	16899	1.189	1.210	1.309	1.340	1.248	1.248
	6	6907	2833	1382	1949	13071	13071	1.514	1.521	1.733	1.755	1.575	1.575
	7	2589	412	293	386	3679	3679	2.336	2.420	3.249	2.795	2.466	2.466
	8	3089	259	210	470	4028	4028	2.908	3.315	4.134	3.725	3.093	3.093
	9	745	72	135	151	1103	1103	4.138	5.019	4.782	4.113	4.271	4.271
	10	1317	252	298	341	2208	2208	5.762	6.382	6.608	6.325	6.034	6.034

Table 1.5.2.5. Quarterly catch-at-age data for plaice in area IV.

Plaice, 2004, landings data

	Landings numbers (1000)					Landings mean weight (kg)				
	1	2	3	4	All	1	2	3	4	All
age										
1	.	3	139	441	582	.	0.186	0.232	0.210	0.215
2	580	1421	3417	4752	10170	0.225	0.241	0.255	0.256	0.252
3	15246	23162	30266	24966	93641	0.253	0.262	0.299	0.310	0.285
4	9740	13149	5786	3247	31922	0.315	0.296	0.381	0.419	0.330
5	8633	5055	3543	2226	19456	0.384	0.379	0.418	0.441	0.395
6	5315	2962	1599	1039	10914	0.430	0.408	0.469	0.479	0.434
7	2287	1048	796	345	4476	0.489	0.484	0.539	0.650	0.509
8	3005	752	231	363	4351	0.495	0.574	0.786	0.743	0.545
9	173	97	51	28	348	0.780	0.809	0.721	1.125	0.807
10	280	100	60	78	519	0.837	0.791	0.750	1.018	0.845

Table 1.5.2.6. Quarterly catch-at-age data for sole in area IV.

Sole, 2004, landings data

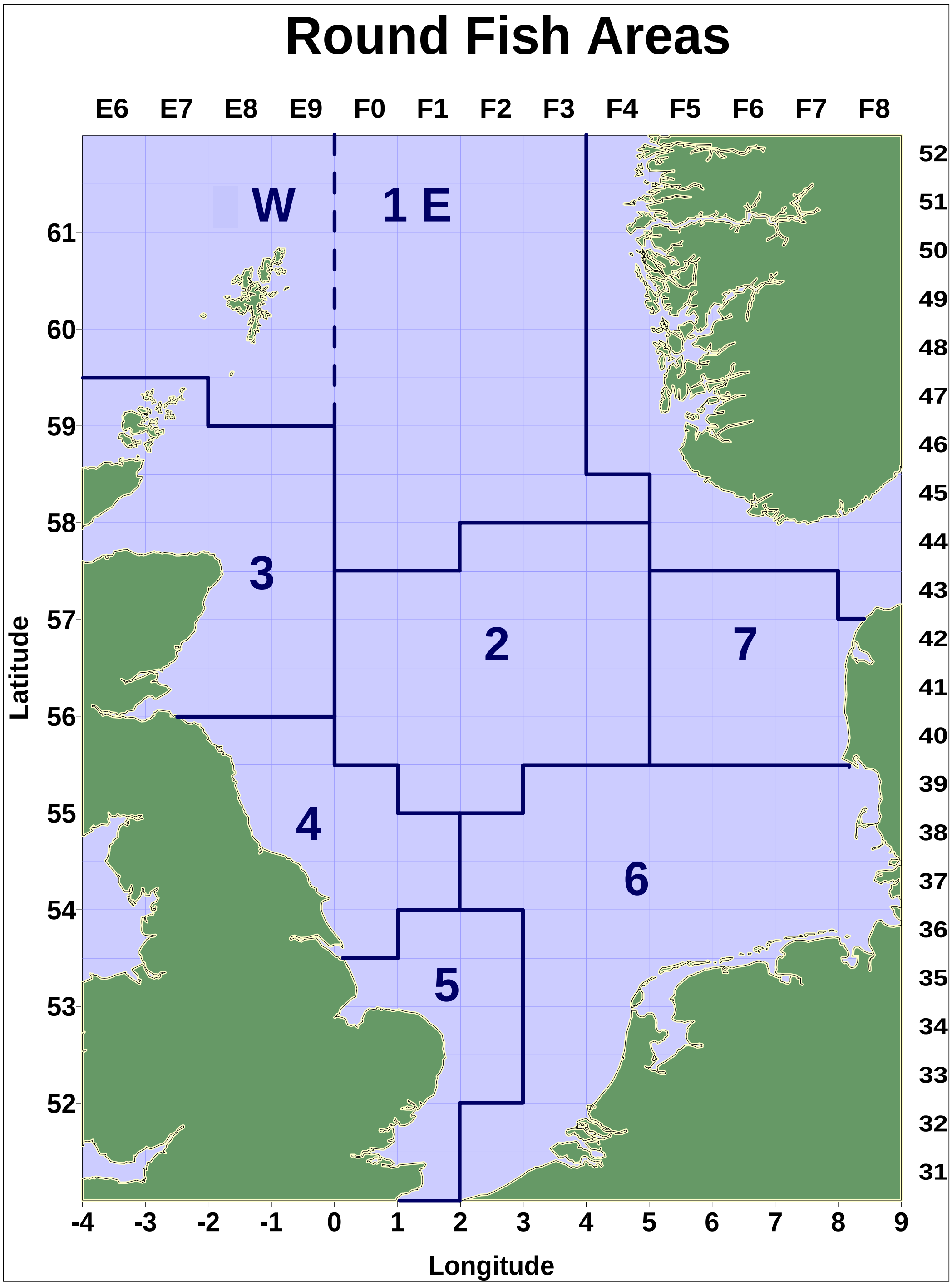
	Landings numbers					Landings mean weight				
	1	2	3	4	All	1	2	3	4	All
age										
1	.	.	376	179	555	.	.	0.121	0.138	0.126
2	568	943	4852	6997	13360	0.147	0.138	0.177	0.199	0.184
3	12953	15706	10018	7255	45933	0.204	0.194	0.218	0.239	0.209
4	1723	2144	1813	2130	7810	0.271	0.235	0.233	0.276	0.254
5	1691	2487	1383	1287	6847	0.329	0.244	0.274	0.239	0.270
6	504	548	450	366	1868	0.304	0.277	0.258	0.280	0.280
7	131	487	182	92	892	0.537	0.309	0.374	0.504	0.376
8	272	221	188	178	859	0.402	0.392	0.378	0.319	0.377
9	94	110	48	28	280	0.365	0.328	0.257	0.345	0.330
10	78	85	52	74	289	0.552	0.421	0.407	0.418	0.453

Table 1.5.2.7. Quarterly catch-at-age data for sandeel in area IV.

Sandeel

		Landings numbers(10^6)					Landings mean weight (g)				
		1	2	3	4	All	1	2	3	4	All
Year	age										
2002	0	.	432	.	.	432	.	1.09	.	.	1.09
	1	3438	102965	1527	0	107931	2.93	6.26	8.29	8.25	6.18
	2	147	11178	478	0	11803	5.79	9.00	12.60	12.63	9.11
	3	1	1462	.	.	1463	27.06	14.10	.	.	14.11
	4	1	469	.	.	470	33.59	23.83	.	.	23.85
2003	0	.	6754	11896	974	19624	.	2.15	3.04	3.34	2.74
	1	224	6982	1027	22	8255	2.78	5.38	8.06	11.19	5.66
	2	40	16856	587	24	17506	7.33	8.39	16.23	17.58	8.67
	3	178	3871	162	1	4212	7.65	10.42	17.30	17.30	10.57
	4	69	1774	28	0	1870	10.06	14.80	13.80	13.80	14.61
2004	0	.	179	5344	0	5522	.	1.73	3.13	3.56	3.09
	1	610	40059	2293	0	42962	2.17	5.68	9.00	13.13	5.81
	2	3	1652	482	0	2136	11.24	10.54	13.46	21.42	11.20
	3	21	4658	416	0	5095	13.24	11.50	13.51	18.50	11.67
	4	0	483	68	.	551	11.14	18.24	12.97	.	17.59
2005	0	.	72	.	.	72	.	2.36	.	.	2.36
	1	.	16902	.	.	16902	.	5.82	.	.	5.82
	2	.	5141	.	.	5141	.	9.57	.	.	9.57
	3	.	378	.	.	378	.	12.06	.	.	12.06
	4	.	447	.	.	447	.	13.43	.	.	13.43

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



2 Overview

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

2.1.1 Fishery descriptions

The demersal fisheries in the North Sea can be categorised as a) human consumption fisheries, and b) industrial fisheries which land the majority of their catch for reduction purposes. Demersal human consumption fisheries usually either target a mixture of roundfish species (cod, haddock, whiting), a mixture of flatfish species (plaice and sole) with a by-catch of roundfish, or *Nephrops* with a bycatch of roundfish and flatfish. A fishery directed at saithe exists along the shelf edge. Landings used by the WG for each stock are summarised in Table 2.1.1. On average 90% of the landings for reduction consist of sandeel, Norway pout, blue whiting and sprat. The industrial landings also contain by-catches of various other species (Table 2.1.2). The industrial by-catches of human consumption species landed for consumption and reduction by the Danish small-mash fleet are given for 1993-2004 in Tables 2.1.3 and 2.1.4 respectively. Similar data by quarter for 2004 are shown in Tables 2.1.5 to 2.1.9.

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

The human-consumption fisheries in the North Sea have been subject to a number of restrictive management measures in recent years, in response to declining stock abundance. These are summarised in Section 2.1.2. In addition, a series of decommissioning rounds have reduced fleet size in a number of countries. These measures have all had an effect on reported effort, although it must be remembered that fleet efficiency is not constant and realised catch rates may not have declined commensurately with effort. Recent trends in reported effort in UK fisheries are described in WD3 and WD8, which show considerable declines. Short-term effort trends have been collated as part of the mixed-fisheries data analysis, and are described in Section 15. Trends in commercial effort and CPUE on each stock is reported in the relevant stock sections. Longer-term trends in reported effort for the UK and Netherlands (all demersal gears) and for the directed Norway pout and sandeel fisheries are summarised in Figure 2.1.1.

The trends in the landings (WG estimates) of the species assessed by the WG are shown in Table 2.1.1. These data are summarised by category in Figure 2.1.2, which demonstrates that the industrial fisheries which used to dominate the North Sea catch in weight have become much less prominent. Human consumption landings have steadily declined over the last 30 years, with an intermediate high in the early 80’s. The landings of the industrial fisheries show the largest annual variations, probably due to the short life span of the main target species. The total demersal landings from the North Sea reached over 2 million t in 1974, and have been around 1.5 million t in the 1990s. The landings by country and fleet segment for the human consumption fisheries (along with some discard estimates) are presented in Section 15. Briefly, most of the human consumption landings are from the Dutch beam-trawl fishery harvesting plaice and sole, and from the Scottish fishery harvesting cod, haddock and whiting. There are strong technical interactions between the cod, haddock and whiting fisheries on the one hand, and between the sole and plaice fisheries on the other. Links with *Nephrops* fisheries are less clear. The flatfish and roundfish landings are generally taken by different fleet segments, with the exception of gill-netters which may potentially target any of these groups of species. The fisheries landing saithe have a relatively low impact on the others.

However, the fisheries directed to cod, haddock and whiting may generate discards of saithe. Most of the saithe landings are taken by the Norwegian, French and German offshore trawlers.

For some stocks, the North Sea assessment area may also cover other regions adjacent to ICES Sub-area IV. Thus, combined assessments were made for cod including IIIaN (Skagerrak) and VIId, for haddock and Norway pout including IIIa, for whiting including VIId, and for saithe including IIIa and VI. Sandeel stocks at Shetlands and in IIIa are dealt with separately.

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

2.1.2 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. Technical measures relevant to each stock are listed in each stock section – for convenience, the recent history of technical measures in the area as a whole are also summarised here.

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

2.1.2.1 Minimum landing size

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

Cod	35 cm
Haddock	30 cm
Saithe	35 cm
Whiting	27 cm
Sole	24 cm
Plaice	27 cm

2.1.2.2 Minimum mesh size

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

Towed nets excluding beam trawls

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

- ***Nephrops* fishing.** It is possible to use a mesh size in range 70-99 mm, provided catches retained on board consist of at least 30% of *Nephrops*. However, the net needs to be equipped with a 80 mm square-meshed panel if a mesh size of 70-99 mm is to be used in the North Sea and if a mesh size of 70-89 mm is to be used in the Skagerrak and Kategatt the codend has to be square meshed.
- **Saithe fishing.** It is possible to use a mesh size range of 110-119 mm, provided catches consist of at least 70% of saithe and less than 3% of cod. This exception however does not apply to Norwegian waters, where the minimum mesh size for all human consumption fishing is 120 mm. Since January 2002 Norwegian trawlers (human 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.

2.1.2.3 Closed areas

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 was 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. It was not continued into 2005.

2.1.2.4 Fishing effort limitation

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

2.1.3 Environmental considerations

The ICES Working Group for Regional Ecosystem Description (WGRED) has produced a very useful report with a description of different ecoregions (see Section 1.4.2). With regards to the short term implications of the ecosystem consideration on the advice in 2005 for the North Sea, WGRED noted that:

- The abundances of three of the major forage species in the North Sea, sand eel, Norway pout, and *Calanus* are all exceptionally low levels. This makes feeding conditions much poorer than usual for many stocks, although the magnitude of the combined effect of all three forage stocks being low at once is unknown.
- Over the past several years there has been an increase in the representation of species with more southerly distributions historically, in at least the southern and western North Sea. This change could have major implications of sustainable management of North Sea stocks and fisheries.
- For most of the demersal stocks, pessimistic assumptions of weights at age are justified due to the poor feeding conditions.
- In the longer term, experts developing management strategies and recovery planning for North Sea stocks need to consider the evidence for and implications of a permanent change in the fish community species composition of the North Sea.

2.1.4 Human consumption fisheries

2.1.4.1 Data

The level of biological sampling in 2003 for most of the stocks assessed by this WG is summarised in Table 1.2.1. The effect of the EU Data Regulation has been to increase sampling effort in some components of the fisheries, but decrease it on others.

Estimates of discarding rates from the Scottish observer sampling programme were used in the assessments of cod, haddock and whiting in the North Sea, after raising to the level of the international catch. A combination of observed (from the Dutch and English sampling programmes) and reconstructed discard rates were used in the North Sea plaice assessment. Other discard sampling programmes have been in place in recent years, but have not been used in the assessments yet because of short time-series or because of collation problems. In general, 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 continued to use a modified assessment method for North Sea cod (Section 3) which estimates unallocated removals on the basis of research-vessel survey data. Such removals may be due to reporting problems, unrecorded discards, changes in natural mortality, or changes in survey catchability, and cannot be interpreted as representing mis- or under-reporting. In addition, increased enforcement of regulations means that misreporting may be less now than previously.

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

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

2.1.4.2 Stock impressions

Historical estimates for yield, mean fishing mortality, spawning-stock biomass and recruitment are given in **Figures** 2.1.3 – 2.1.6 for the stocks considered by this WG. Note that the WG was unable to provide final assessments for cod in IV, IIIa and VIId, for plaice in VIId, and for plaice in IIIa. In addition, analytic assessments are not currently available for the ten *Nephrops* stocks.

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

The estimated yield (landings and discards) for **cod** in Subarea IV and Divisions IIIa and VIId was the lowest in the historical time-series (34,500 t). Exploratory analyses suggested that SSB and recruitment were also very low in 2004. However, estimates of mortality in 2004 were extremely sensitive to sparse data from research-vessel surveys, and the final assessment has been delayed pending the conclusion of the third-quarter English groundfish survey. The third-quarter Scottish groundfish survey indicated large numbers of juvenile cod in coastal waters off north-eat Scotland, but this perception is very uncertain and will need to be confirmed by subsequent surveys.

The strong 1999 year-class again dominated the catches of **haddock** in 2004 (66,500 t). However, the contribution of this year-class to the fishery appears to be drawing to a close, and this estimated yield was the lowest in the historical time-series. Recruitment following the 1999 year-class has been low, and SSB will decline further in the short-term. All sources of information agree that fishing mortality has declined rapidly in this fishery to at or near an historical minimum. Indications from the third-quarter Scottish groundfish survey are that the 2005 year-class may be stronger those in recent years.

Catches of **whiting** have continued to decline, and are now at their lowest-observed level (29,000 t). Information from both commercial fleets and research-vessel surveys indicate similar trends in mortality, biomass and recruitment, with all three being at their lowest-observed levels. This concordance has led the WG to present a final assessment for whiting in this year’s report. However, stock trends are considerably different in earlier years depending on whether catch data (which indicate high abundance) or survey data (which indicate low abundance) are used, and the WG could not describe recent stock trends in terms of biological reference points.

The estimated SSB for **saithe** is still above $\boldsymbol{B_{pa}}$ and is apparently increasing, which is consistent with last year’s assessment. Fishing mortality is at or near the historic low, and recruitment remains just below 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, and in this year’s assessment the recruiting age was increased to 3. Reported landings for 2004 (104,000 t) were near to the recent mean.

Landings of **sole** in 2004 (17,000 t) were at a similar level as in recent years. SSB has fluctuated around a moderate level for several years and for 2004 was estimated to be some way above $\boldsymbol{B_{pa}}$. Fishing mortality appears to have declined rapidly in 2004 and, although uncertain, is now estimated to be below $\boldsymbol{F_{pa}}$. After the strong 2001 year-class, recruitment has fallen back down to near the mean of the full time-series.

As last year, the assessment for **plaice** included discards (based on sampling after 1999, growth modelling before). Although reported landings for 2004 are at the lowest observed level (61,500 t), estimated total catches (120,000 t) are around the recent average. SSB is estimated to be stable, but low and fluctuating between $\boldsymbol{B}_{pa}$ and $\boldsymbol{B}_{lim}$. Fishing mortality is fluctuating around a high level, when compared to historical estimates for this stock. Both the 2001 and 2003 year-classes are estimated to have been strong.

The yields for stocks of ***Nephrops*** are fairly stable from year to year. Reported landings for FU 5 (Botney Gut, 1100 t), FU 6 (Farne Deeps, 2200 t), FU 8 (Firth of Forth, 1100 t), FU 9 (Moray Firth, 1300 t), FU 10 (Noup, 230 t), and FU 32 (Norwegian Deeps, 900 t) are all at or near the respective recent averages. Both FU 7 (Fladen, 8700 t) and FU 33 (Off Horn Reef) are at their highest-observed levels. Indications from TV surveys for FUs 6, 7, 8, and 9 are that stock densities are fluctuating about a long-term mean.

2.1.5 Industrial fisheries

2.1.5.1 Description of fisheries

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

2.1.5.2 Data available

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

2.1.5.3 Trends in landings and effort

Sandeel landings in 1974–1985 fluctuated between 428,000 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. Landings in 2003 (303,000 t) and 2004 (324,000 t) were very low. The fishery in 2005 was closed on July 2nd, after landings of less than 200,000 t during the year to date.

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 (27,100 t) and 2004 (13,500 t) landings continued this trend, and the directed fishery was closed for 2005.

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 has declined steadily since 1997. 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.

2.1.5.4 Stock impressions

Trends in yield, mean *F*, SSB and recruitment for sandeel and Norway pout are given in **Figures** 2.1.3–2.1.6.

Landings in 2004 for **sandeel** in Subarea IV (359,000 t) remained at or near the same low level as in 2003. Landings in 2005 have continued this trend, and following the implementation of a real-time management plan, the fishery was closed on the 2nd July 2005. Estimated SSB is at its lowest observed level. Fishing mortality has declined in recent years but is still high in comparison with the historical estimates, while recruitment remains low.

Landings for **Norway pout** in 2004 (13,500 t) were the lowest observed. The directed Norway pout fishery was closed during 2005, and only very limited bycatch was observed in other fisheries. Estimated SSB for this stock in 2004 was very near to $\boldsymbol{B}_{lim}$, fishing mortality was the lowest in the historical time-series, and recruitment was at or near the historical minimum.

2.2 Stocks in the Skagerrak and Kattegat (Division IIIa)

2.2.1 Fishery descriptions

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

The roundfish, flatfish, and *Nephrops* stocks are historically 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. Since 2003 Dutch beam trawlers have entered the area with a considerable effort for plaice (IIIaN). Effort measures available from the major Danish fleets fishing plaice and cod have been stable for nearly a decade. These fleets do not comprise the entire fishery, but are however considered representative of trends in effort.

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

There are important technical interactions between the fleets. This issue has been discussed by the WG since its 2003 meeting where the analysis was restricted to the North Sea. In 2004 data were also available for the Skagerrak Danish, Norwegian, Swedish and German fisheries. The methodology used is presented in Section 15. 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 hydrography, the biology, and the identity of stocks in the area. The exchange of water between the North Sea and the Baltic is the main hydrographic feature of the area.

2.2.2 Technical measures

2.2.3 Environmental considerations

Several of the stocks in the Skagerrak may not be separate stocks but may interact with stocks in the North 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 Belt Sea/Baltic Sea.

2.2.4 Human consumption fisheries

The official landings of **cod** in Division IIIa were 5800 tonnes in 2004 in the human consumption fishery, which is 2.5 larger than last year due to an increase in the Skagerrak. About 90 % was taken in Skagerrak, and the majority of catches were taken by Denmark. 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. However, the Kattegat cod is covered by the EC recovery plan (Council Regulation no. 423/2004, of 26 February 2004), which allows a TAC even though biomass is below $\boldsymbol{B}_{lim}$. ICES considers the agreement to be inconsistent with the precautionary approach.

Landings of **haddock** in Division IIIa, in the human consumption fishery, amounted to 1443 tonnes in 2004. Most of the catches are taken by Danish fleets in the Skagerrak. Haddock in IIIa is assessed together with the North Sea (Division IV) stock.

Landings of **whiting** (for human consumption) were 185 tonnes in 2004. Most of the landings are taken in Skagerrak. No analytical assessment of whiting in IIIa was possible.

Landings of **saithe** in Divisions IV and IIIa were 4792 tonnes in 2004. The saithe assessment comprises Divisions IV, IIIa, and VI.

The **plaice** landings in Division IIIa has remained stable since 1997 with landings of 9,061 tonnes in 2004. Historically, TAC has not been restrictive for this stock. About 82% of the landings were taken in Skagerrak. Plaice in IIIa is assessed as a separate stock.

The **sole** landings in Division IIIa are mostly taken in Kattegat and this stock is assessed by the Baltic Fisheries Assessment Working Group. Landings in 2004 amounted at around 420 tonnest. Further information may be found in the report of Baltic Fisheries Assessment Working Group.

The ***Nephrops*** stock in Division IIIa consists of two functional units (Kattegat and Skagerrak). Landings in 2004 for both units were around the long-term average.

2.2.5 Industrial fisheries

Most of the landings from the **industrial** fisheries in Division IIIa consisted of sandeel, sprat and herring, but also blue whiting and Norway pout (**Table** 2.2.1). Data was provided by Denmark and Sweden for the years 1999-2004. 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.

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

2.3 Stocks in the Eastern Channel (Division VIId)

2.3.1 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.

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

Effort: The fishing effort of French otter-trawlers and Belgian beam trawlers has strongly increased since the beginning of the 70’s and the French otter-trawlers show now sign of decrease. The fishing effort of both English beam trawlers and inshore trawlers show decreasing trends since the beginning of the series (**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 under investigation and should be available in the near future.

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 around $\boldsymbol{F_{pa}}$ The SSB is above $\boldsymbol{B_{pa}}$ (8000t) following improved recruitment in recent years particularly of the year classes 1998 to 2000 and 2003. There is a tendency to underestimate F and overestimate SSB.

Plaice: Discrepancies between catch-at-age based analyses and surey-based analyses has prevented the WG from assessing the state of this stock.

2.4 Industrial fisheries in Division VIa

There are two distinct industrial fisheries operating in Division VIa; a Norway pout fishery and a sandeel fishery. The Norway pout fishery is now exclusively Danish, whereas the sandeel fishery is almost exclusively Scottish and operates in more inshore areas. No information is available on by-catches in the Norway pout fishery. The sandeel fishery has a small by-catch of other species; information from the 1995 and 1996 catches 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 Division VIa were very low in 2004, reflecting the continued reduced effort in the fishery.

Table 2.1.1. Human consumption (HCO) and industrial bycatch (IBC) landings of assessed species from the North Sea management area in 2004 (tonnes), as used by the WG in assessments.

Sum of landings	stock					
year	cod-347d	had-34	ple-nsea	sai-3a46	sol-nsea	whg-47d
1957			70563		12067	
1958			73354		14287	
1959			79300		13832	
1960			87541		18620	
1961			85984		23566	
1962			87472		26877	
1963	116457	68779	107118		26164	
1964	126041	130944	110540		11342	
1965	181036	162307	97143		17043	
1966	221336	226335	101834		33340	
1967	252977	147778	108819	88326	33439	
1968	288368	105830	111534	113751	33179	
1969	200760	331419	121651	130588	27559	
1970	226124	525325	130342	234962	19685	
1971	328098	237340	113944	265381	23652	
1972	353976	195494	122843	261877	21086	
1973	239051	181518	130429	242499	19309	
1974	214279	153116	112540	298351	17989	
1975	205245	151386	108536	271584	20773	
1976	234169	172607	113670	343967	17326	
1977	209154	145083	119188	216395	18003	
1978	297022	91674	113984	155141	20280	
1979	269973	87094	145347	128360	22598	
1980	293644	105071	139951	131908	15807	100810
1981	335497	138731	139747	132278	15403	89524
1982	303251	176635	154547	174351	21579	80549
1983	259287	167353	144038	180044	24927	87972
1984	228286	134505	156147	200834	26839	86281
1985	214629	165672	159838	220869	24248	62127
1986	204053	169157	165347	198596	18201	64114
1987	216212	111779	153670	167514	17368	68300
1988	184240	107978	154475	135172	21590	56103
1989	139936	80288	169818	108877	21805	45189
1990	125314	55558	156240	103800	35120	46896
1991	102478	48731	148004	108048	33513	53025
1992	114020	74614	125190	99742	29341	52188
1993	121749	81539	117113	111491	31491	53196
1994	110634	82730	110392	109622	33002	49242
1995	136096	77503	98356	121810	30467	46442
1996	126320	79176	81673	114997	22651	41074
1997	124158	82496	83048	107327	14901	35920
1998	146014	81070	71534	106123	20868	28464
1999	96225	65569	80662	110716	23475	30412
2000	71371	47569	81148	91322	22641	28807
2001	49694	40861	81963	95141	19944	25216
2002	54865	58308	70217	115981	16945	21716
2003	30872	44087	66502	105569	17920	16372
2004	28143	48697	61436	104237	17147	13583
Grand Total	7781051	5439705	5424732	6007551	1069209	1283521

Sum of ibc	stock					
year	cod-347d	had-34	ple-nsea	sai-3a46	sol-nsea	whg-47d
1957						
1958						
1959						
1960						
1961						
1962						
1963		13783				
1964		88896				
1965		74921				
1966		46819				
1967		20755				
1968		34327				
1969		338887				
1970		179969				
1971		31812				
1972		29983				
1973		11451				
1974		48895				
1975		42726				
1976		50246				
1977		36982				
1978		11592				
1979		17175				
1980		23796				45757
1981		18306				66609
1982		20658				33042
1983		20316				23680
1984		12764				18897
1985		7001				15325
1986		4331				17966
1987		5889				16479
1988		5475				49219
1989		2770				42711
1990		4559				50718
1991		8014				38311
1992		15420				26901
1993		13156				20099
1994		5741				10354
1995		9909				26561
1996		7973				4702
1997		7299				5965
1998		5376				3141
1999		4168				5183
2000		8751				8886
2001		8097				7357
2002		3717				7327
2003		1149				2743
2004		554				1218
Grand Total		1304407				549151

Table 2.1.2. Species composition in the Danish and Norwegian small-meshed fisheries in the North Sea of the catches landed for reduction (1000 tonnes). Data provided by WG members. The category "other" is subdivided by species in Table 2.1.3.

Year	Sandeel	Sprat	Herring	Norway pout	Blue whiting	Haddock	Whiting	Saithe	Other	Total
1974	525	314	-	736	62	48	130	42		1857
1975	428	641	-	560	42	41	86	38		1836
1976	488	622	12	435	36	48	150	67		1858
1977	786	304	10	390	38	35	106	6		1675
1978	787	378	8	270	100	11	55	3		1612
1979	578	380	15	320	64	16	59	2		1434
1980	729	323	7	471	76	22	46	-		1674
1981	569	209	84	236	62	17	67	1		1245
1982	611	153	153	360	118	19	33	5	24	1476
1983	537	88	155	423	118	13	24	1	42	1401
1984	669	77	35	355	79	10	19	6	48	1298
1985	622	50	63	197	73	6	15	8	66	1100
1986	848	16	40	174	37	3	18	1	33	1170
1987	825	33	47	147	30	4	16	4	73	1179
1988	893	87	179	102	28	4	49	1	45	1388
1989	1039	63	146	162	28	2	36	1	59	1536
1990	591	71	115	140	22	3	50	8	40	1040
1991	843	110	131	155	28	5	38	1	38	1349
1992	854	214	128	252	45	11	27	-	30	1561
1993	578	153	102	174	17	11	20	1	27	1083
1994	769	281	40	172	11	5	10	-	19	1307
1995	911	278	66	181	64	8	27	1	15	1551
1996	761	81	39	122	93	5	5	0	13	1119
1997	1091	99	15	126	46	7	7	3	21	1416
1998	956	131	16	72	72	5	3	3	24	1283
1999	678	166	23	97	89	4	5	2	40	1103
2000	655	191	24	176	98	8	8	6	21	1187
2001	810	156	21	59	76	6	7	3	14	1152
2002	804	142	26	73	107	4	8	8	15	1186
2003	303	175	16	18	139	1	3	8	18	681
2004	324	193	19	12	107	1	2	7	29	692
Avg 74-04	705	199	60	231	65	12	36	8	33	1337

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

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
Hippoglossoid	59	718	1173	946	2160	1673	1024	1694	1428	529
Pleuronectes	34	119	109	372	582	566	1305	218	128	143
Merluccius me	349	165	261	242	290	429	28	359	109	10
Trisopterus m	0	68'3'	0	5'2'	48'2'	121'2'	79'2'	111	36	0
Molva molva[3]	51	1	40	39	37	13	65	10	28	0
Glyptocephalu	236'3'	132	341	44	255'3'	251'3'	1439'3'	195'3'	246	40
Gadiculus arg	1210	729	3043	2494	741	476	801	0	0	0
Others	31715'1'	3853	3604	3670	3528	3154	4444	4553	4106	5141
Total	65892	32994	72724	44827	59277	39866	37559	29685	27026	19077

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

[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, whiting and saithe in 1993 - 2004 from small-meshed fisheries in the North Sea. Landings in tonnes used for human consumtion purposes. These landings have been counted against the Danish human consumtion quotas and have been included in the estimated catch in numbers of the human consumtion landings reported to ICES.

Cod	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Sandeel fishery	89	80	167	208	223	134	16	5	7	11	3	4
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	1
Blue whiting fishery	4	+	0	77	38	94	92	39	31	37	10	8
"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	13

Haddock	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Sandeel fishery	86	16	19	51	32	5	4	1	3	11	4	3
Sprat fishery	20	26	62	2	2	4	2	+	5	1	+	0
Norway pout fishery	547	567	280	128	175	53	84	63	20	15	2	1
Blue whiting fishery	3	+	0	16	8	23	24	8	8	15	9	23
"Others" fishery	70	15	19	8	9	8	10	3	3	17	2	1
Total	726	624	380	205	226	93	124	75	39	59	17	28

Whiting	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Sandeel fishery	19	3	3	+	+	+	+	+	+	+	0	0
Sprat fishery	10	4	3	2	+	+	+	+	+	+	0	0
Norway pout fishery	932	307	201	92	33	11	9	19	9	9	2	1
Blue whiting fishery	6	+	0	9	3	4	1	1	2	2	1	+
"Others" fishery	60	5	2	4	2	1	1	+	+	+	+	0
Total	1,027	319	209	107	38	16	11	20	11	11	3	1

Saithe	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Sandeel fishery	52	52	111	88	73	23	44	6	5	5	3	18
Sprat fishery	37	48	123	9	1	3	6	1	13	13	0	0
Norway pout fishery	589	514	1,057	359	599	264	205	267	245	245	27	11
Blue whiting fishery	2	4	0	155	167	356	476	214	186	186	143	177
"Others" fishery	21	43	73	43	117	137	108	21	11	11	46	3
Total	701	661	1,364	654	957	783	839	509	460	460	219	209

Table 2.1.5. Danish by-catch landings of cod, haddock, whiting and saithe in 1993 - 2004 from small-meshed fisheries in the North Sea. Landings in tonnes used for reduction purposes.

Cod	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Sandeel fishery	185	70	79	288	375	202	51	56	7	12	5	10
Sprat fishery	116	493	174	23	40	11	7	4	4	0	11	3
Norway pout fishery	232	201	680	4	242	161	11	0	81	3	3	1
Blue whiting fishery	0	0		24	37	20	28	0	0	14	0	0
"Others" fishery	126	14	23	2	94	6	4	1	4	1	2	1
Total	659	778	956	341	789	400	101	61	97	30	21	16

Haddock	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Sandeel fishery	2,879	528	534	1,600	524	202	364	1,226	1,557	220	103	33
Sprat fishery	113	685	1,097	18	11	6	62	66	223	27	15	0
Norway pout fishery	3,028	1,399	4,766	1,774	1,454	251	318	1,734	1,252	1,545	16	57
Blue whiting fishery	0	10		153	205	66	195	258	218	133	59	16
"Others" fishery	1,193	71	349	77	137	218	117	40	42	183	96	10
Total	7,214	2,693	6,745	3,622	2,331	744	1,055	3,324	3,292	2,108	289	116

Whiting	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Sandeel fishery	4,493	1,392	3,322	1,909	2,143	902	2,121	1,539	2,761	1,397	444	653
Sprat fishery	4,122	4,352	10,386	784	107	673	1,088	2,107	1,700	2,238	1,105	333
Norway pout fishery	7,071	3,121	7,291	1,373	2,235	178	331	2,935	1,559	1,675	265	232
Blue whiting fishery	0	0		126	113	83	169	71	217	123	30	0
"Others" fishery	2,448	187	4,422	22	173	112	116	89	184	127	63	0
Total	18,134	9,053	25,422	4,214	4,771	1,948	3,825	6,740	6,420	5,560	1,907	1,218

Saithe	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Sandeel fishery	21	0	0	40	0		28		1	0	30	14
Sprat fishery	0	11	297	0	0				3	0	0	0
Norway pout fishery	9	135	490	84	209			116	22	246	0	0
Blue whiting fishery	0	0		20	80	11	8	2	84	72	17	51
"Others" fishery	41	0	542	0	40	1	4	2	7	109	69	0
Total	71	146	1,329	144	329	12	40	120	117	427	116	65

All species	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Sandeel fishery	482,832	611,554	644,473	622,211	761,963	624,925	514,047	551,008	637,518	628,205	274,854	291,445
Sprat fishery	246,980	314,970	344,309	107,243	103,523	145,978	171,757	208,641	170,862	167,472	194,210	200,907
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	8,980
Blue whiting fishery	1,615	419		34,857	13,181	46,052	51,060	34,129	26,038	27,052	21,320	20,295
"Others" fishery	40,283	19,480	48,936	8,882	14,554	17,893	26,945	7,433	10,554	8,503	6,184	10,298
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	531,925

Table 2.1.6. Quarterly Danish by-catch landings of cod, haddock, whiting and saithe in 2004 from small-meshed fisheries in the North Sea. Landings in tonnes used for human consumption purposes. These landings are included in catch in numbers of human consumption landings.

Cod	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		2.2	1.6		3.8
Sprat fishery				0.1	0.1
Norway pout fishery	0.3		0.2	0.3	0.8
Blue whiting fishery	6.4	1.5	0.4		8.3
"Others" fishery	0.2				0.2
Total	6.9	3.7	2.2	0.4	13.2

Haddock	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		2.3	0.7		3.0
Sprat fishery					0.0
Norway pout fishery	0.2		0.2	0.5	0.9
Blue whiting fishery	21.1	0.5	1.2		22.8
"Others" fishery	0.2	1.1			1.3
Total	21.5	3.9	2.1	0.5	28.0

Whiting	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery					0.0
Sprat fishery					0.0
Norway pout fishery	0.4		0.3	0.2	0.9
Blue whiting fishery	0.2		0.1		0.3
"Others" fishery					0.0
Total	0.6	0.0	0.4	0.2	1.2

Saithe	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		0.5	17.9		18.4
Sprat fishery					0.0
Norway pout fishery	0.7		5.8	4.2	10.7
Blue whiting fishery	139.4	30.3	7.1		176.8
"Others" fishery	3.3				3.3
Total	143.4	30.8	30.8	4.2	209.2

All other human consumtion species	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery	0.1	1.8	4.9		6.8
Sprat fishery			0.7	1.4	2.1
Norway pout fishery	0.9		2.7	2.5	6.1
Blue whiting fishery	84.2	54.1	8.7		147.0
"Others" fishery	2.3	1.1	0.1		3.5
Total	87.5	57.0	17.1	3.9	165.5

Table 2.1.7. Quarterly Danish by-catch landings of cod, haddock, whiting and saithe in 2004 from small-meshed fisheries in the North Sea. Landings in tonnes used for reduction purposes.

Cod	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total**
Sandeel fishery		1	9		10
Sprat fishery			3		3
Norway pout fishery				1	1
Blue whiting fishery					0
"Others" fishery			1		1
Total	0	1	13	1	16

Haddock	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total**
Sandeel fishery		32	1		33
Sprat fishery					0
Norway pout fishery	5		49	3	57
Blue whiting fishery	16				16
"Others" fishery	10				10
Total	31	32	50	3	116

Whiting	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total**
Sandeel fishery		541	112		653
Sprat fishery			196	137	333
Norway pout fishery	32		59	141	232
Blue whiting fishery					0
"Others" fishery					0
Total	32	541	367	278	1,218

Saithe	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total**
Sandeel fishery			14		14
Sprat fishery					0
Norway pout fishery					0
Blue whiting fishery	51				51
"Others" fishery					0
Total	51	0	14	0	65

All species	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total**
Sandeel fishery	1,486	236,933	53,026		291,445
Sprat fishery	1,004		52,807	147,096	200,907
Norway pout fishery	626		2,023	6,331	8,980
Blue whiting fishery	10,124	7,558	2,613		20,295
"Others" fishery	9,131		1,167		10,298
Total	22,371	244,491	111,636	153,427	531,925

Table 2.1.8. Number of fish aged and measured from the Danish industrial by-catch sent for reduction, 1998-2004.

	Cod		Haddock		Whiting	
Quarter	N measured	N aged	N measured	N aged	N measured	N aged
1	0	0	3	3	11	6
2	3	3	214	4	23	21
3	136	102	34	32	5	4
4	36	23	2	1	6	6
Total	175	128	253	40	45	37

Table 2.1.9. Numbers ('000) and mean weight (g) at age of commercial roundfish species in 2003 in the bycatch of the Norwegian industrial fishery.

Saithe	2004									
	1. Quarter		2. Quarter		3. Quarter		4. Quarter		Year	
AGE	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
0	0.0	0.000	0.0	0.000	40.7	0.022	0.0	0.000	40.7	0.022
1	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000
2	0.0	0.000	11.9	0.193	81.5	0.153	0.0	0.000	93.4	0.158
3	54.8	0.518	71.4	0.520	661.6	0.713	225.0	0.646	1012.7	0.674
4	384.2	0.671	516.7	0.715	1316.8	0.846	809.8	0.800	3027.5	0.789
5	637.7	0.793	456.3	0.827	764.4	0.928	1049.3	0.965	2907.8	0.896
6	353.0	0.865	172.2	0.906	81.8	1.015	238.1	1.135	845.0	0.964
7	3.1	1.135	12.4	0.908	0.0	0.000	0.0	0.000	15.6	0.954
8	0.8	1.135	0.0	0.000	0.0	0.000	0.0	0.000	0.8	1.135
9	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000
10	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000
Cod	2004									
	1. Quarter		2. Quarter		3. Quarter		4. Quarter		Year	
AGE	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
0	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000
1	0.0	0.000	0.0	0.000	30.0	352.768	0.0	0.000	30.0	352.768
2	7.0	352.768	3.2	352.768	7.3	352.768	8.7	759.201	26.3	487.201
3	4.5	352.768	2.0	352.768	0.7	352.768	3.1	759.201	10.3	474.145
4	0.0	0.000	0.0	0.000	0.0	0.000	0.5	759.201	0.5	759.201
5	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000
6	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000
7	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000
8	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000
9	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000
10	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000
Whiting	2004									
	1. Quarter		2. Quarter		3. Quarter		4. Quarter		Year	
AGE	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
0	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	40.7	0.022
1	0.0	0.000	146.6	87.212	11.0	110.335	10.9	163.240	0.0	0.000
2	0.0	0.000	267.5	107.500	3.5	163.240	12.6	163.240	93.4	0.158
3	27.4	267.012	520.0	151.800	8.0	368.243	17.0	341.021	1012.7	0.674
4	116.2	280.853	273.0	219.442	18.2	403.890	33.8	400.969	3027.5	0.789
5	102.2	369.475	38.7	267.012	6.7	407.000	12.4	407.000	2907.8	0.896
6	27.7	383.761	6.5	267.012	0.0	0.000	0.0	0.000	845.0	0.964
7	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	15.6	0.954
8	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.8	1.135
9	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000
10	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000
Haddock	2004									
	1. Quarter		2. Quarter		3. Quarter		4. Quarter		Year	
AGE	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
0	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	40.7	0.022
1	103.8	101.634	39.7	101.634	266.2	125.653	56.5	107.569	0.0	0.000
2	75.0	161.319	50.8	169.104	64.4	189.361	19.0	287.398	93.4	0.158
3	14.4	222.007	26.7	260.468	10.8	222.542	14.8	299.030	1012.7	0.674
4	45.1	243.023	69.6	295.890	37.9	213.647	51.4	324.592	3027.5	0.789
5	83.8	316.619	180.4	411.413	145.9	671.739	185.1	359.847	2907.8	0.896
6	1.0	430.688	4.2	596.394	0.0	0.000	1.2	430.688	845.0	0.964
7	0.0	0.000	3.5	840.173	0.0	0.000	0.0	0.000	15.6	0.954
8	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.8	1.135
9	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000
10	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000

Table 2.2.1. Catches of the most important species in the industrial fisheres in Division IIIa (' 000 t), 1989-2004.

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

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

Table 2.2.2. By-catches of the most important consumption species in the Danish small meshed fisheries in Division IIIa (t), 1989-2004.

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

Figure 2.1.1. Reported fishing effort of selected demersal fleets in Subarea IV (North Sea). UK and Netherlands data are from all demersal fleets, pout and sandeel refer to the total international fishery. All data have been mean-standardised using a common range (1997–2004).

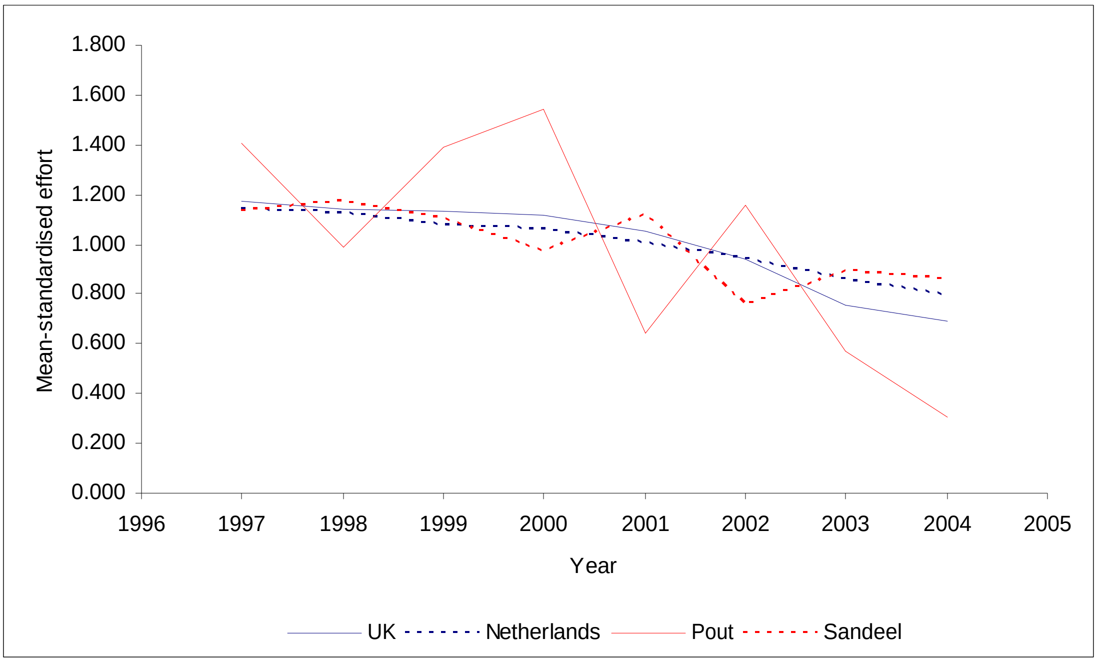


Figure 2.1.2. Total catches for stocks assessed by the WG, by category.

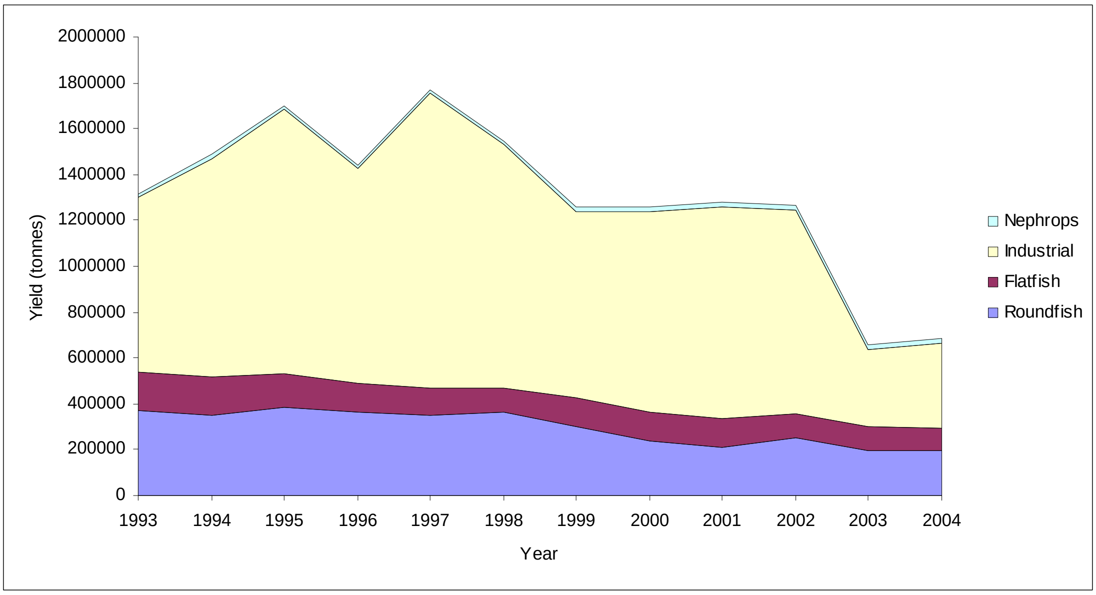


Figure 2.1.3. Historical yield by stock. Where available, time-series of total catch (blue solid), human consumption landings (black solid), discards (red dashed) and industrial bycatch (red dotted) are given.

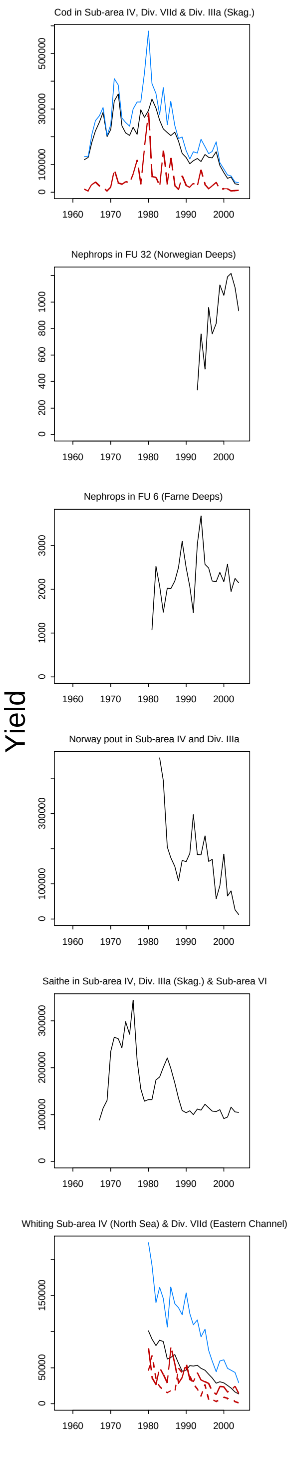


Figure 2.1.4. Historical estimated mean fishing mortality by stock (over age ranges defined in each stock section). Horizontal red lines indicate F_{pa} (dotted) and F_{lim} (solid).

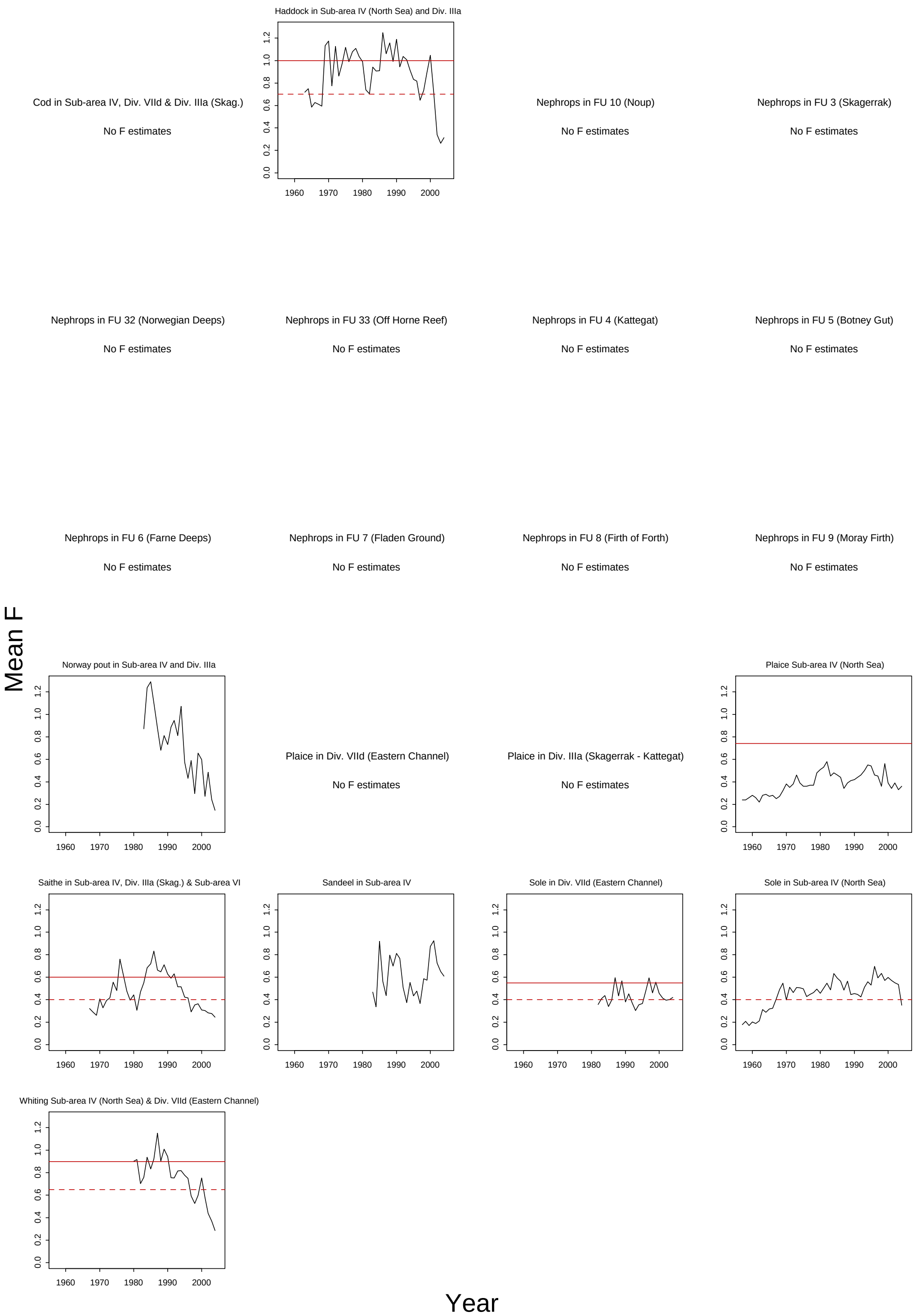


Figure 2.1.5. Historical estimated spawning stock biomass by stock. Horizontal red lines indicate B_{pa} (dotted) and B_{lim} (solid). Estimates for *Nephrops* stocks are total abundance indices from TV surveys.

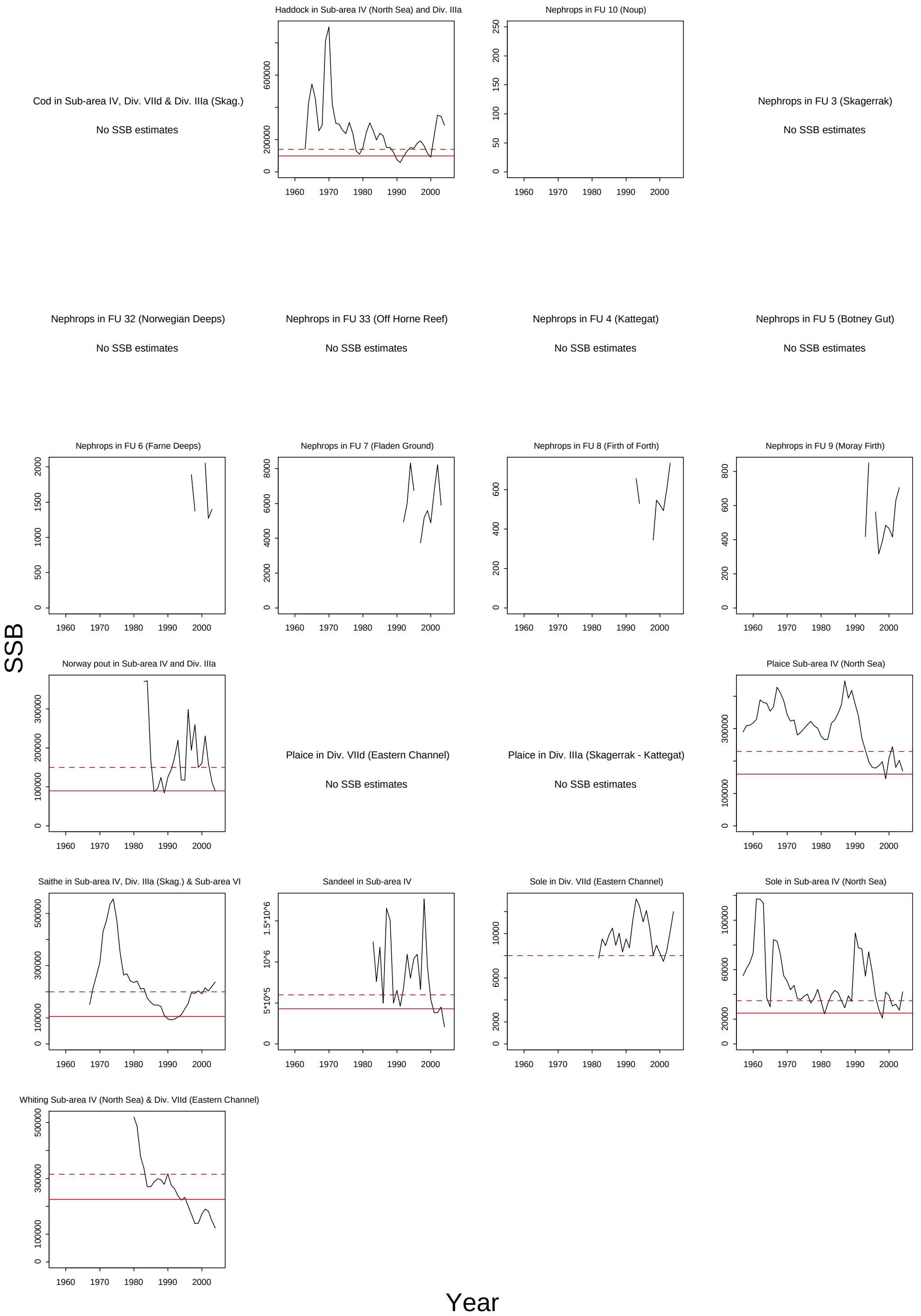


Figure 2.1.6. Historical estimated recruitment by stock.

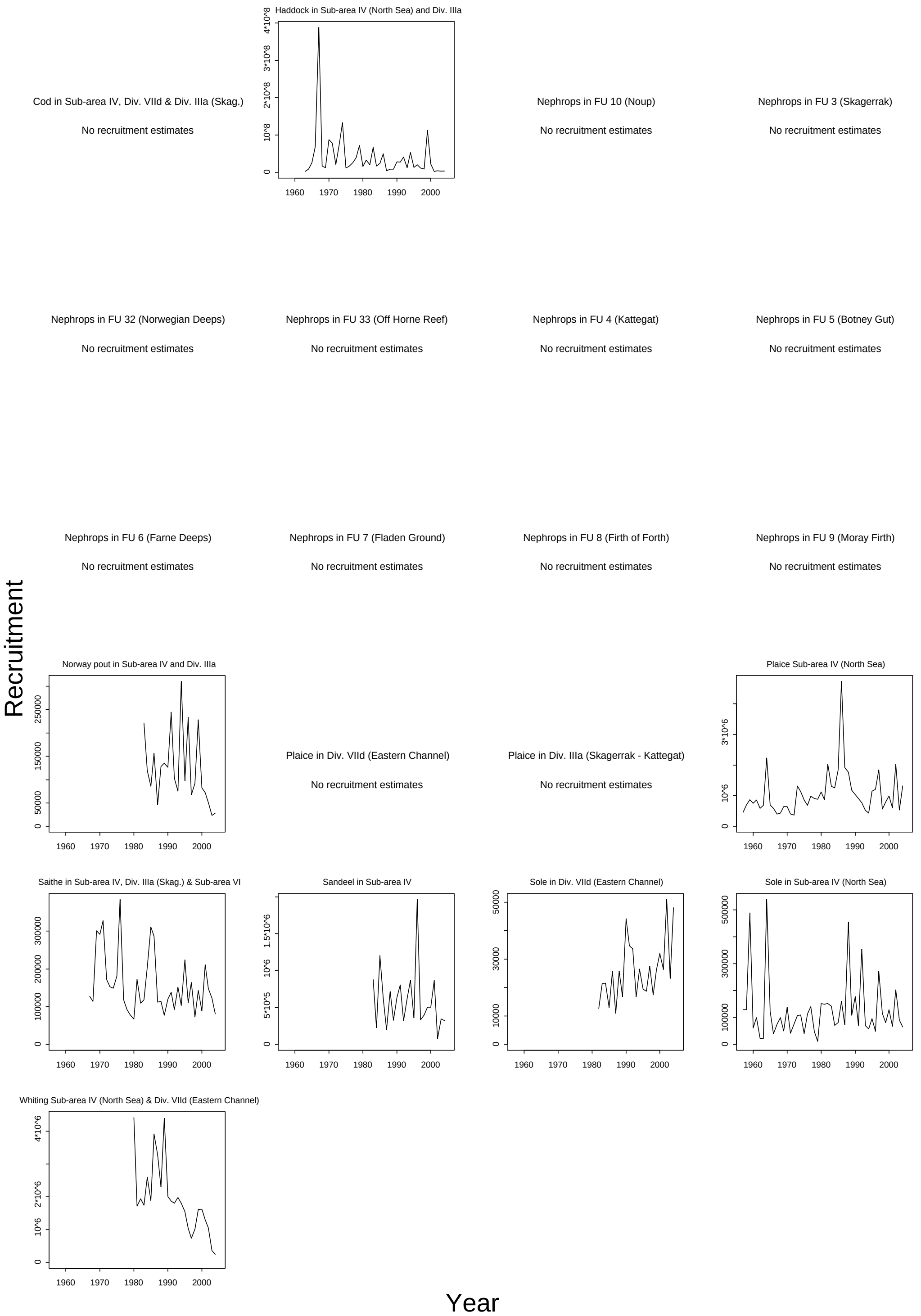
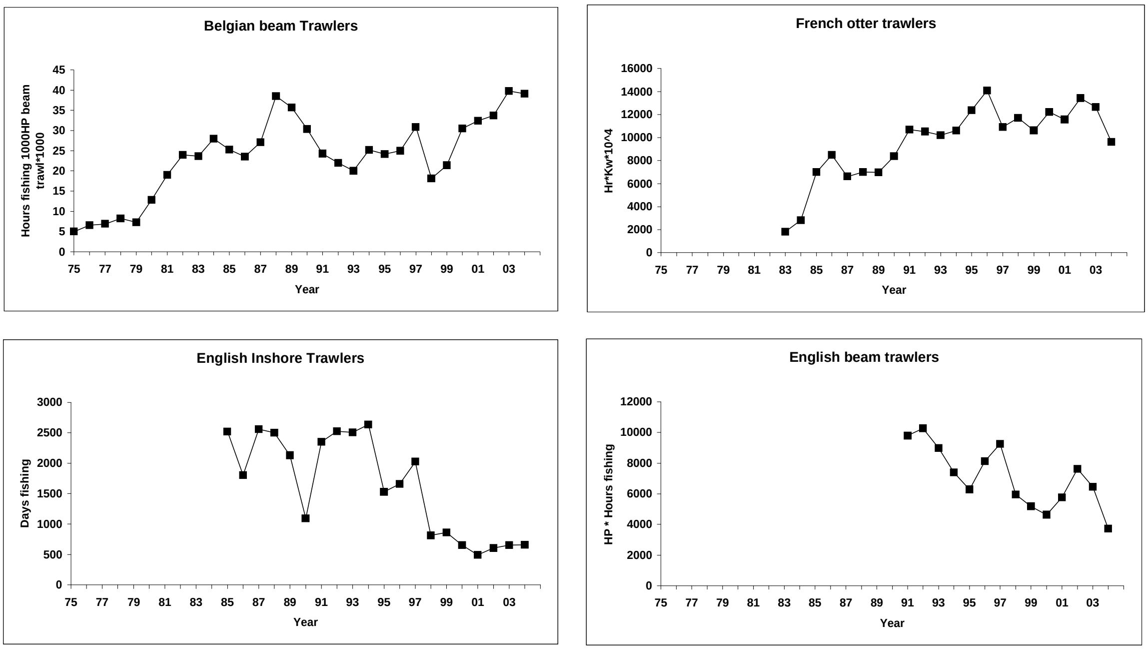


Figure 2.3.1. Reported fishing effort of demersal fleets in Division VIId (eastern English Channel).



3 Cod

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

Due to its very poor state, this stock is classified as an "observation" stock by ICES with the consequence that an update assessment is not considered to be appropriate for it. The assessment of this stock has also been under continuous external review by the North Sea Commission Fisheries Partnership.

3.1 General

3.1.1 Ecosystem aspects

Cod are widely distributed throughout the North Sea. Scientific survey data indicate that young fish (ages 1 and 2) have historically been found in large numbers in the southern part of the North Sea. Adult fish are located in concentrations of distribution in the Southern Bight, the north east coast of England, in the German Bight, the \east Coast of Scotland and in the north-eastern North Sea. As stock abundance fluctuates, these groupings appear to be relatively discreet but the area occupied has contracted. During the last three years, the highest densities of 3+ cod have been observed in the deeper waters of the northern North Sea and in the central North Sea.

A genetic survey of cod in European continental shelf waters using micro-satellite DNA detected significant fine scale differentiation suggesting the existence of at least 3-4 genetically divergent cod populations, resident in the northern North Sea off Bergen Bank, within the Moray Firth, off Flamborough Head and within the Southern Bight (Hutchinson et al., 2001). As is typical of marine fishes, the level of detectable genetic differentiation among these populations was low, which is to be expected from the large population sizes and high dispersal potentials. The biological significance of such low differentiation is often questioned in part because the temporal stability of the observed patterns is generally unknown and where different studies exist these have sometimes provided conflicting results. This new genetic evidence is largely consistent with the limited movements suggested by tagging studies (Anon 1971).

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 yet possible to quantify long-term changes in the use of spawning grounds. Limited data available do suggest a contraction in significant spawning areas, beginning with the loss of sites at Great Fisher Bank and Aberdeen Bank by the 1980s, and more recently from other coastal spawning sites around Scotland and in the Forties area. The information required will soon be available as in 2004 an international consortium comprising England, Scotland, Netherlands, Germany, Denmark and Norway conducted an ichthyoplankton survey covering the North Sea in order to comprehensively survey the distribution of cod and plaice spawning (Fox et. al. 2005). Preliminary results indicate that the recent distribution of stage I cod eggs were located around the southern and eastern edge of

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1 Information on spawning cod and population structuring is taken from a summary prepared for the 2003 meeting of WGNSSK, and presented at that meeting as a working paper by Wright et al 2003.

the Dogger Bank, in the German Bight, off the Moray Firth and to the east of the Shetland Isles; a distribution consistent with historic information. Further results from the study will be published as the analysis is completed.

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

More recently Perry et. al. (2005) analysed the shift in centres of population for 36 North Sea fish species, and for 20 of these, they also examined the movement of southerly or northerly range limits. The study examined fish distributions from long-term trawl survey data in relation to North Sea temperatures, general climatic patterns, the influence of the Gulf Stream, and the relative abundances of northerly and southerly species of zooplankton. The authors found a correlation between the rise of temperature of the North Sea and a northwards shift of the centre of populations of fish such as cod and a southwards movement of other species. The North Sea cod's centre of population has shifted 117 km towards the Arctic while the haddock's southern boundary has also moved 105 km north.

In the case of cod the Bannister and Turrel and the Perry et. al. studies appear to contradict each other. However, Perry et. al did not examine the effects of spatial differences in effort distribution and the fishing mortality to which the commercially exploited fish stocks had been subjected and therefore unbalanced depletions of the local concentrations described by Hutchinson et al., 2001, cannot be excluded as a cause of the distribution shifts.

Cod are predated upon by a variety of species through its life history. The Study Group on Multispecies Assessment in the North Sea (ICES ACFM/D:06) estimated predation mortalities using MSVPA (Multispecies Virtual Population Analysis) with diet information largely derived from the Years of the Stomach databases. Long-term trends have been observed in several partial predation mortalities with significant increases for grey gurnard and grey seals.

MSVPA identified grey gurnard as a significant predator of 0-group cod. The abundance of grey gurnard (as monitored by IBTS) is estimated to have increased in recent years resulting in a rise in estimated predation mortality from 0.77 to 2.12 between 1991 and 2003. A degree of caution is required with these estimates as they assume that the spatial overlap and stomach contents of the species has remained unchanged since 1991. Given the change in abundance of both species this assumption is unlikely to hold and new diet information is required before these predation mortalities can be relied upon.

Several other predators contribute to predation mortality upon 0-group cod, whiting and seabirds being the next largest components.

Grey seals are the major source of predation mortality on older (3+) cod with values currently estimated to be around 0.13 having risen from 0.74 in 1991. The main reason for the rise in partial predation mortality is due to an increase in grey seal numbers, assumed to be 6% per year. There is currently a great deal of uncertainty as to total grey-seal population numbers in the North Sea.. The 6% per year increase in grey-seal numbers no longer seems to be the case as recent indications are that population growth may now be levelling off. New population estimates were obtained and introduced to MSVPA for the years 2001, 2002, 2003. As with the gurnards the dietary information for seals is quite old and new dietary information is due shortly which may result in a re-evaluation of the relatively high M2 values for seals on cod.

3.1.2 Fisheries

Cod are caught by virtually all the demersal gears in Sub-area IV and Divisions IIIa (Skagerrak) and VIId, including beam trawls, otter trawls, seine nets, gill nets and lines. Most of these gears take a mixture of species, but in some of them cod are considered to be a by-catch, for example in beam trawls targeting flatfish and in others the fisheries are directed mainly towards cod, for example some of the fixed gear fisheries.

For some sectors of the otter trawl fleet, particularly twin-rig trawlers, fuel prices, days at sea restrictions and lack of quota for deep-water species have resulted in both changes in spatial activity and gear types used. Fishermen are now less likely to select more distant fishing areas e.g. Rockall Bank or shelf edge fisheries due to the associated fuel costs. Activity is now more often concentrated on ‘home’ grounds in the Northern North Sea. Twin rig vessels, which traditionally operated in Western areas, have formed pair trawl teams. It is probable that the shift in fishing grounds has resulted in increased focus on cod, haddock and whiting away from monkfish, while the switch towards pair trawling will alter commercial CPUE rates due to the considerable differences in efficiency between the two gear types.

Approximately 2/3 of the Danish fleet using 90mm cod-ends in the Skagerrak have opted to use a 120mm square mesh panel to obtain an additional 3 days at sea. The use of the panel results in a substantial increase in selectivity, selection estimates with and without panels fitted are provided in Graham (2005 WD7). Up until June 2005, this option was also available in the North Sea 120mm fishery. The majority of Danish and a smaller percentage of Scottish fleet took opted to use the SMP. The effectiveness of the panel in this fishery is significantly less than in the Skagerrak due to the comparatively higher selection of the 120mm cod-end.

Information on the trends in international effort directed at and taking a by-catch of cod were provided to the Working Group by the STECF study group that met in ISPRA in June 2005 (STECF 2005). UK data were provided by Horwood and Williamson (2005 WD3) and Williamson (2005 WD8).

The STECF estimates of trends in effort are described in Section 15. Overall there has been a marked reduction in the effort associated large mesh fisheries and beam trawlers fishing in the North Sea and an increase in the use of 70 – 90mm mesh directed fishing mortality might therefore be expected to have decreased however this may be compensated for by an increase in discarding (see section 15).

Horwood and Williamson (WD3) note that the UK large mesh, demersal trawl fleet category (>100mm, 4A) has been reduced by decommissioning and days at sea regulations to 40% of the levels recorded in the EU reference year of 2001. There was a movement into the 70-90 mm sector to increase days at sea in 2002 and 2003 but the level of effort stabilised in 2004. The effort of the combined trawl gears have shown a continued decrease of 36% overall, from the EU reference year of 2001.

Williamson (WD8) analysed the proportion of pair trawling within the UK fleets. He noted that there does not appear to have been an increase in the proportion of UK vessels using pair trawls in the North Sea. Pair trawling effort accounted for around 33% of the total UK fishing effort with trawl gear using mesh >100mm across the period of 2001 to 2005. There has been an increase in the proportion of UK boats pair trawling using Nephrops gear from 8 – 13% between 2001 and 2005, representing around 9% of the expended effort.

The spatial distribution of reported international landings for 2000-2004 are shown in Figures 3.1 – 3.3 plotted from the data submitted to STECF (2005). The countries contributing data for analysis are listed in Table 3.1.

The landings distributions are a product of the applied effort distributions and the distribution of the stock; they are not a direct indication of the distribution of the cod stock. In 2000 and 2001 landings generally coincided with the areas of highest density of cod aged 2 and older (the commercially selected ages) seen in the IBTS Q1 survey (Figure 3.4); this was especially apparent for the northern North Sea. However, in recent years a significant proportion of the landings were reported from the Southern Bight, German 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 is a reflection of the large amount of effort deployed in areas of low cod density.

Landings recorded in 2003 and 2004, (Figure 3.2 and 3.3), are distributed closer to the coast than those from previous years. A significant factor influencing the distribution of landings in recent years has been the imposition of days at sea regulations, first introduced in 2003. The effort restrictions have resulted in effort being distributed closer to the coast and this has impacted on the distribution of landings. The catch distributions for 2003 and 2004 illustrate fewer landings from within the central North Sea whereas the survey abundance throughout the area has remained relatively constant but at a low level (Figure 3.4).

3.1.3 ICES advice

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.

And the advice regarding management of demersal fisheries in the North Sea, Division IIIa and the Eastern Channel was:

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 advice for 2005 was presented in relation to single stock exploitation boundaries and mixed fishery implications:

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

According to the agreed management plan the TAC should not be more than 15% above the 2004 level, corresponding to 35 880 t (for Division IIIa and Subarea IV). This implies a 55% reduction in fishing mortality relative to 2003.

Indications are that this would allow a 30% increase in SSB from 2005 to 2006 and rebuilding to above $\mathbf{B}_{lim}$.

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

Targets reference points have not been agreed for this stock, but long-term yield would be maximized by fishing at approximately 20% of the recent levels of fishing effort.

Exploitation boundaries in relation to precautionary limits

Given the low stock size, recent poor recruitment, continued substantial catch [78 000 t in 2003], the uncertainty in the assessment, and the inability to reliably forecast catch, ICES recommends zero catch until the estimate of SSB is above $\mathbf{B}_{lim}$ or other strong evidence of rebuilding is observed.

Within the North Sea demersal fisheries ICES identified the stocks where spawning stock biomass is at reduced reproductive capacity (Cod in the North Sea, Eastern Channel and Skagerrak, Cod in Kattegat, Sandeel in the North Sea) and/or where fishing mortality indicates unsustainable harvesting of the stock (Cod in the North Sea, Eastern Channel and Skagerrak, Cod in Kattegat). Norway pout was being considered as a critical stock because the spawning stock is around $\mathbf{B}_{lim}$ and recent recruitments of this short-living species have been very low. The North Sea mackerel component is still considered to be severely depleted and should be protected. These stocks were considered to be the overriding concerns in the management of all demersal fisheries. Therefore ICES advised that:

Mixed fishery advice:

for cod in Division IIIa, North Sea and Eastern Channel and cod in Kattegat, ICES recommends a zero catch;

for Norway pout in the North Sea ICES recommends that no fishing takes place;

for sandeel in the North Sea ICES recommends a in-year monitoring system or in the absence of that a reduction in fishing effort to 40% of the 2004 level.

Fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2005 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries with minimal bycatch or discards of cod;

Implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised; within the precautionary exploitation limits for all other stocks.

Where stocks extent beyond this area, e.g. into Division VI (saithe and anglerfish) or is widely migratory (Northern hake) taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;

The 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

3.1.4 Management

Management of cod is by TAC and technical measures. The agreed TACs for Cod in Division IIIa (Skagerrak) and Sub-area IV were as follows:

	2003 Agreed TAC (000 t)	2004 Agreed TAC (000 t)	2005 Agreed TAC (000 t)
IIIa (Skagerrak)	3.9	3.9	3.9
IIa + IV	27.3	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 ($\mathbf{B}_{lim}$).*
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 ($\mathbf{B}_{pa}$), 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 2004 and 2005 are contained in regulations 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 by 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 in 2004 (Annex V of Council Regulation (EC) 2287/2003) and for 2005 (Annex IVa of Council Regulation (EC) 27/2005).

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.

3.2 Data available

3.2.1 Landings and discards

Landings data from human consumption fisheries for recent years as officially reported to ICES together with those estimated by the Working Group are given for each area separately and combined in Table 3.2. The Working Group estimate for landings from the three areas combined in 2004 is 28.1 thousand tonnes, split as follows for the separate areas.

	2004 Landings ('000 t)
IIIa(Skagerrak)	3.8
IV	23.5
VIId	0.8
Total	28.1

WG estimates of landings indicate that the TACs for Subarea IV was not fully taken in 2004. This is in keeping with previous years.

Discard numbers-at-age were estimated by applying the 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 working group data coordinator in an appropriate form for inclusion in the international dataset.

For cod in IIIa, IV and VIId, ICES first raised concerns about the mis-reporting and non-reporting of landings in the early 1990s, particularly when TACs became intentionally restrictive for management purposes. Some working group members have since provided estimates of under-reporting of landings to the working group, but by their very nature these are difficult to quantify. In terms of events since the mid-1990s, the working group 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 working group 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 nevertheless comprise the input values to the assessment.

The by-catch of cod from the Danish and Norwegian industrial fisheries that was sent for reduction to fishmeal and oil in 2004 was 16 tonnes (Table 2.1.4). An additional 13t of cod from the Danish Industrial catch was landed for human consumption (Table 2.1.5) and was declared against the cod quota for Denmark.

3.2.2 Age compositions

Landings in numbers at age for age groups 1-11+ and 1963-2004 are given in Table 3.3. 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 2.1.4) and separately for the Skagerrak (Table 3.2), but as in previous years, these data were not included in the assessment.

Age compositions were provided by Denmark, Germany, England, France, the Netherlands, Norway and Scotland (Table 1.2.2).

During 2002 to 2004, 90%, 80% and 75% of the international landings in number were accounted for by juvenile cod aged 1-3.

Discard numbers-at-age are shown in Tables 3.4. The values are derived from the application of Scottish discard ogives to the international landings-at-age and are used in the exploratory assessments. Although in some cases other nations' discard proportions are available for a range of years, these have not been transmitted to the relevant working group data coordinator in an appropriate form for inclusion in the international dataset.

The proportions estimated total numbers discarded are plotted in Figure 3.5 and the proportion of the estimated discards for ages 1- 3, in Figure 3.6. Estimated total numbers discarded have been constant at around 45% since 1995. The proportion of numbers discarded at age 1 have fluctuated around 80% with no decline apparent after the introduction of the 120mm mesh in 2002. At ages 2 and 3 discard proportions have been increasing steadily and are currently around 50% and 15%, respectively, in 2004.

3.2.3 Weight at age

Mean weight at age data for landings are given in Table 3.5. These values were also used as stock mean weights. Long-term trends in mean landings weight at age for ages 1-9 are plotted in Figure 3.7. 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 during the 1980'and 90's. Ages 1 and 2 show little absolute variation over the long-term. Discard mean weights-at-age are shown in Table 3.6.

3.2.4 Maturity and Natural Mortality

Values for natural mortality and maturity are given in Table 3.7, they are applied to all years and are unchanged from those used in recent assessments. The natural mortality values are model estimates from a multi-species VPA fitted by the Multi-species Working Group in 1986. The maturity values were estimated using the International Bottom trawl Survey series 1981-1985. These values were derived for the North Sea and are equally applied to the three stock components.

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. In 2005 the Multispecies Study Group (ICES ACFM/D:06) re-estimated the time series of North Sea multi-species natural mortality rates. The time series of mortalities estimated for cod (Figure 3.8) have trends through time resulting from the revision of seal predation rates at the oldest ages and grey gurnard predation of 0-group cod. Sensitivity of the final assessment results to the values assumed for natural mortality will be examined in a later section.

3.2.5 Catch, effort and research vessel data

Reliable, individual, disaggregated trip data were not available for the analysis of CPUE. Since the mid-to-late 1990s, changes to the 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. Consequently, the effort data, as hours fished, are not considered to be representative of the actual deployed fishing effort.

Section 15 presents a discussion of fishing effort data expressed in terms of kW days that are considered to be a more reliable representation of 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 WG has previously argued that although they are in general agreement with the survey information commercial CPUE tuning series should not be used for the calibration of assessment models due to potential problems with effort recording and hyper-stability in the CPUE series (ICES CM 2002/ACFM:01, ICES Co-op. Res. Rep 2001/246). Therefore, although the commercial fleet series are updated and presented, only survey and commercial landings and discard information are analysed within the following assessment.

Four survey series are available for this assessment:

- English third-quarter groundfish survey (EngGFS), ages 0-7, which covers the whole of the North Sea in August-September each year to about 200m depth using a fixed station design of 75 standard tows. The survey was conducted using the Granton trawl from 1977-1991 and with the GOV trawl from 1992-2003. Only ages 1 6 are used for calibration, as catch rates for older ages are very low. The age-composition data for 2005 from this survey were not available at the WG meeting. At its 2003 meeting, the working group 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 working group 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 young cod are shown in Figure 3.4 (IBTS ages 1-3). The recent dominant effect of the size and distribution of the 1996 and, to a lesser extent, the 1999 year-classes are clearly apparent from these charts.

The complete data available for calibrating the catch-at-age analysis are shown in Table 3.8. These tables include the addition of discard estimates to the fleet landings-at-age.

3.2.5.1 Survey consistency

At the 2004 meeting of this working group (ICES 2004) a benchmark review examined each of the sources of information available for assessment of the status of the North Sea cod stock. The recorded landings data and survey series were screened for sampling errors; the time series of surveys were examined for correlation between and within series and used independently of the catch data as indices of the stock dynamics; finally a catch at age model was fitted to the catch and survey series in order to derive a time series of stock and exploitation estimates.

The analysis showed surveys and commercial series are mostly concordant at ages 2 and 3; thereafter the relationships between survey and commercial series become noisier, but there is still a reasonable degree of concordance between the Scottish survey and the two English commercial series up to age 6. Between the commercial series alone, the agreement within English fleets and within Scottish fleets is generally more consistent than between the English and Scottish fleets.

Consistency between and within North Sea cod survey indices was examined using pairwise bivariate scatterplots in detail in last years report (ICES 2004xxx). It was shown that apart from the French groundfish survey the series demonstrate consistency between adjacent age groups and also between non-adjacent age groups up to the age of 5, although for the EngGFS and ScoGFS, as the difference between ages increases the noisier the observed relationship. The French groundfish survey was shown to be noisy in last year's analysis and until a longer time series of estimates is available it has not been included within the assessment process.

Figures 3.9 – 3.11 present the between adjacent age group pairwise scatter plots for the English, Scottish and IBTS roundfish surveys. The most recent (2004/2005) comparisons are highlighted for the Scottish and IBTS surveys. The indices are consistent in the majority of years across ages apart from the Scottish groundfish survey which has low catch rates in 2005 at ages 2, 3 and 4.

3.3 Data analyses

The following analyses examine the consistency of the catch at age data submitted to the Working Group and that of the survey time series, independently, within both catch at age and survey based models.

3.3.1 Exploratory catch data analyses

As in previous years, a Separable VPA model was used to examine the structure of the catch numbers at age data before its use in a catch at age analysis. The results of the model fit are within ICES files (path). 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.

3.3.2 Exploratory survey analysis

SURBA-based evaluations of stock trends are presented for the IBTSQ1, EngGFS and ScoGFS series. For the IBTSQ1 and ScoGFS, data were available up to and including 2005, for the EngGFS to 2004. The data series were fitted within the SURBA version 3.0 model (see section 1.4.3 for a description of methods) and indices of recruitment, SSB and Z are presented.

The SURBA mean standardised indices by cohort, time series estimates for mean Z, SSB, total biomass and recruitment and retrospective runs are plotted in Figures 3.12 – 3.13 (English ground fish survey), 3.14 – 3.15 (IBTS survey) and Figures 3.16 – 3.17 (Scottish groundfish surveys).

The mean standardised indices indicate that recruitment levels have declined in recent years and during the past 8 years have been consistently well below the historic values. Both the IBTS and Scottish groundfish surveys indicate that the recruitment in 2004 has again been amongst the lowest in the time series.

The wide confidence intervals from these analyses suggest that trends in mean Z cannot be estimated by applying the SURBA model to any of the available survey series.

All the surveys indicate that the cod stock is at a low level, although the estimates of SSB indicate differences in the detailed interpretation of the most recent years of the survey series. The IBTSQ1 and ScoGFS both indicate a substantial decline in SSB since the early- to mid-1980s. All surveys show a decline from slight increase in 1995/6.

The retrospective analyses indicate that the model estimates of SSB, total biomass and recruitment are consistent between years but that mean Z is poorly estimated.

3.3.2.1 Laurec – Shepherd analysis of the survey tuning data.

The Laurec – Shepherd VPA calibration model was used to screen the survey calibration data before fitting within assessment models. The results of the model fit are within ICES files (path). The Laurec – Shepherd model makes the assumption that the selection pattern at the oldest ages is constant, a constraint used to reduce the number of estimated parameters.

Figures 3.18 – 3.20 present the time series of the log catchability residuals from single fleet Laurec – Shepherd tuning models fitted to the English (EGFS), Scottish (ScoGFS), International Bottom Trawl Survey (IBTS) surveys. The Figures illustrate that for the majority of survey ages, catchability is not constant in time it has been increasing and exhibits cohort effects related to population abundance. The increase is more pronounced at the youngest ages of the Scottish and IBTS ground fish 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. Reduced levels of catch at age result in low population sizes and positive catchability residuals. Therefore rather than errors or bias in the survey CPUE, the changes in level in recent catchability could result from bias in the VPA populations induced by additional unrecorded mortality such as under-reporting, changes in discard practice and additional natural mortality.

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). The series were therefore accepted as being suitable for inclusion in analysis of the stock.

3.3.3 B- ADAPT Analysis

The 2003 WGNSSK Working noted that there have been frequent reports from the fishing industry that the recent reductions in TAC have not been observed. The group 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.

At the 2004 working group a development of the ADAPT (Gavaris 1988) model structure B-ADAPT, described in Darby (2004), was used to estimate the potential level of unallocated losses from the stock that would result n consistency between the catch at age data and the survey time series. The model uses survey information to estimate additional mortality not represented by the recorded landings and estimated discards.

At this year’s meeting the model was again applied to the working group estimates of landings and discard numbers at age and landings and discard weight data sets listed in Tables 3.3 – 3.6 and the English (ages 1 – 6), Scottish (ages 1 – 6) and IBTS (ages 1 – 5) groundfish survey series (Table 8). Consistent with the previous year, fishing mortality at the oldest age was estimated as an average of ages 3 – 5; an assumption of a flat topped selection pattern. Catchability of each fleet was assumed to be constant in time and independent at all ages, except for the IBTS survey in which a single catchability was estimated for ages 5 and 6. Equal weight was assumed for the estimates from three survey series in the estimation of parameters. Additional mortality parameters were estimated for the years 1993 – 2003 using a total catch smoothing parameter of 0.5.

Prior to fitting the full B-ADAPT model single fleet runs were carried out in order to examine the consistency of estimates derived from the available time series of survey data. The results of the model fit are within ICES files (path). The recent period during which the English groundfish survey has used a GOV trawl coincides with the period over which additional mortality has been estimated. Therefore catchability at age and the year effects in mortality are confounded and the latter cannot be estimated uniquely. Therefore, for the single survey runs only the IBTS survey and the Scottish groundfish series can be utilised.

Figures 3.21 – 3.24 plot the time series of estimated losses from the stock, fishing mortality, SSB and recruitment. The estimates from a model fitted in which the catch data are treated as exact are also presented.

The estimated removals are higher than the recorded catches in the fits to both the IBTS and Scottish survey series. The pattern of discrepancies between estimated removals and recorded catch shows consistent trends between surveys and with the previous years model fit. The differences increase from 1995 – 1996, followed by a drop in 1997/8, when the 1996 year class arrived in the fishery and then increasing again in 2001 and 2003.

The recruitment patterns are consistent between model fits, the models estimating additional removals indicate higher levels in recent years, but the average is still estimated to be well below historic values.

The SSB estimates from the B-ADPAT model estimating removals from the stock are higher than those assuming exact catches. The time series is consistent between surveys and with the previous years estimates.

The estimates of recent fishing mortality based on the fits to the two survey series are consistently higher than the values estimated with no bias parameter. However, the survey series give markedly differing trends in the most recent years. Estimates from the IBTS survey indicate a decline in fishing mortality to around 0.7, consistent with known reductions in fleet size and days at sea restrictions (Horwood WD3). However the estimates derived from the Scottish groundfish survey exhibit a strong increase in fishing mortality to 1.5.

The underlying cause of the substantial difference between the estimates of mortality derived from the two data sources is evident in Figure 3.10 the comparative pair-wise plots used to examine within survey consistency. The Scottish groundfish survey has very low indices at three ages in 2005 resulting from low catch rates of older fish. The low rates were not recorded in the IBTS survey. Hence the model fitted to the Scottish survey indicates that the fish could have been subject to a substantial increase in mortality during 2005. Detailed examination of the Scottish groundfish survey 2005 third quarter catches did not reveal any errors within the raising process and the results are due to low catches of older fish at the oldest ages.

3.3.4 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 and is unchanged from the previous years perception of the stock’s status.

Two of the three survey indices of SSB have remained stable from 2001 - 2004. This is in agreement with a fishing industry perception of the state of the stock submitted to the working group in the North Sea Survey responses (Ref).

The abundance of the recruiting year classes are also consistent between analyses all indicate the recruitment of 1 year old cod has varied considerably since the 1960s but since 1997 average recruitment has been lower than 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 2004 year class is estimated to be close to the average of the recent low values.

All catch at age models indicate that the mortality rate has remained high since the late 1970s. The models estimate that there reduction in fishing mortality since 2000, however, the magnitude of any reduction and the fishing mortality in the final year are uncertain. The estimates differ between the two survey series available at the meeting.

It is possible that the Scottish groundfish survey results are a year effect in the survey caused by a change in the distribution of cod at the time of the survey. However, it could also be hypothesised, however unlikely, that there has been substantial increase in mortality between the quarter 1 and quarter 3 survey series. Without additional information the likelihood as two which of the two scenarios is correct cannot be determined.

3.3.5 Final assessment

At this meeting the Working Group did not have sufficient fishery independent information collected within 2005 to distinguish between the trends in mortality estimated from model fits to the Scottish and IBTS surveys.

The English groundfish survey is due to be completed at the end of September 2005. The Working Group therefore decided that the analysis of this stock should be suspended until the results of that survey are made available and further analysis can be undertaken to resolve the uncertainty in the level of fishing mortality.

3.4 Quality of the assessment

Discards data for all fleets are based on the Scottish sampling discard at age ogive. The procedure used to raise discards resulted in a 40% SOP error in the discard data for 2005. This will be corrected before a final assessment is submitted.

3.4.1 The North Sea Stock Survey 2005

The North Sea Stock Survey 2005 (Marrs 2005) was submitted to the WG in preliminary form in order that the fishers' perception of the state of the stock could 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 3.24.

The North Sea Survey responses indicate that in the north east North Sea (areas 1, 7, 8 and 9) the fisher's perception of the abundance of cod has been one of gradually increasing abundance. In the western North Sea (areas 3 and 4) there have been steady declines. The survey responses for the central and south eastern North Sea indicate relative stability.

The IBTS survey data (Figure 3.25) are broadly in agreement with the fishers survey (although noisier), recording an increase in stock abundance in the north east, a gradual decline in the west and stability in the south. 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 the older (4+) fish caught by the survey are considered there has been an increase in abundance since 2001.

3.5 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. During 2002 to

2004, 90%, 80% and 75% of the international landings in number were accounted for by juvenile cod aged 1-3.

The exploitation pattern at the youngest ages has remained largely unchanged since the early 1960s despite various changes to technical regulations (gear modifications and mesh size changes) aimed at improving it. The proportion of numbers discarded at age 1 have fluctuated around 80% with no decline apparent after the introduction of the 120mm mesh in 2002. At ages 2 and 3 discard proportions have been increasing steadily and are currently around 50% and 15%, respectively, in 2004. In order to evaluate why this occurs catch composition of the fleets participating in the fishery requires further analysis.

The lack of improvement in the selection pattern is of direct concern in the area of the North Sea east of Scotland, illustrated in Figure 3.26, which plots the densities of O-group cod have been recorded by the Scottish groundfish survey in 2005. The survey recorded the highest catch rates of O-group in its time series and if discard rates in this area are high, the localised recruitment will not lead to any increase in the stock. It is recommended that direct observations of catch and discard rates within this area be given priority with a view to giving the recruits maximum protection.

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, whiting and nephrops, 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 2002 and 2003 compared to that on cod indicate that some degree of de-coupling may have occurred in recent years.

Fishing mortality has declined on the whiting and haddock stocks at rates that are consistent with the reductions in fleet effort discussed in Section 15 and North Sea cod mortality rates may also have been reduced. However, boats may still be targeting cod as a high value species, therefore the reductions in mortality rates for this species may not be to the same extent or maintained despite the recent reductions in TAC.

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 working group indicate increasing discard rates at the youngest ages in recent years.

It is considered that conclusions with respect to the low levels of spawning stock biomass and recruitment are robust to the uncertainty in the level of recent recorded catches and survey information. The level of fishing mortality in the most recent years is uncertain due to uncertainty in the level of reported landings and contradictions in survey catch rates in 2005. Further indications as to the level of recent mortality rates will be available made available in a working document to ACFM when the English groundfish survey results become available in late September 2005.

Table 3.1 The countries contributing cod landings data to the 2005 STECF data base used to illustrate landings the landings distributions presented in Figures 3.1. – 3.3.

Country	Year restrictions	Area restrictions
Belgium	2003-2004	None
Denmark	2000-2004	None
Estonia	No data	No data
Finland	2000-2004	SA 22-24, 25-32
France	2000-2004	None
Germany	2000-2004	None
Ireland	2000-2004	None
Netherlands	2000-2004	None
Latvia	2000-2004	SA 22-24, 25-32
Lithuania	No data	No data
Poland	No data	No data
Sweden	2000-2004	None
UK England	2000-2004	None
UK Scotland	2000-2004	None
Norway	2002-2004	None

Table 3.2. **Nominal landings (in tonnes) of COD in IIIa (Skagerrak), IV and VIId, 1985–2004 as officially reported to ICES and as used by the Working Group.**

Sub-area IV										
Country	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Belgium	4,815	6,604	6,693	5,508	3,398	2,934	2,331	3,356	3,374	2,648
Denmark	42,547	32,892	36,948	34,905	25,782	21,601	18,998	18,479	19,547	19,243
Faroe Islands	71	45	57	46	35	96	23	109	46	80
France	4,834	8,402	8,199	8,323	2,578	1,641	975	2,146	1,868	1,868
Greenland										
Germany	7,675	7,667	8,230	7,707	11,430	11,725	7,278	8,446	6,800	5,974
Netherlands	30,844	25,082	21,347	16,968	12,028	8,445	6,831	11,133	10,220	6,512
Norway	5,766	4,864	5,000	3,585	4,813	5,168	6,022	10,476	8,742	7,707
Poland	-	10	13	19	24	53	15	-	-	-
Sweden	748	839	688	367	501	620	784	823	646	630
UK (E/W/NI)	29,692	25,361	29,960	23,496	18,375	15,622	14,249	14,462	14,940	13,941
UK (Scotland)	60,931	45,748	49,671	41,382	31,480	31,120	29,060	28,677	28,197	28,854
United Kindom										
Total Nominal Catch	187,923	157,514	166,806	142,306	110,444	99,025	86,566	98,107	94,380	87,457
Unallocated landings	6,773	11,292	15,288	14,253	5,256	5,726	1,967	-758	10,200	7,066
WG estimate of total landings	**194,696**	**168,806**	**182,094**	**156,559**	**115,700**	**104,751**	**88,533**	**97,349**	**104,580**	**94,523**
Agreed TAC	**250,000**	**170,000**	**175,000**	**160,000**	**124,000**	**105,000**	**100,000**	**100,000**	**101,000**	**102,000**
	0.78	0.99	1.04	0.98	0.93	1.00	0.89	0.97	1.04	0.93
Division VIId										
Country	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Belgium	501	650	815	486	173	237	182	187	157	228
Denmark	-	4	-	+	+	-	-	1	1	9
France	2,589	9,938	7,541	8,795	n/a	n/a	n/a	2,079	1,771	2,338
Netherlands	-	-	-	1	1	-	-	2	-	-
UK (E/W/NI)	326	830	1,044	867	562	420	341	443	530	312
UK (Scotland)	-	-	-	-	-	7	2	22	2	+
United Kingdom										
Total Nominal Catch	3,416	11,422	9,400	10,149	n/a	n/a	n/a	2,734	2,461	2,887
Unallocated landings	-111	3,722	4,819	580	-	-	-	-65	-29	-37
WG estimate of total landings	**3,305**	**15,144**	**14,219**	**10,729**	**5,538**	**2,763**	**1,886**	**2,669**	**2,432**	**2,850**
Division IIIa (Skagerrak)										
Country	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Denmark	14,521	18,424	17,824	14,806	16,634	15,788	10,396	11,194	11,997	11,953
Sweden	1,914	1,505	1,924	1,648	1,902	1,694	1,579	2,436	2,574	1,821
Norway	193	174	152	392	256	143	72	270	75	60
Germany	-	-	-	-	12	110	12	-	-	301
Others	-	-	-	106	34	65	12	102	91	25
Norwegian coast *	990	917	838	769	888	846	854	923	909	760
Danish industrial by-catch *	1,751	997	491	1,103	428	687	953	1,360	511	666
Total Nominal Catch	16,628	20,103	19,900	16,952	18,838	17,800	12,071	14,002	14,737	14160
Unallocated landings	0	0	0	0	-141	0	-12	0	0	-899
WG estimate of total landings	**16,628**	**20,103**	**19,900**	**16,952**	**18,697**	**17,800**	**12,059**	**14,002**	**14,737**	**13,261**
Agreed TAC	**29,000**	**29,000**	**22,500**	**21,500**	**20,500**	**21,000**	**15,000**	**15,000**	**15,000**	**15,500**
Sub-area IV, Divisions VIId and IIIa (Skagerrak) combined										
	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Total Nominal Catch	207,967	189,039	196,106	169,407	n/a	n/a	n/a	114,843	111,578	104,504
Unallocated landings	6,662	15,014	20,106	14,833	-	-	-	-823	10,171	6,130
WG estimate of total landings	**214,629**	**204,053**	**216,212**	**184,240**	**139,936**	**125,314**	**102,478**	**114,020**	**121,749**	**110,634**

* The Danish industrial by-catch and the Norwegian coast catches are not included in the (WG estimate of) total landings of Division IIIa
n/a not available ** provisional

Table 3.2. Cont'd. **Nominal landings (in tonnes) of COD in IIIa (Skagerrak), IV and VIId, 1985–2004 as officially reported to ICES and as used by the Working Group.**

Sub-area IV

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Belgium	4,827	3,458	4,642	5,799	3,882	3,304	2,470	2,616	1,482	1,615
Denmark	24,067	23,573	21,870	23,002	19,697	14,000	8,358	9,022	4,676	5,889
Faroe Islands	219	44	40	102	96		9	34	36	
France	3,040	1,934	3,451	2,934	1,750	1,222	717	1,777	617	
Germany	9,457	8,344	5,179	8,045	3,386	1,740	1,810	2,018	2,048	2,212
Greenland									1,352	
Netherlands	11,199	9,271	11,807	14,676	9,068	5,995	3,574	4,707	2,305	1,728
Norway	7,111	5,869	5,814	5,823	7,432	6,410	4,383	4,994	4,518	3,205
Poland	-	18	31	25	19	18	18	39	35	
Sweden	709	617	832	540	625	640	661	463	252	226
UK (E/W/NI)	14,991	15,930	13,413	17,745	10,344	6,543	4,087	3,112	2,213	1,889
UK (Scotland)	35,848	35,349	32,344	35,633	23,017	21,009	15,640	15,416	7,852	6,644
United Kindom										
Total Nominal Catch	111,468	104,407	99,423	114,324	79,316	60,881	41,727	44,198	27,386	23,408
Unallocated landings	8,555	2,161	2,746	7,779	-924	-1,114	-754	102	-1,539	141
WG estimate of total landings	**120,023**	**106,568**	**102,169**	**122,103**	**78,392**	**59,767**	**40,973**	**44,300**	**25,847**	**23,549**
Agreed TAC	**120,000**	**130,000**	**115,000**	**140,000**	**132,400**	**81,000**	**48,600**	**49,300**	**27,300**	**27,300**

Division VIId

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2003
Belgium	377	321	310	239	172	110	93	51	54	47
Denmark	-	-	-	-	-	-	-	-		
France	3,261	2,808	6,387	7,788		3,084	1,677	1,361	1,127	
Netherlands	-	+	-	19	3	4	17	6	36	14
UK (E/W/NI)	336	414	478	618	454	385	249	145	121	100
UK (Scotland)	+	4	3	1	-	-	-	-		
United Kingdom										
Total Nominal Catch	3,974	3,547	7,178	8,665	629	3,583	2,036	1,563	1,338	161
Unallocated landings	-10	-44	-135	-85	6,229	-1,258	-463	1,534	-104	646
WG estimate of total landings	**3,964**	**3,503**	**7,043**	**8,580**	**6,858**	**2,325**	**1,573**	**3,097**	**1,234**	**807**

Division IIIa (Skagerrak)

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2003
Denmark	8,948	13,573	12,164	12,340	8,734	7,683	5,901	5,526	3,071	3,039
Sweden	2,658	2,208	2,303	1608	1,909	1,350	1,035	1,716	509	495
Norway	169	265	348	303	345	301	134	146	193	133
Germany	200	203	81	16	54	9	32	83	-	
Others	134	-	-	-	-	-	-	-	-	
Norwegian coast *	846	748	911	976	788	624	846	n/a	n/a	720
Danish industrial by-catch *	749	676	205	97	62	99	687	n/a	n/a	10
Total Nominal Catch	12109	16249	14896	14267	11042	9343	7102	7471	3773	3667
Unallocated landings	0	0	50	1,064	-68	-66	-16	-3	18	120
WG estimate of total landings	**12,109**	**16,249**	**14,946**	**15,331**	**10,974**	**9,277**	**7,086**	**7,468**	**3,791**	**3,787**
Agreed TAC	**20,000**	**23,000**	**16,100**	**20,000**	**19,000**	**11,600**	**7,000**	**7,100**	**3,900**	**3,900**

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

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2003
Total Nominal Catch	127,551	124,203	121,497	137,256	90,987	73,807	50,865	53,232	32,497	27,236
Unallocated landings	8,545	2,117	2,661	8,758	5,238	-2,438	-1,233	1,633	-1,625	907
WG estimate of total landings	**136,096**	**126,320**	**124,158**	**146,014**	**96,225**	**71,369**	**49,632**	**54,865**	**30,872**	**28,143**

* The Danish industrial by-catch and the Norwegian coast catches are not included in the (WG estimate of) total landings of Division IIIa

n/a not available ** provisional

Division IIIa (Skagerrak) landings not included in the assessment

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2003
Norwegian coast *	846.00	748.00	911.00	976.00	788.00	624.00	846.00	n/a	n/a	720
Danish industrial by-catch	749.00	676.00	205.00	97.00	62.00	99.00	687.00	n/a	n/a	10
Total	**1,595.00**	**1,424.00**	**1,116.00**	**1,073.00**	**850.00**	**723.00**	**1,533.00**	**0.00**	**0.00**	**730.00**

Table 3.3 Cod 347d: Landings numbers at age (Thousands)

Landings numbers at age Numbers*10**-3

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	3214	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	2004
1	4938	23769	1255	5941	8294	2220	7192	400	1588
2	36805	29194	81737	9731	23033	20832	7870	9615	4080
3	23364	18646	16958	32224	6472	6200	13252	3511	4945
4	3169	6499	5967	4034	6697	1142	2519	2660	1964
5	1860	1238	2402	1445	1021	1080	366	449	987
6	399	700	509	626	385	144	349	66	150
7	162	153	236	223	139	84	51	49	43
8	88	47	41	91	40	27	31	13	23
9	43	14	16	14	18	14	13	7	8
10	4	15	4	10	5	6	5	3	3
+gp	8	10	12	2	1	1	0	1	0
TOTALNUM	70837	80285	109137	54342	46105	31750	31649	16774	13790
TONSLAND	126320	124158	146014	96225	71371	49632	54865	30872	28143
SOPCOF %	100	100	100	100	100	100	100	102	100

Table 3.4 Cod 347d: Discard numbers at age

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	2004
1	13410	57334	13606	21523	33628	4472	10812	7973	6701
2	19873	11570	80433	4202	4790	29983	2046	8084	3119
3	656	33	1107	7294	0	609	1625	912	652
4	0	0	0	0	0	0	0	65	0
5	0	0	0	0	0	0	0	11	0
6	0	0	0	0	0	0	0	1	0
7	0	0	0	0	0	0	0	1	0
8	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0
TOTALNUM	33939	68938	95146	33019	38418	35064	14483	17046	10472

Table 3.5 Cod 347d: Landings weight at age

Landings weights at age (kg)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.538	0.496	0.581	0.579	0.59	0.64	0.544	0.626	0.579	0.616	0.559
2	1.004	0.863	0.965	0.994	1.035	0.973	0.921	0.961	0.941	0.836	0.869
3	2.657	2.377	2.304	2.442	2.404	2.223	2.133	2.041	2.193	2.086	1.919
4	4.491	4.528	4.512	4.169	3.153	4.094	3.852	4.001	4.258	3.968	3.776
5	6.794	6.447	7.274	7.027	6.803	5.341	5.715	6.131	6.528	6.011	5.488
6	9.409	8.52	9.498	9.599	9.61	8.02	6.722	7.945	8.646	8.246	7.453
7	11.562	10.606	11.898	11.766	12.033	8.581	9.262	9.953	10.356	9.766	9.019
8	11.942	10.758	12.041	11.968	12.481	10.162	9.749	10.131	11.219	10.228	9.81
9	13.383	12.34	13.053	14.059	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	2004
1	0.699	0.656	0.542	0.64	0.621	0.725	0.758	0.608	0.708
2	1.117	0.96	0.922	0.935	1.03	1.004	1.082	1.173	1.002
3	2.147	2.12	1.724	1.663	1.737	2.303	1.916	1.848	2.025
4	4.034	3.821	3.495	3.305	3.196	3.663	3.857	3.255	3.285
5	6.637	6.228	5.387	5.726	4.83	5.871	5.372	5.185	5.253
6	8.494	8.394	7.563	7.403	7.411	7.332	7.991	7.407	7.758
7	9.729	9.979	9.628	8.582	9.532	9.264	9.627	8.704	9.742
8	11.08	11.424	10.643	10.365	10.952	10.081	10.403	12.178	9.783
9	12.264	12.3	11.499	11.6	11.914	12.062	10.963	12.851	11.591
10	12.756	12.761	13.085	12.33	12.437	12.009	12.816	10.772	13.049
+gp	11.3036	13.4162	14.921	11.9257	15.0776	10.1972	11.8422	17.5051	14.1348
SOPCOFAC	0.999	1.0002	0.9998	1.0034	1.0002	1.0001	1.0001	1	0.9999

Table 3.6 Cod347d: Dicard weights at age

Discard weights at age (kg)

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

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

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

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0.342	0.313	0.358	0.257	0.298	0.232	0.294	0.259	0.315
2	0.38	0.453	0.375	0.389	0.422	0.361	0.42	0.344	0.398
3	0.515	0.616	0.481	0.422	0	0.406	0.34	0.54	0.432
4	0	0	0	0	0	0	0	0.675	0
5	0	0	0	0	0	0	0	2.272	0
6	0	0	0	0	0	0	0	2.849	0
7	0	0	0	0	0	0	0	3.585	0
8	0	0	0	0	0	0	0	5.033	0
9	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	5.771	0

Table 3.7 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Natural mortality and proportion mature by age-group.

Age group	**Natural mortality**	**Proportion mature**
1	0.8	0.01
2	0.35	0.05
3	0.25	0.23
4	0.2	0.62
5	0.2	0.86
6	0.2	1.0
7+	0.2	1.0

Table 3.8 COD in IIIa (Skagerrak), IV and VIId: Survey series used in the assessment

IBTS Q1, Ages 1-5. 6 is a plus group

IBTS_Q1_IV						
1982	**2005**					
1	**1**	**0**	**0.25**			
1	**5**		**6 is plus g**			
1	**4.734**	**16.698**	**2.748**	**1.933**	**0.799**	**1.356**
1	**15.856**	**8.955**	**4.065**	**0.904**	**0.974**	**0.875**
1	**0.928**	**18.779**	**3.221**	**1.734**	**0.458**	**0.957**
1	**16.785**	**3.627**	**7.08**	**2.244**	**1.276**	**0.969**
1	**9.425**	**28.837**	**1.512**	**1.79**	**0.613**	**0.841**
1	**5.638**	**6.334**	**6.203**	**0.659**	**0.846**	**1.142**
1	**15.117**	**6.328**	**5.043**	**2.344**	**0.396**	**0.992**
1	**3.951**	**15.668**	**1.879**	**1.038**	**0.964**	**0.623**
1	**2.481**	**4.715**	**4.255**	**0.865**	**0.415**	**0.771**
1	**13.143**	**4.328**	**1.184**	**0.991**	**0.296**	**0.483**
1	**13.088**	**19.519**	**2.03**	**0.686**	**0.557**	**0.386**
1	**14.736**	**4.311**	**2.88**	**0.811**	**0.471**	**0.533**
1	**9.832**	**22.062**	**2.728**	**1.105**	**0.276**	**0.338**
1	**3.435**	**7.976**	**5.922**	**0.679**	**0.617**	**0.406**
1	**39.94**	**6.908**	**2.244**	**1.059**	**0.453**	**0.435**
1	**2.672**	**26.368**	**2.002**	**0.881**	**0.489**	**0.413**
1	**2.112**	**1.578**	**8.077**	**0.766**	**0.41**	**0.527**
1	**6.56**	**3.767**	**0.732**	**2.053**	**0.387**	**0.511**
1	**2.786**	**8.642**	**1.658**	**0.236**	**0.383**	**0.275**
1	**7.744**	**3.385**	**4.284**	**0.492**	**0.119**	**0.222**
1	**0.571**	**2.867**	**1.149**	**1.362**	**0.51**	**0.196**
1	**6.712**	**2.053**	**1.289**	**0.317**	**0.476**	**0.17**
1	**2.276**	**2.187**	**0.635**	**0.543**	**0.233**	**0.424**

Table 3.8 Cont'd. COD in IIIa (Skagerrak), IV and VIId: Survey series used in the assessment

ScoGFS. Ages 1-8

SCOGFS_IV

1982	2005							
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
100	12	11.5	2.8	0.3	0.8	0.3	0.3	0.0

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

Table 3.8 Cont'd. COD in IIIa (Skagerrak), IV and VIId: Survey series used in the assessment

1992-2004, GOV trawl. Ages 1-6

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	**503.45**	191.37	49.73	12.43	15.82	3.40

Table 3.8 Cont'd. COD in IIIa (Skagerrak), IV and VIId: Survey series **not** used in the assessment

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 3.8 Cont'd. COD in IIIa (Skagerrak), IV and VIId: Scottish light trawl. Effort in column one is hours fished (Including discards) Data set **not** used in assessment

SCOTRL_IV

1978	2004									
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
7491	75.420	224.254	140.598	32.505	36.294	3.948	0.543	0.570	0.423	0.000

Table 3.8 Cont'd. COD in IIIa (Skagerrak), IV and VIId: All available tuning data sets ScoSei. Ages 1-12. Effort in column one is hours fished (Including discards) Data set **not** used in assessment

SCOSEI_IV

1978	2004												
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	
15670	455.827	556.955	293.382	46.256	60.575	8.617	1.383	0.936	0.191	0.397	0.000	0.000	

Table 3.8 Cont'd. COD in IIIa (Skagerrak), IV and VIId: All available tuning data sets ScoLtr. Ages 1-11 Effort in column one is hours fished (Including discards) Data set **not** used in assessment

SCOLTR_IV

1978	2004										
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
63953	926.669	700.407	382.10001	93.283	142.166	14.435	3.547	3.004	1.867	7.00E-03	1.30E-02

Table 3.8 Cont'd. COD in IIIa (Skagerrak), IV and VIId: All available tuning data sets EngTrl. Ages 1-12. Effort in column 1 is hours fished (Including discards based on Scottish discarding ogive) Data set **not** used in assessment

ENGTRL_IV

1978	2004											
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
42362	146.52	185.432	109.954	4.907001	2.121	0.435	0.038	0.023	0	0.004	0	0

Table 3.8 Cont'd. COD in IIIa (Skagerrak), IV and VIId: All available tuning data sets EngSei. Ages 1-12. Effort in column 1 is hours fished (Including discards based on Scottish discarding ogive) Data set **not** used in assessment

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

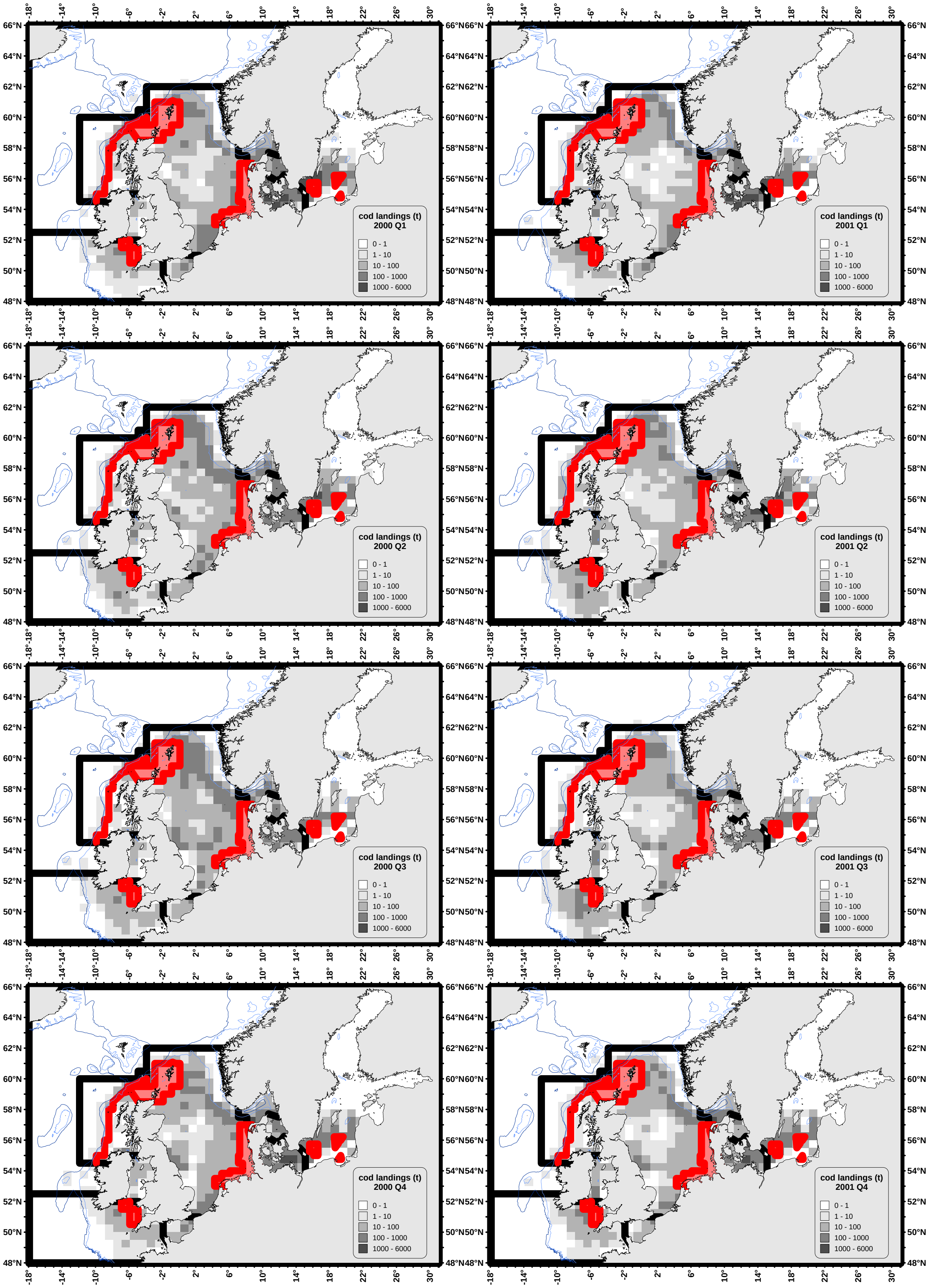

Figure 3.1 International landings 2000-2001 by quarters in comparison with access restricted areas in 2005 affecting demersal fisheries. The 3 eastern Baltic areas are closed all year. Note that Western Baltic (Sub-areas 22-24) is closed from 1 March to 30 April 2005 (inclusive) and the Eastern Baltic (Sub-areas 25-32) is closed from 1 May to 15 September 2005 (inclusive). North Sea is restricted by the plaice box affecting large beam trawlers (kW), and the Shetland box limiting the effort also through a license system. West of Scotland also covered by the Shetland box and the West of Scotland box is closed all year 2005. Celtic Sea closures are until 31 March 2005 (inclusive). Data from STEFC 2005a.

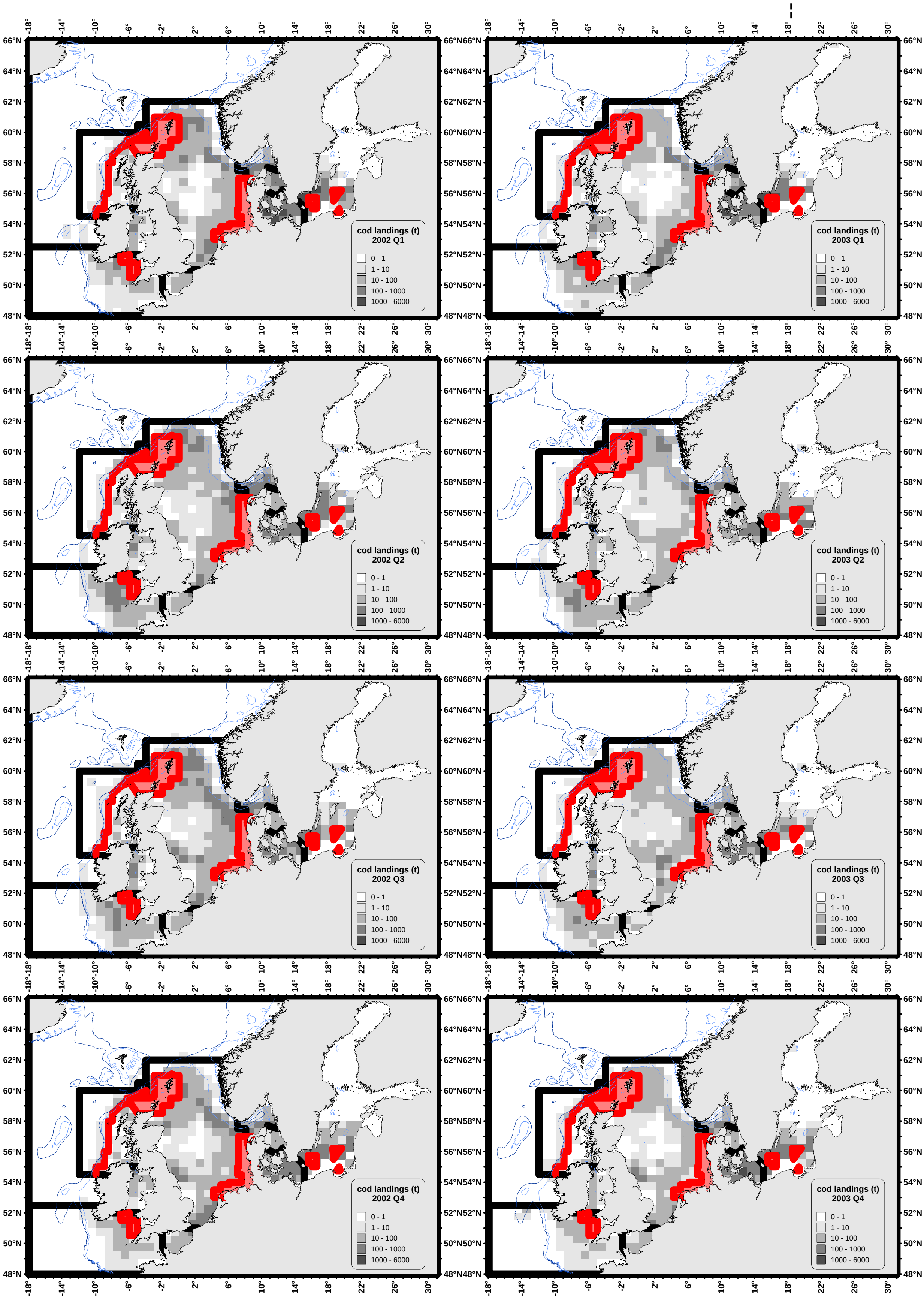

Figure 3.2 International landings 2002-2003 by quarters in comparison with access restricted areas in 2005 affecting demersal fisheries. The 3 eastern Baltic areas are closed all year. Note that Western Baltic (Sub-areas 22-24) is closed from 1 March to 30 April 2005 (inclusive) and the Eastern Baltic (Sub-areas 25-32) is closed from 1 May to 15 September 2005 (inclusive). North Sea is restricted by the plaice box affecting large beam trawlers (kW), and the Shetland box limiting the effort also through a license system. West of Scotland also covered by the Shetland box and the West of Scotland box is closed all year 2005. Celtic Sea closures are until 31 March 2005 (inclusive). Data from STEFC 2005a.

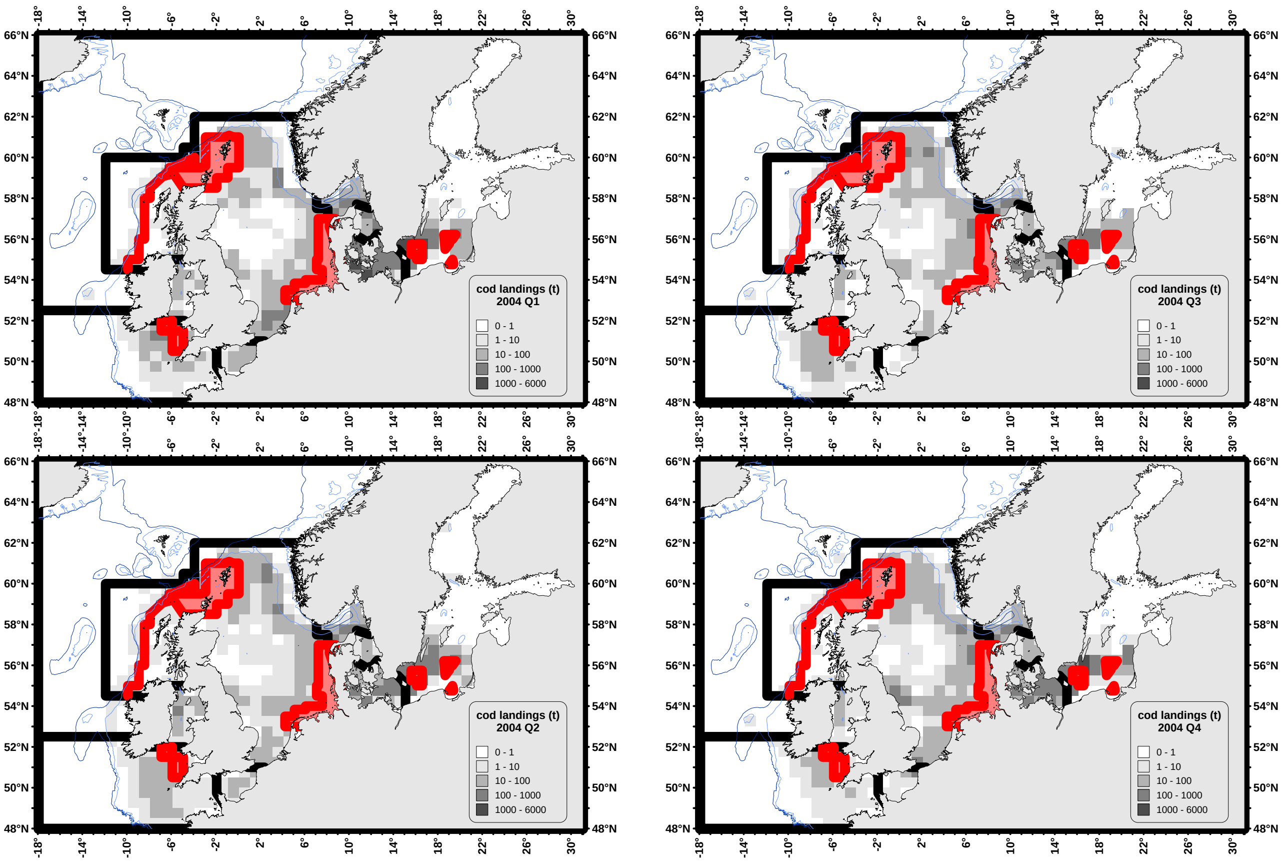

Figure 3.3 International landings 2004 by quarters in comparison with access restricted areas in 2005 affecting demersal fisheries. The 3 eastern Baltic areas are closed all year. Note that Western Baltic (Sub-areas 22-24) is closed from 1 March to 30 April 2005 (inclusive) and the Eastern Baltic (Sub-areas 25-32) is closed from 1 May to 15 September 2005 (inclusive). North Sea is restricted by the plaice box affecting large beam trawlers (kW), and the Shetland box limiting the effort also through a license system. West of Scotland also covered by the Shetland box and the West of Scotland box is closed all year 2005. Celtic Sea closures are until 31 March 2005 (inclusive). Data from STEFC 2005a.

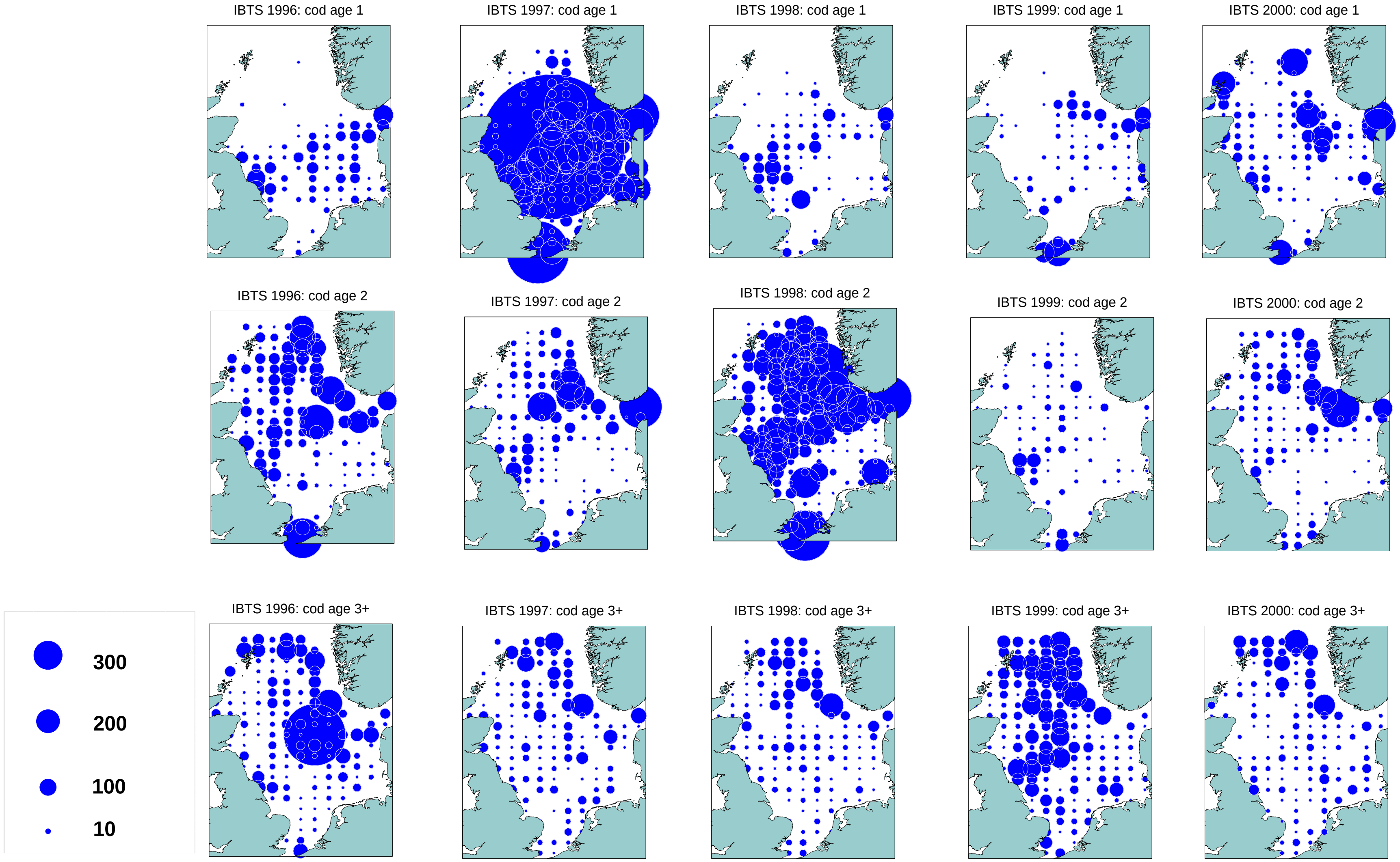

Figure 3.4a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3 caught in the IBTS Q1 survey 1996-2004 for ages 1-3.

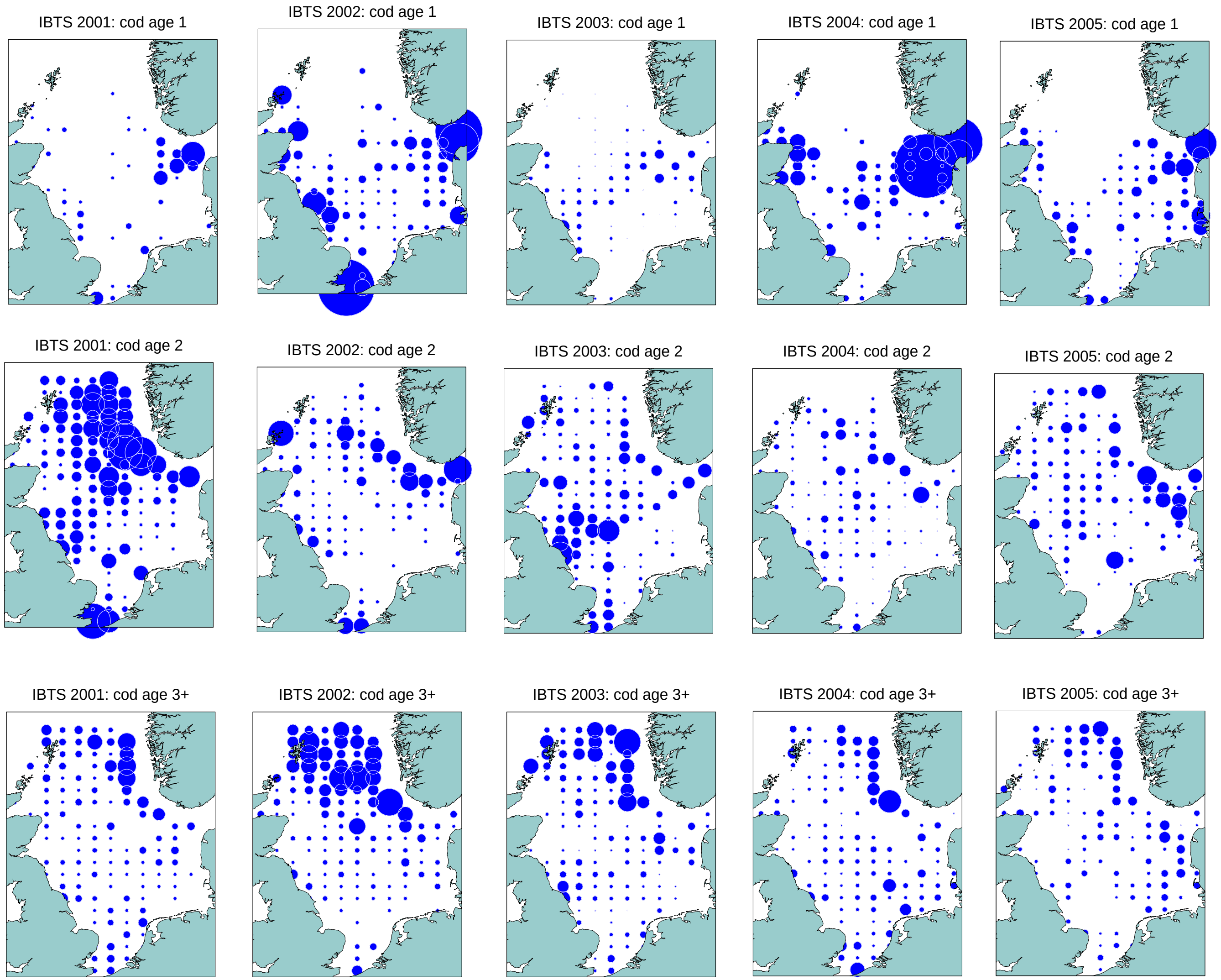

Figure 3.4b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3 caught in the IBTS Q1 survey 1996-2004 for ages 1-3.

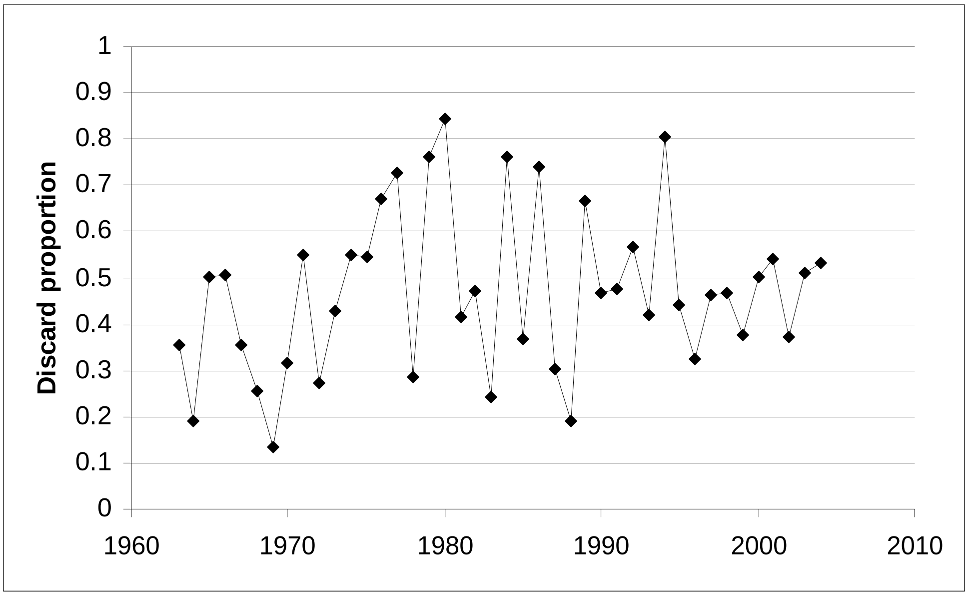

Figure 3.5 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Proportion of total numbers discarded.

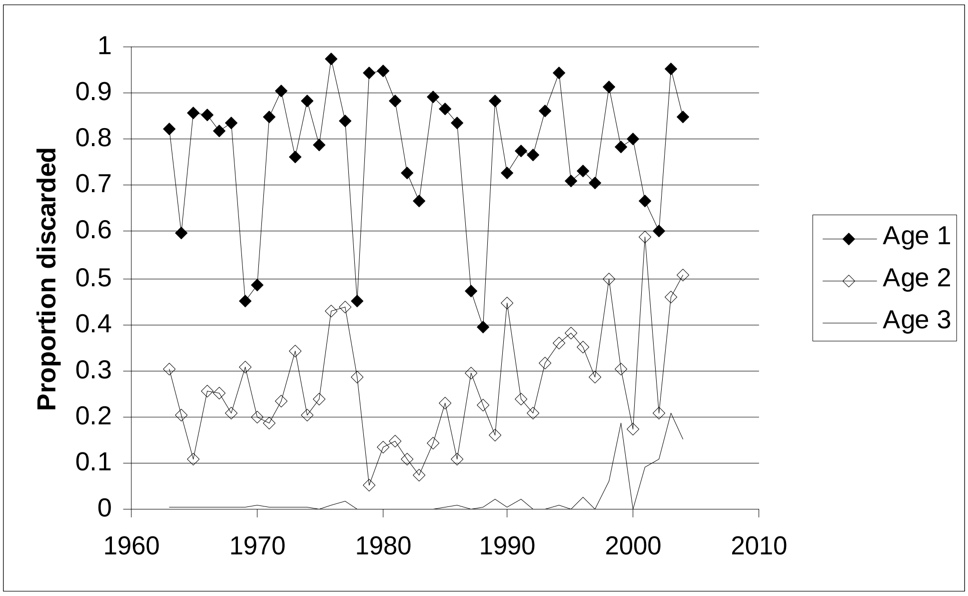

Figure 3.6 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Proportion of numbers discarded at ages 1 to 3.

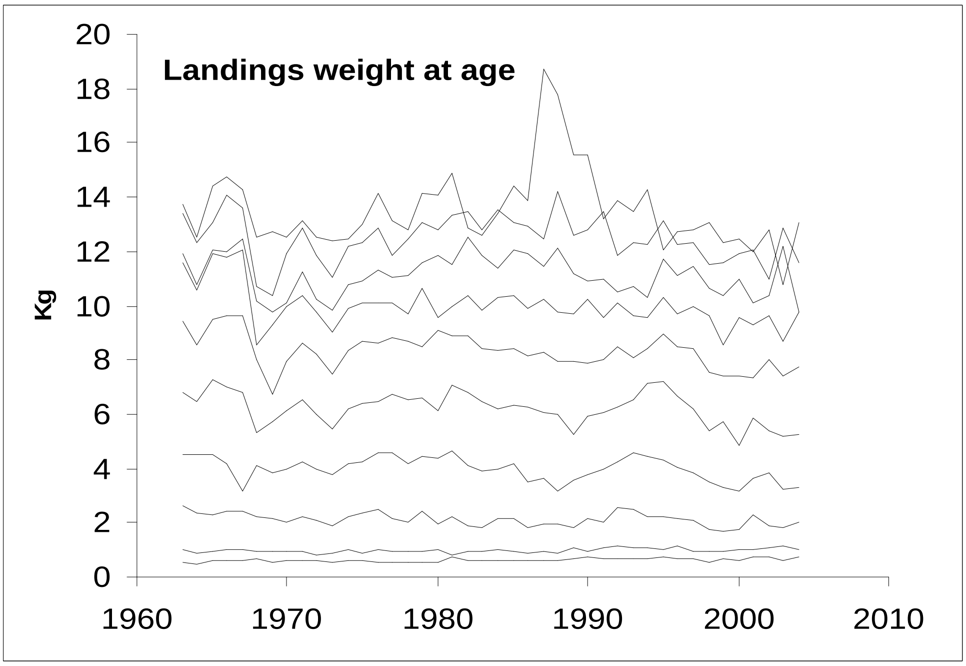

Figure 3.7 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Mean weight at age in the landings.

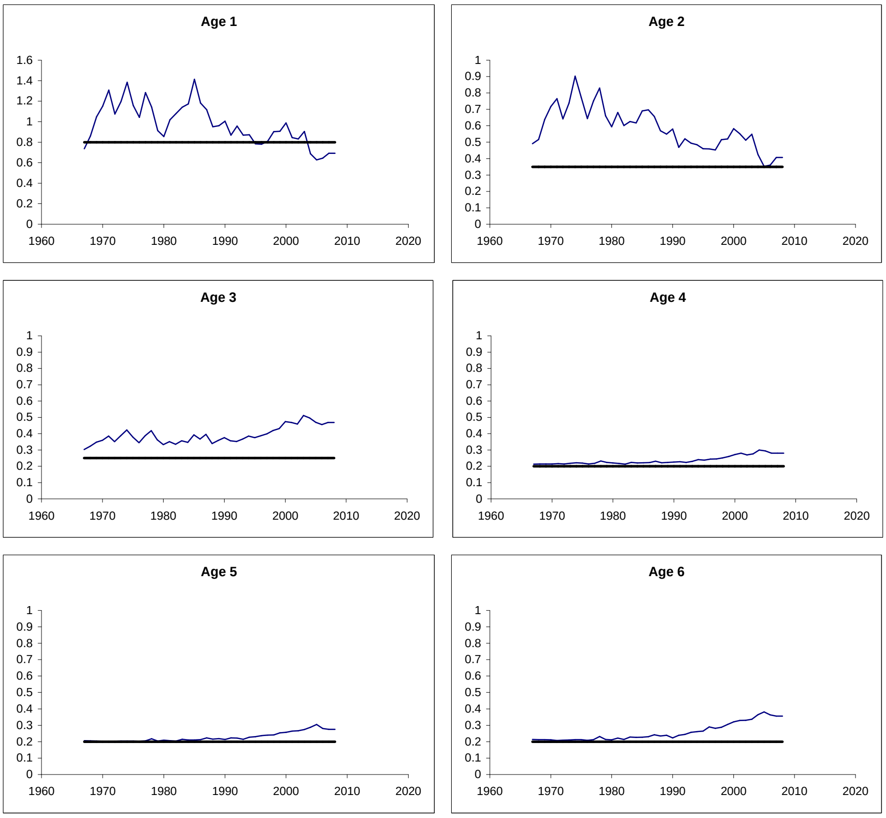

Figure 3.8 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The time series of North Sea cod multi-species natural mortality rates fo ages 1 – 4 estimated by the ICES Multi-species Study Group (ICES 2005x).

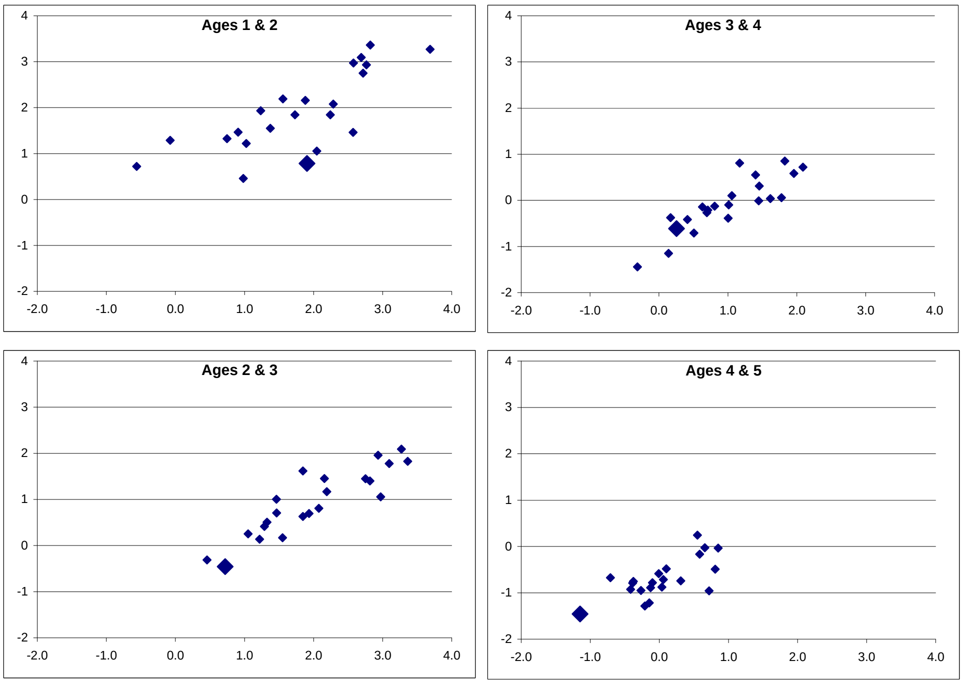

Figure 3.9 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. IBTS groundfish survey indices 1983 – 2005 - log scale plots of indices at adjacent ages; the highlighted points indicate the data collected in the 2004/2005

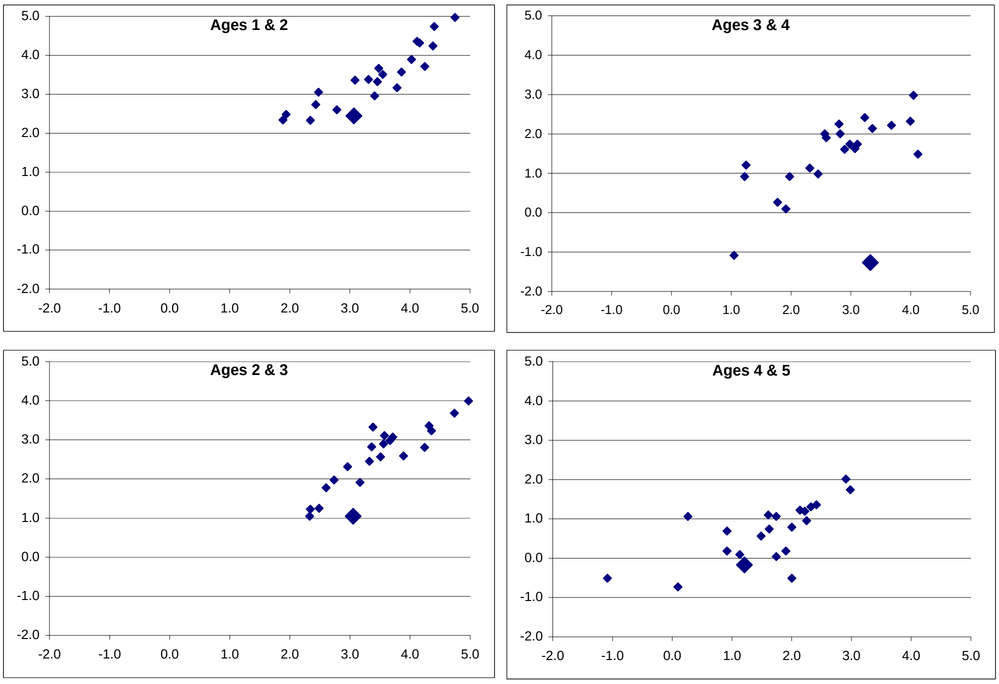

Figure 3.10 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Scottish groundfish survey indices 1982 – 2005 - log scale plots of indices at adjacent ages; the highlighted points indicate the data collected in the 2004/2005

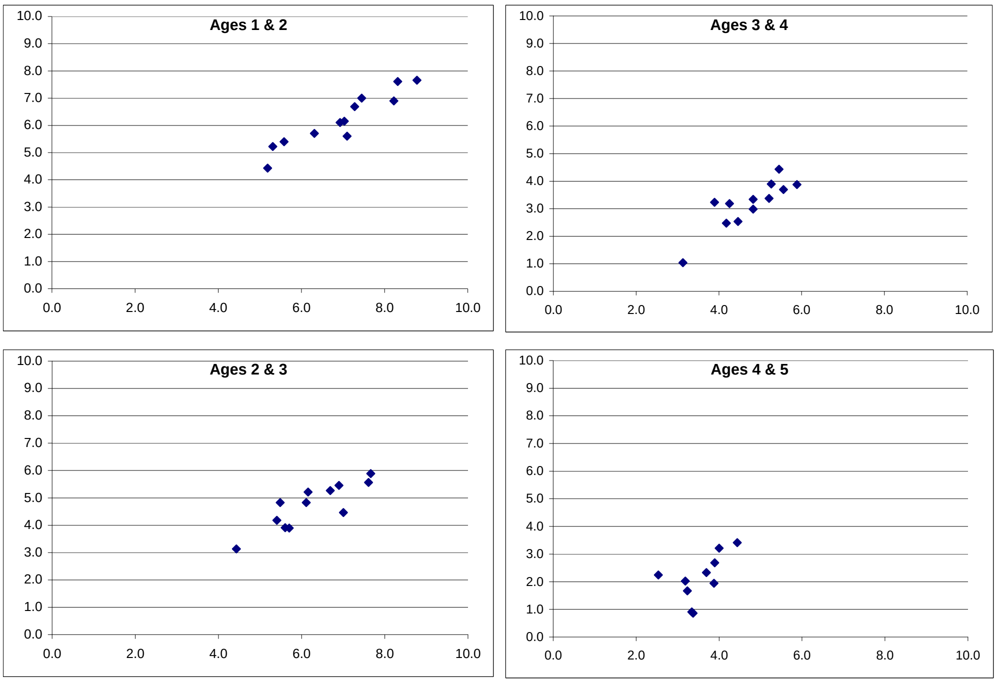

Figure 3.11 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. English groundfish survey indices 1992 - 2004- log scale plots of indices at adjacent ages.

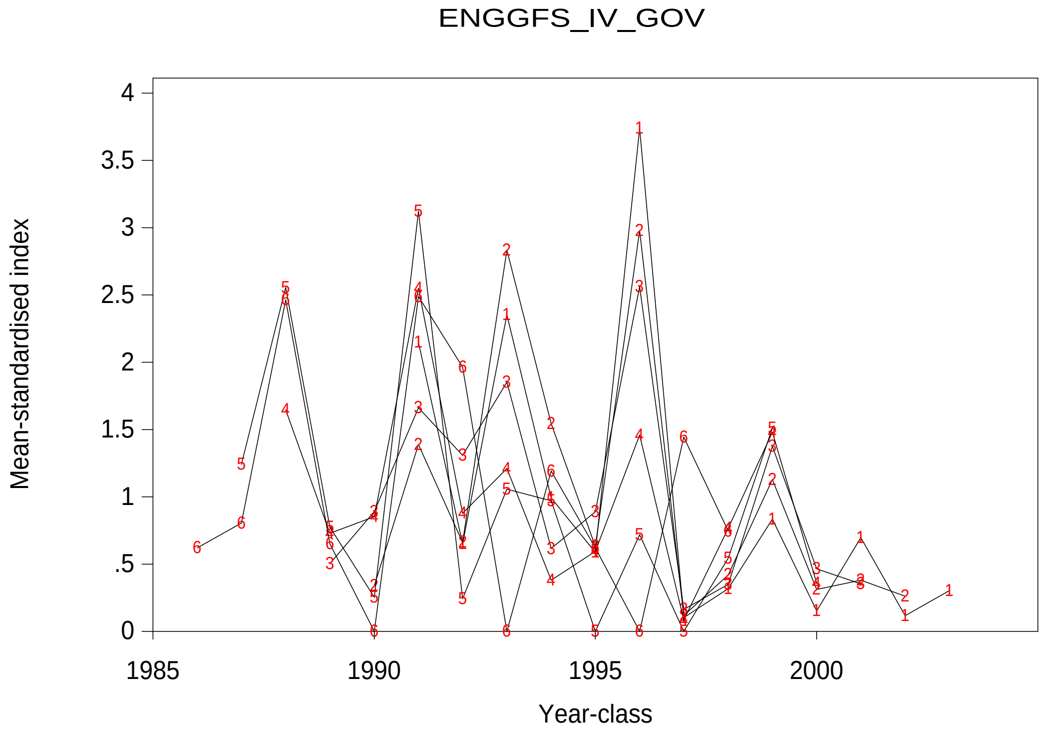

Figure 3.12 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. English groundfish survey SUBRA mean standardised indices by cohort

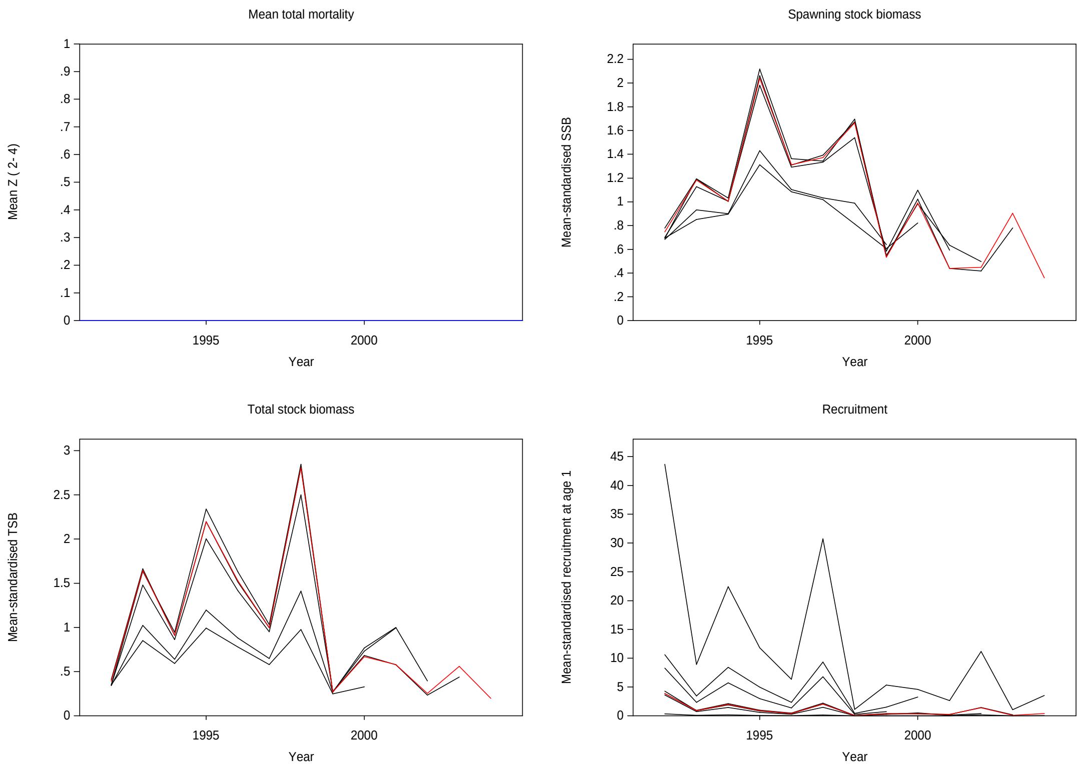

Figure 3.13 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. English groundfish survey retrospetive SUBRA estimates of mean Z, SSB, total biomass and recruitment.

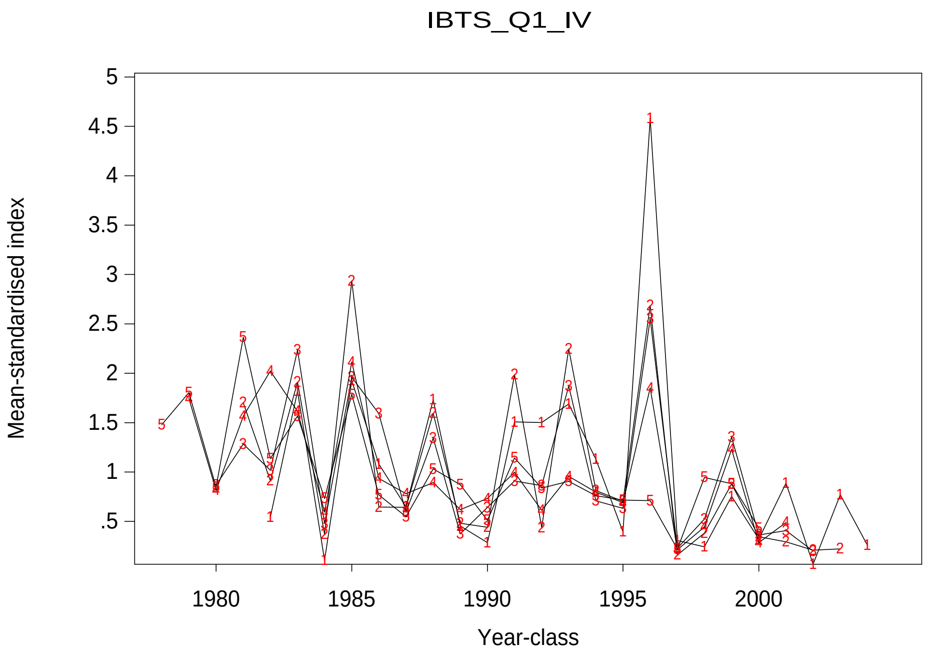

Figure 3.14 North Sea cod – IBTS Q1 groundfish survey SUBRA mean standardised indices by cohort

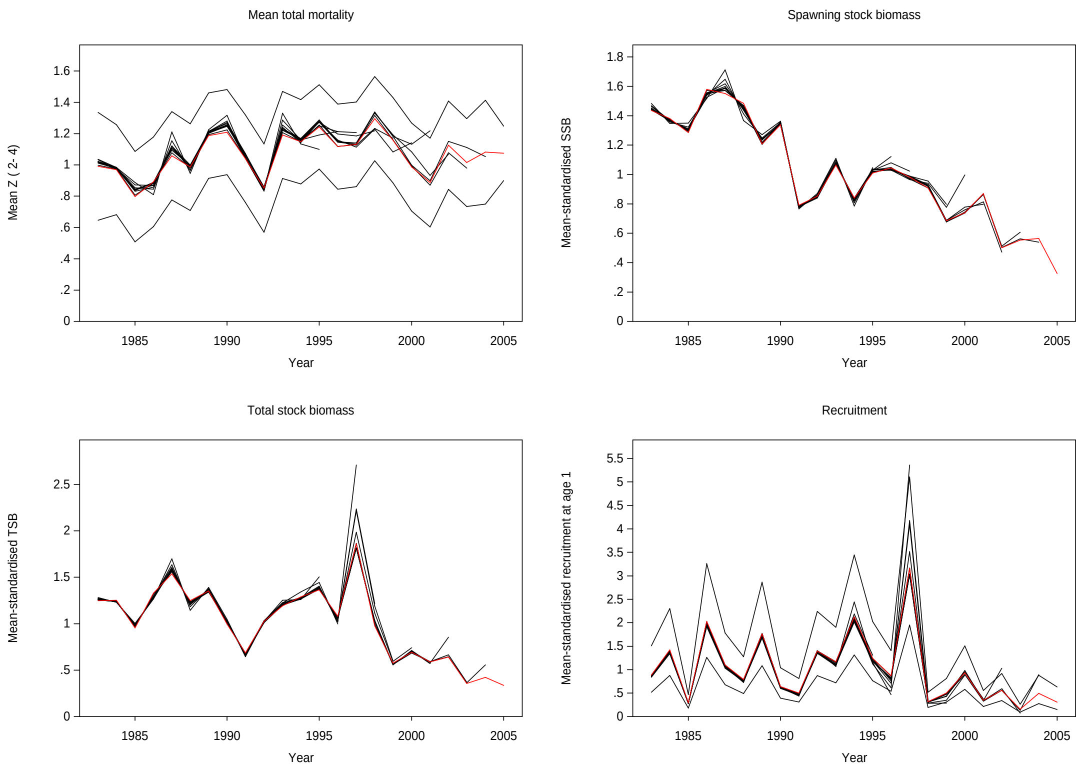

Figure 3.15 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. IBTS Q1 survey retrospetive SUBRA estimates of mean Z, SSB, total biomass and recruitment.

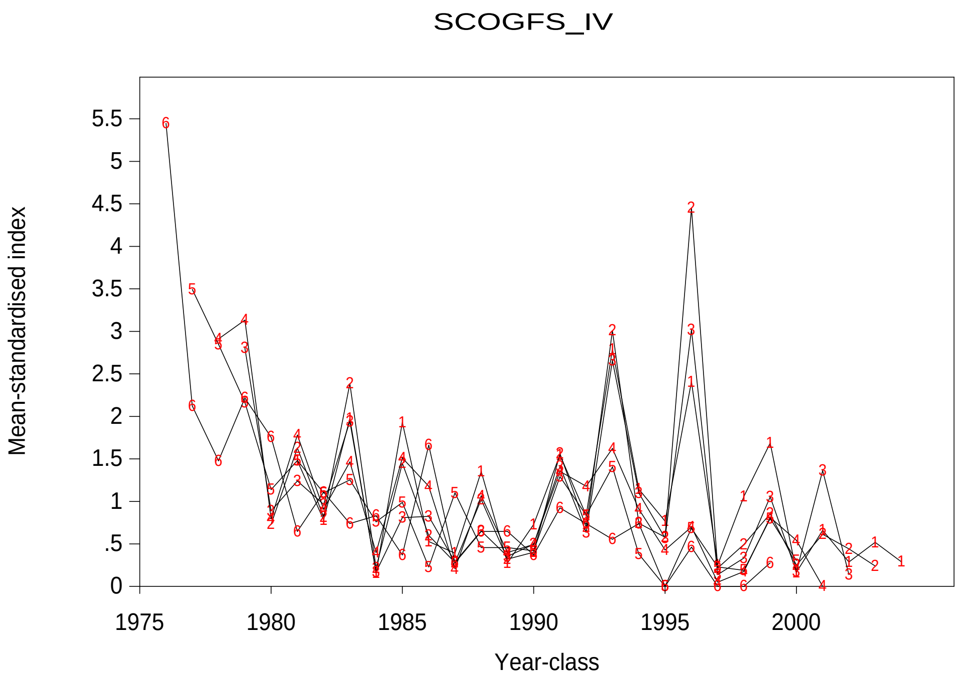

Figure 3.16 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Scottish groundfish survey SUBRA mean standardised indices by cohort

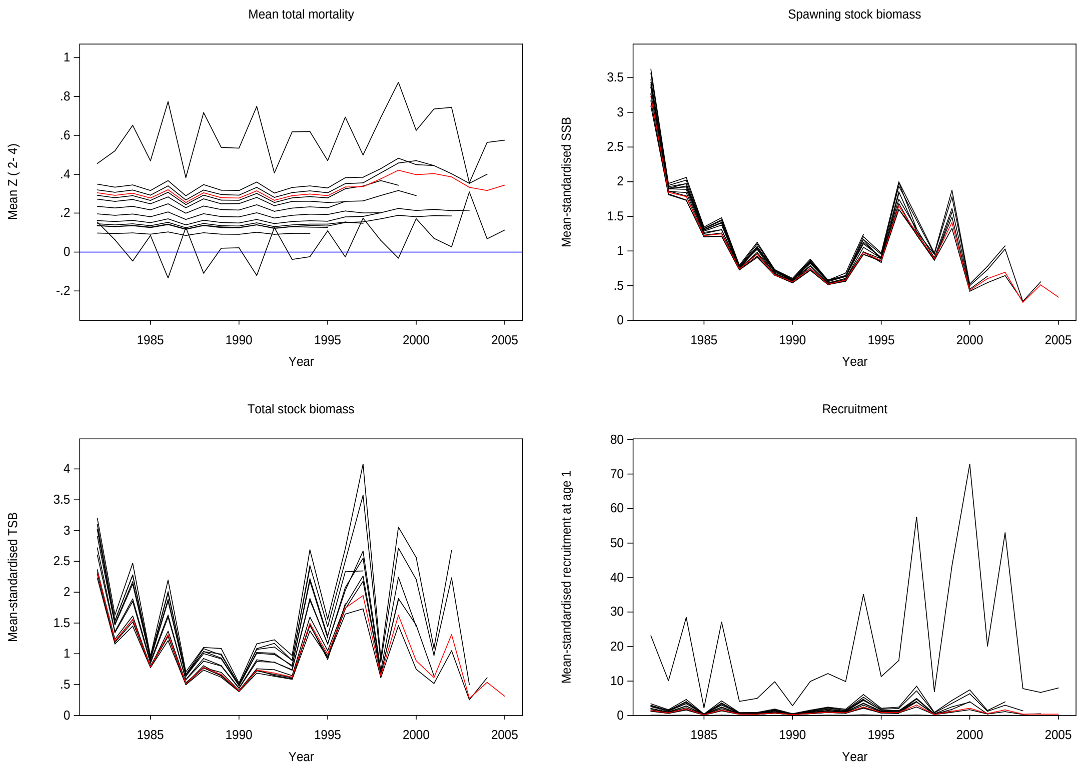

Figure 3.17 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Scottish grundfish survey retrospetive SUBRA estimates of mean Z, SSB, total biomass and recruitment.

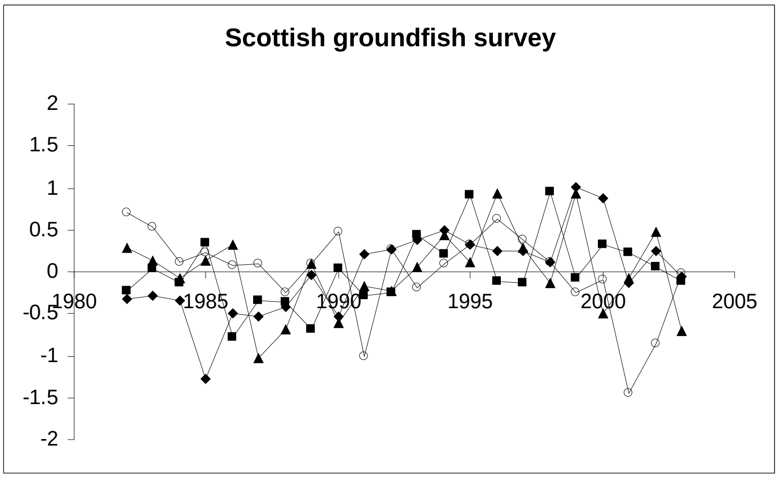

Figure 3.18 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Scottish groundfish survey Laurec-Shepherd analysis log catchability residuals at ages 1 – 4.

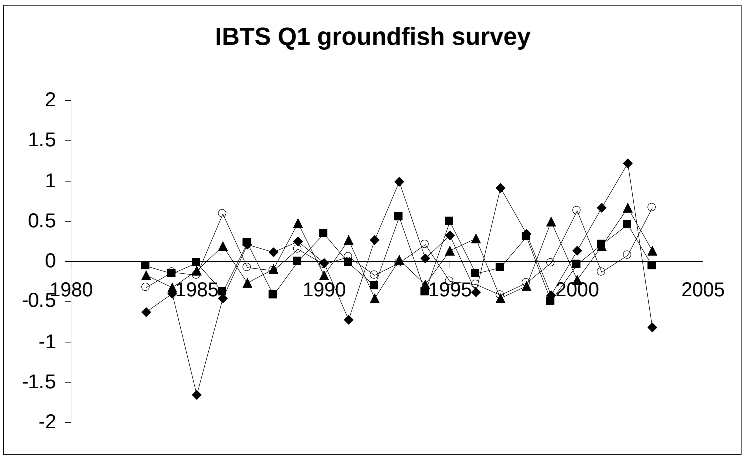

Figure 3.19 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. IBTS Q1 groundfish survey Laurec-Shepherd analysis log catchability residuals at ages 1 – 4.

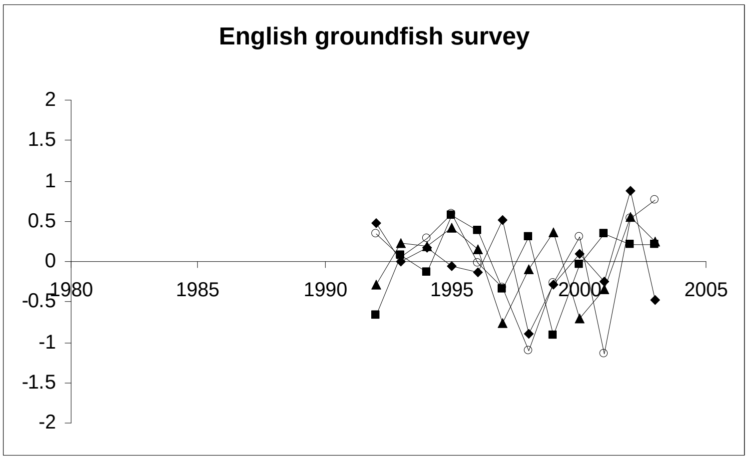

Figure 3.20 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. English groundfish survey Laurec-Shepherd analysis log catchability residuals at ages 1 – 4.

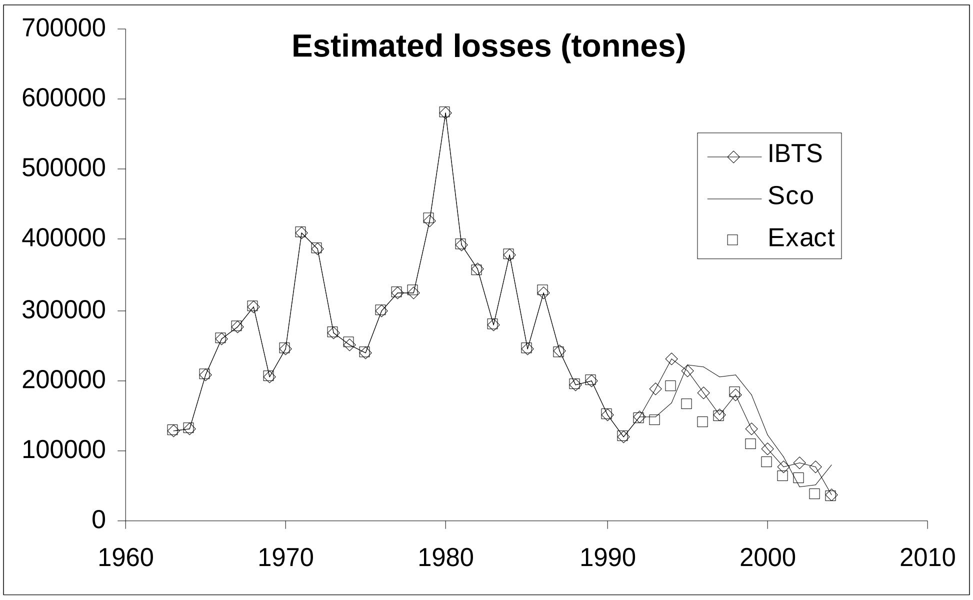

Figure 3.21 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Losses from the stock (1993 – 2004) as estimated by the B-ADAPT model fitted to the IBTS Q1 survey, the Scottish groundfish survey and under the assumption that the catch at age data is exact.

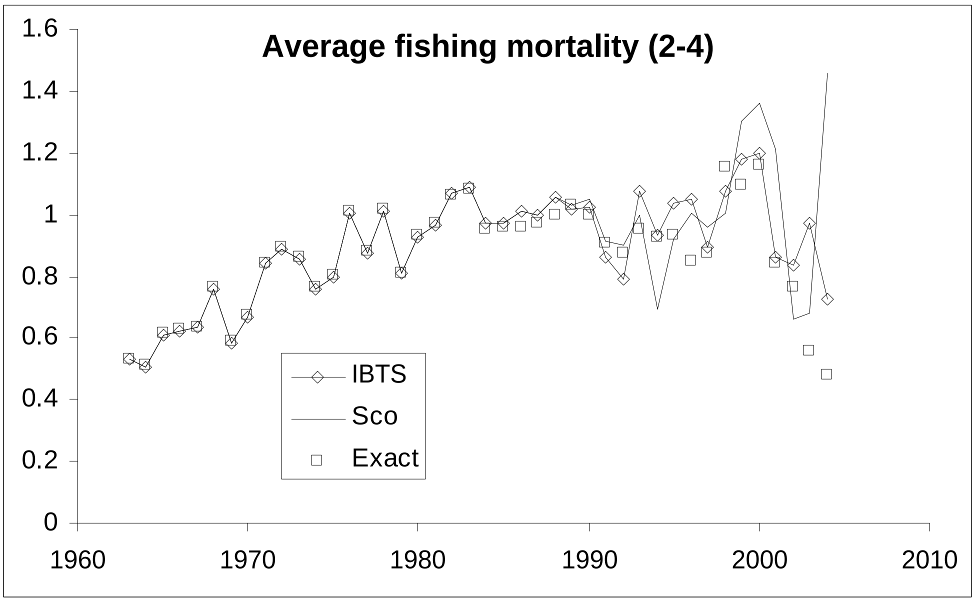

Figure 3.22 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Average fishing mortality as estimated by the B-ADAPT model fitted to the IBTS Q1 survey, the Scottish groundfish survey and under the assumption that the catch at age data is exact.

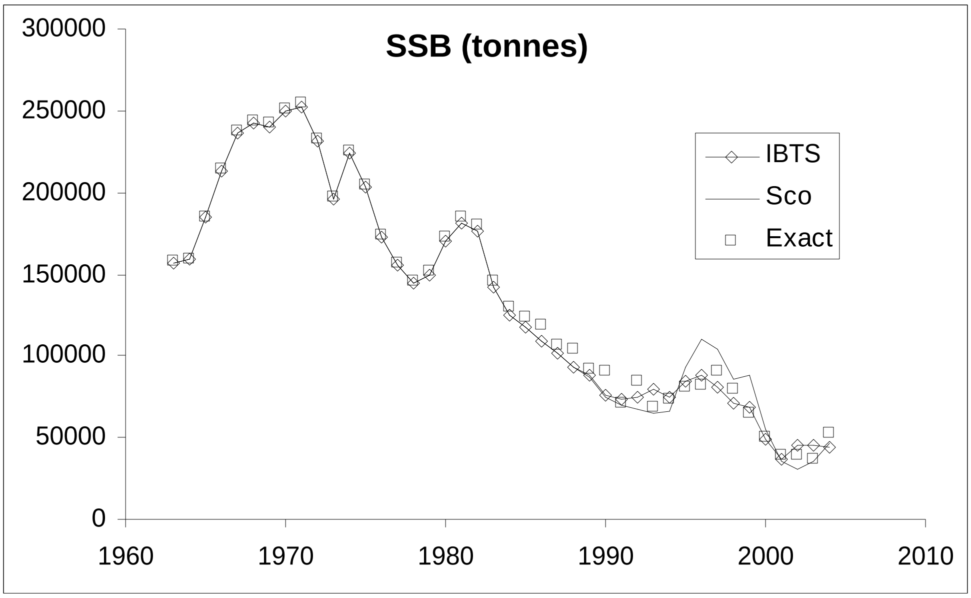

Figure 3.23 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Spawning stock biomass as estimated by the B-ADAPT model fitted to the IBTS Q1 survey, the Scottish groundfish survey and under the assumption that the catch at age data is exact.

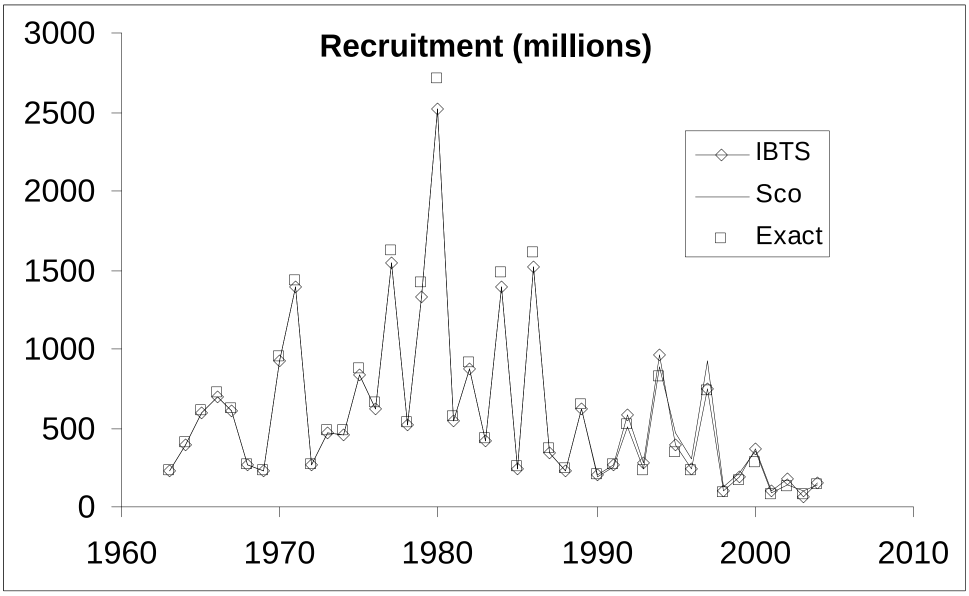

Figure 3.24 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Recruitment as estimated by the B-ADAPT model fitted to the IBTS Q1 survey, the Scottish groundfish survey and under the assumption that the catch at age data is exact.

Figure 3.24 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 3.25 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The time trends in the 2+ (and 4+ in area 1) biomass recorded by the 2000 – 2005 quarter 1 IBTS surveys.

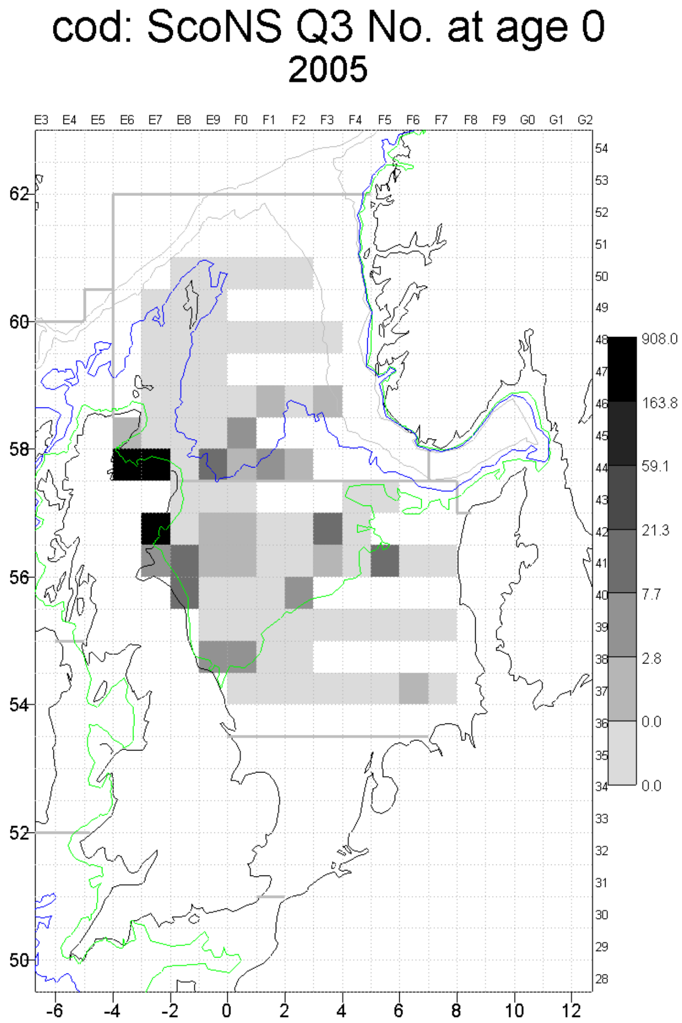

Figure 3.26 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. The distribution of 0 group cod in 2005 as recorded by the Scottish groundfish survey.

4 Haddock

The assessment of haddock in sub-area IV and division IIIa is presented as a benchmark assessment.

4.1 General

4.1.1 Ecosystem aspects

Haddock in sub-area IV and division IIIa occupy the northern and central North Sea and Skagerrak and are possibly linked to the division VIa stock on the West of Scotland. Haddock tend not to live below 300m, but prefer depths between 50m and 200m. They are found as juvenile fish in coastal areas in particular in the Moray firth, around Orkney and Shetland, along the continental shelf at around 200m and continuing round to the Skagerrak. Adult fish are found around Shetland and more centrally in the northern North Sea near the continental shelf edge. They are characterised by sporadically high recruitment leading to dominant year classes in the fishery. These large year-classes tend to lead to slow growth possibly due to density dependent effects. They primarily prey on benthic and epi-benthic invertebrates, sandeels and demersal egg deposits of herring. They are an important prey species for mainly saithe and other gadoids.

4.1.2 Fisheries

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

A large proportion of the haddock stock is taken by the Scottish fleet. The following details apply to the Scottish fleet. With the reduced cod quota, many vessels have tended to concentrate more on the haddock fishery with others taking the opportunity to move between the *Nephrops* and demersal fisheries. Due to the large catches (and size of fish available) a high percentage of the haddock caught were landed ungutted.

The number of Scottish based vessels (over 10m) in the demersal sector was reduced by approximately one third during 2002 and 2003, the bulk of this being due to vessels accepting decommissioning. Although the decommissioning scheme encompassed all vessel types and sizes, a significant number of the vessels which eventually accepted terms were of the older class of vessel. The remaining vessels continue with the same fishing methods although it would appear that there has been a reduction in the segment operating seine net or pair seine. With fishing patterns being dictated by restrictive TACs, many of the vessels were fishing shorter voyages so as to be able to land their fish (un-gutted haddock) in good condition. While some of the vessels took the opportunity to have shorter trips with more time in port, others simply put in more landings during their normal working trips which may have been between 8-12 days. With the change in emphasis towards the haddock fishery it is likely that the effort will increase in the inshore sector.

A shift toward pair trawling from single boat seine and trawls has been observed (WD7), this may imply an increase in efficiency, however WD3 shows that the decommissioning rounds in 2002 and 2003 included a slightly higher proportion of pair trawlers. These two facts together result in no real overall change in fleet composition for 2004 (WD3)

4.1.3 ICES Advice

In 2004, ICES, based on the most recent estimate of SSB and fishing mortality, classified the stock as having full reproductive capacity and that it was being harvested sustainably. SSB in 2003 was estimated at 460 000 t and was expected to remain at that level in 2004. SSB was considered to be well above the $\mathbf{B}_{pa}$ of 140 000 t. However, ICES noted that the stock and fishery is dominated by the 1999 year class and that the 2001-2003 year classes were all estimated to be well below average.

Fishing mortality in 2005 should be less than $\mathbf{F}_{pa}$, which is equivalent to the agreed management plan. Following the agreed management plan would imply human consumption landings of 92 000 t in 2005 which is expected to lead to an SSB of 297 000 t in 2006

For all demersal fisheries in the North Sea, ICES advice was based on mixed-fishery considerations and it advised the following:

Fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2004 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- *with minimal bycatch or discards of cod;*
- *Implement TACs or other restrictions that will curtail fishing mortality for those stocks ... for which reduction in fishing pressure is advised;*
- *within the precautionary exploitation limits for all other stocks.*
- *Where stocks extent beyond this area, e.g. into Division VI (saithe and anglerfish) or is widely migratory (Northern hake) taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;*

4.1.4 Management

In 1999 the EU and Norway have agreed to implement a long-term management plan for the haddock stock, which is consistent with the precautionary approach and is intended to constrain harvesting within safe biological limits and designed to provide for sustainable fisheries and greater potential yield. The plan shall consist of the following elements:

1. *Every effort shall be made to maintain a minimum level of Spawning Stock Biomass (SSB) greater than 100,000 tonnes ($\boldsymbol{B}_{lim}$).*
2. *For 2005 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.30 for appropriate age groups.*
3. *Should the SSB fall below a reference point of 140,000 tonnes ($\boldsymbol{B}_{pa}$), the fishing mortality rate referred to under paragraph 2, shall be adapted in the light of scientific estimates of the conditions then prevailing. Such adaptation shall ensure a safe and rapid recovery of SSB to a level in excess of 140,000 tonnes.*
4. *In order to reduce discarding and to enhance the spawning biomass of haddock, the Parties agreed that the exploitation pattern shall, while recalling that other demersal species are harvested in these fisheries, be improved in the light of new scientific advice from inter alia ICES.*
5. *A review of this arrangement shall take place no later than 31 December 2006.*
6. *This arrangement enters into force on 1 January 2005.*

ICES considers that the agreed Precautionary Approach reference points in the management plan are consistent with the precautionary approach, provided they are used as upper bounds on F and lower bounds on SSB, and not as targets.

Annual management of the fishery operates through TACs. The 2004 and 2005 TACs for haddock in Sub-Area IV and Division IIa (EC waters) were 77,000[1] and 66,000 t respectively, while the TACs for Divisions IIIa, IIIb, IIIc and IIId were 4,940 t and 4,018 t respectively.

EU technical regulations in force in 2004 and 2005 are contained in Council Regulation (EC) 850/98 and its amendments. For the North Sea, the basic minimum mesh size for towed gears for roundfish was 120 mm from the start of 2002, although under a transitional arrangement until 31 December 2002 vessels were allowed to fish with a 110 mm codend provided that the trawl was fitted with a 90 mm square mesh panel and the catch composition of cod retained on board was not greater than 30% by weight of the total catch. From 1 January 2003, the minimum mesh size for towed roundfish gears has been 120 mm. Restrictions on fishing effort were introduced in 2003 and details of its implementation in 2004 can be found in Annex V of Council Regulation (EC) no. 2287/2003 and for 2005 in Annex IVa of Council Regulation

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.

(EC) no 27/2005. For a historical overview of gear changes and technical measures see the stock annex.

The management 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 4.1.4.1) and set a maximum of 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.

4.2 Data available

4.2.1 Catch

Official landings data for each country participating in the fishery are presented in Table 4.2.1.1, together with the corresponding WG estimates and Total Allowable Catch (TAC). The full time series of landings, discards and industrial by-catch (in tonnes) is presented in Table 4.2.1.2. See the stock annex for a description of how the catch data are collated.

4.2.2 Age compositions

Total catch-at-age data are given in Table 4.2.2.1, while catch-at-age data for each catch component are given in Tables 4.2.2.2–4.2.2.4.

4.2.3 Weight at age

Weight-at-age for the total catch in the North Sea is given in Table 4.2.3.1. Weight-at-age in the total catch is a weighted average of weigh-at-age in the human consumption landings, discards and industrial by-catch. Weight-at-age in the total catch is taken as the weight-at-age in the stock. The mean weights-at-age for the separate catch components are given in Tables 4.2.3.2–4.2.3.4.

A summary of the catch data is given in Figure 4.2.5.1. Top left shows a bar graph of total catch, separated by weight, into age class. Each age class retains the same colour to allow one to see the contribution of an age-class to the total catch. Top right presents the mean weight at age in the catch through time, this plot shows evidence for reduced growth rates for large year classes. There is also evidence for a decline in mean weight-at-age in the stock in recent years. Bottom left presents a bubble plot of the number in each age class contributing to the total catch. Finally the plot on the bottom right shows the proportion, by weight, of each age class contributing to the total catch, the colour scheme matches that of the top left plot. This figure (4.2.5.1) shows the strong reliance of the recent fishery on the 1999 year class.

4.2.4 Maturity and natural mortality

Maturity and natural mortality are assumed fixed over time and are given below.

age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Natural Mortality	2.05	1.65	0.40	0.25	0.25	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Proportion Mature	0	0.01	0.32	0.71	0.87	0.95	1	1	1	1	1	1	1	1	1	1

4.2.5 Catch, effort and research vessel data

Survey distribution and annual density at age and for each year is given in Figure 4.2.5.2a for the IBTS Q1 survey. Figure 4.2.5.2b shows the distribution of haddock in 2005 for the quarter

3 Scottish groundfish survey. Both plots show a northern distribution of haddock (statistical rectangles with zero catches are shaded light grey).

In 1998 the research vessel Scotia, that conducts the quarter 3 Scottish groundfish survey, was replaced with a new vessel of the same name. It was considered at the time that the change in vessel did not affect the catchability of the survey and the series was assumed to be consistent through time. In 1999, the coverage of the survey was extended slightly, and to keep indices in accordance with those from previous years, the survey indices from 1999 are corrected for this change. Given that the new vessel has been in operation for 8 years, it is now feasible to split the survey into two parts: 1982-1997, and 1998-2005. This will remove any possibility of an effect caused by the change in vessel. The same has been done previously with the quarter 3 English groundfish survey to remove any possible effects due to a change in gear in 1992.

As XSA uses survey data up to the last year of catch data, the IBTS quarter 1 survey is backshifted three months so that the index for age 4 in 2005 becomes the index for age 3 in 2004, thus allowing the inclusion of the entire series. It is not feasible to do this for the Scottish and English Groundfish surveys as they occur in quarter 3. The IBTS Q1 time series presented are revised estimates (compared to those used last year).

Data available for calibration of the assessment are presented in Table 4.2.5.1a and Table 4.2.5.1b. Trends in survey CPUE are shown in Figure 4.2.5.3a and trends in commercial CPUE in Figure 4.2.5.3b. During preparations for the 2000 round of assessment WG meetings it became apparent that the 1999 effort data for the Scottish commercial fleets were not in accordance with the historical series (Figure 4.2.5.4) 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 of commercial CPUE.

Data available are summarised in the table below, the series used are in bold.

Country	Fleet	Quarter	Code	Year range	Age range available	Age range used
Scotland	seine	Q1-4	ScoSEI	1978-2004	0 - 13	-
	light trawl	Q1-4	ScoLTR	1978-2004	0 - 13	-
	groundfish survey (Scotia II)	**Q3**	**ScoGFS (early)**	**1982-1997**	0 - 8	**0 - 5**
	groundfish survey (Scotia III)	**Q3**	**ScoGFS (recent)**	**1998-2005**	0 - 8	**0 - 5**
England	groundfish survey (Granton trawl)	**Q3**	**EngGFS (early)**	**1977-1991**	0 - 10+	**0 - 5**
	groundfish survey (GOV trawl)	**Q3**	**EngGFS (recent)**	**1992-2004**	0 - 10+	**0 - 5**
International	groundfish survey	**Q1**	IBTS	1983-2005	1 - 6+	1 - 5
			IBTS (backshifted) *	**1982-2004**	0 - 5+	**0 - 4**

* This survey is used as if it occurred at the end of the previous year

4.3 Data analyses

As part of the benchmark review process for North Sea haddock, a range of analyses have been used to explore the various data sources available. The catch-at-age data and survey indices are screened for potential sampling errors and consistency of information on relative year-class strength. Given problems with the recording of effort (section 4.2.5), the available commercial CPUE series are not considered for further analysis. XSA is used as the principle method of assessment, but comparisons with other methods (SURBA and the ADAPT) are included.

4.3.1 Exploratory catch-at-age-based analyses

A Separable VPA analysis is used to screen the catch-at-age data for potential data anomalies before these are used in further analyses. Results are shown in Figure 4.3.1.1, and indicate no obvious anomalies or strong patterns for ages less than 10.

Catch-curve analysis for both commercial and survey catch-at-age data, plotted on a log scale, allow a simple assessment of the consistency of catches, assuming such catches decline consistently with age as influenced be natural and fishing mortality as well as appropriate catchability/selectivity-at-age (ICES CM 2004/ACFM:14). Figure 4.3.1.2 plots the catch-at-age data in the form of log-catch curves linked by cohort, and indicates partial recruitment to the fishery up to age 2. Gradients between consecutive values within a cohort are fairly constant from ages 2 to 7 or 8, after which they become more variable. Figure 4.3.1.3 plots the gradients fitted to each cohort over the age range 2 to 6, the negative of which can be viewed as a rough proxy for total mortality (if mortalities do not vary too much from age to age within a cohort). Values fluctuate around a mean of 1.2-1.3.

There are limits to the interpretation of within-cohort correlation coefficients for a particular data source. Stocks with high recruitment variability tend to produce higher correlations than stocks with low recruitment variability and there may also be a confounding effect of catchability varying with year-class strength, although this may not apply for surveys. Despite these concerns, such correlations do provide useful indicators (ICES CM 2004/ACFM:14). In particular, they can be used to highlight difficulties in the data, which may include phenomena that require further biological interpretation. Within-cohort correlations in the catch-at-age matrix (plotted as log-numbers) are shown in Figure 4.3.1.4. These correlations show good consistency within cohorts up to age 8/9, verifying the ability of the catch-at-age data to track relative cohort strengths. Standard and robust linear regression lines are fitted to the data, and these are consistent indicating no undue influence on the standard regression from “outliers” for most ages.

Laurec-Shepherd based analysis of tuning data

A Laurec-Shepherd based ad-hoc VPA was used to screen the three survey CPUE time series individually for any discrepancies between the commercial catch and survey series prior to their use as tuning indices. The ENGGFS and SCOGFS series are each split in two (1977-1991 and 1992-2004 for the former, and 1982-1997 and 1998-2004 for the latter; justification provided in section 4.2.5), but only fits for the latter half of these series are shown. Log-catchability residuals are given in Figures 4.3.1.5-7. They generally show greater residuals for age 0 and ages 6 and older, with ENGGFS showing a strong trend at age 0, and SCOGFS trends at the older ages. The residuals for the IBTS Q1 are generally small, but there is indication of a trend for older ages. Ages 6 and older are omitted from ENGGFS and SCOGFS, and age 5 (a plus-group) from IBTS Q1 for the purposes of tuning in subsequent XSA analyses.

Extended Survivor Analysis (XSA)

Four exploratory XSA runs were attempted (Runs 1-4). Run 1 performs a SPALY (Same Procedure As Last Year) assessment, while Runs 2 and 3 use split ENGGFS and SCOGFS series due to the previously mentioned vessel and/or gear changes. An additional run (Run 4) was carried out to look at the effect of assuming alternative natural mortality values for North Sea haddock, as derived by the Study Group on Multispecies Assessment in the North Sea (SGMSNS; ICES CM 2005/D:06). This additional run is identical to Run 3 apart from the alternative values for natural mortality. The following Table summarises the exploratory XSA runs.

	Description	Tuning fleets	Year range	Age range	2-parameter q-model	q-plateau
Run 1	SPALY*	ENGGFS SCOGFS IBTS Q1	1992-2004 1982-2004 1982-2004	0-5 0-5 0-4	age 0	age 2
Run 2	Split surveys, q-plateau=age 2	ENGGFS_early ENGGFS SCOGFS_early SCOGFS IBTS Q1	1977-1991 1992-2004 1982-1997 1998-2004 1982-2004	0-5 0-5 0-5 0-5 0-4	age 0	age 2
Run 3	Split surveys, q-plateau=age 3	as for Run 2	as for Run 2	as for Run 2	as for Run 2	age 3
Run 4	Identical to Run 3, but assuming SGMSNS-derived values for natural mortality					

*SPALY=Same Procedure As Last Year. Some data changes have occurred since last year, namely minor corrections to the ENGGFS data and adjustments to the entire IBTS Q1 time series.

The exploratory process also included (not shown) an evaluation of the settings for the two-parameter catchability (q) model and q-plateau. The result of this evaluation (Run 3) was a confirmation of the two-parameter q-model for age 0 only (based on a slope significantly different to one for ENGGFS 98-04), but a re-setting of the q-plateau at age 3. Run 2 was included for comparison with the SPALY assessment (which specifies a q-plateau at age 2).

Figure 4.3.1.8 shows the log-catchability residuals for Runs 1-3. Run 1 indicates strong trends in residuals for SCOGFS, the effect being somewhat reduced in Runs 2 and 3, although year effects remain towards the end of the early half of this series. Trends in residuals are also evident in IBTS Q1 for all three runs.

Figure 4.3.1.9 summarises individual fleet-based estimates of survivors, both relative to the combined weighted estimate (upper panel) and in terms of their percentage contribution (scaled weights) to this weighted estimate (lower panel). Results for only the later half of ENGGFS and SCOGFS are shown because the early half of these series does not contribute to survivor estimates in the terminal year. Run 1 indicates large discrepancies between SCOGFS-based estimates and estimates based on the other two surveys, particularly for the younger ages. This discrepancy is reduced substantially for Runs 2 and 3. The percentage contribution of SCOGFS is small relative to the other surveys for the younger ages, gradually increasing with age. This is indicative of more variable information for the younger ages in SCOGFS compared to the other surveys, also reflected in the between-survey consistency plots (Figures 4.3.2.7-9) for the younger ages.

Figure 4.3.1.10 compares mean F (2-4), SSB and recruitment (age 0) trajectories derived by each of Runs 1-3. Differences between these runs are relatively minor.

Comparisons between Run 3 and 4 are shown in Figure 4.3.1.11. Overall trends in mean F (2-4) and SSB remain the same despite slight adjustments throughout the time series (downward for mean F and upward for SSB), but there are strong downward adjustments in estimates of recruitment based on the alternative values for natural mortality.

Sensitivity of XSA to individual tuning fleets

In order to investigate the sensitivity of XSA to individual-fleet tuning, single-fleet XSAs with the same setting as the exploratory XSA Run 3 were performed. Results were obtained for the later half of the ENGGFS and SCOGFS series, as well as for the IBTS Q1 series, and are shown in Figure 4.3.1.12. Analyses based on the IBTS Q1 series produce slightly different perceptions of mean F (2-4) and SSB towards the end of the time-series, and of the size of the 1999 year-class, compared to the other two surveys. Trends in IBTS Q1 residuals have been highlighted in both the single-fleet ad-hoc VPA runs (Figure 4.3.1.7) and the XSA trial runs (Figure 4.3.1.8).

B-ADAPT-based analysis

Last year the WG used an ADAPT-type model (B-ADAPT) to estimate unallocated mortality rates from the North Sea cod stock (ICES CM 2005/ACFM:07). When the catch data is assumed to be exact, the B-ADAPT model (without unallocated mortality estimation) estimated downwards trends in fishing mortality similar to the trend estimated by the XSA assessment. However, when unallocated mortality for cod was modelled with B-ADAPT, the level of fishing mortality was raised substantially and the similarity between the trends over recent years was removed.

The differing treatment of the catch data sets for cod and haddock raised concerns that information from species that are caught together in a mixed fishery were modelled under differing assumptions as to the validity of the recorded landings. Therefore, in order to examine the sensitivity of the haddock assessment to a potential unallocated mortality, the B-ADAPT model was fitted to the haddock data sets and unallocated mortality estimated. The diagnostics from the fitted models are located in ICES files and illustrated in Figures 4.3.1.13 – 4.3.1.14.

The top two plots in Figure 4.3.1.13 presents the time series of estimated catch multipliers for cod and haddock from the B-ADAPT model fit; a multiplier of 1.0 indicates unbiased catch data. The cod series are taken from last year's assessment due to the lack of a final cod assessment at this year's meeting (Section 3). The multiplier time series show differing historic patterns for the two species. Unallocated cod mortality increased in 1995, 1996 as the stock declined and TAC restrictions increased, decreased when the 1996 year-class arrived in the stock and then increased subsequently. There was a marked increase in 2003. The haddock multiplier estimates increase during 1996 and 1997 then remain constant at around 1.5 until 2003 and 2004 when there is a decrease in the estimated unallocated mortality to around zero. For haddock, the time series of multiplier estimates are similar to the residual patterns within the IBTS Q1 survey series (noted in Figures 4.3.1.7 and 4.3.1.8). The constancy of the estimated multiplier series across recent years suggests that it may be an artefact of the survey series rather than constant bias induced by changes in unallocated mortality from additional discarding, natural mortality or mis-reporting. These would be expected to show variation related to TAC and year-class strength. The B-ADAPT essentially uses only the IBTS Q1 survey to estimate the unallocated mortality multipliers because the newly split time series (ENGGFS and SCOGFS) are not of sufficient length for the model, thus the results resemble a single-fleet IBTS Q1 XSA run.

Figures 4.3.1.13 – 4.3.1.14 present the stock and fishery estimates from the XSA and B-ADAPT. The bottom plot of Figure 4.3.1.13 presents recorded catches and estimated losses. The plots in Figure 4.3.1.14 present the estimated fishing mortality, SSB and recruitment time series. The estimated fishing mortality and recruitment time series are relatively insensitive to the rescaling using unallocated mortality. SSB is revised upwards. The large-scale sensitivity in estimated fishing mortality noted in the cod assessment are not present in the haddock assessment.

The discrepancies between the XSA and B-ADAPT trajectories shown in Figure 4.3.1.14 are similar to those shown in the single-fleet XSA runs between the IBTS Q1-based results and the ENGGFS- and SCOGFS-based results shown in Figure 4.3.1.12.

The potential problems in the IBTS Q1 surveys, reflected as residual trends in both the ad-hoc VPA and XSA trial runs (Figures 4.3.1.7 and 4.3.1.8) mean that results relying solely on the IBTS Q1 series (including the estimates of unallocated mortality from B-ADAPT) cannot be considered reliable.

4.3.2 Exploratory survey-based analyses

Log-abundance indices, linked by cohort, are shown in Figure 4.3.2.1 for all the available survey series. These indicate partial recruitment to the survey gear up to age 1/2 for all three surveys, and little distortion in the cohort curves from year to year, although cohort gradients appear to become shallower towards the end of all three surveys. This is highlighted in Figure 4.3.2.2, which plots the gradients over ages 1-5 for ENGGFS and SCOGFS, and ages 1-4 for IBTS Q1. The negative of these gradients can be considered proxies for total mortality if vulnerability to survey gear is similar for ages within the age range considered. Values from the surveys have means of around 1.3-1.4.

Mean-standardised log-abundance indices by cohort for the three survey series are shown in Figure 4.3.2.3. This Figure demonstrates that each survey is able to consistently detect the relative strength of individual cohorts. This is further highlighted in Figures 4.3.2.4-6, which show good within-survey correlations up to ages 5-6. The consistency between the standard and robust linear regression lines indicate no undue influence on the standard regression from “outliers” in most cases.

The consistency between surveys for each age is shown in Figures 4.3.2.7-9. Correlations are high up to age 5, indicating generally good agreement between surveys.

SURBA-based analysis

Figure 4.3.2.10 shows a comparison of relative trends in SSB and trends in mean total mortality Z (2-4) from XSA Run 3 and single fleet runs of SURBA. The trends in relative SSB from the single fleet survey runs are well correlated with the XSA estimate of SSB. Noteworthy are the points: IBTS 2004 (diamond), and Scottish GFS 2005 (plus). The IBTS index has a plus group at age 6, but is back-shifted to allow the most recent data point to be used in XSA analyses, so effectively, has a plus group at age 5. The Scottish GFS uses a plus group at age 6. SURBA, currently doesn’t model plus groups, so, both these points do not include the large 1999 year-class in the estimate of SSB. For comparison, a SURBA run was carried out on the Scottish GFS but with age 6 as a true age (inverted triangle), the final years trend in relative SSB for this run does not exhibit such a sharp decline.

4.3.3 Conclusions drawn from exploratory analyses

Catch-curve analyses show very consistent descending right-hand limbs, indicating commercial and survey catch-at-age data for haddock track cohorts very well.

High within-cohort correlations for both commercial and survey catch-at-age data highlight once again that data for haddock track cohorts very well. Furthermore, the high correlations between indices from independently conducted surveys for haddock for ages 0-5 indicate the suitability of the combined use of these indices in further assessment work. The good agreement between standard and robust linear regression lines confirms the lack of spuriously high correlations due to “outliers”.

The Separable VPA and single-fleet Laurec-Shepherd ad-hoc VPA analyses confirm the appropriateness of the plus-group and age-range settings for tuning data used in previous years. There are *a priori* reasons for splitting both the ENGGFS and SCOGFS in two, related to vessel and gear changes, so further analyses treat each half of the split series as independent tuning series. Although the earlier half of the ENGGFS tuning series was omitted from previous assessments, there is no reason that it should not be included as an independent tuning series, particularly given the good quality of this data, demonstrated in both the catch-curve and correlation analyses.

The XSA trial runs confirm the setting of a two-parameter q-model as appropriate for age 0, but indicate a q-plateau at age 3 as being more appropriate than that used in previous assessments (age 2). The inclusion of a split series for SCOGFS improves residual patterns somewhat for this survey and results in survivor estimates at the younger ages that are much more consistent with the other surveys. The alternative assessment methods applied (SURBA and B-ADAPT) confirm the general trends in SSB and mean F provided by XSA, therefore there is no reason to change the assessment method applied in previous years.

4.3.4 Final assessment

The XSA trial Run 3 was selected as the XSA final run. The XSA final run takes catchability to be dependent on stock size for age 0, constant catchability for ages 3 and above, and incorporates split ENGGFS and SCOGFS tuning series, together with the full IBTS Q1 series. Although there are relatively minor differences between XSA trial Runs 2 and 3, Run 3 produces slightly better log-catchability residual patterns for the IBTS Q1 series.

The XSA final run tuning diagnostics are presented in Table 4.3.4.1, with log-catchability residuals given in Figure 4.3.4.1. To highlight cohort effects and to show that the model fit to the large 1999 year-class does not produce unusual residuals, the log-catchability values are re-plotted in Figure 4.3.4.2, with the horizontal axes now indicating cohorts.

Fishing mortality estimates for the XSA final run are presented in Table 4.3.4.2, the stock numbers in Table 4.3.4.3, and the assessment summary in Table 4.3.4.4 and Figure 4.3.4.3. A retrospective analysis (possible for only the last three years because of the short second half of the SCOGFS series), shown in Figure 4.3.4.4, does not show large retrospective bias.

4.4 Historic Stock Trends

The historic stock and fishery trends are presented in Figure 4.3.4.3.

The stock experienced a very high peak in recruitment in 1967, with several other much smaller but yet still high peaks throughout the time series, the most recent occurring in 1999. The 1999 peak was subsequently followed by four very low recruitments in 2000-2004.

Mean F (2-4) has fluctuated above $\mathbf{F}_{pa}$ for most of the time series, with extended periods above $\mathbf{F}_{lim}$ as well. However, mean F over recent years has declined and is estimated to have been well below $\mathbf{F}_{pa}$ for the last three years.

The stock experienced very high SSB levels in the late 1960's, but has also had periods below $\mathbf{B}_{lim}$, in the early 1990s and most recently in 2000. Recent levels have been the highest over the past two decades, but SSB is beginning to decline as the 1999 year-class disappears with a number of weak year classes following it.

4.5 Recruitment estimates

Results from SCGGFS indicate that the abundance of the 0-group recruitment in 2005 is substantial. This is illustrated in Figure 4.5.1, which plots the survey CPUE index for age 0 together with estimates of recruitment from the XSA final run. The widespread abundance of the 2005 year-class, as estimated by SCOGFS, is shown in Figure 4.2.5.2b. Provisional accounts from ENGGFS for 2005 appear to confirm that recruitment in 2005 is high. Within-cohort correlations between age 0 and 1 estimated from SCOGFS are relatively high (Figure 4.3.2.5), indicating that SCOGFS provides reasonable estimates of recruitment. It would therefore be appropriate to take this information into account in the short-term forecasts. The RCT3 program was used for this purpose, and Tables 4.5.1 and 4.5.2 present the RCT3 inputs and outputs. The RCT3 estimate of recruitment of 29 672 million (which relies on the estimate of the 2005 year-class from SCOGFS) is shown in Figure 4.5.1.

Recruitment following a high year class has generally tended to be low (Figure 4.3.4.3). In order to take this feature into account, the average of the 5 lowest recruitment values over the period 1992-2001, 9 947 million, has been assumed for recruitment in 2006 and 2007. This value is about 33% of the value assumed for 2005 recruitment. The period considered for this value excludes 2002-2004 because recruitment estimates from the XSA final run are considered less reliable for 2002-2004.

The following table summarises the recruitment, age 1 and age 2 assumptions for the short-term forecast.

Year Class	Age in 2005	XSA (millions)	RCT3 (based on SCOGFS, 2005) (millions)	Average Recruitment (5 lowest values over 1992-2001) (millions)
2003	2	75		
2004	1	422		

2005	0		29 672	
2006	Age 0 in 2006			9 947
2007	Age 0 in 2007			9 947

4.6 Short-term forecasts

The slow growth of the 1999 year class continues to present a problem for the short-term forecast, and there is some indication of a similar problem for the 2000 year-class. This is illustrated in Figure 4.6.1, which presents mean stock weights-at-age from the total catch for the 1999 and 2000 year-classes, together with the overall mean of all year-classes for which there is data (note: stock weights=total catch weights for haddock). The 1999 and 2000 year-classes appear to follow the lower confidence limit about the mean, and mean weight-at-age values corresponding to this lower limit were assumed to represent future stock weights for these two year-classes. For the remaining year classes, future stock weights are assumed to equal the average weight-at-age for the years 2000-2004, omitting the 1999 and 2000 year classes. This was repeated for mean weights-at-age from human consumption landings. However, mean weights at age for the 1999 and 2000 year classes did not show unusual growth in the discard and industrial bycatch components, so future mean weights-at-age were set to the average for the years 2000-2004 for these components.

The 1999 and 2000 year-classes enter the plus-group in 2006 and 2007 respectively, which requires a re-calculation of the plus-group stock and human consumption mean weights for these two years. This was achieved by using XSA final run estimates of stock numbers, appropriately adjusted for mortality, to provide a weighted average of mean weights for ages 7-15, where the low weight of the 1999 and 2000 year-classes were included at the appropriate age.

A further concern for the purposes of short-term forecasts is the level of exploitation on the 1999 year-class relative to other year-classes. Figure 4.6.2 (top plot) shows that the exploitation pattern on the 1999 year-class has been somewhat different to the overall exploitation pattern (averaged over 2002-2004). The latter appears to be dome-shaped whereas, given the continued dominance of the 1999 year-class in the fishery (Figure 4.2.5.1), the exploitation pattern on the 1999 year-class is expected to remain high. The approach used to model future exploitation was to calculate the overall exploitation pattern for the years 1999-2004, omitting the 1999 year-class from the mean F (2-4) calculation used to obtain this exploitation pattern. Partial fishing mortality values were then obtained for each catch component (human consumption, discards and bycatch) by using the relative contribution of each component to the total catch. This process provided an exploitation pattern by catch component for the 1999 year-class, as well as the basis for calculating an average exploitation pattern for each catch component by averaging over the years 2002-2004, omitting the 1999 year-class from this average. The average exploitation pattern by catch component (omitting the 1999 year-class) is shown in the bottom plot of Figure 4.6.2. Future exploitation is based on the average exploitation pattern, but with the values for the 1999 year-class replaced by the value for the 1999 year class at age 5, effectively forcing a flat-topped selection for the 1999 year-class. The resultant exploitation patterns are re-scaled to provide a mean F (2-4) value equal to the average for 2002-2004 (omitting the 1999 year-class).

The inputs to the short-term forecast are presented in Table 4.6.1. Results for the short-term forecasts are presented in Table 4.6.2, with detailed outputs given in Table 4.6.3. Status-quo F is assumed to be the mean F (2-4), calculated over 2002-2004, but omitting the 1999 year-class. The RCT3 estimate is used for recruitment (age 0) in 2005, with values for the remaining ages in 2005 provided by the XSA final run. Recruitment in 2006 and 2007 is taken to be the average of the 5 lowest recruitment values over the period 1992-2001, as estimated by the XSA final run.

At status-quo F in 2005 and 2006, SSB is expected to by at 232 000 tonnes in 2006 and 238 000 tonnes in 2007. The human consumption yield at status-quo F will be around 51 000 tonnes in 2005, and around 42 000 tonnes in 2006. Discards at status-quo F will be around 13 000 tonnes in 2005, and around 22 000 tonnes in 2006.

Table 4.6.4 shows the contribution of the assumed future recruitment values to the forecast estimates of human consumption landings in 2006 and SSB in 2007. The RCT3 estimate of recruitment in 2005 makes a large contribution (21%) to the estimate of SSB in 2007.

4.7 Medium-term forecasts

Due to the uncertainty in the estimation of future recruitment in this stock, no medium-term projections were carried out for this stock.

4.8 Biological reference points

Biological reference points for this stock are presented below, for their technical basis see the stock annex.

	ICES considers that:	**ICES proposed that:**
Limit reference points	**B**lim is 100 000 t	**B**pa be set at 140 000 t
	Flim is 1.0	**F**pa be set at 0.7
Target reference points		**F**y not defined

4.9 Quality of the assessment

Survey data are both consistent within and between surveys, and the catch data are internally consistent. Trends in mortality from catch data and survey indices are similar as are trends in estimated relative SSB. Splitting the Scottish groundfish survey has removed some of the disparity previously observed between this series and the catch data. There is a similar trend observed, though less pronounced than with the full ScoGFS, when comparing the IBTS Q1 series with the catch data. This may be due to the IBTS Q1 series not currently recognising the splits in the EngGFS and ScoGFS as used in the final assessment presented here. Furthermore, including the early EngGFS and early ScoGFS series improves the estimation of fishing mortalities in the oldest age group, and may provide further overall stability in the assessment.

Issues raising concern are centred on how to deal with the 1999 year class in forecasts; there are two main issues. Firstly, reduced growth rate is apparent in the 1999 and 2000 year classes – mean weight at age in these cohorts appears to have increased only marginally from 2003 to 2004. The pragmatic solution of taking the lower 95th percent confidence interval of the mean weight at each age as trajectory for the weight at age for the 1999 and 2000 year classes incorporates the history of growth in the stock, while recognising the slow growth rate of these cohorts. The second issue relates to fishing mortality; it is likely that the 1999 year class will not experience the same dome shaped fishing mortality at age as seen recently in other cohorts. This is principally due to the dominance of the 1999 year class in the population, and thus, the catch. A pragmatic solution here is to presume a flat topped fishing mortality for the 1999 year class, and an average fishing mortality at age for the remaining year classes. It is fair to assume that a year class, that will remain the major component of the catch, will experience a steady mortality into ages 6 and 7, as opposed to a decline in fishing mortality in older ages.

4.10 Status of the Stock

The general perception of the haddock stock remains unchanged from last years' assessment (Figure 4.10.1). All sources of information indicate that mortality has declined from a previously high historic mean to well below $\mathbf{F}_{pa}$, and appears to have remained stable since 2002. Spawning stock biomass is predicted to have fallen slightly from that in 2003 but remains above $\mathbf{B}_{pa}$.

The fishery in 2004 remained dependent on the 1999 year class, with the 2000 to 2004 recruitments being unsubstantial. Recruitment in 2005 is predicted to be large and should enter the fishery as discards in 2006 and as landings in 2008. However, it is possible that the 2005 year class may be heavily discarded, as was seen with the 1999 year class.

4.11 Management Considerations

Recent effort restrictions appear to have reduced fishing mortality effectively in the years 2002 to 2004. However, due to the large 1999 year class passing through the fishery and subsequently being followed by several low recruitments, SSB has begun to decline, and is expected to continue to decline in the near future. Figure 4.11.1 shows the North Sea Commission Fisheries Partnership's stock survey results for haddock. The overall picture from this study echoes that of the stock assessment; that the haddock has been increasing since 2001, with evidence of a stable or reducing biomass in the most recent years, likely due to the ageing 1999 year class. Continued reduced fishing mortality would be preferable to ensure the success of the 2005 recruits, and to maintain the 1999 year class as a proportion of the catch for future years.

Haddock is a specific target for some fleets, but is also caught as part of a mixed fishery also catching cod, whiting and *Nephrops*, it is important to consider the species specific assessments of these species for effective management. However, from fishing patterns in Scotland, and the fact that haddock is experiencing reduced fishing mortality while the exploitation of cod appears to have remained high, there is a possibility that an amount of decoupling has occurred between these fisheries.

EU-Norway have agreed on a Management Plan for this stock. Every effort shall be made to maintain a minimum level of Spawning Stock Biomass (SSB) greater than 100,000 tonnes ($\mathbf{B}_{\text{lim}}$). Furthermore, for 2005 and subsequent years fishing will be restricted on the basis of a TAC consistent with a fishing mortality rate of no more than 0.30 for appropriate age groups.

Table 4.2.1.1 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	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Belgium	0	0	0	0	0	0	
Denmark	1,012	1,033	1,590	3,791	1,741	1,116	
Germany	3	1	128	239	113	69	
Germany, Fed. Rep. of	0	0	0	0	0	0	
Germany,New Länder	0	0	0	0	0	0	
Netherlands	0	0	0	0	6	1	
Norway	168	126	149	149	184	154	
Sweden	206	367	283	393	165	158	
UK - England & Wales	0	0	0	0	0	0	
UK – Scotland	0	0	7	0	0	0	
Total reported	1,389	1,527	2,157	4,572	2,209	1,498	
Unallocated	-29	-42	-254	-435	-401	-55	
WG estimate of H.cons. landings	1,360	1,485	1,903	4,137	1,808	1,443	
WG estimate of industrial by-catch	334	617	218	0	0	0	
WG estimate of total catch	**1,694**	**2,102**	**2,121**	**4,137**	**1,808**	**1,443**	
TAC	*5,400*	*4,450*	*4,000*	*6,300*	*3,150*	*4,940*	*4,018* *

* Includes areas III bcd (EC waters)

Sub-area IV

Country	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Belgium	462	399	606	559	374	373	
Denmark	2,104	1,670	2,407	5,123	3,035	2,074	
Faeroe Islands	55	0	1	25	12	0	
France	0	724	485	914	1,100	0	
Germany	565	342	681	852	1,562	1,240	
Germany, Fed. Rep. of	0	0	0	0	0	0	
Germany,New Länder	0	0	0	0	0	0	
Greenland	0	0	0	0	149	0	
Ireland	0	0	0	0	1	0	
Netherlands	110	119	274	359	187	104	
Norway	3,830	3,150	1,902	2,404	2,213	2,206	
Poland	17	13	12	17	16	0	
Spain	0	0	0	0	0	0	
Sweden	686	596	804	572	477	187	
UK - Eng+Wales+N.Irl.	2,398	1,876	3,334	3,647	1,561	1,158	
UK - England & Wales	0	0	0	0	0	0	
UK – Scotland	53,628	37,772	29,263	39,624	31,526	39,337	
Un. Sov. Soc. Rep.	0	0	0	0	0	0	
Total reported	63,855	46,661	39,769	54,096	42,213	46,679	
Unallocated	354	-577	-811	75	66	575	
WG estimate of H.cons. landings	64,209	46,084	38,958	54,171	42,279	47,253	
WG estimate of discards	42,562	48,841	118,320	45,892	23,499	17,226	
WG estimate of industrial by-catch	3,834	8,134	7,879	3,717	1,149	554	
WG estimate of total catch	**110,605**	**103,059**	**165,157**	**103,780**	**66,927**	**65,033**	
TAC	*88,550*	*73,000*	*61,000*	*104,000*	*51,735*	*77,000*	*66,000* *

* Includes area II a (EC waters)

Division IIIa and Sub-area IV

	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
WG estimate of total catch	112,299	105,161	167,278	107,917	68,735	66,476	
TAC	*93,950*	*77,450*	*65,000*	*110,300*	*54,885*	*81,940*	*70,018* *

* Includes areas II a and III bcd (EC waters)

Table 4.2.1.2 Haddock in Sub-Area IV and Division IIIa. WG estimates of catch components by weight ('000 tonnes) and the proportion of IIIa HC landings to the total HC landings.

	Sub-Area IV (North Sea)				Division IIIa			Total	IIIa HC as proportion of 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%
2004	47.3	17.2	0.6	65.0	1.4	0.0	1.4	66.5	3.0%
Min.	39.0	17.2	0.6	65.0	0.4	0.0	0.4	66.5	1.0%
Mean	126.0	87.2	29.8	243.0	3.5	1.2	4.7	247.8	2.7%
Max.	524.6	260.4	338.4	929.5	10.8	7.2	15.2	930.5	2.0%

Table 4.2.2.1 Haddock in Sub-Area IV and Division IIIa. Catch-at-age data (thousands). Data used in the assessment are highlighted in **bold**.

HC+Disc+IB	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	7+
1963	**1367**	**1307178**	**335092**	**20963**	**13026**	**5781**	**502**	653	566	59	18	0	0	0	0	0	**1296**
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	**881**
1967	**306037**	**838189**	**89083**	**4863**	**3585**	**177857**	**2443**	215	216	57	34	0	0	0	0	0	**522**
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	**6307**
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	**1557**
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	**1104**
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	**975**
1980	**399372**	**678499**	**333261**	**73043**	**10476**	**1901**	**8067**	598	121	162	75	31	9	3	1	0	**1000**
1981	**646419**	**134470**	**423059**	**143151**	**15228**	**2034**	**458**	2498	125	64	23	30	4	1	3	0	**2748**
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	**856**
1985	**139579**	**178878**	**534269**	**78726**	**37445**	**5306**	**7355**	965	212	52	21	88	4	0	0	0	**1342**
1986	**56503**	**160398**	**178824**	**323650**	**27685**	**9691**	**1237**	1810	237	117	49	32	36	13	4	1	**2299**
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	**847**
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	**1232**
1992	**270758**	**209879**	**253286**	**32494**	**6552**	**1250**	**4861**	454	301	293	124	22	6	2	0	0	**1202**
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	**904**
1995	**273689**	**301733**	**85925**	**167801**	**25875**	**7645**	**511**	127	45	62	19	8	6	2	1	0	**270**
1996	**347568**	**53415**	**357942**	**56894**	**55147**	**7503**	**3052**	756	52	31	25	5	8	3	1	0	**881**
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	**1300**
2003	**6132**	**18616**	**14122**	**44745**	**109063**	**1970**	**602**	271	110	89	38	5	1	0	0	0	**514**
2004	**918**	**9872**	**18069**	**6574**	**34945**	**91121**	**723**	147	56	35	35	10	1	0	0	0	**284**

Table 4.2.2.2 Haddock in Sub- Area IV and Division IIIa. HC catch- at- age data (thousands). Data used in the assessment are highlighted in bold.

HC	**0**	**1**	**2**	**3**	**4**	**5**	**6**	7	8	9	10	11	12	13	14	15	**7+**
1963	**0**	**27353**	**118185**	**16692**	**12212**	**5644**	**498**	653	566	59	18	0	0	0	0	0	**642**
1964	**0**	**48**	**250523**	**86368**	**8166**	**4689**	**2283**	286	236	231	25	0	0	0	0	0	**492**
1965	**0**	**2636**	**3445**	**335396**	**23479**	**4063**	**1852**	446	107	90	41	0	0	0	0	0	**238**
1966	**0**	**12976**	**6724**	**4250**	**372535**	**9188**	**1018**	599	165	90	23	2	0	0	0	0	**280**
1967	**0**	**54953**	**33894**	**3845**	**3345**	**174011**	**2421**	215	216	57	34	0	0	0	0	0	**307**
1968	**0**	**18443**	**139035**	**14557**	**1806**	**2495**	**45047**	324	40	13	5	0	0	0	0	0	**59**
1969	**0**	**139**	**713860**	**166997**	**6542**	**2014**	**2381**	18876	200	24	7	0	0	0	0	0	**231**
1970	**0**	**2259**	**51861**	**1133133**	**50823**	**1012**	**1131**	254	5954	67	11	19	0	0	0	0	**6051**
1971	**0**	**34019**	**25862**	**35168**	**369443**	**10006**	**455**	195	147	1592	160	3	5	0	0	0	**1907**
1972	**0**	**12778**	**207267**	**33215**	**19853**	**156344**	**3550**	190	34	27	408	11	0	0	0	0	**480**
1973	**0**	**6024**	**205717**	**193852**	**5829**	**4238**	**39336**	1257	108	29	109	49	5	0	0	0	**299**
1974	**0**	**23993**	**52416**	**227998**	**46793**	**1785**	**1232**	10693	242	23	32	4	5	0	0	0	**306**
1975	**0**	**24144**	**200961**	**38295**	**90302**	**15524**	**978**	620	2709	266	63	11	0	8	0	0	**3057**
1976	**0**	**2301**	**223465**	**142803**	**9721**	**28103**	**4978**	206	76	759	60	3	0	0	0	0	**899**
1977	**0**	**8484**	**31741**	**249285**	**37092**	**4057**	**6021**	1300	135	29	200	3	0	1	0	0	**368**
1978	**0**	**12883**	**54630**	**25305**	**100036**	**8568**	**1152**	2070	402	116	15	64	13	2	0	0	**612**
1979	**0**	**14009**	**110008**	**36486**	**7284**	**27543**	**2219**	262	483	152	54	12	11	1	0	0	**714**
1980	**0**	**8982**	**141895**	**61901**	**9063**	**1843**	**7975**	591	121	161	75	31	9	3	1	0	**402**
1981	**0**	**1759**	**153466**	**112407**	**14679**	**2025**	**455**	2498	125	64	23	30	4	1	3	0	**251**
1982	**0**	**7373**	**38819**	**236209**	**37728**	**2913**	**713**	279	784	30	15	7	2	2	0	0	**840**
1983	**0**	**7101**	**109201**	**52566**	**117819**	**15760**	**1603**	297	61	190	53	6	4	4	0	0	**319**
1984	**0**	**19501**	**75963**	**104651**	**21372**	**31874**	**3788**	596	84	41	112	16	5	1	1	0	**261**
1985	**0**	**2120**	**248125**	**70806**	**36734**	**5076**	**7329**	965	212	52	21	88	4	0	0	0	**378**
1986	**0**	**12132**	**62362**	**261225**	**27548**	**9671**	**1237**	1810	237	117	49	32	36	13	4	1	**489**
1987	**0**	**6896**	**113196**	**37763**	**66221**	**4760**	**2877**	545	778	135	36	50	27	29	5	8	**1068**
1988	**0**	**1524**	**146403**	**76925**	**12024**	**18310**	**1602**	639	166	141	50	18	11	10	15	1	**412**
1989	**0**	**4519**	**16387**	**128051**	**16762**	**2574**	**3916**	498	199	83	30	13	6	2	2	1	**337**
1990	**0**	**5493**	**43168**	**14338**	**45015**	**3269**	**775**	1242	202	78	41	11	11	1	4	2	**350**
1991	**0**	**19482**	**46902**	**21841**	**3812**	**12337**	**976**	401	614	148	54	6	5	1	2	1	**830**
1992	**0**	**2853**	**117953**	**28828**	**6485**	**1247**	**4779**	454	300	293	124	22	6	2	0	0	**748**
1993	**0**	**2488**	**77820**	**86806**	**6976**	**1686**	**450**	1119	146	103	144	59	3	2	0	0	**457**
1994	**0**	**467**	**69457**	**70354**	**27587**	**1860**	**524**	191	509	115	32	27	25	5	0	0	**713**
1995	**0**	**1870**	**29177**	**101663**	**24715**	**7565**	**511**	127	45	62	19	8	6	2	1	0	**142**
1996	**0**	**742**	**74892**	**36685**	**47168**	**7501**	**3052**	756	52	31	25	5	8	3	1	0	**125**
1997	**0**	**1409**	**23943**	**123178**	**14028**	**15208**	**1892**	679	62	15	12	4	4	4	2	0	**103**
1998	**0**	**822**	**38321**	**36736**	**92738**	**5607**	**3543**	472	140	14	6	5	2	2	1	1	**171**
1999	**0**	**994**	**25856**	**53192**	**23301**	**37630**	**2155**	1595	342	41	6	2	1	1	0	0	**393**
2000	**0**	**4750**	**30316**	**28653**	**23407**	**5873**	**8644**	560	234	32	12	2	1	1	0	0	**282**
2001	**0**	**611**	**67196**	**16117**	**7406**	**3929**	**1561**	1295	191	64	17	3	1	0	0	0	**276**
2002	**0**	**639**	**13666**	**111346**	**5640**	**2004**	**1066**	419	458	265	15	8	5	0	0	0	**752**
2003	**0**	**32**	**1091**	**13925**	**73059**	**1920**	**571**	270	109	89	38	5	1	0	0	0	**243**
2004	**0**	**481**	**2897**	**4101**	**22159**	**73191**	**710**	139	56	35	35	10	1	0	0	0	**137**

Table 4.2.2.3 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	**0**
1994	**16059**	**82033**	**217538**	**29100**	**1862**	**53**	**48**	0	0	0	0	0	0	0	0	0	**0**
1995	**3228**	**191807**	**54448**	**65250**	**1095**	**79**	**0**	0	0	0	0	0	0	0	0	0	**0**
1996	**3968**	**35340**	**275597**	**16870**	**7872**	**2**	**0**	0	0	0	0	0	0	0	0	0	**0**
1997	**7162**	**85588**	**50976**	**85664**	**1061**	**182**	**0**	0	0	0	0	0	0	0	0	0	**0**
1998	**3132**	**72793**	**112075**	**10165**	**13766**	**71**	**18**	0	0	0	0	0	0	0	0	0	**0**
1999	**14588**	**69196**	**90861**	**31119**	**1094**	**2064**	**180**	0	0	0	0	0	0	0	0	0	**0**
2000	**2474**	**272894**	**36568**	**12614**	**2764**	**148**	**64**	0	0	0	0	0	0	0	0	0	**0**
2001	**545**	**61878**	**529908**	**6100**	**1446**	**186**	**0**	10	4	0	0	0	0	0	0	0	**4**
2002	**946**	**3872**	**48189**	**127212**	**403**	**8**	**0**	130	0	0	0	0	0	0	0	0	**0**
2003	**1987**	**12601**	**10930**	**29535**	**34480**	**37**	**31**	1	0	0	0	0	0	0	0	0	**1**
2004	**918**	**8801**	**14907**	**2388**	**12528**	**17177**	**5**	3	0	0	0	0	0	0	0	0	**0**

Table 4.2.2.4 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	0
1965	647230	255329	7719	184075	2375	594	119	6	0	0	0	0	0	0	0	0	0
1966	1663325	550235	6562	1009	15901	757	25	2	0	0	0	0	0	0	0	0	0
1967	299787	393545	5554	156	24	2269	12	0	0	0	0	0	0	0	0	0	0
1968	11107	464656	81454	2036	46	19	740	1	0	0	0	0	0	0	0	0	0
1969	70938	15201	1706305	98806	633	380	126	253	0	0	0	0	0	0	0	0	0
1970	874052	171142	88628	485924	3972	153	61	2	0	0	0	0	0	0	0	0	0
1971	325810	575197	10056	3419	6435	302	6	0	0	0	0	0	0	0	0	0	0
1972	239844	241771	57776	1037	148	444	0	0	0	0	0	0	0	0	0	0	0
1973	42005	119383	12604	11	11	199	0	0	0	0	0	0	0	0	0	0	0
1974	590144	281705	33021	47958	4707	84	115	229	0	0	0	0	0	0	0	0	0
1975	45758	614202	87373	4916	5372	146	5	0	5	0	0	0	0	0	0	0	5
1976	171970	69809	190817	30424	48	3071	18	0	0	0	0	0	0	0	0	0	0
1977	108986	155349	31016	71460	2488	251	254	0	0	0	0	0	0	0	0	0	0
1978	299865	134332	12109	864	1582	68	7	6	0	0	0	0	0	0	0	0	0
1979	879999	131887	18520	1579	88	397	17	0	0	0	0	0	0	0	0	0	0
1980	398727	299790	23243	8796	1375	58	92	7	0	1	0	0	0	0	0	0	1
1981	644910	99277	32070	4817	463	6	3	0	0	0	0	0	0	0	0	0	0
1982	275003	174449	15392	14225	1862	494	0	0	0	0	0	0	0	0	0	0	0
1983	488707	64821	14885	5387	2320	3	0	0	0	0	0	0	0	0	0	0	0
1984	92587	98272	11507	4903	380	543	0	0	0	0	0	0	0	0	0	0	0
1985	122079	11672	18397	1832	563	226	18	0	0	0	0	0	0	0	0	0	0
1986	32696	40062	1857	813	106	8	0	0	0	0	0	0	0	0	0	0	0
1987	12217	118539	4290	348	138	0	0	0	0	0	0	0	0	0	0	0	0
1988	15007	3933	19044	3332	620	202	0	0	0	0	0	0	0	0	0	0	0
1989	10251	2918	2013	3206	530	42	99	12	0	0	0	0	0	0	0	0	0
1990	5225	12702	3494	632	2625	401	44	138	8	0	0	0	0	0	0	0	8
1991	116909	26909	3415	631	49	44	0	0	0	0	0	0	0	0	0	0	0
1992	241702	96031	11373	367	29	3	17	0	0	0	0	0	0	0	0	0	0
1993	124495	122384	14151	3240	83	9	0	18	0	0	0	0	0	0	0	0	0
1994	69907	16759	9782	1022	160	7	1	0	0	0	0	0	0	0	0	0	0
1995	270461	108056	2300	888	65	0	0	0	0	0	0	0	0	0	0	0	0
1996	343600	17333	7453	3338	107	0	0	0	0	0	0	0	0	0	0	0	0
1997	32920	47645	11312	4451	184	17	0	0	0	0	0	0	0	0	0	0	0
1998	20771	9942	16963	2748	1562	65	0	0	0	0	0	0	0	0	0	0	0
1999	93667	11232	4531	2932	344	166	3	0	0	0	0	0	0	0	0	0	0
2000	49707	73355	21740	2085	186	5	0	0	0	0	0	0	0	0	0	0	0
2001	2965	24255	35776	10127	35	8	0	0	0	0	0	0	0	0	0	0	0
2002	49807	13889	4489	3638	504	27	0	0	0	0	0	0	0	0	0	0	0
2003	4145	5983	2101	1285	1524	12	0	0	0	0	0	0	0	0	0	0	0
2004	0	590	265	84	258	753	8	4	0	0	0	0	0	0	0	0	0

Table 4.2.3.1 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	**1.354**
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**	**0.126**	**0.253**	**0.509**	**0.731**	**0.857**	**0.837**	1.606	2.260	2.702	2.073	0.000	0.000	0.000	0.000	0.000	**1.718**
1969	**0.011**	**0.063**	**0.216**	**0.406**	**0.799**	**0.891**	**1.031**	1.094	2.040	3.034	3.264	0.000	0.000	0.000	0.000	0.000	**1.107**
1970	**0.013**	**0.073**	**0.222**	**0.352**	**0.735**	**0.873**	**1.191**	1.362	1.437	2.571	3.950	3.869	0.000	0.000	0.000	0.000	**1.458**
1971	**0.011**	**0.107**	**0.247**	**0.362**	**0.506**	**0.887**	**1.267**	1.534	1.337	1.275	1.969	4.306	3.543	0.000	0.000	0.000	**1.366**
1972	**0.024**	**0.116**	**0.242**	**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**	**0.240**	**0.372**	**0.586**	**0.649**	**0.725**	1.044	1.302	2.796	1.726	2.020	2.158	0.000	0.000	0.000	**1.177**
1974	**0.024**	**0.128**	**0.226**	**0.343**	**0.548**	**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**	**0.101**	**0.241**	**0.356**	**0.449**	**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**	**0.125**	**0.224**	**0.401**	**0.512**	**0.588**	**0.922**	1.933	1.784	1.306	2.425	2.528	0.000	0.000	0.000	0.000	**1.520**
1977	**0.019**	**0.108**	**0.241**	**0.345**	**0.601**	**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**	**0.144**	**0.253**	**0.418**	**0.441**	**0.719**	**0.742**	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**	**0.290**	**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**	**0.104**	**0.283**	**0.486**	**0.732**	**1.046**	**0.936**	1.394	1.599	1.593	1.726	3.328	1.119	3.071	3.111	0.000	**1.540**
1981	**0.009**	**0.074**	**0.262**	**0.476**	**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**	**0.292**	**0.460**	**0.784**	**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**	**0.297**	**0.448**	**0.651**	**0.915**	**1.214**	1.162	1.920	1.376	1.395	1.907	2.853	4.689	0.000	0.000	**1.365**
1984	**0.010**	**0.141**	**0.300**	**0.489**	**0.670**	**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**	**0.279**	**0.480**	**0.668**	**0.857**	**1.049**	1.459	1.833	2.124	2.145	2.003	2.387	2.471	2.721	3.970	**1.593**
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	**0.008**	**0.126**	**0.265**	**0.406**	**0.615**	**1.029**	**1.276**	1.433	1.529	1.877	2.054	1.940	2.471	2.411	2.996	2.638	**1.592**
1988	**0.024**	**0.165**	**0.217**	**0.417**	**0.589**	**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	**0.027**	**0.197**	**0.300**	**0.372**	**0.605**	**0.811**	**0.982**	1.364	1.655	1.684	2.249	2.166	2.364	2.389	2.307	1.146	**1.519**
1990	**0.044**	**0.194**	**0.292**	**0.430**	**0.473**	**0.771**	**0.967**	1.167	1.529	2.037	2.653	2.530	2.392	3.444	1.852	4.731	**1.308**
1991	**0.029**	**0.177**	**0.320**	**0.472**	**0.639**	**0.650**	**1.042**	1.232	1.481	1.776	1.996	2.253	2.404	1.070	3.509	2.936	**1.470**
1992	**0.018**	**0.107**	**0.306**	**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**	**0.115**	**0.280**	**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**	**0.116**	**0.250**	**0.419**	**0.597**	**0.943**	**1.208**	1.570	1.469	1.620	2.418	2.108	2.849	2.403	2.580	0.000	**1.606**
1995	**0.013**	**0.102**	**0.297**	**0.363**	**0.592**	**0.763**	**1.099**	1.423	1.685	1.873	1.881	2.508	1.674	1.699	2.243	0.000	**1.645**
1996	**0.019**	**0.127**	**0.246**	**0.388**	**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	**0.021**	**0.133**	**0.277**	**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**	**0.252**	**0.392**	**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	**0.023**	**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	**0.048**	**0.119**	**0.253**	**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	**1.141**
2001	**0.021**	**0.109**	**0.216**	**0.309**	**0.466**	**0.697**	**0.754**	0.971	1.892	1.198	2.114	2.706	3.237	2.534	1.239	3.425	**1.110**
2002	**0.016**	**0.088**	**0.255**	**0.325**	**0.528**	**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**	**0.210**	**0.317**	**0.403**	**0.674**	**0.770**	1.155	1.380	1.646	2.181	2.209	2.506	2.606	1.981	3.092	**1.377**
2004	**0.054**	**0.175**	**0.252**	**0.388**	**0.393**	**0.443**	**0.726**	1.040	1.372	1.741	1.765	2.355	2.172	0.000	0.000	0.000	**1.331**

Table 4.2.3.2 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	**7+**
1963	**0.000**	**0.233**	**0.326**	**0.512**	**0.715**	**0.817**	**1.009**	1.131	1.173	1.576	1.825	0.000	0.000	0.000	0.000	0.000	**1.179**
1964	**0.000**	**0.221**	**0.313**	**0.459**	**0.695**	**0.870**	**0.934**	1.386	1.148	1.470	1.781	0.000	0.000	0.000	0.000	0.000	**1.351**
1965	**0.000**	**0.310**	**0.357**	**0.410**	**0.679**	**0.907**	**1.242**	1.182	1.482	1.707	2.239	0.000	0.000	0.000	0.000	0.000	**1.361**
1966	**0.000**	**0.301**	**0.384**	**0.416**	**0.553**	**0.995**	**1.288**	1.529	1.938	1.727	2.963	2.040	0.000	0.000	0.000	0.000	**1.665**
1967	**0.000**	**0.260**	**0.404**	**0.510**	**0.614**	**0.645**	**1.063**	1.501	1.922	2.069	2.348	0.000	0.000	0.000	0.000	0.000	**1.792**
1968	**0.000**	**0.256**	**0.361**	**0.591**	**0.761**	**0.863**	**0.846**	1.610	2.260	2.702	2.073	0.000	0.000	0.000	0.000	0.000	**1.722**
1969	**0.000**	**0.178**	**0.302**	**0.506**	**0.870**	**0.984**	**1.065**	1.102	2.040	3.034	3.264	0.000	0.000	0.000	0.000	0.000	**1.115**
1970	**0.000**	**0.242**	**0.310**	**0.403**	**0.786**	**0.949**	**1.235**	1.370	1.437	2.571	3.950	3.869	0.000	0.000	0.000	0.000	**1.458**
1971	**0.000**	**0.256**	**0.335**	**0.399**	**0.524**	**0.905**	**1.281**	1.534	1.337	1.275	1.969	4.306	3.543	0.000	0.000	0.000	**1.366**
1972	**0.000**	**0.244**	**0.329**	**0.421**	**0.523**	**0.609**	**1.003**	1.366	2.241	2.006	1.651	2.899	0.000	0.000	0.000	0.000	**1.635**
1973	**0.000**	**0.225**	**0.315**	**0.406**	**0.606**	**0.663**	**0.726**	1.044	1.302	2.796	1.726	2.020	2.158	0.000	0.000	0.000	**1.176**
1974	**0.000**	**0.275**	**0.320**	**0.389**	**0.585**	**0.908**	**0.954**	0.963	1.513	2.315	2.508	4.152	2.264	0.000	0.000	0.000	**0.984**
1975	**0.000**	**0.258**	**0.345**	**0.408**	**0.487**	**0.686**	**1.248**	1.124	1.094	1.720	2.217	2.854	0.000	3.426	0.000	0.000	**1.174**
1976	**0.000**	**0.250**	**0.344**	**0.467**	**0.516**	**0.614**	**0.923**	1.933	1.784	1.306	2.425	2.528	0.000	0.000	0.000	0.000	**1.521**
1977	**0.000**	**0.286**	**0.362**	**0.396**	**0.614**	**0.630**	**0.817**	1.181	1.943	2.322	1.780	3.189	0.000	4.119	0.000	0.000	**1.340**
1978	**0.000**	**0.275**	**0.356**	**0.457**	**0.470**	**0.725**	**0.789**	0.956	1.398	2.124	2.868	1.849	2.454	4.782	0.000	0.000	**1.115**
1979	**0.000**	**0.274**	**0.361**	**0.468**	**0.642**	**0.668**	**0.935**	1.187	1.187	1.468	2.679	1.624	1.760	1.643	0.000	0.000	**1.326**
1980	**0.000**	**0.299**	**0.367**	**0.526**	**0.750**	**1.056**	**0.934**	1.392	1.599	1.592	1.726	3.328	1.119	3.071	3.111	0.000	**1.541**
1981	**0.000**	**0.339**	**0.385**	**0.525**	**0.754**	**1.149**	**1.481**	1.180	1.634	1.764	1.554	1.492	3.389	4.273	1.981	0.000	**1.226**
1982	**0.000**	**0.300**	**0.364**	**0.507**	**0.818**	**1.237**	**1.441**	1.672	1.456	2.634	2.164	1.924	1.886	3.179	0.000	0.000	**1.558**
1983	**0.000**	**0.312**	**0.387**	**0.482**	**0.663**	**0.925**	**1.243**	1.162	1.920	1.376	1.395	1.907	2.853	4.689	0.000	0.000	**1.366**
1984	**0.000**	**0.281**	**0.376**	**0.515**	**0.677**	**0.810**	**1.097**	1.100	1.868	2.425	1.972	2.247	2.422	2.822	4.995	0.000	**1.389**
1985	**0.000**	**0.277**	**0.359**	**0.502**	**0.671**	**0.871**	**1.051**	1.459	1.833	2.124	2.145	2.003	2.387	2.471	2.721	3.970	**1.594**
1986	**0.000**	**0.276**	**0.351**	**0.433**	**0.613**	**0.863**	**1.257**	1.195	1.715	1.525	2.484	2.653	2.538	3.075	2.778	2.894	**1.348**
1987	**0.000**	**0.274**	**0.345**	**0.451**	**0.622**	**1.029**	**1.276**	1.433	1.529	1.877	2.054	1.940	2.471	2.411	2.996	2.638	**1.592**
1988	**0.000**	**0.258**	**0.324**	**0.445**	**0.619**	**0.752**	**1.284**	1.424	1.551	1.627	1.680	3.068	2.468	2.885	3.337	2.863	**1.565**
1989	**0.000**	**0.310**	**0.388**	**0.415**	**0.617**	**0.810**	**0.982**	1.361	1.653	1.684	2.236	2.166	2.364	2.389	2.307	1.146	**1.519**
1990	**0.000**	**0.308**	**0.379**	**0.484**	**0.516**	**0.802**	**1.039**	1.191	1.543	2.037	2.653	2.530	2.392	3.444	1.852	4.731	**1.341**
1991	**0.000**	**0.319**	**0.377**	**0.480**	**0.643**	**0.653**	**1.042**	1.232	1.481	1.776	1.996	2.253	2.404	1.070	3.509	2.936	**1.468**
1992	**0.000**	**0.336**	**0.379**	**0.510**	**0.751**	**1.017**	**0.904**	1.395	1.538	1.912	1.997	2.067	2.441	1.781	0.000	0.000	**1.637**
1993	**0.000**	**0.326**	**0.393**	**0.483**	**0.684**	**0.896**	**1.173**	1.111	1.592	1.737	1.920	1.718	2.274	2.516	0.000	0.000	**1.297**
1994	**0.000**	**0.288**	**0.390**	**0.482**	**0.617**	**0.962**	**1.296**	1.570	1.469	1.620	2.418	2.108	2.849	2.403	2.580	0.000	**1.606**
1995	**0.000**	**0.312**	**0.396**	**0.421**	**0.603**	**0.767**	**1.099**	1.423	1.685	1.873	1.881	2.508	1.674	1.699	2.243	0.000	**1.644**
1996	**0.000**	**0.342**	**0.359**	**0.462**	**0.515**	**0.780**	**0.870**	0.846	1.833	2.025	1.623	2.393	2.369	2.598	3.439	0.000	**0.999**
1997	**0.000**	**0.333**	**0.396**	**0.412**	**0.601**	**0.618**	**0.909**	0.966	1.647	2.247	2.146	2.634	2.757	2.262	2.867	2.782	**1.092**
1998	**0.000**	**0.263**	**0.361**	**0.429**	**0.460**	**0.657**	**0.762**	1.103	1.153	1.825	2.357	2.150	2.824	2.423	2.085	2.509	**1.163**
1999	**0.000**	**0.286**	**0.347**	**0.416**	**0.482**	**0.510**	**0.717**	0.782	0.749	1.247	1.559	1.913	2.232	2.392	2.912	2.225	**0.791**
2000	**0.000**	**0.298**	**0.366**	**0.419**	**0.520**	**0.622**	**0.653**	1.100	1.091	1.760	1.959	2.331	2.385	2.315	3.810	1.843	**1.142**
2001	**0.000**	**0.378**	**0.348**	**0.439**	**0.498**	**0.714**	**0.754**	0.976	1.922	1.198	2.114	2.706	3.237	2.534	1.239	3.425	**1.117**
2002	**0.000**	**0.356**	**0.427**	**0.393**	**0.556**	**0.742**	**0.924**	0.997	1.423	1.941	2.368	1.840	2.349	2.762	0.000	0.000	**1.407**
2003	**0.000**	**0.311**	**0.424**	**0.450**	**0.439**	**0.679**	**0.777**	1.156	1.382	1.647	2.181	2.209	2.506	2.606	1.981	3.092	**1.381**
2004	**0.000**	**0.348**	**0.372**	**0.461**	**0.444**	**0.467**	**0.729**	1.054	1.372	1.741	1.765	2.355	2.172	0.000	0.000	0.000	**1.346**

Table 4.2.3.3 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	7+
1963	**0.064**	**0.139**	**0.218**	**0.327**	**0.397**	**0.321**	**0.321**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1964	**0.065**	**0.177**	**0.249**	**0.306**	**0.337**	**0.321**	**0.321**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1965	**0.064**	**0.131**	**0.200**	**0.341**	**0.613**	**0.321**	**0.321**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1966	**0.063**	**0.141**	**0.208**	**0.244**	**0.310**	**0.321**	**0.321**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1967	**0.064**	**0.171**	**0.209**	**0.274**	**0.306**	**0.321**	**0.321**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1968	**0.063**	**0.186**	**0.212**	**0.256**	**0.318**	**0.321**	**0.321**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1969	**0.064**	**0.129**	**0.216**	**0.237**	**0.301**	**0.321**	**0.321**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1970	**0.063**	**0.129**	**0.210**	**0.238**	**0.263**	**0.321**	**0.321**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1971	**0.063**	**0.134**	**0.201**	**0.242**	**0.263**	**0.321**	**0.321**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1972	**0.063**	**0.139**	**0.206**	**0.237**	**0.261**	**0.321**	**0.321**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1973	**0.063**	**0.131**	**0.201**	**0.235**	**0.263**	**0.321**	**0.321**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1974	**0.062**	**0.145**	**0.200**	**0.233**	**0.259**	**0.321**	**0.321**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1975	**0.050**	**0.123**	**0.200**	**0.257**	**0.275**	**0.348**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1976	**0.079**	**0.176**	**0.197**	**0.237**	**0.292**	**0.337**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1977	**0.071**	**0.196**	**0.197**	**0.216**	**0.309**	**0.347**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1978	**0.037**	**0.180**	**0.199**	**0.222**	**0.224**	**0.265**	**0.284**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1979	**0.053**	**0.118**	**0.219**	**0.242**	**0.259**	**0.340**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1980	**0.051**	**0.149**	**0.231**	**0.274**	**0.324**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1981	**0.073**	**0.160**	**0.198**	**0.290**	**0.650**	**0.727**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1982	**0.072**	**0.197**	**0.248**	**0.271**	**0.264**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1983	**0.067**	**0.187**	**0.237**	**0.347**	**0.476**	**0.711**	**0.792**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1984	**0.046**	**0.162**	**0.245**	**0.317**	**0.300**	**0.314**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1985	**0.040**	**0.155**	**0.214**	**0.264**	**0.336**	**0.423**	**0.421**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1986	**0.045**	**0.138**	**0.184**	**0.245**	**0.408**	**0.329**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1987	**0.023**	**0.159**	**0.200**	**0.225**	**0.287**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1988	**0.063**	**0.172**	**0.170**	**0.238**	**0.254**	**0.360**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1989	**0.085**	**0.187**	**0.229**	**0.268**	**0.335**	**0.708**	**0.844**	0.000	2.572	0.000	3.048	0.000	0.000	0.000	0.000	0.000	**2.810**
1990	**0.046**	**0.196**	**0.229**	**0.249**	**0.266**	**0.290**	**0.333**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1991	**0.065**	**0.179**	**0.243**	**0.344**	**0.464**	**0.493**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1992	**0.043**	**0.137**	**0.246**	**0.286**	**0.347**	**0.000**	**0.415**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1993	**0.027**	**0.142**	**0.237**	**0.287**	**0.344**	**0.369**	**0.000**	0.369	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.369**
1994	**0.044**	**0.126**	**0.211**	**0.269**	**0.306**	**0.304**	**0.270**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1995	**0.064**	**0.131**	**0.251**	**0.275**	**0.363**	**0.384**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1996	**0.046**	**0.138**	**0.219**	**0.279**	**0.297**	**0.358**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1997	**0.063**	**0.161**	**0.254**	**0.286**	**0.321**	**0.385**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1998	**0.041**	**0.162**	**0.231**	**0.293**	**0.315**	**0.391**	**0.428**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1999	**0.049**	**0.183**	**0.217**	**0.273**	**0.307**	**0.304**	**0.250**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2000	**0.030**	**0.129**	**0.246**	**0.281**	**0.319**	**0.355**	**0.287**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2001	**0.045**	**0.116**	**0.205**	**0.307**	**0.308**	**0.364**	**0.000**	0.411	0.416	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.413**
2002	**0.042**	**0.166**	**0.226**	**0.268**	**0.352**	**0.378**	**0.000**	0.357	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.357**
2003	**0.067**	**0.128**	**0.223**	**0.265**	**0.332**	**0.536**	**0.654**	0.951	0.946	1.154	0.000	0.000	0.000	0.000	0.000	0.000	**0.979**
2004	**0.054**	**0.173**	**0.232**	**0.280**	**0.308**	**0.342**	**0.639**	0.716	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.716**

Table 4.2.3.4 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	7+
1963	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1964	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.500**
1965	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.500**
1966	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.500**
1967	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1968	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.500**
1969	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.500**
1970	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.500**
1971	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1972	**0.023**	**0.067**	**0.136**	**0.255**	**0.288**	**0.231**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1973	**0.035**	**0.068**	**0.141**	**0.246**	**0.327**	**0.396**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1974	**0.022**	**0.058**	**0.150**	**0.260**	**0.359**	**0.579**	**0.277**	0.447	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.447**
1975	**0.020**	**0.039**	**0.173**	**0.275**	**0.267**	**0.413**	**0.585**	0.000	0.585	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.585**
1976	**0.012**	**0.046**	**0.181**	**0.304**	**0.473**	**0.360**	**0.725**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1977	**0.013**	**0.042**	**0.184**	**0.307**	**0.490**	**0.352**	**0.442**	1.234	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.272**
1978	**0.011**	**0.040**	**0.174**	**0.286**	**0.372**	**0.473**	**0.411**	0.456	1.315	0.000	1.400	0.000	0.000	0.000	0.000	0.000	**0.458**
1979	**0.009**	**0.039**	**0.177**	**0.285**	**0.384**	**0.461**	**0.735**	1.234	1.315	0.000	1.400	0.000	0.000	0.000	0.000	0.000	**1.319**
1980	**0.012**	**0.039**	**0.176**	**0.268**	**0.623**	**0.722**	**1.102**	1.591	0.000	1.796	0.000	0.000	0.000	0.000	0.000	0.000	**1.620**
1981	**0.009**	**0.040**	**0.176**	**0.371**	**0.467**	**0.858**	**1.200**	1.234	1.315	1.319	1.400	0.000	0.000	0.000	0.000	0.000	**1.262**
1982	**0.010**	**0.040**	**0.206**	**0.379**	**0.636**	**0.751**	**1.225**	1.233	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.287**
1983	**0.008**	**0.047**	**0.173**	**0.428**	**0.584**	**1.006**	**1.225**	1.234	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.284**
1984	**0.009**	**0.045**	**0.211**	**0.414**	**0.626**	**0.751**	**1.225**	1.234	1.315	1.319	1.400	1.400	0.000	0.000	0.000	0.000	**1.289**
1985	**0.009**	**0.043**	**0.186**	**0.371**	**0.550**	**0.563**	**0.565**	1.234	1.315	1.319	1.400	0.000	0.000	0.000	0.000	0.000	**1.265**
1986	**0.010**	**0.040**	**0.186**	**0.375**	**0.626**	**1.259**	**1.225**	1.234	1.315	1.319	1.400	0.000	0.000	0.000	0.000	0.000	**1.256**
1987	**0.006**	**0.038**	**0.258**	**0.442**	**0.908**	**1.171**	**1.225**	1.234	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.292**
1988	**0.018**	**0.077**	**0.196**	**0.274**	**0.455**	**0.549**	**1.225**	1.234	1.315	1.319	1.400	0.000	0.000	0.000	0.000	0.000	**1.259**
1989	**0.015**	**0.165**	**0.251**	**0.347**	**0.670**	**0.923**	**1.065**	1.492	1.315	0.000	1.400	0.000	0.000	0.000	0.000	0.000	**1.491**
1990	**0.005**	**0.104**	**0.229**	**0.506**	**0.609**	**0.842**	**0.829**	0.796	0.956	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**0.805**
1991	**0.027**	**0.058**	**0.206**	**0.357**	**0.472**	**0.477**	**1.225**	1.234	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.284**
1992	**0.015**	**0.059**	**0.217**	**0.422**	**0.552**	**0.615**	**0.548**	1.234	0.621	0.820	0.000	0.000	0.000	0.000	0.000	0.000	**0.662**
1993	**0.008**	**0.053**	**0.206**	**0.399**	**0.521**	**0.578**	**1.225**	0.582	1.315	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.582**
1994	**0.011**	**0.055**	**0.155**	**0.435**	**0.595**	**0.698**	**0.490**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1995	**0.012**	**0.045**	**0.193**	**0.285**	**0.387**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1996	**0.018**	**0.077**	**0.136**	**0.162**	**0.264**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1997	**0.007**	**0.076**	**0.149**	**0.309**	**0.419**	**0.601**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1998	**0.020**	**0.075**	**0.166**	**0.291**	**0.351**	**0.453**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1999	**0.018**	**0.064**	**0.177**	**0.304**	**0.416**	**0.309**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2000	**0.058**	**0.070**	**0.113**	**0.176**	**0.370**	**0.203**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2001	**0.014**	**0.086**	**0.133**	**0.110**	**0.353**	**0.431**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2002	**0.016**	**0.064**	**0.178**	**0.283**	**0.374**	**0.431**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2003	**0.012**	**0.031**	**0.056**	**0.231**	**0.326**	**0.339**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2004	**0.000**	**0.116**	**0.183**	**0.255**	**0.276**	**0.446**	**0.539**	0.840	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.840**

Table 4.2.5.1a Haddock in Sub-Area IV and Division IIIa. Data available for calibration of the assessment. Data used in the assessment are highlighted in **bold**.

English Groundfish Survey, age 0 – 10+. Survey period: 0.5-0.75. Span: 1977-1991

EngGFS (early)	effort	**0**	**1**	**2**	**3**	**4**	**5**	6	7	8	9	10+
1977	100	**53.48**	**6.68**	**3.21**	**6.16**	**0.93**	**0.07**	0.09	0.01	0.00	0.01	0.00
1978	100	**35.83**	**13.69**	**2.62**	**0.24**	**2.22**	**0.21**	0.00	0.07	0.01	0.00	0.01
1979	100	**87.55**	**29.55**	**5.46**	**0.87**	**0.11**	**0.44**	0.04	0.00	0.02	0.00	0.00
1980	100	**37.40**	**62.33**	**16.73**	**2.57**	**0.27**	**0.04**	0.14	0.02	0.00	0.00	0.00
1981	100	**153.75**	**17.32**	**43.91**	**7.56**	**0.74**	**0.06**	0.00	0.06	0.01	0.00	0.01
1982	100	**28.13**	**31.55**	**7.98**	**11.80**	**1.02**	**0.24**	0.10	0.01	0.01	0.00	0.00
1983	100	**83.19**	**21.82**	**10.95**	**2.14**	**2.17**	**0.27**	0.04	0.01	0.00	0.00	0.00
1984	100	**22.85**	**59.93**	**6.16**	**3.08**	**0.42**	**0.48**	0.10	0.01	0.00	0.01	0.02
1985	100	**24.59**	**18.66**	**23.82**	**2.11**	**0.70**	**0.20**	0.13	0.04	0.01	0.00	0.00
1986	100	**26.60**	**14.97**	**4.47**	**3.38**	**0.28**	**0.17**	0.04	0.04	0.01	0.00	0.00
1987	100	**2.24**	**28.19**	**4.31**	**0.53**	**0.69**	**0.05**	0.03	0.00	0.00	0.00	0.00
1988	100	**6.07**	**2.86**	**18.35**	**1.55**	**0.16**	**0.28**	0.04	0.01	0.00	0.00	0.00
1989	100	**9.43**	**8.17**	**1.45**	**3.97**	**0.25**	**0.03**	0.06	0.01	0.02	0.00	0.00
1990	100	**28.19**	**6.64**	**1.98**	**0.29**	**0.88**	**0.05**	0.03	0.01	0.01	0.00	0.00
1991	100	**26.33**	**11.50**	**0.96**	**0.23**	**0.05**	**0.22**	0.01	0.01	0.00	0.00	0.00

English Groundfish Survey, age 0 – 10+. Survey period: 0.5-0.75. Span: 1992-2004

EngGFS (recent)	effort	**0**	**1**	**2**	**3**	**4**	**5**	6	7	8	9	10+
1992	100	**82.77**	**19.69**	**9.77**	**0.58**	**0.05**	**0.01**	0.08	0.00	0.05	0.00	0.01
1993	100	**13.58**	**24.61**	**5.86**	**1.67**	**0.06**	**0.02**	0.00	0.01	0.00	0.00	0.00
1994	100	**94.30**	**8.07**	**9.02**	**0.84**	**0.28**	**0.02**	0.00	0.00	0.00	0.00	0.00
1995	100	**17.99**	**38.31**	**4.45**	**3.40**	**0.28**	**0.09**	0.01	0.00	0.00	0.00	0.00
1996	100	**20.62**	**8.97**	**14.39**	**1.20**	**0.69**	**0.07**	0.03	0.00	0.00	0.00	0.00
1997	100	**13.03**	**14.86**	**4.33**	**6.61**	**0.23**	**0.22**	0.03	0.01	0.00	0.00	0.00
1998	100	**5.30**	**8.89**	**5.68**	**1.35**	**1.42**	**0.08**	0.05	0.00	0.01	0.00	0.00
1999	100	**210.98**	**5.57**	**2.83**	**1.23**	**0.42**	**0.40**	0.01	0.01	0.00	0.00	0.00
2000	100	**31.02**	**84.11**	**1.52**	**0.55**	**0.25**	**0.11**	0.12	0.00	0.00	0.00	0.00
2001	100	**0.37**	**9.64**	**32.49**	**1.02**	**0.28**	**0.12**	0.05	0.02	0.06	0.00	0.00
2002	100	**0.92**	**1.33**	**7.60**	**20.40**	**0.18**	**0.03**	0.05	0.03	0.01	0.00	0.00
2003	100	**1.08**	**2.02**	**0.42**	**4.71**	**15.18**	**0.24**	0.01	0.07	0.03	0.00	0.00
2004	100	**0.94**	**1.57**	**1.07**	**0.14**	**1.92**	**5.12**	0.06	0.06	0.02	0.03	0.00

Scottish Groundfish Survey. Ages 0-8. Survey period: 0.5-0.75. Span: 1982-1997.

ScoGFS (early)	effort	**0**	**1**	**2**	**3**	**4**	**5**	6	7	8
1982	100	**1235**	**2488**	**996**	**1336**	**115**	**7**	2	1	2
1983	100	**2203**	**1813**	**1611**	**372**	**455**	**53**	12	1	1
1984	100	**873**	**4367**	**788**	**336**	**55**	**65**	9	5	1
1985	100	**818**	**1976**	**2981**	**232**	**103**	**14**	22	4	2
1986	100	**1747**	**2329**	**574**	**598**	**36**	**27**	4	3	+
1987	100	**277**	**2393**	**704**	**106**	**128**	**8**	5	1	2
1988	100	**406**	**467**	**1982**	**170**	**27**	**23**	2	1	+
1989	100	**432**	**886**	**214**	**574**	**31**	**4**	7	1	+
1990	100	**3163**	**1002**	**240**	**32**	**103**	**7**	1	3	1
1991	100	**3471**	**1705**	**178**	**21**	**5**	**16**	2	+	1
1992	100	**8270**	**3832**	**963**	**48**	**8**	**3**	8	+	+
1993	100	**859**	**5836**	**1380**	**269**	**6**	**4**	1	3	+
1994	100	**13762**	**1265**	**2080**	**210**	**53**	**2**	+	+	+
1995	100	**1566**	**8153**	**734**	**926**	**74**	**28**	2	0	0
1996	100	**1980**	**2231**	**4705**	**231**	**206**	**22**	6	+	0
1997	100	**972**	**2779**	**849**	**1397**	**66**	**56**	6	+	+

Table 4.2.5.1a cont. Haddock in Sub-Area IV and Division IIIa. Data available for calibration of the assessment. Data used in the assessment are highlighted in **bold**.

Scottish Groundfish Survey. Ages 0-5+. Survey period: 0.5-0.75. Span: 1998-2005.

ScoGFS (recent)	effort	**0**	**1**	**2**	**3**	**4**	**5**	6	7	8
1998	100	**3280**	**6349**	**1924**	**490**	**511**	**24**	18	2	+
1999	100	**66067**	**1907**	**1141**	**688**	**197**	**164**	6	7	1
2000	100	**11902**	**30611**	**460**	**221**	**130**	**73**	27	4	3
2001	100	**79**	**3790**	**11352**	**179**	**65**	**40**	18	14	1
2002	100	**2149**	**675**	**2632**	**6931**	**70**	**37**	18	3	3
2003	100	**2159**	**1172**	**307**	**2092**	**4344**	**22**	17	8	2
2004	100	**1729**	**1198**	**547**	**101**	**819**	**1420**	9	1	1
2005	100	**19708**	**761**	**657**	**153**	**52**	**278**	620	4	3

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

IBTS Q1	effort	**1**	**2**	**3**	**4**	**5**	6+
1983	10	**302.874**	**402.643**	**89.387**	**116.396**	**13.142**	2.055
1984	10	**1072.285**	**221.275**	**127.77**	**20.408**	**20.865**	4.645
1985	10	**230.968**	**833.257**	**107.583**	**32.337**	**3.58**	6.556
1986	10	**573.023**	**266.912**	**303.546**	**17.888**	**6.483**	2.157
1987	10	**912.559**	**328.062**	**45.201**	**58.263**	**4.35**	2.429
1988	10	**101.691**	**677.641**	**97.126**	**12.638**	**14.034**	2.072
1989	10	**219.705**	**98.091**	**274.81**	**16.63**	**2.113**	4.697
1990	10	**217.448**	**139.114**	**32.975**	**50.39**	**3.163**	1.801
1991	10	**680.231**	**134.076**	**25.023**	**4.26**	**8.476**	2.439
1992	10	**1144.693**	**327.882**	**16.914**	**3.015**	**0.658**	2.205
1993	10	**1242.121**	**519.521**	**152.384**	**8.839**	**1.076**	0.963
1994	10	**227.919**	**491.051**	**97.656**	**23.308**	**1.566**	0.788
1995	10	**1355.485**	**201.069**	**176.165**	**24.343**	**5.286**	0.827
1996	10	**267.411**	**813.268**	**65.869**	**46.682**	**7.744**	3.061
1997	10	**849.943**	**353.882**	**466.731**	**24.987**	**15.243**	3.424
1998	10	**357.597**	**420.926**	**103.531**	**112.624**	**8.751**	5.427
1999	10	**211.139**	**222.907**	**127.054**	**48.208**	**36.661**	4.357
2000	10	**3734.185**	**107.06**	**48.638**	**24.547**	**15.586**	10.057
2001	10	**894.651**	**2255.213**	**47.899**	**10.962**	**7.256**	5.722
2002	10	**58.211**	**492.299**	**1387.875**	**10.001**	**7.462**	4.351
2003	10	**93.989**	**39.001**	**255.617**	**539.987**	**4.905**	3.321
2004	10	**71.88**	**81.973**	**38.47**	**176.099**	**322.191**	1.023
2005	10	**69.973**	**60.987**	**32.624**	**10.999**	**61.287**	95.693

Table 4.2.5.1b Haddock in Sub-Area IV and Division IIIa. Data available for calibration of the assessment. Data used in the assessment are highlighted in **bold**. Scottish Seiners CPUE. Ages 0-13.

ScoSEI	fishing hours	0	1	2	3	4	5	6	7	8	9	10	11	12	13
1978	325246	1665	160843	69033	14340	44152	2366	482	673	86	29	3	16	6	0
1979	316419	543	83631	78815	17215	3040	8073	648	70	113	24	4	1	1	0
1980	297227	210	131314	128306	26205	3393	501	2415	123	20	56	23	13	1	1
1981	289672	345	10367	134260	55726	5181	702	102	579	15	22	1	10	2	0
1982	297730	1445	31143	30969	118898	14297	682	145	39	230	1	9	1	0	0
1983	333168	18101	29021	77289	30414	50115	6394	583	119	15	69	26	1	2	0
1984	388085	422	120868	63391	49286	9426	14977	1594	254	18	8	38	3	2	0
1985	382910	2052	29239	164839	33203	15993	2293	2846	308	47	19	9	28	2	0
1986	425017	8265	33999	72604	155836	12895	4169	490	620	58	11	20	15	11	3
1987	418734	138	43646	97731	19731	28883	1989	1174	199	285	31	16	15	12	7
1988	377132	499	11576	201533	37421	4736	7415	718	290	80	70	27	6	6	7
1989	355735	123	19004	19274	91070	8389	1091	1611	223	89	40	13	6	4	1
1990	300076	712	35844	46489	9055	26705	1434	302	408	67	29	5	3	0	0
1991	336675	2226	66144	30755	9531	1485	5028	308	122	183	42	11	1	1	0
1992	300217	1232	30384	64733	8588	1512	290	1180	79	57	53	18	4	0	1
1993	268413	2913	74523	88375	34997	2349	446	100	314	29	15	14	3	0	1
1994	264738	3231	26626	125357	34127	10522	415	138	42	95	9	7	7	2	1
1995	204545	236	67772	32301	70290	8734	2181	117	39	13	9	4	2	3	1
1996	177092	1333	9192	123829	18532	17077	2161	707	84	12	8	11	3	2	1
1997	166817	3109	30046	19165	59309	3918	4083	495	195	10	7	2	0	0	2
1998	150361	38	12692	36813	12003	26564	1659	856	69	22	4	2	2	0	0
1999	93796	3466	23253	35102	21991	6628	11164	690	456	56	12	0	1	0	0
2000	69505	110	46422	13650	8497	5610	1761	2357	110	41	4	1	0	0	0
2001	36135	60	3973	91165	4469	1720	799	273	263	27	18	1	1	0	0
2002	21817	14	708	10089	45219	1177	400	169	61	45	15	1	1	0	0
2003	15374	29	395	1312	8571	23778	346	80	32	11	4	5	2	0	0
2004	15674	0	3711	6459	868	9719	24783	125	19	4	4	3	1	0	0

Scottish light trawlers, ages 0-13.

ScoLTR	fishing hours	0	1	2	3	4	5	6	7	8	9	10	11	12	13
1978	236929	1692	45733	11471	2914	12279	774	110	167	24	4	0	5	1	0
1979	287494	464	44562	23135	4109	714	3644	203	20	57	20	0	0	1	0
1980	333197	180	92519	46282	8062	755	197	1015	61	18	8	5	0	0	0
1981	251504	436	7979	58146	13653	1518	161	20	320	12	6	7	6	0	0
1982	250870	352	24575	10170	33463	3937	133	67	7	58	0	0	2	0	0
1983	244349	63676	19635	48680	6955	11807	1258	124	27	4	25	7	0	0	2
1984	240725	514	56769	22191	13375	2074	3392	402	98	15	7	14	1	0	0
1985	268136	3548	38850	57422	4913	2787	414	872	128	27	2	0	18	0	0
1986	279767	4371	26322	26549	32339	2797	1014	124	307	43	37	2	2	2	3
1987	351128	97	26220	33648	6464	7197	496	377	72	119	27	2	4	3	4
1988	391988	209	2931	57589	14075	2367	2924	167	84	28	21	6	0	0	0
1989	405883	1077	10415	2919	24895	2754	541	627	109	30	21	7	4	1	1
1990	441084	201	11886	19205	2665	10237	669	168	264	45	14	5	2	1	0
1991	408056	1041	44141	12394	3356	564	2213	226	80	146	38	16	2	1	0
1992	473955	1838	20443	31073	3889	757	144	766	98	52	58	17	3	1	0
1993	447064	231	39863	39176	20213	1527	362	84	274	29	27	26	8	2	1
1994	480400	1482	8267	49047	23557	6304	474	128	42	64	13	7	7	2	2
1995	442010	144	22874	13762	32063	5821	1658	97	15	13	17	3	2	1	1
1996	445995	353	14281	72692	9860	13959	2041	955	304	10	14	7	1	2	1
1997	479449	460	15907	13451	49548	3537	4511	553	163	13	2	2	1	1	1
1998	427868	157	27498	33166	9597	29614	1666	1228	173	46	4	1	1	0	1
1999	329750	2101	24475	36849	24426	5531	11752	841	579	94	9	2	0	0	0
2000	280938	5	64710	15038	11707	7061	1300	2593	174	83	8	2	1	0	0
2001	245489	87	15567	173376	6323	2897	1253	365	444	62	17	9	0	0	0
2002	184096	8	982	11514	53313	1738	664	395	165	218	94	5	4	2	0
2003	98723	71	2804	3186	10931	30249	601	235	123	56	35	15	2	1	0
2004	63953	0	1114	3797	1602	6436	18851	243	68	26	17	11	3	0	0

Table 4.3.4.1 Haddock in Sub-Area IV and Division IIIa. XSA final run : Tuning diagnostics

```
Lowestoft VPA Version 3.1

   6/09/2005  18:29

 Extended Survivors Analysis

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

 CPUE data from file hadivef.txt

 Catch data for  42 years. 1963 to 2004. Ages  0 to   7.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                   ,    year, year,  age ,  age
 ENGFS_early         ,   1977, 2004,   0,     5,   .500,   .750
 ENGGFS              ,   1992, 2004,   0,     5,   .500,   .750
 SCOGFS_early        ,   1982, 2004,   0,     5,   .500,   .750
 SCOGFS              ,   1998, 2004,   0,     5,   .500,   .750
 IBTS_Q1(backshift&5p,   1982, 2004,   0,     4,   .990,  1.000


 Time series weights :

      Tapered time weighting not applied


 Catchability analysis :

      Catchability dependent on stock size for ages <    1

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


      Catchability independent of age for ages >=    3


 Terminal population estimation :

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

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

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

      Prior weighting not applied


 Tuning had not converged after   30 iterations


 Total absolute residual between iterations
 29 and  30 =     .00047

 Final year F values
 Age          ,      0,      1,      2,      3,      4,      5,      6
 Iteration 29,  .0008,  .0563,  .2949,  .4119,  .2357,  .2313,  .2231
 Iteration 30,  .0008,  .0563,  .2949,  .4118,  .2356,  .2312,  .2230
```

Table 4.3.4.1 cont. Haddock in Sub-Area IV and Division IIIa. XSA final run : Tuning diagnostics

Regression weights

	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Fishing mortalities

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	.059	.047	.009	.007	.003	.006	.004	.036	.005	.001
1	.106	.078	.128	.133	.168	.057	.071	.149	.090	.056
2	.516	.462	.457	.638	.858	.813	.350	.170	.421	.295
3	.924	.964	.663	.620	1.033	1.114	1.005	.251	.190	.412
4	1.060	1.024	.819	.946	.797	1.211	.774	.598	.180	.236
5	.994	1.155	.980	.911	1.299	.465	.620	.409	.369	.231
6	1.878	1.769	1.106	.635	1.343	1.242	.208	.316	.201	.223

XSA population numbers (Thousands)

	AGE						
YEAR	0	1	2	3	4	5	6
1995	1.33E+07	6.84E+06	2.60E+05	3.15E+05	4.49E+04	1.34E+04	6.67E+02
1996	2.09E+07	1.62E+06	1.18E+06	1.04E+05	9.75E+04	1.21E+04	4.07E+03
1997	1.20E+07	2.56E+06	2.87E+05	4.99E+05	3.09E+04	2.73E+04	3.12E+03
1998	9.38E+06	1.53E+06	4.33E+05	1.22E+05	2.00E+05	1.06E+04	8.38E+03
1999	1.12E+08	1.20E+06	2.57E+05	1.53E+05	5.10E+04	6.06E+04	3.50E+03
2000	2.26E+07	1.44E+07	1.94E+05	7.31E+04	4.25E+04	1.79E+04	1.35E+04
2001	2.37E+06	2.90E+06	2.62E+06	5.78E+04	1.87E+04	9.86E+03	9.20E+03
2002	3.97E+06	3.03E+05	5.18E+05	1.24E+06	1.65E+04	6.71E+03	4.34E+03
2003	3.22E+06	4.92E+05	5.02E+04	2.93E+05	7.50E+05	7.06E+03	3.65E+03
2004	3.28E+06	4.12E+05	8.64E+04	2.21E+04	1.89E+05	4.88E+05	4.00E+03

Estimated population abundance at 1st Jan 2005

	0.00E+00	4.22E+05	7.48E+04	4.31E+04	1.14E+04	1.16E+05	3.17E+05

Taper weighted geometric mean of the VPA populations:

	2.12E+07	2.94E+06	4.70E+05	1.57E+05	4.81E+04	1.36E+04	3.82E+03

Standard error of the weighted Log(VPA populations) :

	1.1445	1.1575	1.1630	1.2063	1.2202	1.2451	1.1023

Table 4.3.4.1 cont. Haddock in Sub-Area IV and Division IIIa. XSA final run : Tuning diagnostics

Log catchability residuals.

Fleet : ENGFS_early

Age	1977	1978	1979	1980	1981	1982	1983	1984
0	.45	-.31	-.14	.67	1.16	.15	-.11	.14
1	-.51	-.23	.00	.17	.43	.30	.36	.16
2	.22	-.30	-.08	.32	.56	.38	.10	-.04
3	-.25	-.83	.13	.65	.83	.38	.29	.16
4	.26	.10	-.23	.34	.59	-.01	-.03	-.06
5	-.13	.02	-.14	.08	-.06	.28	-.06	-.09

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	-.13	-.80	-.44	-.30	.06	-.18	-.21	99.99	99.99	99.99
1	.39	-.21	-.33	-.12	.20	.03	-.63	99.99	99.99	99.99
2	.05	.07	-.46	.17	.05	-.09	-.94	99.99	99.99	99.99
3	.21	-.42	-.53	.15	.02	-.10	-.71	99.99	99.99	99.99
4	.00	-.30	-.56	-.23	-.11	-.09	-.54	99.99	99.99	99.99
5	.31	-.02	-.53	.07	-.47	-.20	-.14	99.99	99.99	99.99

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99

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

Age	1	2	3	4	5
Mean Log q	-15.5064	-15.0169	-15.1654	-15.1654	-15.1654
S.E(Log q)	.3304	.3643	.4753	.3121	.2398

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.86	.844	16.96	.73	15	.50	-16.96

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.02	-.188	15.52	.84	15	.35	-15.51
2	.84	1.652	14.69	.89	15	.29	-15.02
3	.86	1.296	14.71	.87	15	.40	-15.17
4	.96	.533	15.02	.92	15	.30	-15.22
5	.96	.573	15.01	.94	15	.22	-15.24

Table 4.3.4.1 cont. Haddock in Sub-Area IV and Division IIIa. XSA final run : Tuning diagnostics

Fleet : ENGGFS

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.11	.21	-.08
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.17	.01	.07
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.43	-.01	-.10
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.33	-.01	-.58
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.63	-.51	-.47
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.62	-.19	-.16

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	.34	-.04	.23	-.06	-.35	.11	-.26	-.23	.06	-.04
1	.13	.11	.18	.19	-.02	.14	-.41	-.09	-.19	-.29
2	.32	-.05	.16	.14	.10	-.27	-.10	-.04	-.45	-.14
3	.11	.20	.15	-.05	-.12	-.13	.65	.11	.05	-.71
4	-.36	-.25	-.34	-.30	-.23	-.33	.34	-.07	.28	-.38
5	-.35	-.40	-.20	-.25	-.17	-.74	-.01	-1.03	.89	-.38

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	-15.7398	-15.3365	-15.4203	-15.4203	-15.4203
S.E(Log q)	.1919	.2353	.3539	.3843	.5334

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	.60	7.765	16.99	.97	13	.21	-17.41

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	.92	1.805	15.64	.98	13	.16	-15.74
2	.93	1.128	15.17	.96	13	.22	-15.34
3	.94	.666	15.20	.91	13	.34	-15.42
4	.93	1.184	15.32	.96	13	.26	-15.67
5	1.01	-.111	15.76	.91	13	.47	-15.70

Table 4.3.4.1 cont. Haddock in Sub-Area IV and Division IIIa. XSA final run : Tuning diagnostics

Fleet : SCOGFS_early

Age	1977	1978	1979	1980	1981	1982	1983	1984
0	99.99	99.99	99.99	99.99	99.99	-.18	-.86	-.32
1	99.99	99.99	99.99	99.99	99.99	-.23	-.12	-.45
2	99.99	99.99	99.99	99.99	99.99	.27	.16	-.13
3	99.99	99.99	99.99	99.99	99.99	.23	.57	-.02
4	99.99	99.99	99.99	99.99	99.99	-.17	.44	-.07
5	99.99	99.99	99.99	99.99	99.99	-1.23	.34	-.06

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	-.71	-.78	.09	-.28	-.25	.31	.42	.79	-.02	.96
1	.16	-.06	-.78	.08	-.01	.15	-.53	.31	.35	-.01
2	-.05	-.01	-.30	-.08	.11	-.23	-.66	-.23	.20	.09
3	.04	-.12	-.10	-.03	.12	-.27	-1.07	-.38	-.05	-.19
4	.12	-.32	-.21	.02	-.16	-.21	-.81	-.68	-1.04	-.35
5	-.32	.11	-.34	-.40	-.45	-.13	-.73	-.05	-.03	-.69

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	.47	.22	.13	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	.36	.49	.28	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	.18	.49	.19	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	.58	.33	.37	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	.09	.32	.20	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	.25	.21	.23	99.99	99.99	99.99	99.99	99.99	99.99	99.99

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

Age	1	2	3	4	5
Mean Log q	-10.6108	-10.0821	-10.2887	-10.2887	-10.2887
S.E(Log q)	.3552	.2718	.4008	.4415	.4767

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.88	.655	13.32	.67	16	.55	-12.83

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.19	-1.315	9.83	.78	16	.41	-10.61
2	.92	.954	10.32	.91	16	.25	-10.08
3	.79	2.765	10.64	.93	16	.26	-10.29
4	.76	4.021	10.50	.95	16	.22	-10.47
5	.91	.790	10.39	.86	16	.40	-10.49

Table 4.3.4.1 cont. Haddock in Sub-Area IV and Division IIIa. XSA final run : Tuning diagnostics

Fleet : SCOGFS

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	99.99	99.99	99.99	-.04	-.20	.08	-1.56	.51	.70	.51
1	99.99	99.99	99.99	.64	-.30	-.08	-.56	.02	.05	.23
2	99.99	99.99	99.99	.06	.19	-.46	-.14	-.10	.25	.20
3	99.99	99.99	99.99	-.11	.25	-.09	-.13	-.01	.20	-.11
4	99.99	99.99	99.99	-.36	-.04	-.02	-.16	-.07	-.02	-.27
5	99.99	99.99	99.99	-.54	-.12	-.22	-.13	.04	-.55	-.71

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

Age	1	2	3	4	5
Mean Log q	-9.6187	-9.4358	-9.4693	-9.4693	-9.4693
S.E(Log q)	.3806	.2535	.1600	.1996	.4427

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	.78	.918	12.31	.77	7	.83	-11.28

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	-.660	9.23	.92	7	.43	-9.62
2	1.09	-1.089	9.15	.96	7	.27	-9.44
3	.95	1.102	9.59	.99	7	.15	-9.47
4	1.02	-.501	9.57	.99	7	.15	-9.60
5	1.09	-1.122	9.77	.97	7	.30	-9.79

Table 4.3.4.1 cont. Haddock in Sub-Area IV and Division IIIa. XSA final run : Tuning diagnostics

Fleet : IBTS_Q1(backshift&5p

Age	1977	1978	1979	1980	1981	1982	1983	1984
0	99.99	99.99	99.99	99.99	99.99	-.46	-.43	-.57
1	99.99	99.99	99.99	99.99	99.99	-.18	-.36	-.25
2	99.99	99.99	99.99	99.99	99.99	-.10	-.24	.02
3	99.99	99.99	99.99	99.99	99.99	-.06	-.11	-.14
4	99.99	99.99	99.99	99.99	99.99	-.17	-.36	-.56
5	No data for this fleet at this age							

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	-.02	-.31	.04	.08	.05	-.03	.51	.20	-.27	.00
1	.04	-.17	-.20	.38	-.01	.02	-.31	.17	-.25	.02
2	-.22	-.28	-.05	.13	.38	-.18	-.82	.09	-.26	-.28
3	-.31	-.13	.03	.00	-.09	.02	-.77	.23	-.25	-.09
4	-.38	-.04	-.14	-.18	-.11	-.40	-.62	-.42	-.10	-.41
5	No data for this fleet at this age									

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	-.13	.53	.20	-.06	.23	.46	.06	.04	-.04	-.09
1	-.10	.49	.25	.13	-.32	.13	.23	.02	.22	.07
2	-.16	.24	.14	.11	-.11	.11	.42	.17	.86	.02
3	-.21	.31	-.05	.47	-.02	-.01	.03	.20	.46	.49
4	.08	-.06	.33	.02	.39	.22	.63	.16	.11	-.11
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	-7.1924	-7.2147	-7.4390	-7.4390
S.E(Log q)	.2313	.3230	.2808	.3264

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	.97	.516	8.82	.93	23	.29	-8.58

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.09	-1.804	6.51	.95	23	.24	-7.19
2	1.05	-.652	6.93	.89	23	.34	-7.21
3	1.02	-.256	7.37	.93	23	.29	-7.44
4	.98	.305	7.59	.93	23	.31	-7.53

Table 4.3.4.1 cont. Haddock in Sub-Area IV and Division IIIa. XSA final run : Tuning diagnostics

```
Terminal year survivor and F summaries :

 Age  0   Catchability dependent on age and year class strength

 Year class = 2004

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 ENGFS_early         ,          1.,  .000,       .000,    .00,   0,  .000,     .000
 ENGGFS              ,     404200.,  .300,       .000,    .00,   1,  .474,     .000
 SCOGFS_early        ,          1.,  .000,       .000,    .00,   0,  .000,     .000
 SCOGFS              ,     702217.,  .896,       .000,    .00,   1,  .053,     .000
 IBTS_Q1(backshift&5p,     386398.,  .315,       .000,    .00,   1,  .430,     .000

   P shrinkage mean  ,    2940361.,   1.16,,,,                        .032,     .000

   F shrinkage mean  ,      25133.,   2.00,,,,                        .011,     .013

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    422184.,       .21,      .24,    5,   1.146,   .001

 Age  1   Catchability constant w.r.t. time and dependent on age

 Year class = 2003

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 ENGFS_early         ,          1.,  .000,       .000,    .00,   0,  .000,     .000
 ENGGFS              ,      66798.,  .212,       .175,    .82,   2,  .435,     .063
 SCOGFS_early        ,          1.,  .000,       .000,    .00,   0,  .000,     .000
 SCOGFS              ,     102251.,  .370,       .177,    .48,   2,  .143,     .041
 IBTS_Q1(backshift&5p,      76276.,  .217,       .055,    .25,   2,  .416,     .055

   F shrinkage mean  ,      33767.,   2.00,,,,                        .005,     .121

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     74762.,       .14,      .08,    7,    .598,   .056


 Age  2   Catchability constant w.r.t. time and dependent on age

 Year class = 2002

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 ENGFS_early         ,          1.,  .000,       .000,    .00,   0,  .000,     .000
 ENGGFS              ,      35887.,  .173,       .027,    .16,   3,  .400,     .345
 SCOGFS_early        ,          1.,  .000,       .000,    .00,   0,  .000,     .000
 SCOGFS              ,      51327.,  .233,       .077,    .33,   3,  .228,     .253
 IBTS_Q1(backshift&5p,      47708.,  .181,       .065,    .36,   3,  .367,     .270

   F shrinkage mean  ,      21055.,   2.00,,,,                        .004,     .532

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     43137.,       .11,      .06,   10,    .548,   .295


Age  3   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
 ENGFS_early         ,          1.,  .000,       .000,    .00,   0,  .000,     .000
 ENGGFS              ,       7674.,  .161,       .134,    .83,   4,  .345,     .563
 SCOGFS_early        ,          1.,  .000,       .000,    .00,   0,  .000,     .000
 SCOGFS              ,      11326.,  .191,       .162,    .85,   4,  .283,     .414
 IBTS_Q1(backshift&5p,      16733.,  .161,       .182,   1.13,   4,  .367,     .298

   F shrinkage mean  ,       5422.,   2.00,,,,                        .005,     .728

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     11388.,       .10,      .13,   13,   1.279,   .412
```

Table 4.3.4.1 cont. Haddock in Sub-Area IV and Division IIIa. XSA final run : Tuning diagnostics

```
Age  4   Catchability constant w.r.t. time and age (fixed at the value for age)  3

Year class = 2000

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
ENGFS_early         ,         1.,   .000,       .000,    .00,   0,  .000,     .000
ENGGFS              ,    101712.,   .148,       .109,    .74,   5,  .325,     .265
SCOGFS_early        ,         1.,   .000,       .000,    .00,   0,  .000,     .000
SCOGFS              ,    102432.,   .159,       .122,    .77,   5,  .308,     .263
IBTS_Q1(backshift&5p,    146819.,   .142,       .111,    .78,   5,  .364,     .191

  F shrinkage mean  ,     29190.,   2.00,,,,                        .003,     .721

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   116091.,       .09,      .08,   16,    .890,   .236


Age  5   Catchability constant w.r.t. time and age (fixed at the value for age)  3

Year class = 1999

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
ENGFS_early         ,         1.,   .000,       .000,    .00,   0,  .000,     .000
ENGGFS              ,    308624.,   .148,       .108,    .73,   6,  .329,     .237
SCOGFS_early        ,         1.,   .000,       .000,    .00,   0,  .000,     .000
SCOGFS              ,    272319.,   .156,       .108,    .69,   6,  .341,     .264
IBTS_Q1(backshift&5p,    387965.,   .147,       .051,    .34,   5,  .326,     .193

  F shrinkage mean  ,     92353.,   2.00,,,,                        .004,     .638

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   317210.,       .09,      .06,   18,    .736,   .231

Age  6   Catchability constant w.r.t. time and age (fixed at the value for age)  3

Year class = 1998

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
ENGFS_early         ,         1.,   .000,       .000,    .00,   0,  .000,     .000
ENGGFS              ,      3554.,   .219,       .205,    .94,   6,  .308,     .169
SCOGFS_early        ,         1.,   .000,       .000,    .00,   0,  .000,     .000
SCOGFS              ,      2011.,   .202,       .098,    .48,   6,  .406,     .282
IBTS_Q1(backshift&5p,      2796.,   .190,       .070,    .37,   5,  .273,     .210

  F shrinkage mean  ,      1910.,   2.00,,,,                        .013,     .295

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     2620.,       .12,      .09,   18,    .774,   .223
```

Table 4.3.4.2 Haddock in Sub-Area IV and Division IIIa. *F* at age

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

At 6/09/2005 18:31

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1963	1964
AGE		
0	.0016	.0434
1	.1219	.0564
2	.7914	.4438
3	.6391	1.1202
4	.7267	.6872
5	.7653	.7973
6	.7172	.8775
+gp	.7172	.8775
FBAR 2- 4	.7190	.7504

Table 8 Fishing mortality (F) at age

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
0	.0716	.0701	.0022	.0018	.0168	.0299	.0120	.0322	.0023	.0130
1	1.3531	1.3051	.2633	.0515	.0215	.5027	.4747	.1694	.3744	.3520
2	.4010	.8142	1.0863	.5803	.6543	1.0391	.6645	.7944	.5661	.9376
3	.4901	.3409	.3999	.9110	1.3932	1.1454	.7989	1.3723	1.1631	.9541
4	.8640	.7247	.3440	.2914	1.3465	1.3308	.8615	1.2063	.8593	1.0151
5	1.0111	.8713	.8545	.4505	.7436	.8037	.9935	1.1248	.9619	.7263
6	.7964	.6515	.5371	.5555	1.1752	1.1063	.8942	1.2498	1.0061	.9083
+gp	.7964	.6515	.5371	.5555	1.1752	1.1063	.8942	1.2498	1.0061	.9083
FBAR 2- 4	.5850	.6266	.6101	.5942	1.1313	1.1717	.7750	1.1243	.8628	.9690

Table 8 Fishing mortality (F) at age

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
0	.0113	.0298	.0130	.0217	.0347	.0731	.0571	.0387	.0271	.0157
1	.3360	.3086	.3374	.3857	.1754	.1897	.1771	.1738	.1528	.1257
2	.9629	.8186	1.0111	1.0071	.8615	.7064	.4509	.4245	.6616	.6777
3	1.2709	1.3424	1.0510	1.1480	1.1263	1.1305	.9425	.8187	.9896	1.0019
4	1.1130	.8106	1.1705	1.1682	1.1197	1.1360	.8242	.8727	1.1731	1.0447
5	1.0262	1.3268	1.1356	.9250	1.1521	1.0891	.7218	.4442	1.1842	1.2635
6	1.1504	1.1740	1.1324	1.4084	.6491	1.4321	.8679	.6034	.4192	1.0130
+gp	1.1504	1.1740	1.1324	1.4084	.6491	1.4321	.8679	.6034	.4192	1.0130
FBAR 2- 4	1.1156	.9905	1.0775	1.1077	1.0359	.9910	.7392	.7053	.9414	.9081

Table 8 Fishing mortality (F) at age

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
0	.0164	.0032	.0090	.0055	.0039	.0057	.0127	.0187	.0315	.0045
1	.2084	.1287	.1193	.1383	.1064	.1986	.1568	.1480	.1735	.1545
2	.6190	1.0376	.9104	.8025	.6666	1.1278	.8029	.7432	.8130	.5713
3	.9880	1.2681	1.1058	1.3400	1.0066	1.2136	1.0525	1.2312	1.0593	1.0907
4	1.1202	1.4323	1.1636	1.3284	1.3044	1.2224	.9762	1.1280	1.1430	1.0810
5	.8085	1.1068	1.1605	1.4055	1.1458	1.2923	1.0490	1.0968	1.1337	1.2826
6	1.1977	.4376	1.3249	2.3089	1.7205	2.2114	1.6414	2.1129	2.0962	2.0286
+gp	1.1977	.4376	1.3249	2.3089	1.7205	2.2114	1.6414	2.1129	2.0962	2.0286
FBAR 2- 4	.9091	1.2460	1.0600	1.1569	.9926	1.1879	.9439	1.0342	1.0051	.9143

Table 8 Fishing mortality (F) at age

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	FBAR 02-04
AGE											
0	.0590	.0475	.0094	.0071	.0027	.0064	.0041	.0363	.0053	.0008	.0141
1	.1061	.0784	.1277	.1331	.1684	.0571	.0708	.1490	.0902	.0563	.0985
2	.5159	.4622	.4573	.6381	.8577	.8132	.3497	.1701	.4213	.2949	.2954
3	.9239	.9642	.6627	.6200	1.0333	1.1142	1.0049	.2507	.1901	.4118	.2842
4	1.0598	1.0244	.8195	.9456	.7975	1.2115	.7739	.5980	.1800	.2356	.3379
5	.9936	1.1546	.9799	.9107	1.2990	.4654	.6198	.4088	.3687	.2312	.3362
6	1.8782	1.7686	1.1062	.6349	1.3428	1.2422	.2077	.3163	.2011	.2230	.2468
+gp	1.8782	1.7686	1.1062	.6349	1.3428	1.2422	.2077	.3163	.2011	.2230	
FBAR 2-4	.8332	.8169	.6465	.7346	.8961	1.0463	.7095	.3396	.2638	.3141	

Table 4.3.4.3. 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 6/09/2005 18:31

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1963,	1964,
AGE		
0,	24064,	92014,
1,	259948,	3093,
2,	7485,	44195,
3,	503,	2274,
4,	286,	207,
5,	119,	108,
6,	11,	45,
+gp,	28,	15,
TOTAL,	292445,	141950,

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
0,	263163,	688326,	3885138,	170966,	121527,	877106,	781863,	215009,	730920,	1331878,
1,	11342,	31537,	82615,	499055,	21969,	15384,	109592,	99457,	26803,	93878,
2,	561,	563,	1642,	12193,	91028,	4129,	1787,	13093,	16124,	3540,
3,	19007,	252,	167,	371,	4575,	31719,	979,	616,	3966,	6136,
4,	578,	9068,	140,	87,	116,	885,	7858,	343,	122,	965,
5,	81,	190,	3422,	77,	51,	24,	182,	2586,	80,	40,
6,	40,	24,	65,	1192,	40,	20,	9,	55,	687,	25,
+gp,	14,	20,	14,	10,	303,	102,	39,	10,	27,	205,
TOTAL,	294786,	729980,	3973202,	683951,	239610,	929368,	902310,	331169,	778729,	1436666,

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
0,	115136,	165133,	260093,	395804,	720671,	157962,	324386,	204531,	666322,	171185,
1,	169253,	14656,	20634,	33050,	49859,	89612,	18902,	39441,	25330,	83483,
2,	12679,	23228,	2067,	2828,	4316,	8035,	14236,	3041,	6366,	4176,
3,	929,	3245,	6867,	504,	692,	1222,	2658,	6079,	1333,	2202,
4,	1841,	203,	660,	1870,	125,	175,	307,	806,	2088,	386,
5,	272,	471,	70,	159,	453,	32,	44,	105,	262,	503,
6,	16,	80,	102,	18,	52,	117,	9,	17,	55,	66,
+gp,	58,	17,	27,	38,	22,	14,	52,	27,	20,	15,
TOTAL,	300185,	207033,	290521,	434272,	776189,	257169,	360594,	254048,	701777,	262015,

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
0,	239384,	496579,	41598,	84168,	85764,	280724,	273931,	408237,	126851,	533690,
1,	21695,	30316,	63724,	5307,	10776,	10998,	35932,	34820,	51583,	15824,
2,	14139,	3383,	5119,	10862,	888,	1861,	1732,	5899,	5767,	8329,
3,	1421,	5103,	803,	1381,	3264,	305,	404,	520,	1881,	1715,
4,	630,	412,	1118,	207,	282,	929,	71,	110,	118,	508,
5,	106,	160,	77,	272,	43,	59,	213,	21,	28,	29,
6,	116,	39,	43,	20,	55,	11,	13,	61,	6,	7,
+gp,	21,	71,	24,	12,	11,	21,	16,	15,	19,	11,
TOTAL,	277511,	536063,	112507,	102229,	101081,	294908,	312312,	449682,	186253,	560113,

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,
AGE											
0,	133167,	208834,	119948,	93767,	1124661,	226348,	23652,	39667,	32158,	32818,	0,
1,	68396,	16161,	25637,	15298,	11985,	144395,	28952,	3032,	4924,	4118,	4222,
2,	2604,	11813,	2870,	4334,	2572,	1945,	26193,	5180,	502,	864,	748,
3,	3153,	1042,	4988,	1218,	1535,	731,	578,	12376,	2929,	221,	431,
4,	449,	975,	309,	2002,	510,	425,	187,	165,	7501,	1886,	114,
5,	134,	121,	273,	106,	606,	179,	99,	67,	71,	4879,	1161,
6,	7,	41,	31,	84,	35,	135,	92,	43,	37,	40,	3172,
+gp,	3,	11,	13,	15,	29,	13,	93,	53,	31,	16,	36,
TOTAL,	207913,	238998,	154069,	116823,	1141933,	374171,	79845,	60583,	48152,	44842,	9884,

AGE,	GMST 63-02	AMST 63-02
0,	232374,	422604,
1,	32296,	59843,
2,	5190,	9820,
3,	1624,	3468,
4,	434,	963,
5,	127,	298,
6,	38,	90,

Table 4.3.4.4. Haddock in Sub-Area IV and Division IIIa. Stock summary table

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Run title : #Haddock in the North Sea and Skagerrak, ages 0-7+

At  6/09/2005  18:31

    Table 16    Summary     (without SOP correction)

               Terminal Fs derived using XSA (With F shrinkage)
```

	Recruitment Age 0	Total Biomass	SSB	Total Catch	HC	Disc	IBC	Yield/SSB	F (2-4)	F HC (2-4)	F Disc (2-4)	F IBC (2-4)
1963	2.406	3473	140	272	69	189	14	1.94	0.72	0.49	0.2	0.03
1964	9.201	1314	430	380	131	160	89	0.88	0.75	0.47	0.12	0.16
1965	26.316	1101	544	299	162	62	75	0.55	0.59	0.34	0.1	0.14
1966	68.833	1497	458	347	226	74	47	0.76	0.63	0.36	0.17	0.1
1967	388.514	5514	254	247	148	78	21	0.97	0.61	0.35	0.23	0.03
1968	17.097	6901	288	302	106	162	34	1.05	0.59	0.38	0.15	0.07
1969	12.153	2476	813	931	331	260	339	1.15	1.13	0.69	0.15	0.29
1970	87.711	2545	899	807	525	101	180	0.90	1.17	0.7	0.2	0.27
1971	78.186	2532	419	447	237	177	32	1.07	0.78	0.54	0.18	0.06
1972	21.501	2192	301	354	195	128	30	1.17	1.12	0.84	0.24	0.04
1973	73.092	4116	296	308	182	115	11	1.04	0.86	0.65	0.21	0
1974	133.188	4767	259	369	153	167	49	1.43	0.97	0.6	0.23	0.13
1975	11.514	2388	237	455	151	260	43	1.92	1.12	0.68	0.34	0.1
1976	16.513	1096	306	377	173	154	50	1.23	0.99	0.62	0.25	0.11
1977	26.009	1060	237	226	145	44	37	0.96	1.08	0.68	0.21	0.18
1978	39.580	1103	131	180	92	77	12	1.38	1.11	0.79	0.28	0.04
1979	72.067	1324	110	146	87	42	17	1.33	1.04	0.85	0.14	0.04
1980	15.796	1438	152	224	105	95	24	1.47	0.99	0.75	0.13	0.11
1981	32.439	967	243	217	139	60	18	0.89	0.74	0.57	0.14	0.03
1982	20.453	1070	304	238	177	41	21	0.78	0.71	0.54	0.11	0.05
1983	66.632	2226	257	254	167	66	20	0.99	0.94	0.69	0.21	0.04
1984	17.118	1657	199	223	135	75	13	1.12	0.91	0.72	0.15	0.03
1985	23.938	1164	239	258	166	85	7	1.08	0.91	0.76	0.13	0.02
1986	49.658	1955	223	226	169	52	4	1.01	1.25	0.94	0.3	0.01
1987	4.160	1090	151	177	112	59	6	1.17	1.06	0.81	0.24	0.01
1988	8.417	620	152	176	108	62	5	1.16	1.16	0.86	0.25	0.05
1989	8.576	619	122	109	80	26	3	0.89	0.99	0.74	0.22	0.03
1990	28.072	1568	75	93	56	33	5	1.23	1.19	0.78	0.36	0.04
1991	27.393	1527	59	97	49	40	8	1.66	0.94	0.81	0.11	0.03
1992	40.824	1331	96	138	75	48	15	1.43	1.03	0.85	0.17	0.02
1993	12.685	979	130	174	82	80	13	1.34	1.01	0.74	0.24	0.03
1994	53.369	1407	151	154	83	65	6	1.02	0.91	0.63	0.27	0.01
1995	13.317	1101	147	145	78	57	10	0.98	0.83	0.58	0.24	0.01
1996	20.883	994	178	160	79	73	8	0.90	0.82	0.53	0.26	0.02
1997	11.995	890	192	142	82	52	7	0.74	0.65	0.42	0.2	0.03
1998	9.377	710	162	132	81	45	5	0.81	0.73	0.47	0.22	0.04
1999	112.466	2965	116	112	66	43	4	0.97	0.9	0.52	0.35	0.03
2000	22.635	2923	91	105	48	49	9	1.15	1.05	0.7	0.26	0.09
2001	2.365	982	228	167	41	118	8	0.73	0.71	0.39	0.2	0.11
2002	3.967	649	351	108	58	46	4	0.31	0.34	0.22	0.1	0.02
2003	3.216	562	344	69	44	23	1	0.20	0.26	0.07	0.17	0.02
2004	3.282	575	289	66	49	17	1	0.23	0.31	0.15	0.16	0
mean	40.403	1842	256	248	130	87	31	1.05	0.87	0.6	0.2	0.06
units	1000 million	1000 tonnes	1000 tonnes	1000 tonnes	1000 tonnes	1000 tonnes	1000 tonnes					

Table 4.5.1. Haddock in Sub-Area IV and Division IIIa. Input to RCT3.

```
had3a&4 (age 0)
     10       30        2
   1976   165133      -11     6.68      -11      -11      -11      -11      -11      -11      -11      -11
   1977   260093    53.48    13.69      -11      -11      -11      -11      -11      -11      -11      -11
   1978   395804    35.83    29.55      -11      -11      -11      -11      -11      -11      -11      -11
   1979   720671    87.55    62.33      -11      -11      -11      -11      -11      -11      -11      -11
   1980   157962     37.4    17.32      -11      -11      -11      -11      -11      -11      -11      -11
   1981   324386   153.75    31.55      -11      -11      -11     2488      -11      -11      -11  402.643
   1982   204531    28.13    21.82      -11      -11     1235     1813      -11      -11  302.874  221.275
   1983   666322    83.19    59.93      -11      -11     2203     4367      -11      -11 1072.285  833.257
   1984   171185    22.85    18.66      -11      -11      873     1976      -11      -11  230.968  266.912
   1985   239384    24.59    14.97      -11      -11      818     2329      -11      -11  573.023  328.062
   1986   496579     26.6    28.19      -11      -11     1747     2393      -11      -11  912.559  677.641
   1987    41598     2.24     2.86      -11      -11      277      467      -11      -11  101.691   98.091
   1988    84168     6.07     8.17      -11      -11      406      886      -11      -11  219.705  139.114
   1989    85764     9.43     6.65      -11      -11      432     1002      -11      -11  217.448  134.076
   1990   280724    28.19     11.5      -11      -11     3163     1705      -11      -11  680.231  327.882
   1991   273931    26.33      -11      -11    19.69     3471     3832      -11      -11 1144.693  519.521
   1992   408237      -11      -11    82.77    24.61     8270     5836      -11      -11 1242.121  491.051
   1993   126851      -11      -11    13.58     8.07      859     1265      -11      -11  227.919  201.069
   1994   533690      -11      -11     94.3    38.31    13762     8153      -11      -11 1355.485  813.268
   1995   133167      -11      -11    17.99     8.97     1566     2231      -11      -11  267.411  353.882
   1996   208834      -11      -11    20.62   14.863     1980     2779      -11      -11  849.943  420.926
   1997   119948      -11      -11   13.032    8.891      972      -11      -11     6349  357.597  222.907
   1998    93767      -11      -11    5.302    5.572      -11      -11     3280     1907  211.139   107.06
   1999  1124661      -11      -11  210.984   84.112      -11      -11    66067    30611 3734.185 2255.213
   2000   226348      -11      -11   31.023    9.635      -11      -11    11902     3790  894.651  492.299
   2001    23652      -11      -11    0.372    1.329      -11      -11       79      675   58.211   39.001
   2002      -11      -11      -11    0.919    2.021      -11      -11     2149     1172   93.989   81.973
   2003      -11      -11      -11    1.078    1.565      -11      -11     2159     1198    71.88   60.987
   2004      -11      -11      -11    0.936      -11      -11      -11     1729      761   69.973      -11
   2005      -11      -11      -11      -11      -11      -11      -11    19708      -11      -11      -11
enggfs_77-91_age0
enggfs_77-91_age1
enggfs_92-04_age0
enggfs_92-04_age1
scogfs_82-97_age0
scogfs_82-97_age1
scogfs_98-05_age0
scogfs_98-05_age1
ibtsq1_82-04_age0
ibtsq1_82-04_age1
```

Table 4.5.2. Haddock in Sub-Area IV and Division IIIa. RCT3 output.

```
Analysis by RCT3 ver3.1 of data from file: hadrec0.txt

had3a&4 (age 0)

Data for   10 surveys over   30 years :  1976 - 2005

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as    .00
Minimum of   3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass =   2003

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

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

enggfs
enggfs
enggfs     .74   9.81    .16   .981     10    .73   10.36     .211     .371
enggfs    1.08   9.33    .19   .970     11    .94   10.34     .246     .272
scogfs
scogfs
scogfs     .59   7.12    .50   .940      4   7.68   11.62     .793     .026
scogfs    1.04   3.29    .52   .907      5   7.09   10.66     .789     .026
ibtsq1     .98   6.12    .32   .898     20   4.29   10.33     .378     .115
ibtsq1    1.08   5.98    .27   .924     21   4.13   10.44     .313     .168

                                       VPA Mean =   12.25     .876     .021

Yearclass =   2004

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

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

enggfs
enggfs
enggfs     .74   9.81    .16   .981     10    .66   10.30     .212     .664
enggfs
scogfs
scogfs
scogfs     .59   7.12    .50   .940      4   7.46   11.49     .797     .047
scogfs    1.04   3.29    .52   .907      5   6.64   10.19     .833     .043
ibtsq1     .98   6.12    .32   .898     20   4.26   10.31     .379     .208
ibtsq1

                                       VPA Mean =   12.25     .876     .039

Yearclass =   2005

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

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

enggfs
enggfs
enggfs
enggfs
scogfs
scogfs
scogfs     .59   7.12    .50   .940      4   9.89   12.91     .823     .531
scogfs
ibtsq1
ibtsq1

                                       VPA Mean =   12.25     .876     .469


Year     Weighted      Log     Int     Ext      Var     VPA      Log
Class     Average      WAP     Std     Std     Ratio             VPA
         Prediction           Error   Error

2003       34396     10.45     .13     .14     1.16
2004       33896     10.43     .17     .22     1.65
2005      296718     12.60     .60     .33      .30
```

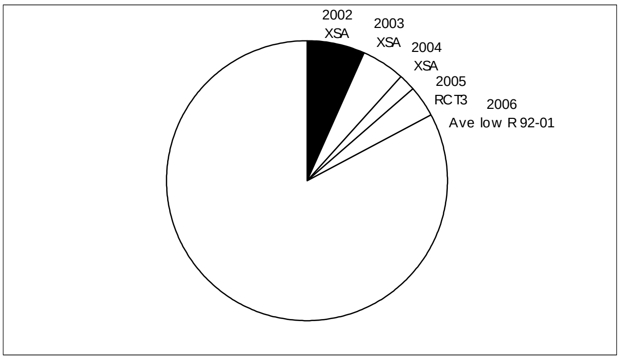
Table 4.6.4 Haddock in IV and IIIa
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class			2002	2003	2004	2005	2006
Stock No. (thousands) of 0 year-olds			3967	3216	3282	29672	9948
Source			XSA	XSA	XSA	RCT3	Ave low R 92-01
Status Quo F:							
% in	2005	landings	4.7	1.6	0.4	0.0	-
% in	2006		6.7	5.0	1.9	3.6	0.0
% in	2005	SSB	4.1	2.1	0.2	0.0	-
% in	2006	SSB	4.5	4.0	2.4	1.9	0.0
% in	2007	SSB	3.5	3.8	3.9	21.1	0.6

GM : geometric mean recruitment

Haddock in IV and IIIa : Year-class % contribution to

a) 2006 HC landings



b) 2007 SSB

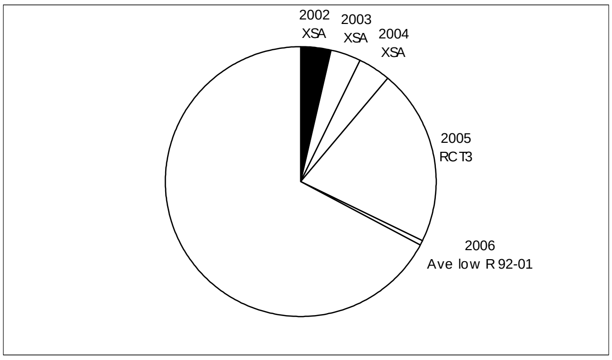


Table 4.6.1. Haddock in Sub-Area IV and Division IIIa. Short term forecast input.

MFDP version 1a
Run: had
Time and date: 17:58 15/09/2005
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2005

Age	N	M	Mat	PF	PM	SWt
0	296718	2.05	0	0	0	0.03
1	4222	1.65	0.01	0	0	0.12
2	748	0.4	0.32	0	0	0.238
3	431	0.25	0.71	0	0	0.355
4	114	0.25	0.87	0	0	0.497
5	1161	0.2	0.95	0	0	0.462
6	3172	0.2	1	0	0	0.59
7	36	0.2	1	0	0	1.53

Catch

Age	Sel	CWt	DSel	DCWt
0	0	0	0.0011	0.048
1	0.0025	0.338	0.0486	0.143
2	0.0383	0.387	0.2381	0.226
3	0.167	0.44	0.1464	0.28
4	0.3	0.525	0.0602	0.324
5	0.3669	0.465	0.0044	0.395
6	0.1952	0.6	0.0458	0.527
7	0.2299	1.543	0.0101	0.609

Industrialbycatch

Age	Sel	CWt
0	0.0115	0.025
1	0.0439	0.073
2	0.0274	0.133
3	0.0057	0.211
4	0.0207	0.34
5	0.0035	0.37
6	0.002	0.539
7	0.0012	0.84

2006

Age	N	M	Mat	PF	PM	SWt
0	99477	2.05	0	0	0	0.03
1	.	1.65	0.01	0	0	0.12
2	.	0.4	0.32	0	0	0.238
3	.	0.25	0.71	0	0	0.355
4	.	0.25	0.87	0	0	0.497
5	.	0.2	0.95	0	0	0.681
6	.	0.2	1	0	0	0.59
7	.	0.2	1	0	0	0.775

Catch

Age	Sel	CWt	DSel	DCWt
0	0	0	0.0011	0.048
1	0.0025	0.338	0.0486	0.143
2	0.0383	0.387	0.2381	0.226
3	0.167	0.44	0.1464	0.28
4	0.3	0.525	0.0602	0.324
5	0.3669	0.689	0.0044	0.395
6	0.236	0.6	0.0043	0.527
7	0.1952	0.792	0.0458	0.609

Industrialbycatch

Age	Sel	CWt
0	0.0115	0.025
1	0.0439	0.073
2	0.0274	0.133
3	0.0057	0.211
4	0.0207	0.34
5	0.0035	0.37
6	0.0009	0.539
7	0.002	0.84

2007

Age	N	M	Mat	PF	PM	SWt
0	99477	2.05	0	0	0	0.03
1	.	1.65	0.01	0	0	0.12
2	.	0.4	0.32	0	0	0.238
3	.	0.25	0.71	0	0	0.355
4	.	0.25	0.87	0	0	0.497
5	.	0.2	0.95	0	0	0.681
6	.	0.2	1	0	0	0.765
7	.	0.2	1	0	0	0.903

Catch

Age	Sel	CWt	DSel	DCWt
0	0	0	0.0011	0.048
1	0.0025	0.338	0.0486	0.143
2	0.0383	0.387	0.2381	0.226
3	0.167	0.44	0.1464	0.28
4	0.3	0.525	0.0602	0.324
5	0.3669	0.689	0.0044	0.395
6	0.236	0.767	0.0043	0.527
7	0.1952	0.908	0.0458	0.609

Industrialbycatch

Age	Sel	CWt
0	0.0115	0.025
1	0.0439	0.073
2	0.0274	0.133
3	0.0057	0.211
4	0.0207	0.34
5	0.0035	0.37
6	0.0009	0.539
7	0.002	0.84

Input units are *10-5 and kg - output in hundred tonnes

Table 4.6.2. Haddock in Sub-Area IV and Division IIIa. Short term forecast output.

MFDP version 1a
Run: had
Time and date: 17:58 15/09/2005
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2005									
		Catch	Landings		Discards		Industrialby	Landings	
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	FMult	FBar	Yield
12259	2656	1	0.1684	508	0.1482	128	1	0.0179	49

2006										2007	
		Catch	Landings		Discards		Industrialby	Landings			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	FMult	FBar	Yield	Biomass	SSB
9962	2321	0	0	0	0	0	1	0.0179	78	8634	2949
.	2321	0.1	0.0168	46	0.0148	23	1	0.0179	78	8563	2886
.	2321	0.2	0.0337	91	0.0296	46	1	0.0179	78	8493	2824
.	2321	0.3	0.0505	135	0.0445	68	1	0.0179	77	8425	2764
.	2321	0.4	0.0674	178	0.0593	90	1	0.0179	77	8359	2706
.	2321	0.5	0.0842	220	0.0741	112	1	0.0179	77	8294	2649
.	2321	0.6	0.1011	261	0.0889	134	1	0.0179	77	8231	2593
.	2321	0.7	0.1179	301	0.1038	155	1	0.0179	77	8169	2539
.	2321	0.8	0.1347	341	0.1186	176	1	0.0179	76	8109	2486
.	2321	0.9	0.1516	379	0.1334	197	1	0.0179	76	8049	2434
.	2321	1	0.1684	416	0.1482	217	1	0.0179	76	7992	2383
.	2321	1.1	0.1853	452	0.1631	238	1	0.0179	76	7935	2334
.	2321	1.2	0.2021	488	0.1779	258	1	0.0179	76	7880	2286
.	2321	1.3	0.219	523	0.1927	278	1	0.0179	75	7826	2239
.	2321	1.4	0.2358	556	0.2075	297	1	0.0179	75	7773	2194
.	2321	1.5	0.2527	589	0.2224	317	1	0.0179	75	7722	2149
.	2321	1.6	0.2695	622	0.2372	336	1	0.0179	75	7672	2105
.	2321	1.7	0.2863	653	0.252	355	1	0.0179	75	7622	2063
.	2321	1.8	0.3032	684	0.2668	373	1	0.0179	74	7574	2021
.	2321	1.9	0.32	714	0.2816	392	1	0.0179	74	7527	1981
.	2321	2	0.3369	744	0.2965	410	1	0.0179	74	7481	1941

Input units are *10-5 and kg - output in hundred tonnes

Table 4.6.3. Haddock in Sub-Area IV and Division IIIa. Short term forecast detailed output.

MFDP version 1a
Run: had
Time and date: 17:58 15/09/2005
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

Year:	2005	F multiplier	1	Fleet1 HCF	0.1684	Fleet1 DFb	0.1482								
	Catch						Industrialbycatch								
Age	F	CatchNos	Yield	DF	DCatchNos	DYield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	0.0011	138	7	0.0115	1444	36	296718	8902	0	0	0	0
1	0.0025	5	2	0.0486	97	14	0.0439	88	6	4222	507	42	5	42	5
2	0.0383	21	8	0.2381	128	29	0.0274	15	2	748	178	239	57	239	57
3	0.167	55	24	0.1464	48	13	0.0057	2	0	431	153	306	109	306	109
4	0.3	25	13	0.0602	5	2	0.0207	2	1	114	57	99	49	99	49
5	0.3669	324	151	0.0044	4	2	0.0035	3	1	1161	536	1103	510	1103	510
6	0.1952	500	300	0.0458	117	62	0.002	5	3	3172	1871	3172	1871	3172	1871
7	0.2299	7	10	0.0101	0	0	0.0012	0	0	36	55	36	55	36	55
Total		937	508		538	128		1558	49	306602	12259	4998	2656	4998	2656

Year:	2006	F multiplier	1	Fleet1 HCF	0.1684	Fleet1 DFb	0.1482								
	Catch						Industrialbycatch								
Age	F	CatchNos	Yield	DF	DCatchNos	DYield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	0.0011	46	2	0.0115	484	12	99477	2984	0	0	0	0
1	0.0025	45	15	0.0486	867	124	0.0439	783	57	37720	4526	377	45	377	45
2	0.0383	20	8	0.2381	126	28	0.0274	15	2	737	175	236	56	236	56
3	0.167	47	21	0.1464	41	12	0.0057	2	0	370	131	263	93	263	93
4	0.3	54	28	0.0602	11	4	0.0207	4	1	244	121	212	105	212	105
5	0.3669	17	12	0.0044	0	0	0.0035	0	0	61	41	58	39	58	39
6	0.236	125	75	0.0043	2	1	0.0009	0	0	653	386	653	386	653	386
7	0.1952	325	257	0.0458	76	46	0.002	3	3	2060	1596	2060	1596	2060	1596
Total		633	416		1170	217		1291	76	141322	9962	3859	2321	3859	2321

Year:	2007	F multiplier	1	Fleet1 HCF	0.1684	Fleet1 DFb	0.1482								
	Catch						Industrialbycatch								
Age	F	CatchNos	Yield	DF	DCatchNos	DYield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	0.0011	46	2	0.0115	484	12	99477	2984	0	0	0	0
1	0.0025	15	5	0.0486	291	42	0.0439	263	19	12646	1517	126	15	126	15
2	0.0383	181	70	0.2381	1126	255	0.0274	130	17	6588	1568	2108	502	2108	502
3	0.167	46	20	0.1464	41	11	0.0057	2	0	365	129	259	92	259	92
4	0.3	47	24	0.0602	9	3	0.0207	3	1	209	104	182	91	182	91
5	0.3669	36	25	0.0044	0	0	0.0035	0	0	130	88	123	84	123	84
6	0.236	7	5	0.0043	0	0	0.0009	0	0	34	26	34	26	34	26
7	0.1952	275	250	0.0458	64	39	0.002	3	2	1743	1574	1743	1574	1743	1574
Total		607	400		1578	352		884	52	121192	7992	4576	2383	4576	2383

Input units are *10-5 and kg - output in hundred tonnes

Figure 4.1.4.1 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.

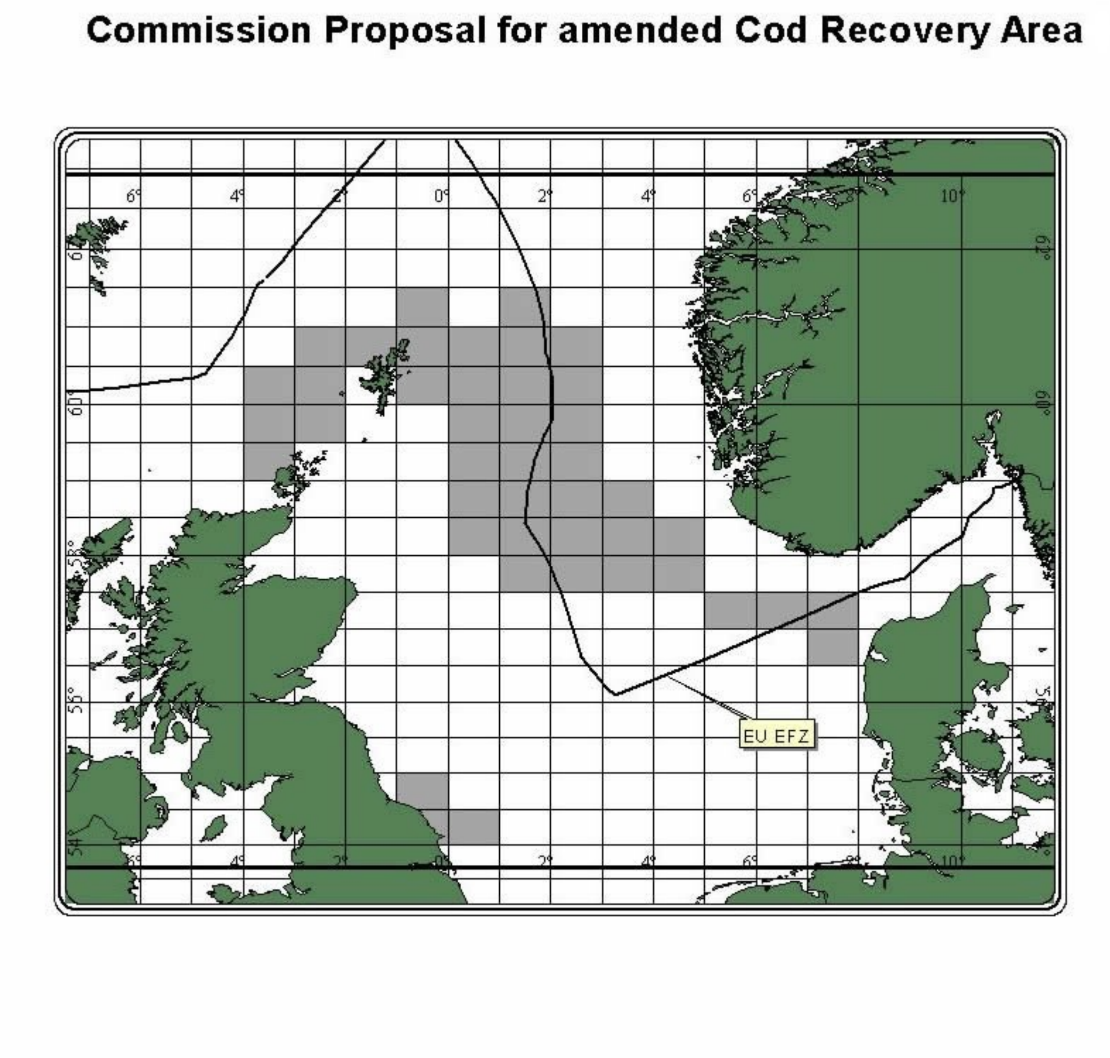


Figure 4.2.5.1 Haddock in Sub-Area IV and Division IIIa. Summary of catch data showing age contribution to total catch, mean weight at age in the catch, numbers landed at age and the proportion by weight of each age in the catch (colours show a cohorts history in the catch data).

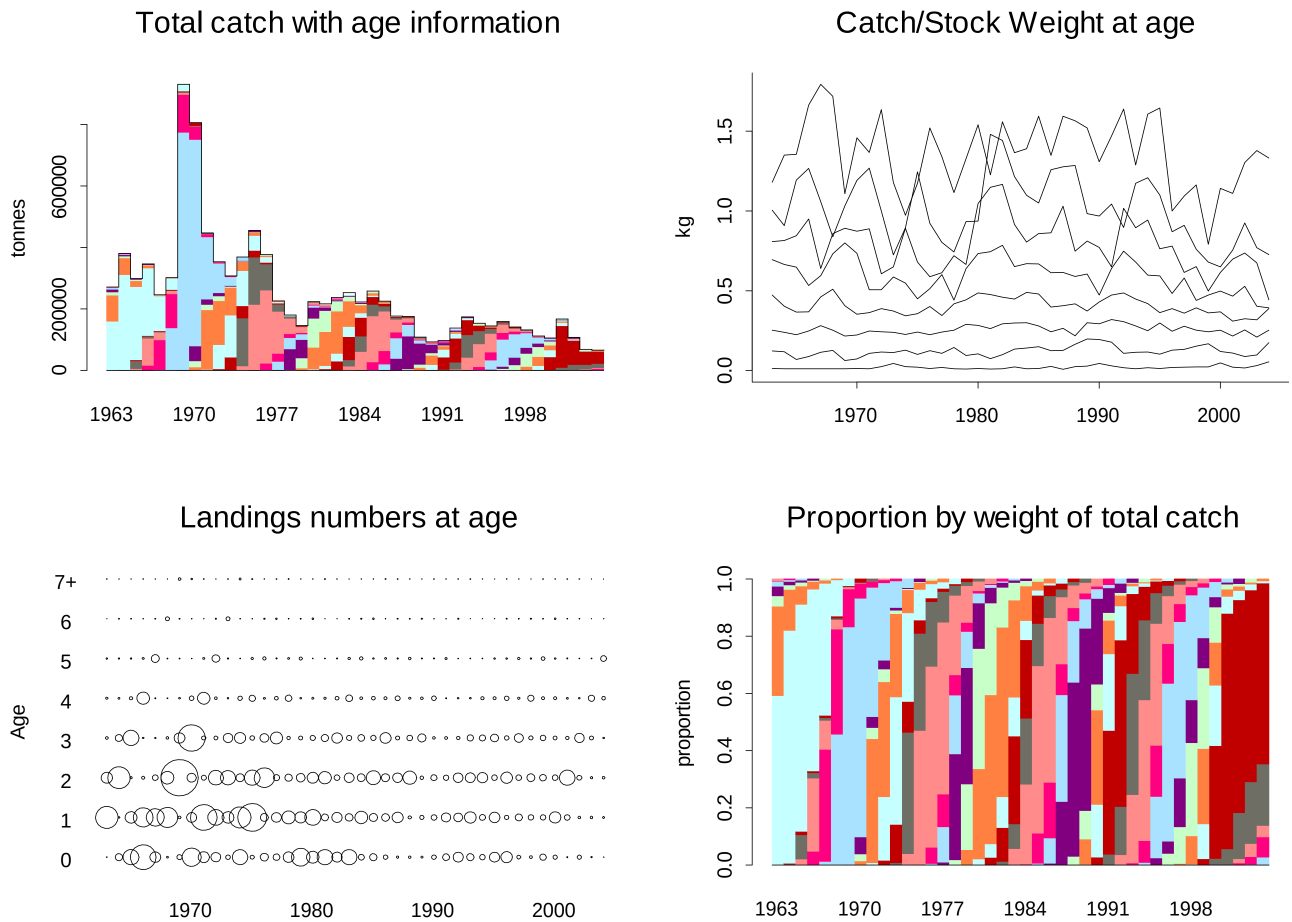


Figure 4.2.5.2.a.Haddock in Sub-Area IV and Division IIIa. Spatial distribution of haddock from the Q1 IBTS.

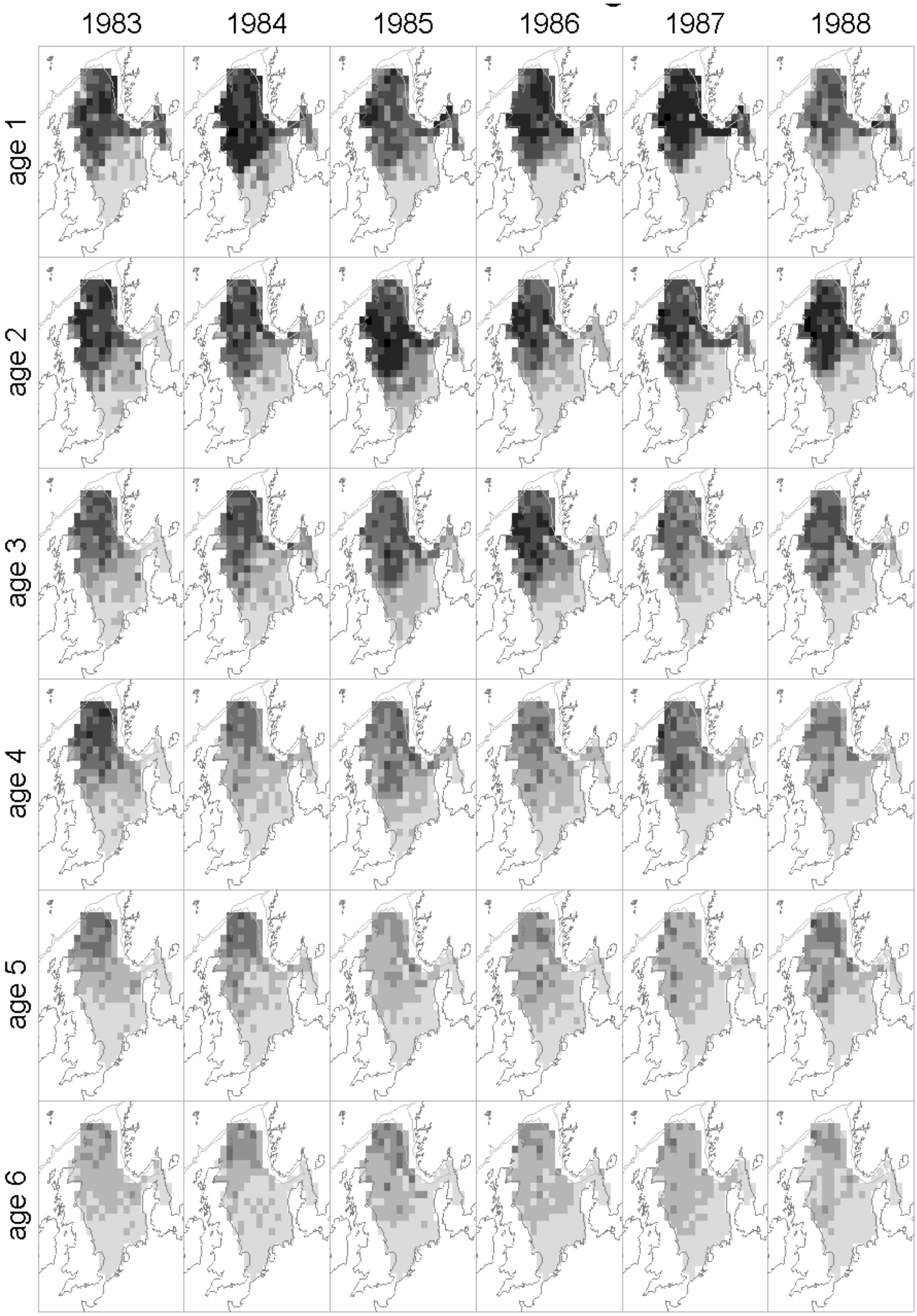


Figure 4.2.5.2.a cont..Haddock in Sub-Area IV and Division IIIa. Spatial distribution of haddock from the Q1 IBTS.

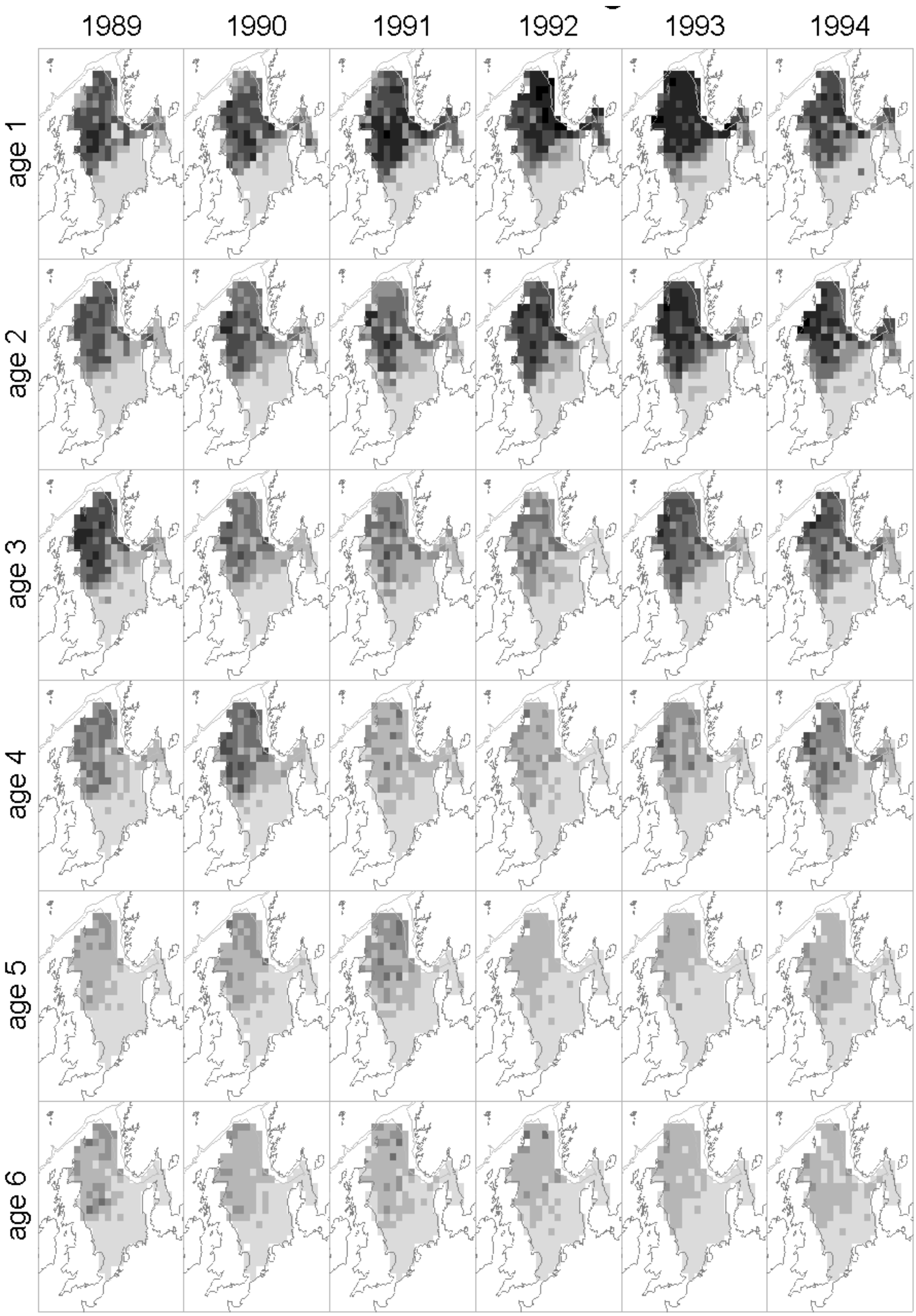


Figure 4.2.5.2.a cont..Haddock in Sub-Area IV and Division IIIa. Spatial distribution of haddock from the Q1 IBTS.

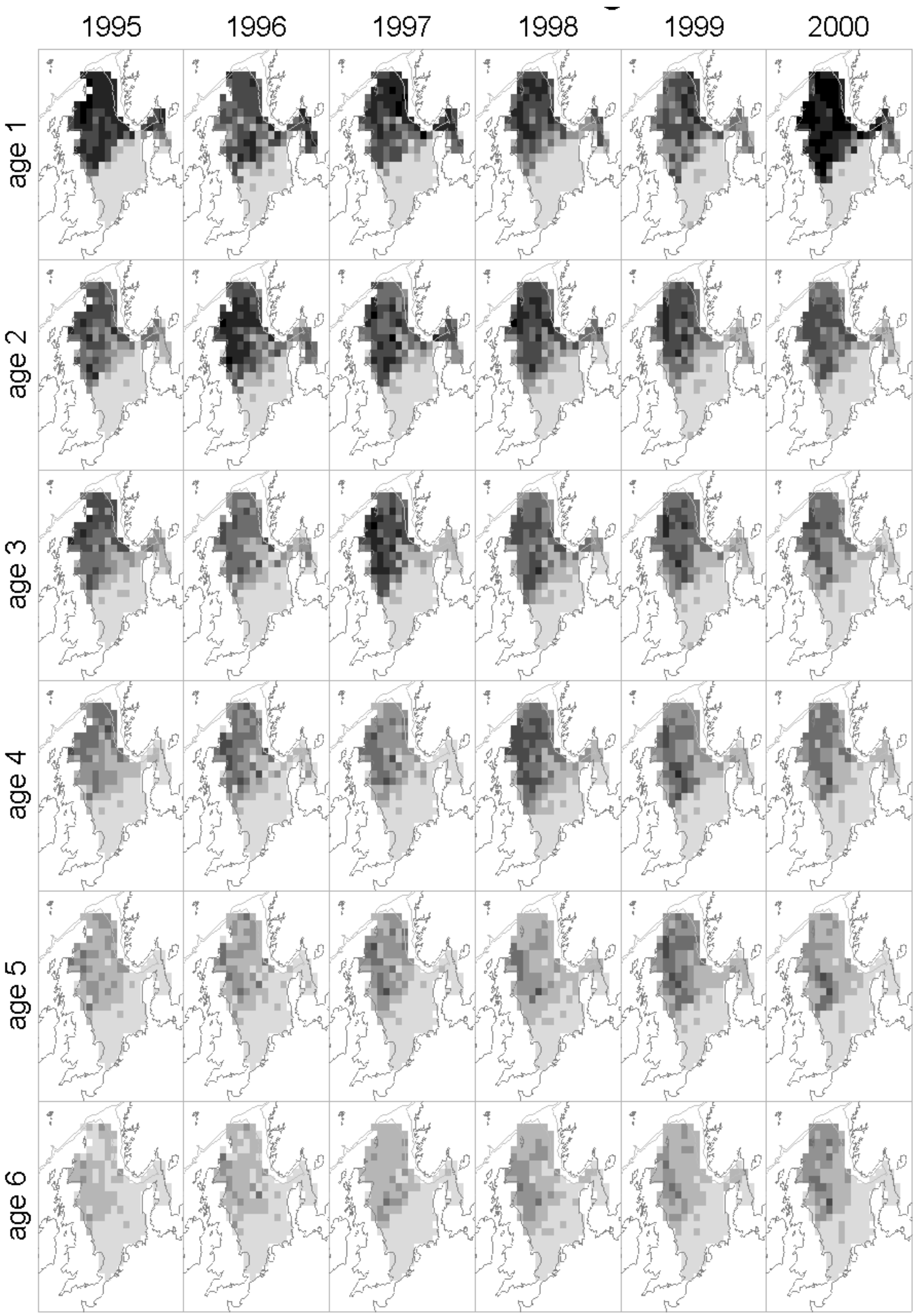


Figure 4.2.5.2.a cont..Haddock in Sub-Area IV and Division IIIa. Spatial distribution of haddock from the Q1 IBTS.

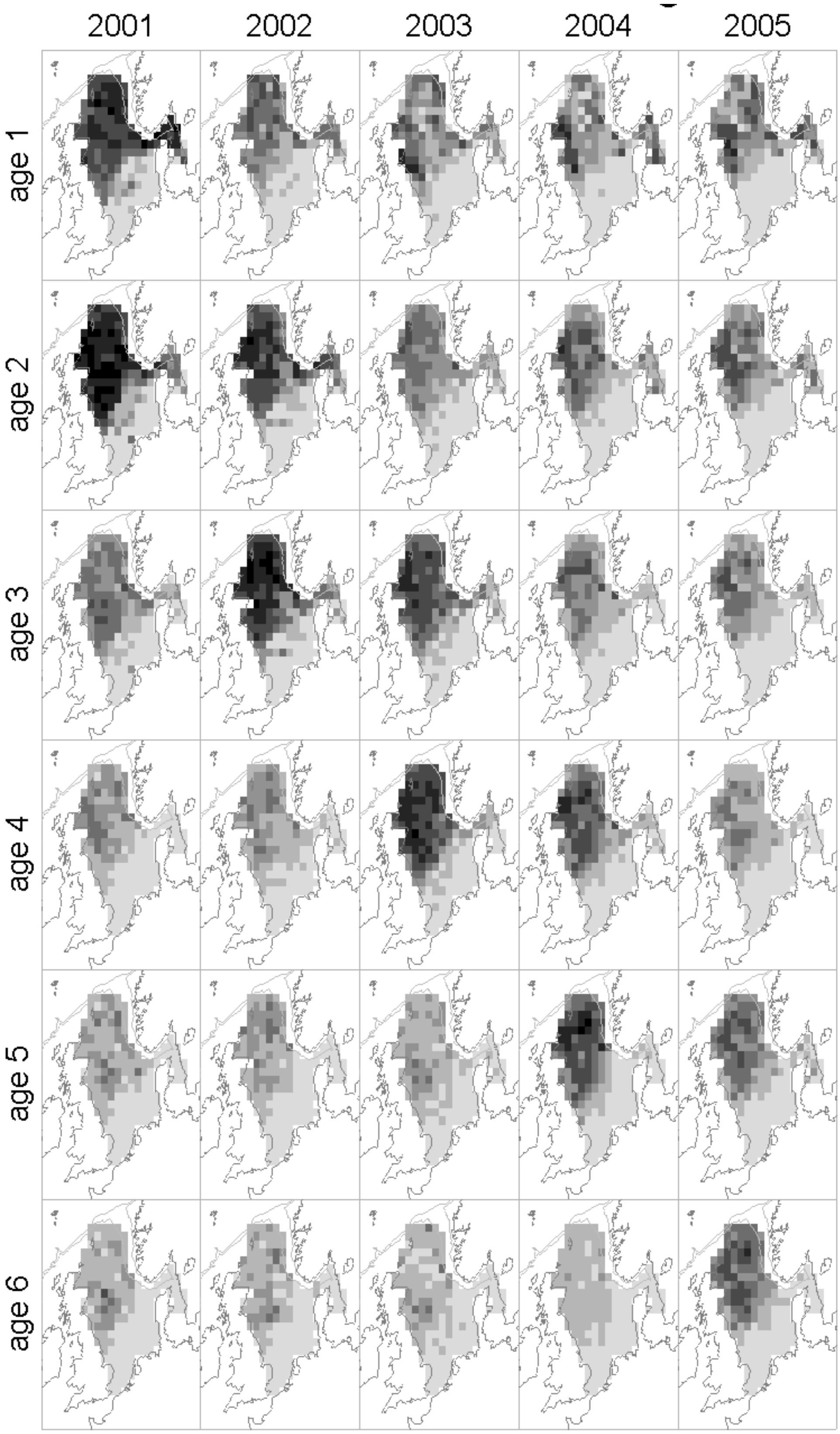


Figure 4.2.5.2.a cont. Haddock in Sub-Area IV and Division IIIa. Spatial distribution of haddock from the Q1 IBTS – scale used.

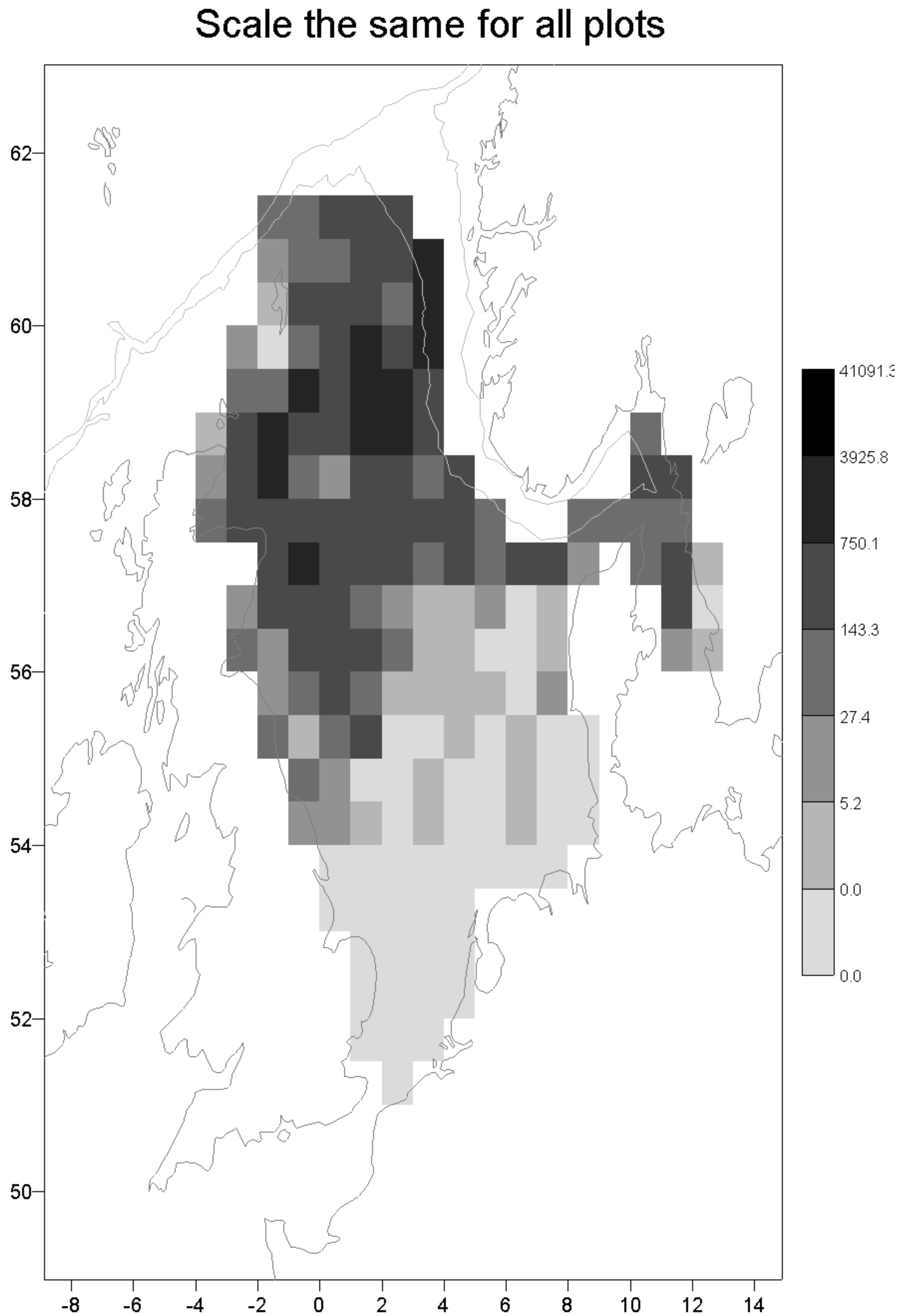


Figure 4.2.5.2.b. Haddock in Sub-Area IV and Division IIIa. Spatial distribution of age 0 haddock in 2005 from the Q3 Scottish groundfish survey.

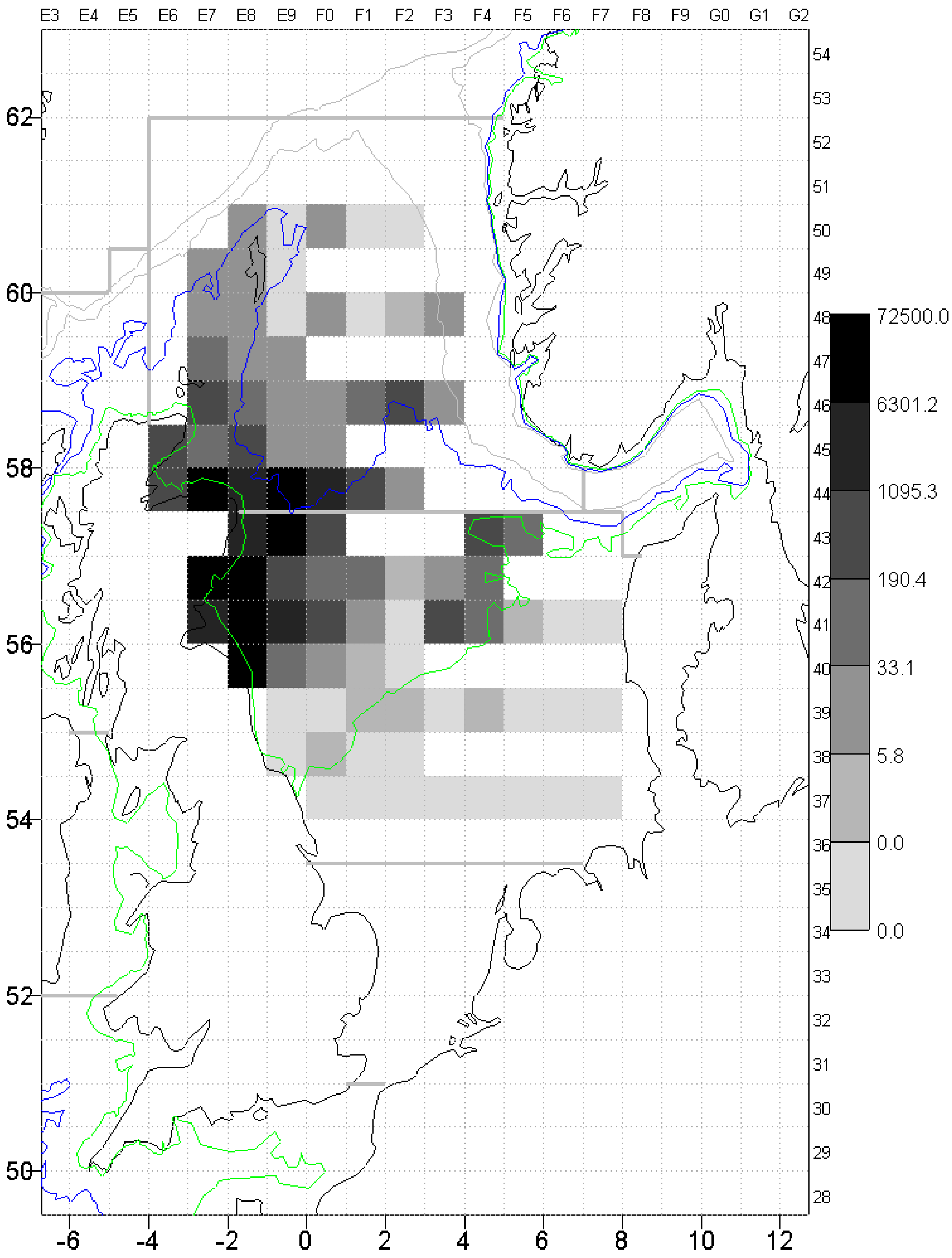


Figure 4.2.5.2.b cont.. Haddock in Sub-Area IV and Division IIIa. Spatial distribution of age 1 haddock in 2005 from the Q3 Scottish groundfish survey.

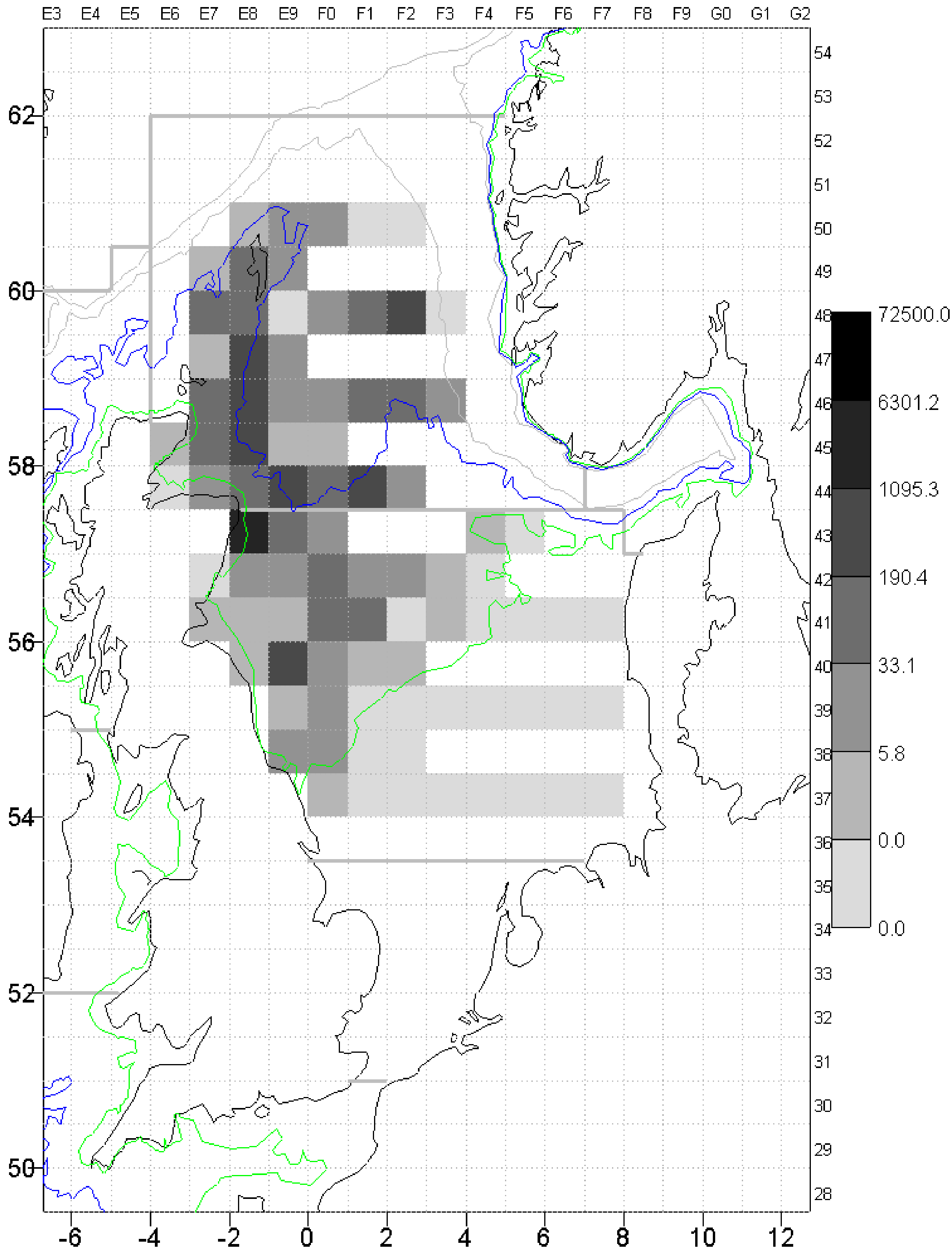


Figure 4.2.5.2.b cont.. Haddock in Sub-Area IV and Division IIIa. Spatial distribution of age 2 haddock in 2005 from the Q3 Scottish groundfish survey.

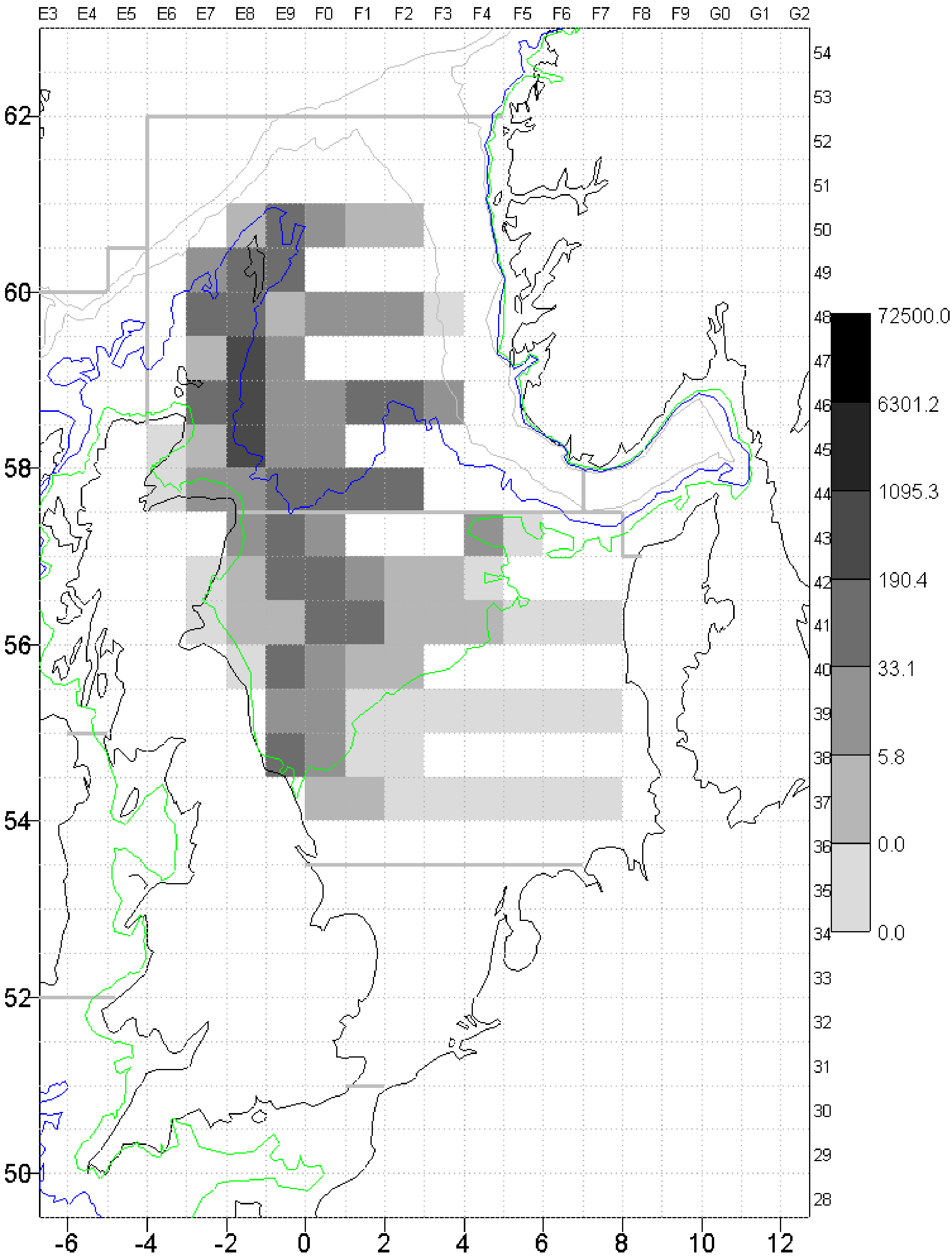


Figure 4.2.5.2.b cont.. Haddock in Sub-Area IV and Division IIIa. Spatial distribution of age 3+ haddock in 2005 from the Q3 Scottish groundfish survey.

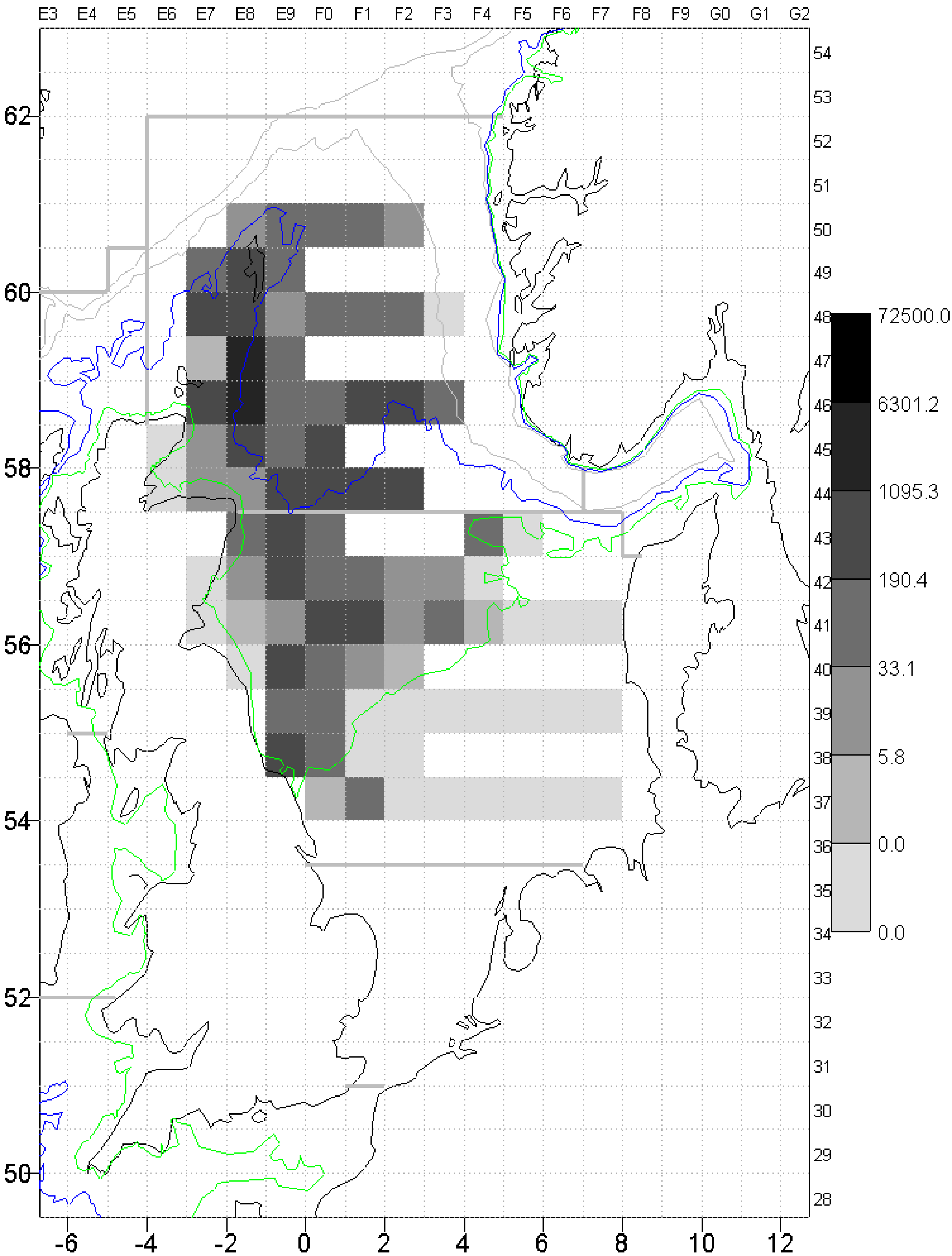


Figure 4.2.5.3.a. Haddock in Sub-Area IV and Division IIIa. Log-CPUE data at age from surveys.

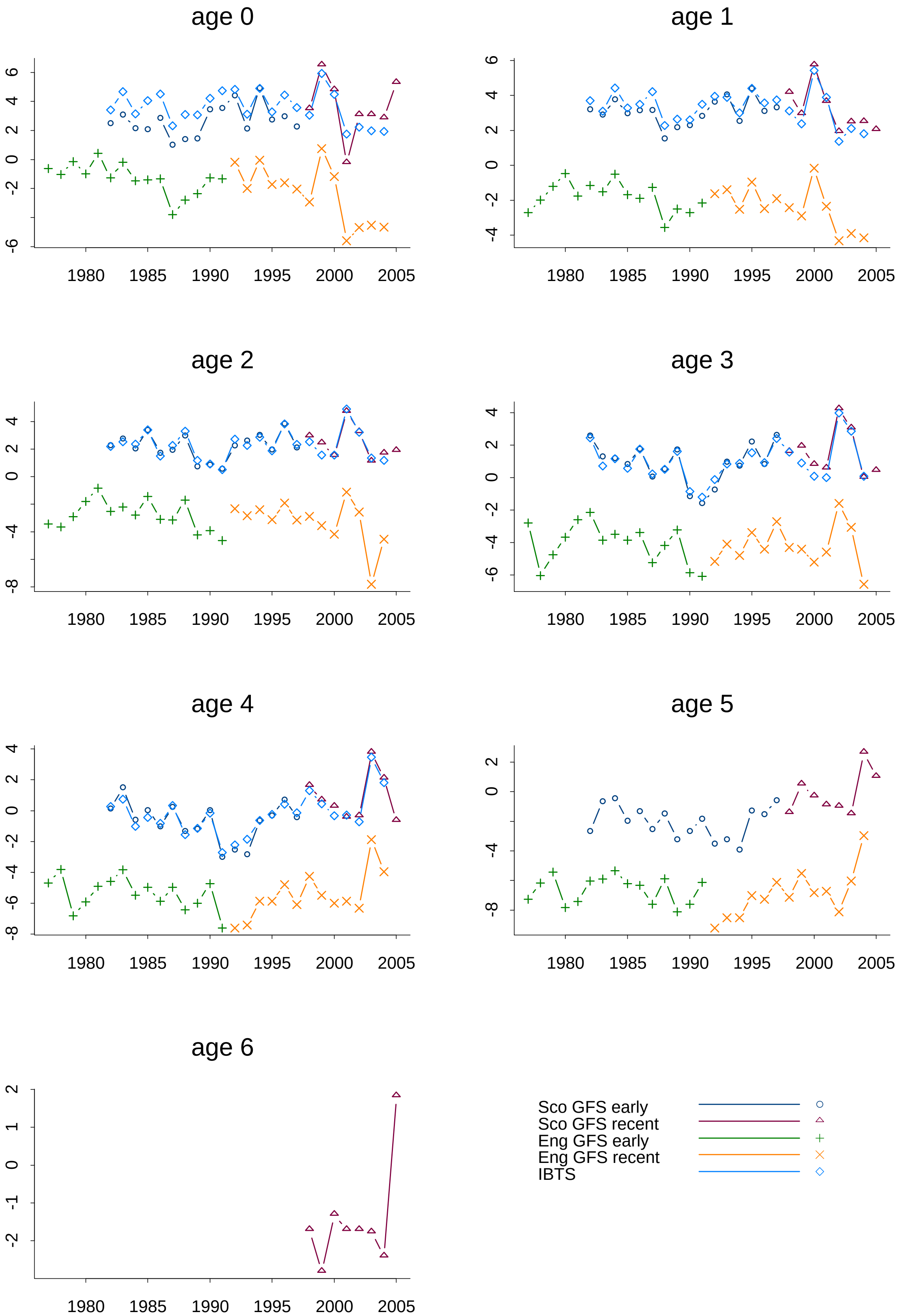


Figure 4.2.5.3.b. Haddock in Sub-Area IV and Division IIIa. Commercial log-CPUE data at age.

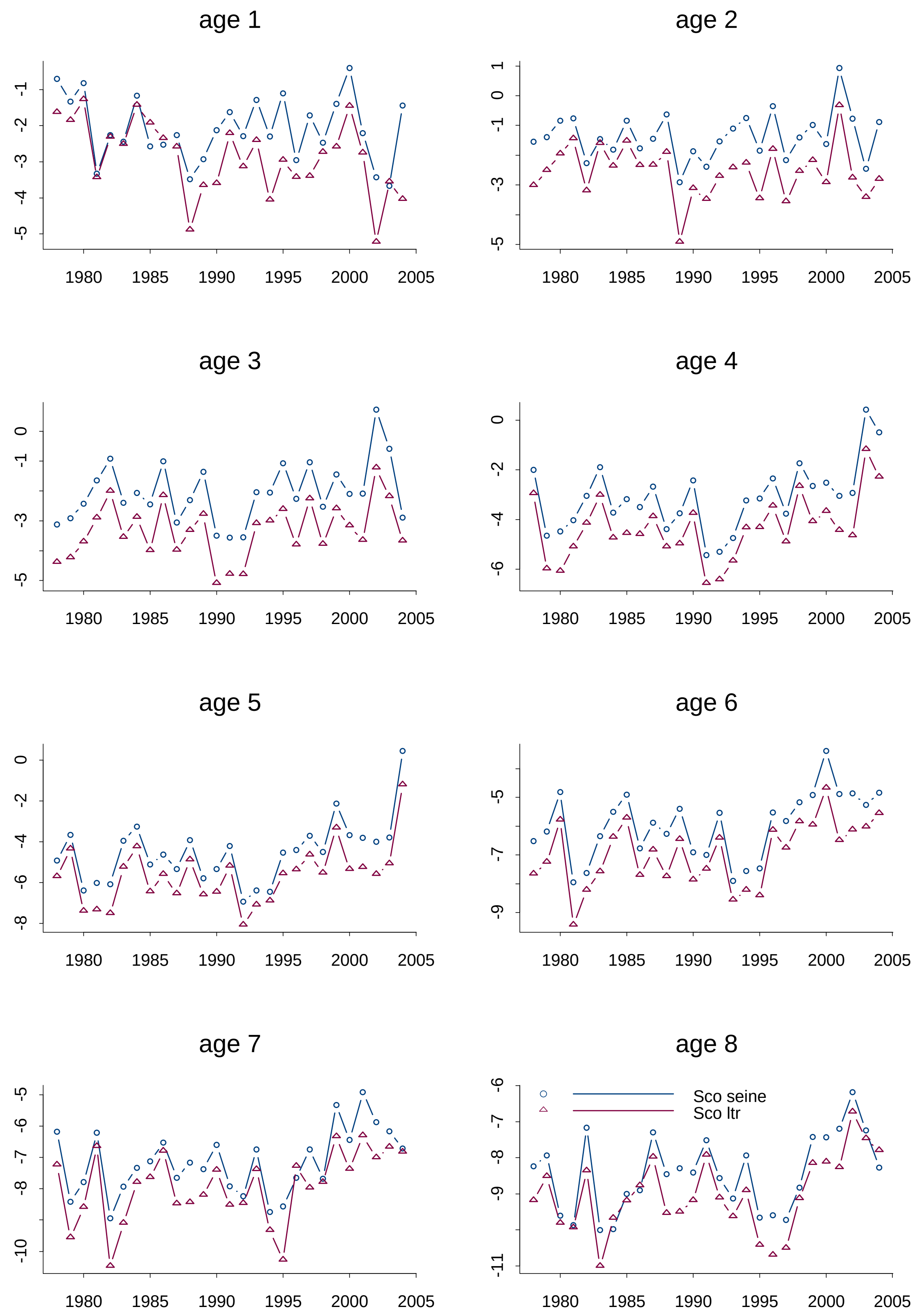


Figure 4.2.5.4. Haddock in Sub-Area IV and Division IIIa. Nominal hours fished by UK fleets. The values plotted are those from table 4.2.11, indicating the catch at age fleet information available to the WG. Recording of hours fished is not mandatory in logbooks in the UK and is not considered to be representative of deployed fishing effort.

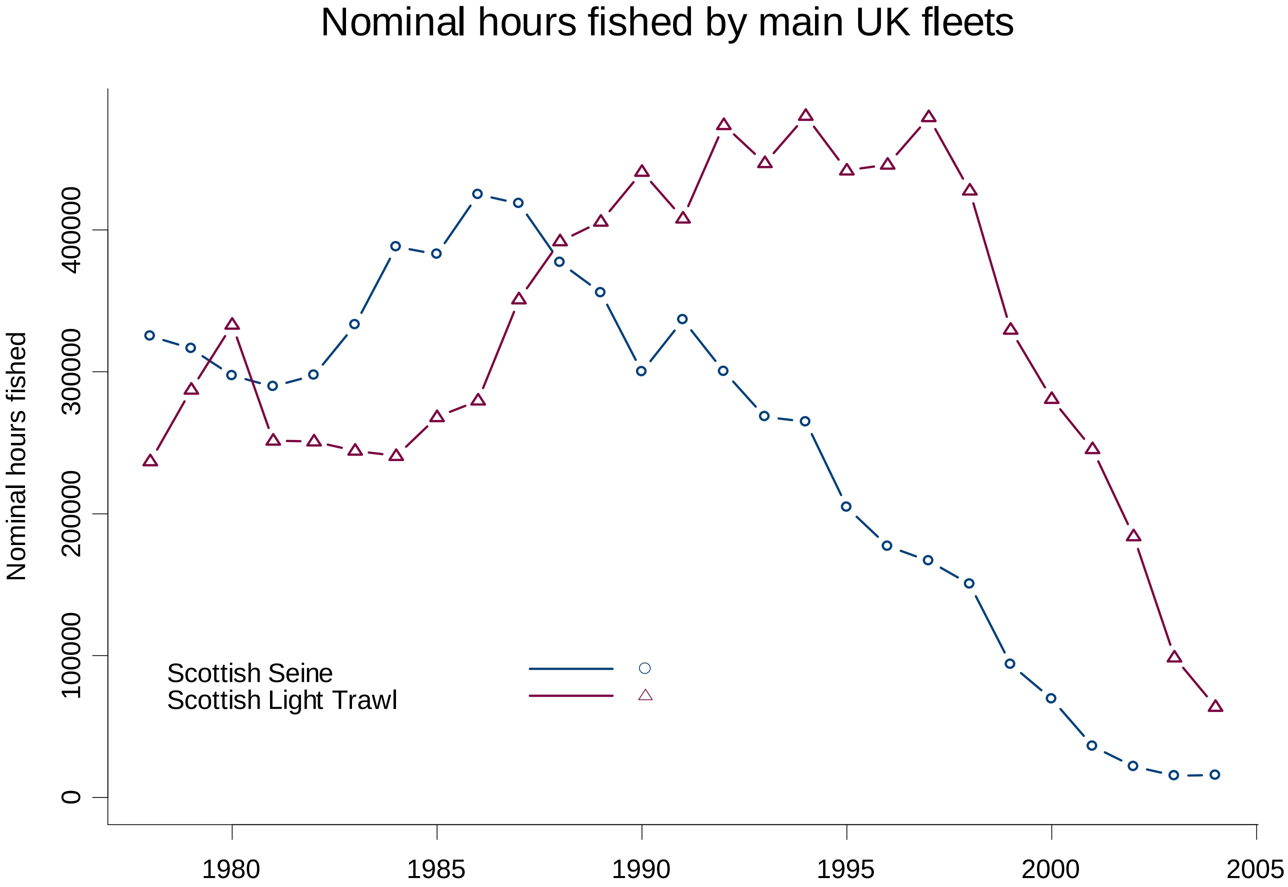


Figure 4.3.1.1 Haddock in Sub-Area IV and Division IIIa. A separable VPA fit, with a weighting of 1 for all years. The choice of reference age, terminal F and terminal S were 2, 0.6 and 0.3 respectively. The top plot shows log-catch ratio residuals, while the bottom left plot shows a time-series of F, and bottom right the selectivity pattern. White bubbles show negative residuals.

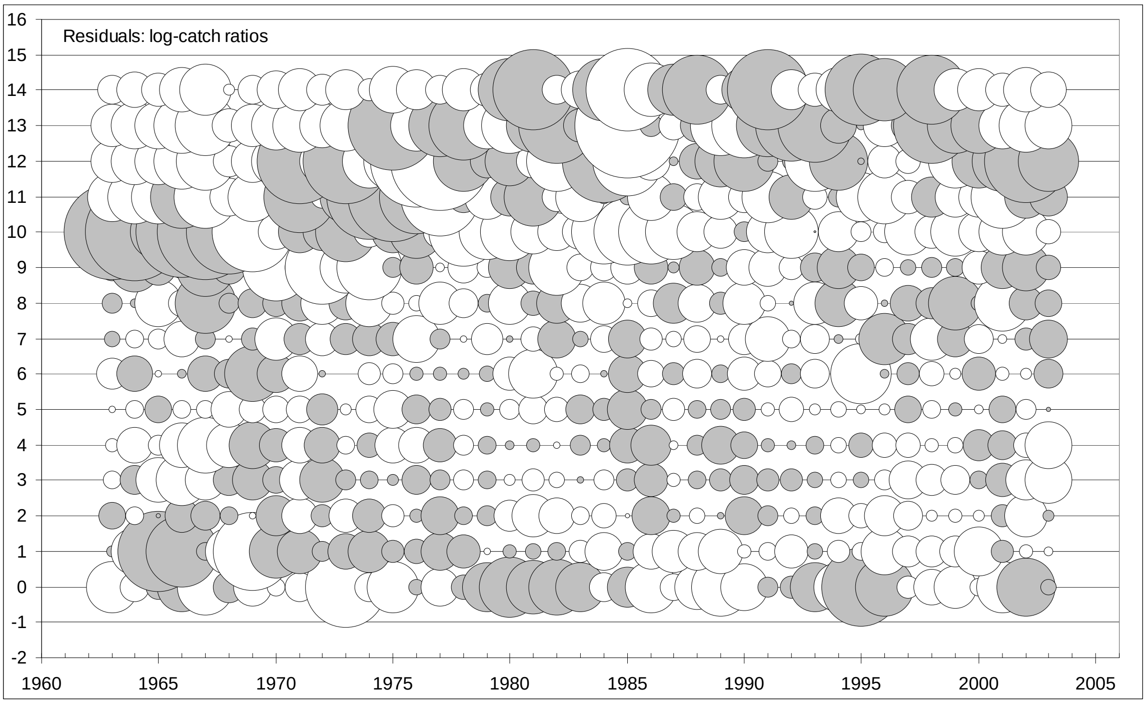


Figure 4.3.1.2 Haddock in Sub-Area IV and Division IIIa. Log-catch by cohort for catches.

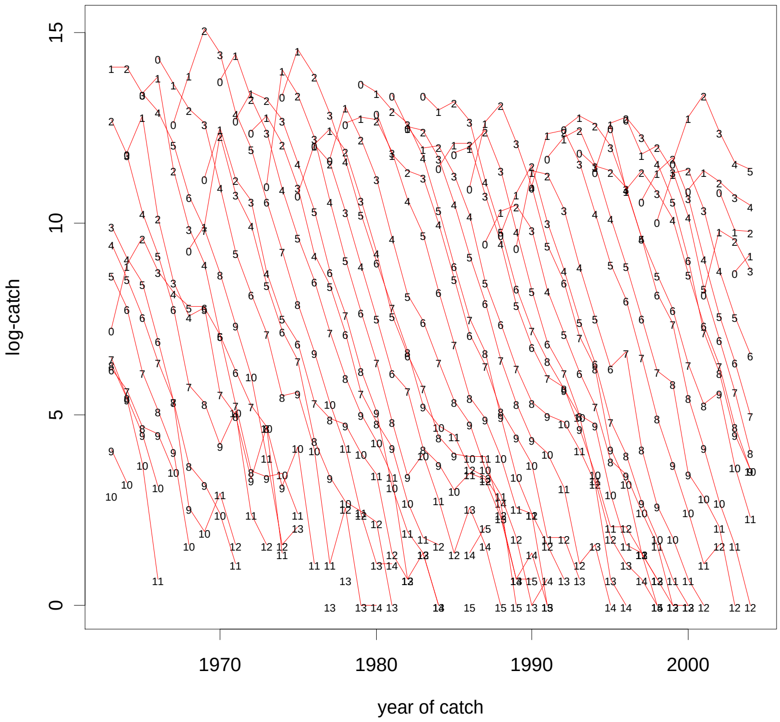


Figure 4.3.1.3 Haddock in Sub-Area IV and Division IIIa. Gradients of log-catches per cohort for the age-range specified, calculated from Figure 4.3.1.1.

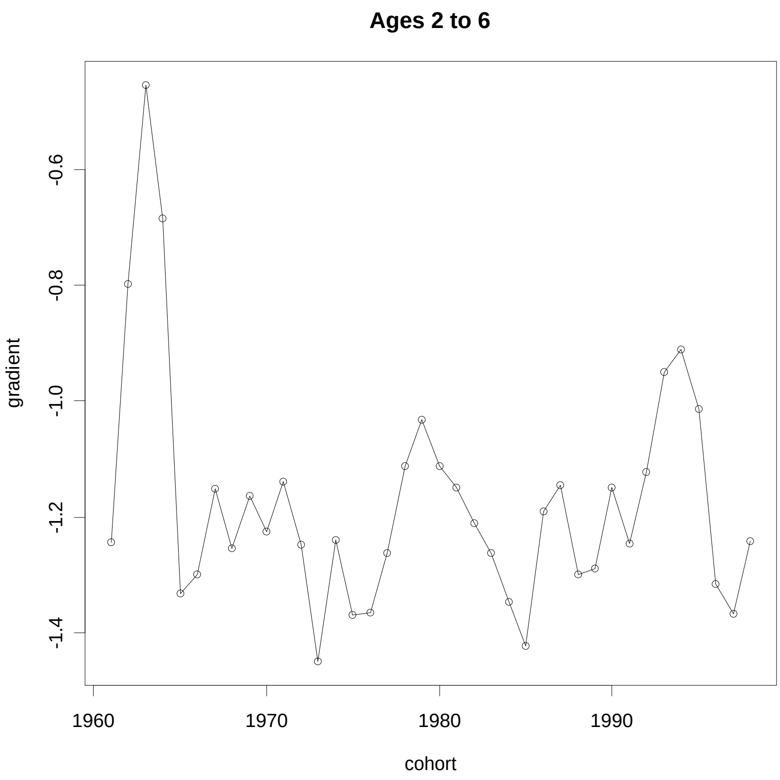


Figure 4.3.1.4 Haddock in Sub-Area IV and Division IIIa. Correlations in the catch-at-age matrix (log-numbers). Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line a robust linear regression line, and "cor" denotes the correlation coefficient.

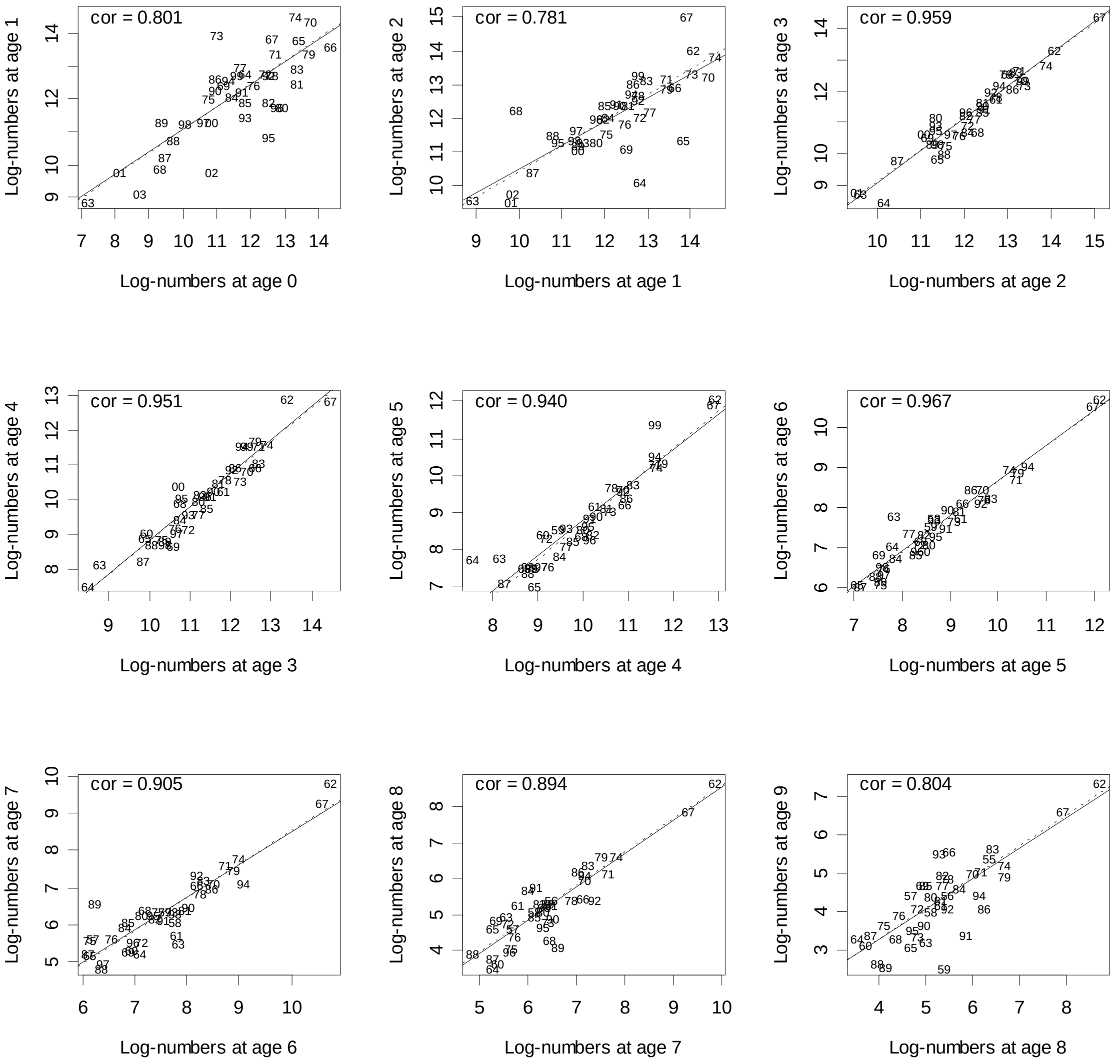


Figure 4.3.1.4 cont. Haddock in Sub-Area IV and Division IIIa. Correlations in the catch-at-age matrix (log-numbers)

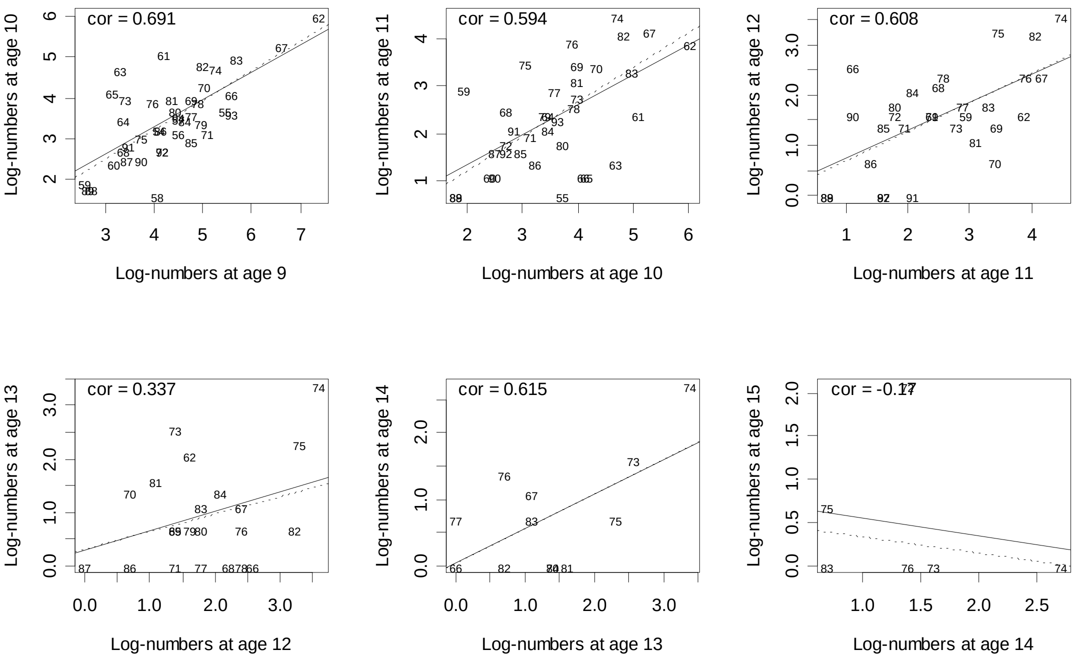


Figure 4.3.1.5 Haddock in Sub-Area IV and Division IIIa. Ad-hoc VPA results (using Laurec-Shepherd tuning) for ENGGFS (1992-2004). The plots show log-catchability residuals (white bubbles are negative).

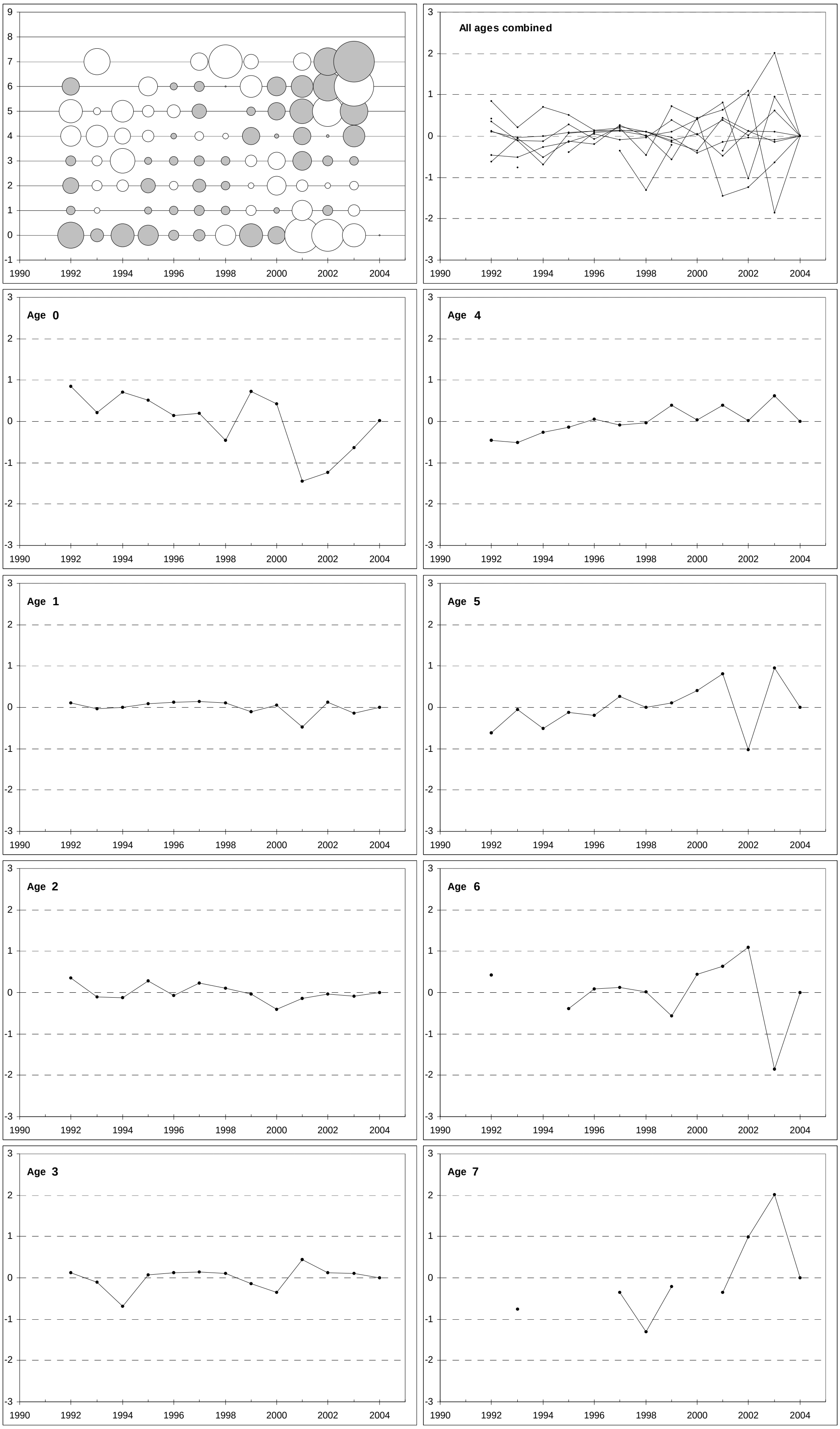


Figure 4.3.1.6 Haddock in Sub-Area IV and Division IIIa. Ad-hoc VPA results (using Laurec-Shepherd tuning) for SCOGFS (1998-2004). The plots show log-catchability residuals (white bubbles are negative).

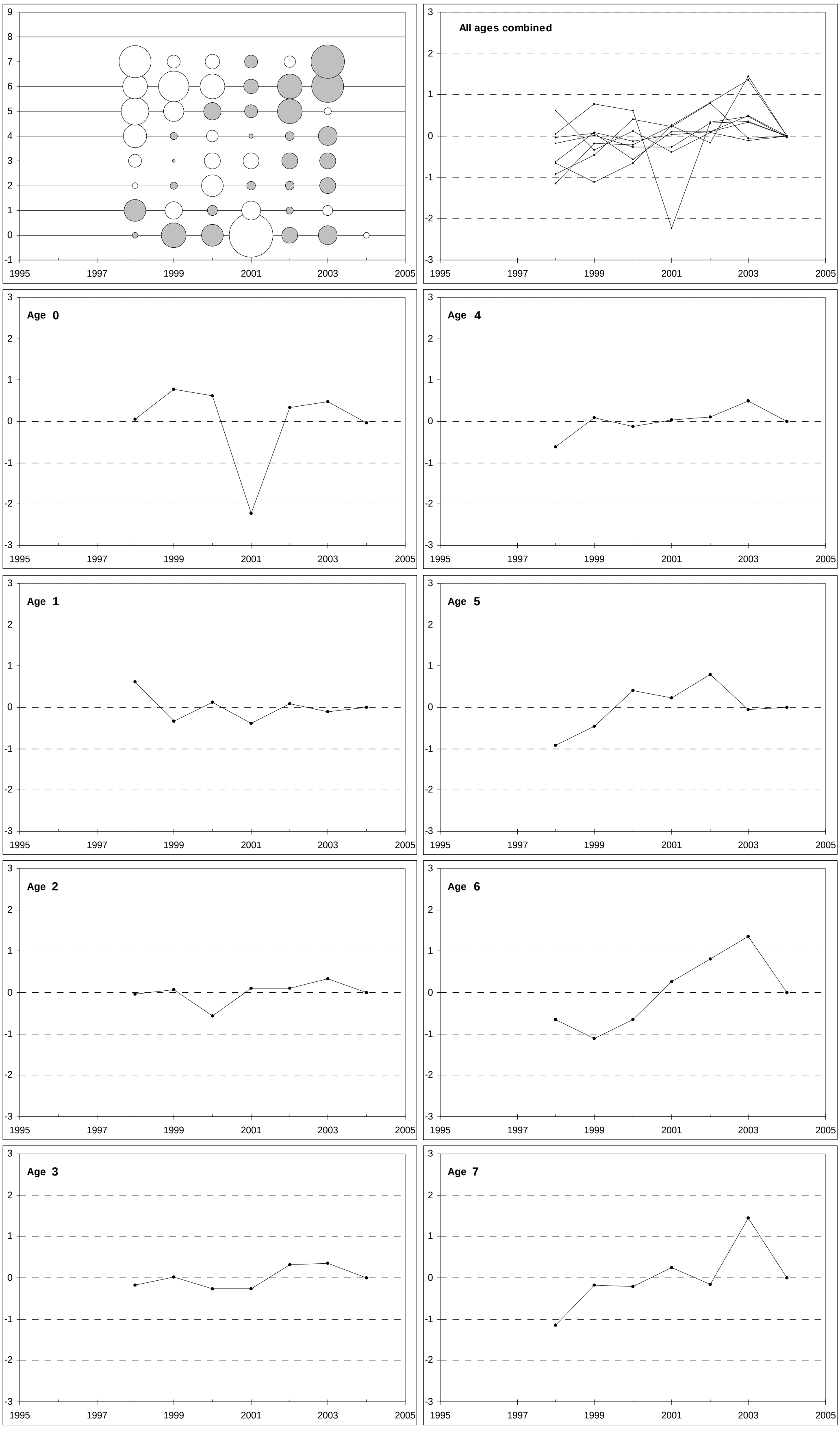


Figure 4.3.1.7 Haddock in Sub-Area IV and Division IIIa. Ad-hoc VPA results (using Laurec-Shepherd tuning) for IBTS Q1 (note the age 5 tuning index is a plusgroup). The plots show log-catchability residuals (white bubbles are negative).

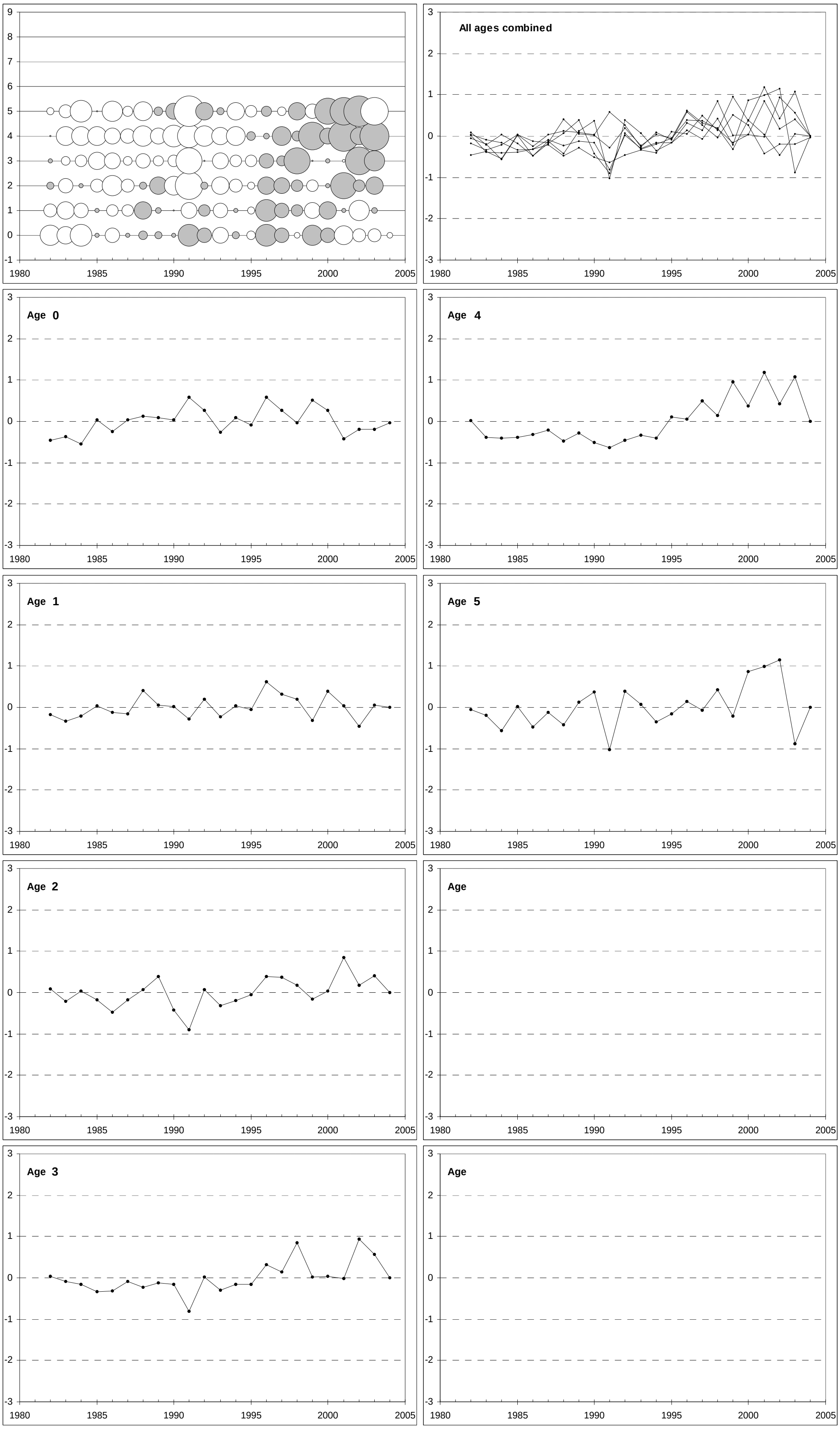


Figure 4.3.1.8 Haddock in Sub-Area IV and Division IIIa. XSA residuals: comparison of 3 trial runs. The two halves of each of ENGGFS and SCOGFS are treated as independent tuning series in Runs 2 and 3, hence the residuals are separated by a solid vertical line indicating the appropriate split in the time series.

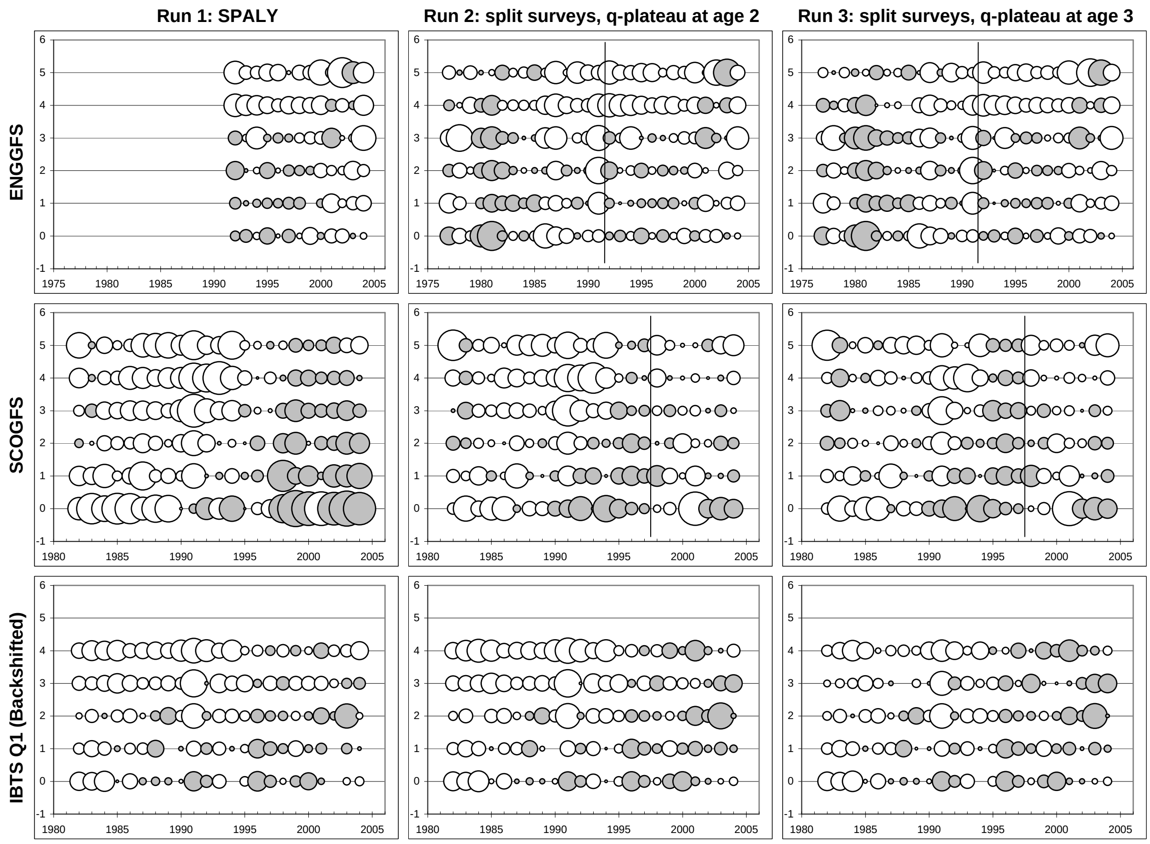


Figure 4.3.1.9 Haddock in Sub-Area IV and Division IIIa. XSA: comparison of 3 trial runs.

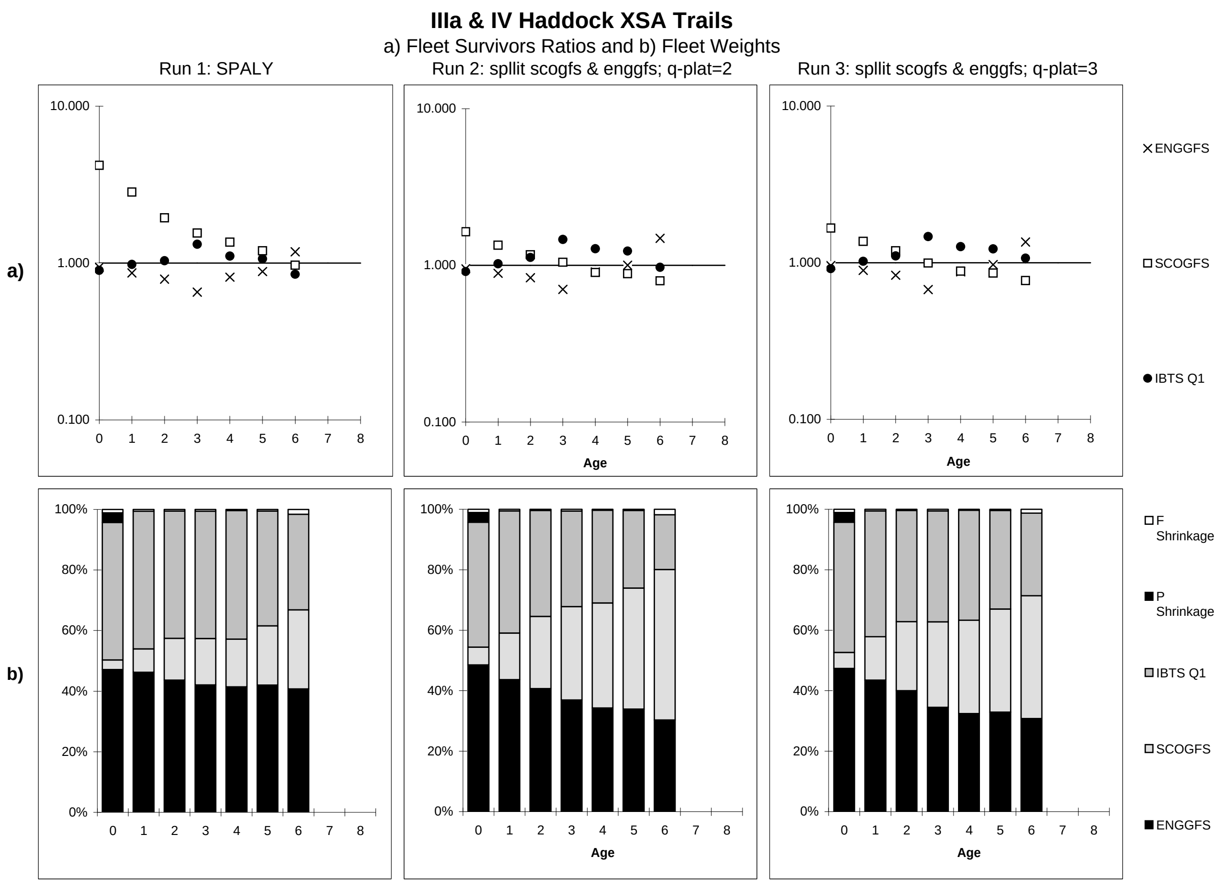


Figure 4.3.1.10 Haddock in Sub-Area IV and Division IIIa. XSA summary output: comparison of 3 trial runs. The light horizontal lines indicate $\mathbf{F}_{pa}$ (top plot) and $\mathbf{B}_{pa}$ (middle plot), while the dark ones indicate $\mathbf{F}_{lim}$ (top plot) and $\mathbf{B}_{lim}$ (middle plot).

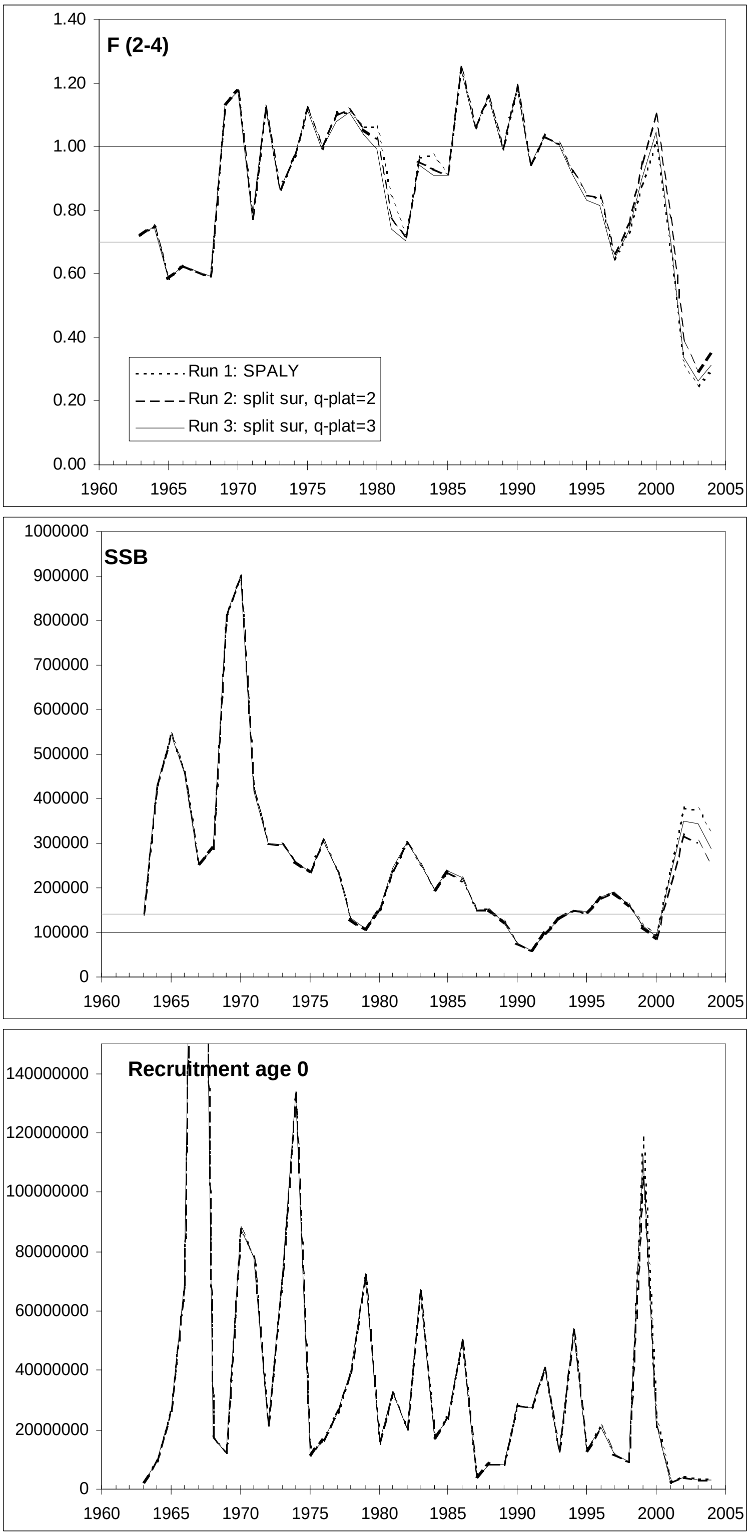


Figure 4.3.1.11 Haddock in Sub-Area IV and Division IIIa. XSA: Sensitivity of Run 3 assessments in terms of assuming alternative values for M-at-age (taken from the Study Group on Multispecies Assessment in the North Sea, ICES 2005). The light horizontal lines indicate $\mathbf{F}_{pa}$ (top plot) and $\mathbf{B}_{pa}$ (middle plot), while the dark ones indicate $\mathbf{F}_{lim}$ (top plot) and $\mathbf{B}_{lim}$ (middle plot).

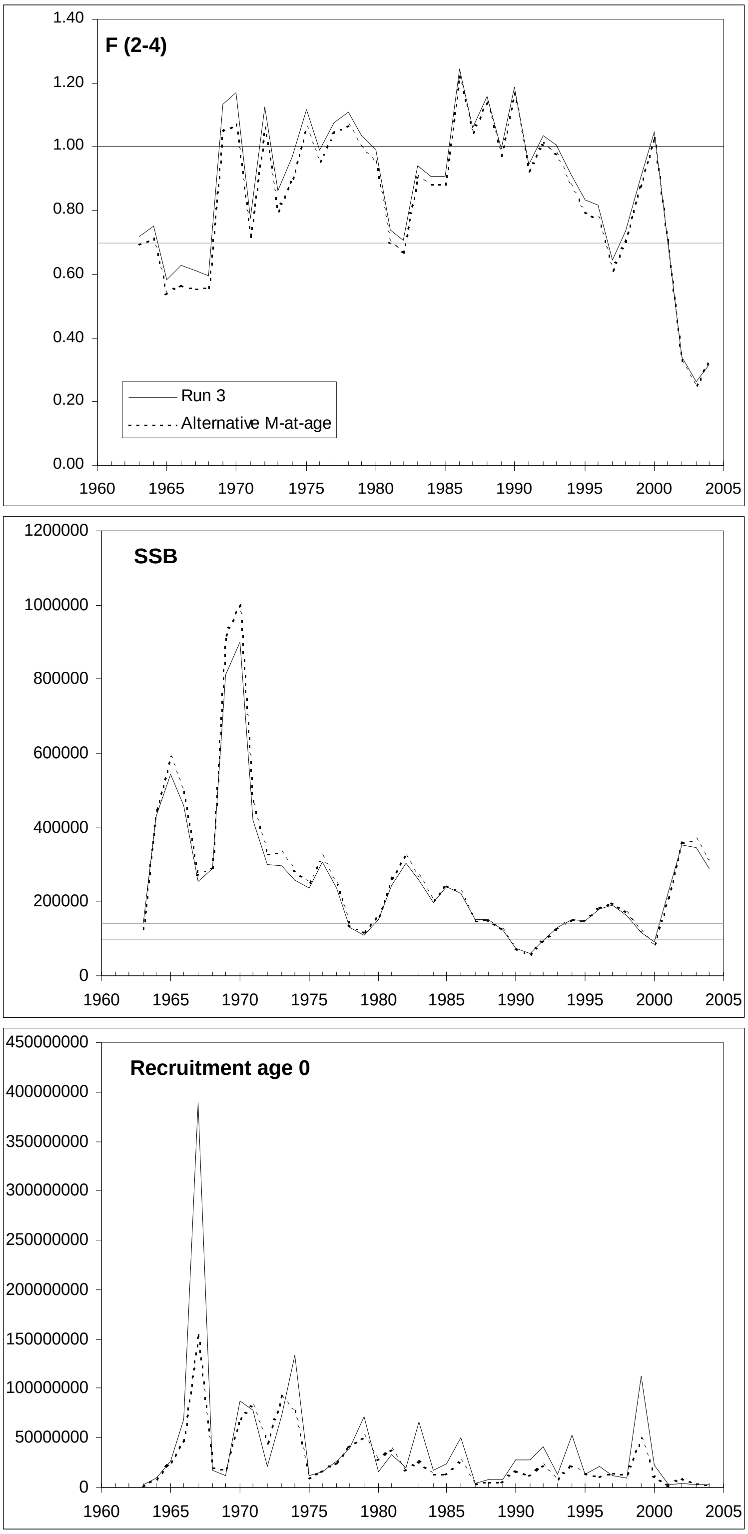


Figure 4.3.1.12 Haddock in Sub-Area IV and Division IIIa. Comparison of F (ages 2-4), SSB and Recruitment time series for individual-fleet XSA runs (with the same setting as Run 3), together with final-year estimates for F (2-4) and SSB shown on a single plot (top-right).

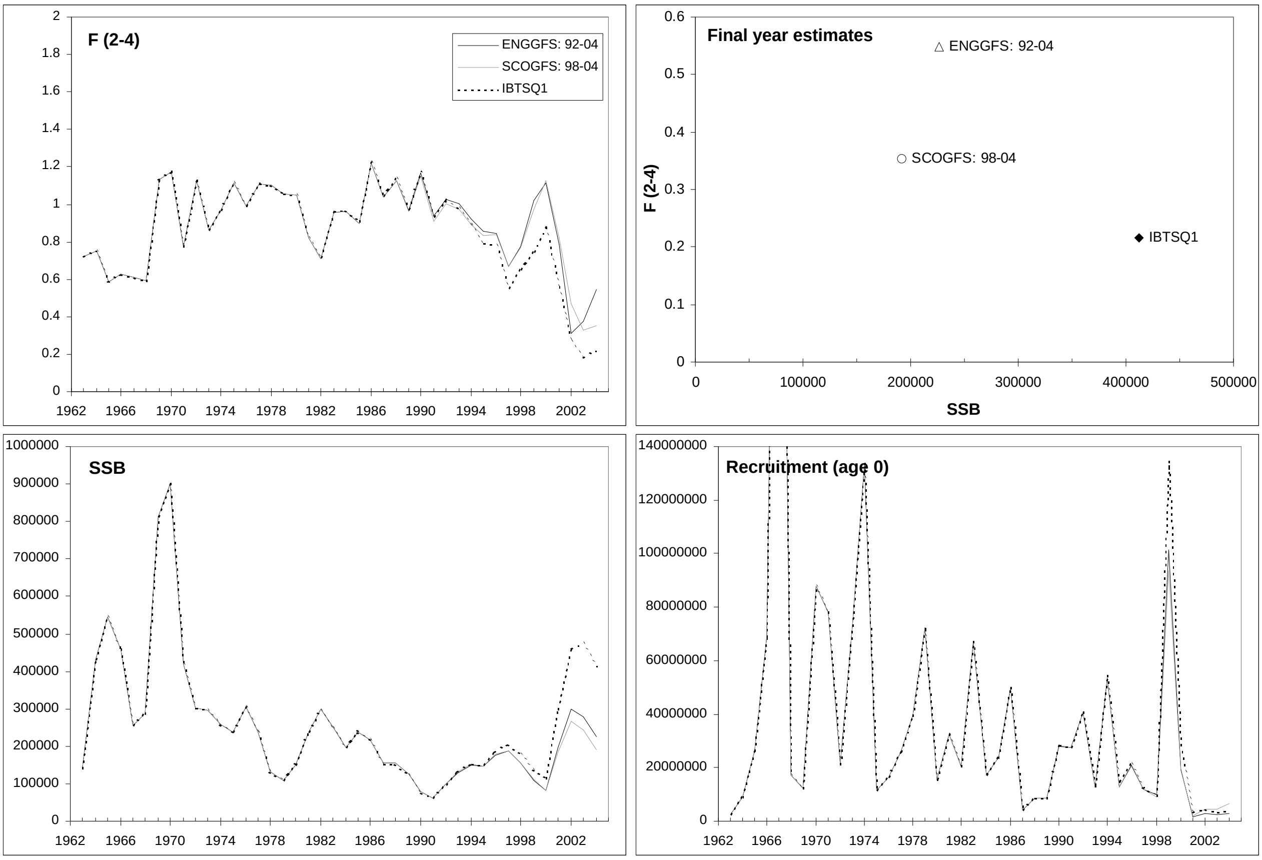


Figure 4.3.1.13 Haddock in Sub-Area IV and Division IIIa. The ratio of survey estimates of total losses through unallocated mortality to the recorded catches (landings + discards). The top plot shows results for cod (from the 2004 WG) and the middle plot those for haddock. The bottom plots shows a time series of B-ADAPT estimated losses from the haddock stock (1993 – 2004, solid squares) and recorded catches (landings + discards, open squares).

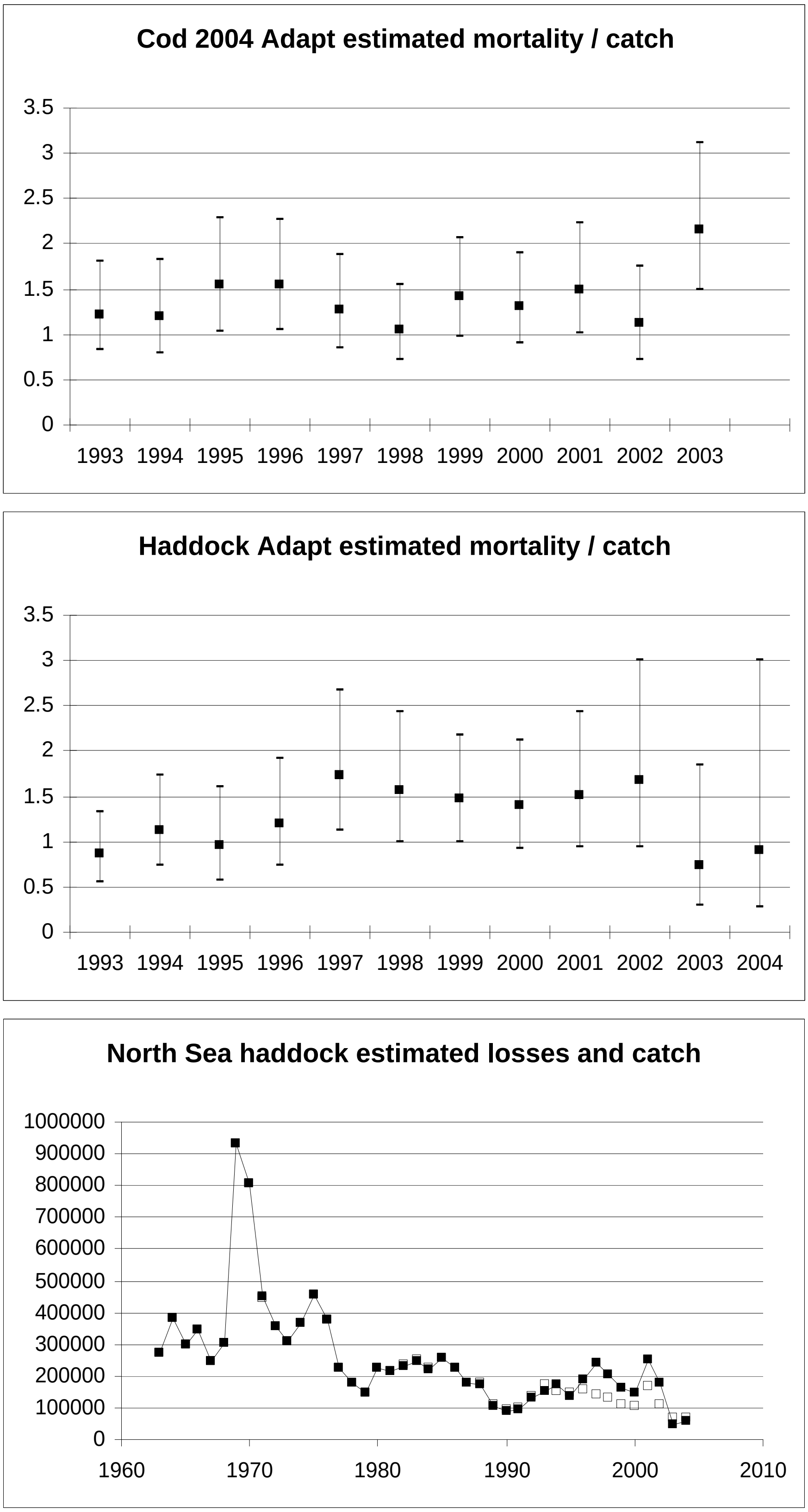


Figure 4.3.1.14 Haddock in Sub-Area IV and Division IIIa North Sea haddock – The time series of B-ADAPT (solid squares) and XSA (open squares) estimated mean F (2-4), SSB and recruitment shown in the top, middle and bottom plots respectively.

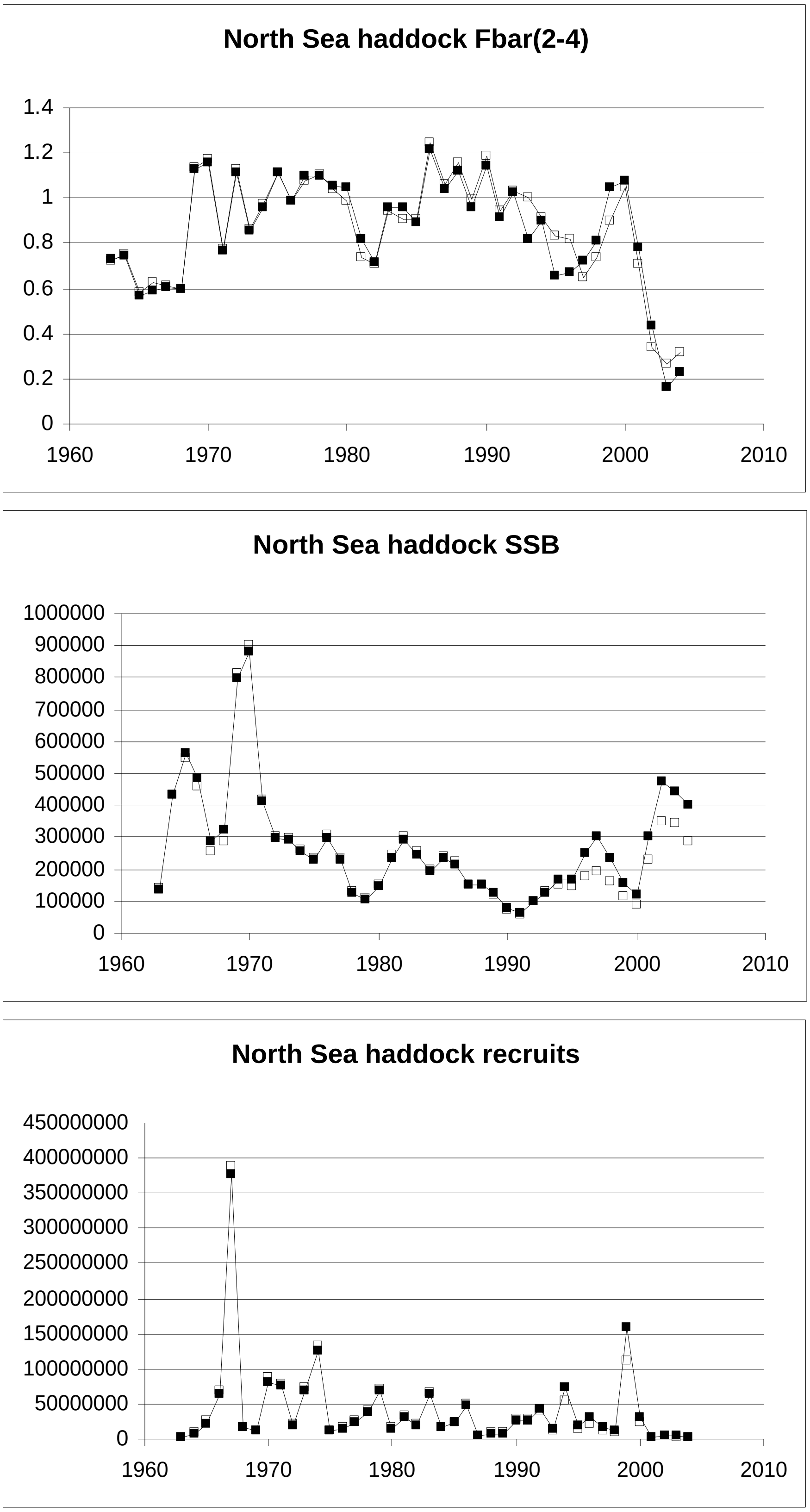


Figure 4.3.2.1 Haddock in Sub-Area IV and Division IIIa. Log-abundance indices by cohort for each of the three tuning fleets (all are surveys; note age 5 for the IBTS Q1 survey is a plusgroup).

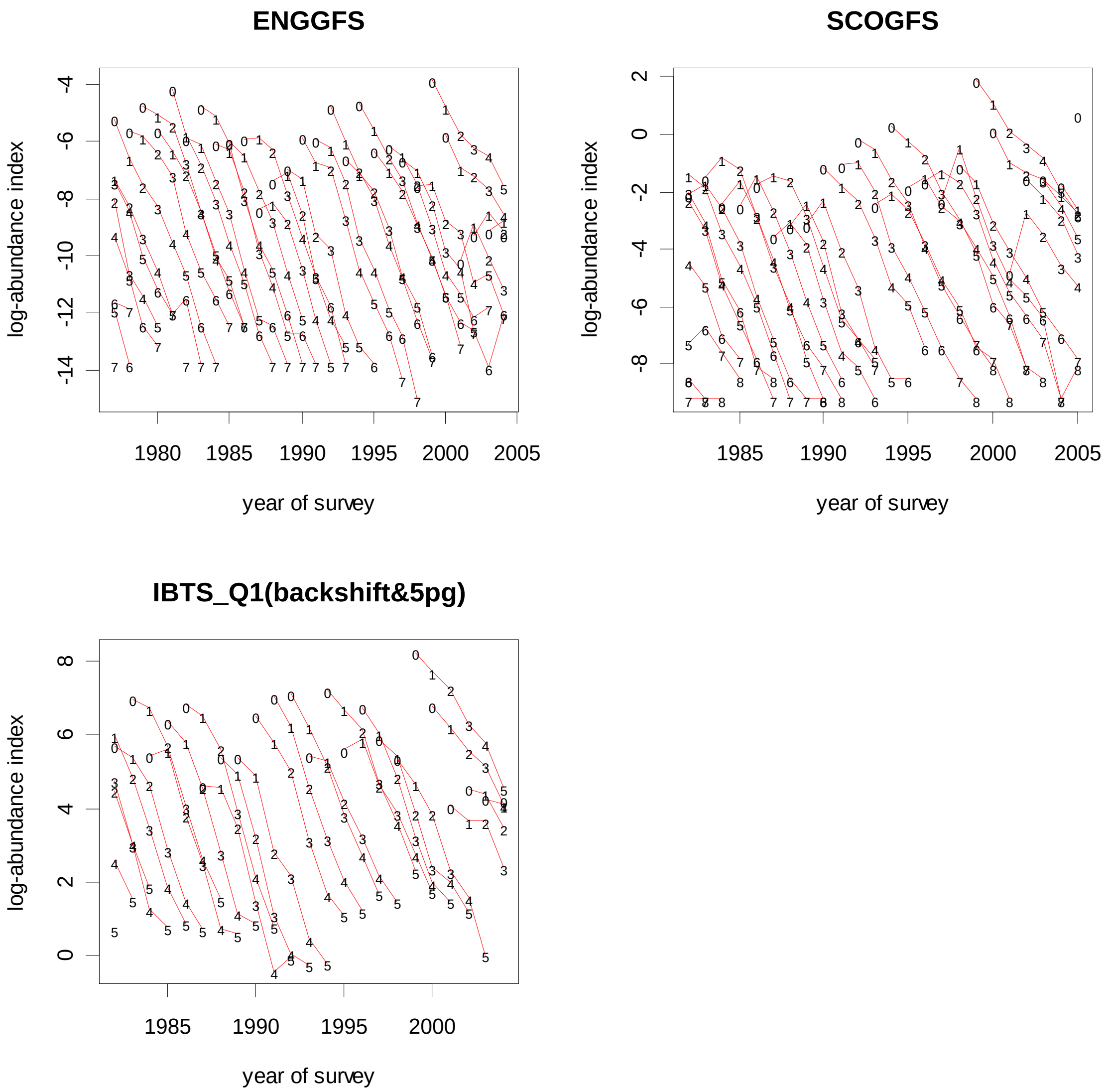


Figure 4.3.2.2 Haddock in Sub-Area IV and Division IIIa. Gradients of log-abundance per cohort for each of the three tuning fleets (all are surveys) for age-ranges specified separately for each fleet, calculated from Figure 4.3.2.1.

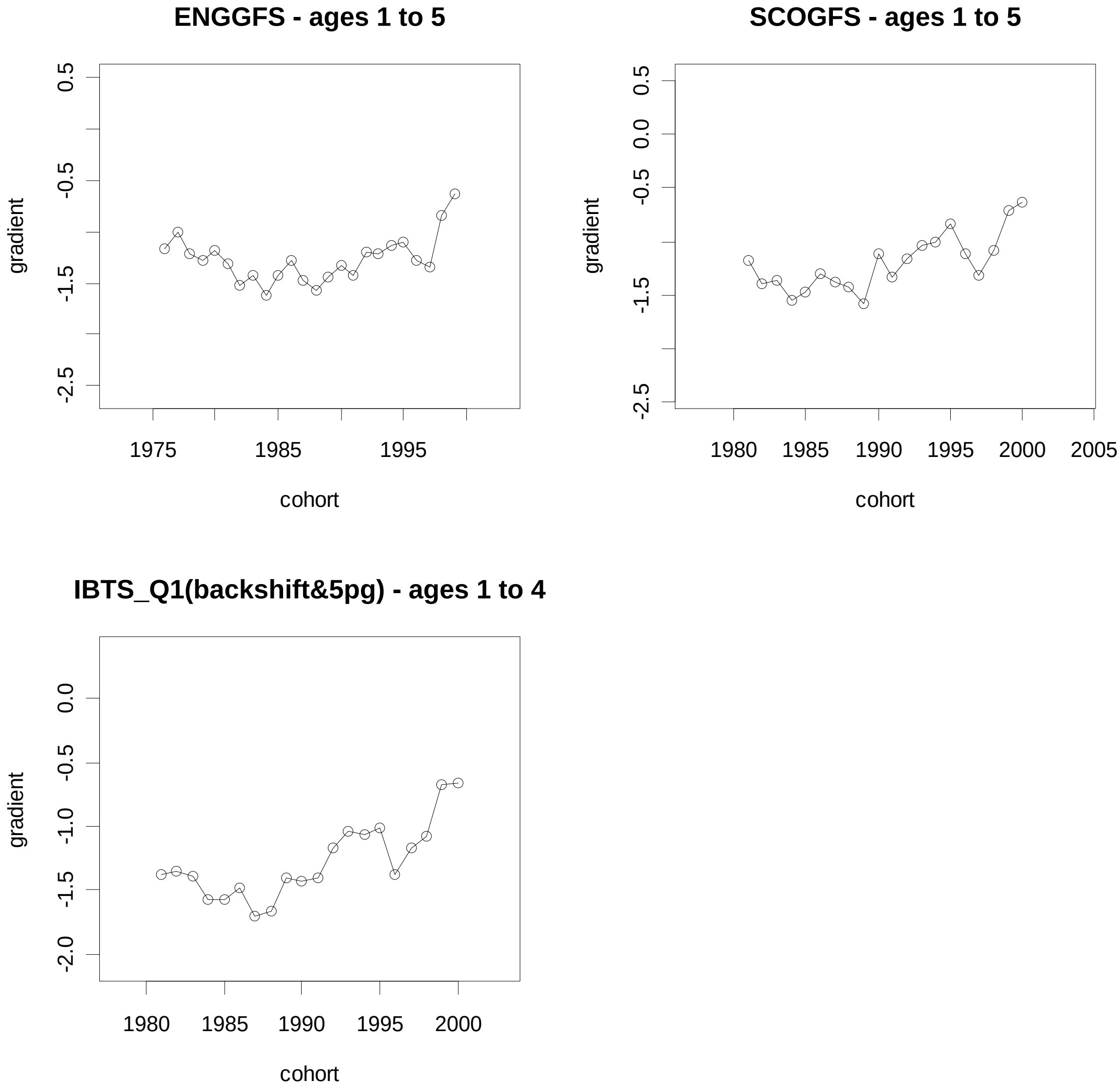


Figure 4.3.2.3 Haddock in Sub-Area IV and Division IIIa. Log-mean-standardised abundance indices by cohort for each of the three tuning fleets (all are surveys; note age 5 for the IBTS Q1 survey is a plusgroup).

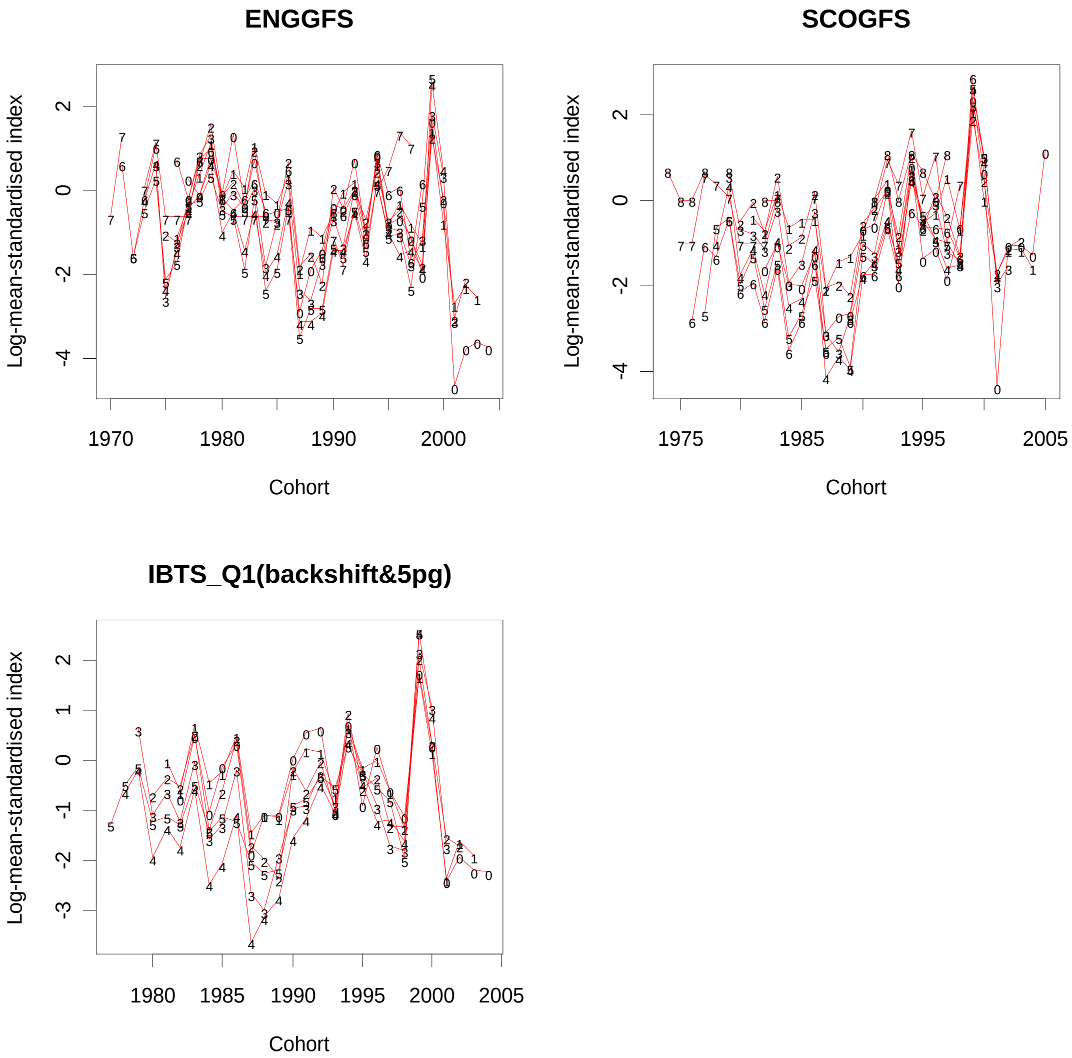


Figure 4.3.2.4 Haddock in Sub-Area IV and Division IIIa. Within-survey correlations for ENGGFS for the period 1977-2004. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line a robust linear regression line, and “cor” denotes the correlation coefficient.

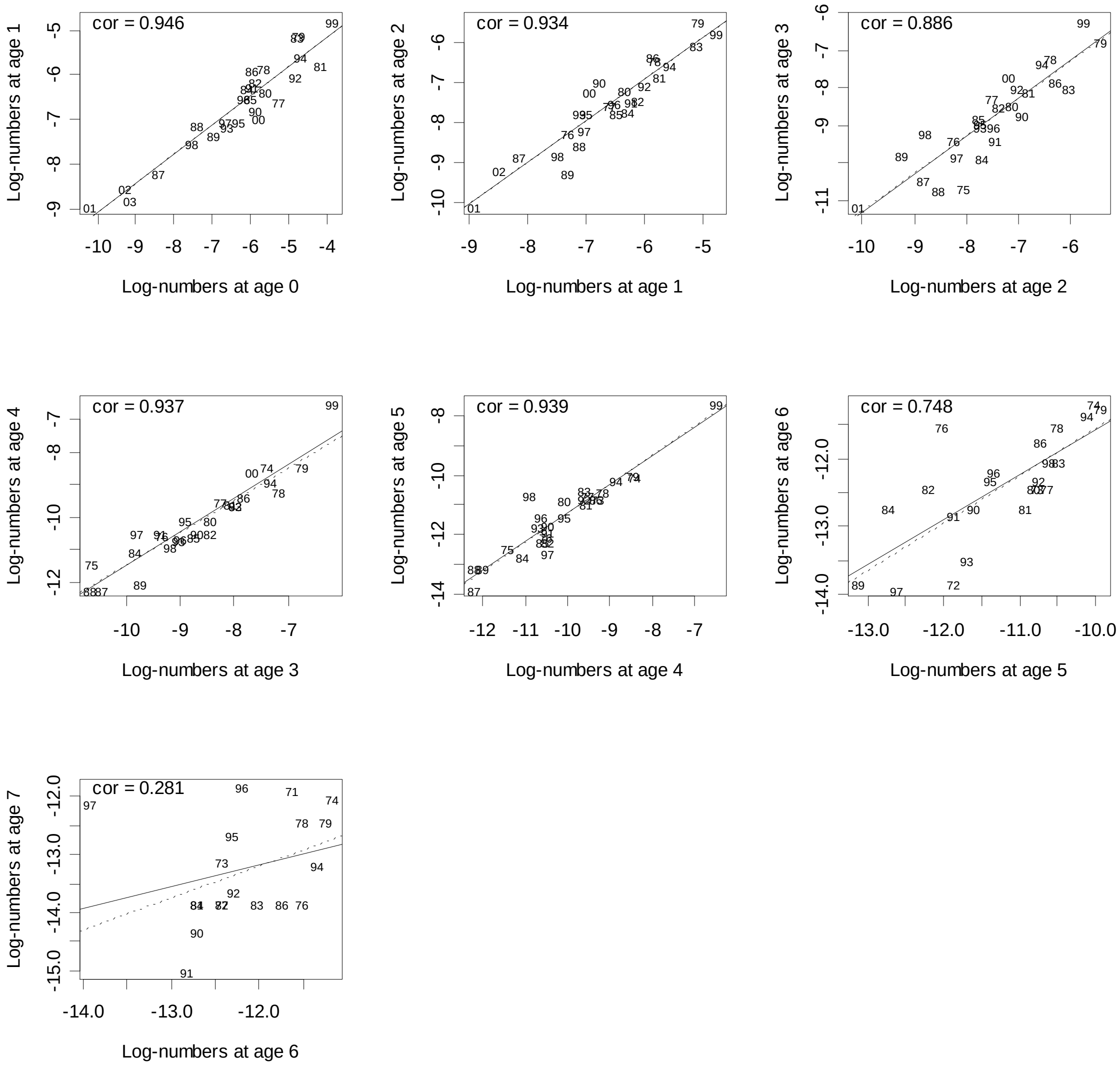


Figure 4.3.2.5 Haddock in Sub-Area IV and Division IIIa. Within-survey correlations for SCOGFS for the period 1982-2005. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line a robust linear regression line, and “cor” denotes the correlation coefficient.

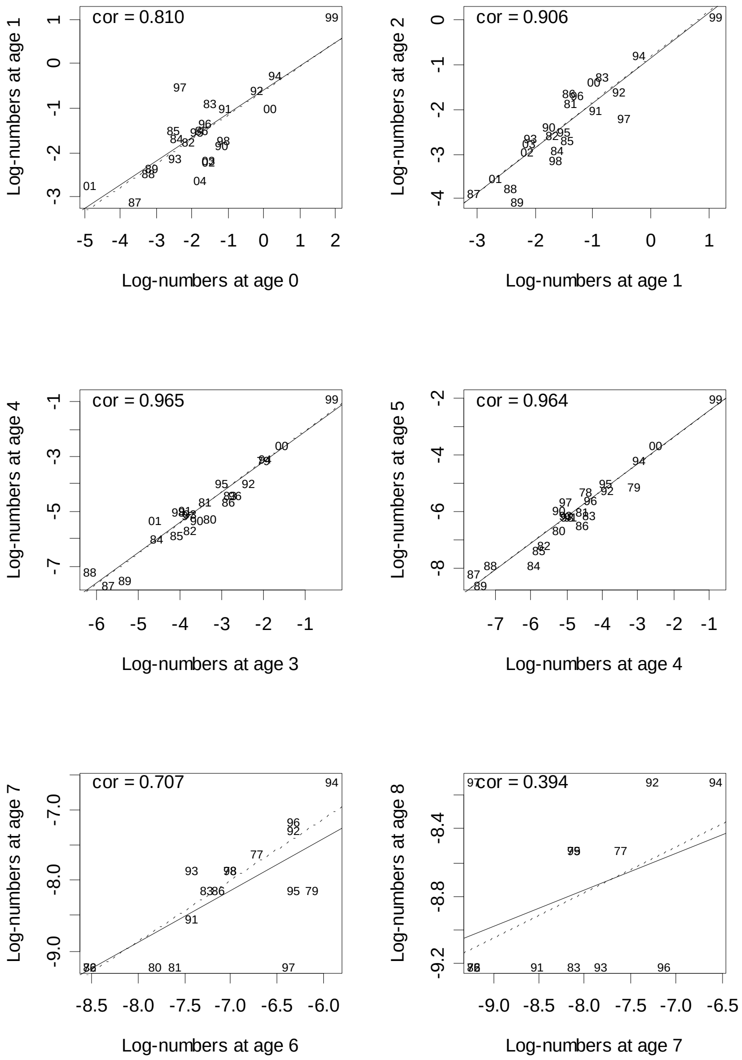


Figure 4.3.2.6 Haddock in Sub-Area IV and Division IIIa. Within-survey correlations for IBTS Q1 (back-shifted; note: age 5 is a plusgroup) for the period 1982-2004. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line a robust linear regression line, and “cor” denotes the correlation coefficient.

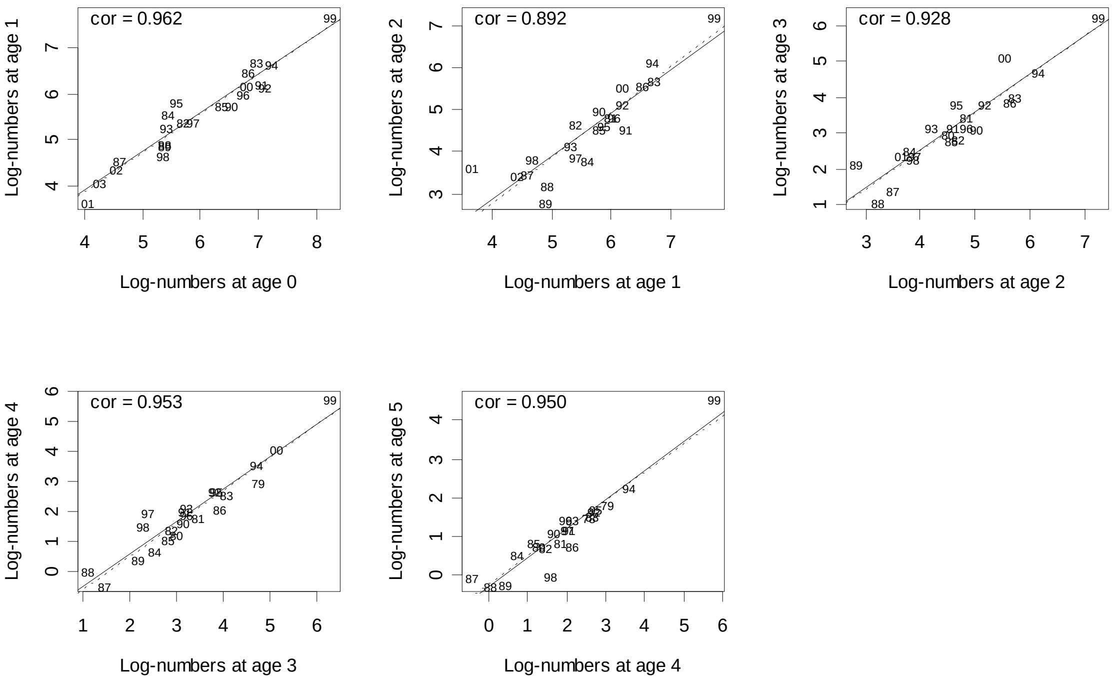


Figure 4.3.2.7 Haddock in Sub-Area IV and Division IIIa. Between-survey correlations for ENGGFS and SCOGFS, by age. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line a robust linear regression line, and “cor” denotes the correlation coefficient.

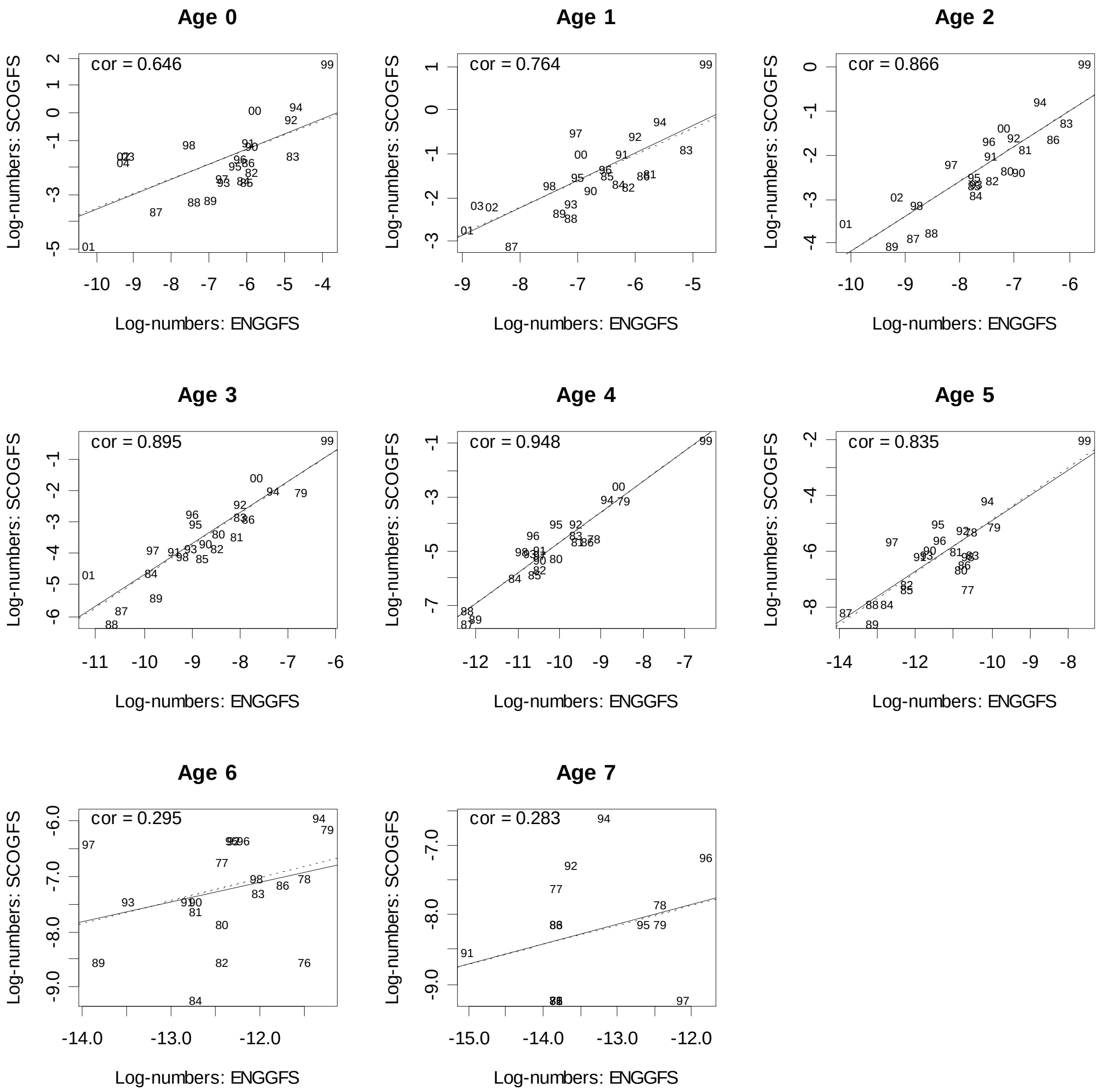


Figure 4.3.2.8 Haddock in Sub-Area IV and Division IIIa. Between-survey correlations for ENGGFS and IBTS Q1 (backshifted; note: age 5 for the IBTS Q1 survey is a plusgroup), by age. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line a robust linear regression line, and “cor” denotes the correlation coefficient.

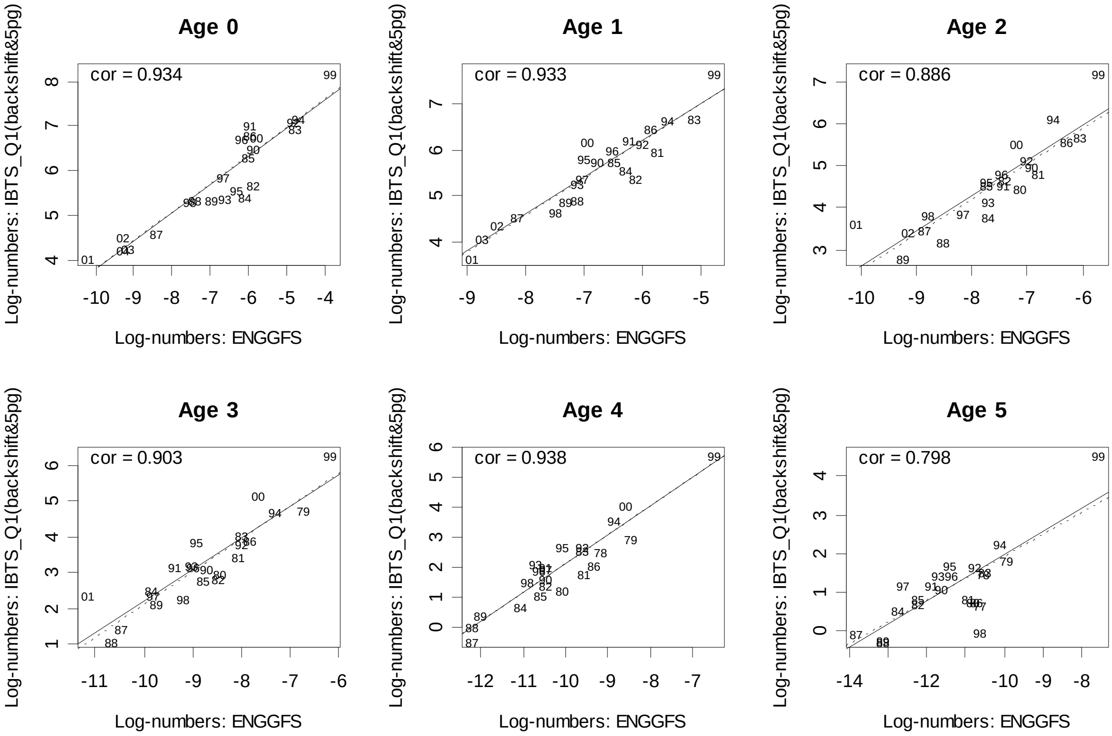


Figure 4.3.2.9 Haddock in Sub-Area IV and Division IIIa. Between-survey correlations for SCOGFS and IBTS Q1 (backshifted; note: age 5 for the IBTS Q1 survey is a plusgroup), by age. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line a robust linear regression line, and “cor” denotes the correlation coefficient.

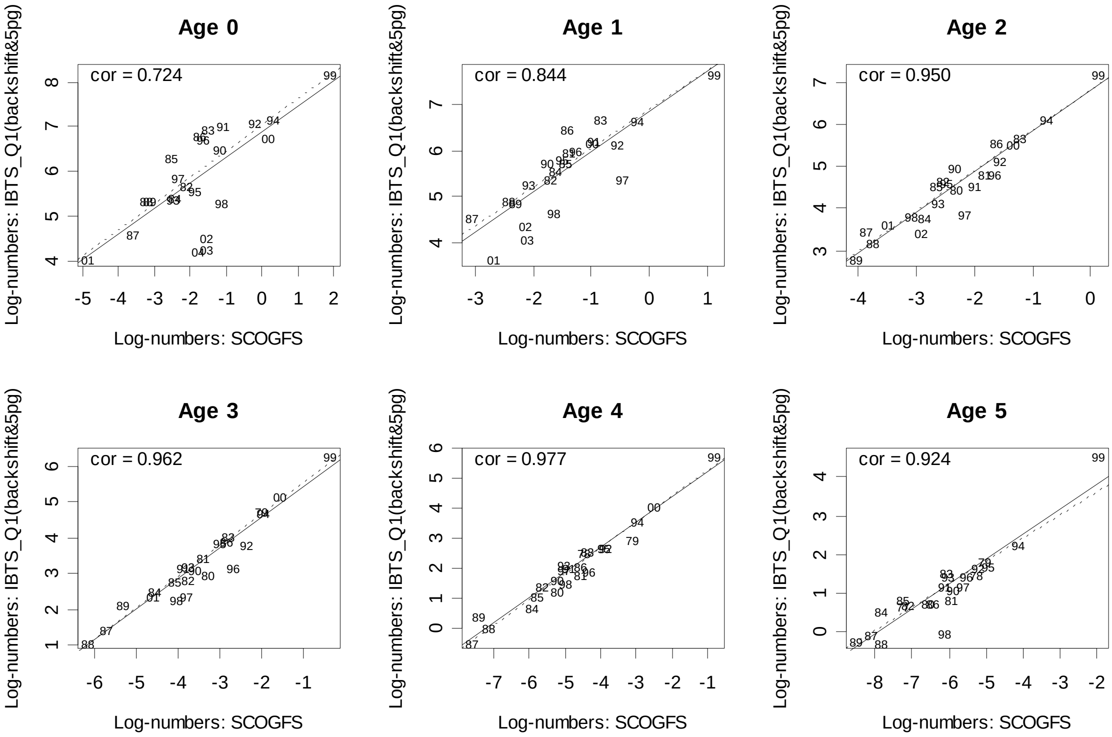


Figure 4.3.2.10 Haddock in Sub-Area IV and Division IIIa. Comparison of XSA final run with single fleet SURBA runs: Relative SSB and mean Z.

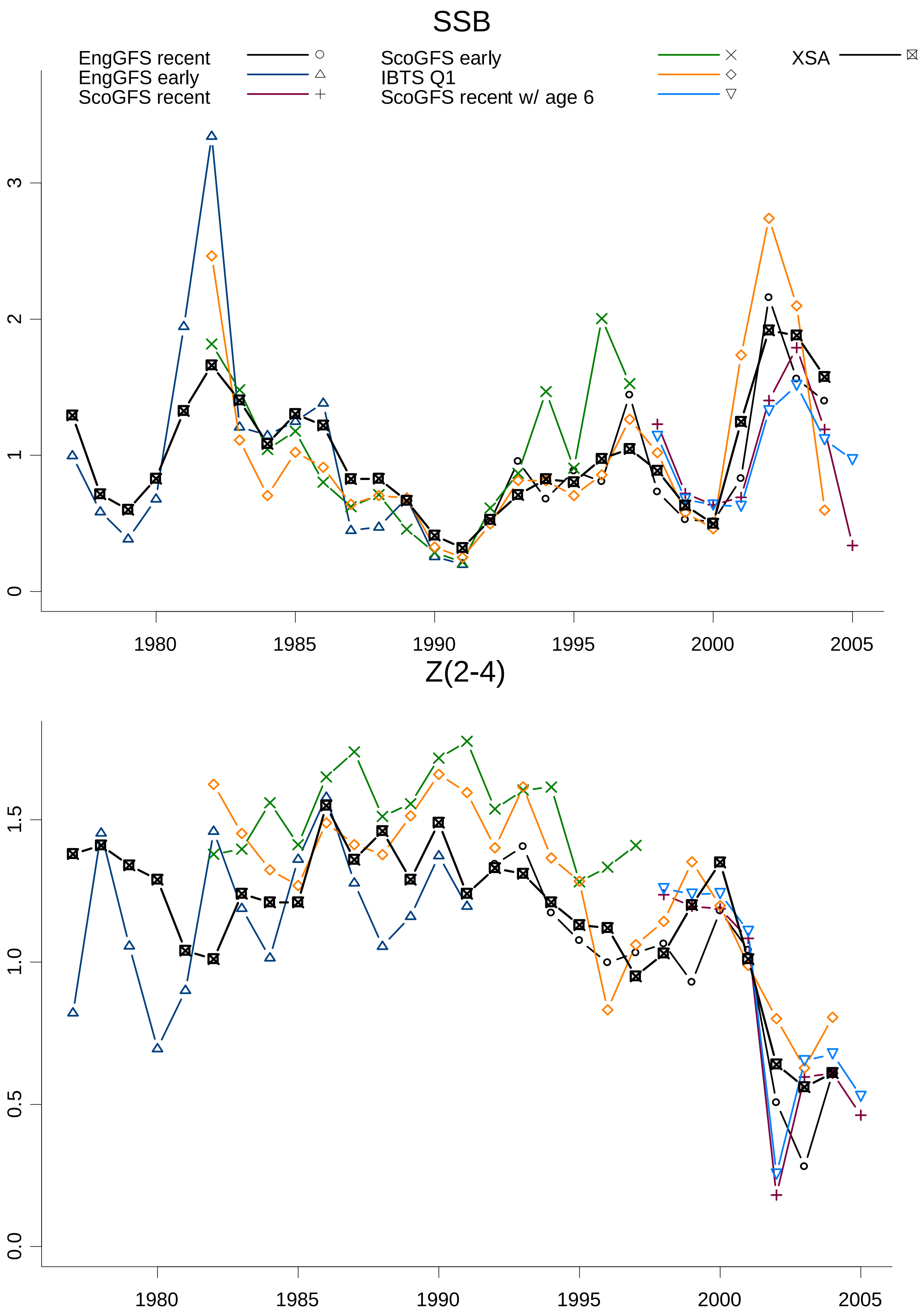


Figure 4.3.4.1 Haddock in Sub-Area IV and Division IIIa. XSA final run: log catchability residuals. The two halves of each of ENGGFS and SCOGFS are treated as independent tuning series, hence the residuals are separated by a solid vertical line indicating the appropriate split in the time series.

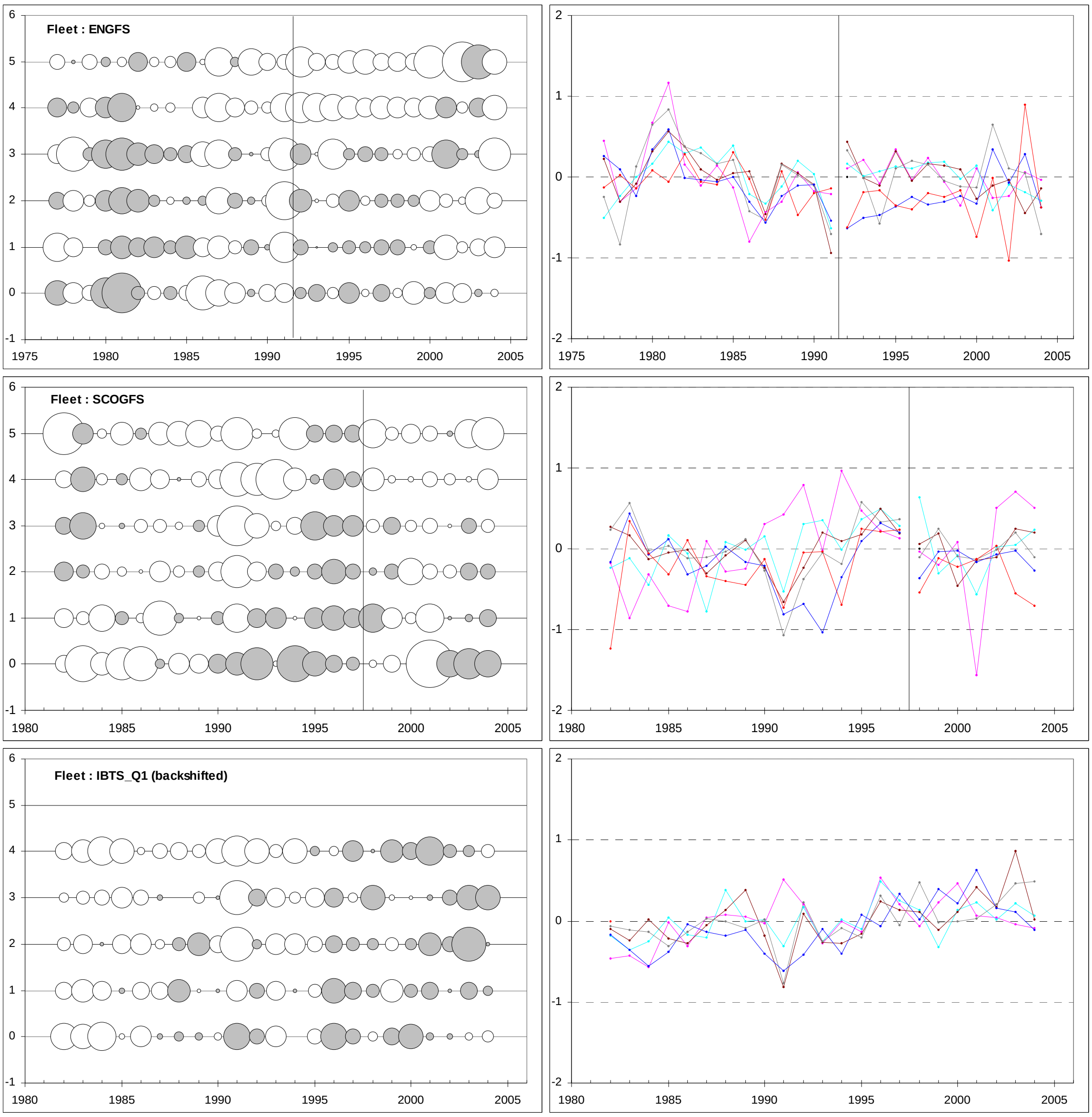


Figure 4.3.4.2 Haddock in Sub-Area IV and Division IIIa. XSA final run: log catchability residuals. This is a repeat of Figure 4.3.7.1, except that the residuals are now lined up by cohort, indicated on the x-axes, with the solid slanted line in the bubble plots indicating the split in the ENGGFS and SCOGFS series. A vertical grey line highlights the residuals associated with the large 1999 year-class.

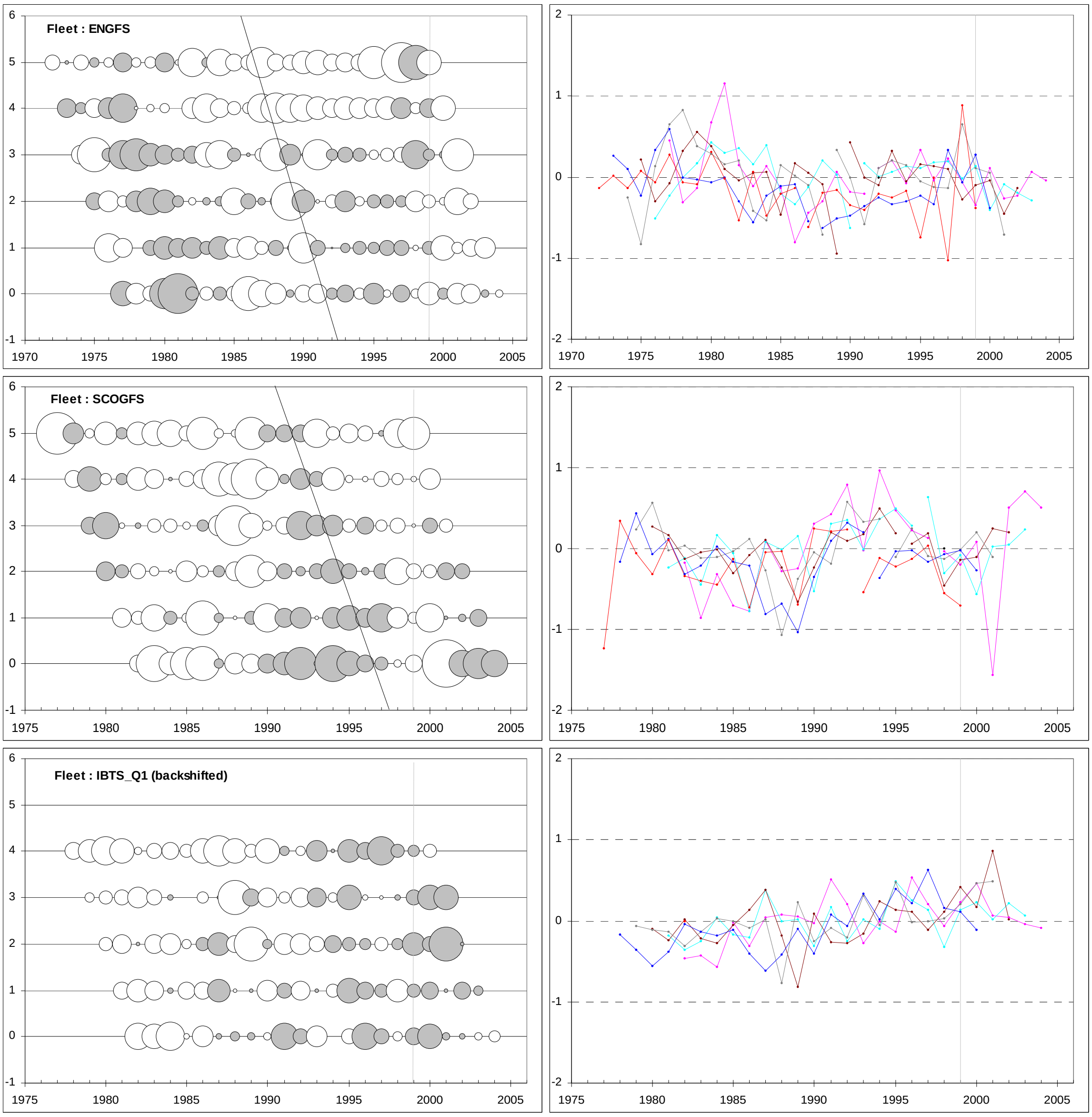


Figure 4.3.4.3 Haddock in Sub-Area IV and Division IIIa. XSA final run: Summary plots. The broken horizontal lines indicate $\mathbf{F}_{pa}$ (top right plot) and $\mathbf{B}_{pa}$ (bottom right plot), while the solid ones indicate $\mathbf{F}_{lim}$ (top right plot) and $\mathbf{B}_{lim}$ (bottom right plot).

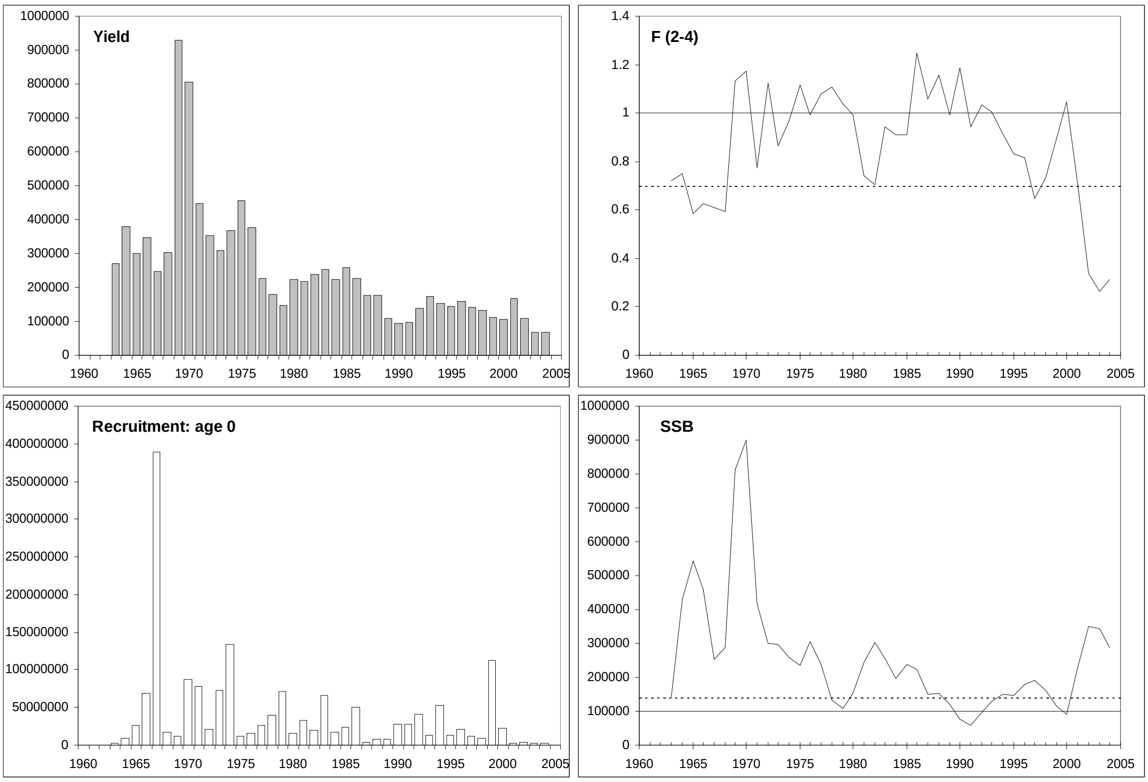


Figure 4.3.4.4 Haddock in Sub-Area IV and Division IIIa. XSA final run: retrospective patterns (last 3 years).

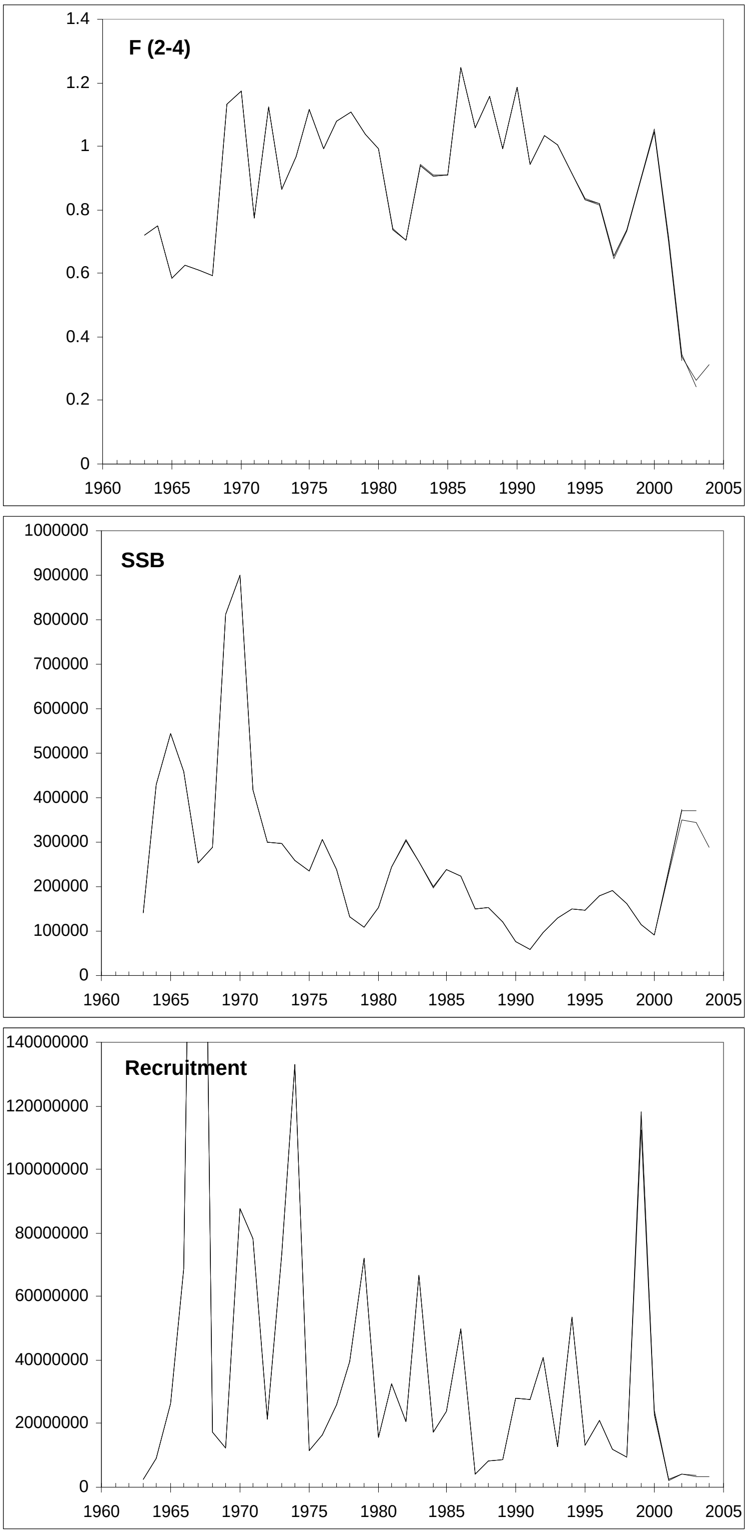


Figure 4.5.1 Haddock in Sub-Area IV and Division IIIa. Scottish groundfish survey CPUE for age 0 in quarter 3 (line) compared to estimates of recruits at age 0 from the final XSA run (bars shaded grey), with the recruitment for 2005 (estimated using RCT3) taken forward in the short term forecast, shaded in black.

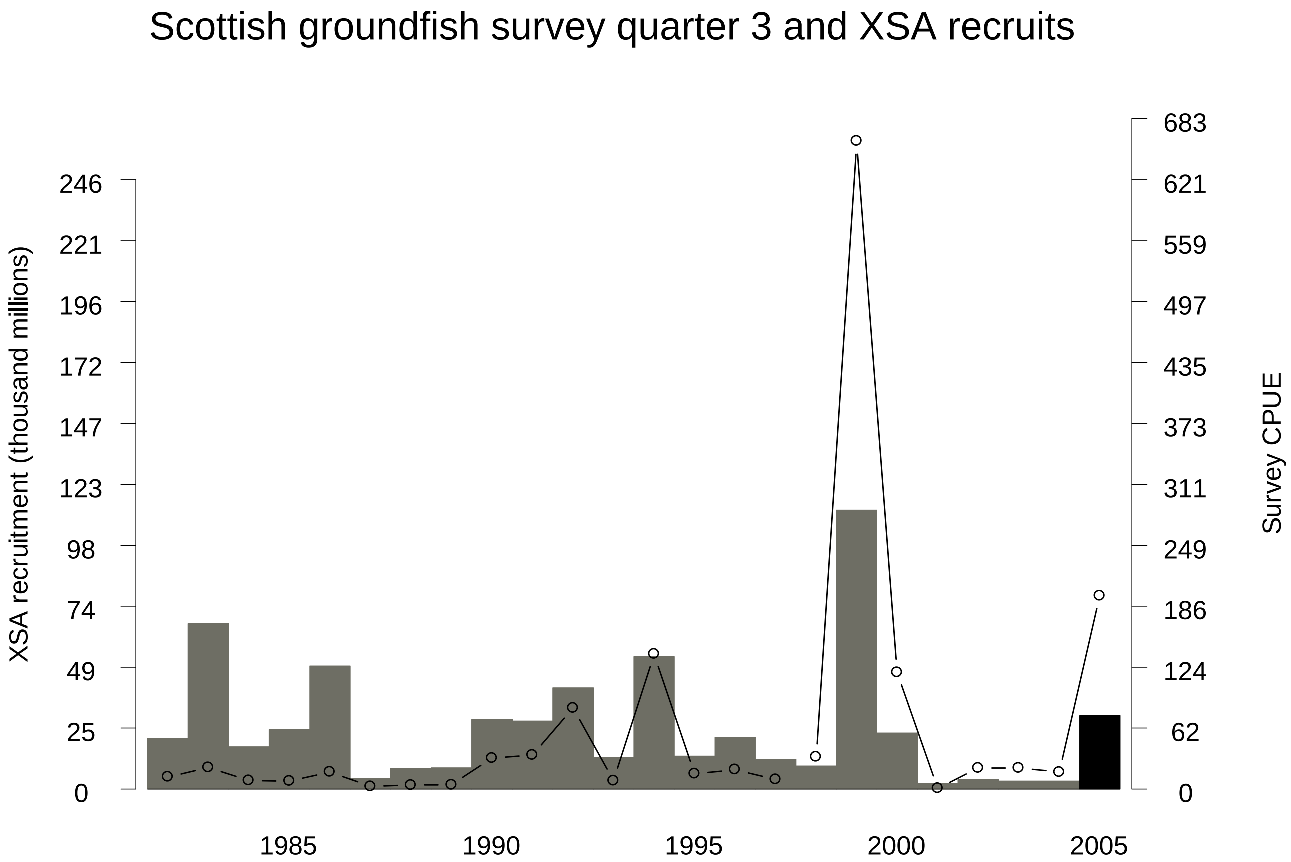


Figure 4.6.1 Haddock in Sub-Area IV and Division IIIa. Mean weights-at-age of the total catch by year class, shown for the 1999 and 2000 year-classes, and for the overall mean for year-classes 1953-2004. The hashed lines reflect 2 standard deviations from the overall mean.

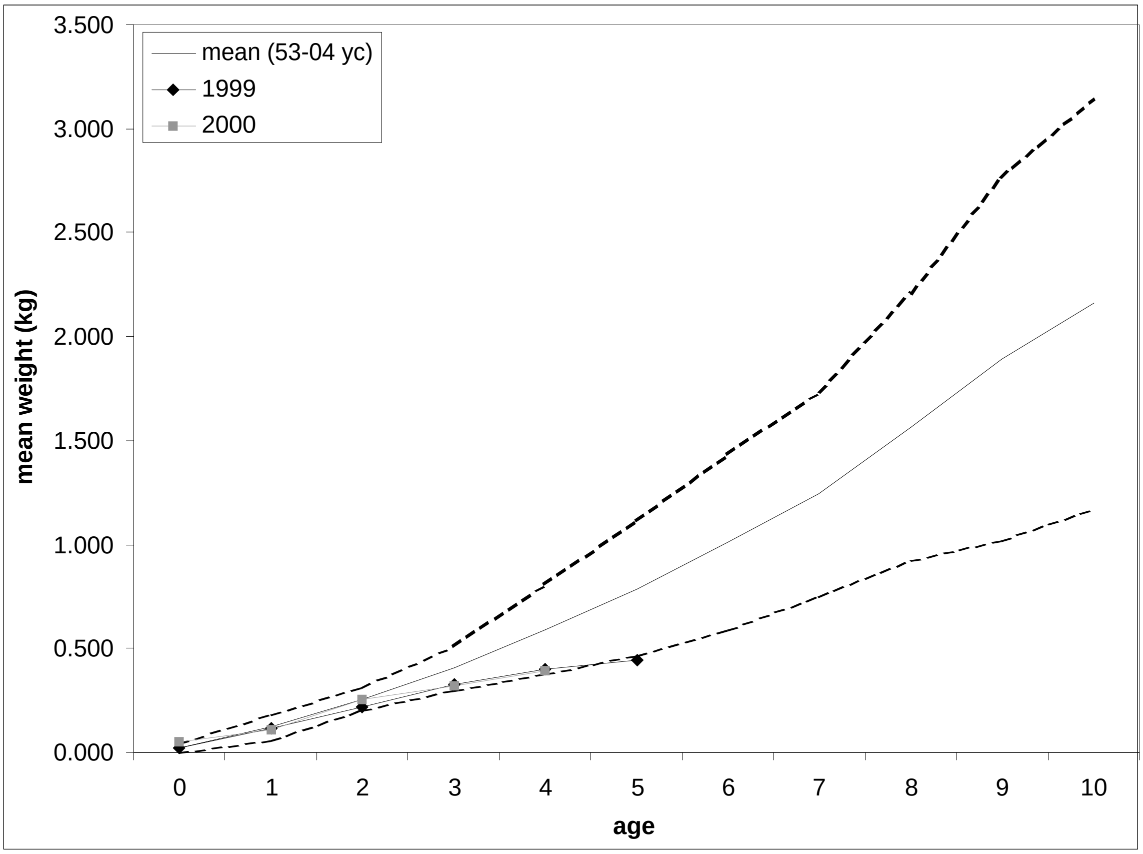


Figure 4.6.2 Haddock in Sub-Area IV and Division IIIa. Overall exploitation pattern (top plot) and exploitation pattern by catch component (bottom plot), averaged over 2002-2004. Exploitation on the 1999 year-class is shown in the top plot. The 1999 year-class has been excluded from the calculation of the overall exploitation pattern (thick line in top plot), and from the catch component-based exploitation patterns (all curves in bottom plot).

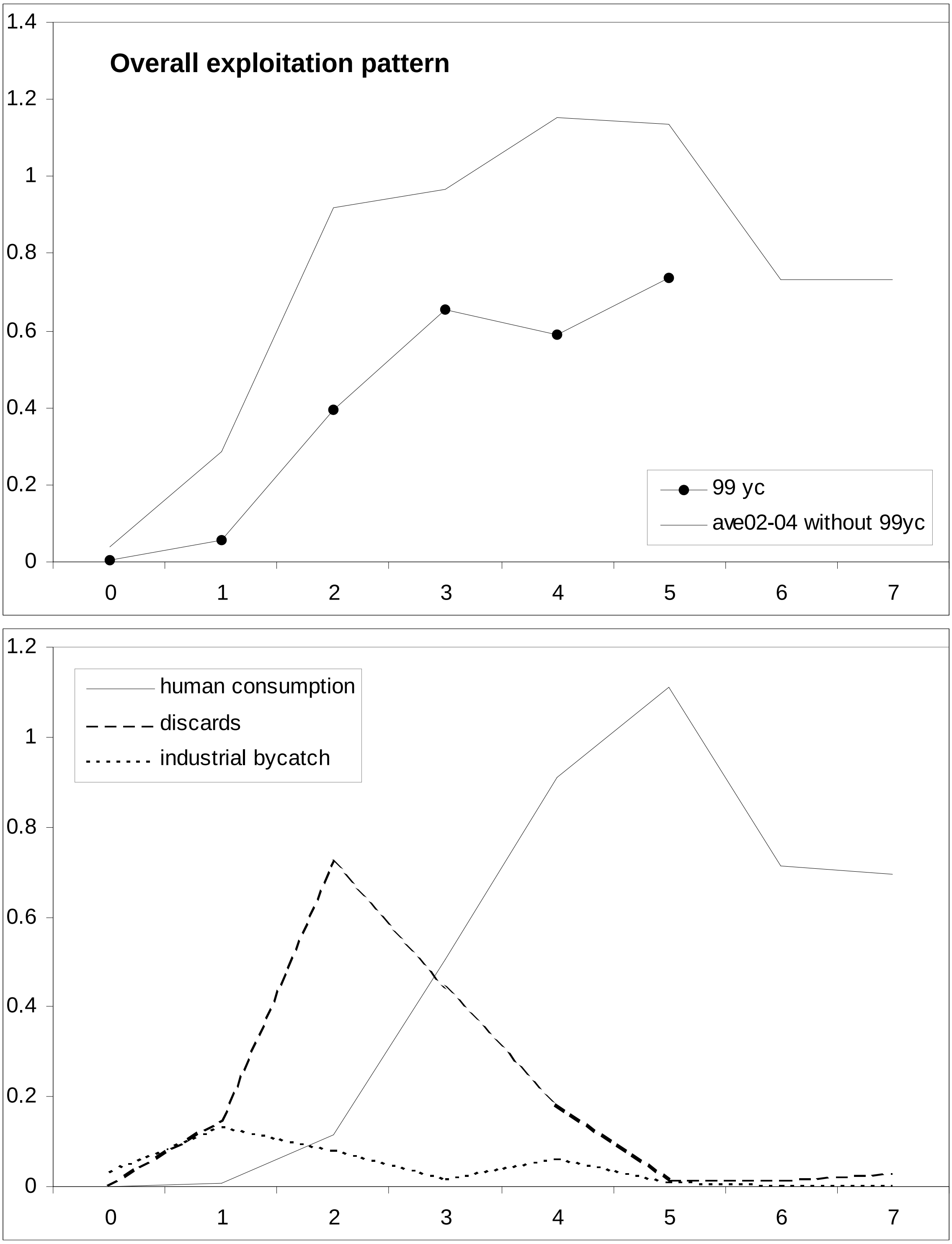


Figure 4.10.1 Haddock in Sub-Area IV and Division IIIa. Historical performance of the assessment.

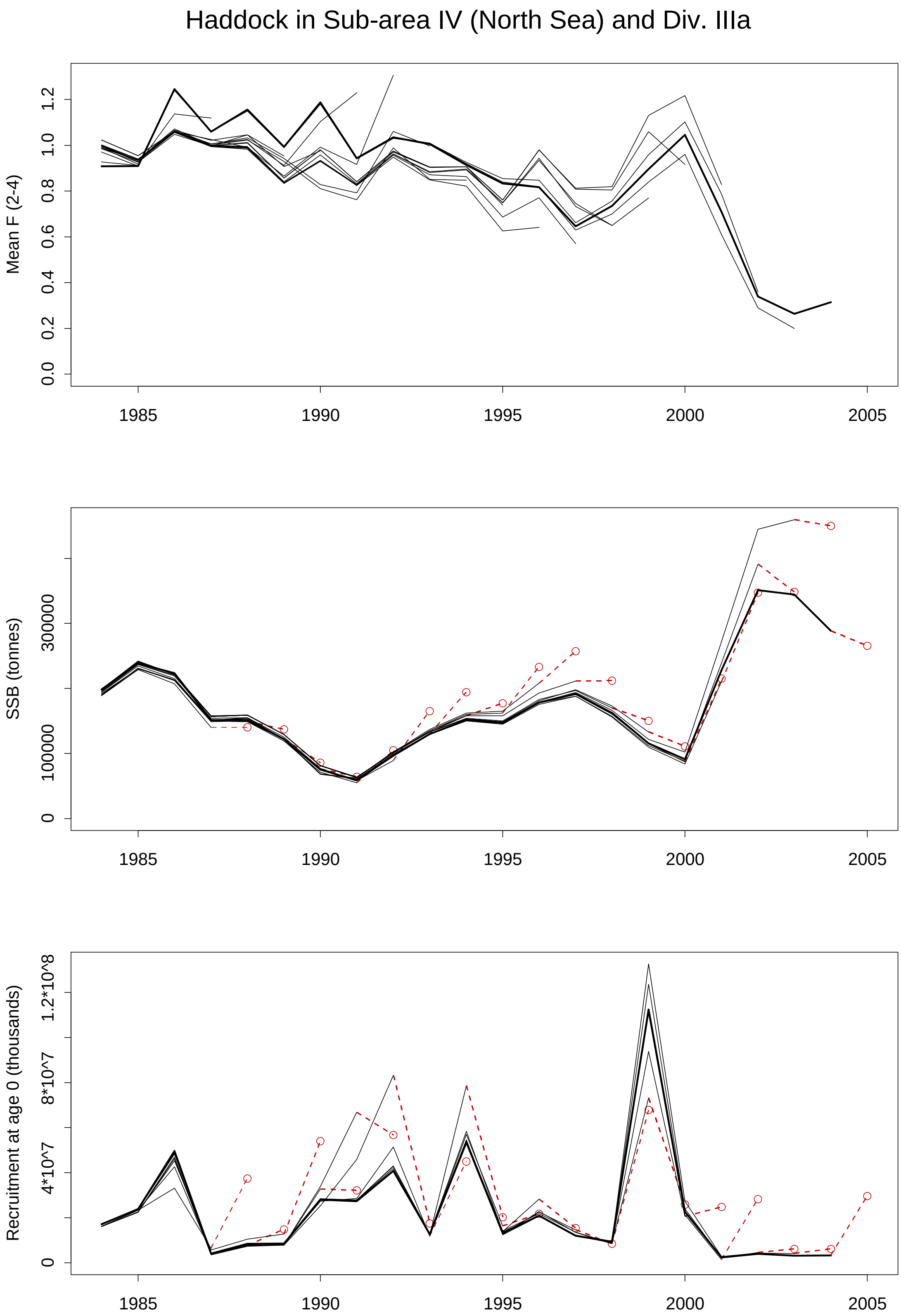
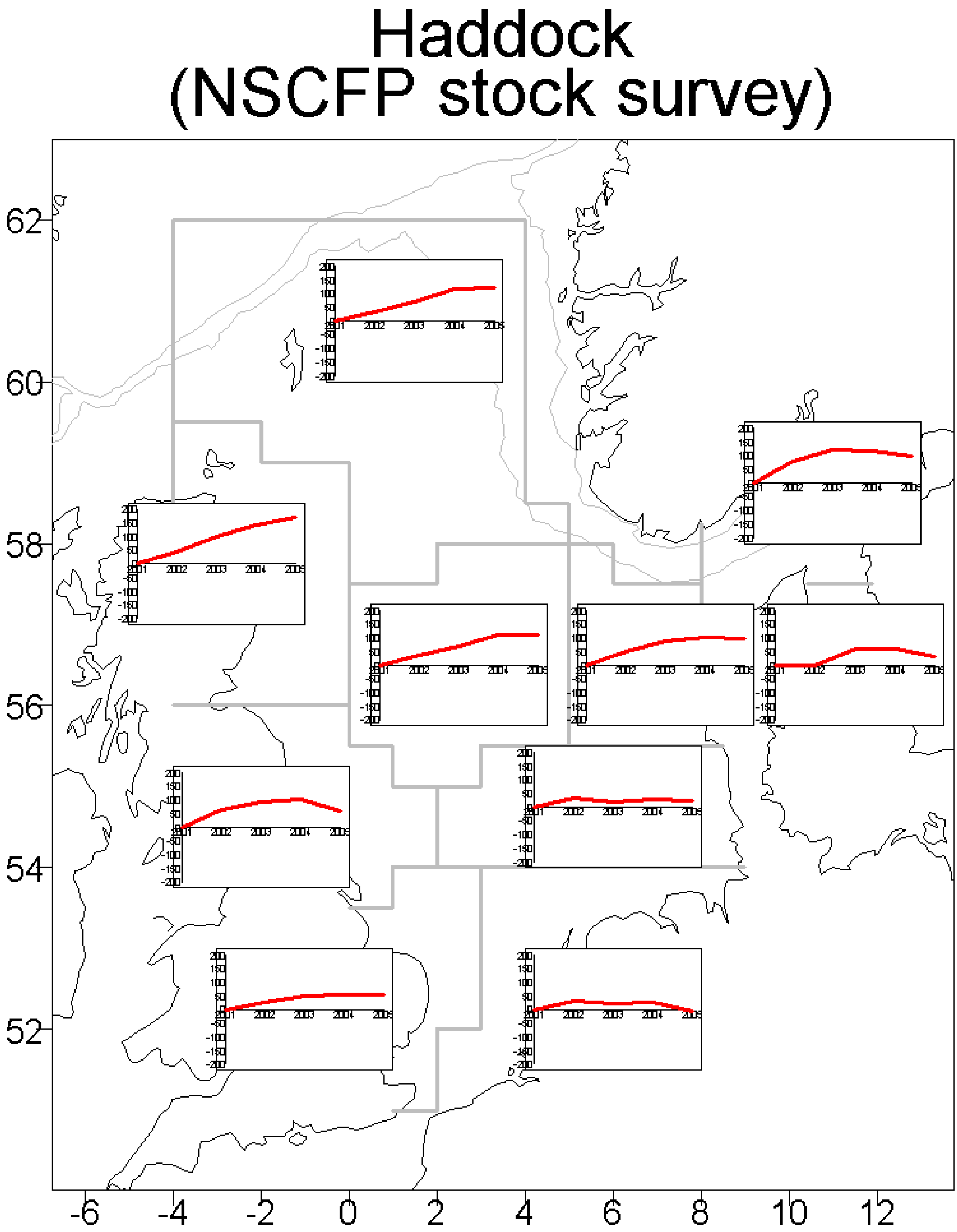


Figure 4.11.1 Haddock in Sub-Area IV and Division IIIa. Results of the North Sea fishermen survey.



5 Whiting in Sub-area IV and Divisions VIId and IIIa

5.1 Whiting in Sub-area IV and Divisions VIId - General

Since 1996 this assessment has covered whiting in the North Sea (ICES Sub-area IV) and eastern Channel (ICES Division VIId). Prior to 1996 whiting in these areas were assessed separately. The current assessment was formally to be classified as an update assessment. However, in the absence of an agreed assessment from the last working group meeting (2004), additional evaluations were carried out to build on the previous benchmark assessment exercise. In addition, a meeting of the new Study Group on Stock Identity and Management Units of Whiting (SGSIMUW) has reported to ICES (ICES CM 2005/G:03) and information from it has contributed to the work undertaken here.

5.1.1 Ecosystems aspects

Whiting are found throughout the North Sea, predominantly to the south of the Norwegian Deep and its extension around the north of the Shetland Isles. The report of the SGSIMUW documents the background to the basis of the long-held view that whiting in the northern and southern North Sea comprise diferent stock units, and concludes that sufficient information exists to support the view of stock units that are separated in the region of the Dogger Bank – an area associated in the summer with the separation of mixed and stratified water and roughly approximated by the 50m depth contour. Limited tagging information indicates limited movement of whiting across this boundary.

Results from key runs of the ICES SG on Multispecies Assessment in the North Sea (SGMSNS) (ICES CM 2005/D:06) indicate three major sources of mortality for whiting. For ages three and above, the primary source of mortality is the fishery, followed by predation by seals and, in earlier periods, by cod. For ages 0-1, grey gurnard is a very important important predator. More notable, there is evidence for cannibalism on the 0- and 1-group. It has been postulated by Bromley et al. (1997) that the spawning habit of whiting, *i.e.*, multiple spawings over a protracted period, may provide continued food resources for earlier spawned 0-group whiting.

Results from SGMSNS shows that that the main diet of whiting is commercial important fish species, and that predominant prey species of whiting were whiting, sprat, Norway pout, sandeel and haddock.

5.1.2 The Fishery

For whiting, spatial information on landings suggest three distinct areas of major catch: a northern zone, an area off the eastern English coast; and a southern area extending into the English Channel.

In the northern area, roundfish are caught in otter trawl and seine fisheries, currently with a 120 mm minimum mesh size. These are mixed demersal fisheries with more specific targeting of individual species in some areas and/or seasons. Cod, haddock and whiting form the predominant roundfish catch in the mixed fisheries, although there can be important bycatches of other species, notably saithe and anglerfish in the northern and eastern North Sea and of *Nephrops* in the more offshore *Nephrops* grounds. The southern whiting fishery uses 80 mm nets and is, in part, regulated by catch composition rules.

Whiting also comprise a bycatch in the beam trawl fisheries and the *Nephrops* fisheries, both of which can operate with 80 mm mesh sizes depending on area (beam trawls) or gear configuration (*Nephrops* trawls).

The increase in minimum mesh size in the towed demersal roundfish fisheries was forecast to lead to short-term losses in yield that would not be expected to be recovered as long-term gains (Kunzlik, 2003). Fishers directly affected by this change also consider the effect will be a loss in yield. Due to the EC regulations affecting fishing activity (section 5.1.4) it is known that some vessels that have switched activity from the roundfish fisheries into the *Nephrops* fisheries to gain more permitted days at sea. This will in part offset losses in the yield of whiting attributible to the increased minimum mesh size in the towed demersal roundfish fisheries due to the smaller mesh size that can be used in the *Nephrops* fishery.

In 2005, fuel price increases and a lack of quota for deep-water species has resulted in some vessels formerly fishing in deep-water and along the shelf edge to move into the northern North Sea with the shift in fishing grounds likely to result in achange in the species composition of their catches from monkfish to roundfish species including whiting.

5.1.3 ICES advice

For the fishery in 2004, the ICES advice was presented in a format to provide mixed-fishery advice. For whiting the single species exploitation boundaries were that:

> *Fishing mortality in 2004 should be less than* $\boldsymbol{F}_{pa}$*. Catch should not increase in 2004 compared to recent years.*

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 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, 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.

ICES considerations in 2004 for the fishery in 2005 was that the state of the stock was unknown. With respect to the single stock exploitation boundaries and precautionary limits, it considered in the light of inconsistencies in the assessment that catches in 2005 should not be allowed to increase above the recent average of 52 000t (1997-2003) implying human consumption landings in 2005 of 25 000 t.

For all demersal fisheries in the North Sea, ICES advice for 2005 was based on mixed-fishery considerations and it advised the following:

Fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2004 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

with minimal bycatch or discards of cod;

Implement TACs or other restrictions that will curtail fishing mortality for those stocks … for which reduction in fishing pressure is advised;

within the precautionary exploitation limits for all other stocks.

Where stocks extent beyond this area, e.g. into Division VI (saithe and anglerfish) or is widely migratory (Northern hake) taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;

5.1.4 Management

Management of whiting is by TAC and technical measures. The agreed TACs for whiting in Subarea IVand Division IIa (EU waters) was 16 000t in 2004 and 28 500 in 2005.

EU technical regulations in force in 2004 and 2005 are contained in Council Regulation (EC) 850/98 and its amendments. For the North Sea, the basic minimum mesh size for towed gears for roundfish was 120 mm from the start of 2002, although under a transitional arrangement until 31 December 2002 vessels were allowed to fish with a 110 mm codend provided that the trawl was fitted with a 90 mm square mesh panel and the catch composition of cod retained on board was not greater than 30% by weight of the total catch. From 1 January 2003, the minimum mesh size for towed roundfish gears has been 120 mm. Restrictions on fishing effort were introduced in 2003 and details of it implementation in 2004 can be found in Annex V of Council Regulation (EC) no. 2287/2003 and for 2005 in Annex IVa of Council Regulation (EC) no 27/2005. The minimum landing size for whiting in the North Sea is 27 cm.

Whiting are a by-catch in some *Nephrops* fisheries that use a smaller mesh size, although landings are restricted through by-catch regulations. They are also caught in flatfish fisheries that use a smaller mesh size. Industrial fishing with small-meshed gear is permitted, subject to by-catch limits of protected species including whiting. Regulations also apply to the area of the Norway pout box, preventing industrial fishing with small meshes in an area where the by-catch limits are likely to be exceeded.

There is no separate TAC for Division VIId, landings from this Division are counted against the TAC for Divisions VIIb-k combined (27 000 t in 2004 and 21 600t in 2005). The minimum mesh size for whiting in Division VIId is 80 mm, with a 27 cm minimum landing size.

5.2 Data available

Total nominal landings are given in Table 5.2.1 for the North Sea (Sub-area IV) and Eastern Channel (Division VIId).

5.2.1 Landings and Discards

In 2002, the working group decided to truncate the catch-at-age data to start from 1980. This was due to the very large change in estimated recruitment levels around 1980 that was present in the assessment. The working group could not determine whether this was due to a shift in the recruitment regimen or because discard data for years prior to 1978 were not measured but estimated according to a discard ogive that may not have been representative of discarding during the earlier period (biological reference points for this stock had originally been established on the basis of the truncated series, so this represented no change with respect to them).

For the North Sea, the total international catches were 24 700 t in 2004, of which 9 200 t were human consumption landings, 14 200 t discards and 1 200 t industrial by-catch. The human consumption landings were the lowest ever recorded. Discards in the North Sea, although greater than the landings, were the second lowest value recorded. The whiting industrial bycatch was also the lowest on record due to the very limited fishery for Norway pout in 2004. For the eastern Channel, the total catch in 2004 (4 300 t) was below the average of the last 20 years.

No short-term catch predictions have been presented for this stock for the last two years, so it is not possible to compare the actual 2004 catches with earlier predictions.

Total international catches as estimated by the Working Group for the combined North Sea and Eastern Channel are shown in Table 5.2.2 for this period. Eastern Channel catches as used by the Working Group are also shown separately in Table 5.2.3. Catch by category (human consumption landings, discards and industrial by-catch) are shown in Figure 5.2.1 for the period 1980-2004. Discard data apply to the North Sea catches only. In earlier years when eastern Channel landings were a much smaller proportion of the landings from the combined areas, the omission of discard data for eastern Channel whiting would be of less concern than now, where eastern Channel landings comprise around one third of the combined area landings. There is no industrial fishery in the eastern Channel.

It can be seen from Figure 5. 2.1 that human consumption landings have fluctuated around approximately 45% of the total catch during the period 1980-2004.

Mis-reporting of whiting is not considered to be a problem.

5.2.2 Age compositions

Total international catch numbers at age (IV and VIId combined) are presented in Table 5.2.4. Total international human consumption landings (North Sea and eastern Channel combined) are given in Table 5.2.5. Discard and industrial by-catch numbers at age for the North Sea are presented in Tables 5.2.6 - 5.2.7. The Scottish discard estimates are raised to international landings for the North Sea fleets. This reflects historical practice but may be inappropriate due to different spatial distributions in fleet effort and discarding practices; however, other nation’s discard values have yet to be supplied in a form that can be used in the assessment, for example only partial rather than complete age-compositions may be provided

The total catch of whiting for the period 1980-2004 has generally comprised in excess of 80% one- to three-year olds. In 2004 that figure fell to approximately 60%, with a low representation of two-year-olds (2002 yearclass).

5.2.3 Weight at age

Mean weights at age (Sub-Area IV and Division VIId combined) in the catch are presented in Table 5.2.8. these are also used as stock weights. Mean weights at age (both areas combined) in human consumption landings are presented in Table 5.2.9, and for the discards and industrial by-catch in the North Sea in in Tables 5.2.10 and 5.2.11. These are shown graphically in Figure 5.2.2.

The mean weight-at-age of age 1 whiting in human consumption landings increased in 2002-2004, as did the mean weights of the youngest ages discarded in 2004. Although this is not an indication of a permanent change and may just reflect variability in the data, it remains possible that this is a consequence of the 2002 minimum mesh-size increase in towed demersal roundfish gears. An increase in the mean weight-at-age in the catch resulting from a change in minium mesh-size will, where weight in the catch is assumed to equal weight in the stock, bias the stock mean weights relative to the period before the mesh increase.

5.2.4 Maturity and natural mortality

Values for natural mortality and maturity remain unchanged from those used in recent assessments and are:

Age	1	2	3	4	5	6	7	8+
Natural Mortality	0.95	0.45	0.35	0.30	0.25	0.25	0.20	0.20
Maturity Ogive	0.11	0.92	1.00	1.00	1.00	1.00	1.00	1.00

Their derivation is given in the Stock Annex.

5.2.5 Catch, effort and research vessel data

The report of the 2001 meeting of this WG (ICES CM 2002/ACFM:01), and the ICES advice for 2002 (ICES Coop. 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. Nevertheless, a summary of all available tuning series is presented in Table 5.2.12. The full commercial CPUE and survey tuning indices available to the working group are presented in Table 5.2.13. These data sets are presented in full in response to previous requests from the NSCFP.

Indices for 2005 from the first-quarter IBTS (IBTS_Q1) and the third-quarter English (EGFS) and Scottish (SGFS) groundfish surveys were available for calibration purposes. Data from the VIId French groundfish survey were supplied for 2005, but in a form that was different from previous data and it has not been used here. Data from the 2005 EGFS were not available during the meeting, although they *may* be available between it and the October meeting of the ACFM. The EGFS and SGFS series form part of the third-quarter IBTS index (IBTS_Q3). The practice of this working group has been to use the EGFS and SGFS series individually rather than to use a combined IBTS_Q3 index as they pre-date it. A thorough evaluation of the IBTS_Q3 index and the separate EGFS and SGFS series will be required for each of the roundfish stocks if the former is to be considered a replacement for the latter two.

The IBTS surveys for whiting treat age 6 as a plus group. Therefore only ages 1 to 5 of the IBTS survey data have been used in analyses. As this survey occurs in the first quarter of the year, for inclusion in some catch-at-age methods it is down-shifted by one year and one age and considered to have taken place at the very end of the preceding year. This is to permit use of the most recent index (2005) in the relevant analysis.

5.3 Data analyses

In the past, the working group has expressed concern about the lack of consistency between survey indices for this stock and also between the survey indices and the catch-at-age data. The recently constituted SG on Stock Identity and Management Units of Whiting and contributors from the EU FINE contract (Survey-based abundance indices that account for fine spatial scale information for North Sea stocks, EU Study 98/029) demonstrated that the IBTS_Q1 index from 1991 onwards appears to be consistent with the catch-at-age data, and for that reason, a truncated version of the IBTS_Q1 index series (1991-2005) has been used here for exploratory purposes with regard to issues highlighted at previous meetings of this working group and also raised by the 2004 NSCFP review panel (specifically to take account of possible effects of ageing errors in the assessment and to consider the likely change in exploitation pattern resulting from the mesh-size reguation changes in 2002). The other survey indices were not considered in that part of the evaluation, but have been used subsequently in deriving a final assessment.

5.3.1 Exploratory catch-at-age analyses

A number of catch-at-age analyses were undertaken at the 2004 meeting of the working group and presented in its report. Nearly all the catch-at-age analyses indicated that the stock was at or near its lowest observed level, and below B_{lim}. However, the modelled survey-based analyses indicated that the stock was at or near its highest observed level or stable, and the empirical survey estimates indicated a peak in SSB in 2001 followed by a reduction in the three subsequent years. As a result, no assessment was put forward by the working group for consideration by the ACFM.

A number of reasons were suggested to possibly account for these contradictions, including the effects of population sub-structuring on the survey indices and catch-at-age analyses and the effects of potential ageing errors (annual structures in otoliths can easily be interpreted differently by different age-readers). In its review of the analyses that had been undertaken, the North Sea Fisheries Partnership Review Panel suggested the working group should attempt a less age-structured assessment approach and should also consider the likely change in fishing gear selectivity resulting from the move from a 100 mm minimum mesh size in towed demersal roundfish gears to 120 mm in 2002.

The working group therefore adopted the following protocol for the current meeting:

Repeat the recent age-based assessments using the IBTS_Q1 calibration series from 1991-2004 that has been shown to be consistent with the catch-at-age analyses by SGSIMUW and project FINE collaborators: *i.e.*, using previous model formulations of extended survivors analysis (XSA – Shepherd, 1999) and the Kalman filter time-series method (TSA – Gudmundsson, 1994, Fryer, 2001));

Carry out an additional age-structured assessment that permits the estimation of differing exploitation patterns over consecutive time periods: *i.e.*, using an integrated catch-at-age analysis (ICA – Patterson, 2001)) that explicitly considered a change in exploitation pattern in 2002

Carry out an assessment using a less age-dependent method: *i.e.*, using the catch-survey analysis method (CSA – Collie & Sissenwine, 1983, Mesnil, 2003)

On the basis of results from the foregoing, consider whether a standard age-based assessment can be presented.

5.3.1.1 XSA

An XSA model configuration was based on runs undertaken at the 2003 and 2004 meetings of the working group. The basic configuration was:

Catch at age data	Ages 1 to 8+
Calibration period	1990-2004
Calibration data[1]	1990-2004; age 0-4
Catchability independent of stock size	Age 1
Catchability plateau	Age 4
Weighting	Tricubic over 15 years
Shrinkage	Last three years and four ages
Shrinkage SE	0.5
Minimum SE for fleet survivors estimates	0.3

[1]The IBTS_Q1 index was downshifted one year and one age to permit use of the 2005 indices, hence calibration from 1990 to 2004 over ages 0-4.

For initial purposes, a single run was carried out using the IBTS_Q1 series alone. The log-catchability residuals from this run are shown in Figure 5.3.1 and indicate a step change in 1999 from predominantly negative residuals to predominantly positive ones.

From the XSA diagnostic output (not presented), the IBTS_Q1 calibration series gets *ca* 70% of the weighting in the estimation of survivors from age 1 to 4 compared to the effect of shrinkage to mean F, 50% of the weighting at age 5, with shrinkage predominating at the older ages. The survey index and shrinkage estimate of survivors from ages 1 and 2 are very close, but the estimates from shrinkage imply lower survivors estimates from the older ages.

The stock summary from this run indicates a SSB declining to its lowest level in the period with recruitment in 2003 and 2004 at very low levels (Figure 5.3.2). Mean F is also indicated to be at its lowest level in the time period

A retrospective analysis was made of the IBTS_Q1-calibrated XSA and results are shown in Figure 5.3.3 in which there appear phases of under- or overestimation of recruitment and SSB.

5.3.1.2 TSA

A single TSA model formulation was run for comparative purposes, and calibrated with the IBTS_Q1 indices for 1991-2005. The run was an updated version of TSA run 9 from the 2004 working group (ICES CM 2005/ACFM:07) that incorporates the estimation of a Ricker stock-recruit function within the overall model estimation and which models the human consumption catch data separately from the industrial by-catch.

The stock trends from this runs are shown in Figure 5.3.4, and like the XSA assessment, each of the SSB, recruitment and fishing mortality are currently estimated at their lowest values in the series. For this stock, TSA runs have previously indicated strong retrospective patterns, and this is repeated here (Figure 5.3.5), with SSB severely overestimated in recent years.

No diagnostics or tabulated outputs are presented for the TSA analysis, as the retrospective performance of the configuration used here is very poor, and it is used for comparative purposes only.

5.3.1.3 ICA

ICA has not routinely been used to asess this stock in the past, altough occasional exploratory runs have been presented. There was insufficient time available at the working group to refine the selection of an ICA configuration and, mostly, default values were selected. The base configuration was as follows:

Period for separable constraint	9 years
Last year for 1st selection pattern	2001 (gives 6 years for estimation)
First year for 2nd selection pattern	2002 (gives 3 years for estimation)
Reference age for separable constraint	3
S on oldest age	Set to 1.4 for each selection pattern
Catchability model	Linear for all ages (≡ XSA choice)
Default survey weighting	Set to 1 for all age
Other weightings	Manual defaults

From the text table, it can be seen that the option was selected to estimate different exploitation patterns over consecutive periods. The first period selected comprised a 6 year estimation period when the minimum mesh size for towed demersal roundfish gears in the North Sea was 100 mm. The second period comprises the years since 2000, and reflects the adoption of a 120 mm minimum mesh size for those gears in 2002. A model was selected that assumed uncorrelated errors in the survey indices, and exploratory runs (not presented) showed the assessment to be relatively insensitive to this.

In addition to this base configuration, one other option was explored in the comparative model runs to include the simultaneous estimation of a Ricker stock-recruit function in the overall model fit.

Stock trends from the two comparative runs are shown in Figure 5.3.6. They are virtually indistinguishable. The selection patterns estimated in these model fits are shown in Figure 5.3.7 with error bars representing ± 1 standard deviation. The point estimates indicate that selection since the adoption of a more selective minimum mesh-size has worsened (*i.e.*, younger ages show higher selection at age). This is counter-intuitive, and would be considered incorrect given the expectation of improved selection under the larger mesh size (*e.g.*, Kunzlik, 2003). A three year period is a short one over which to estimate the selection pattern of the post mesh-size increase period, and the estimation of the selection pattern for that period was very sensitive to the choice of reference age for the separable constraint. (see section 5.6 for a further discussion of this problem).

5.3.1.4 CSA

The previous sections have discussed some fairly typical age-based assessment approaches. To address the potential problem of inconsistent age interpretations of the fishery and survey catch-at-age data, the Catch-Survey Analysis (CSA) method has been applied. Briefly, CSA is a model that recognises two life-history stages in the population: recruits and post-recruits, and uses survey indices of the two stages to calibrate commercial catch data from the corresponding stages. For North Sea and eastern Channel whiting, one-year-olds were considered to be the recruits and 2-group and older fish the post-recruits.

The implementation of the method that has been used is the fortran CSA routine of Mesnil (2004) – CSAo. This assumes measurement error in the indices and no process error. This implementation also allows retrospective fits to be made to evaluate the consistency of the method to the addition of successive years' data, and can bootstrap the model residuals to calculate distribution percentiles and parameter precision.

For use in CSA, the whiting catch and IBTS_Q1 indices were split into recruits and age-aggregated post-recruits for the period 1991 to 2004, 1991 being the year at which there appears to be improved consistency between the IBTS_Q1 index and the commercial catch data. One-group fish were treated as the recruits so it is assumed that one-year-olds at least can be differentiated from the older ages with reasonable accuracy. A description of the method is available in the program documentation available on the ICES web-site, but basically the partition of the data into two stages is necessary to calibrate the following model that underpins the method:

$$N_{y+1} = \left(N_y + R_y\right)e^{-M_y} - C_y\ e^{-M_y(1-\tau)}$$

Where y is an annual time step in this case, N_y is the population size of post-recruits at the start of year $_y$, R_y is the equivalent population size of recruits, M is the instantaneous coefficient of natural mortality and τ is the fraction of the year when the catch is taken instantaneously (*eg*., 0.5 represents the mid-point of the year).

For the measurement error CSA model fits explored here, τ was assumed = 0.5 and two other values need to be supplied. A value of natural mortality is required (invariant over time and the same for the recruit and post-recruit stages) and an estimate of the ratio, *s*, of the survey catchability of recruits relative to the post-recruits. The first requirement gives a problem with respect to North Sea and eastern Channel whiting insofar that the usual assumptions of natural mortality are strongly age-dependent, based on smoothed multispecies VPA estimates (see section 5.2.4). In particular, the age 1 recruits have an assumed M=0.95, declining to 0.45 at age 2 then further declining to 0.2 at age 7. Consequently, exploratory model fits were made for a range of values of M. With regard to the value of *s*, the ratio of catchabilties between the two stages, varying assumptions were tested, including the option to search for the "best" value based on the sum-of-squares minima across model runs with differing input values of s. This value is subsequently referred to as s_{min}.

Baseline runs were undertaken assuming a value of M=0.45, the age 2 value. For these, values of s from 0.2 to 1.2 were tested in model runs and their goodness-of-fit evaluated from the retrospective and bootstrap model outputs. The option to search for s_{min} was also evaluated.

Figure 5.3.8 shows the results of the baseline runs in terms of their estimate of recruit and post-recruit numbers. From this it can be seen that the estimation of population numbers is sensitive to the choice of *s*, and particularly so at its smaller values. According to the search procedure, s_{min} is approximately 0.70 for baseline M. However, for whiting, the retrospective model fits from runs that search for s_{min} are very sensitive to the inclusion of additional data over the period examined here. This can be seen from Figure 5.3.9 in which the population numbers are given for retrospective model fits. By and large the direction of year-on-year changes is similar, but the population level about which the changes occur varies considerably. Underlying this is the fact that s_{min} varies across the retrospective fits. This was further examined across retrospective runs that searched for s_{min} for differing values of M. Figure 5.3.10 illustrates the results of this from which it can be seen that the estimate of s_{min} that is derived by the search procedure is sensitive to the inclusion of an additional year's data. Consequently, the search procedure does not in this case diminish the need for an external estimate of the catchability ratio.

Another approach that was used to try and determine the "best" value of *s*, or at least a minimal range of candidate values, was a rather "brute force" approach to examine the retrospective patterns and bootstrapped parameter precision across a range of values of *s*, for the baseline M, to see whether particular combinations behaved "better" than others. This showed initially promising results. From Figure 5.3.11 it is clear that for M=0.45, that at a values of *s* between 0.6 and 0.8, the precision of the catchability estimate and its relative bias shift in a way that implies values of s greater than 0.6 may be appropriate. This is also implied by the much better retrospective behaviours of the model fits for values of s greater than 0.6. Figure 5.3.12 shows corresponding retrospective estimates of recruits from CSA fits with M=0.45 and *s*=0.4 and 0.8.

Unfortunately, the observation of improved precision and bias in the catchability estimates at higher values of *s* did not hold true for a range of values of natural mortality. The text table, below demonstrates the problem. The highlighted cells indicate combinations of M and *s* that demonstrate improved parameter precision and relative bias compared with the non-highlighted cells. It is not true under the range of natural mortality values examined that an *s*-ratio greater than 0.6 leads to improvements in the model fit.

CV(q)

		Catchability ratio, s				
		0.4	0.6	0.8	1	1.2
M	0.35	0.094	0.442	0.754	0.034	0.044
	0.45	0.392	0.473	0.495	0.042	0.062
	0.55	0.058	0.591	0.038	0.06	0.106

Relative bias (q)

		Catchability ratio, s				
		0.4	0.6	0.8	1	1.2
M	0.35	7.8	-92.3	-91.1	0.6	2.2
	0.45	-90.9	-93.9	-67.4	1.4	4.1
	0.55	3.9	-94.4	-0.5	3.1	8.9

In addition to the precision and bias of parameter estimates, a further aid to evaluation of the model fits is to examine the stability of the estimates in a retrospective analysis. This was done for the combinations of natural mortality and catchability ratio shown in the preceding text table. Visual inspection of the retrospective patterns indicated that the variable most sensitive to retrospective patterning was the estimate of recruit numbers. The CSAo program calculates Mohn's rho, a quantity that measures the degree to which retrospective estimates differ, and this corresponded well to the visual inspection in the retrospective plots (due to the sheer number of the plots, 45, they are not presented in the report). The following text table gives the value of Mohn's rho for the retrospective analysis of recruit estimation. The highlighted cells of the table indicate the absolute value of rho, with shading corresponding to its order of magnitude.

Retrospective analysis of recruit nos - ABS(rho)

		Catchability ratio, s				
		0.4	0.6	0.8	1	1.2
M	0.35	0.698	0.318	0.067	0.044	0.021
	0.45	0.500	0.085	0.020	0.004	0.004
	0.55	0.339	0.027	0.028	0.056	0.977

Bearing in mind the precision/bias of the catchability estimates and the stability of the estimates of variables of interest such as recruit numbers, this suggests that a CSA model fit assuming M=0.45 and s-ratio=1.0 is the most appropriate for this data set within the bounds that have been explored and assuming the CSAo program is a robust implementation of the method. In fact, the combination of M=0.45 and s-ratio=1.0 provides rho estimates whose absolute values are uniformly of the lowest order of magnitude – none of the other combinations match that. Although this is a rather *ad hoc* approach to selection of the most appropriate set of input values, the purpose here is not to present an assessment using this method, but to use it to explore the effects of reducing the assessment's dependency on highly age-disaggregated data.

Residuals from the selected CSA model fit are shown in Figure 5.3.13 and stock trends are shown in Figure 5.3.14 – SSB is not calculated within the CSAo program due to the aggregation of post-recruit ages into the population estimate. However, the maturity ogive traditionally used in this assessment gives a proportion mature of 0.92 for two-year-olds, and 1.00 for ages greater than two, so in this case, the post-recruit estimate of numbers approximates to the number of mature fish which if multiplied by the mean weight of the post-recruits will approximate to the spawning biomass.

The harvest rate is a very approximate proxy for fishing mortality, calculated by dividing the catch in numbers of the post-recruits by the estimated population size of post-recruits.

Retrospective plots from the CSA model are shown in Figure 5.3.15.

5.3.2 Exploratory survey-based analyses

A substantial amount of effort was expended in data exploration of the various surveys at the previous meeting of this working group. Some of this has been repeated this year, but the general conclusions from the previous meeting are reiterated first:

Survey trends from the mean-standardised indices agreed relatively well for age 1 and older fish from 1995 onwards, other than for the French VIId groundfish survey which is more variable and less consistent in that period than the other series;

The IBTS_Q1, EGFS and SGFS surveys were each shown to be internally consistent over the period 1992-2003;

Stock sub-structuring was thought possibly to contribute to any longer-term inconsistency between series, further evaluation of which remains an objective of SGSIMUW;

Modelled stock trends from the ScoGFS and EngGFS surveys indicated that the spawning stock had generally increased since the 1980s, and was at a relatively high level compared to historical values, whereas the IBTS_Q1 survey indicated a highly variable but relatively stable stock;

Relative trends in spawning biomass agreed well from 1995, indicating a decrease to 1998, followed by an increase to a peak around 2001 and a subsequent decrease in the three subsequent years;

For this meeting, the IBTS_Q1, EGFS and SGFS survey series were analysed using SURBA3, an updated implementation of the Cook (1997) model for estimating survey-based stock trends. Stock trends estimated from SURBA, residuals from the model fits, the retrospective model fits, and cohort curves are shown in Figures 5.3.16 – 5.3.19 (IBTS_Q1), 5.3.20 – 5.3.23 (EGFS) and 5.3.24 – 5.3.27 (SGFS).

For the IBTS_Q1 index, the SSB trend described from an equivalent model fit last year was of a highly variable but stable SSB. The addition of the 2005 index value also indicates a variable SSB, but one that is at its lowest value in the series having declined from a high value in 2001. The model demonstrates little retrospective patterning in SSB.

For the EGFS index, SSB is estimated to be at a low level in 2004. This series shows strong retrospective patterning in its estimation of SSB, although year on year trends seem to be estimated consistently, the overall level about which those changes occur differs markedly.

For the SGFS index, SSB is estimated to be declining to a recent low, but is higher than the lowest values in the series from the mid- to late-1980s.

All three series are consistent in indicating a recent decline in SSB from a peak in 2001 (consistent with the 2004 WG conclusion). The 2005 IBTS_Q1 and SGFS series indicates this decline to be continuing whilst results from the 2005 EGFS index are awaited.

The IBTS_Q1 series was available to the working group as a set of area-based for the period 1983-2004; unfortunately it was unavailable in this form for 2005. Nevertheless, this permitted a series of area-based SURBA estimates of the stock trends to be made for 1983-2004. The IBTS standard roundfish areas are shown for reference in Figure 5.3.28, and the area-based SURBA estimates of SSB are shown in Figure 5.3.29. These indicate for most areas that SSB has declined in the most recent years, either to a low or moderate level. Notable exceptions to this pattern are standard roundfish areas 2 (central) and 4 (southwest Scottish coast and northeast English coast) which indicate a recent increase to a high level and fluctuations about a relatively high level respectively.

5.3.3 Conclusions

Figure 5.3.30 shows the estimated stock trends from the XSA, TSA, ICA (incorporating a stock-recruit model fit) and the selected CSA model fit (each method calibrated solely by the IBTS_Q1 indices 1991-2004 or 2005 depending on the method). The catch at-age methods show great consistency in the estimates of recruitment and SSB over the calibration period, and are consistent with the less age-dependent CSA results in terms of year on year changes and the overall decline in values over the period. The ICA and XSA estimates of mean fishing mortality are less in agreement with the TSA results indicating lower values and a smoother decline over recent years. Nevertheless, they each indicate that fishing mortality is at or close to an historically low level. The CSA estimate of harvest rate is not strictly comparable to those of fishing mortality, but shows recent values to be lower than earlier ones.

From these analyses, it is clear that the commercial catch data whether age-disaggregated or not, demonstrate very similar stock trends when calibrated against the IBTS_Q1 indices for 1991 onwards. The plot of one-year-old XSA abundance against IBTS_Q1 1-gp index is shown in Figure 5.3.31 and demonstrates the very clear distinction in the relationship between the estimates and indices from 1991 onwards compared with the earlier period. This is further illustrated by comparing mean (1992-2003) standardised estimates of XSA SSB against corresponding mean standardised SURBA estimates of SSB (Figure 5.3.32)

In fact, the fundamental issue with respect to this assessment is illustrated by Figure 5.3.33. In it, the mean standardised trends in SSB are shown as estimated by the exploratory XSA and by the IBTS_Q1 SURBA; the picture would be similar for any of the age disaggregated assessments that have been presented here. Between 1983 and 1990, the signal from the commercial catch-at-age data and the survey indices are fundamentally different, whereas from 1991 onwards they broadly agree. (1983 is the first year in which IBTS_Q1 gears were fully standardised to the GOV trawl, hence its use as the first year in the survey series for the whiting assessment). This working group is unable to provide a convincing explanation as to why this should be the case and SGSIMUW has yet to complete its evaluation of area-based effects on the assessment. Readers are referred to section 5.10 for a consideration of area-based trends from the fishers' survey and to section 5.3.2 for an area-disaggregated SURBA analysis of IBTS_Q1 indices.

5.3.4 Final assessment

Having noted the correspondence between the commercial catch data and the IBTS_Q1 indices for the period 1991 onwards, and the correspondence between age-disaggregated and a less age-dependent assessment approach for that period, there seems little reason exclude consideration of a final age-based assessment. XSA was the method chosen for this as the TSA model configuration was considered too highly sensitive to retrospective patterning, and there appears to be too few years' data available to exploit the advantage of ICA to estimate different exploitation patterns for recent consecutive periods.

An initial XSA run was made individually for the IBTS_Q1, EGFS and SGFS survey series using the base configuration described in section 5.3.1.1, using 15 years of survey indices (IBTS_Q1 indices were down-shifted one year and one age to make use of the most recent survey data in XSA). For the single fleet runs, only weak shrinkage was used (shrinkage SE=1.5). Log catchability residuals from these single fleet runs are shown in Figure 5.3.34. There is an indication of a step change in the residuals for both the EGFS and SGFS in 1995, but given the down-weighting of older data in the analyses, this was not considered sufficient to prevent their use.

All three survey series were then incorporated in a combined XSA run using the same configuration, but with stronger shrinkage (shrinkage SE=0.5). The XSA diagnostics from this run are shown in Table 5.3.1. Log catchbility residual plots are shown in Figure 5.3.35 and are not greatly different from the single fleet runs. Figure 5.3.36 shows the individual fleet estimates of fishing mortality in 2004 along with the three-year mean to which estimates were shrunk and the overall weighted average XSA estimate. It can be seen that with the exception of fishing mortality at age 1, the survey fleets show good consistency. At age 1, the SGFS estimates lower fishing mortality than the two other fleets. The overall XSA estimate is close to the survey-based estimates and, for ages 3 to 6 it is substantially lower than the shrinkage mean. Figure 5.3.37 shows the proportionate contribution to the XSA estimates of fishing mortality at age by each fleet and from shrinkage to the mean. For the youngest and oldest ages, the survey series comprise 80% of the weightings whereas for the other ages this increase to 90%.

A retrospective analysis of this XSA configuration is given in Figure 3.38. There is a weak tendency to overestimate SSB and to underestimate mean fishing mortality more severely. For this reason, and because the XSA estimates were dominated by the survey indices rather than shrinkage, it was decided to accept this configuration as the final assessment rather than to explore the effects of weaker shrinkage.

Estimated fishing mortality and population numbers at age are given in Tables 5.3.2 and 5.3.3.

Comment on the final assessment

At its 2004 meeting, the working group felt unable to present a final assessment because nearly all the catch-based analyses indicated a stock at or close to its lowest level, and the survey-based evaluations indicated a stock at either a high or a stable level. Figure 5.3.39 shows the current mean-standardised comparison in relation to results from the final XSA run and the IBTS_Q1, EGFS and SGFS SURBA analyses. This shows the current SGFS SSB value to be at a moderate and declining value; the IBTS_Q1 SSB to be at its lowest level in the period 1983-2005 (both incorporating 2005 indices) and the EGFS SSB to be at a low and declining level (2005 index not yet available). All indications are that the stock has declined in the most recent few years and the recent trends in all stock estimates are reasonably consistent since 1996. The close correspondence since 1991 between the IBTS_Q1 stock trends and the XSA values is further noted.

It remains of concern that the stock trends estimated from the various sources diverge considerably for the earlier years. Due to the correspondence of recent stock trends, the working group considers the final assessment to be sufficiently good to take forward into catch prediction. It also notes that the data sources indicate the stock to be at a low level or, in the case of the SGFS, to be declining rapidly towards a low value. However, due to the different signals from the catch and survey indices prior to the early or mid 1990s, the working group does not feel able to comment on the current state of the stock in terms of its defined precautionary biomass limits.

5.4 Historical stock trends

Stock trends from the final XSA are given in Table 5.4.1 and shown in Figure 5.4.1. Recruitment, SSB and fishing mortality are all at the lowest point of their series.

5.5 Recruitment estimates

There is information on one-year old abundance in 2005 from both the IBTS_Q1 and SGFS surveys, but no reliable index of 0-group abundance. As the IBTS_Q1 series was down-shifted by one age and year to permit use of the 2005 survey in the final XSA, this meant that only the age 2 to age 5 IBTS_Q1 indices were used in the analysis. For the SGFS 1-group series, only indices prior to 2005 were used in the analysis; no use was made of the 2005 survey index. Consequently, these two index series are available for recruit calibration of one-year-olds in 2005. However, as previously noted, there is an inconsistency between the survey data and the commercial catch-at-age data for earlier years, with greater consistency in more recent years. Consequently, it is necessary to use only data from the more recent period in recruit calibration.

Mean standardised indices of one-year-old abundance and mean standardised XSA 1-group estimates are shown in Figure 5.5.1. This indicates that the IBTS_Q1 index is most consistent with the XSA from 1991 onwards, although it does reflect some peaks and troughs in the earlier part of the series too. The SGFS is most consistent from 1995 onwards, but as with the IBTS_Q1 series, it too reflects some of the same relative year-on-year changes in the earlier period. Nevertheless, in order to use only the most consistent data for the recruit calibration procedure, these were the cut-off years that were chosen.

The RCT3 program was used for recruit calibration, with default options selected. The RCT3 input file is shown in Table 5.5.1 and the results are given in Table 5.5.2. One-year-old abundance in 2005 is estimated from RCT3 to be 618 million, under half the geometric mean recruitment over 1991-2002 (1,400 million). Both index series imply low 1-group abundance in 2005. Consequently the RCT3 estimate was taken forward into prediction.

No reliable information is available for the 2005 yearclass in 2006. Given the consistency between the commercial catch-at-age data and the IBTS data since 1990, this indicates a period over which an average value of recruitment may be estimated to provide an input to prediction for the 2005 yearclass as one-year-olds. The geometric mean XSA abundance of one-year-olds over the period 1991-2002 is 1,400 million, but of the most recent ten yearclasses on which information is available (yearclasses 1995-2004, ie including the RCT3 estimate of the 2004 yearclass), eight are estimated to have been below that value. Consequently, the geometric mean recruitment of those yearclasses (833 million) has been used to estimate one-year-old abundance in 2006 for input to prediction.

5.6 Short-term forecasts

A short-term forecast was carried out based on the final XSA assessment. XSA survivors in 2005 were used as input population numbers for ages 2 and older. The RCT3 estimate of 618 million was used for one-year-old abundance in 2005 and the geometric mean (1995-2004) from XSA was used for recruitment in 2006 (914 million).

Ordinarily, the input fishing mortality rates would be the status quo fishing mortality estimated as a recent average, with or without being scaled to the mean of the most recent year. However, inspection of the fishing mortalities-at-age (Table 5.3.2) indicates values of F at ages 1 and 2 in 2003 that appear anomalous given the overall trend in fishing mortality. This is further unexpected given the mesh-size increase in 2002 in the roundfish fisheries that would be expected to reduce fishing mortality on the younger ages relative to the older fish and the reduction in industrial by-catch as a result of the decreasing activity in the Norway pout fishery.

To help choose the appropriate input fishing mortalities for prediction, average fishing mortality at age was calculated for each of 2000-2001 and 2003-2004, years that pre- and post-date the 2002 change in minimum mesh-size. In addition, status quo F was also calculated for the recent three year period 2002-2004 and scaled to the 2004 mean (this reflects traditional practice in estimating status quo F where there is a recent trend in mean fishing mortality). Each of these was mean-standardised, using the mean over ages 2-6, to compare exploitation patterns, as was the XSA estimates of fishing mortality in 2004. These mean-standardised exploitation patterns are shown in Figure 5.6.1. (The pre- and post-2002 exploitation patterns are not too dissimilar to those estimated in the ICA analysis (section 5.3.1.3) and indicate a feature of the data rather than the assessment method). Given the similarity in exploitation pattern between the status quo F estimate and the XSA estimate of F in 2004, the working group decided to use the XSA 2004 estimates for input to prediction. In this way, the inconsistent estimates of F in 2002 are excluded from consideration.

Mean weights for catch prediction were averaged over 2002-2004 for each catch category. Total catch mean weights were used as stock mean weights

The input to prediction is shown in Table 5.6.1. Results are presented in Table 5.6.2 and 5.6.3.

Assuming $F_{2005}=F_{2004}$ results in human consumption landings in 2005 of 13.5 kt from a total catch of 25.2 kt. For the same fishing mortality in 2006, human consumption landings are predicted to be 12.6 kt resulting in a SSB in 2007 of 103 kt. Under the assumptions of the prediction, SSB in 2007 will be below B_{lim} even in the absence of fishing in 2006 (but see discussion under sections 5.9 and 5.10).

5.7 Medium-term projections

No medium-term projection was undertaken.

5.8 Biological reference points

The precautionary fishing mortality and biomass reference points agreed by the EU and Norway, (unchanged since 1999), are as follows:

Blim = 225,000 t; Bpa = 315,000 t; Flim = 0.90; Fpa = 0.65.

5.9 Quality of the assessment

Previous meetings of this WG have concluded that the survey data and commercial catch data contain varying signals concerning the stock. Analyses by working group members and by the SGSIMUW indicate that data since the early- to mid- 1990s are sufficiently consistent to undertake a catch-at-age analysis calibrated against survey data from the most recent period. This has been taken forward into prediction for catch option purposes. However, due to the lack of concordance in the data pre-dating the early 1990s, the working group considers that it is not possible categorically to classify the current state of the stock with reference to precautionary reference points as the biomass reference points are derived from a consideration of the stock dynamics at a time when the commercial catch-at-age data and the survey data conflict.

Various analyses indicate that the differences could be due to spatial structuring within the stock, although it is not clear why this appears less of a problem in more recent years. SGSIMUW will concentrate on spatial evaluations in the forthcoming year.

Due to the likely population structuring in the North Sea and Eastern Channel, it is probable that the overall stock estimates may not reflect trends in more localised areas.

Despite the minimum mesh-size increase in 2002 in the towed demersal roundfish gears and the decline in industrial bycatch as activity in the norway pout fishery has declined, there are seemingly anomalous estimates of fishing mortality at ages 1 and 2 in 2003. The working group has no explanation for this. It is possible that the age interpretation of whiting samples may cause problems with the catch-at-age data, but a less age-structured assessment showed similar recent trends in stock biomass to the age-based assessment.

An appropriate time series of discard data suitable for use in catch-at-age analysis was available only for Scottish catches. For assessment purposes, historical discards for other human consumption fleets are estimated by extrapolation from Scottish data. Whereas some individual countries may now supply current discard data, this is likely to reflect a different value for discards than if the Scottish discard rates had been applied – there is the possibility of a step-change occurring in the series of discards if other countries' observed values differ from the Scottish discard pattern. In some cases, discard data are collected by other countries, but not made available to data collators in time for the Working Group, or were made available in a form that could not be incorporated without significant changes to the data collation software that is used.

The historic performance of the assessment is summarised in Figure 5.9.1.

5.10 State of the stock

For reasons discussed in section 5.9, the working group is cautious about interpreting the current state of the stock with respect to its precautionary biomass reference points. Nevertheless, all indications are that the stock at the level of the entire North Sea and eastern Channel is at or approaching a low level relative to the period since 1991. Fishing mortality is estimated to be low relative to that period. Whiting mature at a relatively young age and trends in SSB respond fairly rapidly to changes in recruitment.

Spatial effects, possibly due to population structuring in the North Sea and eastern Channel, are likely to result in different localised perceptions of the abundance of whiting. This is reflected by the area-based IBTS_Q1 survey analyses presented in section 5.3.2 (NB does not include 2005). This indicates for most areas that SSB has declined in the most recent years, either to a low or moderate level. Notable exceptions to this pattern were the IBTS standard roundfish areas 2 (central) and 4 (southwest Scottish coast and northeast English coast) which indicated a recent increase to a high level or fluctuations about a relatively high level.

Indications from the fishers' survey also vary by area. Figure 5.10.1 shows the fishers' perception trends in abundance in the North Sea between 2001 and 2005. In general, this indicates that whiting in the southern area are considered to be relatively more abundant whereas those in the central and northern area have remained stable or declined. Comparison is hindered by the lack of area-based information from the 2005 IBTS_Q1 survey. Nevertheless, the indication of a more northerly decline in abundance is reflected in both the IBTS_Q1 spatial analysis and the fishers' survey. The increasing trend in abundance off the northeast English/southwest Scottish coast is also reflected by both surveys. The area in which a major difference in perception occurs in in IBTS standard roundfish area 5 (off the southeast to eastern coast of England) for which the fishers' survey indicates a trend of increasing abundance whereas the IBTS_Q1 indicates a recent steep decline.

5.11 Management considerations

Whiting are caught in mixed demersal roundfish fisheries, fisheries targeting flatfish, the *Nephrops* fisheries and the Norway pout fishery.

The current minimum mesh-size in the mixed demersal roundfish fishery in the North Sea should result in reduced discards from that sector compared with the longer-term discard rates. Discarding is likely to remain a problem in the other demersal consumption fisheries either due to their capture below the minimum landing size or because whiting is not a commercial species for those fleets.

Catches of whiting in the North Sea are also likely to be affected by the effort reduction seen in the targeted demersal roundfish fisheries, although this will in part be offset by increases in the number of vessels switching from roundfish to *Nephrops*

The by-catch of whiting in the Norway pout fishery is dependent on activity in that fishery, and this has recently declined.

TACs for this stock are split between two areas: (i) Subarea IVand Division IIa (EU waters) and, (ii) Divisions VIIb-k. Since 1996 when the North Sea and eastern Channel whiting assessments were first combined into one, 11.5% of any combined area catch option has been attributed to the VIId component for TAC management purposes. This value is based on the average contribution of Division VIId human consumption landings to the combined area human consumption landings over the period 1992-1996.

5.12 Whiting in Division IIIa

Total landings are shown in Table 5.12.1.

No assessment of this stock was possible

Table 5.2.1 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	2004
Belgium	1,030	944	1,042	880	843	391	268	529	536	454	270	248	140.2
Denmark	1,377	1,418	549	368	189	103	46	58	105	105	96	89	62
Faroe Islands	16	7	2	21	-	6	1	1	-	-	17	5	0
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	511	441	239	124	187	196	103	176	424	402	354	334	296.4
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	978
Norway	232	130	79	115	66	75	65	68	33	44	47	39	23
Poland	-	-	-	-	-	-	1	-	-	-	-	-	-
Sweden	22	18	10	1	1	1	+	9	4	6	7	10	1.8
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	1,207.2
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	5,059.6
United Kingdom													
Total	46,998	47,301	42,216	41,400	35,116	31,573	23,938	26,402	24,453	18,834	15,608	10,996	7,768.3
Unallocated landings	-554	680	401	-348	1,006	-276	-72	-421	-412	592	308	-337	
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	9233
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	14256
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	1218
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	24707

*Preliminary.
[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	2004
Belgium	66	74	61	68	84	98	53	48	65	75	58	66	44.9
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	132
UK (E.&W)	419	321	293	280	199	147	185	135	118	134	112	109	79.5
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	6,828	274.4
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	4,350

*Preliminary.

Sub-area IV and Division VIId

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
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	29,057

Annual TAC for Subarea IV and Division IIa

	2000	2001	2002	2003	2004
TAC	29,700	32,358	16,000	16,000	16,000

Table 5.2.2 Whiting in IV and VIId. Annual weight and numbers caught, 1980–2004. Human consumption landings are for both the North Sea and eastern Channel. Discards and industrial by-catch refer to the North Sea only.

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
2004	29	14	13	1	146	47	56	42
Min	29	14	13	1	146	47	56	42
GM	95	45	31	14	725	160	214	300
AM	108	51	34	22	878	178	250	450
Max	224	101	80	67	2020	340	583	1659

Table 5.2.3 Whiting in VIId (eastern Channel). Annual weight and numbers caught, year 1980–2004.

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
2004	4350	16366
Min	3483	13648
GM	5555	21951
AM	5728	22680
Max	9167	35509

Table 5.2.4 Whiting in IV and VIId. Total catch numbers at age (thousands).

	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	265359	162899	192640	205646	323408	203321	576731	267051	430344
2	416008	346343	114444	184746	175965	141716	167077	368229	307429
3	286077	266517	245246	118412	124886	82037	169577	122748	179502
4	90718	102295	88137	131508	49505	37847	46517	85240	39635
5	52969	27776	26796	37231	59817	14420	13367	11392	17901
6	10751	12297	6909	8688	13860	17445	3487	4556	2175
7	1152	3540	2082	1780	2964	3328	3975	928	544
8+	767	326	484	930	613	904	569	1035	168

	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	331672	253745	128507	239791	217539	163609	137481	72645	53408
2	173676	505010	191193	165354	167577	147177	139010	113956	74200
3	191942	129126	187195	89563	124287	90611	111489	98476	82944
4	78464	86324	36830	93636	46543	47533	35728	48575	42154
5	14367	32270	26209	11967	46136	17384	15161	14235	18492
6	5050	2002	5519	6878	3946	17264	5159	4695	3358
7	516	735	542	2609	1519	998	4515	1294	1020
8+	334	112	273	117	771	460	474	1113	460

	1998	1999	2000	2001	2002	2003	2004
1	71430	178079	66789	84121	49857	72709	25440
2	44697	91355	124365	86178	61239	104040	16412
3	42771	45627	63526	58908	82940	53560	24354
4	36459	34175	23888	20559	34006	42048	25738
5	17756	18528	16232	9177	8007	14305	19126
6	6392	7547	8791	4814	2043	2372	7285
7	1426	2049	4322	2232	1457	474	1193
8+	407	676	1265	1268	754	397	298

Table 5.2.5 Whiting in IV and VIId. Human consumption landings numbers at age (thousands).

	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	3656	4240	10890	10568	14388	2288	12879	11074	7462
2	62405	69211	46703	68640	62693	51194	44500	72372	61360
3	152570	104348	124656	67312	99204	57049	111527	70504	94163
4	68422	78253	59393	101342	41277	32340	37287	73742	29147
5	41430	23698	21376	31266	51745	12974	11285	10808	16556
6	9911	12036	5664	8330	12735	16361	3379	4506	2158
7	1135	3530	2058	1730	2813	3238	3912	928	544
8+	767	326	484	921	613	904	557	1004	164

	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	8636	6949	11610	9603	5980	17126	8832	12516	6522
2	28406	54361	43110	45154	29305	31660	28132	26768	23543
3	77009	45423	91129	48838	64353	46217	58538	47593	48237
4	44307	50603	26169	60806	33514	36814	28013	36288	31904
5	9249	17747	21697	9956	34651	14169	13767	12023	15824
6	3888	1407	4687	6223	2989	14706	4953	4453	2957
7	420	622	405	1496	1361	928	4401	1116	1017
8+	249	110	273	110	771	446	467	1113	443

	1998	1999	2000	2001	2002	2003	2004
1	17081	16689	15406	12257	2606	403	3972
2	19894	26966	31989	28499	10343	11610	2813
3	25016	25863	28500	27332	30858	13991	9633
4	24713	23792	14327	17518	22328	18981	13312
5	14717	14708	11841	8640	6703	9515	11860
6	5446	6660	6657	4506	1710	1861	4411
7	1213	1882	3774	2092	1328	443	747
8+	301	591	1159	1249	638	396	274

Table 5.2.6 Whiting in IV and VIId. Discard numbers at age (thousands), representing North Sea discards only.

	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	103203	50407	53753	152488	200589	154232	404604	158531	65021
2	250735	96509	26922	85318	82563	48791	120492	202154	87197
3	88399	57403	52349	33325	16814	15117	43479	34824	51135
4	14135	7313	18230	23442	4437	2985	5242	9776	5877
5	10795	1285	2972	4309	4495	761	627	582	846
6	786	149	343	295	1034	801	108	49	16
7	0	10	22	25	151	65	63	0	0
8+	0	0	0	9	0	0	12	31	3

	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	150598	79488	76938	98967	124426	77783	46209	30480	19347
2	36712	245129	77383	57629	101119	97847	77320	82020	28837
3	61442	33194	74005	26527	49064	36762	48601	48240	30616
4	21267	23488	4900	22976	8992	9528	6943	11319	9175
5	3276	12012	1828	1199	10709	2856	1318	2192	2392
6	103	253	89	350	519	2337	205	239	399
7	8	87	60	1064	131	6	113	179	2
8+	12	0	0	2	0	0	6	0	17

	1998	1999	2000	2001	2002	2003	2004
1	29979	84613	33848	27570	8670	54781	8603
2	18755	51740	75869	44645	31959	87376	9086
3	16361	14422	23590	21930	43444	36989	13669
4	10992	8844	2898	2528	9491	21853	12279
5	2976	3077	2257	385	1099	4400	7267
6	935	857	1547	268	211	461	2862
7	213	166	474	140	128	31	446
8+	106	85	107	19	116	1	24

Table 5.2.7 Whiting in IV and VIId. Industrial bycatch numbers at age (thousands).

	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	158500	108252	127998	42591	108431	46801	159249	97446	357861
2	102869	180623	40818	30789	30709	41731	2086	93704	158872
3	45108	104767	68242	17774	8868	9871	14572	17420	34205
4	8162	16729	10514	6723	3790	2522	3987	1722	4611
5	744	2793	2448	1656	3577	685	1456	1	500
6	55	112	902	63	91	284	0	0	0
7	18	0	2	25	0	26	0	0	0
8+	0	0	0	0	0	0	0	0	0

	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	172438	167308	39959	131221	87133	68701	82439	29648	27539
2	108558	205521	70701	62571	37153	17670	33558	5168	21820
3	53491	50508	22062	14198	10870	7632	4351	2643	4091
4	12890	12233	5761	9854	4037	1192	772	968	1075
5	1842	2511	2684	812	776	359	76	21	276
6	1060	342	743	305	437	221	0	2	2
7	89	26	78	49	27	64	0	0	0
8+	72	2	0	6	0	14	0	0	0

	1998	1999	2000	2001	2002	2003	2004
1	24370	76777	17535	44294	38580	17525	12865
2	6047	12649	16508	13034	18937	5054	4513
3	1395	5342	11436	9646	8638	2580	1052
4	754	1539	6663	513	2186	1214	147
5	63	743	2134	152	205	390	0
6	12	30	586	40	121	49	11
7	0	0	74	0	0	0	0
8+	0	0	0	0	0	0	0

Table 5.2.8 Whiting in IV and VIId. Total catch mean weights at age (kg).

	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.075	0.083	0.061	0.107	0.089	0.094	0.105	0.077	0.054
2	0.176	0.168	0.184	0.191	0.188	0.192	0.183	0.148	0.146
3	0.252	0.242	0.253	0.273	0.271	0.284	0.255	0.247	0.223
4	0.328	0.321	0.314	0.325	0.337	0.332	0.318	0.297	0.301
5	0.337	0.379	0.376	0.384	0.382	0.402	0.378	0.375	0.346
6	0.458	0.411	0.478	0.426	0.391	0.435	0.475	0.379	0.423
7	0.458	0.444	0.504	0.452	0.463	0.494	0.468	0.542	0.506
8+	0.572	0.720	0.736	0.537	0.567	0.438	0.626	0.584	0.694

	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.070	0.083	0.103	0.082	0.073	0.080	0.087	0.093	0.091
2	0.157	0.137	0.169	0.185	0.175	0.170	0.181	0.167	0.178
3	0.225	0.209	0.218	0.257	0.252	0.254	0.258	0.236	0.243
4	0.267	0.250	0.290	0.277	0.319	0.323	0.341	0.302	0.295
5	0.318	0.279	0.307	0.332	0.329	0.371	0.385	0.387	0.333
6	0.391	0.408	0.338	0.346	0.349	0.367	0.430	0.406	0.381
7	0.431	0.490	0.365	0.314	0.403	0.414	0.434	0.428	0.381
8+	0.394	0.599	0.401	0.503	0.380	0.416	0.420	0.430	0.418

	1998	1999	2000	2001	2002	2003	2004
1	0.091	0.076	0.113	0.072	0.067	0.053	0.109
2	0.180	0.174	0.182	0.191	0.156	0.114	0.190
3	0.236	0.233	0.238	0.227	0.222	0.195	0.240
4	0.281	0.256	0.288	0.283	0.281	0.260	0.265
5	0.314	0.289	0.287	0.270	0.314	0.298	0.304
6	0.339	0.303	0.277	0.300	0.360	0.352	0.298
7	0.330	0.309	0.277	0.287	0.357	0.383	0.304
8+	0.367	0.287	0.273	0.294	0.346	0.365	0.358

Table 5.2.9 Whiting in IV and VIId. Human consumption landings mean weights at age (kg).

	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.204	0.194	0.186	0.199	0.194	0.187	0.189	0.188	0.194
2	0.239	0.242	0.230	0.240	0.231	0.248	0.230	0.226	0.226
3	0.273	0.292	0.282	0.282	0.279	0.307	0.279	0.286	0.256
4	0.335	0.331	0.340	0.332	0.346	0.337	0.327	0.310	0.328
5	0.358	0.378	0.396	0.383	0.391	0.408	0.376	0.381	0.351
6	0.473	0.411	0.461	0.429	0.403	0.443	0.484	0.381	0.425
7	0.457	0.445	0.507	0.452	0.472	0.498	0.472	0.542	0.506
8+	0.572	0.720	0.736	0.538	0.567	0.438	0.632	0.593	0.702

	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.178	0.201	0.204	0.195	0.195	0.184	0.172	0.170	0.171
2	0.226	0.220	0.250	0.248	0.251	0.250	0.255	0.222	0.207
3	0.253	0.260	0.252	0.290	0.287	0.297	0.298	0.274	0.261
4	0.288	0.292	0.309	0.307	0.348	0.345	0.367	0.328	0.314
5	0.345	0.335	0.318	0.342	0.359	0.393	0.398	0.407	0.348
6	0.370	0.449	0.349	0.358	0.388	0.382	0.437	0.413	0.398
7	0.440	0.522	0.388	0.383	0.422	0.413	0.437	0.448	0.381
8+	0.405	0.601	0.401	0.503	0.380	0.412	0.422	0.430	0.421

	1998	1999	2000	2001	2002	2003	2004
1	0.164	0.184	0.166	0.160	0.199	0.209	0.210
2	0.209	0.237	0.226	0.217	0.223	0.239	0.221
3	0.259	0.270	0.271	0.268	0.269	0.263	0.250
4	0.304	0.280	0.300	0.286	0.304	0.309	0.295
5	0.330	0.302	0.292	0.269	0.325	0.310	0.333
6	0.360	0.314	0.315	0.303	0.376	0.373	0.335
7	0.344	0.317	0.278	0.291	0.365	0.389	0.339
8+	0.424	0.295	0.274	0.294	0.344	0.366	0.368

Table 5.2.10 Whiting in IV and VIId. Discard mean weights at age (kg), representing North Sea discards only.

	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.107	0.131	0.091	0.114	0.101	0.105	0.123	0.090	0.063
2	0.166	0.164	0.182	0.167	0.162	0.169	0.166	0.149	0.146
3	0.202	0.197	0.211	0.235	0.216	0.213	0.190	0.206	0.181
4	0.244	0.230	0.225	0.264	0.246	0.238	0.208	0.205	0.210
5	0.253	0.289	0.241	0.290	0.265	0.242	0.227	0.263	0.219
6	0.264	0.252	0.244	0.317	0.248	0.253	0.194	0.257	0.235
7	0.000	0.268	0.261	0.277	0.278	0.255	0.217	0.000	0.000
8+	0.000	0.000	0.000	0.365	0.000	0.000	0.311	0.292	0.284

	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.083	0.095	0.089	0.093	0.087	0.090	0.102	0.094	0.125
2	0.164	0.130	0.154	0.173	0.160	0.151	0.163	0.151	0.181
3	0.191	0.183	0.177	0.210	0.205	0.203	0.204	0.198	0.213
4	0.213	0.186	0.213	0.215	0.237	0.230	0.233	0.225	0.225
5	0.227	0.196	0.230	0.241	0.235	0.244	0.247	0.281	0.233
6	0.241	0.249	0.253	0.245	0.225	0.254	0.247	0.265	0.256
7	0.351	0.302	0.268	0.220	0.213	0.332	0.332	0.304	0.617
8+	0.221	0.000	0.000	1.183	0.000	0.000	0.290	0.000	0.352

	1998	1999	2000	2001	2002	2003	2004
1	0.086	0.100	0.127	0.084	0.130	0.057	0.178
2	0.173	0.166	0.167	0.183	0.167	0.098	0.233
3	0.204	0.197	0.195	0.217	0.196	0.169	0.240
4	0.228	0.201	0.226	0.259	0.224	0.215	0.232
5	0.234	0.225	0.209	0.248	0.224	0.262	0.257
6	0.224	0.231	0.219	0.240	0.225	0.257	0.241
7	0.247	0.212	0.222	0.225	0.272	0.293	0.246
8+	0.206	0.227	0.264	0.243	0.352	0.055	0.245

Table 5.2.11 Whiting in IV and VIId. Industrial bycatch mean weights at age (kg).

	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.051	0.056	0.038	0.058	0.053	0.054	0.054	0.043	0.050
2	0.164	0.141	0.133	0.148	0.173	0.150	0.150	0.085	0.115
3	0.281	0.218	0.232	0.311	0.289	0.263	0.262	0.173	0.197
4	0.412	0.318	0.320	0.431	0.343	0.382	0.381	0.262	0.245
5	0.380	0.433	0.366	0.651	0.390	0.454	0.455	0.400	0.380
6	0.389	0.596	0.674	0.565	0.228	0.504	0.500	0.500	0.500
7	0.561	0.600	0.284	0.602	0.600	0.584	0.600	0.600	0.600
8+	1.000	0.800	0.840	0.802	0.896	0.809	0.800	0.822	0.800

	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.053	0.073	0.101	0.066	0.044	0.042	0.069	0.059	0.048
2	0.137	0.123	0.136	0.150	0.155	0.132	0.159	0.143	0.144
3	0.224	0.181	0.213	0.228	0.259	0.242	0.310	0.235	0.250
4	0.285	0.199	0.269	0.242	0.264	0.374	0.373	0.233	0.321
5	0.344	0.280	0.265	0.335	0.308	0.521	0.511	0.347	0.348
6	0.482	0.355	0.279	0.219	0.235	0.555	0.000	0.250	0.588
7	0.396	0.335	0.322	0.255	0.392	0.440	0.000	0.000	0.000
8+	0.385	0.473	0.000	0.282	0.000	0.555	0.000	0.000	0.000

	1998	1999	2000	2001	2002	2003	2004
1	0.045	0.027	0.041	0.040	0.044	0.035	0.032
2	0.105	0.077	0.164	0.164	0.101	0.101	0.083
3	0.200	0.146	0.242	0.132	0.184	0.189	0.143
4	0.304	0.196	0.289	0.320	0.293	0.302	0.264
5	0.286	0.286	0.339	0.351	0.415	0.418	0.000
6	0.000	0.000	0.000	0.386	0.380	0.462	0.380
7	0.000	0.000	0.588	0.000	0.000	0.000	0.000
8+	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 5.2.12 Whiting in IV and VIId. Summary of available tuning series.

Country	Fleet	Code	Year range	Age Range
Scotland	Groundfish survey	SCOGFS	1982–2005	0-6
	Seiners	SCOSEI	1978–2004	0–10
	Light trawlers	SCOLTR	1978–2004	0–10
England	Groundfish survey	ENGGFS	1977–2004	0-6
France	Trawlers	FRATRB	1978–2001	1–9
		FRATRO_IV	1986–2004[1]	0-8
		FRATRO-7d	1986-2004	1-7
		FRAGFS-7d	1988–2003[1]	0-3
International	Groundfish survey[2]	IBTS_QI	1967–2005	1-6[3]
	Q II survey[4]	IBTS_Q2_SCO	1991–1997	1-6
	Q IV survey[5]	IBTS_Q4-ENG	1991–1996	0-7

[1] Excluding 2002.
[2] Formerly IYFS
[3] Age 6 is a plus group
[4] Scottish sub-set of IBTS data – discontinued in 1997.
[5] English sub-set of IBTS data – discontinued in 1996.

Table 5.2.13 Whiting in IV and VIId. Complete available tuning series. First column represents effort, subsequent columns are ascending age groups.

SCOSEI_IV

1978	2004										
1	1	0	1								
0	10										
325246	5345.92	14993.60	29307.94	43710.81	15390.20	1057.94	1408.92	200.99	36.00	0.00	7.00
316419	302.00	90749.85	41091.74	28124.23	14745.01	6083.68	676.92	155.75	3.00	0.00	0.00
297227	668.98	27032.33	73704.44	37657.65	11914.98	9367.98	2556.00	260.00	229.00	27.00	7.00
289672	93.00	8726.79	22243.64	25047.81	10551.99	2402.00	2084.00	374.00	41.00	4.00	1.00
297730	43.00	3720.99	7032.00	26194.14	13117.11	2713.03	539.01	277.00	81.00	5.00	0.00
333168	572.01	11565.39	14957.38	21690.02	34199.11	9830.62	2154.56	406.80	157.78	16.26	0.00
388035	296.72	4922.50	24015.61	20669.76	14985.59	21269.32	4715.24	959.96	87.28	49.59	6.94
381647	773.22	20067.84	20263.32	19695.99	8956.38	4795.86	8013.08	1362.79	333.95	17.89	5.96
425017	137.76	139498.17	48705.18	34509.26	11340.96	2624.40	1097.50	1771.08	215.94	7.27	0.00
418536	1358.85	13793.33	52715.14	38938.77	18440.26	3637.71	1096.91	297.74	348.42	15.88	3.97
377132	26.01	2502.07	28446.11	44869.26	12631.40	4071.61	678.72	63.97	20.99	16.99	2.00
355735	10.13	6878.80	15704.13	41407.43	23710.40	4769.04	1323.23	112.08	43.04	10.72	0.71
252732	184.88	14229.83	124635.82	27694.11	29920.98	14767.80	720.82	206.52	23.23	0.02	0.00
336675	886.65	11951.95	44964.26	63414.28	10436.10	8730.12	1742.93	195.19	93.63	0.00	0.25
300217	426.21	16613.69	19452.01	21217.15	27961.87	2804.54	1958.07	564.87	32.42	3.39	0.00
268413	599.77	9563.69	31623.36	26012.82	12457.88	14446.11	899.25	332.18	153.13	7.51	8.25
264738	82.71	9235.94	21451.65	22570.72	11778.49	5530.94	5611.98	203.91	115.77	14.69	0.00
204545	26.01	8287.88	22152.73	30006.96	9018.67	3874.63	1373.44	1270.02	86.01	14.99	18.13
177092	223.90	5732.24	26020.51	21430.22	10505.52	3483.37	1031.27	295.71	289.16	28.12	1.00
166817	175.60	6627.68	8974.45	16231.23	9922.01	4445.23	575.33	109.85	61.63	37.34	2.35
150361	14.45	3710.69	4694.83	6806.23	6840.32	3669.55	1417.13	243.74	12.81	1.89	12.27
93796	663.34	13384.17	13750.43	7009.42	6068.11	3461.79	1684.05	409.19	77.42	3.15	0.00
69505	2.79	5176.09	11207.84	6458.23	2111.81	1971.96	835.64	297.65	89.60	6.92	0.04
36135	929.75	606.97	6352.27	5592.05	1715.36	485.81	352.94	145.84	65.57	10.54	0.00
21830	1.94	1017.01	3348.65	7715.86	2181.93	363.15	139.67	78.78	23.47	5.90	0.00
15371	5.07	387.66	1088.55	2514.00	2980.16	1045.83	256.33	30.10	16.93	5.08	1.13
15663	0.00	282.37	688.63	1912.47	2003.35	1710.98	455.79	108.50	16.33	4.43	0.41

Table 5.2.13 (cont'd) Whiting in IV and VIId. Complete available tuning series. First column represents effort, subsequent columns are ascending age groups.

SCOLTR_IV

1978	2004										
1	1	0	1								
0	10										
236944	7158.39	8785.46	19909.95	30722.31	14472.60	956.04	1612.07	635.03	72.00	6.00	0.00
287494	368.00	171147.28	42910.40	23154.59	17995.66	4057.93	376.99	286.00	57.00	5.00	0.00
333197	869.00	20805.96	58381.99	38436.16	9525.06	9430.05	1864.01	144.00	145.00	3.00	0.00
251504	170.99	6576.46	19069.21	21549.75	9706.15	1777.02	1455.03	310.01	9.00	1.00	0.00
250870	6390.16	5214.10	8196.98	26680.54	12944.74	3333.92	646.98	338.99	74.00	16.00	3.00
244349	20191.06	37495.68	17925.87	12535.31	19234.31	6123.52	1216.61	182.80	140.85	25.97	1.00
240775	2553.17	38266.77	16048.09	10784.18	6306.82	9018.98	2371.19	478.59	13.13	30.29	5.05
267393	1221.65	28760.94	9368.37	7616.93	3085.79	1333.19	2901.19	443.13	173.09	13.85	0.00
279727	796.71	8138.43	8571.90	9577.94	4108.82	767.44	425.28	608.60	51.64	2.03	0.00
351131	599.52	18761.18	25933.34	16160.77	5954.48	1182.95	388.46	116.04	128.99	3.93	0.00
391988	60.00	2397.96	15778.77	22525.54	5127.73	1640.63	207.22	31.03	15.02	6.01	6.01
405883	491.80	20318.75	10051.62	21389.72	10836.81	2394.09	448.22	33.08	54.36	2.39	0.61
371493	371.48	3676.88	35321.99	7664.57	8960.09	3423.01	159.54	39.94	5.34	0.07	0.00
408056	688.42	8726.88	11908.03	22145.62	3192.25	2906.40	628.63	49.90	40.87	0.45	0.25
473955	1379.23	17580.58	14551.32	11822.72	15417.66	1500.40	1160.44	304.40	12.75	0.34	0.66
447064	614.45	16438.91	20513.15	14385.55	6590.76	10105.47	574.20	203.58	97.35	24.36	4.59
480400	1259.30	4132.65	15771.00	13004.65	6453.76	2710.23	2997.31	171.83	83.94	13.86	0.00
442010	208.07	9248.04	15886.83	19322.30	6261.60	2982.51	1092.21	1131.71	88.83	3.48	14.19
445995	188.32	6661.92	12461.08	13523.11	9223.33	3012.11	860.73	281.91	242.80	8.93	0.54
479449	100.18	2557.22	6767.92	15603.23	9463.72	4535.19	628.02	181.35	51.94	30.82	0.31
427868	39.44	5096.42	5350.24	8058.40	9506.50	4311.78	1728.79	275.71	57.74	12.20	2.67
329750	1274.23	26518.76	20672.07	9295.36	6705.67	4079.53	2051.46	487.24	40.79	7.35	0.10
280938	1.15	8384.66	16220.42	9287.05	3788.38	2621.24	1469.79	601.84	79.39	7.11	0.17
245489	2221.71	1303.16	11409.11	10419.00	3287.13	745.34	430.51	247.31	65.76	26.77	0.00
184099	5.78	979.77	4652.75	11067.22	3686.10	817.98	221.33	179.72	60.26	13.00	0.00
98721	12.51	871.43	1639.36	3985.89	5135.98	2079.84	286.25	73.38	59.19	7.07	4.84
63953	0.00	224.41	1088.23	2224.72	2463.17	2167.51	669.35	123.12	18.47	15.34	1.09

Table 5.2.13 (cont'd) Whiting in IV and VIId. Complete available tuning series. First column represents effort, subsequent columns are ascending age groups.

FRATRB_IV

1978	2004								
1	1	0	1						
1	9								
69739	1153	10312	14789	8544	807	1091	227	34	4
89974	698	12272	14379	10884	3789	394	315	45	14
63577	90	5388	11298	4605	4051	1004	78	71	10
76517	144	6591	13139	8196	2090	1644	314	16	10
78523	173	1643	16561	11241	3948	1035	539	119	14
69720	500	4407	8188	16698	5541	1061	228	126	19
76149	317	4281	7465	4576	5999	1596	308	32	26
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
	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	2004								
1	1	0	1						
0	8								
56099	19.48	1541.94	1891.94	7145.98	3782.82	599.91	157.52	39.03	2.14
71765	12.20	2507.72	4984.96	1271.29	5713.14	412.56	257.90	91.79	69.82
84052	0.31	2536.92	8981.89	3222.83	704.34	1320.59	122.85	55.31	0.54
88397	26.94	2958.16	3739.55	5628.95	1654.27	208.58	280.47	47.27	10.86
71750	37.70	3209.61	6169.85	3780.85	2456.12	365.14	28.65	43.61	1.65
67836	323.02	4464.91	6083.87	2864.37	1412.45	776.93	84.61	5.78	2.53
51340	355.02	3426.92	6498.04	1939.69	635.38	358.08	96.22	4.78	0.12
62553	937.84	3950.46	4586.36	4306.75	877.04	289.87	68.31	39.73	6.21
51241	86.53	7005.88	3298.43	1190.63	612.13	108.28	11.05	8.38	0.98
57823	262.76	6331.03	6125.08	2673.85	543.82	98.58	19.19	0.03	1.79
50163	577.46	5522.73	4742.85	3214.22	890.19	155.83	7.73	12.12	0.03
48904	266.77	1961.14	4676.60	3929.12	1020.11	220.78	18.01	3.07	0.02
38103	566.68	4893.44	1959.25	532.61	161.28	68.00	35.86	0.39	1.55
-9	51.18	7651.96	2885.69	1452.71	960.37	500.08	133.31	45.54	30.71
30082	129.16	7366.57	8191.31	2452.95	1056.07	737.31	454.67	345.11	94.79
50846	3357.15	10766.56	15475.91	6922.60	3226.67	1700.58	637.70	344.65	127.90
52609	625.48	9276.84	16879.91	7857.03	5528.14	1701.23	188.34	18.53	23.06
21074	0.00	937.63	366.50	918.84	946.50	743.29	255.68	35.66	4.22

Table 5.2.13 (cont'd) Whiting in IV and VIId. Complete available tuning series. First column represents effort, subsequent columns are ascending age groups. Indices in bold were used in the final assessment (including predictions).

SCOGFS_ IV							
1982	2005						
1	1	0.5	0.75				
0	6						
100	102	653	971	972	224	60	16
100	210	563	578	407	511	116	17
100	442	1048	371	170	77	92	18
100	169	1577	973	247	63	36	18
100	406	1111	452	224	27	5	5
100	120	1405	1150	208	77	16	3
100	642	967	1606	452	70	19	2
100	427	4043	741	733	157	13	6
100	1943	2239	2053	248	255	47	5
100	1379	1769	950	759	51	40	9
100	2417	2925	1267	553	585	47	26
100	247	3169	1168	423	156	182	6
100	648	2635	950	254	57	34	23
100	1243	4176	2010	903	196	58	22
100	440	2888	3047	1215	460	43	15
100	317	1824	1434	1191	319	122	17
100	12302	4141	1285	649	321	131	62
100	15276	5410	2090	615	329	129	58
100	17076	6646	3329	676	202	130	81
100	117	3499	2451	844	207	51	48
100	1606	4980	2422	1608	724	94	44
100	5393	1891	1433	1211	823	276	36
100	2553	2580	440	583	566	408	96
100	1818	1139	830	249	336	236	203

ENGGFS_ IV							
1977	2004						
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
100		5.80	4.00	6.08	2.77	1.37	0.59

Table 5.2.13 (cont'd) Whiting in IV and VIId. Complete available tuning series. First column represents effort, subsequent columns are ascending age groups. Indices in bold were used in the final assessment (including predictions).

IBTS_Q1 (6+ group)

1967	2005					
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	128.47	124.13	109.37	76.20	32.13	6.06
1	434.49	177.97	88.98	30.26	25.36	10.46
1	339.18	362.26	65.85	18.62	7.13	7.41
1	468.74	268.27	194.65	32.12	6.60	3.85
1	684.90	561.08	90.44	45.50	4.90	1.91
1	447.99	865.72	314.31	32.98	12.61	1.32
1	1446.08	538.56	414.76	109.90	12.05	5.09
1	518.94	862.35	198.16	91.61	16.94	3.67
1	1007.62	686.45	479.62	70.95	37.63	7.60
1	907.30	665.71	240.16	150.83	12.68	13.93
1	1075.62	522.81	244.59	65.48	59.02	11.45
1	721.71	627.41	181.02	68.07	11.86	9.11
1	678.59	448.48	239.45	58.07	11.87	5.59
1	502.36	485.97	244.70	69.74	23.09	9.85
1	287.73	342.21	162.53	60.43	18.01	9.18
1	543.12	160.70	125.38	54.04	15.50	9.26
1	676.27	305.46	94.68	57.44	25.81	11.09
1	756.85	537.86	182.24	53.06	20.00	14.77
1	648.65	598.39	299.18	98.32	25.71	26.18
1	670.59	416.82	275.25	66.61	22.11	10.42
1	136.74	305.56	243.06	137.20	50.64	13.63
1	184.25	89.32	170.31	100.92	50.06	23.65
1	167.24	55.84	31.63	56.51	38.40	29.09

Table 5.2.13 (cont'd) Whiting in IV and VIId. Complete available tuning series. First column represents effort, subsequent columns are ascending age groups.

FRATRO_7D							
1986	2004						
1	1	0.00	1.00				
1	7						
257794	2586.59	2249.77	7740.58	4462.98	804.35	198.40	19.35
188236	1954.81	5050.15	907.04	4606.14	331.43	218.34	53.97
215422	2233.10	7957.35	2551.70	536.69	1192.83	127.34	61.15
320383	2577.84	3916.35	6005.56	1489.83	216.08	342.97	50.48
257120	2491.70	5240.14	3362.65	2168.19	251.50	29.80	51.08
294594	4009.06	8176.54	3984.56	2625.40	1474.03	155.42	10.50
285718	5732.56	10924.16	3241.05	881.71	587.01	171.40	3.38
283999	3158.34	6542.83	8606.51	1676.81	442.49	123.89	79.06
286019	13931.57	7979.57	3268.93	1776.04	443.66	40.33	20.73
268151	6301.32	8449.94	5260.61	1217.42	263.53	62.53	8.18
274495	6140.12	6465.75	5465.37	1622.56	324.48	47.21	14.16
282216	3320.15	8143.54	6607.75	1974.21	450.88	58.75	8.43
291360	9921.00	6863.22	2384.88	781.09	264.61	104.76	15.31
	5536.90	5976.23	2822.66	1672.18	702.49	343.31	69.31
215553	7096.32	7026.28	1733.97	1724.37	1374.95	876.77	674.78
163848	89.05	6101.35	10124.09	3975.55	2563.21	2302.84	1039.71
192589	985.42	1922.07	6247.38	6475.65	2269.58	461.30	463.12
296717	154.90	6896.37	5488.74	5551.26	2397.47	311.73	64.69
89127	1830.97	705.87	2311.74	2945.43	2611.11	901.64	109.43

FRAGFS_7d				
1988	2004			
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
27	19.56	6.84	30.65	4.12

Table 5.2.13 (cont'd) Whiting in IV and VIId. Complete available tuning series. First column represents effort, subsequent columns are ascending age groups.

IBTS_Q4_ENG_IV			Survey discontinued					
1991	1996							
1	1	0.75	1					
0	7							
100	46.83	55.28	19.64	15.09	3.25	1.85	1.33	0.03
100	94.23	45.09	26.46	5.38	5.03	0.65	0.53	0.12
100	78.87	54.21	19.47	7.16	2.33	0.83	0.24	0.01
100	69.85	61.33	26.41	4.14	0.84	0.62	0.11	0.08
100	71.33	108.00	41.72	11.19	2.56	0.52	0.20	0.07
100	29.98	36.56	30.33	8.65	4.82	1.63	0.52	0.33

IBTS_Q2_SCO_IV			Survey discontinued			
1991	1997					
1	1	0.25	0.5			
1	6					
100	94.90	38.56	22.86	3.74	1.23	0.51
100	129.76	47.50	11.42	4.28	1.14	0.45
100	104.67	41.49	20.86	5.17	4.85	0.36
100	65.40	35.71	8.55	2.38	0.90	0.75
100	191.61	77.30	26.19	4.42	2.21	0.41
100	44.02	49.62	22.30	8.33	1.25	0.59
100	14.07	22.60	18.02	6.43	1.40	0.13

Table 5.3.1 Whiting in IV and VIId. XSA final run: tuning report

```
Lowestoft VPA Version 3.1
   12/09/2005  14:44
 Extended Survivors Analysis
 Whiting in the North Sea and eastern Channel, ages 1-8+ (31/09/2005)
 CPUE data from file EF.dat
 Catch data for  45 years. 1960 to 2004. Ages  1 to   8.
      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 IBTS_Q1_IV          ,   1990, 2004,   0,     4,   .990,  1.000
 SCOGFS_IV           ,   1990, 2004,   1,     6,   .500,   .750
 ENGGFS_IV           ,   1992, 2004,   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   4 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   39 iterations
1

 Regression weights
       ,  .482,  .610,  .725,  .820,  .893,  .944,  .976,  .993,  .999, 1.000

 Fishing mortalities
    Age,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004

      1,  .153,  .119,  .123,  .119,  .194,  .068,  .108,  .078,  .392,  .183
      2,  .343,  .322,  .300,  .249,  .392,  .359,  .201,  .184,  .420,  .246
      3,  .625,  .567,  .531,  .358,  .563,  .688,  .364,  .385,  .305,  .201
      4,  .771,  .742,  .602,  .556,  .647,  .793,  .586,  .432,  .399,  .271
      5,  .970,  .939,  .801,  .612,  .688,  .840,  .947,  .525,  .356,  .348
      6, 1.050, 1.055,  .638,  .788,  .617,  .924,  .696,  .599,  .305,  .327
      7,  .932,  .877,  .711,  .644,  .657,  .946,  .660,  .480,  .273,  .254


 XSA population numbers (Thousands)
                               AGE
 YEAR ,           1,            2,            3,            4,            5,            6,
7,
 1995 ,    1.56E+06, 5.99E+05, 2.86E+05, 7.73E+04, 2.77E+04, 8.99E+03, 8.23E+03,
 1996 ,    1.04E+06, 5.19E+05, 2.71E+05, 1.08E+05, 2.65E+04, 8.16E+03, 2.45E+03,
 1997 ,    7.43E+05, 3.58E+05, 2.40E+05, 1.08E+05, 3.80E+04, 8.07E+03, 2.21E+03,
 1998 ,    1.03E+06, 2.54E+05, 1.69E+05, 9.93E+04, 4.40E+04, 1.33E+04, 3.32E+03,
 1999 ,    1.62E+06, 3.53E+05, 1.26E+05, 8.34E+04, 4.22E+04, 1.86E+04, 4.70E+03,
 2000 ,    1.64E+06, 5.16E+05, 1.52E+05, 5.07E+04, 3.24E+04, 1.65E+04, 7.81E+03,
 2001 ,    1.32E+06, 5.93E+05, 2.30E+05, 5.39E+04, 1.70E+04, 1.09E+04, 5.11E+03,
 2002 ,    1.06E+06, 4.57E+05, 3.09E+05, 1.13E+05, 2.22E+04, 5.14E+03, 4.22E+03,
 2003 ,    3.60E+05, 3.80E+05, 2.43E+05, 1.48E+05, 5.42E+04, 1.02E+04, 2.20E+03,
 2004 ,    2.44E+05, 9.42E+04, 1.59E+05, 1.26E+05, 7.37E+04, 2.96E+04, 5.87E+03,
 Estimated population abundance at 1st Jan 2005
    ,     0.00E+00, 7.87E+04, 4.70E+04, 9.17E+04, 7.12E+04, 4.06E+04, 1.66E+04,
 Taper weighted geometric mean of the VPA populations:
    ,     9.27E+05, 3.73E+05, 2.09E+05, 9.33E+04, 3.58E+04, 1.21E+04, 3.97E+03,
 Standard error of the weighted Log(VPA populations) :
    ,        .6943,    .5783,    .3090,    .3747,    .4755,    .5483,    .4970,
1
 Log catchability residuals.

 Fleet : IBTS_Q1_IV
  Age  ,  1990,  1991,  1992,  1993,  1994
     1 ,   .24,   .17,   .09,   .13,  -.15
     2 ,  -.04,   .08,  -.04,  -.09,  -.08
     3 ,   .21,  -.19,  -.14,  -.07,  -.04
     4 ,   .20,  -.20,  -.06,  -.60,  -.48
     5 , No data for this fleet at this age
```

```
     6 , No data for this fleet at this age


  Age  ,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004
     1 ,   .07,   .09,  -.32,  -.01,   .18,   .15,   .05,  -.08,   .08,  -.20
     2 ,  -.01,  -.29,  -.20,  -.19,   .28,   .36,  -.02,   .10,   .16,  -.30
     3 ,  -.19,  -.34,  -.37,  -.13,   .29,   .84,  -.28,   .17,   .02,  -.24
     4 ,   .23,  -.38,  -.67,  -.12,  -.11,   .78,   .36,   .30,  -.02,  -.25
     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,   -7.0522,   -7.0085,   -7.1550,   -7.2806,
 S.E(Log q),     .1573,     .2300,     .3692,     .4266,



 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,     .90,    1.530,      7.73,     .97,     15,     .13,   -7.05,
  2,     .84,    1.400,      7.91,     .92,     15,     .18,   -7.01,
  3,    1.99,   -1.227,      2.11,     .18,     15,     .71,   -7.15,
  4,    3.31,   -2.078,     -2.33,     .10,     15,    1.19,   -7.28,
1


 Fleet : SCOGFS_IV
  Age  ,  1990,  1991,  1992,  1993,  1994
     1 , -1.17, -1.40,  -.79,  -.83,  -.94
     2 , -1.02,  -.95,  -.76,  -.63, -1.06
     3 , -1.13, -1.02,  -.48,  -.78, -1.08
     4 ,  -.60, -1.48,  -.35,  -.68, -1.59
     5 , -1.09, -1.12,  -.37,  -.48, -1.00
     6 ,  -.79, -1.64,  -.18, -1.16, -1.32


  Age  ,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004
     1 ,  -.34,  -.32,  -.44,   .05,  -.09,   .03,  -.37,   .18,   .49,  1.06
     2 ,  -.26,   .29,  -.11,   .10,   .34,   .41,  -.14,   .10,  -.09,   .02
     3 ,  -.12,   .19,   .27,  -.09,   .27,   .26,  -.13,   .23,   .14,  -.24
     4 ,  -.26,   .24,  -.22,  -.15,   .10,   .20,   .04,   .46,   .29,   .00
     5 ,  -.36,  -.63,  -.04,  -.23,  -.16,   .21,  -.01,   .07,   .15,   .23
     6 ,  -.16,  -.44,  -.56,   .33,  -.18,   .46,   .22,   .82,  -.25,  -.32


 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,   -9.5075,   -9.5533,   -9.6333,   -9.6550,   -9.6550,   -9.6550,
 S.E(Log q),     .5430,     .3477,     .3468,     .4367,     .3442,     .5621,



 Regression statistics :

 Ages with q independent of year class strength and constant w.r.t. time.
 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q
  1,    2.74,   -3.721,      2.15,     .39,     15,     .93,   -9.51,
  2,    1.13,    -.515,      9.13,     .69,     15,     .41,   -9.55,
  3,    1.15,    -.311,      9.24,     .38,     15,     .42,   -9.63,
  4,     .95,     .122,      9.74,     .45,     15,     .44,   -9.65,
  5,     .89,     .503,      9.83,     .73,     15,     .31,   -9.75,
  6,    1.52,    -.960,      9.88,     .32,     15,     .85,   -9.72,
1


 Fleet : ENGGFS_IV
  Age  ,  1990,  1991,  1992,  1993,  1994
     1 , 99.99, 99.99,  -.53,  -.71,  -.44
     2 , 99.99, 99.99,  -.39,  -.48,  -.60
     3 , 99.99, 99.99,  -.64,  -.46,  -.68
```

```
     4 , 99.99, 99.99,  -.57,  -.38,  -.32
     5 , 99.99, 99.99,   .26,  -.78,  -.43
     6 , 99.99, 99.99,  1.23,   .57, -1.43


  Age  ,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004
     1 ,  -.15,  -.40,  -.25,  -.44,   .07,   .28,   .42,   .76,  -.18,  -.08
     2 ,   .26,  -.39,  -.26,   .33,  -.05,   .17,  -.30,   .15,   .16,   .27
     3 ,   .12,  -.07,   .25,  -.45,   .22,   .06,  -.20,  -.03,   .32,   .24
     4 ,   .28,  -.38,   .03,   .13,  -.14,   .04,   .13,  -.03,   .34,  -.12
     5 ,  -.61,  -.52,   .20,  -.03,  -.07,  -.13,   .14,  -.59,   .43,  -.28
     6 ,   .01,  -.07,  1.06,  -.41,  -.90,  -.33,   .57,  -.65,   .39,  -.21


 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,  -14.4655,  -14.5026,  -14.6798,  -14.8508,  -14.8508,  -14.8508,
 S.E(Log q),     .4141,     .2924,     .2985,     .2271,     .3880,     .6730,



 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,     .91,     .456,     14.40,     .78,     13,     .40,  -14.47,
  2,    1.35,   -1.609,     15.10,     .74,     13,     .36,  -14.50,
  3,    1.17,    -.393,     15.09,     .43,     13,     .37,  -14.68,
  4,    1.07,    -.305,     15.10,     .71,     13,     .26,  -14.85,
  5,     .91,     .339,     14.60,     .68,     13,     .35,  -14.99,
  6,    1.76,   -1.019,     19.16,     .20,     13,    1.17,  -14.94,
1

 Terminal year survivor and F summaries :
 Age  1   Catchability constant w.r.t. time and dependent on age
 Year class = 2003
 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 IBTS_Q1_IV          ,     64153.,   .300,       .000,    .00,   1,  .459,     .220
 SCOGFS_IV           ,    226279.,   .572,       .000,    .00,   1,  .126,     .068
 ENGGFS_IV           ,     72346.,   .436,       .000,    .00,   1,  .217,     .198
   F shrinkage mean  ,     70548.,    .50,,,,                        .198,     .202
 Weighted prediction :
 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     78671.,       .21,      .23,    4,   1.131,   .183

1
 Age  2   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
 IBTS_Q1_IV          ,     40666.,   .216,       .188,    .87,   2,  .393,     .279
 SCOGFS_IV           ,     52814.,   .312,       .194,    .62,   2,  .201,     .222
 ENGGFS_IV           ,     54666.,   .255,       .195,    .76,   2,  .298,     .215
   F shrinkage mean  ,     41838.,    .50,,,,                        .108,     .272
 Weighted prediction :
 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     46950.,       .14,      .09,    7,    .661,   .246

 Age  3   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
 IBTS_Q1_IV          ,     87730.,   .191,       .118,    .62,   3,  .344,     .209
 SCOGFS_IV           ,     80298.,   .242,       .098,    .40,   3,  .237,     .227
 ENGGFS_IV           ,    123394.,   .202,       .144,    .71,   3,  .337,     .153
   F shrinkage mean  ,     47841.,    .50,,,,                        .082,     .356
 Weighted prediction :
 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     91720.,       .12,      .11,   10,    .897,   .201

1
 Age  4   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
IBTS_Q1_IV          ,     70676.,   .177,       .075,    .43,   4,  .313,     .273
SCOGFS_IV           ,     73905.,   .215,       .085,    .39,   4,  .228,     .262
ENGGFS_IV           ,     79695.,   .169,       .121,    .71,   4,  .386,     .245
  F shrinkage mean  ,     36116.,    .50,,,,                         .073,     .478
Weighted prediction :
Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    71220.,       .11,      .08,   13,    .719,   .271

Age  5   Catchability constant w.r.t. time and age (fixed at the value for age)  4
Year class = 1999
Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
IBTS_Q1_IV          ,     43234.,   .180,       .050,    .28,   4,  .229,     .330
SCOGFS_IV           ,     48128.,   .199,       .070,    .35,   5,  .293,     .301
ENGGFS_IV           ,     40707.,   .165,       .139,    .84,   5,  .386,     .347
  F shrinkage mean  ,     19816.,    .50,,,,                         .093,     .616
Weighted prediction :
Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    40552.,       .11,      .08,   15,    .795,   .348

1
 Age  6   Catchability constant w.r.t. time and age (fixed at the value for age)  4
 Year class = 1998
 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 IBTS_Q1_IV          ,     19272.,   .188,       .146,    .77,   4,  .183,     .288
 SCOGFS_IV           ,     17925.,   .201,       .121,    .60,   6,  .319,     .306
 ENGGFS_IV           ,     17587.,   .171,       .107,    .63,   6,  .378,     .312
   F shrinkage mean  ,      8999.,    .50,,,,                         .121,     .539
 Weighted prediction :
 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     16595.,       .11,      .09,   17,    .744,   .327

 Age  7   Catchability constant w.r.t. time and age (fixed at the value for age)  4
 Year class = 1997
 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 IBTS_Q1_IV          ,      5439.,   .205,       .163,    .79,   4,  .133,     .181
 SCOGFS_IV           ,      3800.,   .228,       .082,    .36,   6,  .316,     .250
 ENGGFS_IV           ,      3442.,   .196,       .163,    .83,   6,  .349,     .273
   F shrinkage mean  ,      3227.,    .50,,,,                         .201,     .288
 Weighted prediction :
 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
   3726.,     .14,     .08,   17,    .532,   .254
```

Table 5.3.2 Whiting in IV and VIId. XSA final run: Fishing mortality

Run title : Whiting in the North Sea and eastern Channel, ages 1-8+ (31/09/2005)

At 12/09/2005 14:46

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1980,	1981,	1982,	1983,	1984,
AGE					
1,	.1014,	.1652,	.1734,	.2103,	.2233,
2,	.4401,	.3294,	.2933,	.4552,	.5164,
3,	.8223,	.7515,	.5312,	.7466,	.8708,
4,	.9750,	.9979,	.7189,	.7345,	1.0277,
5,	1.2296,	1.0954,	.8931,	.8800,	1.0479,
6,	.9440,	1.2779,	1.0099,	.9178,	1.1220,
7,	1.0040,	1.0426,	.7963,	.8282,	1.0288,
+gp,	1.0040,	1.0426,	.7963,	.8282,	1.0288,
0 FBAR 2- 6,	.8822,	.8904,	.6893,	.7468,	.9170,

Table 8 Fishing mortality (F) at age

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
1,	.1901,	.2697,	.1406,	.3584,	.1290,	.2264,	.1168,	.2395,	.1939,	.1568,
2,	.2494,	.4252,	.5076,	.4307,	.4312,	.5487,	.4871,	.3870,	.4793,	.3445,
3,	.6352,	.7045,	.8694,	.6556,	.6958,	.9111,	.5179,	.5772,	.7548,	.6853,
4,	.8736,	1.1921,	1.2435,	.9653,	.8218,	.9830,	.8843,	.6344,	.8251,	.9079,
5,	1.1654,	1.0467,	1.3454,	1.1468,	1.4953,	1.1717,	1.1042,	.9365,	.8549,	.9955,
6,	1.1822,	1.1563,	1.6545,	1.1913,	1.5053,	.9659,	.6717,	1.1381,	1.0690,	1.0477,
7,	.9749,	1.0367,	1.2943,	1.0010,	1.1432,	1.0194,	.8030,	.8368,	.8833,	.9313,
+gp,	.9749,	1.0367,	1.2943,	1.0010,	1.1432,	1.0194,	.8030,	.8368,	.8833,	.9313,
0 FBAR 2- 6,	.8212,	.9050,	1.1241,	.8779,	.9899,	.9161,	.7330,	.7346,	.7966,	.7962,

1

Table 5.3.2 (cont'd) Whiting in IV and VIId. XSA final run: Fishing mortality

Run title : Whiting in the North Sea and eastern Channel, ages 1-8+ (31/09/2005)

At 12/09/2005 14:46

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	FBAR **-**
AGE											
1,	.1526,	.1187,	.1229,	.1185,	.1943,	.0677,	.1083,	.0785,	.3921,	.1832,	.2179,
2,	.3433,	.3217,	.3001,	.2489,	.3918,	.3589,	.2008,	.1836,	.4200,	.2462,	.2833,
3,	.6252,	.5671,	.5312,	.3581,	.5628,	.6883,	.3640,	.3847,	.3051,	.2012,	.2970,
4,	.7705,	.7420,	.6017,	.5559,	.6465,	.7930,	.5862,	.4320,	.3993,	.2708,	.3674,
5,	.9705,	.9389,	.8015,	.6117,	.6881,	.8401,	.9466,	.5254,	.3556,	.3480,	.4097,
6,	1.0500,	1.0548,	.6382,	.7884,	.6169,	.9240,	.6960,	.5992,	.3050,	.3274,	.4105,
7,	.9319,	.8765,	.7114,	.6439,	.6570,	.9463,	.6599,	.4799,	.2726,	.2544,	.3356,
+gp,	.9319,	.8765,	.7114,	.6439,	.6570,	.9463,	.6599,	.4799,	.2726,	.2544,	
0 FBAR 2- 6,	.7519,	.7249,	.5745,	.5126,	.5812,	.7209,	.5587,	.4250,	.3570,	.2787,	

Table 5.3.3 Whiting in IV and VIId. XSA final run: Population number

Run title : Whiting in the North Sea and eastern Channel, ages 1-8+ (31/09/2005)

At 12/09/2005 14:46

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1980,	1981,	1982,	1983,	1984,
AGE					
1,	4423048,	1719960,	1945654,	1743364,	2598959,
2,	1463367,	1545551,	563875,	632664,	546342,
3,	607921,	600895,	708926,	268157,	255882,
4,	169230,	188246,	199713,	293698,	89566,
5,	84825,	47287,	51410,	72091,	104387,
6,	19941,	19317,	12315,	16391,	23288,
7,	2010,	6042,	4192,	3493,	5098,
+gp,	1314,	546,	960,	1798,	1036,
0 TOTAL,	6771655,	4127843,	3487044,	3031656,	3624558,

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

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
1,	1888925,	3923064,	3274382,	2297653,	4405590,	2013677,	1875142,	1810580,	1984959,	1812334,
2,	804001,	604083,	1158549,	1100263,	620972,	1497561,	620971,	645278,	551103,	632381,
3,	207852,	399492,	251766,	444687,	456072,	257266,	551628,	243278,	279409,	217586,
4,	75481,	77605,	139164,	74375,	162681,	160261,	72897,	231583,	96251,	92563,
5,	23743,	23342,	17454,	29729,	20985,	52982,	44425,	22303,	90968,	31245,
6,	28508,	5766,	6382,	3540,	7355,	3664,	12785,	11469,	6809,	30131,
7,	5906,	6807,	1413,	950,	838,	1271,	1086,	5086,	2862,	1821,
+gp,	1576,	956,	1541,	288,	531,	190,	539,	225,	1429,	826,
0 TOTAL,	3035993,	5041114,	4850651,	3951484,	5675022,	3986873,	3179473,	2969802,	3013791,	2818886,

1

Table 5.3.3 (cont'd) Whiting in IV and VIId. XSA final run: Population n umber

Run title : Whiting in the North Sea and eastern Channel, ages 1-8+ (31/09/2005)

At 12/09/2005 14:46

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	GMST 80-**	AMST 80-**
AGE													
1,	1562355,	1043575,	742738,	1027461,	1621768,	1641048,	1317598,	1062515,	360452,	244327,	0,	1874004,	2075493,
2,	599158,	518730,	358417,	254034,	352940,	516460,	593125,	457255,	379913,	94185,	78671,	649889,	723351,
3,	285701,	271038,	239761,	169287,	126288,	152096,	230002,	309379,	242659,	159165,	46950,	295774,	327581,
4,	77266,	107739,	108331,	99329,	83390,	50692,	53853,	112628,	148391,	126038,	91720,	110097,	122458,
5,	27660,	26489,	38006,	43971,	42204,	32362,	16993,	22200,	54168,	73740,	71220,	36546,	42046,
6,	8992,	8162,	8067,	13280,	18575,	16517,	10879,	5136,	10224,	29562,	40552,	10906,	12925,
7,	8231,	2451,	2214,	3319,	4701,	7806,	5106,	4224,	2197,	5869,	16595,	3083,	3779,
+gp,	849,	2074,	985,	935,	1532,	2247,	2865,	2165,	1828,	1460,	4653,		
0 TOTAL,	2570212,	1980258,	1498519,	1611616,	2251399,	2419228,	2230421,	1975504,	1199832,	734346,	350362,		

1

Table 5.4.1 Whiting in IV and VIId. XSA final run: Stock summary

Run title : Whiting in the North Sea and eastern Channel, ages 1-8+ (31/09/2005)
,

At 12/09/2005 14:46

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 2- 6,
1980,	4423048,	837816,	522371,	223517,	.4279,	.8822,
1981,	1719960,	636484,	489007,	192049,	.3927,	.8904,
1982,	1945654,	492860,	378624,	140195,	.3703,	.6893,
1983,	1743364,	512749,	337432,	161212,	.4778,	.7468,
1984,	2598959,	485840,	271620,	145741,	.5366,	.9170,
1985,	1888925,	441815,	271144,	106363,	.3923,	.8212,
1986,	3923064,	665686,	288801,	161744,	.5601,	.9050,
1987,	3274382,	537218,	299324,	138775,	.4636,	1.1241,
1988,	2297653,	419899,	295676,	133470,	.4514,	.8779,
1989,	4405590,	561715,	279888,	123753,	.4422,	.9899,
1990,	2013677,	483768,	317899,	153453,	.4827,	.9161,
1991,	1875142,	458007,	277516,	124975,	.4503,	.7330,
1992,	1810580,	408032,	265834,	109704,	.4127,	.7346,
1993,	1984959,	375881,	239652,	116165,	.4847,	.7966,
1994,	1812334,	360811,	223759,	92606,	.4139,	.7962,
1995,	1562355,	362126,	232916,	103268,	.4434,	.7519,
1996,	1043575,	295637,	202493,	73957,	.3652,	.7249,
1997,	742738,	238536,	173290,	59102,	.3411,	.5745,
1998,	1027461,	226527,	139920,	44312,	.3167,	.5126,
1999,	1621768,	255908,	140708,	59179,	.4206,	.5812,
2000,	1641048,	347525,	174252,	60907,	.3495,	.7209,
2001,	1317598,	286054,	192404,	49062,	.2550,	.5587,
2002,	1062515,	253671,	184765,	46552,	.2520,	.4250,
2003,	360452,	169320,	148885,	43208,	.2902,	.3570,
2004,	244327,	149658,	124487,	29057,	.2334,	.2787,
Arith. Mean ,	1933645,	410542,	258907,	107693,	.4010,	.7322,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

Table 5.5.1 Whiting in IV and VIId. Input to RCT3.

Whiting in IV and VIId RCT3 age 1
2 15 2

'Yearclass'	'XSA age 1'	'SGFS age 1'	'IBTS_Q1 age 1'
1990	1875142	-1	1007.621
1991	1810580	-1	907.297
1992	1984959	-1	1075.624
1993	1812334	-1	721.709
1994	1562355	4176	678.590
1995	1043575	2888	502.361
1996	742738	1824	287.733
1997	1027461	4141	543.117
1998	1621768	5410	676.270
1999	1641048	6646	756.853
2000	1317598	3499	648.649
2001	1062515	4980	670.591
2002	-1	1891	136.742
2003	-1	2580	184.250
2004	-1	1139	167.235

Table 5.5.2 Whiting in IV and VIId. Results from RCT3.

Analysis by RCT3 ver3.1 of data from file :

whi47d.inp

Whiting in IV and VIId RCT3 age 1

Data for 2 surveys over 15 years : 1990 - 2004

Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 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
SGFS a	.86	6.85	.23	.648	8	7.55	13.37	.333	.302
IBTS_Q	1.00	7.66	.15	.819	12	4.93	12.57	.309	.352
						VPA Mean =	14.12	.311	.346

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
SGFS a	.86	6.84	.23	.645	8	7.86	13.64	.302	.325
IBTS_Q	1.01	7.61	.16	.813	12	5.22	12.86	.284	.368
						VPA Mean =	14.12	.311	.307

Yearclass = 2004

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
SGFS a	.87	6.83	.23	.642	8	7.04	12.93	.438	.202
IBTS_Q	1.02	7.54	.16	.805	12	5.13	12.75	.314	.393
						VPA Mean =	14.11	.310	.405

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2002	628253	13.35	.18	.46	6.25		
2003	727078	13.50	.17	.37	4.62		
2004	617674	13.33	.20	.45	5.29		

Table 5.6.1 Whiting in IV and VIId. Input data for catch forecast

Label	Value	Label	Value
Number at age		Weight in the stock	
N1	618000	WS1	.08
N2	78668	WS2	.15
N3	46950	WS3	.22
N4	91719	WS4	.27
N5	71219	WS5	.31
N6	40550	WS6	.34
N7	16599	WS7	.35
N8	4650	WS8	.36
H.cons selectivity		Weight in the HC catch	
sH1	.03	WH1	.21
sH2	.04	WH2	.23
sH3	.08	WH3	.26
sH4	.14	WH4	.30
sH5	.22	WH5	.32
sH6	.20	WH6	.36
sH7	.16	WH7	.36
sH8	.23	WH8	.36
Discard selectivity		Weight in the discards	
sD1	.06	WD1	.12
sD2	.14	WD2	.17
sD3	.11	WD3	.20
sD4	.13	WD4	.22
sD5	.13	WD5	.25
sD6	.13	WD6	.24
sD7	.10	WD7	.27
sD8	.02	WD8	.22
Industrial selectivity		Weight in Ind. bycatch	
sI1	.09	WI1	.04
sI2	.07	WI2	.09
sI3	.01	WI3	.17
sI4	.00	WI4	.29
sI5	.00	WI5	.28
sI6	.00	WI6	.41
sI7	.00	WI7	.00
sI8	.00	WI8	.00
Natural mortality		Proportion mature	
M1	.95	MT1	.11
M2	.45	MT2	.92
M3	.35	MT3	1.00
M4	.30	MT4	1.00
M5	.25	MT5	1.00
M6	.25	MT6	1.00
M7	.20	MT7	1.00
M8	.20	MT8	1.00
Relative effort in HC fishery		Year effect for natural mortality	
HF05	1.00	K05	1.00
HF06	1.00	K06	1.00
HF07	1.00	K07	1.00
Relative effort in industrial fishery			
IF05	1.00		

IF06 1.00
IF07 1.00

Recruitment in 2006 and 2007
R06 833000
R07 833000
Proportion of F before spawning = .00
Proportion of M before spawning = .00

Stock numbers in 2005 are VPA survivors.
These are overwritten at Age
Human consumption, discard and bycatch Fs are obtained from exploitation pattern in 2004.
Fs are distributed between consumption, discards and bycatch by mean proportion retained in 2004.

Table 5.6.2 Whiting in IV and VIId. Short-term catch forecast. Catch options

F multipliers in the 2006 human consumption fishery from 0 to 0.6

		Year							
		2005	2006						
Mean F	Ages								
H.cons	2 to 6	.26	.00	.03	.05	.08	.11	.13	.16
Ind BC	2 to 6	.02	.02	.02	.02	.02	.02	.02	.02
Effort relative to	2004								
H.cons		1.00	.00	.10	.20	.30	.40	.50	.60
Ind BC		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass at start of year									
Total		136.8	151.3	151.3	151.3	151.3	151.3	151.3	151.3
Spawning		94.0	92.6	92.6	92.6	92.6	92.6	92.6	92.6
Catch weight (,000t)									
H.cons		13.5	.0	1.4	2.8	4.1	5.4	6.7	7.9
Discards		10.0	.0	1.2	2.4	3.5	4.6	5.7	6.8
Ind BC		1.7	2.8	2.8	2.8	2.8	2.8	2.8	2.7
Total Landings		15.2	2.8	4.2	5.6	6.9	8.2	9.4	10.7
Total Catch		25.2	2.8	5.4	7.9	10.4	12.8	15.2	17.5
Biomass at start of	2007								
Total			182.5	180.2	178.0	175.9	173.8	171.8	169.8
Spawning			122.5	120.3	118.2	116.1	114.0	112.0	110.0

F multipliers in the 2006 human consumption fishery from 0.7 to 1.3

		Year							
		2005	2006						
Mean F	Ages								
H.cons	2 to 6	.26	.18	.21	.24	.26	.29	.32	.34
Ind BC	2 to 6	.02	.02	.02	.02	.02	.02	.02	.02
Effort relative to	2004								
H.cons		1.00	.70	.80	.90	1.00	1.10	1.20	1.30
Ind BC		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomass at start of year									
Total		136.8	151.3	151.3	151.3	151.3	151.3	151.3	151.3
Spawning		94.0	92.6	92.6	92.6	92.6	92.6	92.6	92.6
Catch weight (,000t)									
H.cons		13.5	9.1	10.3	11.5	12.6	13.7	14.8	15.9
Discards		10.0	7.9	9.0	10.0	11.0	12.0	13.0	14.0
Ind BC		1.7	2.7	2.7	2.7	2.7	2.7	2.7	2.6
Total Landings		15.2	11.9	13.0	14.2	15.3	16.4	17.5	18.6
Total Catch		25.2	19.8	22.0	24.2	26.3	28.4	30.5	32.5
Biomass at start of	2007								
Total			167.8	165.9	164.1	162.3	160.5	158.8	157.1
Spawning			108.1	106.2	104.4	102.6	100.9	99.2	97.5

Table 5.6.3 Whiting in IV and VIId. Short-term catch forecast. Detailed tables for $F_{2006} = F_{2005}$

Forecast for year 2005
F multiplier H.cons=1.00
F multiplier Indust=1.00

Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	618000	10575	22925	34239	67739
2	78669	2392	7724	3837	13952
3	46950	2873	4075	314	7262
4	91720	9791	9029	112	18932
5	71220	11568	7086	0	18654
6	40550	6109	3962	15	10086
7	16600	2125	1269	0	3394
8	4650	874	77	0	951
Wt	137	13	10	2	25

Forecast for year 2006
F multiplier H.cons=1.00
F multiplier Indust=1.00

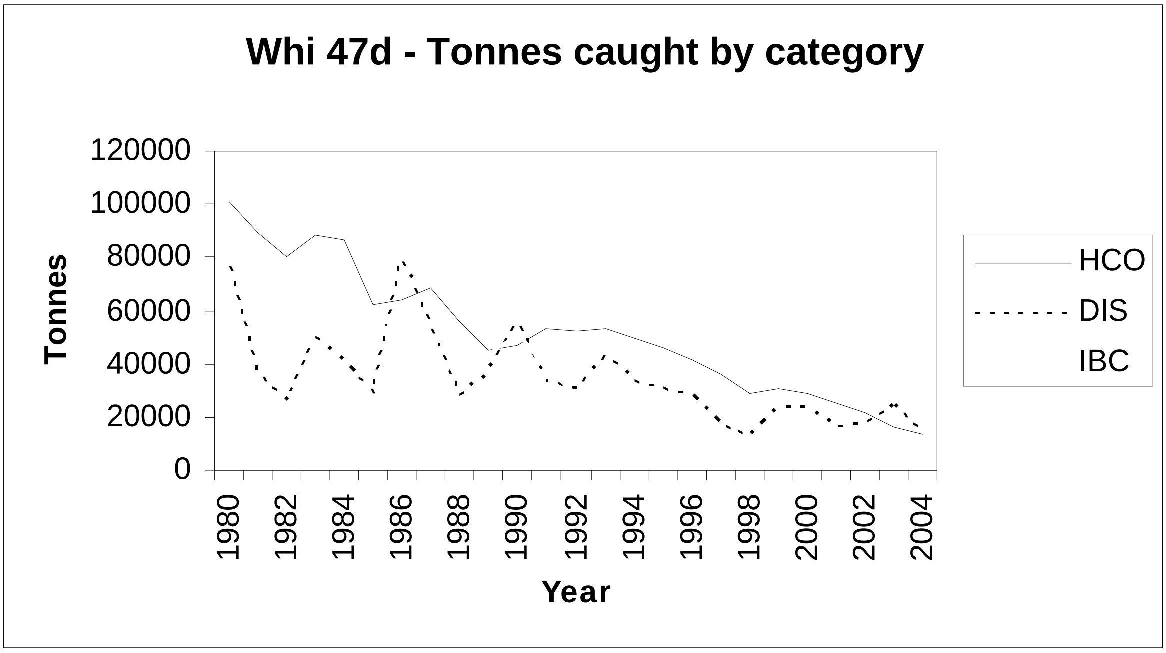
Populations		Catch number			
Age	Stock No.	H.Cons	Discards	By-catch	Total
1	833000	14254	30900	46151	91305
2	198997	6049	19539	9705	35293
3	39215	2400	3404	262	6066
4	27055	2888	2663	33	5584
5	51823	8417	5156	0	13574
6	39165	5900	3826	15	9741
7	22763	2914	1740	0	4654
8	13490	2535	223	0	2758
Wt	151	13	11	3	26

Table 5.12.1 Division Nominal landings (t) of Whiting from Division IIIa as supplied by the Study Group on IIIa Demersal Stocks (ICES 1992b) and updated by the Working Group.

Year	Denmark			Norway	Sweden	Others	Total
1975	19,018			57	611	4	19,690
1976	17,870			48	1,002	48	18,968
1977	18,116			46	975	41	19,178
1978	48,102			58	899	32	49,091
1979	16,971			63	1,033	16	18,083
1980	21,070			65	1,516	3	22,654
	Total consumption	Total industrial	Total				
1981	1,027	23,915	24,942	70	1,054	7	26,073
1982	1,183	39,758	40,941	40	670	13	41,664
1983	1,311	23,505	24,816	48	1,061	8	25,933
1984	1,036	12,102	13,138	51	1,168	60	14,417
1985	557	11,967	12,524	45	654	2	13,225
1986	484	11,979	12,463	64	477	1	13,005
1987	443	15,880	16,323	29	262	43	16,657
1988	391	10,872	11,263	42	435	24	11,764
1989	917	11,662	12,579	29	675	-	13,283
1990	1,016	17,829	18,845	49	456	73	19,423
1991	871	12,463	13,334	56	527	97	14,041
1992	555	10,675	11,230	66	959	1	12,256
1993	261	3,581	3,842	42	756	1	4,641
1994	174	5,391	5,565	21	440	1	6,027
1995	85	9,029	9,114	24	431	1	9,570
1996	55	2,668	2,723	21	182	-	2,926
1997	38	568	606	18	94	-	718
1998	35	847	882	16	81	-	979
1999	37	1,199	1,236	15	111	-	1,362
2000	59	386	445	17	138	1	622
2001	61	n/a	n/a	27	126	+	214
2002	101	n/a	n/a	23	127	1	252
2003	93	n/a	n/a	20	71	2	186
2004	93	n/a	n/a	17*	74	1	185

*Preliminary.

Figure 5.2.1 Whiting in IV and VIId. The contribution of different catch components to the total catch.



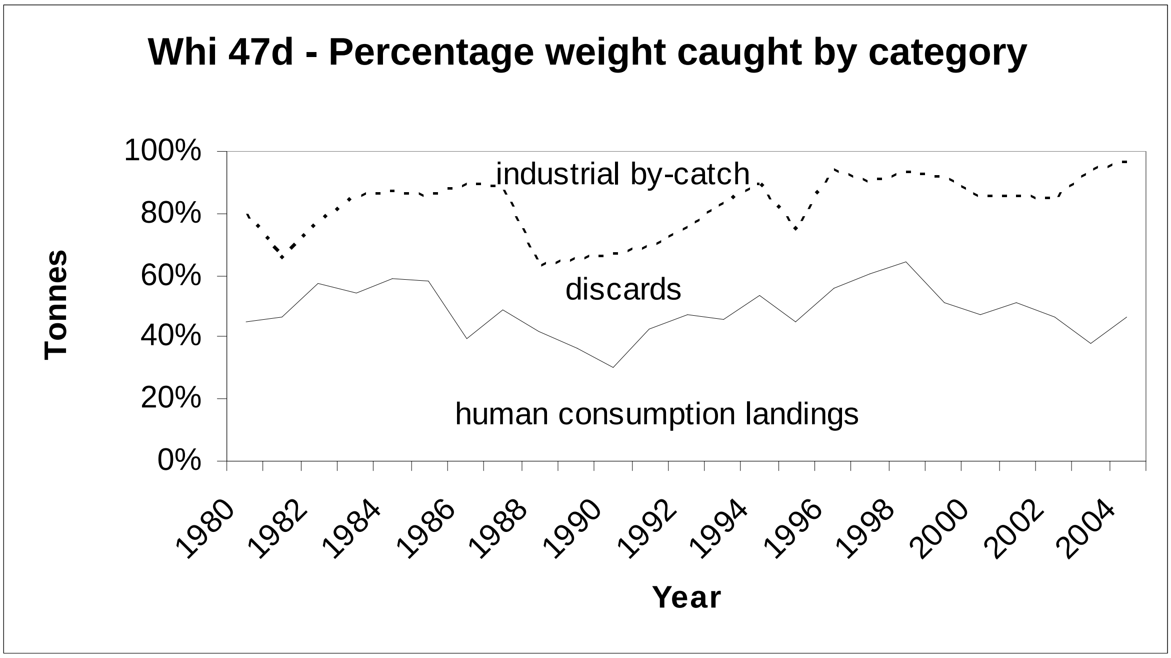
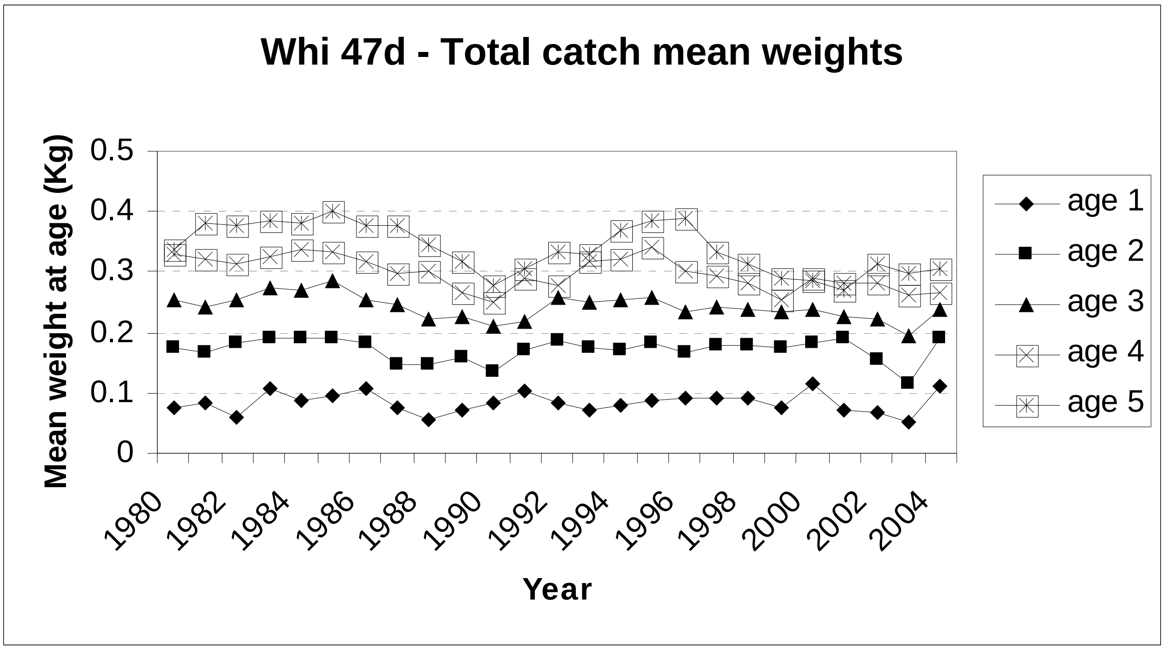


Figure 5.2.2 Whiting in IV and VIId. Mean weights at age (kg) by catch component. Total catch mean weights are also used as stock mean weights.



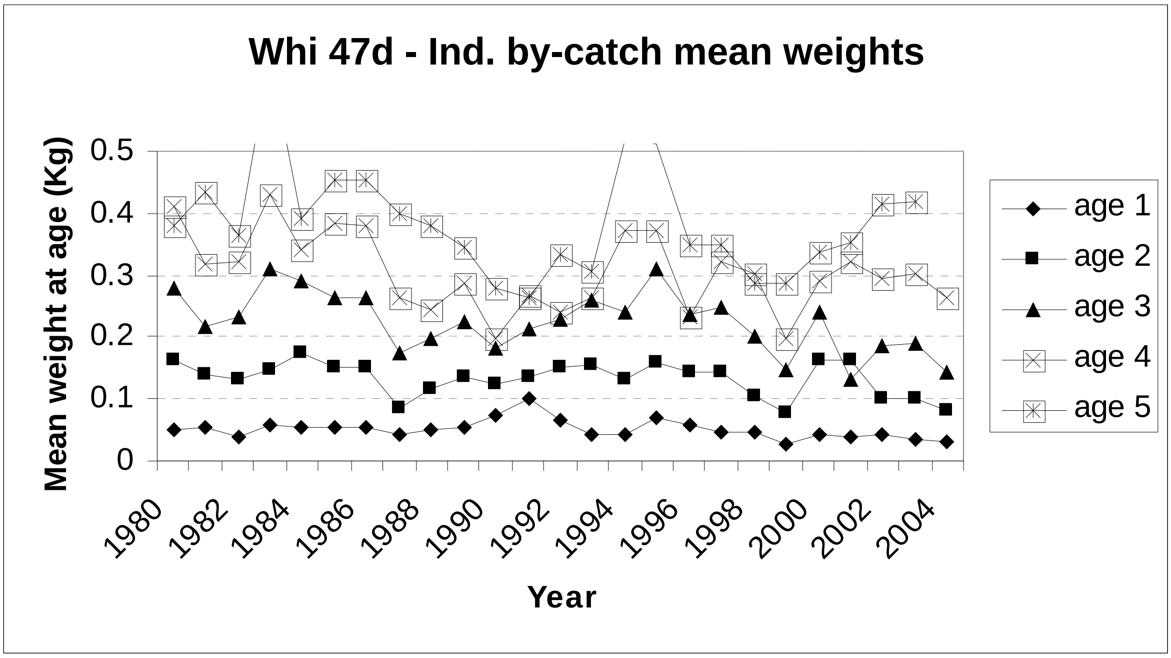
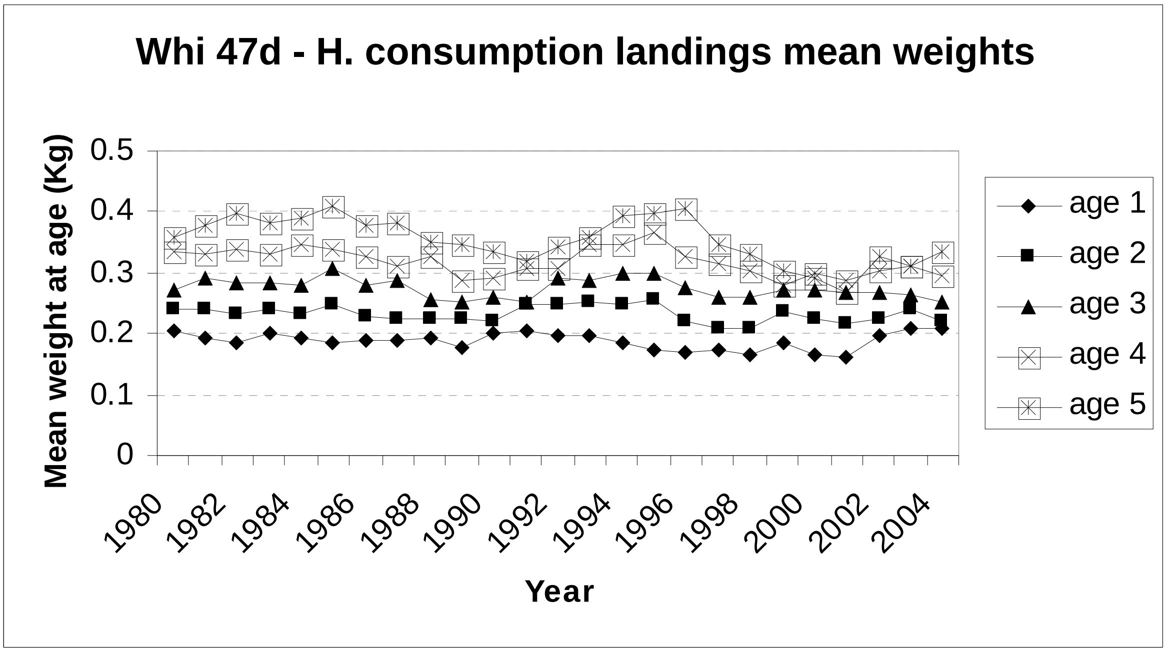


Figure 5.2.2 (cont'd) Whiting in IV and VIId. Mean weights at age (kg) by catch component.



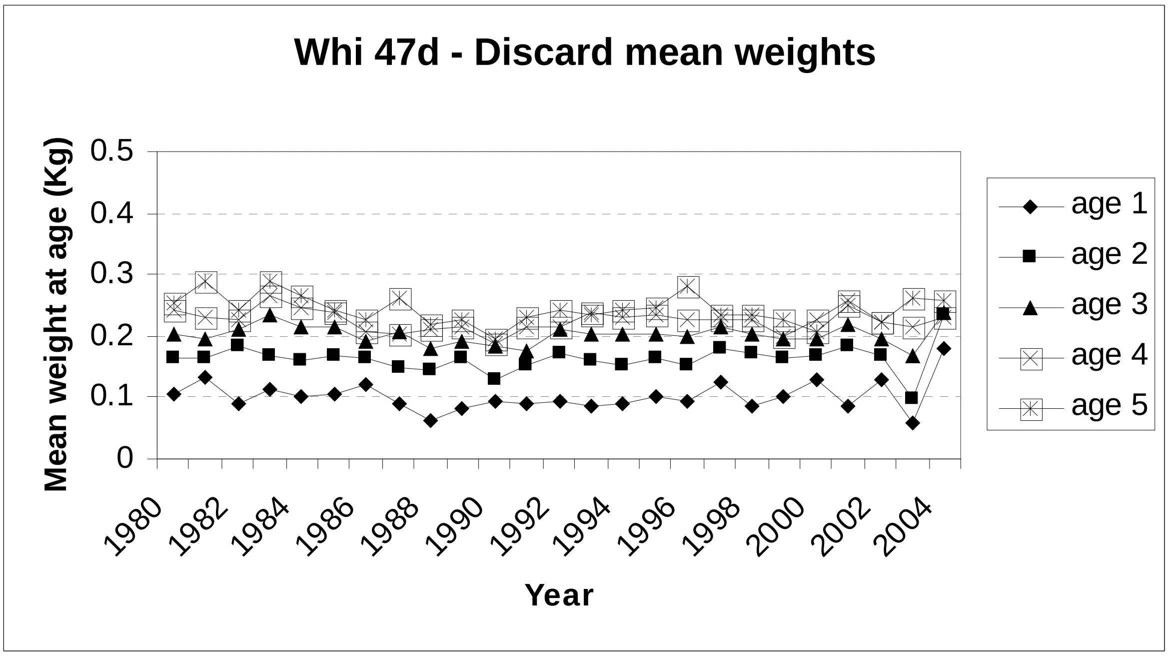


Figure 5.3.1 Whiting in IV and VIId. Exploratory XSA: log-catchability residuals from the IBTS_Q1 calibration.

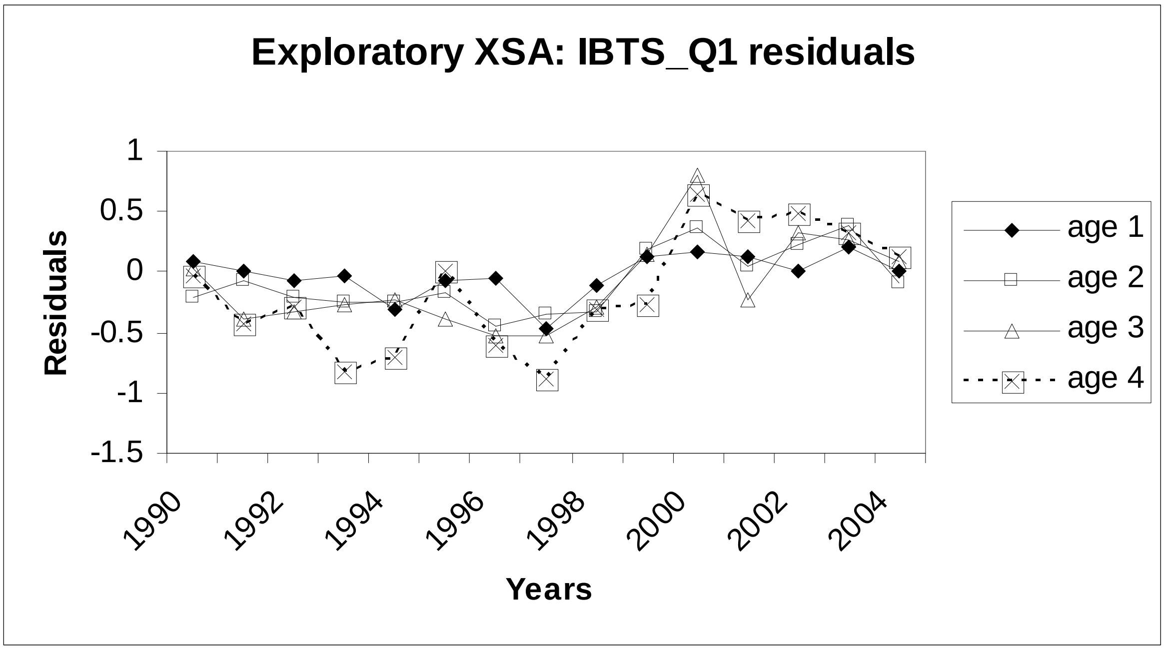


Figure 5.3.2 Whiting in IV and VIId. XSA stock trends for the exploratory XSA incorporating IBTS_Q1 survey indices.

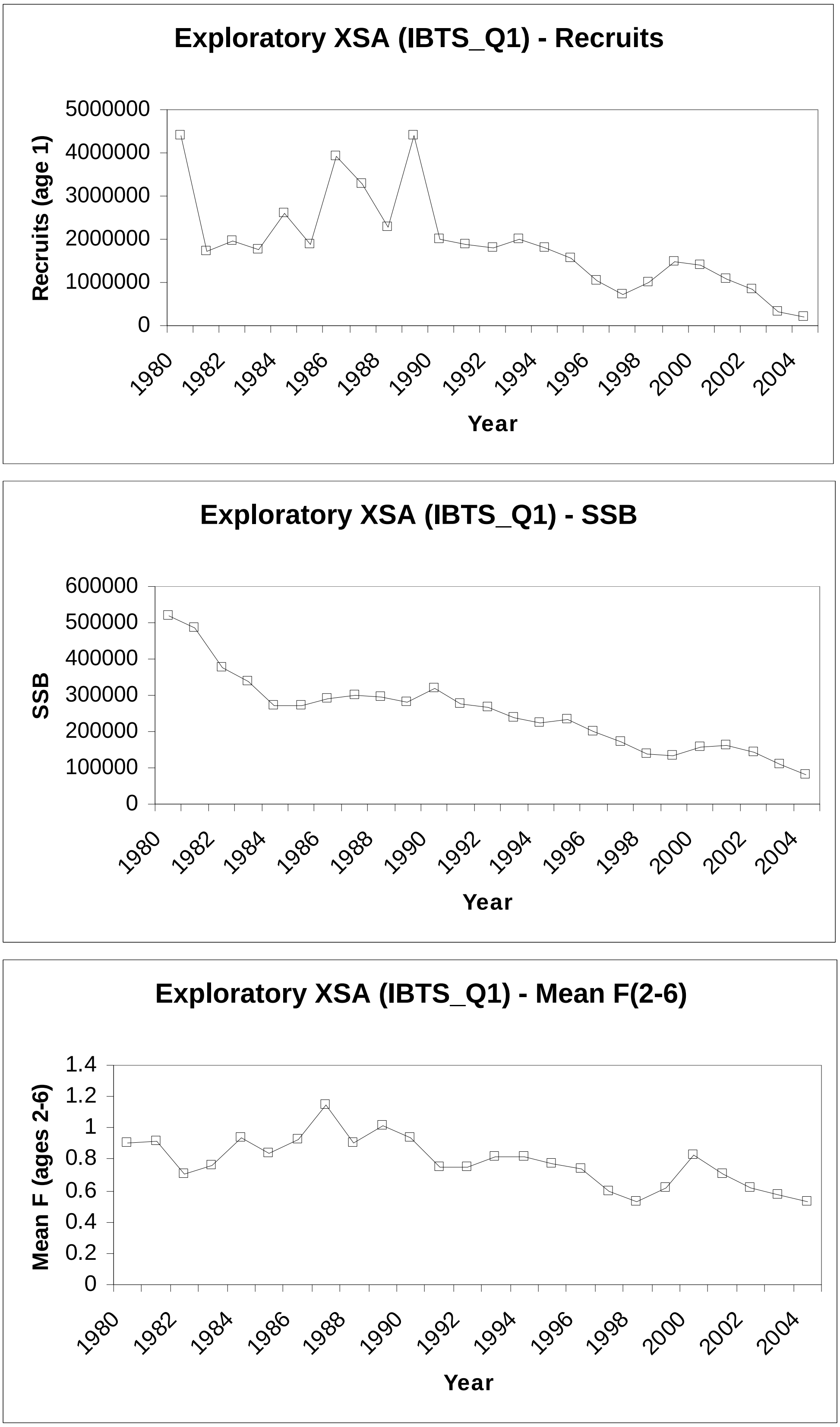
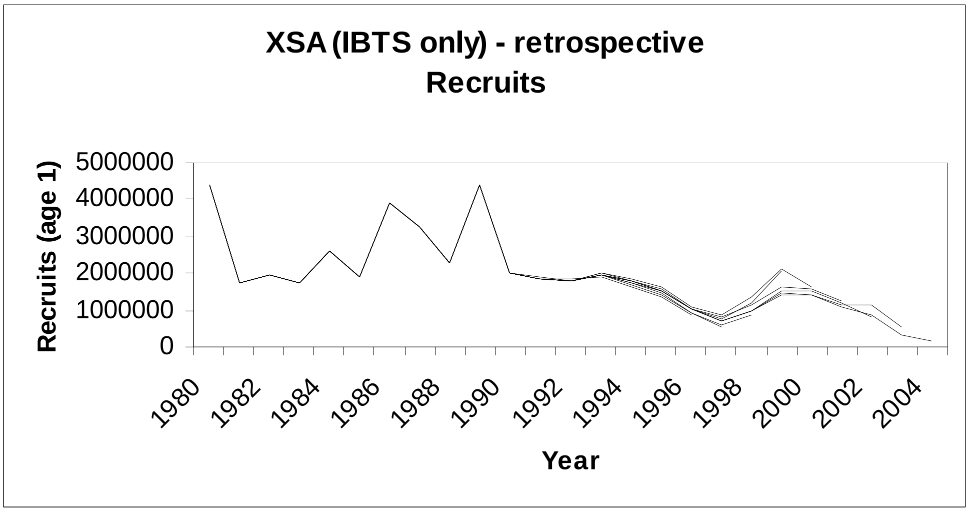
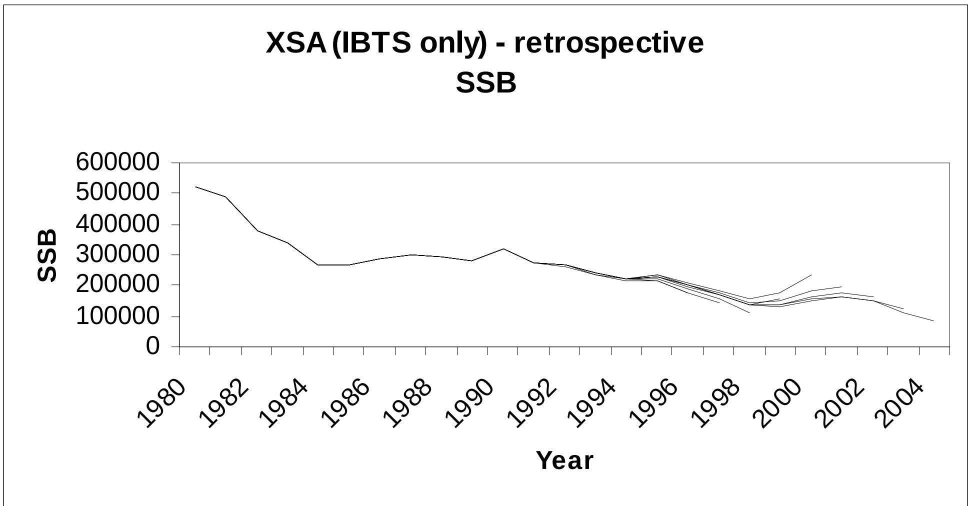


Figure 5.3.3. Whiting in IV and VIId. Exploratory XSA: retrospective patterns for the IBTS_Q1-calibrated run.





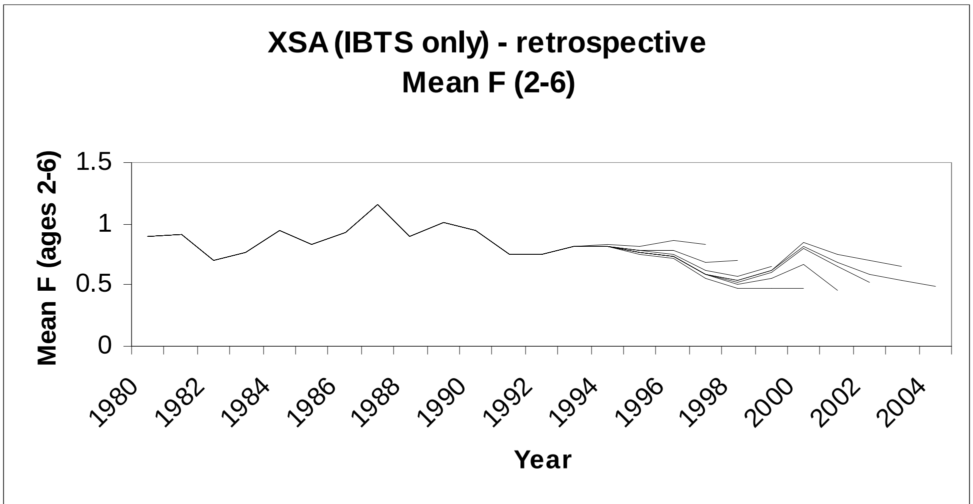


Figure 5.3.4 Whiting in IV and VIId. Exploratory TSA: model results calibrated by IBTS_Q1 indices and incorporating the estimation of a Ricker stock-recruit function.

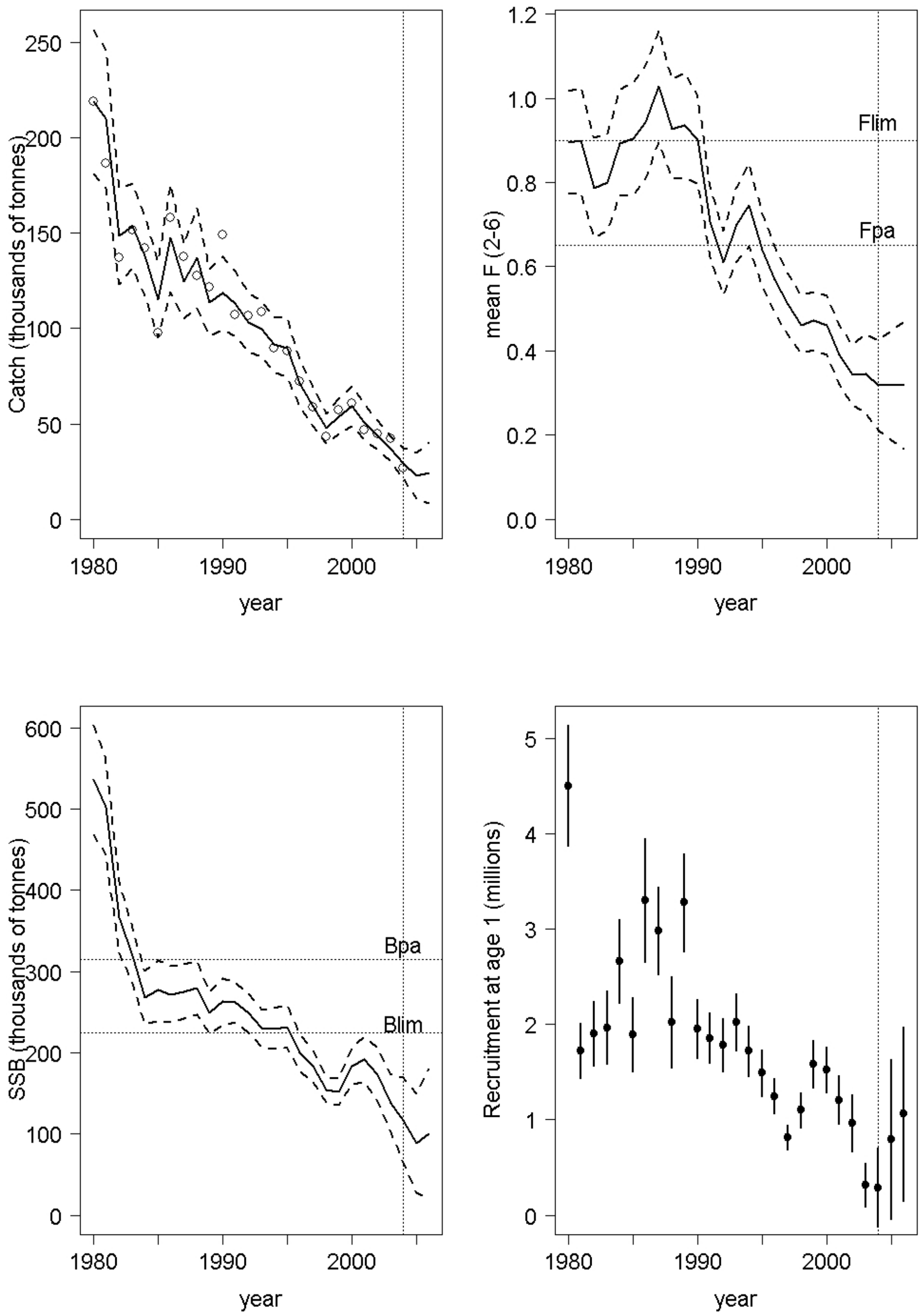


Figure 5.3.5 Whiting in IV and VIId. Exploratory TSA: retrospective patterns.

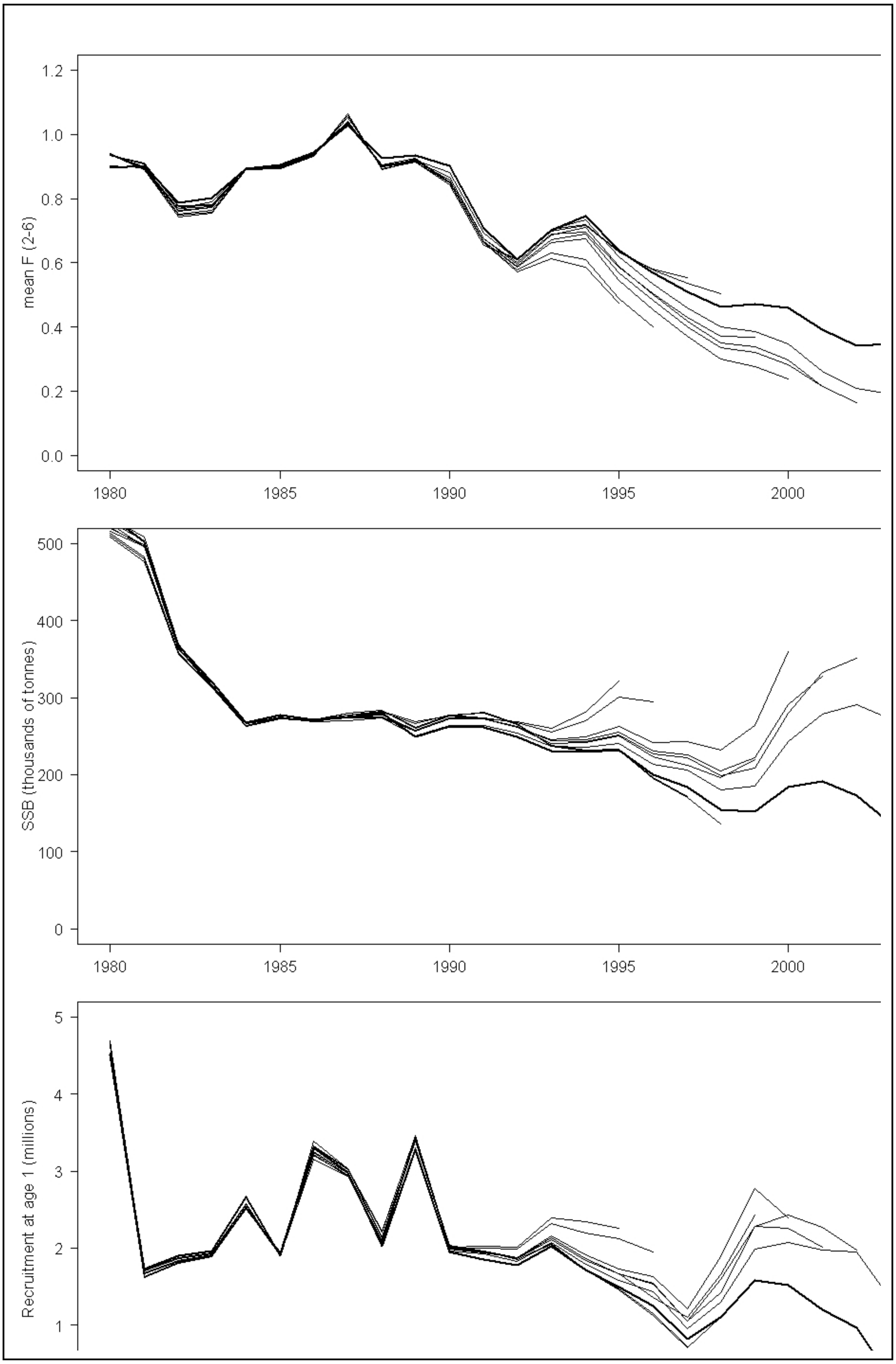
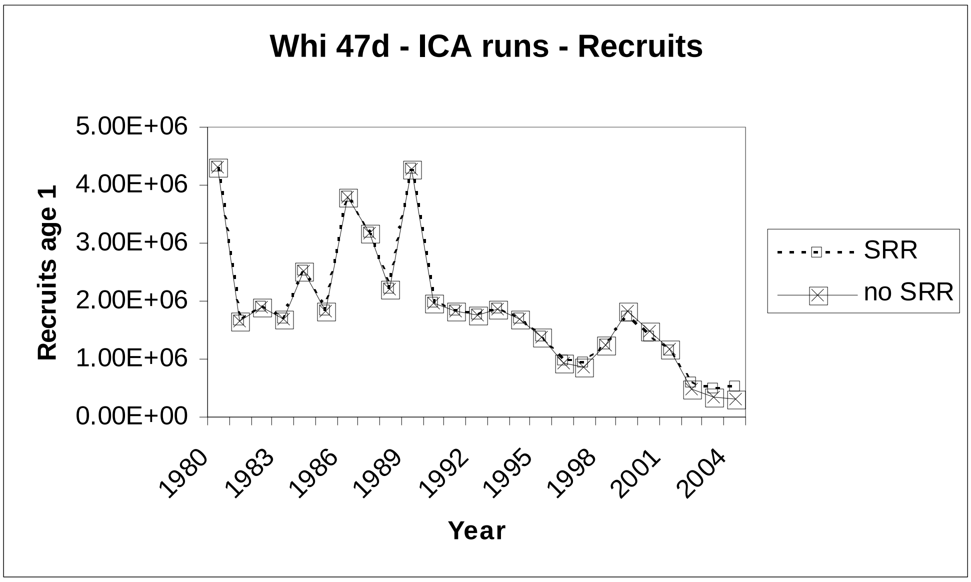
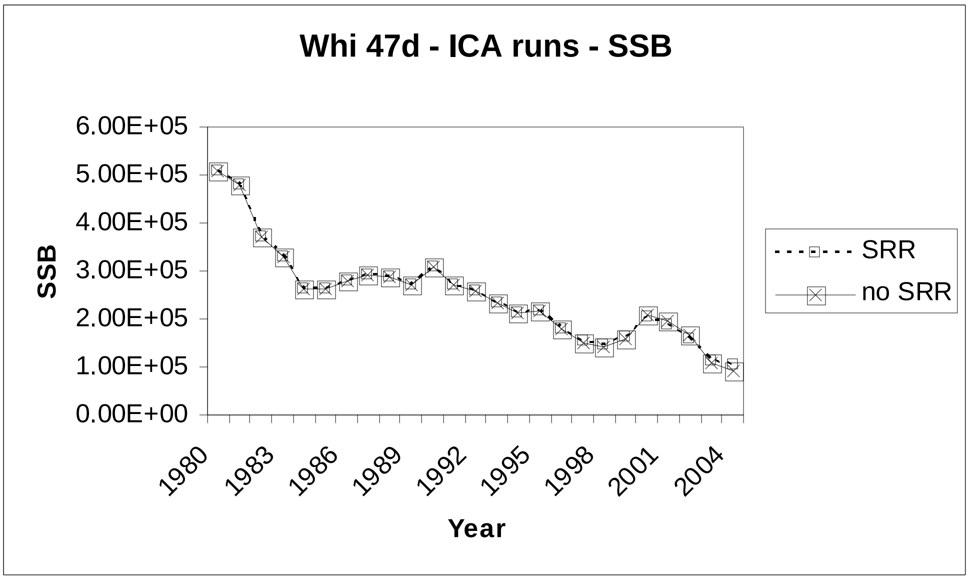


Figure 5.3.6 Whiting in IV and VIId. Exploratory ICA: stock trends.





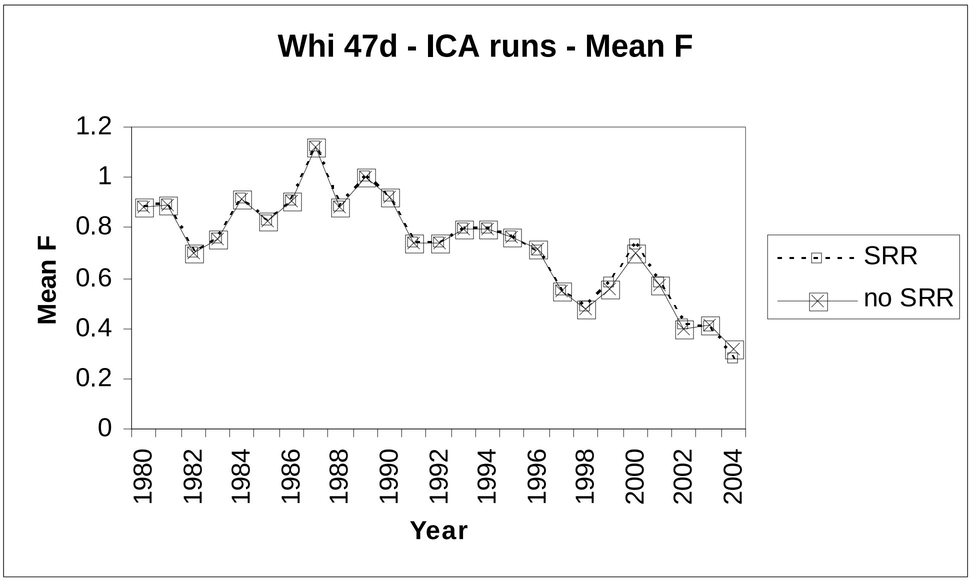
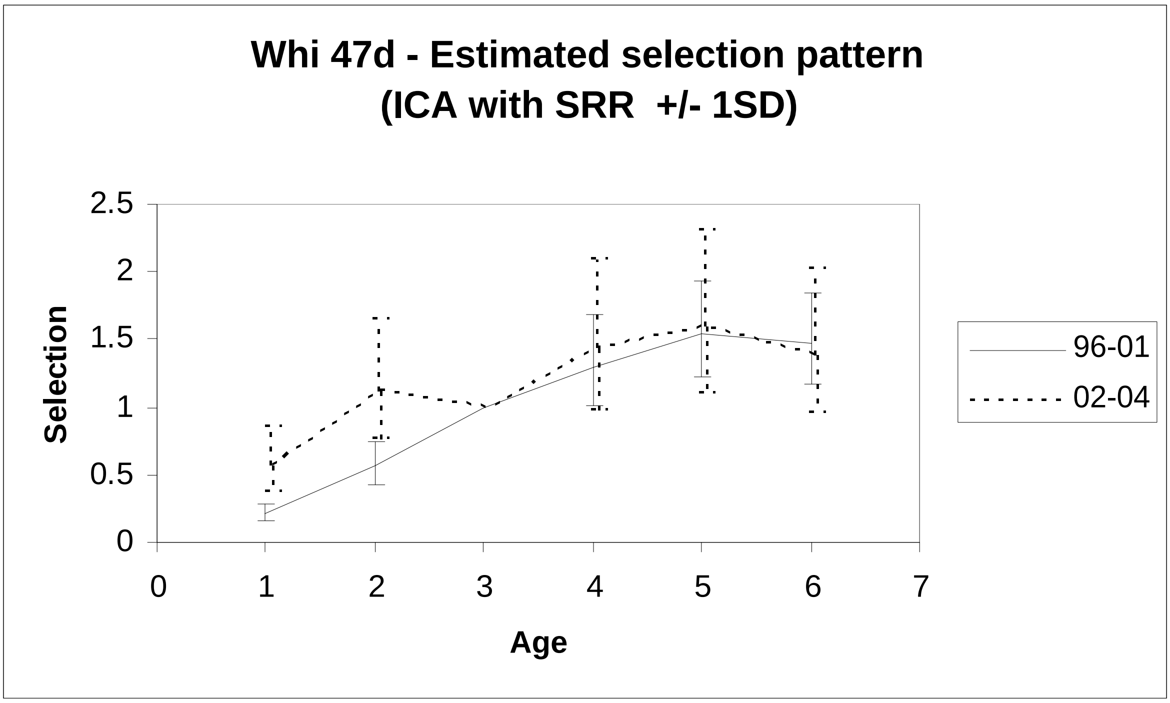


Figure 5.3.7 Whiting in IV and VIId. Exploratory ICA: selection pattern estimates pre- and post-dating the adoption in 2002 of 120 mm minimum mesh sizes in North Sea towed demersal roundfish gears. The selection patterns shown below arise from a model configuration that simultaneously fitted the parameters of a ricker stock-recruit curve (ICA with SRR) and one which did not (ICA without SRR). Error bars are ± 1 standard deviation



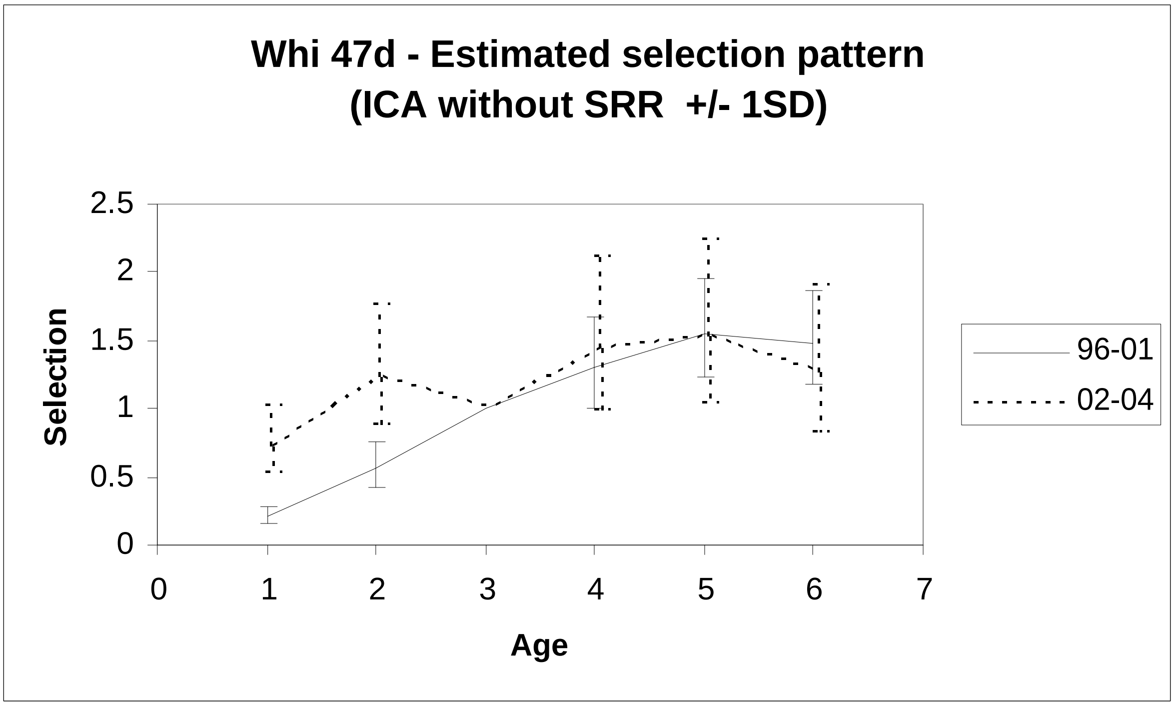
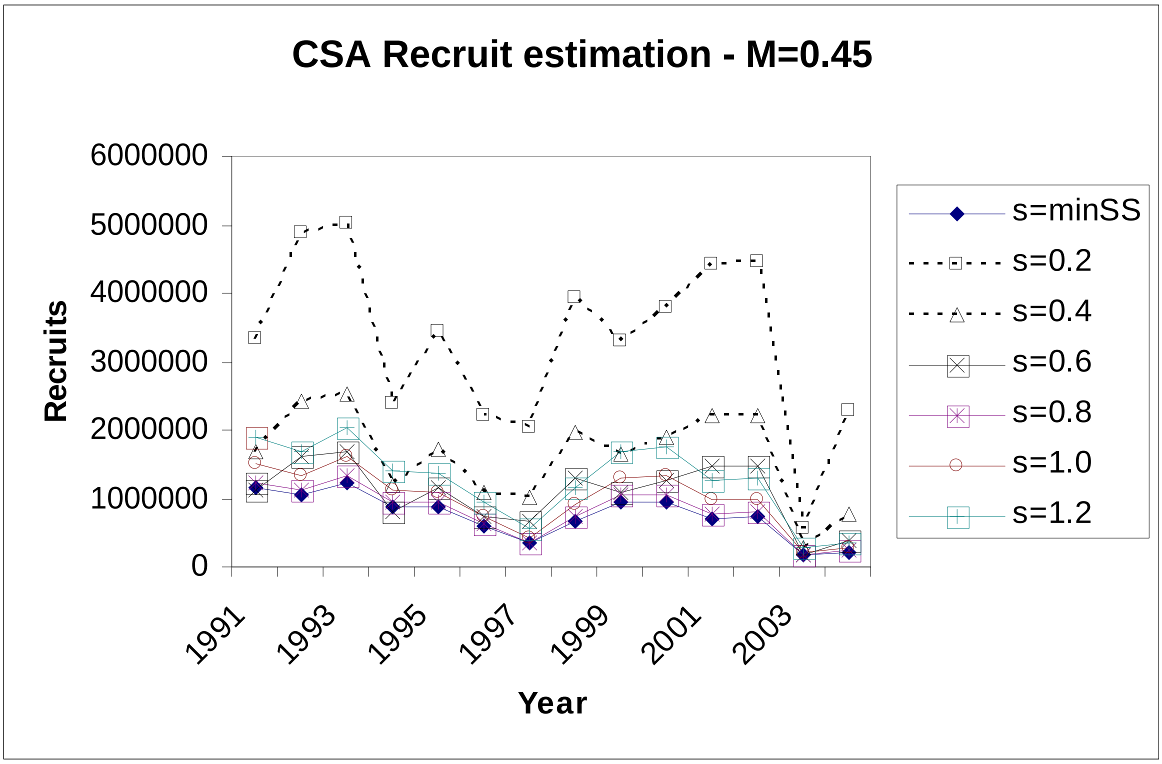


Figure 5.3.8 Whiting in IV and VIId. Exploratory CSA model fits assuming baseline natural mortality (M=0.45) and varying choices of ratio between recruit and post-recruit catchabilities .



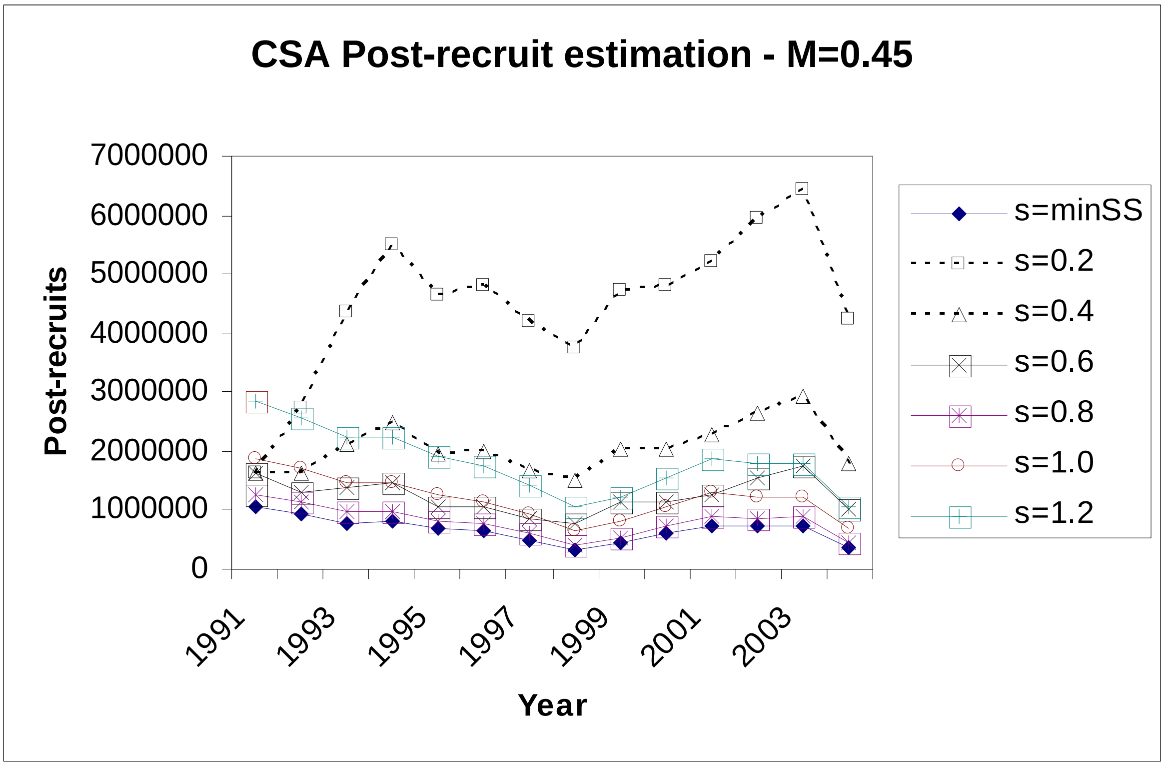
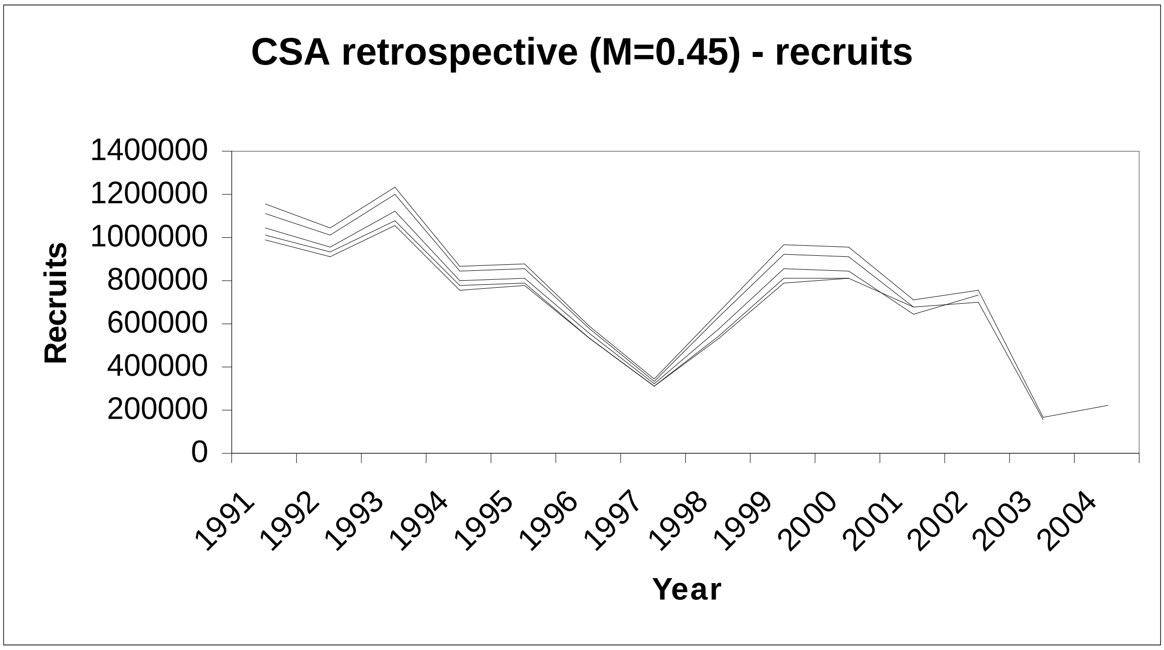


Figure 5.3.9 Whiting in IV and VIId. CSA retrospective estimates of population numbers using the "best fit" search procedure to estimate the catchability ratio, s_{min} for CSA runs with baseline M.



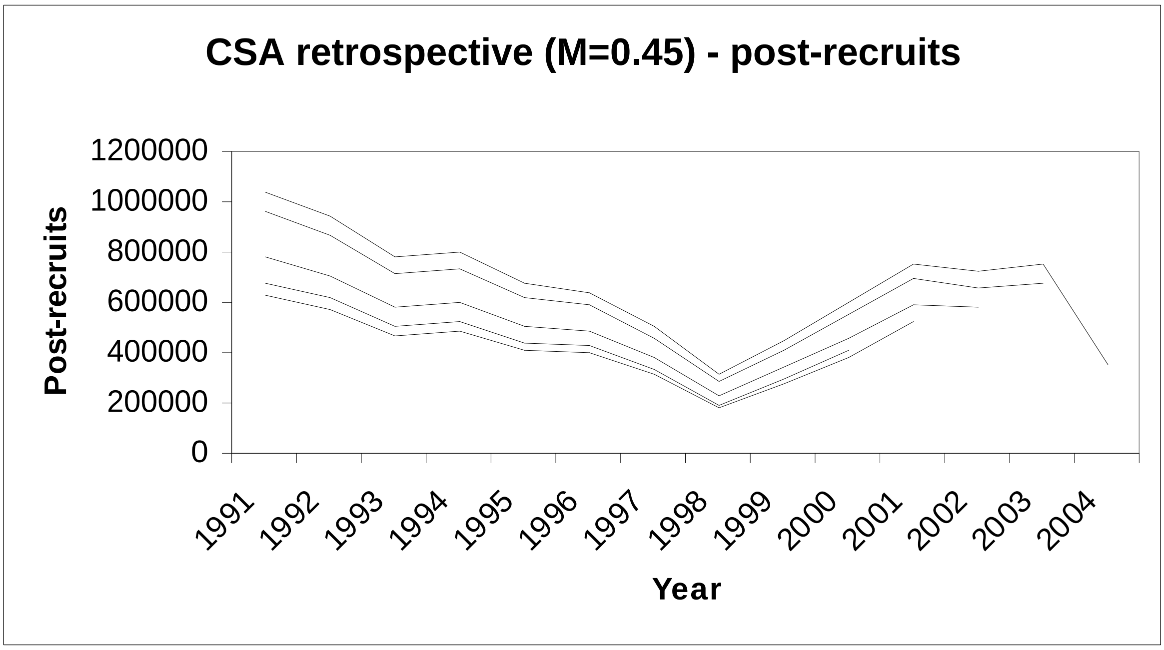


Figure 5.3.10 Whiting in IV and VIId. Variation in the "best" estimate of the CSA catchability ratio, s_{min}, from the search algorithm implemented in the program used here. The graph shows the estimate of s_{min} from each of a number of retrospective analyses across a number of assumed values of natural mortality.

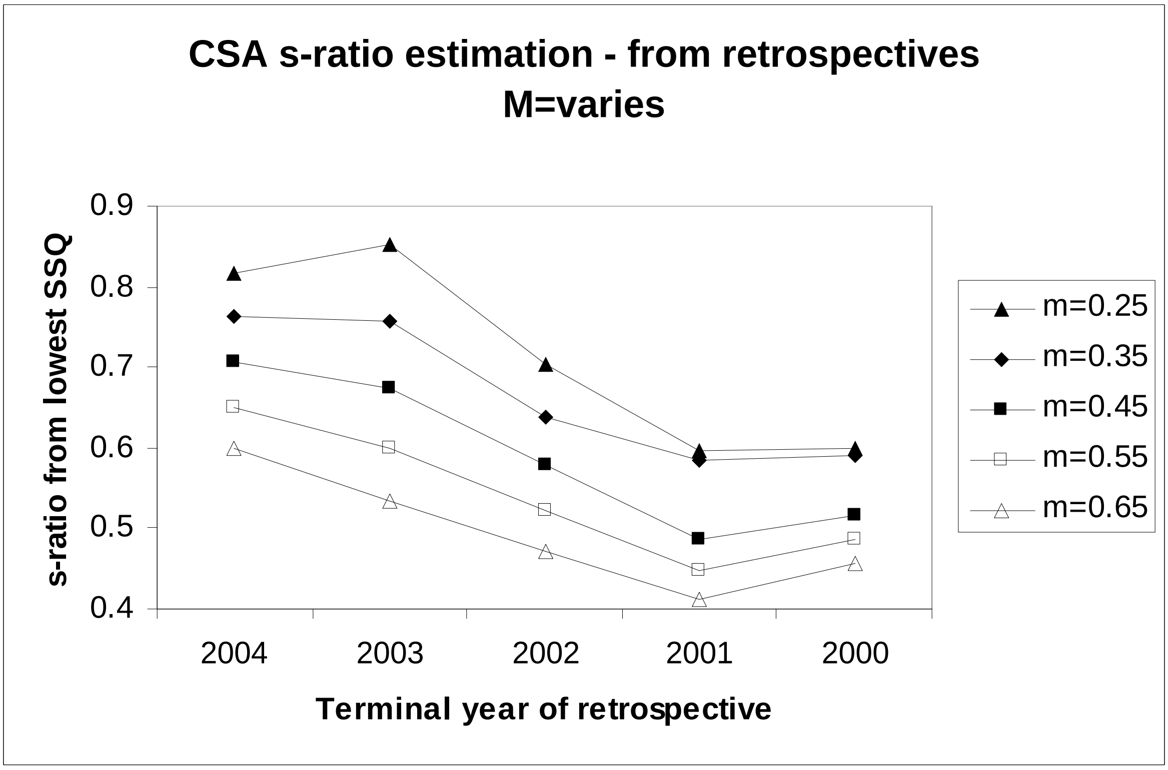
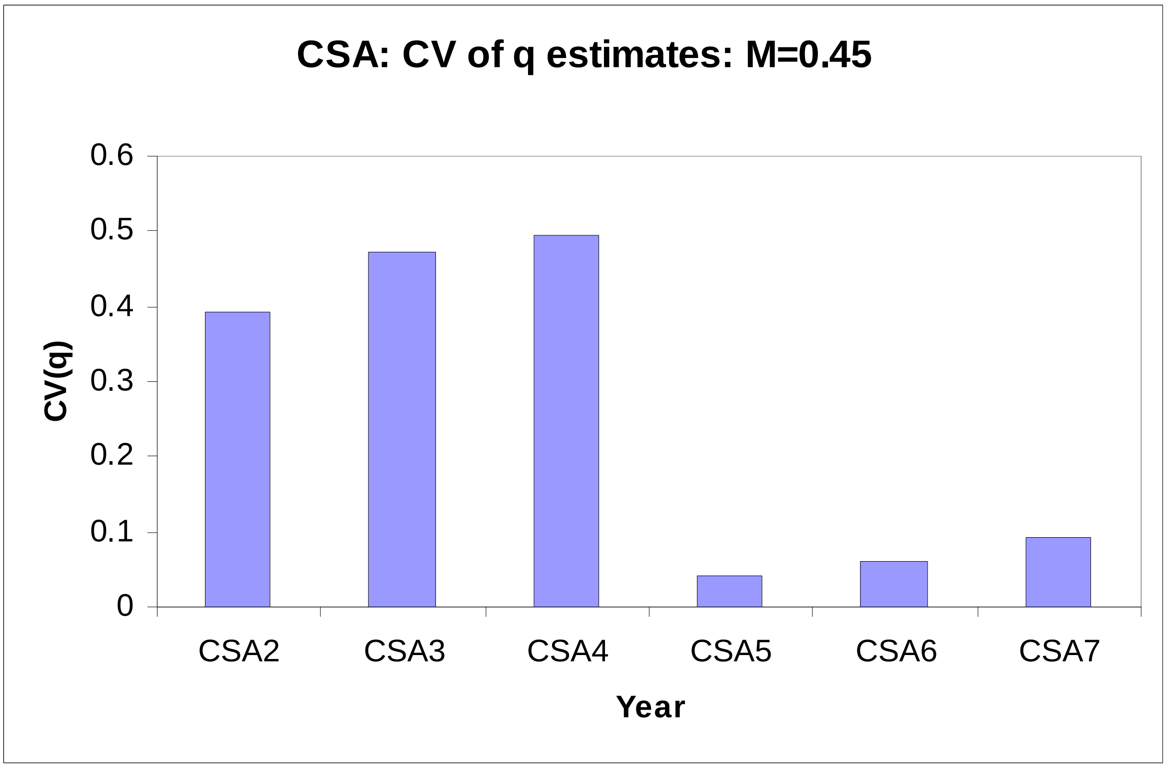


Figure 5.3.11 Whiting in IV and VIId. Bootstrapped estimates of the coefficient of variation and relative bias of post-recruit catchability contingent on variations in the ratio between recruit and post-recruit catchabilities. The corresponding values of s for each run wereCSA2 s= 0.2; CSA3 s= 0.4; CSA4 s=0.6 ; CSA5 s= 0.8; CSA6 s= 1.0; CSA7 s=1.2 ;



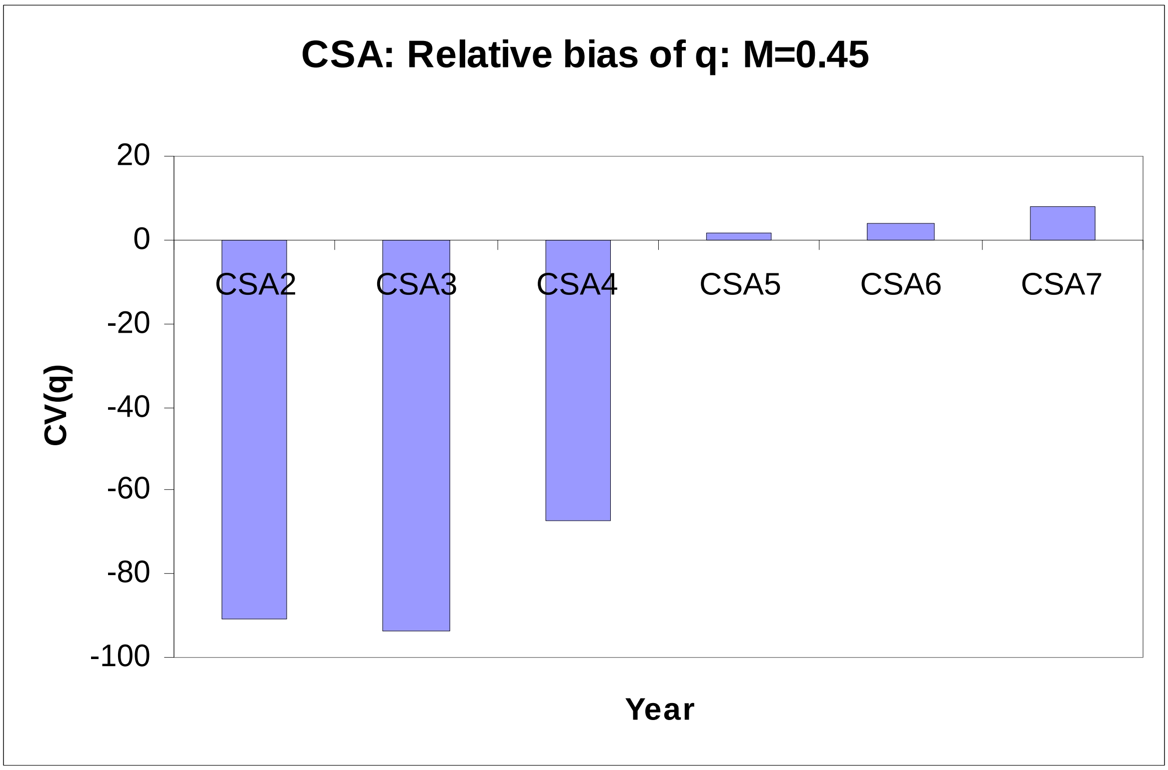
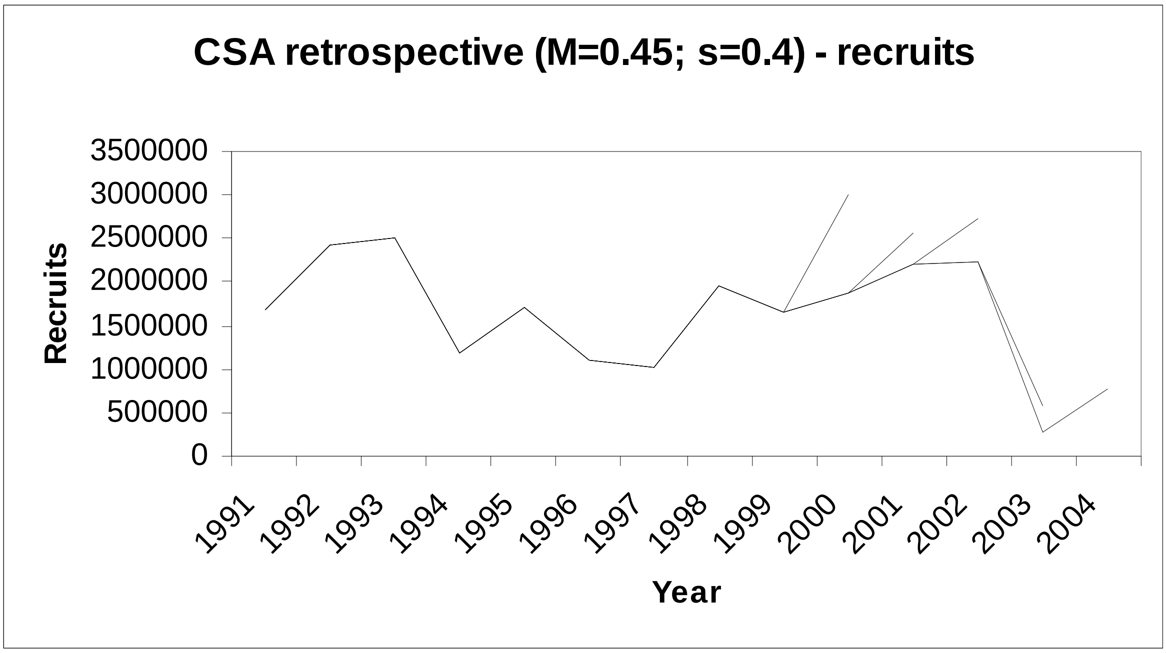


Figure 5.3.12 Whiting in IV and VIId. CSA retrospective estimates of recruits from model fits with M=0.45 and s=0.4 (upper graph) and 0.8 (lower graph). The difference would be even more stark if the graphs shared the same scaling on the x-axis, and is representative of the improved retrospective performance for value of s greater than 0.6 at this value of M.



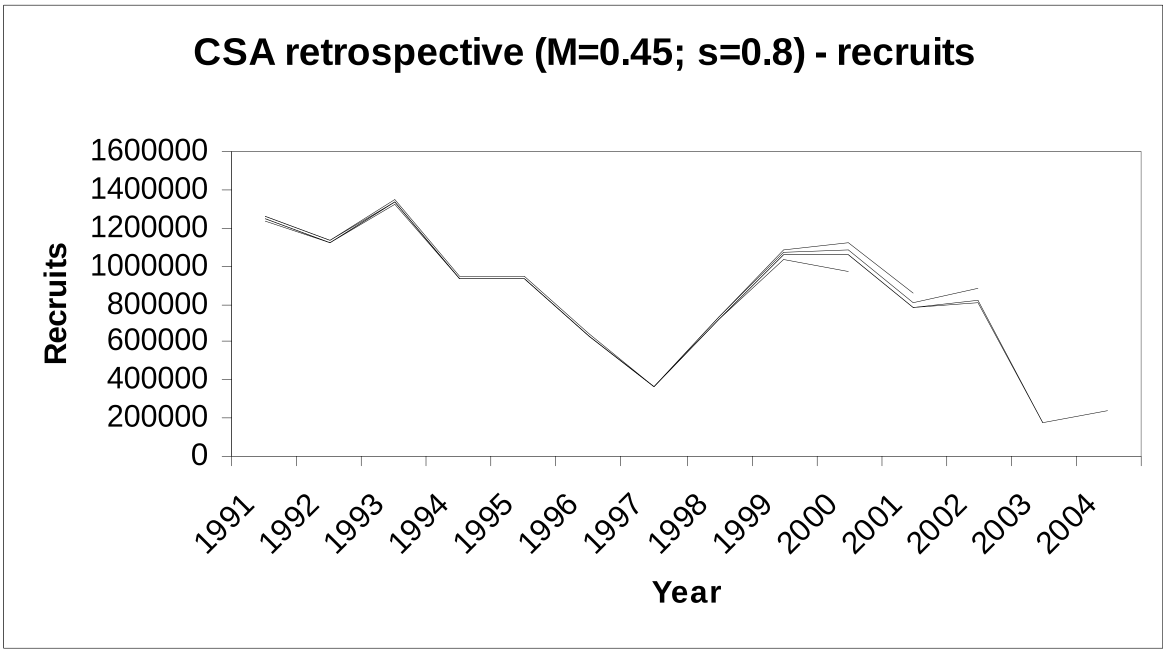
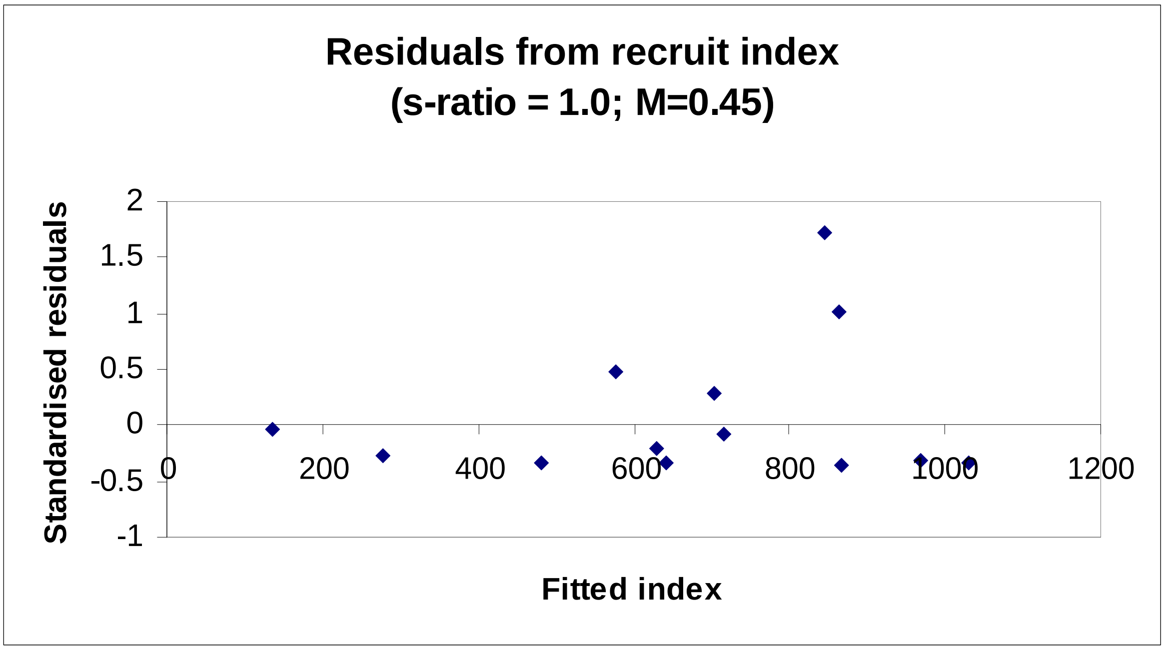


Figure 5.3.13 Whiting in IV and VIId. CSA model residuals assuming input choices of M=0.45 and s-ratio=1.0



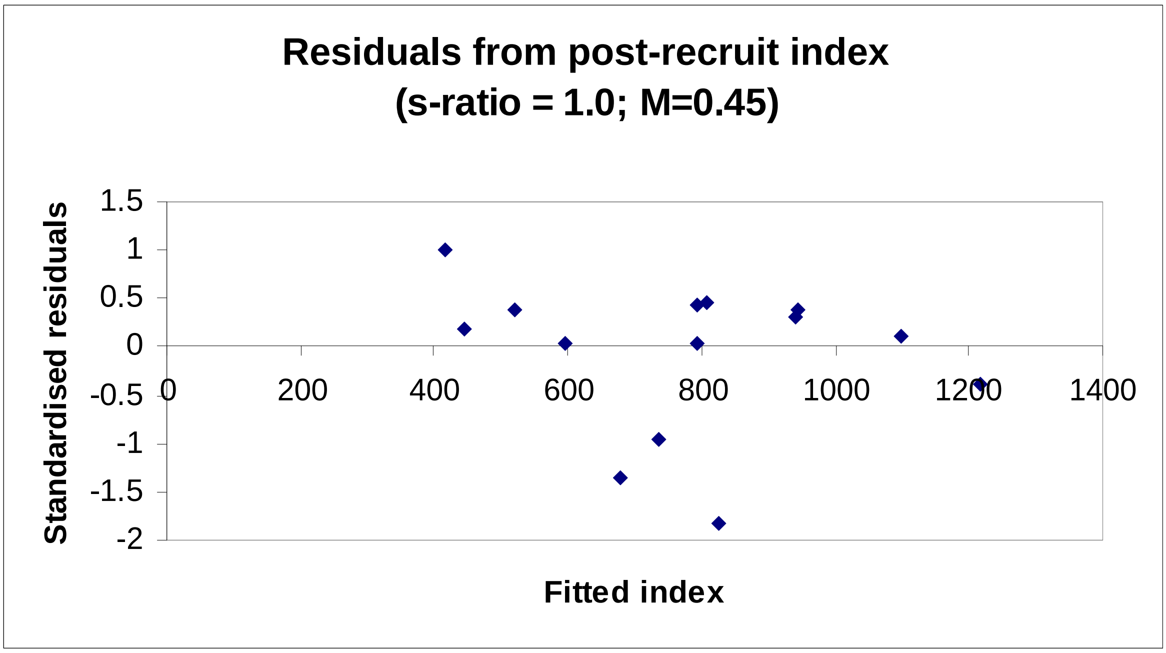
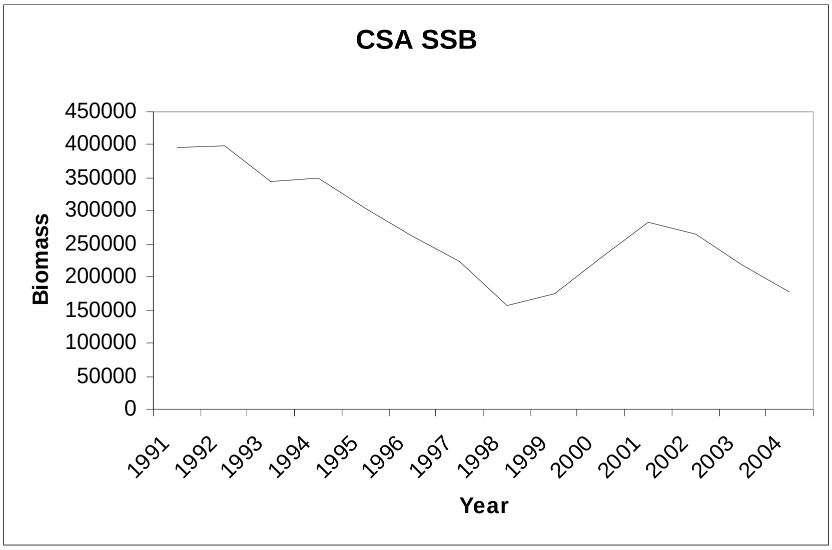


Figure 5.3.14 Whiting in IV and VIId. CSA stock trends assuming M=0.45 and S-ratio=1.0.



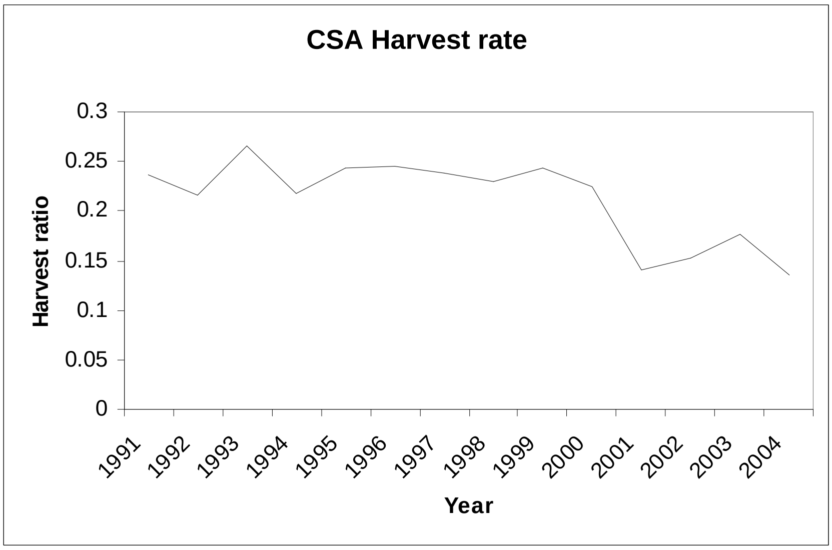
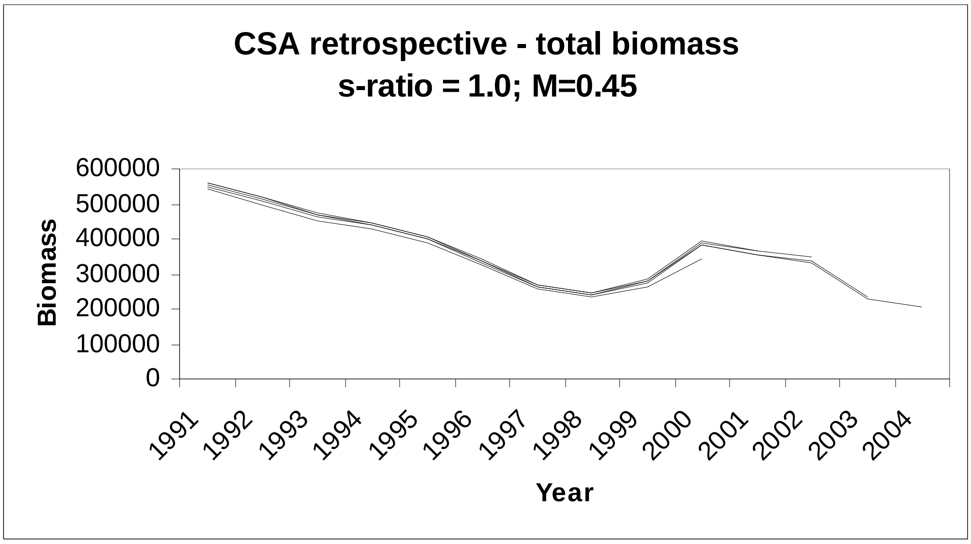
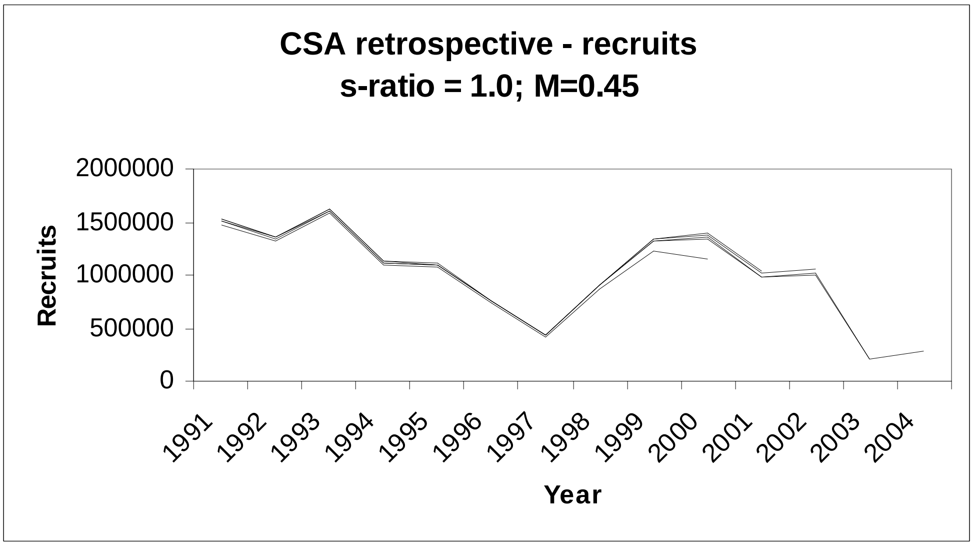


Figure 5.3.15 Whiting in IV and VIId. CSA model retrospective results for total biomass, recruit numbers and post-recruit numbers.





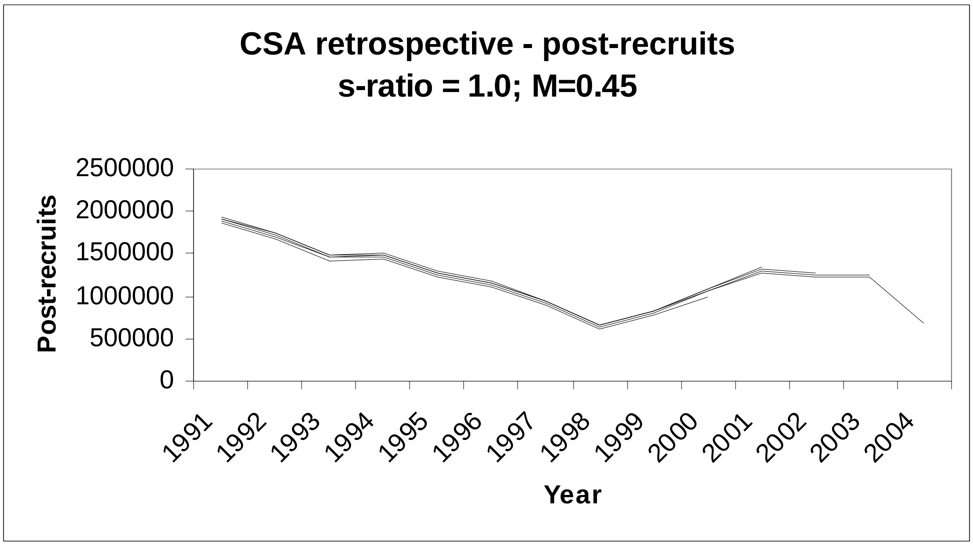


Figure 5.3.16 Whiting in IV and VIId. SURBA stock trends (IBTS_Q1). 1983-2005.

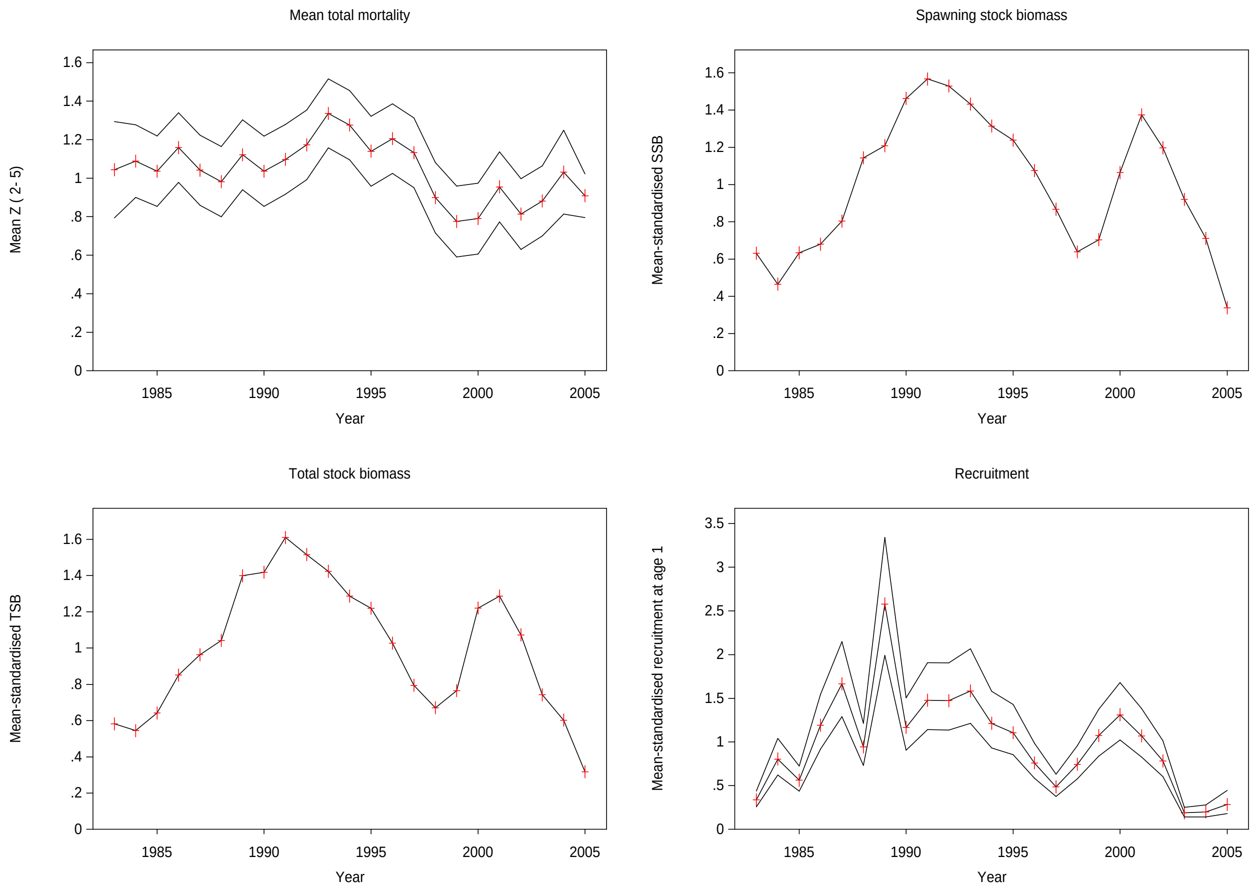


Figure 5.3.17 Whiting in IV and VIId. SURBA residual plot (IBTS_Q1). 1983-2005.

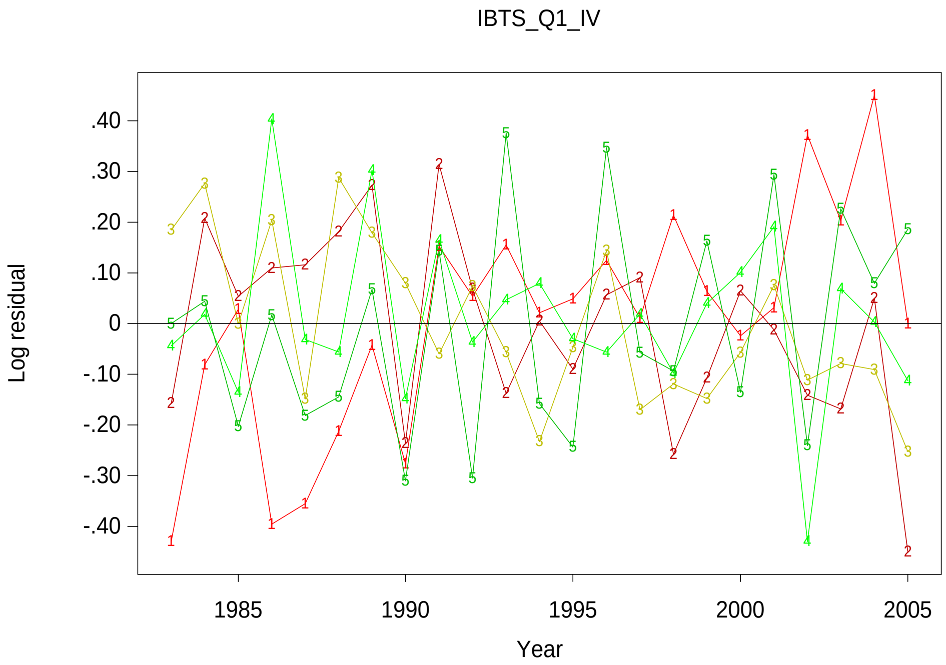


Figure 5.3.18 Whiting in IV and VIId. SURBA retrospective plot (IBTS_Q1). 1983-2005.

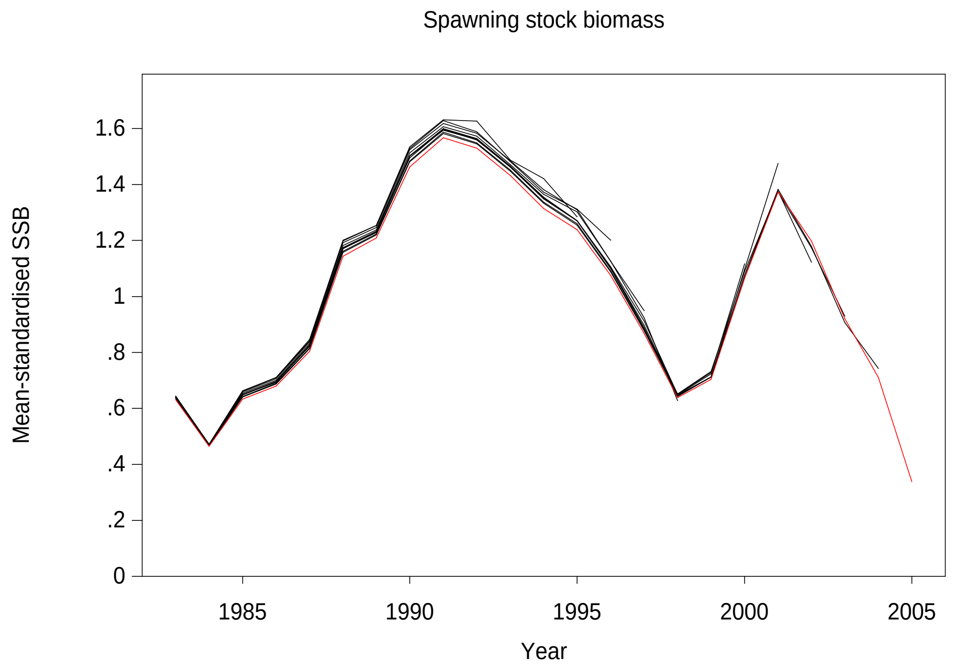


Figure 5.3.19 Whiting in IV and VIId. SURBA cohort plots (IBTS_Q1). 1983-2005.

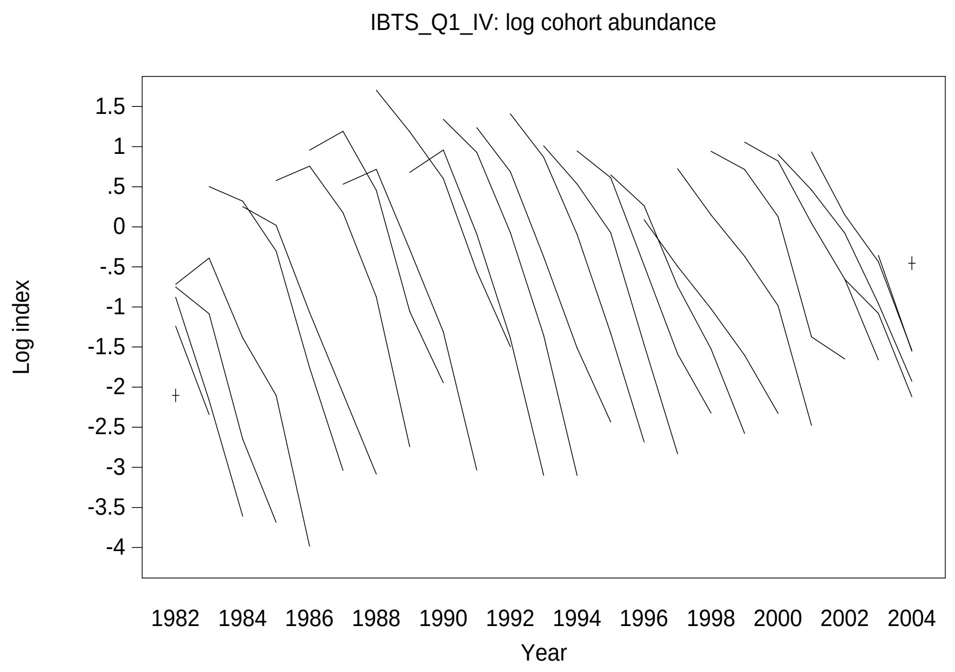


Figure 5.3.20 Whiting in IV and VIId. SURBA stock trends (EGFS). 1983-2004.

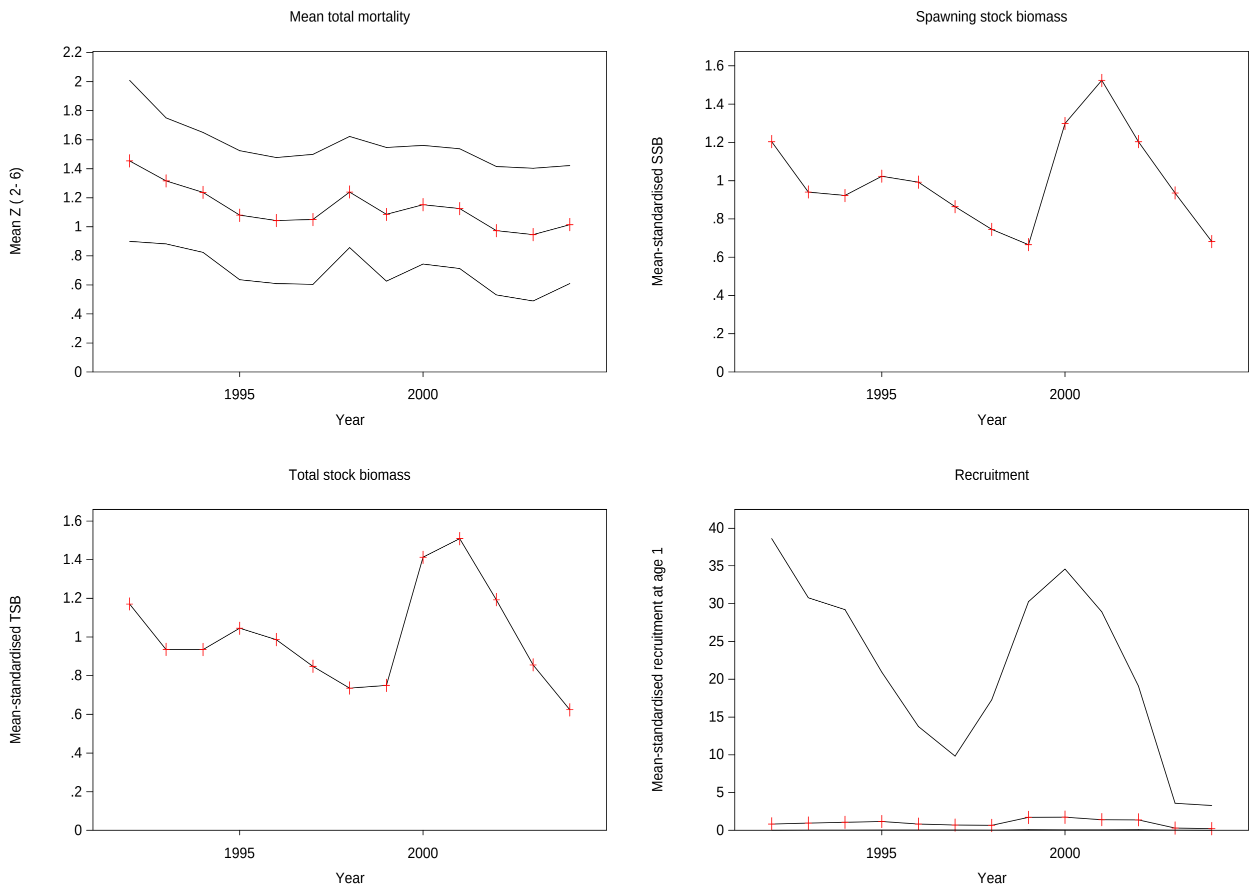


Figure 5.3.21 Whiting in IV and VIId. SURBA residual plot (EGFS). 1983-2004.

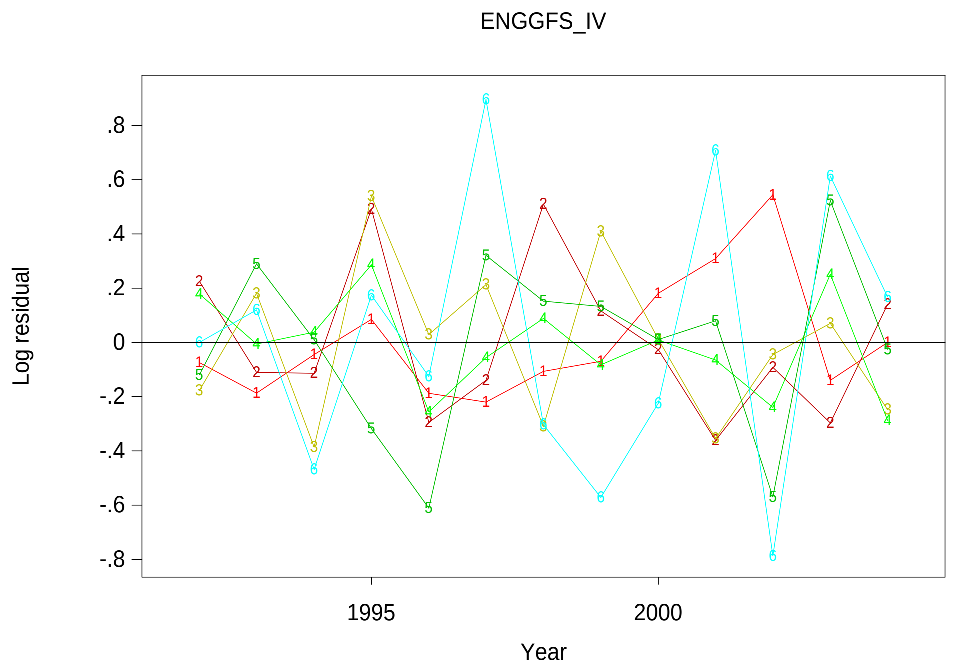


Figure 5.3.22 Whiting in IV and VIId. SURBA retrospective plot (EGFS). 1983-2004.

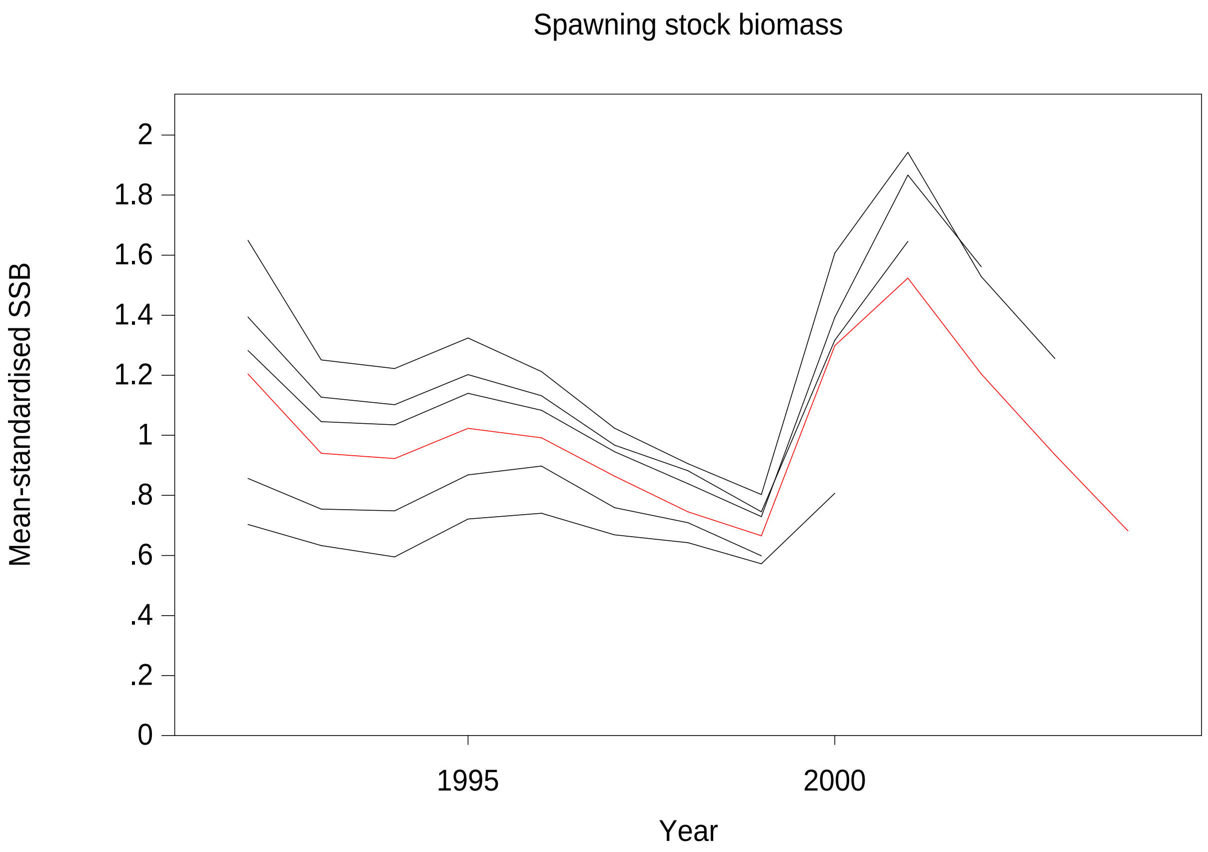


Figure 5.3.23 Whiting in IV and VIId. SURBA cohort plots (EGFS). 1983-2004.

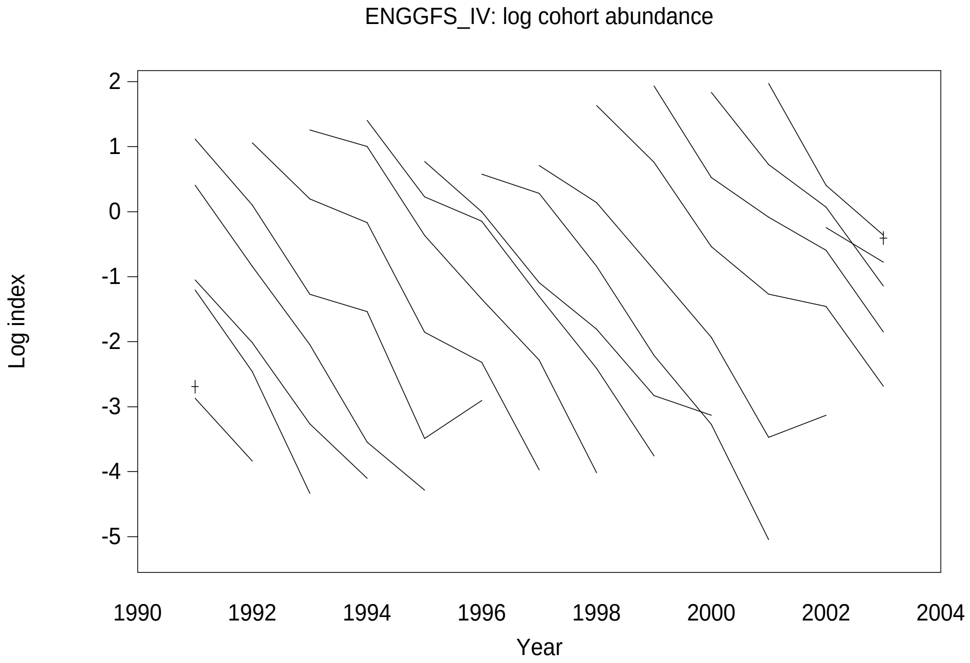


Figure 5.3.24 Whiting in IV and VIId. SURBA stock trends (SGFS). 1983-2005.

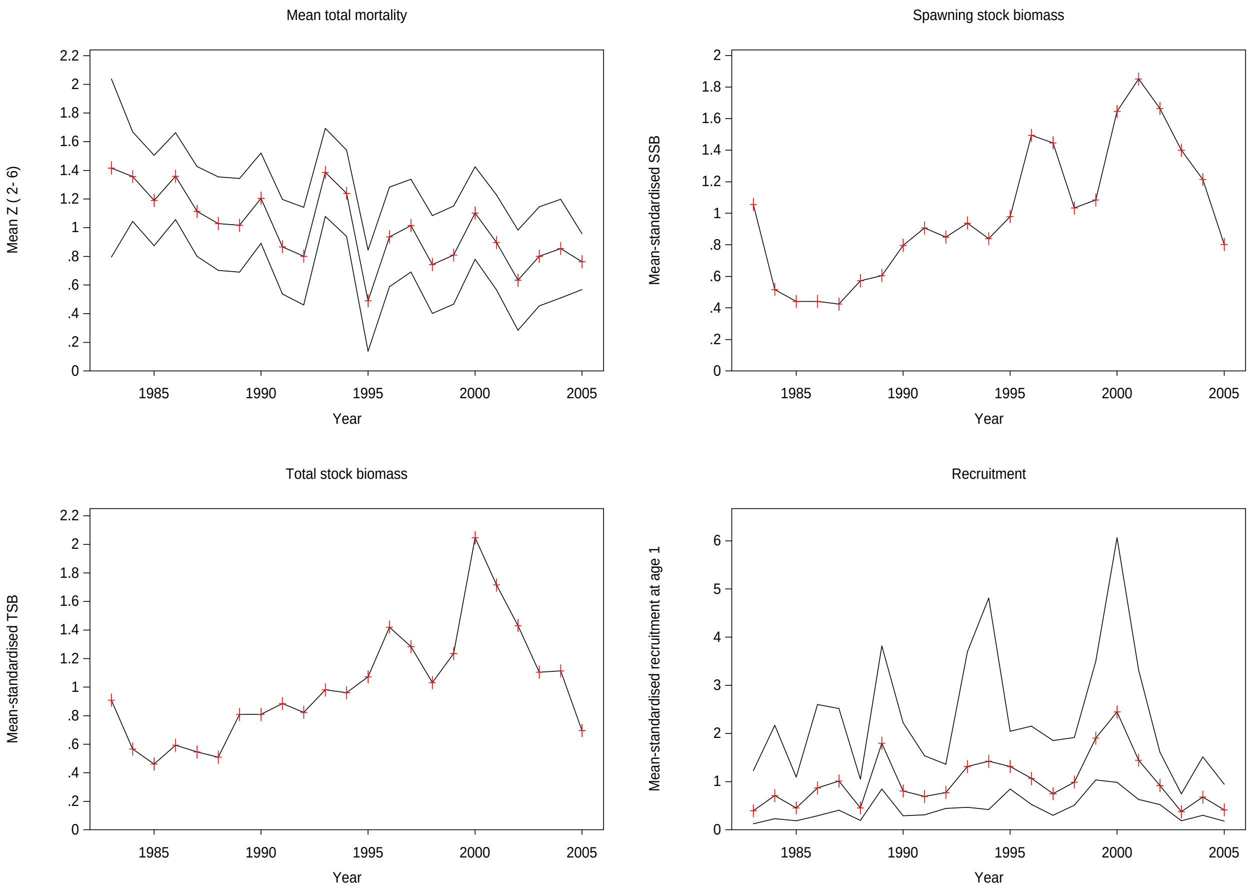


Figure 5.3.25 Whiting in IV and VIId. SURBA residual plot (SGFS). 1983-2005.

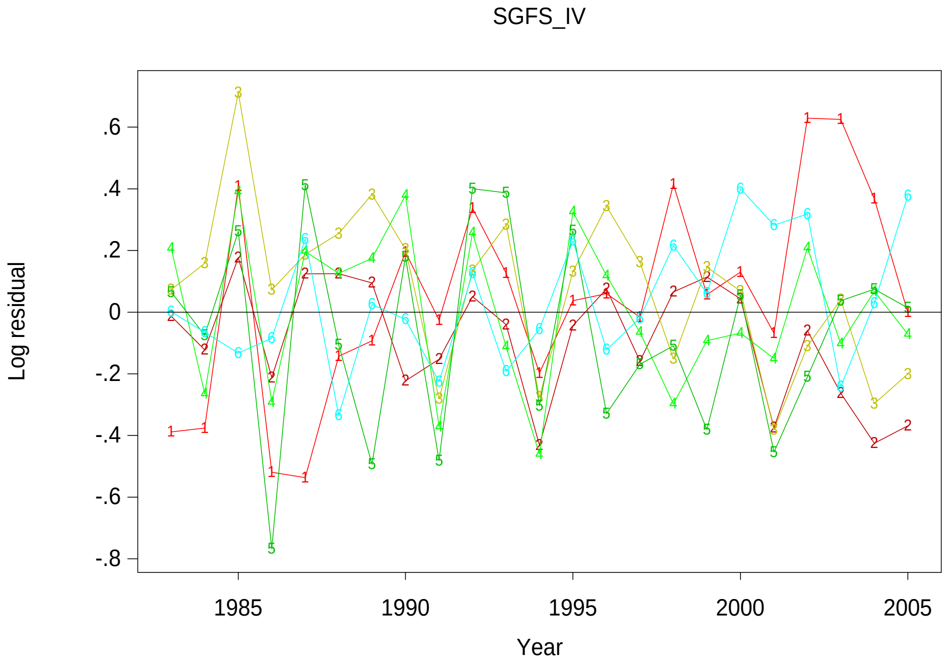


Figure 5.3.26 Whiting in IV and VIId. SURBA retrospective plot (SGFS). 1983-2005.

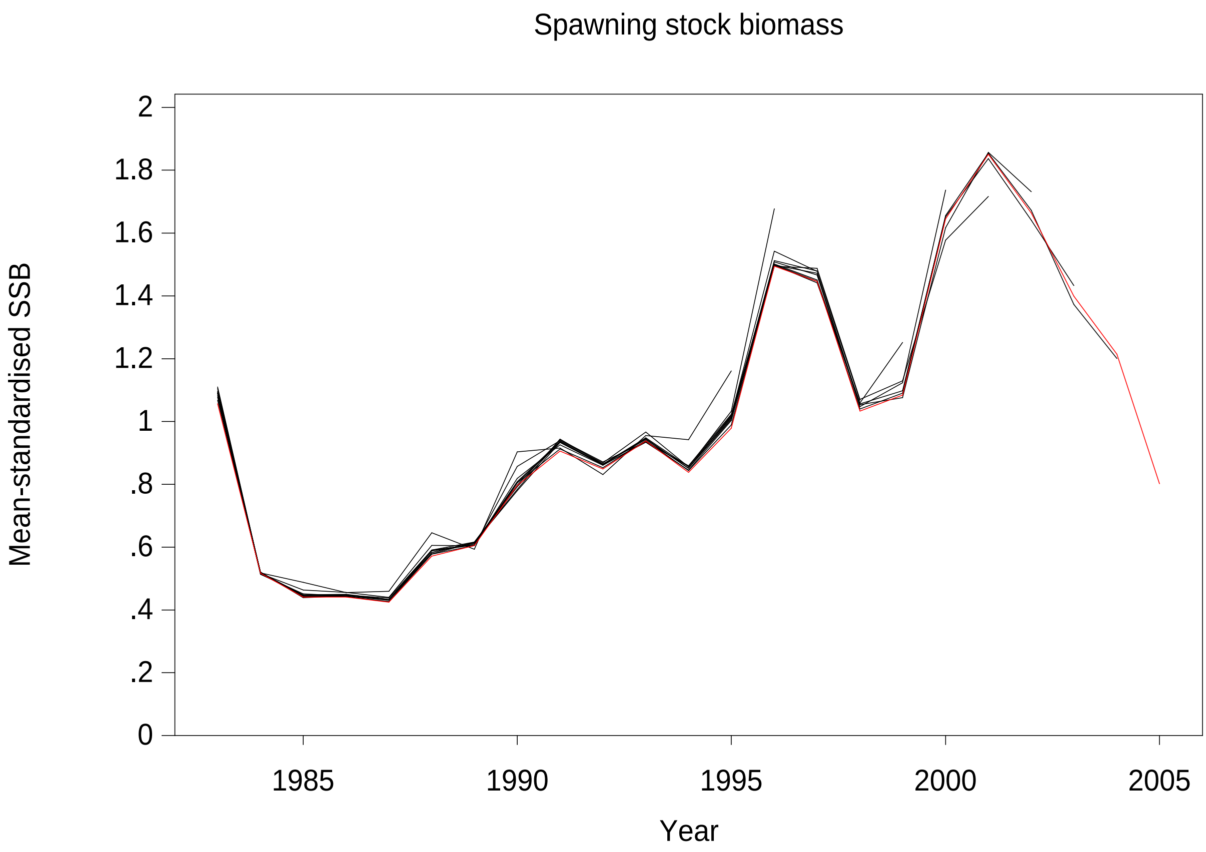


Figure 5.3.27 Whiting in IV and VIId. SURBA cohort plots (SGFS). 1983-2005.

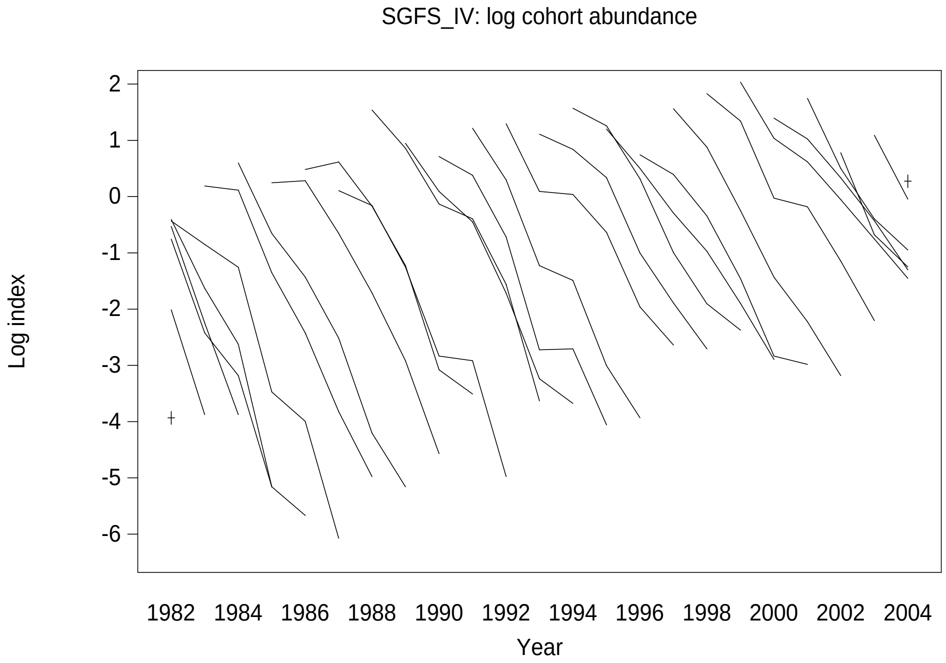


Figure 5.3.28 North Sea IBTS standard roundfish areas.

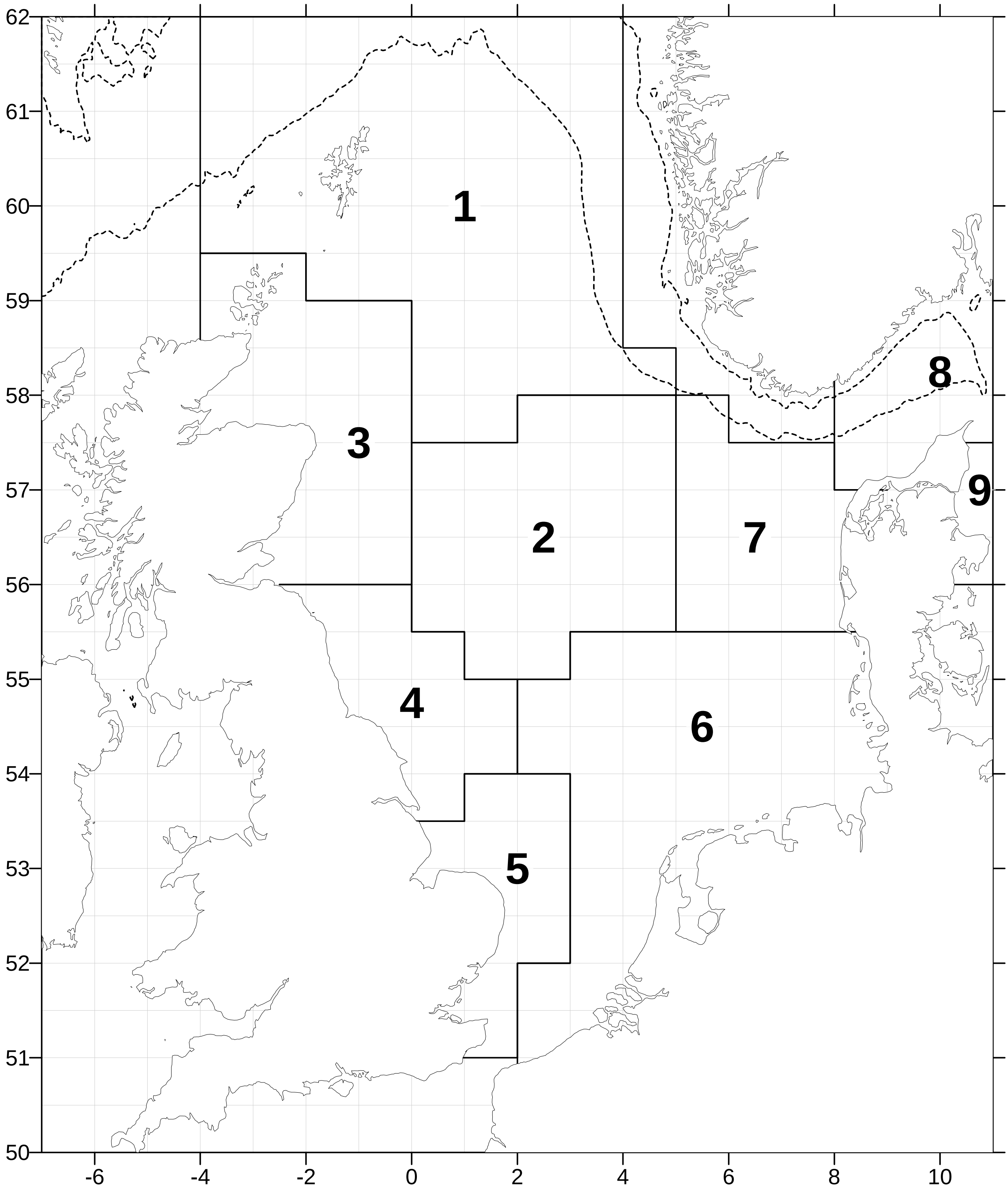


Figure 5.3.29 Whiting in IV and VIId. IBTS_Q1 SURBA-based SSB estimates by IBTS sub-areas.

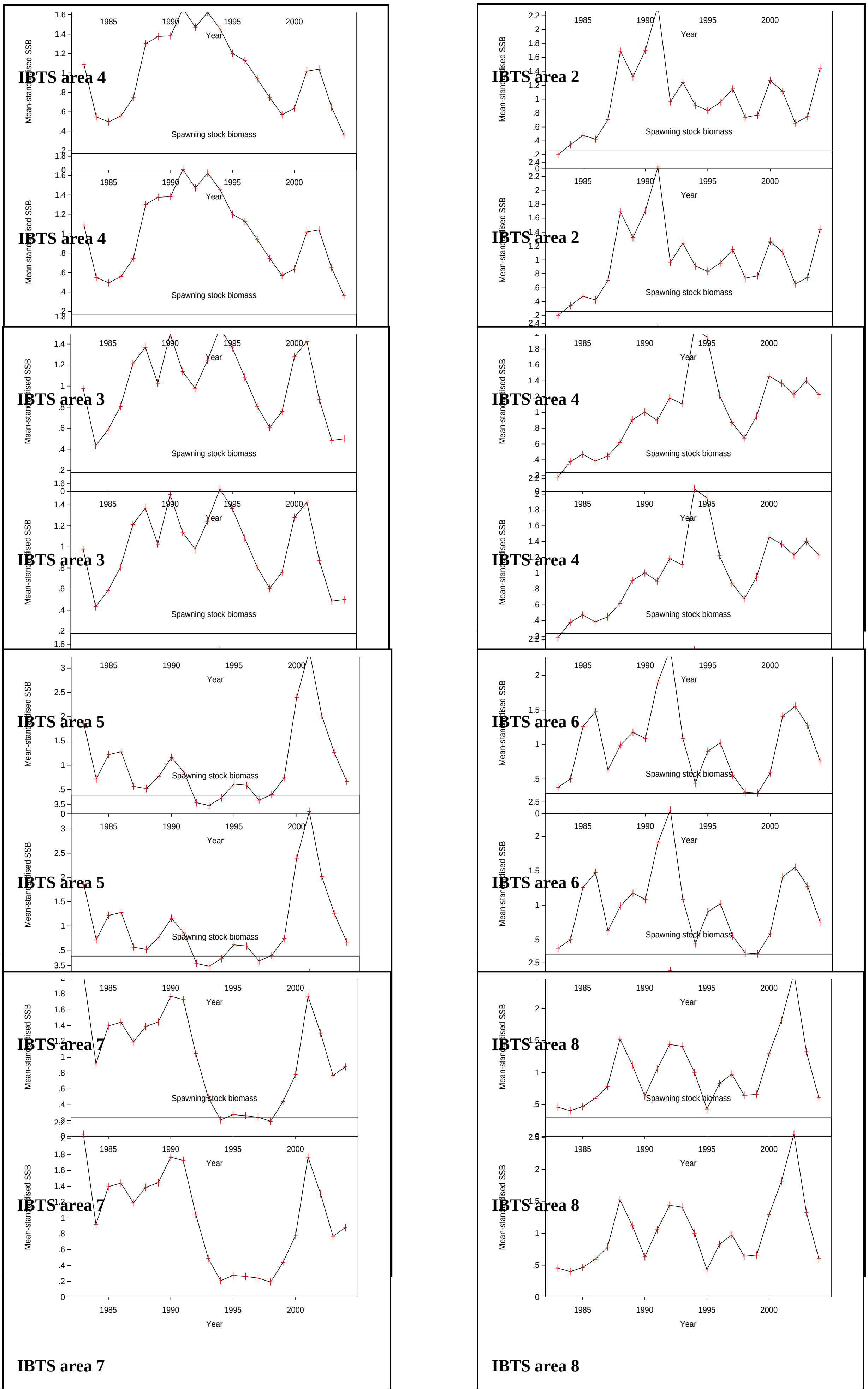
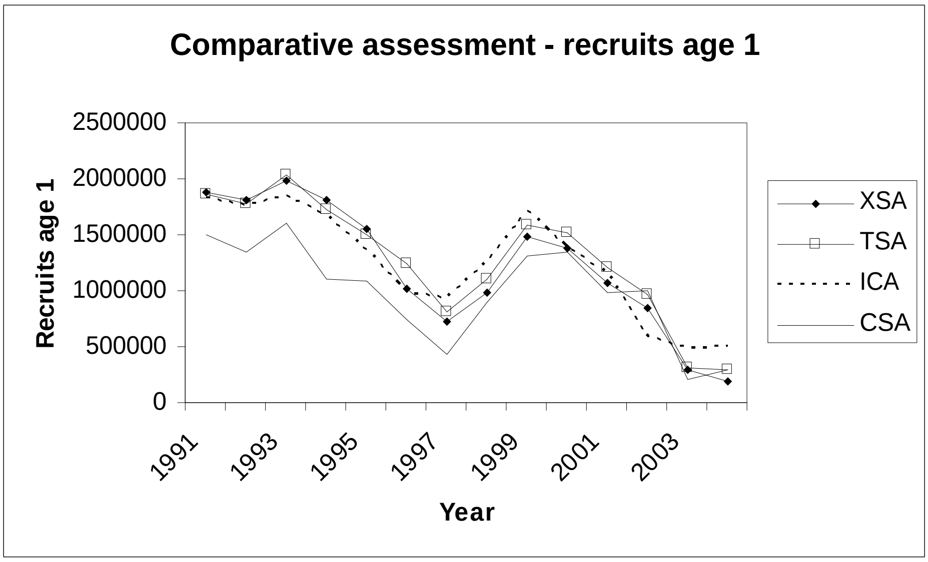
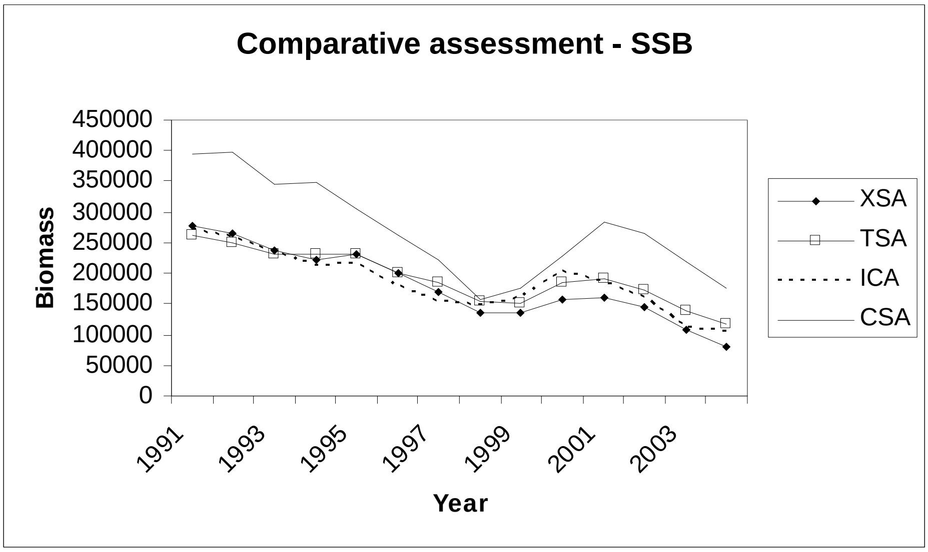


Figure 5.3.30 Whiting in IV and VIId. Stock trends from comparative exploratory assessment methods calibrated against the IBTS_Q1 index since 1990. The CSA harvest rate (bottom graph) is plotted on a separate axis to the fishing mortality estimates from the catch-at-age analyses.





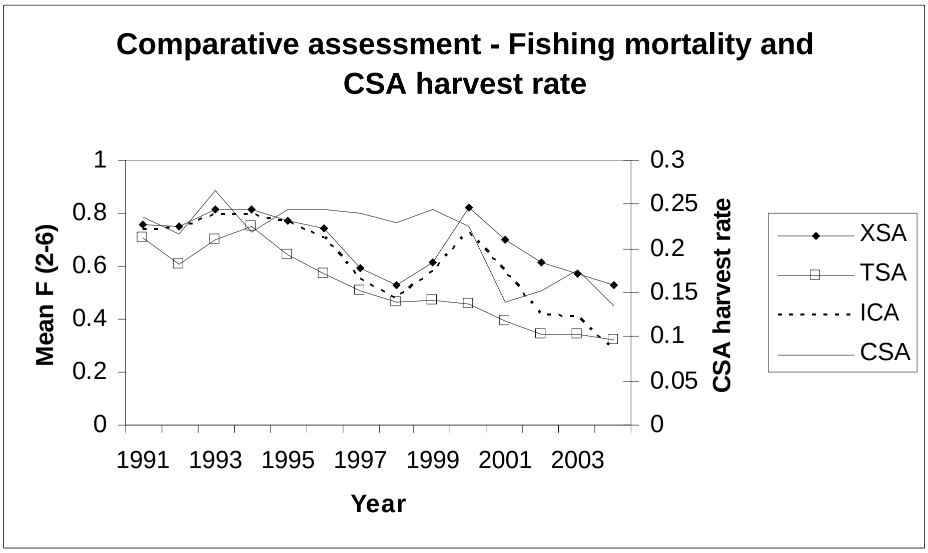


Figure 5.3.31 Whiting in IV and VIId. Exploratory XSA one-year-old abundance and IBTS_Q1 1-group indices between 1983 and 1990 and between 1991 and 2004.

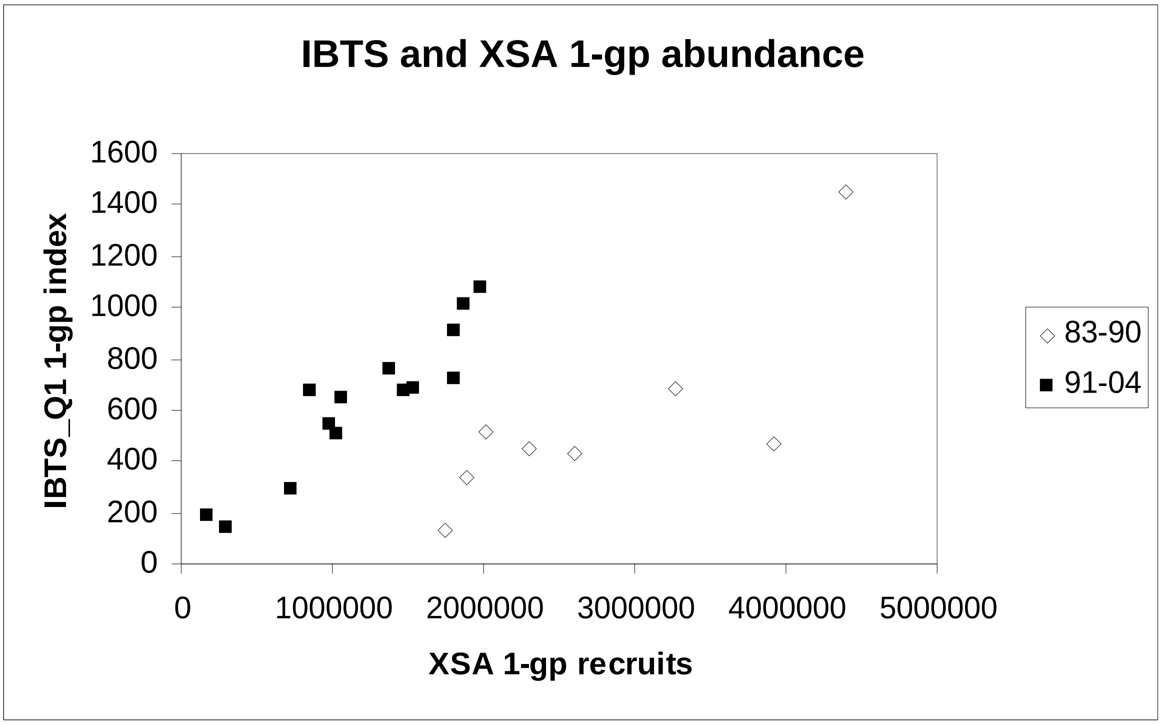


Figure 5.3.32 Whiting in IV and VIId. Mean (1992-2003) standardised SSB from the exploratory XSA and IBTS_Q1 SURBA.

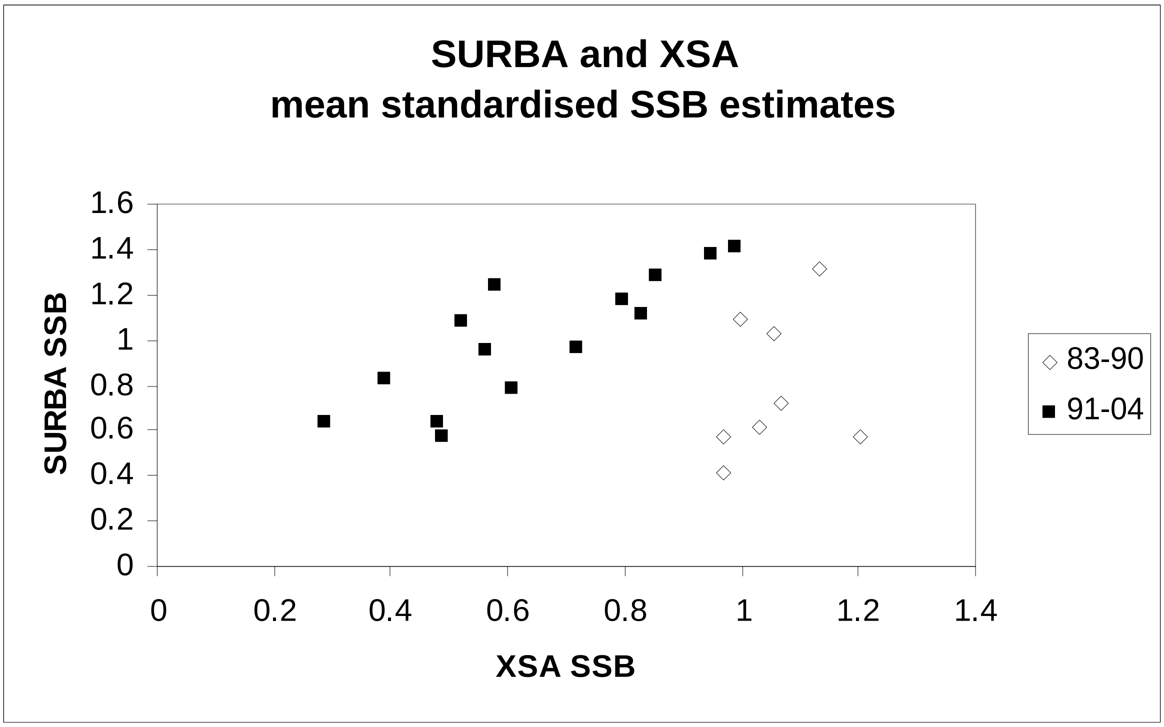


Figure 5.3.33 Whiting in IV and VIId. Mean standardised trends in SSB from the exploratory XSA and IBTS_Q1 SURBA.

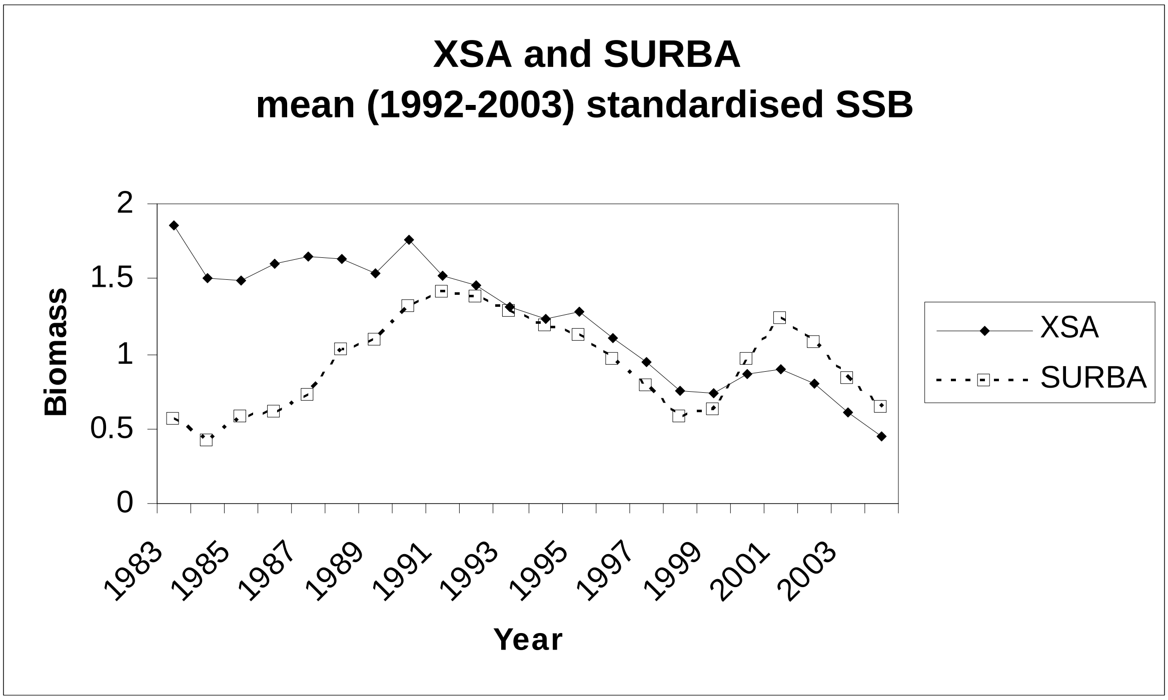


Figure 5.3.34 Whiting in IV and VIId. Single fleet XSA: Log catchability residuals.

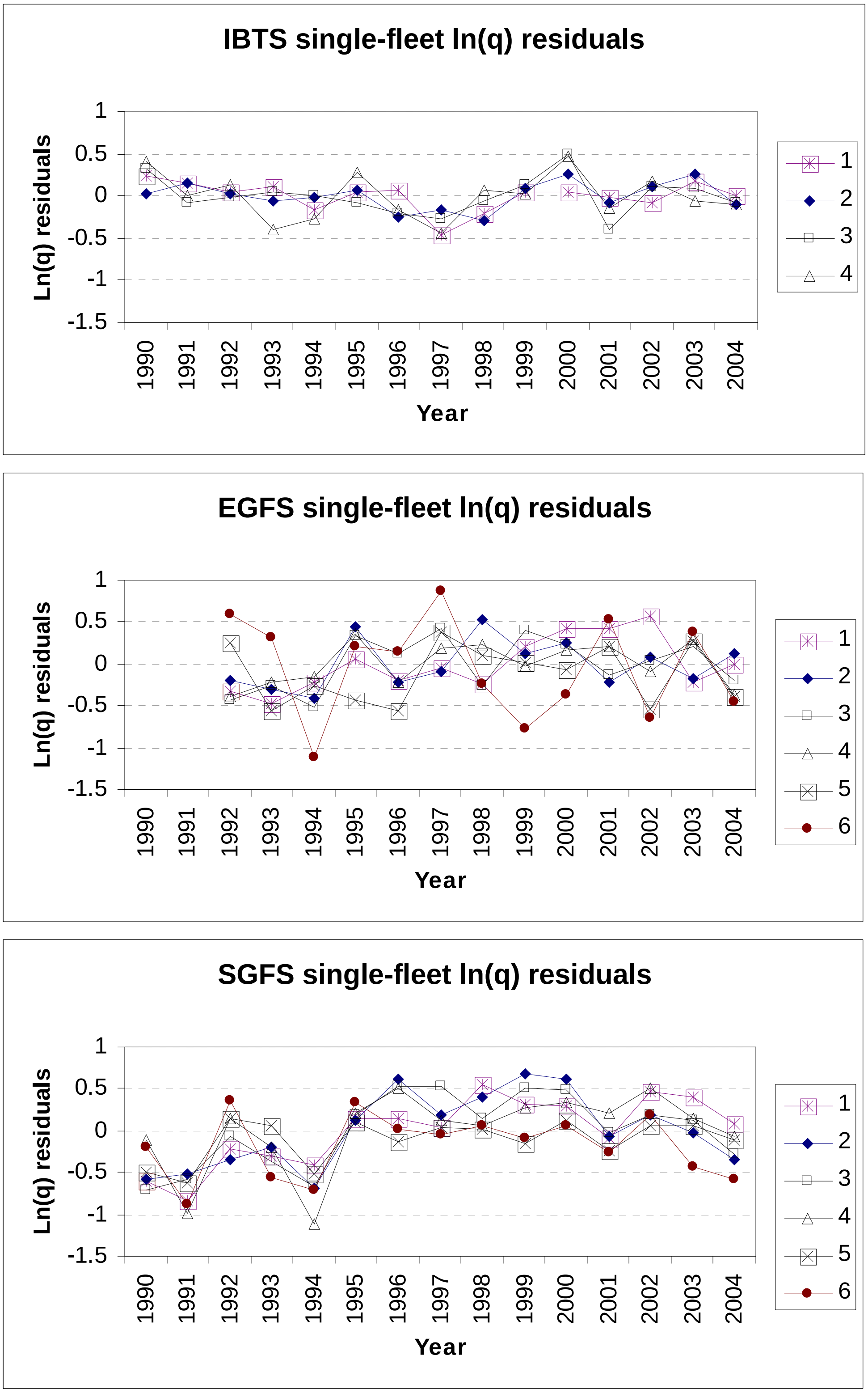
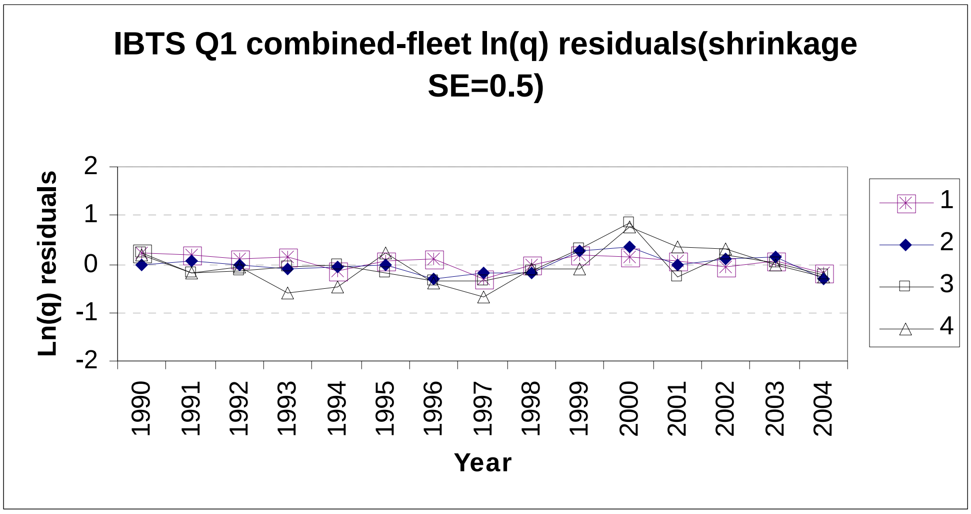
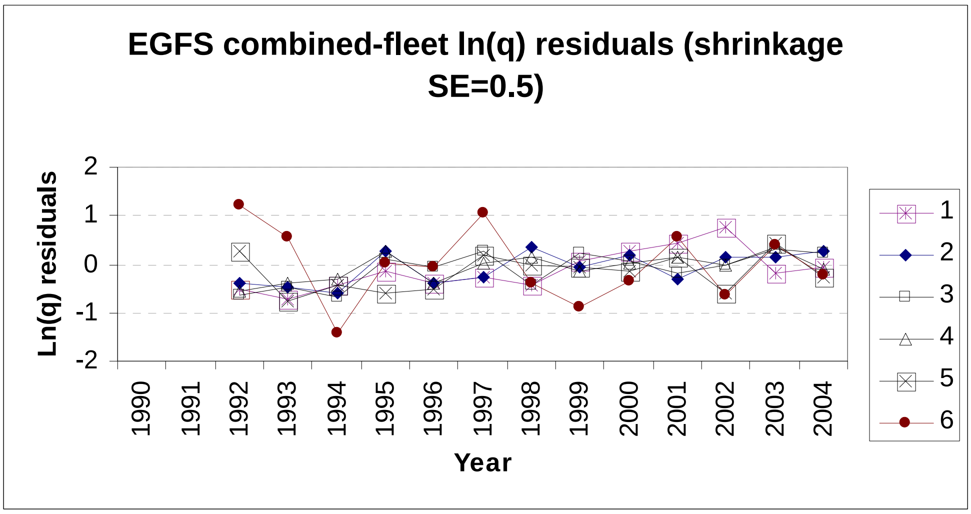


Figure 5.3.35 Whiting in IV and VIId. Combined fleet final run XSA: Log catchability residuals.





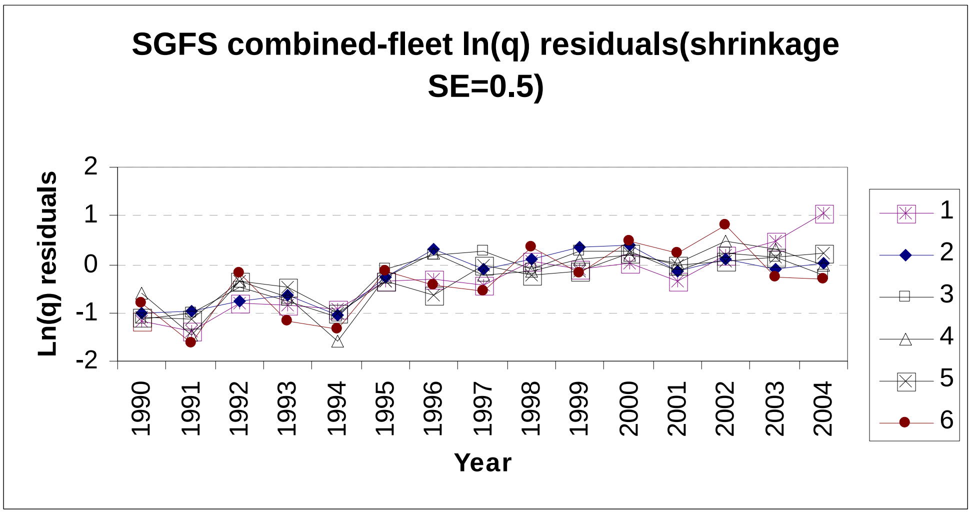


Figure 5.3.36 Whiting in IV and VIId. Individual fleet estimates of fishing mortality from the combined fleet final run XSA relative to the 3 year shrinkage mean and the overall XSA estimate of fishing mortality.

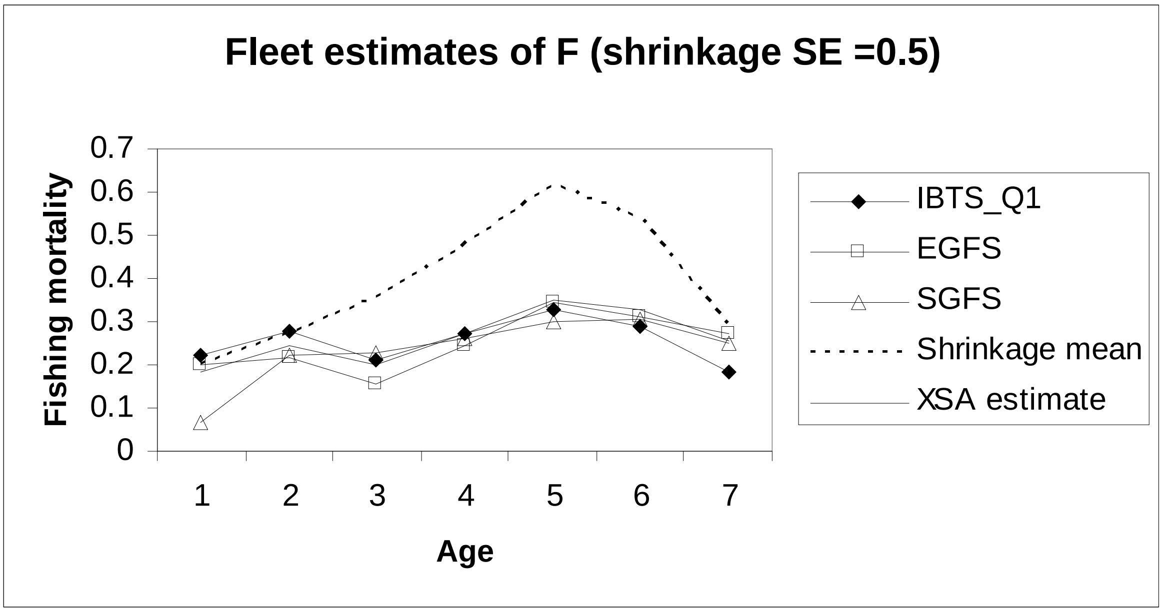


Figure 5.3.37 Whiting in IV and VIId. Proportionate weights attributed to individual fleet estimates and mean shrinkage contributing to the combined fleet final run XSA.

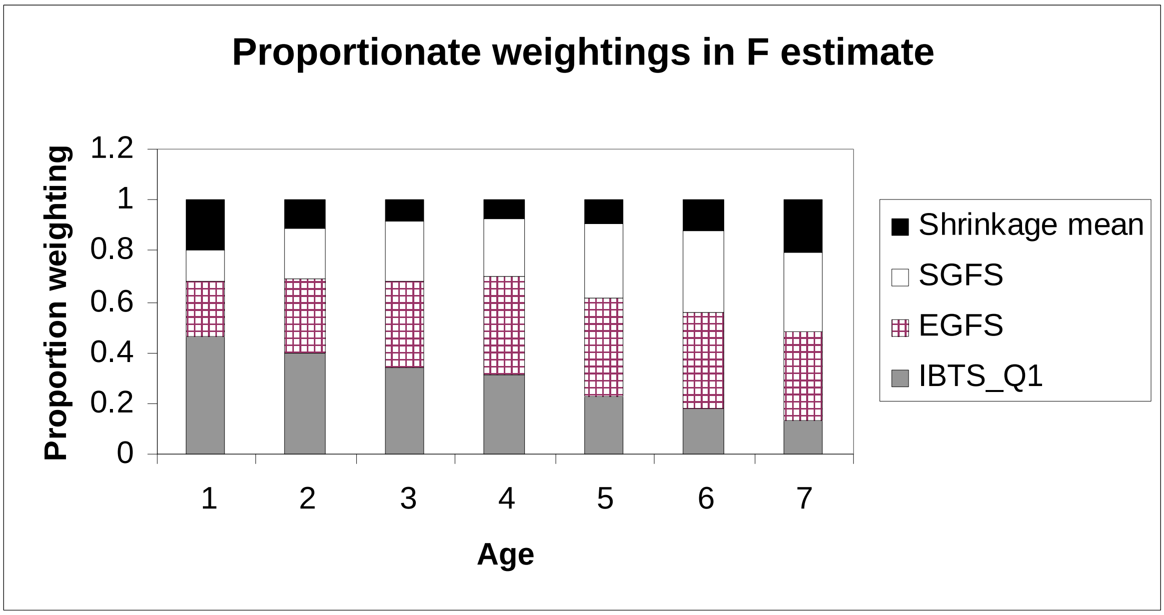
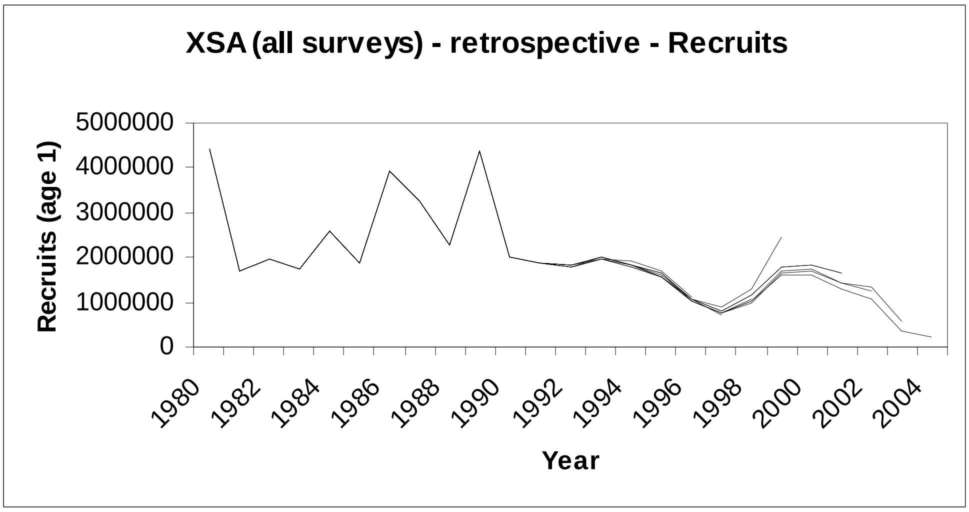
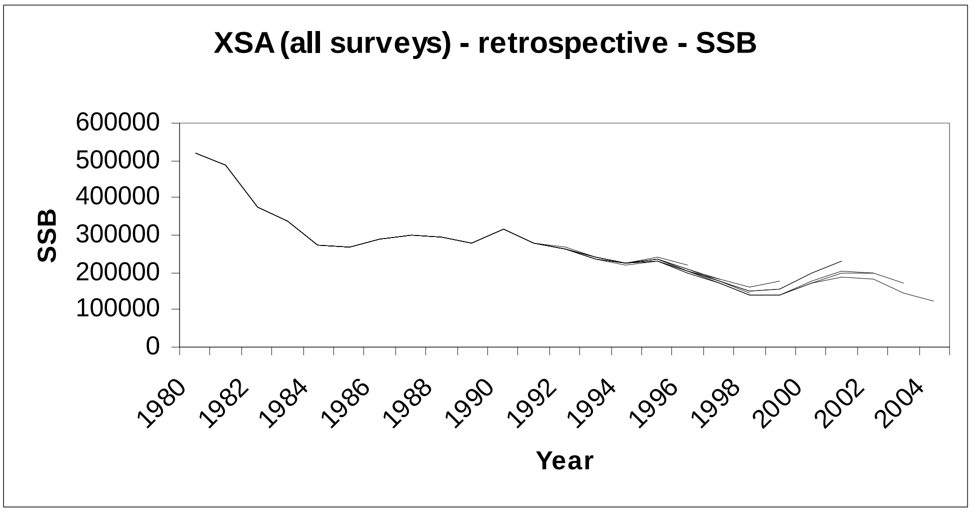


Figure 5.3.38 Whiting in IV and VIId. Retrospective results from the combined fleet final run XSA.





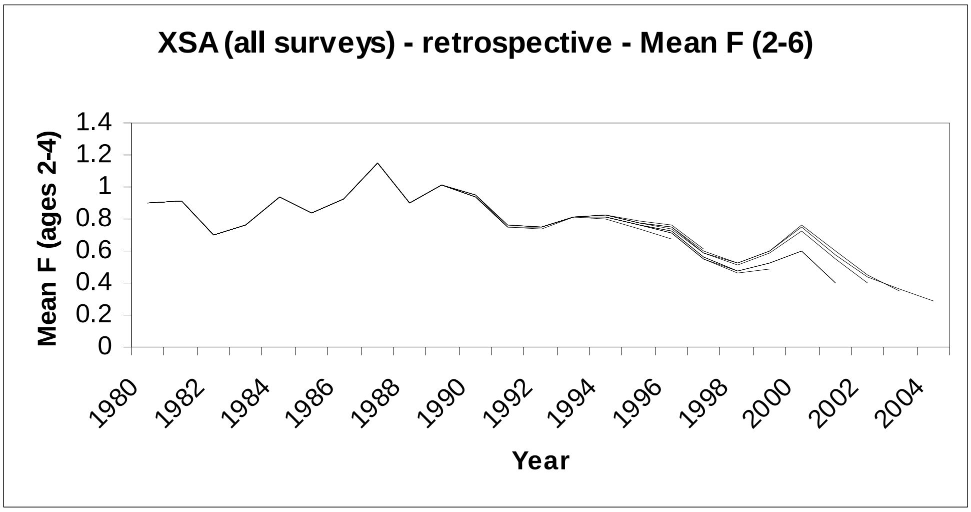


Figure 5.3.39 Whiting in IV and VIId. Mean-standardised SSB trends from the final XSA and IBTS_Q1, EGFS and SGFS.

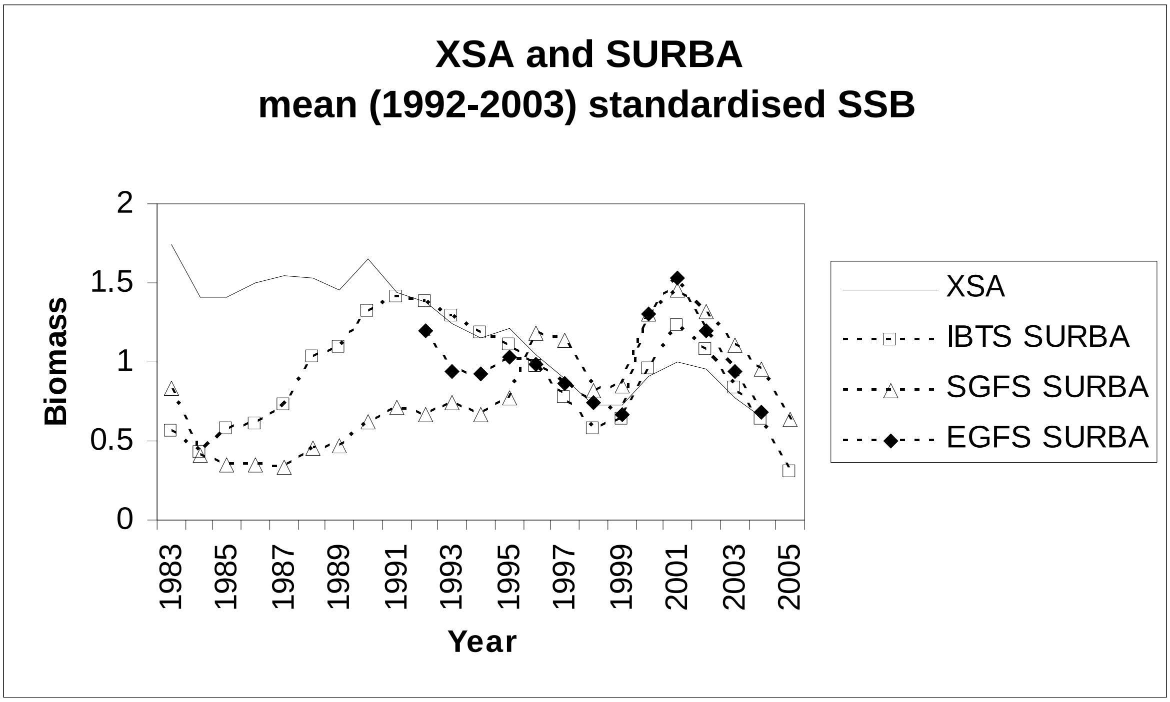
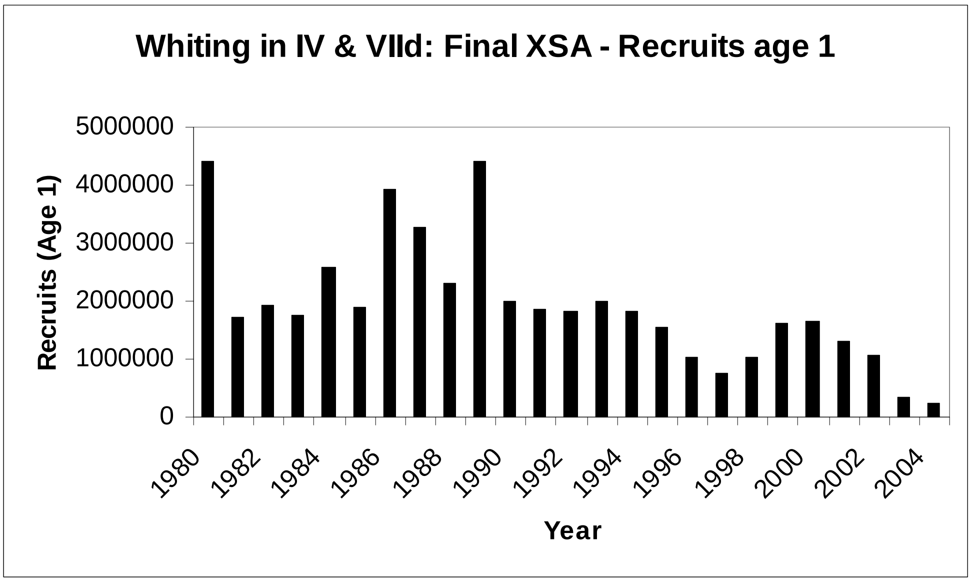
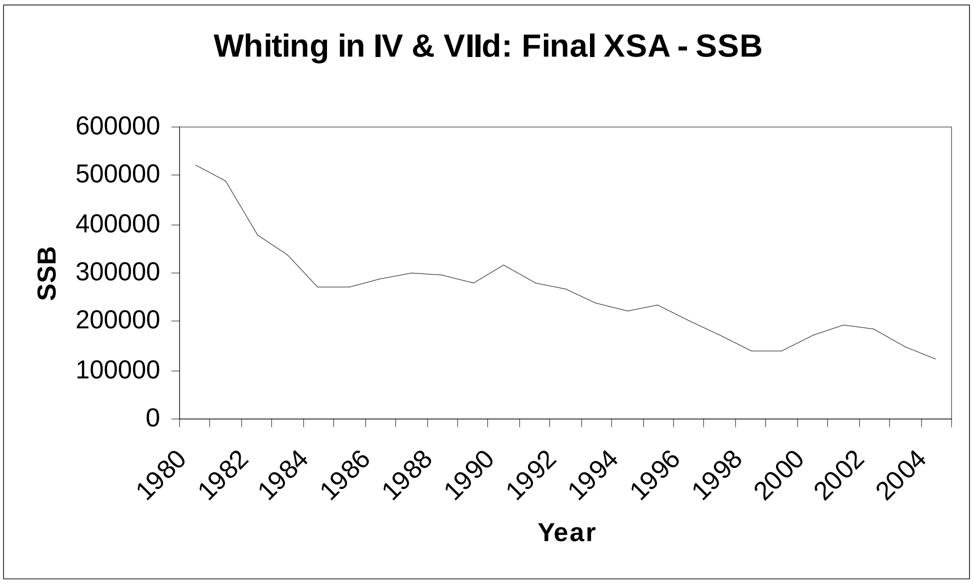


Figure 5.4.1 Whiting in IV and VIId. Stock trends from the combined fleet final run XSA.





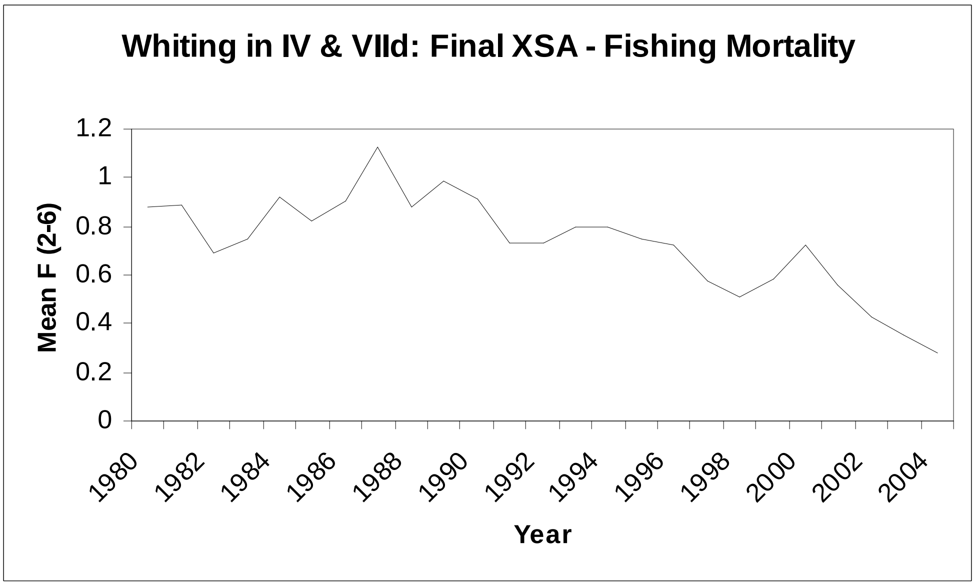


Figure 5.5.1 Whiting in IV and VIId. Mean-standardised one-year-old abundance from XSA, IBTS_Q1 and SGFS.

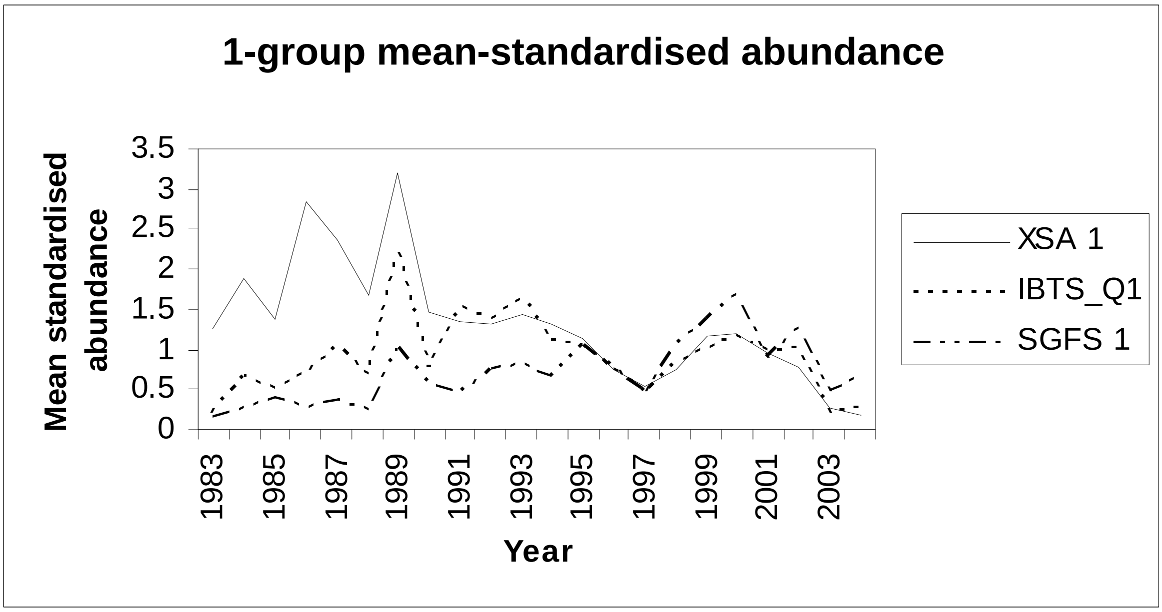


Figure 5.6.1 Whiting in IV and VIId. Mean-standardised exploitation patterns.

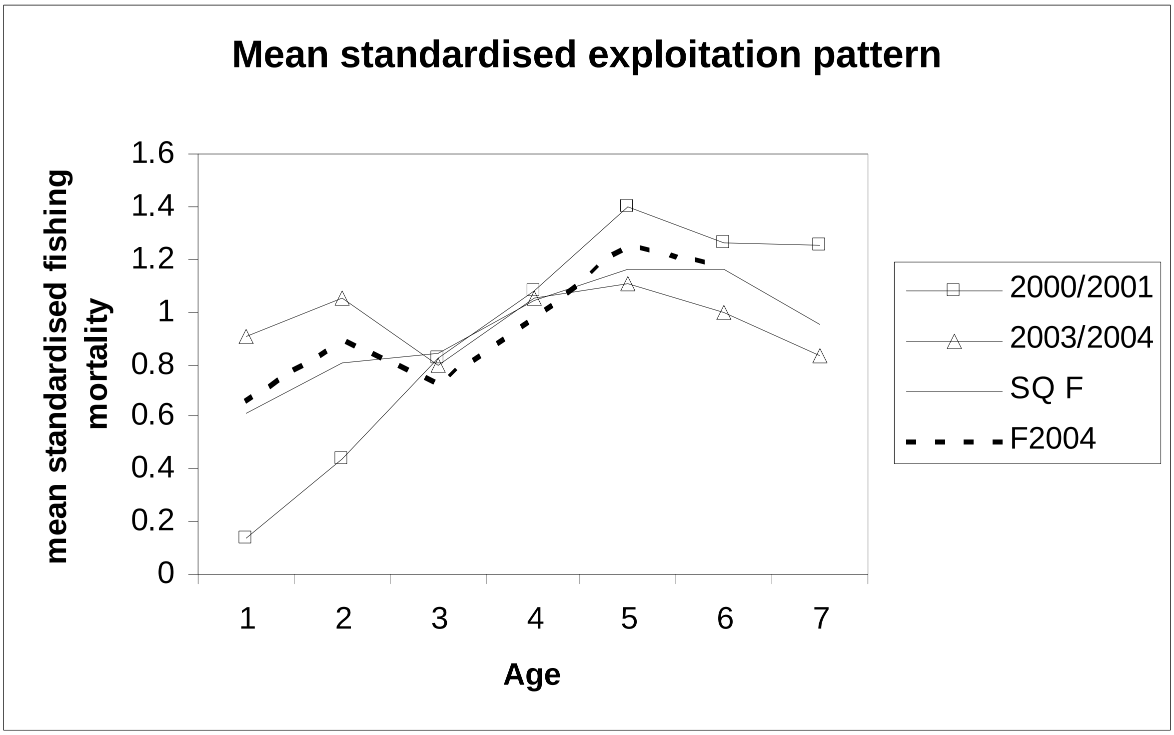


Figure 5.9.1. Whiting in IV and VIId. Historical performance of the assessment. Circles indicate single-year forecasts.

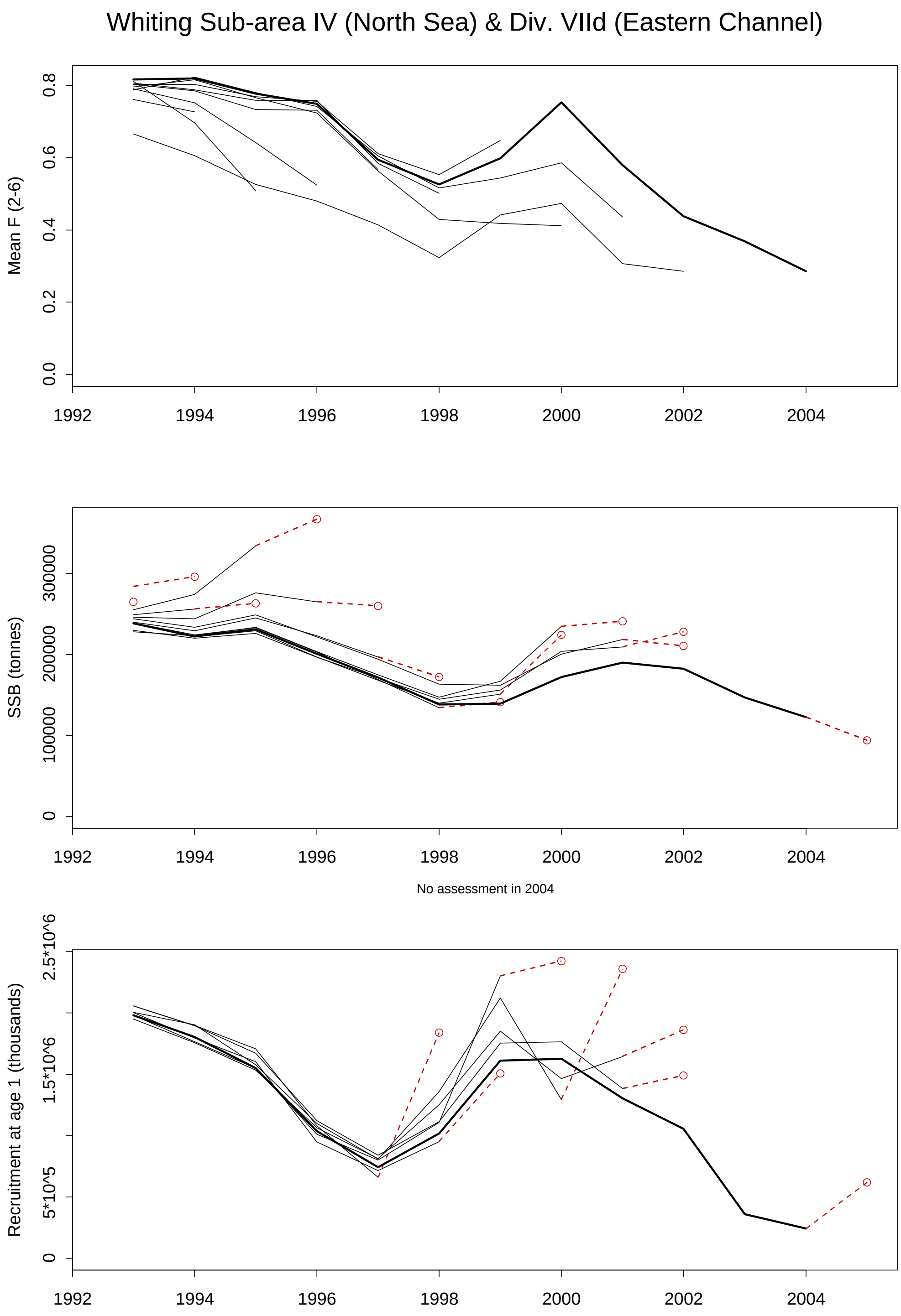
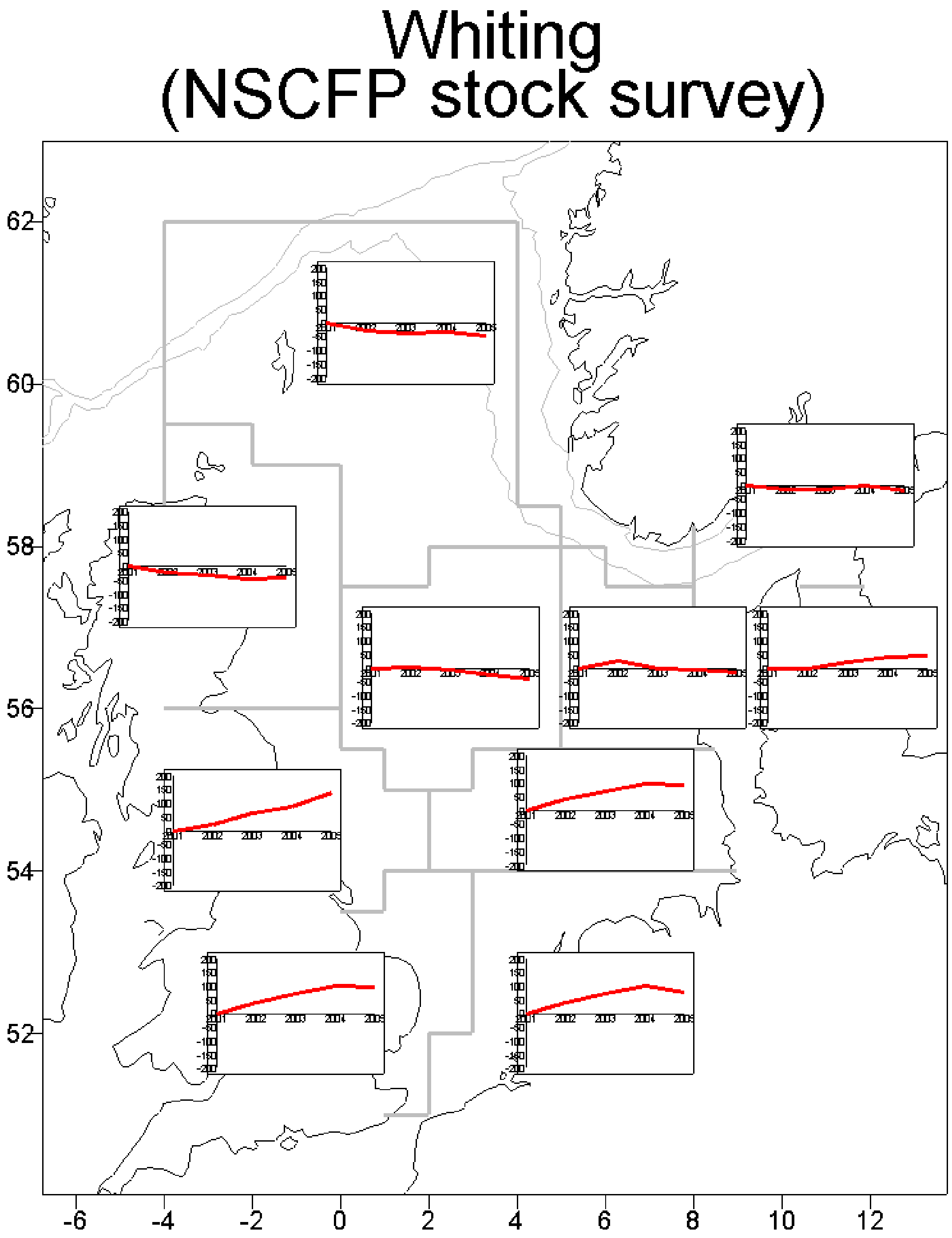


Figure 5.10.1 Whiting in IV and VIId. Trends in the abundance of North Sea whiting (2001-2005) from the fishers' survey, recorded by IBTS standard roundfish area.



6 SAITHE IN SUB-AREA IV, VI AND DIVISION IIIa

The 2005 assessment of saithe in sub-area IV, VI and division IIIa is classified as a benchmark assessment. Detailed biological and methodological information can be found in the stock annex.

6.1 General

6.1.1 Ecosystem aspects

The geographical distribution of juvenile (< age 3) and adults saithe differs. Typical for all saithe stocks are the inshore nursery grounds. Juvenile saithe in the North Sea are therefore mainly distributed along the west and south coast of Norway, the coast of Shetland and the coast of Scotland. Around age 3 the individuals gradually migrate from the costal areas to the northern part of the North Sea (57°N - 62°N). The age at maturity is between 4 and 6 years, and spawning takes place in January-March at about 200 m depth along the Northern Shelf edge and the western edge of the Norwegian deeps. Larvae and post-larvae are widely distributed in Atlantic water masses across the northern part of the North Sea, and around May the 0-group appear along the coast (of Norway, Shetland and Scotland). The west coast of Norway is probably the most important nursery ground for saithe in the North Sea.

When saithe exceeds 60-70 cm in length the diet changes from plankton (krill, copepods) to fish (mainly Norway pout, blue whiting, haddock and herring). Large saithe (>70 cm) has a highly migratory behaviour and the feeding migrations extend from far into the Norwegian Sea to across the Norwegian deeps to the coast. Because of its life-history, saithe in the North Sea is partly “geographically” protected from heavy exploitation as juveniles and as large adults.

Tagging experiments by various countries have shown that exchange between all saithe stock components in the northeast Atlantic takes place. In particular, exchange between the saithe stock north of 62°N (northeast Arctic saithe) and saithe in the North Sea has been observed (this probably also includes drift of larva and 0-group).

6.1.2 Fisheries

A general description of the fishery is given in the stock annex.

In 2004 the landings were estimated to be around 100 000 t in Sub-area IV and Division IIIa, and around 4 000 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. Significant discards appear only in Scottish trawlers (due to TAC regulations), and the estimate is about 9000 tons in 2004 (see Table 15.2.4.1). However, as Scottish discarding rates are not representative of the majority of the saithe fishery these have not been used in the assessment.

6.1.3 ICES advice

For 2004 ICES classified the stock as being within safe biological limits. In a single species context, ICES recommended a fishing mortality below $\boldsymbol{F}_{pa}$ 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.

For 2005 ICES considered the stock to be inside safe biological limits, however, the ICES advice for the stock was presented in the context of mixed fisheries.

Exploitation boundaries in relation to existing managent plans

Following the agreed management plan, landings in 2005 should be 150 000 t (137 000 t in IV and IIIa and 14 000 t in VI) which is expected to allow an increase in SSB to 241 000 t in 2006.

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

Target reference points have not been agreed for this stock. The current fishing mortality ($\mathbf{F}_{sq}$) is estimated as 0.29, which is above rates that would lead to high long-term yields ($\mathbf{F}_{0.1}$=0.13 and $\mathbf{F}_{max}$=0.25). Fishing at $\mathbf{F}_{0.1}$ is expected to lead to landings in 2005 of 56 000 t and SSB in 2006 of around 330 000 t.

For all demersal fisheries in the North Sea, ICES advice was based on mixed-fishery considerations and it advised the following:

Fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2004 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- *with minimal bycatch or discards of cod;*
- *Implement TACs or other restrictions that will curtail fishing mortality for those stocks … for which reduction in fishing pressure is advised;*
- *within the precautionary exploitation limits for all other stocks.*
- *Where stocks extent beyond this area, e.g. into Division VI (saithe and anglerfish) or is widely migratory (Northern hake) taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;*

6.1.4 Management

Management of saithe is by TAC and technical measures. The fishery is not regulated by days at sea for vessels that have less bycatch than 5% of each cod, plaice and sole. The agreed TAC for saithe in Sub-Area IV and Division IIIa for 2004 was 190 000 t. In Division Vb and Sub-Areas VI, XII, and XIV the TAC for 2004 was 20 000 t. For 2005 the TACs were 145 000 t and 15 044 t, respectively. Current technical measures are described in Section 2.1.2.

In 2004 EU and Norway *agreed to implement a long-term plan for the saithe stock in the Skagerrak, the North Sea and west of Scotland, which is consistent with a precautionary approach and designed to provide for sustainable fisheries and high yields. The plan shall consist of the following elements:*

1. *Every effort shall be made to maintain a minimum level of Spawning biomass (SSB) greater than 106 000 tonnes ($\boldsymbol{B}_{lim}$).*
2. *Where the SSB is estimated to be above 200 000 tonnes the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.30 for appropriate age groups.*
3. *Where the SSB is estimated to be below 200 000 tonnes but above 106 000 tonnes The TAC shall not exceed a level which, on the basis of a scientific evaluation by ICES, will result in a fishing mortality rate equal to 0.30-0.20*(200 000-SSB)/94 000.*
4. *Where the SSB is estimated by the ICES to be below the minimum level of SSB of 106 000 tonnes the TAC shall be set at a level corresponding to a fishing mortality rate of no more than 0.1.*

5. *Where the rules in paragraphs 2 and 3 would lead to a TAC which deviates by more than 15% from the TAC the preceding year the Parties shall fix aTAC that is no more tha 15% greater or 15% less than the TAC of the preceding year.*
6. *Notwithstanding paragraph 5 the Parties may where considered appropriate reduce the TAC by more than 15% compared to the TAC of the preceding year.*
7. *A review of this arrangement shall take place no later than 31 December 2007.*
8. *This arrangement enters into force on 1 January 2005.*

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. 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. FRS (Aberdeen) is responsible for the database with catch at age data from the different countries. The sum-of-products (SOP) was about 10 000 tonnes lower then and nominal landings for 2004.

6.2.3 Weight at age

Weight at age in the catch is presented in Table 6.2.3 and Figure 6.2.2. These are also used as stock weights. After a decreasing trend in mean weights from the mid-1990ies to 2003 the weights for many age groups increased slightly from 2003 to 2004. As noted in ACFM technical minutes, the mean weight of the plus group was exceptionally low in 2002-2003, but it has increased steadily from 2002 to 2004.

6.2.4 Maturity and natural mortality

A natural mortality rate of 0.2 is used for all ages and years, and a constant maturity ogive is used:

Age	1	2	3	4	5	6	7+
Proportion mature	0.0	0.0	0.0	0.15	0.7	0.9	1.0

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. Trends in relative LPUE and effort for the commercial fleets are shown in Figure 6.2.1. There are 4 available commercial series of effort and catch at age and 5 series of survey indices:

- French fresh fish trawl, age range: 2-10+ (“FRAtrb”)
- German bottom trawl, age range: 2-10+ (“GERotb”)
- Norwegian bottom trawl, age range: 3-10+ (“NORtrl”)
- Scottish light trawl, age range: 2-10+ (“SCOltr”)
- Norwegian acoustic survey, age range 3-7 (“NORacu”)
- IBTS quarter 1, age range: 1-6 (“IBTSq1”)
- IBTS quarter 3, age range: 1-6 (“IBTSq3”)

- English groundfish survey, age range: 2-3 (“ENGgfs”)
- Scottish groundfish survey, age range 2-3 (“SCOgfs”)

(a more detailed description of the series is given in the stock annex)

Due to methodological changes the Scottish and English groundfish surveys are split in two if used for tuning (Scottish: before 1998 and 1998 onwards, English: before 1992 and 1992 onwards).

6.3 Exploratory analyses

Since a high number of tuning series are available for North Sea saithe, an important part of this benchmark process is to evaluate each of these series in terms of internal consistency, between-series consistency and catchability residuals. The landings at age data are also briefly explored and different XSA-runs are performed to check the effect of using different tuning fleet combinations and F-shrinkage.

6.3.1 Exploration of available tuning series

Mean standardised CPUE from the commercial tuning series are shown in Figure 6.3.1, and mean standardised survey indices are shown in Figure 6.3.2. FRAtrb, GERotb and NORtrl show fairly good between-series consistency, while SCOltr shows a different trend for age 3-6 in recent years. This could be due to problems with the Scottish effort data (effort has not been a mandatory field in EU-logbooks). The survey indices have fairly good between-series consistency for IBTSq3, NORacu, ENGgfs and SCOgfs, while IBTSq1 shows a different trend for age 1-3.

Plots of log CPUE by cohort is shown in Figure 6.3.3. For the commercial fleets it can be seen that age 2 and 3 are partly recruited to the fishery. There is some distortion in the NORtrl cohort curves and in the survey plots. IBTSq1 seems particularly poor in tracking year classes.

SURBA was used as an exploratory tool to investigate the internal consistency within the available tuning fleets. Scatter plots of log-transformed indices between ages for similar cohorts are shown in Figure 6.3.4. All the commercial series show fairly good internal consistency (positive slope of the fitted regression lines for neighbouring ages) except for between ages 2 and 3. IBTSq1 and the SCOgfs and ENGgfs series shows poor internal consistency, while IBTSq3 and NORacu are fairly consistent except for the youngest age groups in IBTSq3 and age 7 in NORacu.

6.3.2 Exploration of catch data

The reviewers in ACFM Technical Minutes recommended to investigate the age composition in the plus group (in order to explain the low values in 2002 and 2003), and this is shown for 2000-2004 in Figure 6.3.5. The low mean weights in 2002 and 2003 seems to bee due to a relative high proportion of the strong 1992 year class in the catches, and this year class had an exceptionally low mean weight (under 4 kg for age 10).

6.3.3 Separable VPA

A separable VPA was run on the catch at age data from the last 10 years in order to examine the structure of the data. Equal weighting of 1.0 was used on all ages and years. Based on the F-selection pattern from last year’s assessment, terminal F was set to 0.5 on age 5 and S was set to 1.3. The log catch residuals from the run are shown in Figure 6.3.6. Log catch residuals are large for age 1 and fairly large for age 2. This is expected since age 1 and 2 are only partly recruited to the fishery and the estimated catch of these two age groups is very low (in weight) and variable. It does not seem to be a consistent trend in the residuals.

6.3.4 Single fleet Laurec-Shepherd

Single-fleet Laurec-Shepherd runs (without shrinkage) were performed with each of the available tuning series to explore potential mismatch with the catch data. Time series of log catchability residuals from these runs are shown in Figure 6.3.7. Residuals for age 1 and age 2 are large compared with the other ages. There is a clear trend with time in the residuals from SCOltr, and IBTSq1 generally have large residuals.

6.3.5 Extended Survivors Analysis (XSA)

Based on the exploration of tuning series it was decided to exclude IBTSq1 (low internal and external consistency and high catchability residuals), ENGgfs (low internal consistency and high catchability residuals) and ScoLTR (low external consistency, trend in the catchability residuals and problems with effort data) as tuning series in XSA runs. The ScoGFS series was removed because of low internal consistency. It was also decided to exclude age 7 from NORacu because of the poor internal consistency with younger age groups. Since acceptable tuning data for age 1 and 2 does not seem to exist, and since the catches of these ages are very low and variable (due to the inshore distribution of these ages) the working group decided use age 3 as recruits. Figure 6.3.8 shows the relative year class strength from two XSA runs where the youngest age group is 1 and 3, respectively (the same settings as in last year’s assessment are used except that age 7 is removed from the NORacu fleet and IBTSq3 age 3-6 is included as a tuning fleet). Increasing the youngest age has little effect on estimates of relative year class strength (Fig. 6.3.8) (Fbar and SSB were identical in the two runs).

Using the same settings as described above (same as last year except age 3 is the recruitment age), XSA runs with different combinations of tuning fleets were performed, and the effect on SSB, Fbar and recruitment is shown in Figure 6.3.9. Different tuning fleet combinations lead to different results for the most recent years, but none of the combinations causes the perception of the stock status to change significantly.

The effect on the retrospective pattern of using F-shrinkage of 0.5, 1.0 and 2.0 is shown in Figure 6.3.10. An F-shrinkage of 0.5 improves the retrospective pattern, and there is little difference between F-shrinkage of 1.0 and 2.0 (1.0 was used in last year’s assessment). The effect on the SSB, Fbar and recruitment estimates of different F-shrinkages is shown in Figure 6.3.11.

6.3.6 Survey based analysis

SURBA was used (Lambda = 1.0, Rererence age = 4) to explore the trend in SSB, Z(3-6), TSB and recruitment only using the survey indices (IBTSq3 and NORacu), and the results are shown in Figure 6.3.12. A comparison of the relative trend in SSB from XSA and SURBA is shown in Figure 6.3.13. Both methods show an increase in SSB over the last decade, however, both the variation and the increase during the last 4 years is larger for SURBA.

6.4 Final assessment

The settings in the final XSA assessment are (last year’s settings are also shown):

Year of assessment:	2004	2005
Assessment model:	XSA	XSA
Fleets:	FRAtrb (age range: 3-9, 1990 onwards)	FRAtrb (age range: 3-9, 1990 onwards)
	GERotb (age range: 3-9, 1995 onwards)	GERotb (age range: 3-9, 1995 onwards)

	NORtrl (age range: 3-9, 1980 onwards)	NORtrl (age range: 3-9, 1980 onwards)
	NORacu (age range: 3-7, 1995 onwards)	NORacu (age range: 3-6, 1995 onwards)
		IBTSq3 (age range: 3-6, 1991 onwards)
Age range:	1-10+	3-10+
Catch data:	1967-2994	1967-2994
Fbar:	3-6	3-6
Time series weights:	Tricubic over 20 years	Tricubic over 20 years
Power model for ages:	No	No
Catchability plateau:	Age 7	Age 7
Survivor est. shrunk towards the mean F:	5 years / 3 ages	5 years / 3 ages
S.e. of mean (F-shrinkage):	1.0	1.0
Min. s.e. of population estimates:	0.3	0.3
Prior weighting:	no	no
Number of iterations before convergence:	37	39

Outputs from the final run are given in Table 6.4.1 (diagnostics), Table 6.4.2 (fishing mortality at age), Table 6.4.3 (population numbers at age), and Table 6.4.4 (stock summary). The XSA log catchability residuals are shown in Figure 6.4.1, the relative weights of F-shrinkage and tuning fleets are shown in Figure 6.4.2 and historical performance of the assessment is shown in Figure 6.4.3.

6.5 Recruitment estimates

No reliable information about the 2002 year class is currently available, so it was decided to use a geometric mean of the estimated number of age 3 from the period 1988-2002. The reason for only using this period is that the recruitment level and variance seem to be on different levels before and after around 1988. Year class strength estimates used for short-term prognosis are summarized in the table below:

Year class	Age in 2005	XSA	GM(88-02)
2001	4	**61 630**	
2002	3		**123 801**

6.6 Historical trends

The historic stock and fishery trends are presented in Figure 6.6.1 (and Table 6.4.4). The reported landing increased from 1967 to the highest observed landing levels in the mid-

1970ties. After 1976 the landings decreased rapidly to a stable level in 1979-1981 and increased again from 1981 to 1985. From 1985 the reported landings decreased and levelled of in 1989 to a fairly stable level where they have stayed since. The last three years (2002-2004) TAC levels have been far higher than the reported landings. The set TAC and the forecasted landing for 2005 indicate that this will also be the case in 2005. Estimated fishing mortality show the same trends as landings in the period 1967-1985 while it has decreased continuously since 1985 till present (except some small jumps), reaching below $\mathbf{F}_{lim}$ in 1993 and below $\mathbf{F}_{pa}$ in 1997. Estimated SSB increased from 1967 reaching the highest observed level in 1974 where after it decreased to below $\mathbf{B}_{lim}$ in 1990. After 1991 SSB increased to above $\mathbf{B}_{pa}$ in 1999. SSB is estimated to have been slightly above $\mathbf{B}_{pa}$ since 2001. The mean and variance in estimated recruitment (measured at age 3) are higher before around 1988 than after, e.g., the six strongest year classes observed all occurred in the earliest period. Estimated recruitment has decreased since 2001.

6.7 Short-term prognosis

The short-term prognosis was performed using the same method and settings as last year. Inputs are presented in Table 6.7.1. The average over the last three years are used for weight at age in the stock and catch. Fishing mortalities at age are also estimated to be an arithmetic average over the last three years. Number at age 3 (recruitment) is taken as the geometric mean of estimated number at age 3 from the period 1988-2002. Population numbers at age 4 and older are the XSA survivor estimates. The management option table are given in Table 6.7.2 and the forecast is summarised in Table 6.7.3 and Figure 6.7.1. Status quo fishing mortality ($\mathbf{F}_{sq}$) in 2005 and 2006 is expected to lead to landings of about 100 000 tonnes in 2006 and a slight decrease in the expected spawning stock biomass in 2007. A fishing mortality higher than $\mathbf{F}_{pa}$ in 2006 (and $\mathbf{F}_{sq}$ in 2005) is expected to lead to a spawning stock biomass in 2007 which is below $\mathbf{B}_{pa}$. The forecasted contribution of the most recent year classes in landings and SSB are shown in Table 6.7.4. The probability profiles for the short term forecast are shown in Figure 6.7.2. A sensitivity analysis identifying some of the sources of uncertainty underlying the prediction is presented in Figure 6.7.3.

6.8 Biological reference points

Since the relative year class strength hardly changed in this year's final assessment (age 3 used as recruits) relative to last year's assessment (age 1 used as recruits), it was not considered necessary to revise the PA reference points (see Fig. 6.3.9). $\mathbf{F}_{0.1}$, $\mathbf{F}_{max}$, $\mathbf{F}_{med}$ and $\mathbf{F}_{high}$ were revised according to new information. The biological reference points are:

$\mathbf{F}_{0.1}$	0.10	$\mathbf{F}_{lim}$	0.60
$\mathbf{F}_{max}$	0.22	$\mathbf{F}_{pa}$	0.40
$\mathbf{F}_{med}$	0.35	$\mathbf{B}_{lim}$	106 000 t
$\mathbf{F}_{high}$	>0.54	$\mathbf{B}_{pa}$	200 000 t

6.9 Quality of the assessment

This assessment agrees well with the fishermen's perception of the stock in the main distributional area of saithe (Fig. 6.9.1). Compared to last year's assessment, the changes in estimated SSB and F(3-6) for 2003 and backwards are very small. Though only compared for the four last years, the annual revisions of recruitment (which was large before) seems to improve when age 3 is used as recruits instead of age 1.

A problem with this assessment is the required use of commercial CPUE for tuning (the survey series which are used only contain usable information for age 3-6). There are many reasons for why commercial CPUE may fail to track changes in relative abundance. The most serious reason is so-called hyperstability; that is commercial catch rates remaining high while population abundance drops, which may occur when vessels are able to locate fish concentration independently of population size. Hyperstability can be discovered in time if the degree of the fleet's spatial concentration is monitored. Norway and Germany have now permitted the use of data from their satellite based vessel monitoring systems for research purposes, which makes it possible to perform such monitoring of the German and Norwegian tuning fleets.

The most serious problem with stock forecasts for saithe is the lack of reliable information about year class strength before age 3. An annual 0-group survey has been conducted by IMR (Norway) since 1999 in the northern North Sea, but this will not be continued due to lack of relationship between the 0-group index and later XSA population estimates for the year classes 1999-2001 (the 0-group index for the 2000 year class is extremely high, while this year class is estimated to be around average for age 4 in this year's assessment). IMR considers to start a new survey along the west coast of Norway to measure the relative abundance of saithe between 1 and 3 years old (when the saithe is distributed along the coast).

6.10 Status of the stock

The general perception of the status of the saithe stock remains unchanged from last year's assessment. Fishing mortality appears to be below $\mathbf{F}_{pa}$ and the spawning stock biomass appears to be above $\mathbf{B}_{pa}$.

6.11 Management considerations

The ICES advice applies to the combined areas IIIa, IV, and VI.

The reported landings have been much lower than the TAC the last three years. Information from fishermen indicates that very low prices on saithe combined with high fuel prices are causing these reductions.

Bycatch of other demersal fish species occurs in the trawl fishery for saithe. Saithe is also taken as unintentional by-catch in other fisheries.

The stock of saithe in the North Sea is expected to remain within safe biological limits if the TAC for 2006 is set according to the agreed management plan. However, the estimated recruitment has declined rapidly the last four years. Thus, even with the current situation with low fishing mortality the spawning stock biomass is expected to decrease in the medium-term.

Table 6.2.1 Nominal catch (in tonnes) of Saithe in Subarea IV and Division IIIa and Subarea VI, 1998-2004, as officially reported to ICES.

SAITHE IV and IIIa

Country	1998	1999	2000	2001	2002	2003	2004*
Belgium	249	200	122	24	107	44*	21
Denmark	3967	4494	3529	3575	5668	6954	7983
Faroe Islands	1298	1101					
France	11786*	24305[1]*	19200	20472	25441	18001	
Germany	10117	10481	9273	9479	10999	8956	9589
Greenland	-	-	601[2]*	1526[2]*	-*		
Ireland	-	-	1	-	-		
Netherlands	7	7	11	20	6	11*	3
Norway	50254	56150	43665	43725*	58983*	61690*	61128
Poland	813	862	747	727	752	734*	
Russia	-	-	67	-	-	-	
Sweden	1857	1929	1468	1627	1863	1876	2245
UK (E/W/NI)	2293	2874	1227	1186	2521	1215	456
UK (Scotland)	5353	5420	5484	5219	6596	5829	5920
Total reported	87994	107823	85395	87580	112936	105310	87346
Unallocated	12269	-510	2281	2093	3852	-3771	12406
W. G. Estimate	100263	107314	87676	89673	116788	101539	99752[3]
TAC	97000	110000	85000	87000	135000	165000	190000

*Preliminary. [1]Reported by TAC area, IIa(EC),IIIa-d(EC) and IV. [2]Preliminary data reported in Division IVa.
[3]Age 3+

Table 6.2.1 continued

SAITHE VI

Country	1998	1999	2000	2001	2002	2003	2004*
Belgium	-	-	-	-	-	-*	
Denmark	-	-	-	-	-	-	
Faroe Islands		2					
France	3635*	3467[1]*	3310	5157	3062	3499	
Germany	506	250	305	466	467	54	4
Ireland	216	320	410	399	91		
Norway	41	126	58	92*	136*	22*	16
Portugal	-	-	-	-	-	-	
Russia	-	3	25	1	1	6	
Spain	54	23	3	15	4		
UK (E/W/NI)	526	503	276	273	307	263	29
UK (Scotland)	2402	2084	2463	2246	1567	1189	1555
Total reported	7380	6778	6850	8649	5635	5033	1610
Unallocated	1056	564	-960	-1831	-449	217	2876
W. G. Estimate	8436	7342	5890	6818	5186	5250	4486[3]
TAC	10900	7500	7000	9000	14000	17119	20000

*Preliminary. [1]Reported by TAC area, Vb(EC),VI, XII and XIV.
[3]Age 3+

SAITHE IV, IIIa and VI

	1998	1999	2000	2001	2002	2003	2004
WG estimate	108699	114655	93566	96491	121974	106789	104237

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	1974
AGE								
3	17330	23223	30235	37249	69809	48075	54332	66938
4	16220	21231	17681	76661	57792	66095	37698	33740
5	15531	13184	11057	15000	32737	25317	26849	14123
6	2303	6023	7609	12128	4736	21207	16061	20688
7	1594	429	5738	3894	4248	3672	8428	14666
8	292	242	791	1792	2843	2944	2000	5199
9	198	123	626	318	1874	1641	1357	1477
+gp	183	145	150	267	774	1607	2381	1955

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	56987	207823	27461	35059	16332	17494	26178	31895	28242	80933
4	25864	53060	54967	27269	14216	12341	8339	40587	20604	32172
5	10319	11696	14755	18062	11182	9015	6739	9174	26013	12957
6	7566	6253	5490	3312	8699	6718	3675	5978	5678	13011
7	13657	3976	3777	1138	2805	5658	3335	2145	4893	1657
8	9357	5362	3447	1033	733	1150	3396	1454	1494	1252
9	3501	3586	3812	768	540	509	657	982	1036	335
+gp	2687	3490	4701	3484	2089	2302	2536	1254	1327	646

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	134024	55435	31220	32578	22128	40808	46117	18404	37823	19958
4	55605	91223	97470	26408	30752	19583	29871	33614	20828	40194
5	13281	15186	13990	35323	13187	11322	7467	12753	11845	13034
6	4765	5381	3158	3828	10951	4714	3583	3193	3125	4297
7	3005	2603	1811	1908	1557	2776	1716	1524	1568	947
8	682	1456	1240	1104	739	745	953	696	1511	346
9	399	445	910	776	419	281	367	518	814	427
+gp	742	900	700	680	488	364	458	422	1026	794

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE										
3	26664	11066	15036	10363	9429	7064	17355	20066	11661	5314
4	26034	38861	19299	31017	13872	17295	18565	42915	20209	14987
5	14797	11786	30177	16367	26684	8940	23497	9003	25759	17695
6	3774	7731	3676	16077	8389	12339	3622	9001	6269	13412
7	3494	3163	2640	2231	10070	3159	3518	2441	7061	3819
8	674	808	1012	1206	2346	3226	1417	2936	1512	4104
9	552	210	291	567	891	641	1121	1828	1979	1118
+gp	800	491	288	277	657	441	218	1588	1039	806

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	1967	1968	1969	1970	1971	1972	1973	1974
AGE								
3	0.93	1.28	0.97	0.94	0.84	0.81	0.82	0.86
4	1.36	1.65	1.56	1.44	1.35	1.20	1.41	1.56
5	2.10	1.99	2.26	2.06	2.18	1.96	1.64	2.38
6	3.19	3.01	2.71	2.72	2.94	2.37	2.57	2.75
7	3.75	4.04	3.56	3.60	3.77	3.79	3.36	3.43
8	5.32	4.43	4.41	4.46	4.63	4.23	4.68	4.50
9	5.89	6.14	5.22	5.69	5.17	4.63	4.81	5.71
+gp	7.72	7.41	6.77	6.85	6.16	6.33	6.44	7.86

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	0.89	0.70	0.76	0.82	1.11	0.95	0.96	1.09	1.03	0.79
4	1.50	1.31	1.26	1.33	1.62	1.82	1.82	1.57	1.72	1.61
5	2.49	2.26	1.93	2.15	2.24	2.39	2.72	2.53	2.15	2.30
6	3.30	3.07	3.11	3.34	3.10	3.03	3.59	3.22	3.14	2.69
7	3.76	4.03	4.16	4.52	4.05	4.09	4.54	4.21	3.69	3.90
8	4.30	4.38	4.60	4.90	5.27	5.13	5.48	5.13	4.63	4.66
9	5.54	5.11	4.86	5.45	6.31	5.94	6.98	5.90	5.51	6.18
+gp	7.56	7.15	6.54	7.40	7.96	8.15	8.72	8.82	8.45	8.47

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	0.66	0.69	0.67	0.78	0.90	0.84	0.79	0.96	0.90	0.94
4	1.27	1.04	0.88	0.98	1.04	1.20	1.16	1.19	1.26	1.12
5	1.95	1.79	1.82	1.39	1.42	1.58	1.75	1.61	1.75	1.60
6	2.77	2.43	3.07	2.79	2.00	2.25	2.36	2.24	2.64	2.43
7	3.41	3.57	4.21	4.02	3.91	3.24	3.17	3.67	3.19	3.62
8	4.95	4.21	5.33	5.25	5.02	4.86	4.22	4.33	3.98	4.79
9	5.86	5.65	6.13	6.32	6.43	6.31	6.07	5.41	5.08	6.55
+gp	8.85	8.22	8.60	8.65	8.43	8.42	8.19	7.05	6.89	8.33

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE										
3	1.00	0.97	0.90	0.89	0.88	1.03	0.80	0.80	0.72	0.88
4	1.29	1.19	1.14	0.97	1.06	1.13	1.07	0.86	0.95	1.02
5	1.82	1.81	1.45	1.39	1.21	1.54	1.30	1.32	1.08	1.26
6	2.56	2.37	2.59	1.74	1.75	1.68	2.06	1.76	1.66	1.58
7	3.55	2.95	3.56	2.95	2.34	2.59	2.57	2.28	2.25	2.48
8	4.77	4.71	4.53	3.88	3.49	3.08	3.52	3.12	3.35	3.10
9	5.27	6.09	6.16	5.00	4.84	4.77	4.17	3.94	3.77	4.29
+gp	7.89	8.38	8.87	7.23	6.75	7.46	6.19	3.78	4.29	5.56

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.

108									
FRATRB_IV									
1978	2004								
1	1	0	1						
2	10								
69739	248	**1853**	**3183**	**5447**	**762**	**190**	**154**	**122**	163
89974	230	**4525**	**3618**	**4128**	**2809**	**329**	**87**	**51**	84
63577	528	**3149**	**4450**	**2322**	**1412**	**746**	**104**	**45**	29
76517	4538	**9067**	**2893**	**2423**	**939**	**456**	**258**	**36**	48
78523	1285	**6001**	**10009**	**2630**	**1328**	**543**	**164**	**98**	21
69720	799	**3487**	**5770**	**8617**	**1183**	**270**	**86**	**37**	29
76149	1311	**5482**	**8632**	**5121**	**3837**	**232**	**155**	**33**	49
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	802.91	**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**	**67.67**	**11.93**	5.811
7902	351.996	**717.161**	**1480.817**	**498.716**	**73.572**	**24.402**	**7.133**	**5.741**	1.447
13527	1025.751	**3917.8**	**2253.44**	**1162.23**	**103.625**	**8.299**	**8.648**	**6.183**	9.637
14417	434.898	**1770.754**	**3652.84**	**1381.104**	**434.086**	**38.895**	**5.317**	**2.71**	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	**1087.28**	**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	**724.1021**	**1339.454**	**2372.881**	**269.951**	**144.906**	**25.554**	**29.28**	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
5234	59.109	**447.218**	**977.66**	**1020.943**	**494.617**	**92.582**	**35.628**	**19.772**	19.963

NORTRL_IV								
1980	2004							
1	1	0	1					
3	10							
18317	**186**	**1290**	**658**	**980**	**797**	**261**	**60**	82
28229	**88**	**844**	**1345**	**492**	**670**	**699**	**119**	64
47412	**6624**	**12016**	**2737**	**2112**	**341**	**234**	**19**	77
43099	**4401**	**4963**	**8176**	**1950**	**2367**	**481**	**357**	84
47803	**20576**	**7328**	**2207**	**3358**	**433**	**444**	**106**	51
66607	**27088**	**21401**	**5307**	**1569**	**637**	**56**	**46**	4
57468	**5297**	**29612**	**3589**	**818**	**393**	**122**	**25**	33
30008	**2645**	**18454**	**2217**	**290**	**235**	**201**	**198**	64
18402	**3132**	**2042**	**2214**	**141**	**157**	**74**	**134**	43
17781	**649**	**2126**	**835**	**694**	**309**	**154**	**65**	7
10249	**804**	**781**	**924**	**519**	**203**	**63**	**12**	3
28768	**14348**	**4968**	**1194**	**518**	**203**	**51**	**56**	1
35621	**3447**	**9532**	**4031**	**1087**	**465**	**165**	**109**	6
24572	**7635**	**4028**	**2878**	**1018**	**526**	**365**	**252**	252
30628	**3939**	**16098**	**4276**	**926**	**251**	**72**	**203**	21
32489	**4347**	**9366**	**5412**	**833**	**1644**	**273**	**203**	104
40400	**3790**	**14429**	**4414**	**2765**	**1144**	**189**	**16**	13
36026	**2894**	**5266**	**9837**	**1419**	**892**	**299**	**72**	28
24510	**1376**	**8279**	**5454**	**5662**	**977**	**489**	**243**	55
20570	**783**	**2527**	**6741**	**2333**	**3573**	**1162**	**342**	187
15520	**284**	**1628**	**2054**	**4261**	**1066**	**1203**	**221**	87
20593	**4554**	**4982**	**6332**	**922**	**1224**	**506**	**388**	44
29278	**3173**	**9667**	**2808**	**3061**	**780**	**1298**	**839**	838
40324	**1526**	**5194**	**10190**	**3583**	**4418**	**791**	**1003**	570
31303	**651**	**2525**	**5496**	**6353**	**2195**	**2581**	**643**	439

Table 6.2.4. (Cont'd). 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.

GER_OTB_IV

1995	2004								
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
13708	14	**334**	**2040**	**1928**	**1079**	**200**	**235**	**47**	58

SCOLTR_IV+VI

1989	2004								
1	1	0	1						
2	10								
2	2	0	2	0	0	0	0	0	0
4	20	0	0	0	0	0	0	0	0
623326	405.295	1784.58	579.547	191.218	311.675	54.991	16.6	6.884	17.59
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	824.22	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	22.14	10.704
570325	582.394	480.486	813.008	307.944	394.84	56.611	34.767	12.468	5.031
428743	666.565	361.113	215.344	433.657	101.33	136.95	35.921	30.959	10.356
199274	34.83012	359.0818	572.1864	233.4932	260.9414	63.78785	60.24703	28.40842	21.82884
281187	124.5513	282.1293	352.8433	583.1024	96.65596	113.1928	38.03049	32.6836	6.050017
199274	34.83012	359.0818	572.1864	233.4932	260.9414	63.78785	60.24703	28.40842	21.82884

IBTSq1

1984	2004					
1	1	0	0.25			
1	6					
1	0.061	0.084	0.068	0.33	1.074	1.313
1	0.249	0.223	25.734	3.578	0	6.589
1	0.133	1.852	65.432	3.058	0.164	0.533
1	0.249	0.354	0.488	2.413	0.169	0.697
1	0.066	0.004	1.328	0.755	0.923	0.59
1	0.052	0	1.596	1.452	0.384	0.9
1	0	0.103	0.646	0.837	0.338	1.743
1	0.024	0.062	4.576	2.058	0.776	0.135
1	0.013	0.08	0.284	2.218	0.33	0.544
1	0.054	1.939	0.481	1.195	2.296	1.732
1	0.088	0.385	2.81	7.496	1.094	0.433
1	0.003	0.014	0.434	0.859	1.074	0.743
1	0.385	0.571	1.681	16.544	1.083	0.463
1	0.022	0	0.034	1.381	2.198	0.499
1	0.052	0.028	0.219	2.166	1.343	1.815
1	0.114	0.01	0.297	0.882	2.537	1.187
1	0.074	0.047	0.819	0.23	0.41	3.018
1	0.63	0.006	0.124	0.683	1.68	0.767
1	0.076	0.065	2.59	6.729	2.857	5.236
1	0.003	0.432	1.786	11.43	21.104	2.062
1	0.015	0.002	1.761	6.589	9.29	3.062

Table 6.2.4.(Cont'd). 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.

FRASAI_VI

1977	2004							
1	1	0	1					
3	10							
62969	1031	1435	1156	531	440	308	219	236
68760	1989	1771	972	548	163	151	99	199
65281	1428	1101	808	444	303	133	198	154
53693	2626	698	538	492	409	194	69	107
50917	1562	1111	387	283	233	141	102	87
48428	2214	917	829	347	253	153	93	45
42497	2823	1762	647	605	434	129	82	71
42608	2273	1830	613	461	204	93	37	26
73608	3412	2358	1230	992	478	144	79	39
74959	4910	7188	3119	1016	678	228	109	65
75003	1492	5836	1651	1157	660	389	218	148
94109	4011	2534	2004	786	676	472	228	201
72656	4443	3975	1589	893	199	142	71	72
59465	2975	2028	684	477	330	161	85	91
51011	1792	1697	619	287	184	111	43	96
44974	637	1528	528	192	50	32	26	9
56762	1474	1921	855	196	70	33	22	11
41971	1810	1288	600	245	77	49	32	57
42174	206	657	516	257	118	48	33	68
33655	596	484	298	202	50	13	6	11
24262	519	579	640	120	47	18	4	5
33360	650	1051	359	401	40	24	10	7
-9	-9	-9	-9	-9	-9	-9	-9	-9
-9	500	1295	274	319	89	93	12	9
-9	1076	1140	1206	113	73	47	13	3
-9	813	968	155	210	43	61	30	17
-9	385	938	722	250	134	31	21	12
-9	23	456	361	656	279	116	45	5

SCOGFS_IV

1982	2005		
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	
1	1770	6360	
1	380	3360	
1	820	13110	

Table 6.2.4. (Cont'd). 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.

ENGGFS_IV						
1977	2004					
1	1	0.5	0.75			
2	3					
1	104.54	484.92				
1	72.39	57.36				
1	2.79	104.99				
1	18.6	179.6				
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	786.6				
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				
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				
1	-9.00	-9.00				
NORACU						
1995	2004					
1	1	0.5	0.75			
2	7					
1	6566	**56244**	**4756**	**1214**	**174**	161
1	1303	**21480**	**29698**	**6125**	**4593**	1821
1	5421	**22585**	**16188**	**24939**	**3002**	2472
1	2428	**15180**	**48295**	**13540**	**11194**	1173
1	3751	**16933**	**21109**	**27036**	**4399**	3590
1	4618	**34551**	**82338**	**14213**	**13842**	3018
1	16118	**72108**	**28764**	**17405**	**3870**	1091
1	1397	**82501**	**163524**	**17479**	**4475**	2437
1	596	**67774**	**107730**	**41675**	**4581**	3420
1	0	**34153**	**43811**	**31636**	**6413**	238
IBTSq3						
1991	2004					
1	1	0.5	0.75			
1	6					
1	0.761	0.605	**1.946**	**0.402**	**0.064**	**0.122**
1	0.763	0.27	**1.077**	**2.76**	**0.516**	**0.277**
1	0.093	1.753	**7.977**	**2.769**	**1.129**	**0.378**
1	0	0.69	**1.117**	**1.615**	**0.893**	**0.822**
1	0.818	0.58	**13.959**	**2.501**	**1.559**	**0.814**
1	0.287	2.151	**3.825**	**6.533**	**1.112**	**1.335**
1	0.147	0.51	**3.757**	**3.351**	**7.461**	**1.534**
1	0.014	0.148	**1.892**	**3.921**	**1.333**	**1.912**
1	0.989	0.337	**2.1**	**2.019**	**2.949**	**1.37**
1	0.012	0.556	**3.479**	**8.836**	**1.081**	**1.196**
1	0.675	3.322	**21.496**	**6.173**	**3.937**	**1.15**
1	0.168	1.089	**10.748**	**18.974**	**1.327**	**1.738**
1	0.252	1.841	**19.272**	**23.802**	**13.402**	**1.266**
1	0.288	0.379	**3.601**	**4.975**	**2.611**	**1.09**

Table 6.4.1. Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

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Lowestoft VPA Version 3.1

   7/09/2005  14:29

 Extended Survivors Analysis

 SAITHE IN IV, VI and IIIa : 1967 - 2004

 CPUE data from file c:\wgnssk05\assessment\final.tun

 Catch data for  38 years. 1967 to 2004. Ages  3 to  10.

 Fleet,        First, Last, First, Last, Alpha,  Beta
                year, year,  age ,  age
 FRATRB_IV       1990, 2004,   3,     9,   .000,  1.000
 NORTRL_IV       1980, 2004,   3,     9,   .000,  1.000
 GER_OTB_IV      1995, 2004,   3,     9,   .000,  1.000
 NORACU,        1995, 2004,   3,     6,   .500,   .750
 IBTSq3         1991, 2004,   3,     6,   .500,   .750


 Time series weights :

      Tapered time weighting applied
      Power =    3 over  20 years


 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    7


 Terminal population estimation :

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

      S.E. of the mean to which the estimates  are shrunk =   1.000

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

      Prior weighting not applied


 Tuning converged after   39 iterations

1


 Regression weights
       ,  .751,  .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000




Fishing mortalities
    Age,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004

      3,  .141,  .118,  .107,  .172,  .076,  .092,  .095,  .162,  .111,  .075
      4,  .567,  .314,  .310,  .334,  .368,  .194,  .372,  .360,  .244,  .204
      5,  .576,  .549,  .431,  .473,  .538,  .431,  .440,  .310,  .382,  .351
      6,  .403,  .688,  .326,  .432,  .476,  .515,  .310,  .299,  .370,  .351
      7,  .956,  .711,  .532,  .337,  .533,  .329,  .268,  .355,  .407,  .405
      8,  .540,  .601,  .519,  .498,  .724,  .322,  .240,  .375,  .389,  .440
      9, 1.218,  .318,  .451,  .626,  .873,  .438,  .176,  .558,  .470,  .561


1
```

Table 6.4.1. cont. Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

XSA population numbers (Thousands)

YEAR	AGE 3	4	5	6	7	8	9
1995	2.24E+05	6.64E+04	3.73E+04	1.26E+04	6.27E+03	1.79E+03	8.66E+02
1996	1.10E+05	1.59E+05	3.08E+04	1.72E+04	6.87E+03	1.98E+03	8.52E+02
1997	1.64E+05	7.99E+04	9.53E+04	1.46E+04	7.07E+03	2.76E+03	8.86E+02
1998	7.23E+04	1.21E+05	4.80E+04	5.07E+04	8.61E+03	3.40E+03	1.35E+03
1999	1.43E+05	4.98E+04	7.08E+04	2.45E+04	2.69E+04	5.03E+03	1.69E+03
2000	8.85E+04	1.08E+05	2.82E+04	3.39E+04	1.25E+04	1.30E+04	2.00E+03
2001	2.11E+05	6.61E+04	7.30E+04	1.50E+04	1.66E+04	7.34E+03	7.68E+03
2002	1.48E+05	1.57E+05	3.73E+04	3.85E+04	9.03E+03	1.04E+04	4.72E+03
2003	1.22E+05	1.03E+05	8.97E+04	2.24E+04	2.34E+04	5.18E+03	5.84E+03
2004	8.11E+04	8.97E+04	6.61E+04	5.01E+04	1.27E+04	1.27E+04	2.88E+03

Estimated population abundance at 1st Jan 2005

0.00E+00	6.16E+04	5.99E+04	3.81E+04	2.89E+04	6.92E+03	6.71E+03

Taper weighted geometric mean of the VPA populations:

1.24E+05	8.74E+04	4.55E+04	2.05E+04	9.26E+03	4.28E+03	1.85E+03

Standard error of the weighted Log(VPA populations) :

.3535	.3811	.5118	.6229	.6500	.7649	.8122

Log catchability residuals.

Fleet : FRATRB_IV

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
3	99.99	99.99	99.99	99.99	99.99	.52	-.17	.14	.84	.33
4	99.99	99.99	99.99	99.99	99.99	.25	.32	.27	.23	.32
5	99.99	99.99	99.99	99.99	99.99	.00	-.01	.13	.11	.18
6	99.99	99.99	99.99	99.99	99.99	-.29	.31	-.37	-.50	.28
7	99.99	99.99	99.99	99.99	99.99	.88	.59	-.51	-1.67	-.24
8	99.99	99.99	99.99	99.99	99.99	-.18	.64	-1.00	-1.21	-1.46
9	99.99	99.99	99.99	99.99	99.99	.15	-.03	-.32	-.73	-1.26

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	.07	-.59	-.57	-.08	-.81	.23	-.53	.82	.26	.13
4	-.22	-.37	-.26	-.43	-.32	-.18	.31	.62	.18	-.20
5	-.50	-.29	-.14	-.01	-.09	.35	.55	-.06	-.20	-.04
6	-.43	.14	-.66	.14	-.05	.81	.36	.39	-.54	-.03
7	-.08	.05	-.08	-.89	.02	.60	.20	.49	.23	.28
8	-.07	-.23	-.77	-.70	-1.02	.38	-.73	.22	.33	-.66
9	.34	.00	.15	-.52	-.44	.56	-.67	-.22	.58	.29

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	-13.7615	-12.6916	-12.4285	-12.8901	-13.4760	-13.4760	-13.4760
S.E(Log q)	.5185	.3424	.2708	.4439	.5827	.7621	.5477

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	1.38	-.588	14.53	.20	15	.74	-13.76
4	.98	.056	12.67	.56	15	.35	-12.69
5	1.05	-.274	12.51	.77	15	.30	-12.43
6	.77	1.449	12.21	.80	15	.33	-12.89
7	.72	1.452	12.28	.74	15	.40	-13.48
8	.78	1.158	12.69	.74	15	.47	-13.90
9	.93	.352	13.18	.73	15	.52	-13.59

Table 6.4.1. cont. Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

Fleet : NORTRL_IV

Age	1980	1981	1982	1983	1984
3	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99
6	99.99	99.99	99.99	99.99	99.99
7	99.99	99.99	99.99	99.99	99.99
8	99.99	99.99	99.99	99.99	99.99
9	99.99	99.99	99.99	99.99	99.99

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
3	1.00	-.59	.37	1.01	-.14	.23	1.93	.59	1.30	.77
4	.72	.98	.63	-.13	-.01	-.09	.42	.68	.27	1.10
5	-.18	-.25	-.10	-.43	-.66	.11	-.38	.50	.20	.34
6	-.72	-.97	-1.10	-1.37	-.35	.34	-.65	.16	.53	-.37
7	-1.35	-1.44	-.91	-.58	.07	-.14	-1.02	-.48	.47	-.54
8	-2.38	-2.19	-.73	-.72	.37	-.19	-1.69	-.78	.52	-1.02
9	-1.97	-2.33	-.36	.17	.17	-.72	-.53	-.30	.96	.89

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	-.02	.33	-.23	.26	-.85	-1.10	.53	.20	-.69	-.89
4	.76	-.02	-.22	.21	.10	-.91	.50	-.06	-.63	-.98
5	.25	.01	-.26	.24	.27	.23	.13	-.42	-.30	-.37
6	-.58	.21	-.33	.24	.27	.85	-.24	-.34	.07	.08
7	.85	.08	-.16	.03	.45	.20	-.25	-.41	.08	.24
8	.14	-.52	-.32	.34	1.09	.28	-.34	-.03	-.15	.42
9	.85	-2.27	-.63	.63	1.02	.51	-.68	.40	.01	.57

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	-14.1495	-12.7469	-12.2064	-12.2360	-12.0595	-12.0595	-12.0595
S.E(Log q)	.7819	.6114	.3125	.4450	.4334	.6329	.9100

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	.64	.824	13.28	.35	20	.51	-14.15
4	1.83	-.938	13.89	.11	20	1.13	-12.75
5	1.22	-.987	12.53	.66	20	.38	-12.21
6	.82	1.020	11.82	.76	20	.36	-12.24
7	.83	.991	11.57	.78	20	.36	-12.06
8	.74	1.455	11.15	.76	20	.45	-12.11
9	.93	.219	11.65	.48	20	.88	-11.96

Fleet : GER_OTB_IV

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	-.14	-.16	-.22	.38	-1.00	.55	.29	.21	-.02	.03
4	.29	-.29	.02	-.21	-.17	.11	.29	.28	-.44	.12
5	-.11	-.05	-.15	-.32	-.12	.16	.35	.18	-.03	.01
6	.20	-.02	-.71	-.03	.16	.53	.17	.16	-.32	-.17
7	-.01	.42	-.27	-.10	.38	.05	.63	-.56	-.24	-.24
8	-.55	1.07	-.18	.04	-.44	.30	.67	-.34	-.65	-.07
9	-.18	.50	-.14	.08	-.05	.07	.12	-.18	-.52	-.14

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	-14.9154	-13.2331	-12.8066	-12.9320	-13.1450	-13.1450	-13.1450
S.E(Log q)	.4376	.2664	.1975	.3404	.3764	.5454	.2687

Table 6.4.1. 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,	1.54,	-.877,	16.63,	.26,	10,	.68,	-14.92,
4,	1.13,	-.446,	13.46,	.62,	10,	.32,	-13.23,
5,	1.06,	-.341,	12.92,	.82,	10,	.22,	-12.81,
6,	.89,	.515,	12.63,	.75,	10,	.32,	-12.93,
7,	.83,	.784,	12.50,	.74,	10,	.32,	-13.14,
8,	1.03,	-.088,	13.28,	.63,	10,	.60,	-13.17,
9,	1.15,	-1.173,	14.00,	.90,	10,	.30,	-13.20,

Fleet : NORACU

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	-.12,	-.38,	-.74,	-.27,	-.90,	.30,	.17,	.70,	.66,	.36
4	-1.61,	-.81,	-.73,	-.03,	.05,	.52,	.08,	.94,	.87,	.09
5	-2.10,	-.31,	-.11,	-.01,	.34,	.55,	-.20,	.40,	.44,	.45
6	-2.49,	.65,	.17,	.30,	.12,	.97,	.38,	-.42,	.19,	-.29
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

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

Age ,	3,	4,	5,	6
Mean Log q,	-1.0538,	-.5521,	-.8386,	-1.4179,
S.E(Log q),	.5614,	.7666,	.7283,	.8834,

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,	1.23,	-.346,	-1.38,	.24,	10,	.73,	-1.05,
4,	.62,	.868,	4.71,	.42,	10,	.48,	-.55,
5,	.76,	.530,	3.24,	.40,	10,	.58,	-.84,
6,	.71,	.653,	3.92,	.42,	10,	.65,	-1.42,

Fleet : IBTSq3

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
3	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.82,	-1.15,	.41,	-1.22
4	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-1.86,	-.12,	-.08,	-.92
5	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-2.35,	-.33,	.06,	-.21
6	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-1.35,	-.22,	.15,	.32
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	.47,	-.13,	-.55,	-.38,	-1.01,	-.02,	.93,	.64,	1.38,	.09
4	-.24,	-.32,	-.30,	-.54,	-.29,	.30,	.54,	.79,	1.37,	-.08
5	.07,	-.09,	.61,	-.40,	.04,	-.11,	.24,	-.26,	1.23,	-.12
6	.25,	.61,	.69,	-.27,	.15,	-.29,	.36,	-.17,	.09,	-.87
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

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

Age ,	3,	4,	5,	6
Mean Log q,	-9.9395,	-9.4650,	-9.6705,	-9.5202,
S.E(Log q),	.8036,	.7164,	.6451,	.5063,

Table 6.4.1. cont. Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

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 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,     .57,    1.112,     10.72,     .41,     14,     .45,   -9.94,
  4,     .64,     .910,     10.16,     .41,     14,     .46,   -9.47,
  5,     .53,    3.027,     10.18,     .82,     14,     .26,   -9.67,
  6,    1.55,   -1.496,      9.28,     .44,     14,     .74,   -9.52,

 Terminal year survivor and F summaries :

 Age  3   Catchability constant w.r.t. time and dependent on age
 Year class = 2001

 Fleet,                Estimated,  Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                Survivors,  s.e,       s.e,   Ratio,    , Weights,    F
 FRATRB_IV              70328.,   .540,       .000,    .00,   1,  .228,     .066
 NORTRL_IV              25215.,   .814,       .000,    .00,   1,  .101,     .175
 GER_OTB_IV             63583.,   .461,       .000,    .00,   1,  .314,     .073
 NORACU                 88349.,   .591,       .000,    .00,   1,  .191,     .053
 IBTSq3                67327.,   .838,       .000,    .00,   1,  .095,     .069

 F shrinkage mean  ,   42257.,   1.00,,,,                      .072,     .108

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     61630.,       .26,      .16,    6,    .602,   .075

1
 Age  4   Catchability constant w.r.t. time and dependent on age
 Year class = 2000

 Fleet,               Estimated,  Int,       Ext,    Var,    N, Scaled,  Estimated
      ,               Survivors,  s.e,       s.e,   Ratio,    , Weights,    F
 FRATRB_IV             55968.,   .298,       .204,    .69,   2,  .284,     .217
 NORTRL_IV             24921.,   .502,       .139,    .28,   2,  .099,     .434
 GER_OTB_IV            64922.,   .252,       .062,    .25,   2,  .399,     .190
 NORACU                93282.,   .477,       .275,    .58,   2,  .107,     .136
 IBTSq3               101103.,   .559,       .719,   1.29,   2,  .080,     .126

F shrinkage mean  ,   37399.,   1.00,,,,                      .032,     .309

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     59873.,       .16,      .14,   11,    .878,   .204


 Age  5   Catchability constant w.r.t. time and dependent on age

 Year class = 1999

 Fleet,               Estimated,  Int,       Ext,    Var,    N, Scaled,  Estimated
      ,               Survivors,  s.e,       s.e,   Ratio,    , Weights,    F
 FRATRB_IV             43329.,   .214,       .191,    .89,   3,  .298,     .314
 NORTRL_IV             26464.,   .275,       .136,    .49,   3,  .189,     .473
 GER_OTB_IV            33327.,   .195,       .175,    .90,   3,  .349,     .392
 NORACU                73070.,   .411,       .119,    .29,   3,  .073,     .198
 IBTSq3                62337.,   .435,       .461,   1.06,   3,  .069,     .229

F shrinkage mean  ,   30394.,   1.00,,,,                      .022,     .423

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     38087.,       .12,      .11,   16,    .902,   .351
```

Table 6.4.1. cont. Saithe in Sub-Areas IV and VI and Division IIIa. XSA diagnostics.

```
1
 Age  6   Catchability constant w.r.t. time and dependent on age
 Year class = 1998

 Fleet,               Estimated,  Int,       Ext,    Var,    N, Scaled,  Estimated
      ,               Survivors,  s.e,       s.e,   Ratio,    , Weights,    F
 FRATRB_IV              28744.,   .201,      .202,   1.01,   4,  .267,     .352
 NORTRL_IV              26213.,   .243,      .130,    .54,   4,  .198,     .380
 GER_OTB_IV             29562.,   .178,      .109,    .61,   4,  .347,     .344
 NORACU                 36965.,   .393,      .240,    .61,   4,  .065,     .284
 IBTSq3                 28717.,   .351,      .555,   1.58,   4,  .100,     .352

F shrinkage mean  ,   24921.,   1.00,,,,                         .022,     .397

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     28881.,       .11,      .09,   21,    .853,   .351


 Age  7   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
 FRATRB_IV              6823.,   .196,      .156,    .79,   5,  .249,     .410
 NORTRL_IV              6594.,   .222,      .183,    .82,   5,  .232,     .421
 GER_OTB_IV             6827.,   .169,      .144,    .85,   5,  .369,     .410
 NORACU                 8952.,   .392,      .066,    .17,   4,  .050,     .326
 IBTSq3                 7338.,   .349,      .137,    .39,   4,  .076,     .386

F shrinkage mean  ,   7460.,   1.00,,,,                         .024,     .381

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      6916.,       .10,      .06,   24,    .623,   .405

 Age  8   Catchability constant w.r.t. time and age (fixed at the value for age)  7
 Year class = 1996

 Fleet,               Estimated,  Int,       Ext,    Var,    N, Scaled,  Estimated
      ,               Survivors,  s.e,       s.e,   Ratio,    , Weights,    F
 FRATRB_IV              7389.,   .200,      .211,   1.05,   6,  .243,     .407
 NORTRL_IV              6683.,   .221,      .160,    .72,   6,  .240,     .442
 GER_OTB_IV             6653.,   .169,      .144,    .85,   6,  .376,     .443
 NORACU                 4766.,   .391,      .283,    .72,   4,  .044,     .576
 IBTSq3                 6051.,   .350,      .212,    .61,   4,  .066,     .478

F shrinkage mean  ,   7264.,   1.00,,,,                         .031,     .413

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      6710.,       .11,      .08,   27,    .726,   .440

 Age  9   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
 FRATRB_IV              1746.,   .216,      .092,    .42,   7,  .226,     .457
 NORTRL_IV              1292.,   .226,      .134,    .59,   7,  .188,     .578
 GER_OTB_IV             1144.,   .168,      .110,    .65,   7,  .479,     .634
 NORACU                 1642.,   .409,      .187,    .46,   4,  .028,     .480
 IBTSq3                 1507.,   .359,      .169,    .47,   4,  .044,     .514
F shrinkage mean  ,    2047.,   1.00,,,,                         .036,     .402

 Weighted prediction :
 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1344.,       .11,      .06,   30,    .552,   .561
```

Table 6.4.2. Saithe in Sub-Areas IV and VI and Division IIIa. Fishing mortality (F) at age.

Fishing mortality (F) at age

YEAR	1967	1968	1969	1970	1971	1972	1973	1974
AGE								
3	0.1628	0.2548	0.1178	0.1521	0.2682	0.3711	0.499	0.6879
4	0.2632	0.3074	0.3145	0.4897	0.3728	0.4397	0.5628	0.6748
5	0.3781	0.3551	0.2599	0.4828	0.3998	0.2768	0.3202	0.4242
6	0.4836	0.2455	0.3574	0.507	0.2735	0.4925	0.2838	0.4388
7	0.4161	0.1524	0.3913	0.3127	0.3319	0.3538	0.3695	0.4556
8	0.2603	0.1004	0.4639	0.2016	0.3965	0.4054	0.3317	0.4106
9	0.3893	0.1668	0.407	0.3426	0.336	0.4201	0.3303	0.4381
+gp	0.3893	0.1668	0.407	0.3426	0.336	0.4201	0.3303	0.4381
F(3- 6)	0.3219	0.2907	0.2624	0.4079	0.3286	0.395	0.4164	0.5564

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	0.427	0.9113	0.2974	0.5434	0.2649	0.3406	0.1838	0.3881	0.3074	0.5737
4	0.6293	0.9306	0.655	0.5448	0.4424	0.3284	0.2695	0.4813	0.4686	0.6946
5	0.4463	0.6616	0.7376	0.4641	0.4506	0.5638	0.3002	0.5372	0.6616	0.6147
6	0.4243	0.5384	0.7715	0.3553	0.4267	0.5408	0.4735	0.477	0.7714	0.8508
7	0.5873	0.4144	0.7469	0.3487	0.5823	0.5497	0.5709	0.5649	0.9444	0.5351
8	0.5974	0.4832	0.7843	0.4635	0.398	0.5034	0.7701	0.5277	1.0385	0.6751
9	0.5407	0.4823	0.7753	0.3918	0.4725	0.5356	0.6101	0.5274	0.9281	0.6935
+gp	0.5407	0.4823	0.7753	0.3918	0.4725	0.5356	0.6101	0.5274	0.9281	0.6935
F(3- 6)	0.4817	0.7605	0.6154	0.4769	0.3962	0.4434	0.3067	0.4709	0.5522	0.6834

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	0.647	0.2406	0.3686	0.3784	0.3797	0.4717	0.4589	0.2473	0.3222	0.2404
4	1.0502	1.4122	0.8776	0.617	0.7555	0.6917	0.7741	0.7307	0.4907	0.6801
5	0.7045	0.9673	0.8714	0.9727	0.7349	0.7085	0.6243	0.9401	0.6225	0.662
6	0.4803	0.7056	0.5348	0.6247	0.9754	0.6421	0.5083	0.6029	0.6291	0.4822
7	0.4754	0.53	0.547	0.738	0.5639	0.7164	0.5117	0.4218	0.6858	0.392
8	0.4394	0.4467	0.5221	0.7809	0.7267	0.5846	0.5784	0.4017	1.009	0.3085
9	0.47	0.5806	0.562	0.7427	0.7953	0.6858	0.6491	0.7336	1.2264	0.9205
+gp	0.47	0.5806	0.562	0.7427	0.7953	0.6858	0.6491	0.7336	1.2264	0.9205
F(3- 6)	0.7205	0.8314	0.6631	0.6482	0.7114	0.6285	0.5914	0.6303	0.5161	0.5162

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	FBAR 67-04	FBAR 00-04
AGE												
3	0.141	0.118	0.1067	0.1724	0.0759	0.0923	0.0954	0.1623	0.1112	0.0751	0.3067	0.1073
4	0.5675	0.3142	0.3103	0.3337	0.3677	0.1943	0.3717	0.3599	0.2443	0.2042	0.532	0.2749
5	0.5763	0.5488	0.431	0.4731	0.5383	0.4305	0.44	0.3102	0.382	0.3509	0.5427	0.3827
6	0.4035	0.688	0.3265	0.4317	0.476	0.5154	0.3096	0.2992	0.37	0.3508	0.5018	0.369
7	0.9558	0.7108	0.5324	0.3372	0.5327	0.329	0.2676	0.3548	0.4067	0.4053	0.5011	0.3527
8	0.5402	0.6013	0.5189	0.4979	0.7236	0.322	0.2402	0.3751	0.3891	0.4404	0.5068	0.3534
9	1.2178	0.3176	0.4513	0.626	0.8729	0.4376	0.1758	0.5581	0.4696	0.5612	0.5748	0.4404
+gp	1.2178	0.3176	0.4513	0.626	0.8729	0.4376	0.1758	0.5581	0.4696	0.5612		
F(3- 6)	0.4221	0.4172	0.2936	0.3527	0.3645	0.3081	0.3042	0.2829	0.2769	0.2453		

Table 6.4.3. 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	1974
AGE								
3	127455	114114	300687	291832	327927	171369	152849	148736
4	77470	88671	72415	218823	205228	205318	96805	75981
5	54512	48750	53387	43290	109791	115734	108295	45147
6	6638	30578	27984	33705	21871	60267	71847	64370
7	5177	3351	19585	16026	16621	13621	30154	44290
8	1407	2796	2356	10843	9597	9764	7829	17062
9	680	888	2070	1213	7256	5285	5330	4601
+gp	621	1041	490	1008	2974	5132	9287	6037
TOTAL	273960	290187	478974	616741	701266	586492	482397	406224

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	181231	384086	117982	92422	77554	66982	172338	109584	117943	204893
4	61206	96815	126417	71748	43946	48718	39011	117412	60860	71009
5	31679	26709	31255	53765	34067	23117	28721	24395	59404	31185
6	24184	16600	11284	12238	27676	17774	10770	17416	11671	25098
7	33983	12954	7933	4271	7023	14788	8473	5492	8850	4418
8	22992	15465	7008	3077	2468	3212	6988	3920	2556	2818
9	9265	10358	7810	2619	1585	1357	1590	2649	1893	741
+gp	7036	9983	9494	11780	6071	6070	6066	3347	2385	1409
TOTAL	371576	572969	319182	251921	200391	182019	273956	284214	265562	341571

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	310915	286475	111923	114291	77401	119926	138486	92834	151753	103207
4	94521	133286	184386	63386	64096	43348	61263	71654	59354	90021
5	29027	27074	26583	62768	28002	24652	17771	23129	28251	29749
6	13808	11748	8425	9105	19428	10994	9938	7793	7397	12412
7	8776	6993	4750	4041	3992	5998	4736	4894	3492	3228
8	2118	4467	3370	2250	1582	1859	2399	2325	2628	1440
9	1175	1118	2339	1637	844	626	848	1101	1274	784
+gp	2165	2232	1779	1414	969	800	1047	885	1570	1434
TOTAL	462505	473393	343556	258892	196312	208203	236489	204615	255718	242277

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	GMST 67-02	GMST 85-02
AGE													
3	224029	109869	164177	72309	142603	88530	210861	148027	122436	81147	0	145443	135753
4	66440	159293	79940	120812	49825	108222	66090	156935	103038	89691	61630	85906	85105
5	37335	30840	95256	47987	70848	28241	72956	37312	89656	66075	59873	40057	35720
6	12563	17178	14585	50684	24479	33861	15033	38470	22402	50096	38087	18247	14981
7	6274	6871	7069	8615	26949	12451	16558	9030	23352	12668	28881	8606	6802
8	1786	1975	2764	3398	5035	12952	7336	10373	5185	12730	6916	4095	3108
9	866	852	886	1347	1691	1999	7685	4724	5836	2877	6710	1893	1364
+gp	1229	1980	870	650	1228	1364	1487	4059	3034	2052	2302		
T	350522	328859	365547	305802	322657	287621	398005	408930	374939	317336	204399		

Table 6.4.4. 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 3	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 6
1967	127455	395633	150837	88326	0.5856	0.3219
1968	114114	520412	211722	113751	0.5373	0.2907
1969	300687	694137	263958	130588	0.4947	0.2624
1970	291832	890598	312004	234962	0.7531	0.4079
1971	327927	1018291	429563	265381	0.6178	0.3286
1972	171369	903640	474084	261877	0.5524	0.395
1973	152849	847469	534471	242499	0.4537	0.4164
1974	148736	833709	554884	298351	0.5377	0.5564
1975	181231	743399	472038	271584	0.5753	0.4817
1976	384086	752208	351496	343967	0.9786	0.7605
1977	117982	509337	263077	216395	0.8226	0.6154
1978	92422	463665	267996	155141	0.5789	0.4769
1979	77554	418845	240920	128360	0.5328	0.3962
1980	66982	396254	234933	131908	0.5615	0.4434
1981	172338	494015	240779	132278	0.5494	0.3067
1982	109584	510009	209765	174351	0.8312	0.4709
1983	117943	465128	213100	180044	0.8449	0.5522
1984	204893	463463	174959	200834	1.1479	0.6834
1985	310915	487123	158457	220869	1.3939	0.7205
1986	286475	482493	148858	198596	1.3341	0.8314
1987	111923	378982	149082	167514	1.1236	0.6631
1988	114291	314239	143749	135172	0.9403	0.6482
1989	77401	251453	109884	108877	0.9908	0.7114
1990	119926	255948	96487	103800	1.0758	0.6285
1991	138486	274000	92427	108048	1.169	0.5914
1992	92834	269558	94726	99742	1.053	0.6303
1993	151753	319218	102335	111491	1.0895	0.5161
1994	103207	311616	111283	109622	0.9851	0.5162
1995	224029	455528	134392	121810	0.9064	0.4221
1996	109869	443117	155345	114997	0.7403	0.4172
1997	164177	466913	195322	107327	0.5495	0.2936
1998	72309	386425	193860	106123	0.5474	0.3527
1999	142603	404239	203681	110716	0.5436	0.3645
2000	88530	405335	192003	91322	0.4756	0.3081
2001	210861	474247	214628	95141	0.4433	0.3042
2002	148027	457369	202496	115981	0.5728	0.2829
2003	122436	425443	221113	105569	0.4774	0.2769
2004	81147	419147	237740	104237	0.4385	0.2453
2005	123801*		244000			
Arith. Mean	158715	500069	230486	158094	0.758	0.4708
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

*GM 1988-2002

Table 6.7.1. Saithe in Sub-Areas IV and VI and Divisions IIIa. Input data for catch forecast and linear sensitivity analysis.

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N3	123801	0.34	WS3	0.80	0.10
N4	61629	0.26	WS4	0.94	0.08
N5	59872	0.16	WS5	1.22	0.10
N6	38086	0.12	WS6	1.67	0.05
N7	28880	0.11	WS7	2.34	0.05
N8	6916	0.10	WS8	3.19	0.04
N9	6710	0.11	WS9	4.00	0.07
N10	2301	0.11	WS10	4.54	0.20
H.cons selectivity			Weight in the HC catch		
sH3	0.12	0.32	WH3	0.80	0.10
sH4	0.27	0.24	WH4	0.94	0.08
sH5	0.35	0.14	WH5	1.22	0.10
sH6	0.34	0.15	WH6	1.67	0.05
sH7	0.39	0.14	WH7	2.34	0.05
sH8	0.40	0.17	WH8	3.19	0.04
sH9	0.53	0.15	WH9	4.00	0.07
sH10	0.53	0.15	WH10	4.54	0.20
Natural mortality			Proportion mature		
M3	0.20	0.10	MT3	0.00	0.10
M4	0.20	0.10	MT4	0.15	0.10
M5	0.20	0.10	MT5	0.70	0.10
M6	0.20	0.10	MT6	0.90	0.10
M7	0.20	0.10	MT7	1.00	0.10
M8	0.20	0.10	MT8	1.00	0.00
M9	0.20	0.10	MT9	1.00	0.00
M10	0.20	0.10	MT10	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF05	1.00	0.08	K05	1.00	0.10
HF06	1.00	0.08	K06	1.00	0.10
HF07	1.00	0.08	K07	1.00	0.10
Recruitment in 2006 and 2007					
R06	123801	0.34			
R07	123801	0.34			

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

Stock numbers in 2005 are VPA survivors.

Table 6.7.2. Saithe in Sub-Areas IV and VI and Division IIIa. Management option table.

	Year 2005	2006										
Mean F Ages			$F_{0.1}$	F_{max}			F_{med}			F_{high}	
H.cons 3 to 6	0.27	0.00	0.10	0.22	0.27	0.30	0.35	0.40	0.46	0.54	0.59
Effort relative to 2004											
H.cons	1.00	0.00	0.39	0.81	1.00	1.11	1.30	1.48	1.70	2.00	2.20
Biomass											
Total 1 January	420	427	427	427	427	427	427	427	427	427	427
SSB at spawning time	244	235	235	235	235	235	235	235	235	235	235
Catch weight (,000t)											
H.cons	99.1	0.0	42.9	83.2	99.7	108.7	123.7	137.0	152.2	171.4	183.2
Biomass in year.... 2007											
Total 1 January		544	495	448	429	419	402	387	369	348	334
SSB at spawning time		332	289	250	234	225	211	198	184	166	155

	Year 2005	2006									
Effort relative to 2004											
H.cons	1.00	0.00	0.39	0.81	1.00	1.11	1.30	1.48	1.70	2.00	2.20
Est. Coeff. of Variation											
Biomass											
Total 1 January	0.10	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
SSB at spawning time	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Catch weight											
H.cons	0.11	0.00	0.22	0.14	0.13	0.12	0.11	0.11	0.11	0.11	0.11
Biomass in year.... 2007											
Total 1 January		0.12	0.12	0.13	0.13	0.13	0.14	0.14	0,14	0.15	0.15
SSB at spawning time		0.11	0.11	0.12	0.12	0.12	0.12	0.13	0.13	0.13	0.14

Table 6.7.3. Saithe in Sub-Areas IV and VI and Division IIIa. Detailed forecast tables.

Forecast for year 2005
F multiplier H.cons=1.00

Age	Populations Stock No.	Catch number H.Cons	Catch number Total
3	123801	12313	12313
4	61629	13233	13233
5	59872	16041	16041
6	38086	10006	10006
7	28880	8490	8490
8	6916	2089	2089
9	6710	2524	2524
10	2301	866	866
Wt	420	99	99

Forecast for year 2006
F multiplier H.cons=1.00

Age	Populations Stock No.	Catch number H.Cons	Catch number Total
3	123801	12313	12313
4	90258	19381	19381
5	38557	10330	10330
6	34612	9093	9093
7	22195	6525	6525
8	16025	4840	4840
9	3788	1425	1425
10	4342	1633	1633
Wt	427	100	100

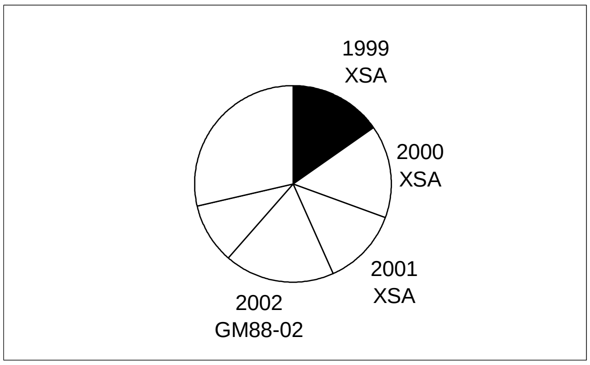
Table 6.7.4. Saithe in IV, IIIa, and VI. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

Saithe in Sub-Areas IV and VI and Division IIIa. : Year-class % contribution to

Year-class			1999	2000	2001	2002	2003
Stock No. (thousands) of 3 year-olds			148027	122436	81147	123801	123801
Source			XSA	XSA	XSA	GM88-02	GM88-02
Status Quo F:							
% in	2005	landings	16.9	19.7	12.5	9.9	-
% in	2006	landings	15.3	15.2	12.6	18.3	9.9
% in	2005	SSB	23.5	21.0	3.6	0.0	-
% in	2006	SSB	22.0	22.1	14.0	5.4	0.0
% in	2007	SSB	16.8	20.2	14.3	20.6	5.4

GM : geometric mean recruitment

a) 2006 landings



b) 2007 SSB

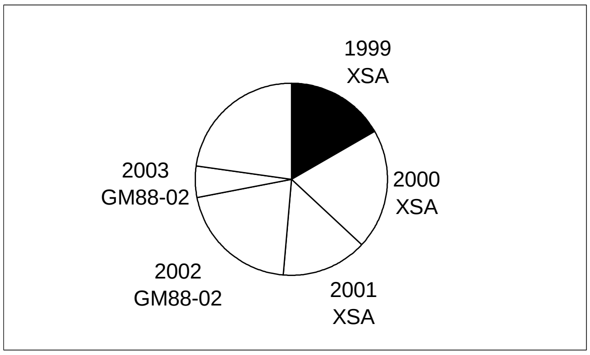


Figure 6.2.1. Saithe in IV, IIIa, and VI. Relative trends in effort and landings per unit effort for the commercial tuning fleets.

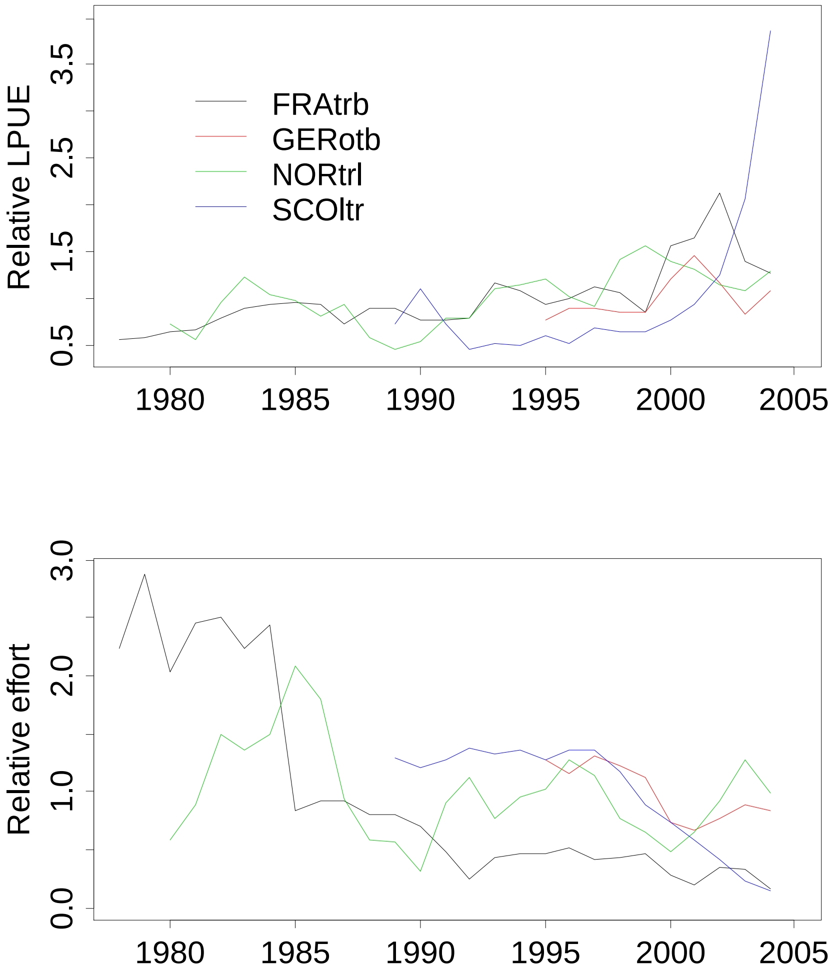


Figure 6.2.2. Saithe in IV, IIIa, and VI. Trends in mean weights at age.

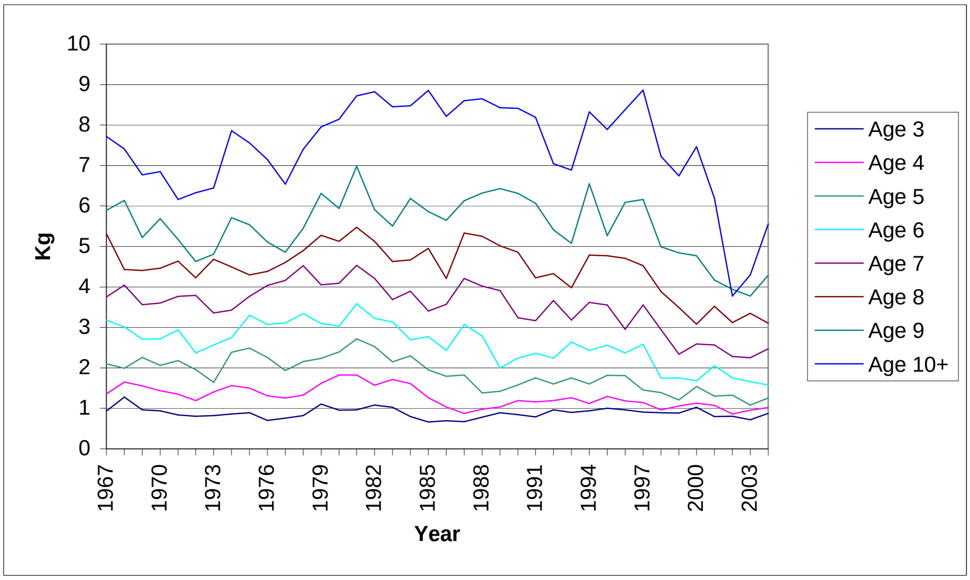


Figure 6.3.1. Saithe in IV, IIIa, and VI. Mean standardised commercial CPUE series.

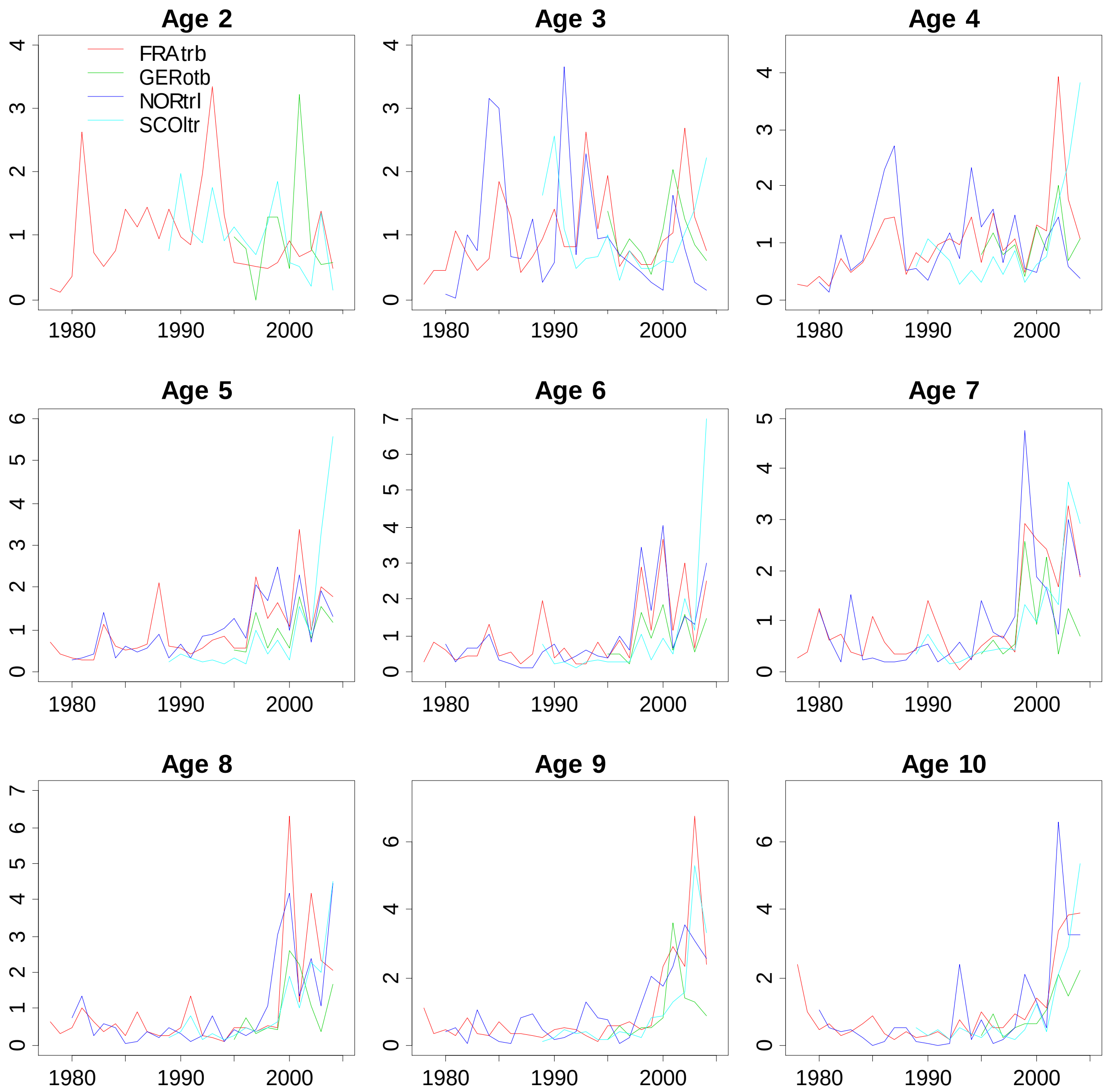


Figure 6.3.2. Saithe in IV, IIIa, and VI. Mean standardised survey indices.

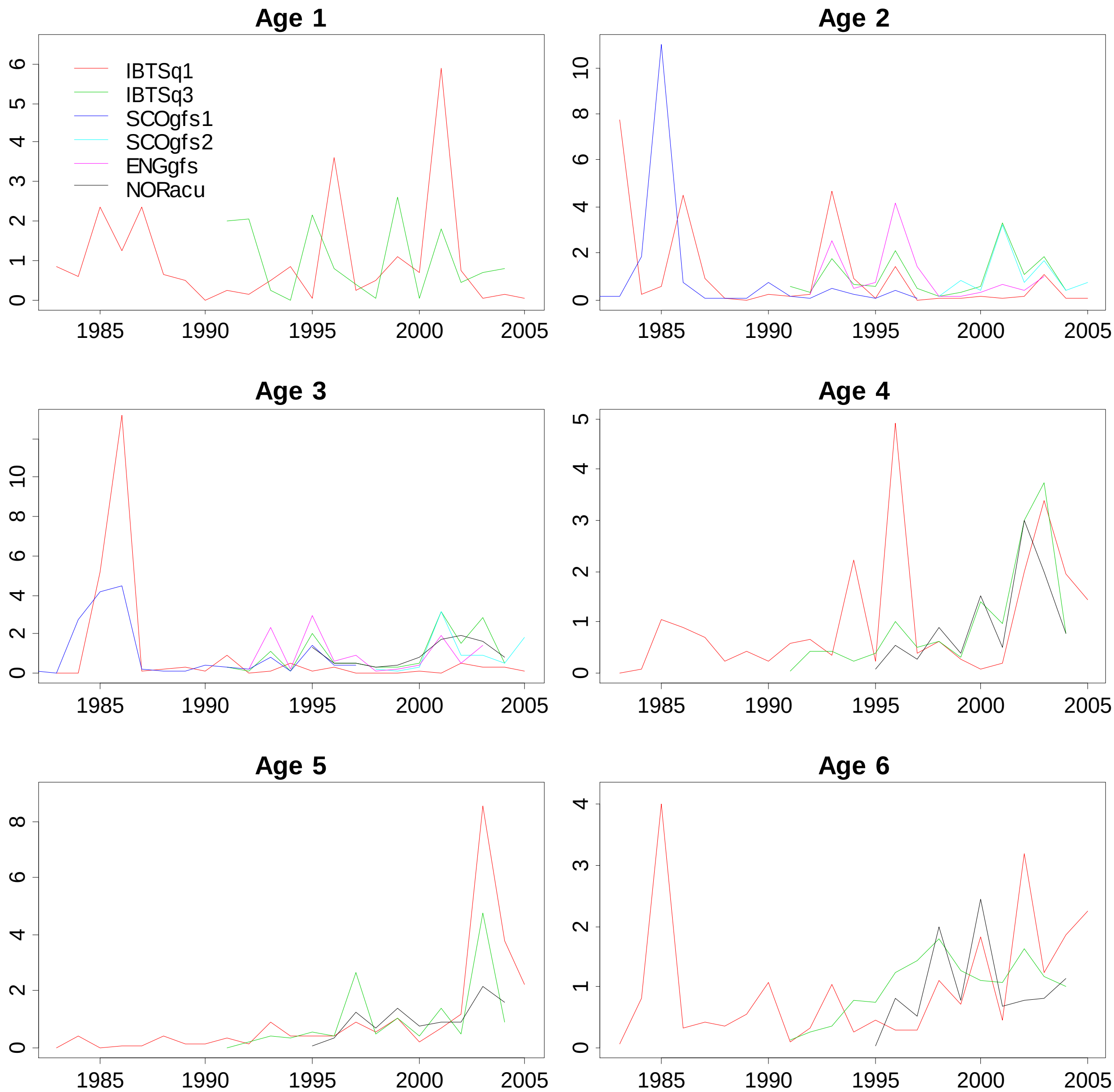


Figure 6.3.3. Saithe in IV, IIIa, and VI. Log CPUE by cohort.

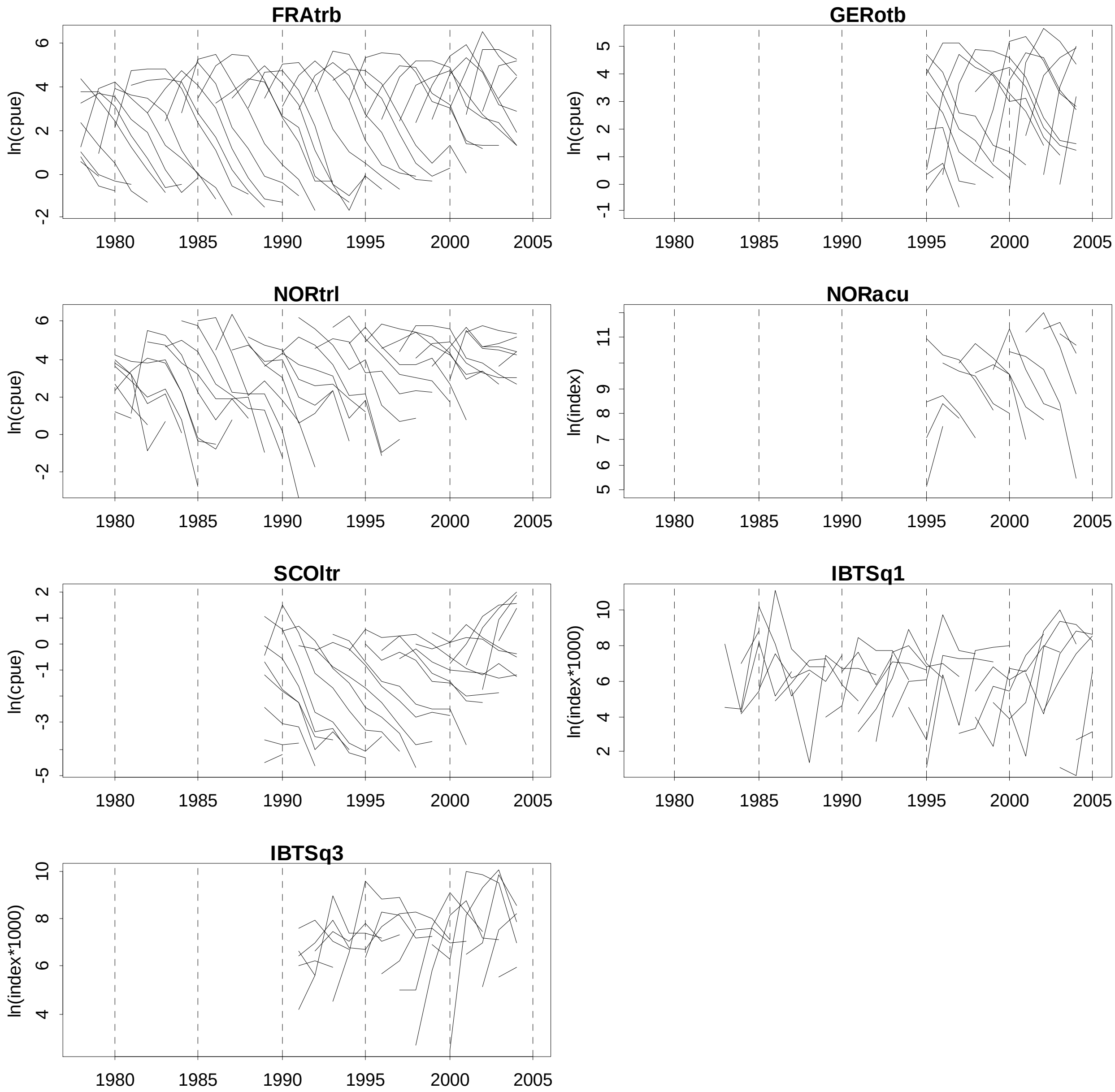


Fig. 6.3.4. Saithe in Sub-Areas IV and VI and division IIIa. Comparative scatterplots at age for FRAtrb.

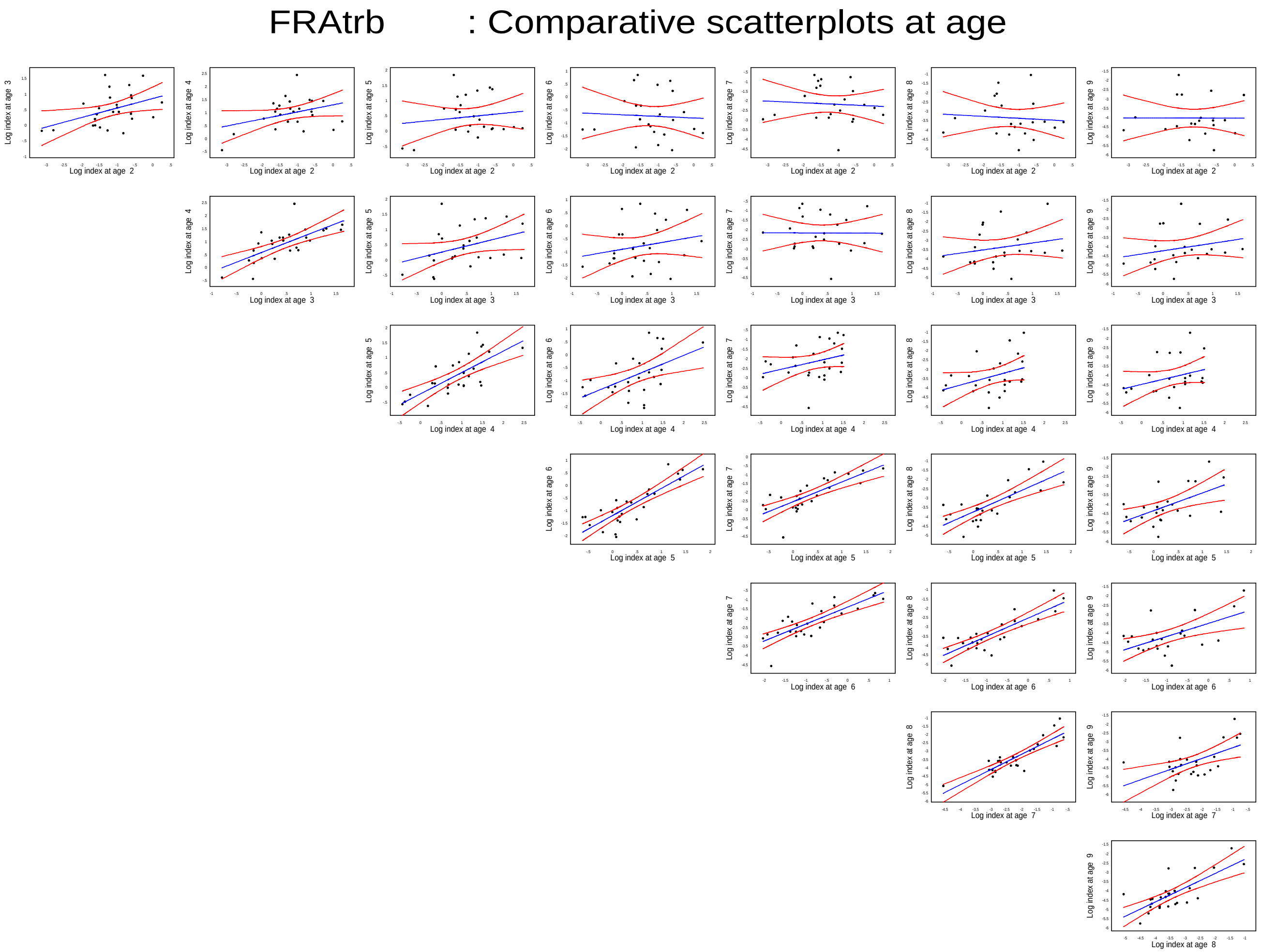


Fig. 6.3.4. Saithe in Sub-Areas IV and VI and division IIIa. Comparative scatterplots at age for GERotb.

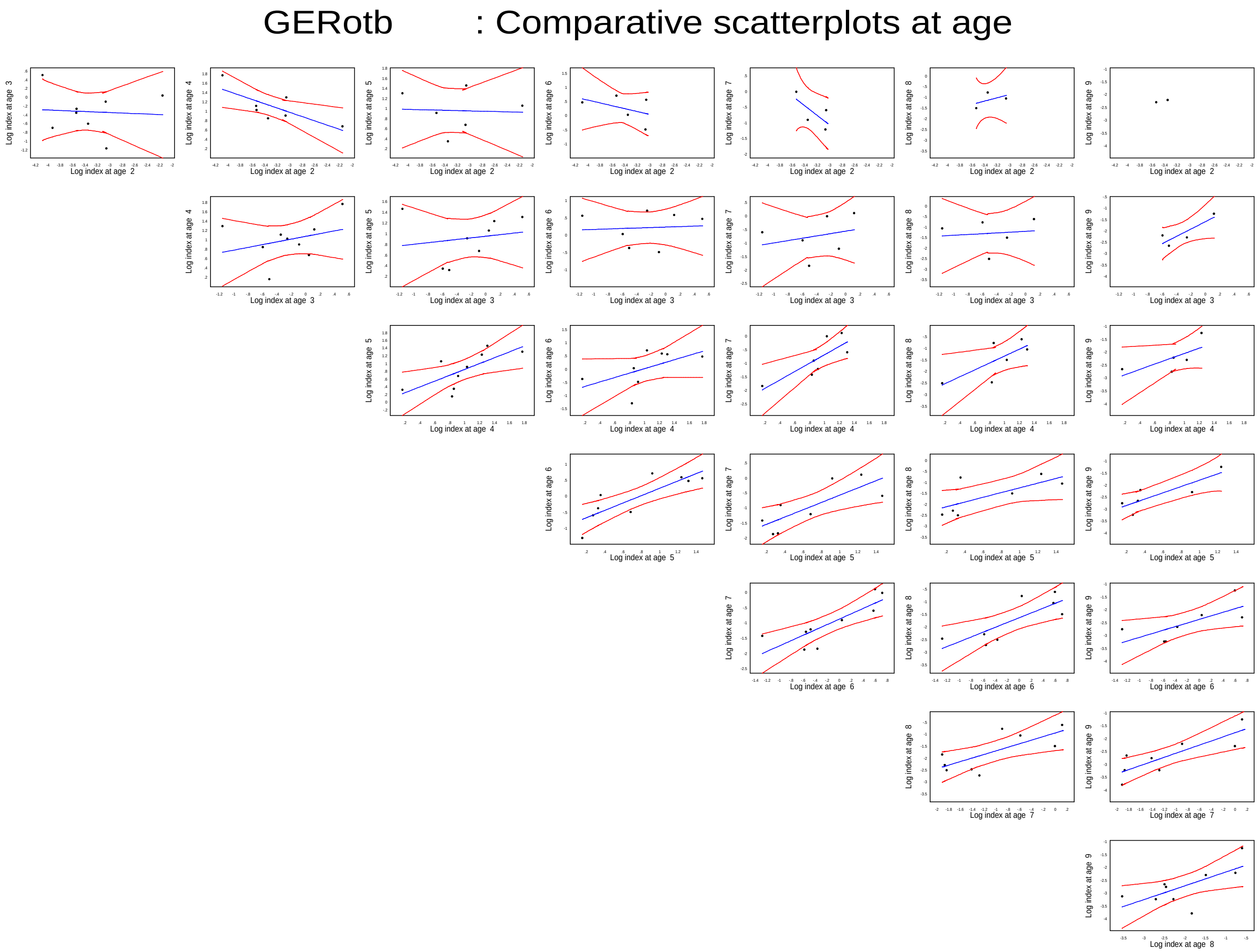


Fig. 6.3.4. (Cont'd). Saithe in Sub-Areas IV and VI and division IIIa. Comparative scatterplots at age for NORtrl.

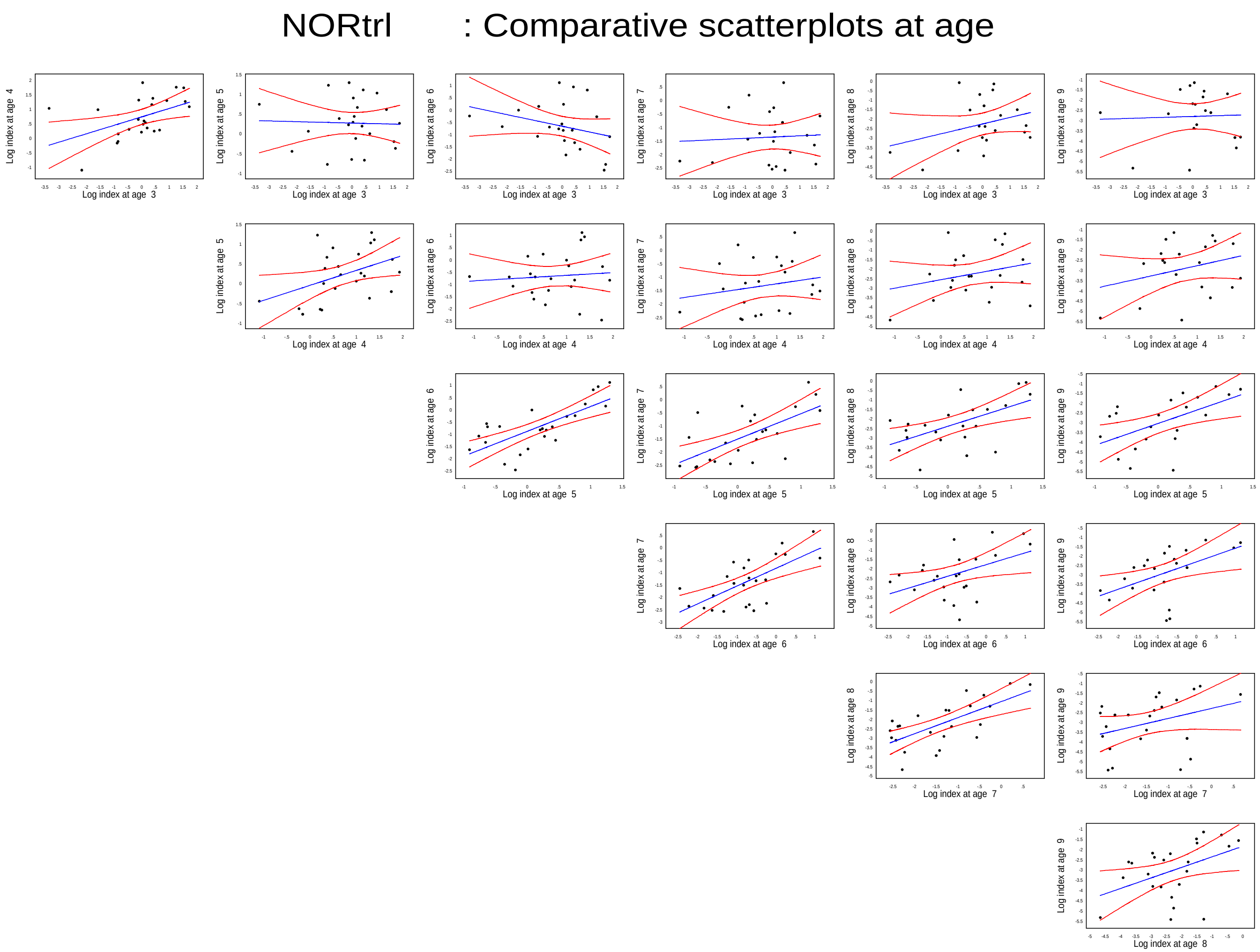


Fig. 6.3.4. (Cont'd). Saithe in Sub-Areas IV and VI and division IIIa. Comparative scatterplots at age for SCOtrl.

SCOltr : Comparative scatterplots at age

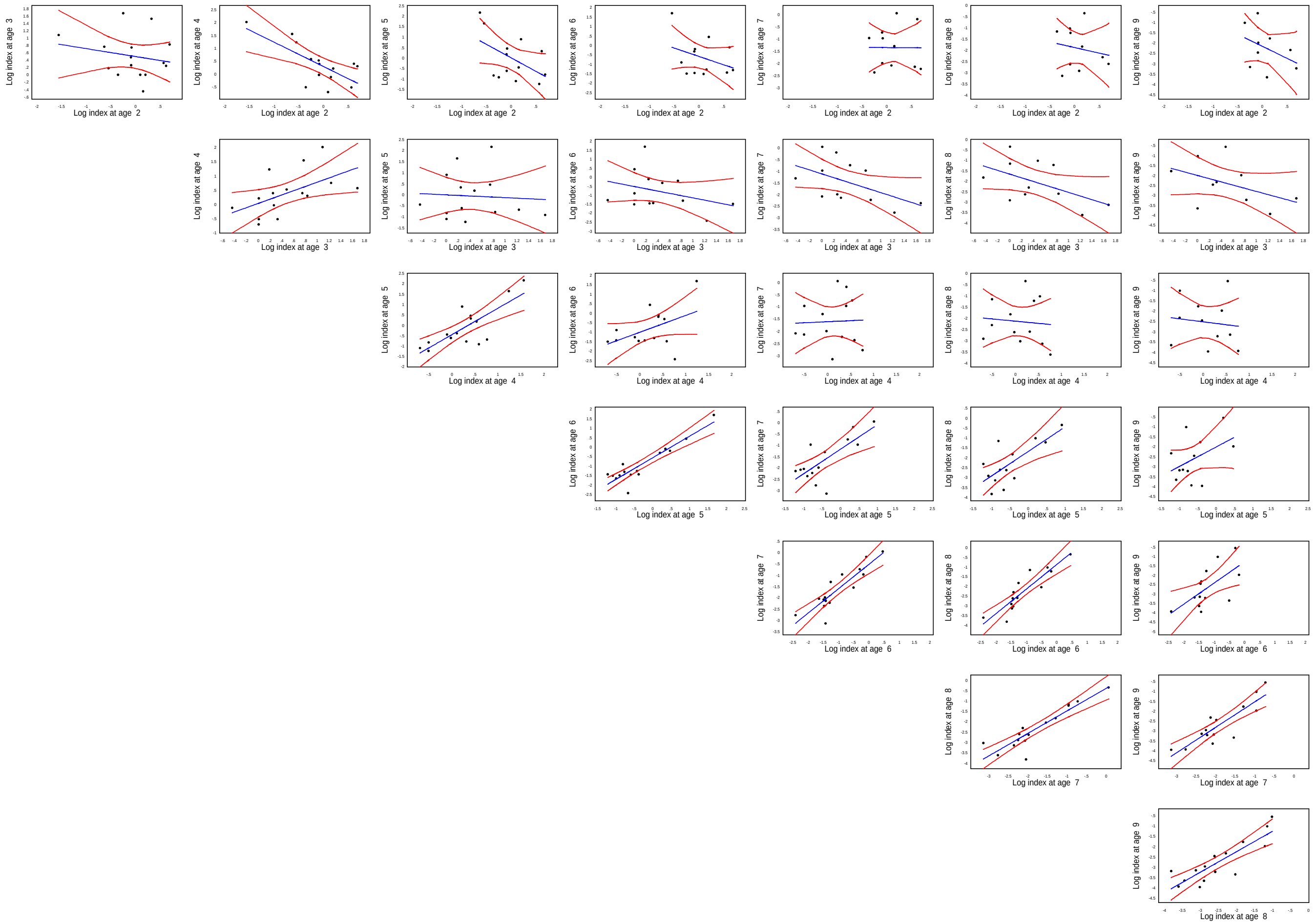


Fig. 6.3.4. (Cont'd). Saithe in Sub-Areas IV and VI and division IIIa. Comparative scatterplots at age for IBTSq1.

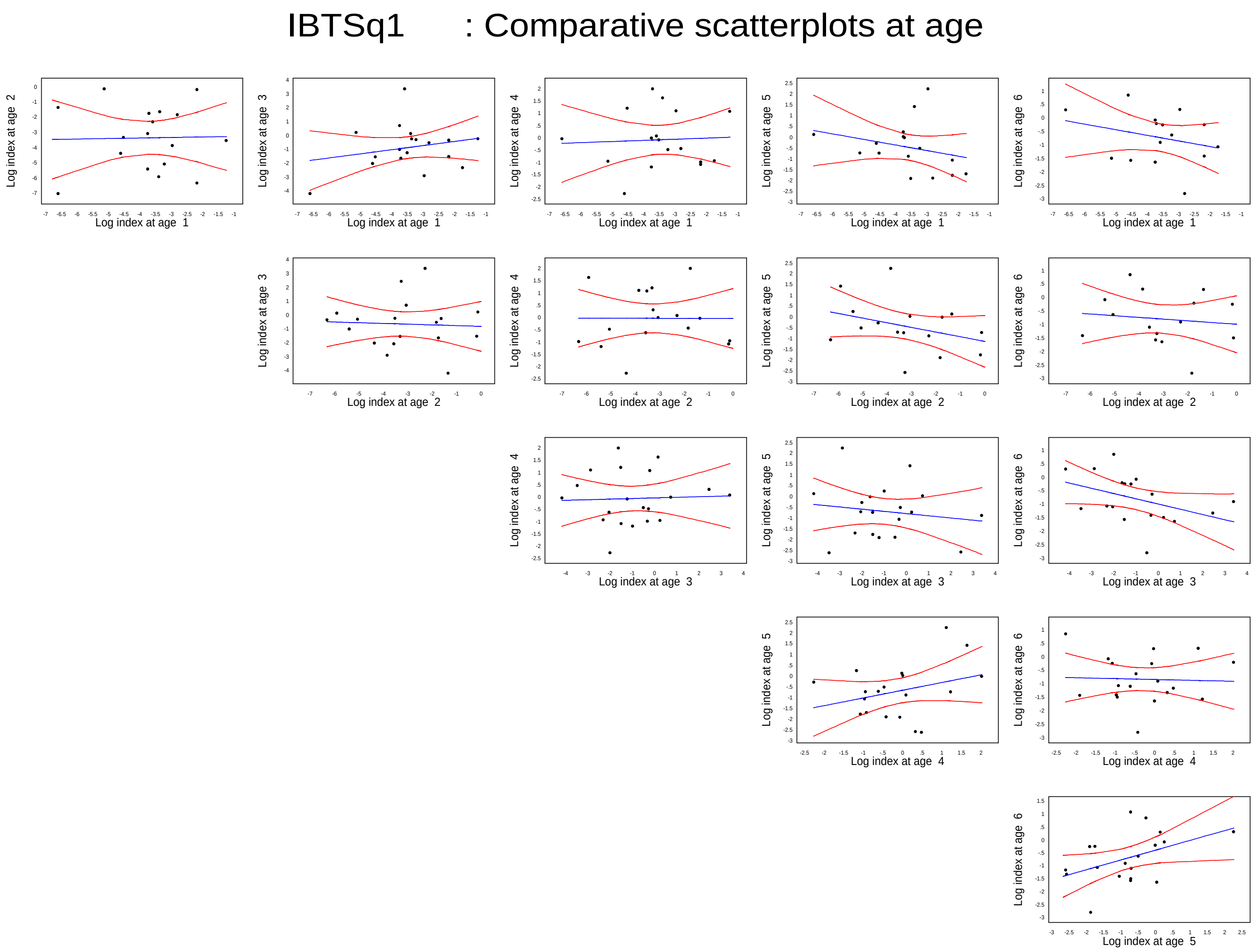


Fig. 6.3.4. (Cont'd). Saithe in Sub-Areas IV and VI and division IIIa. Comparative scatterplots at age for IBTSq3.

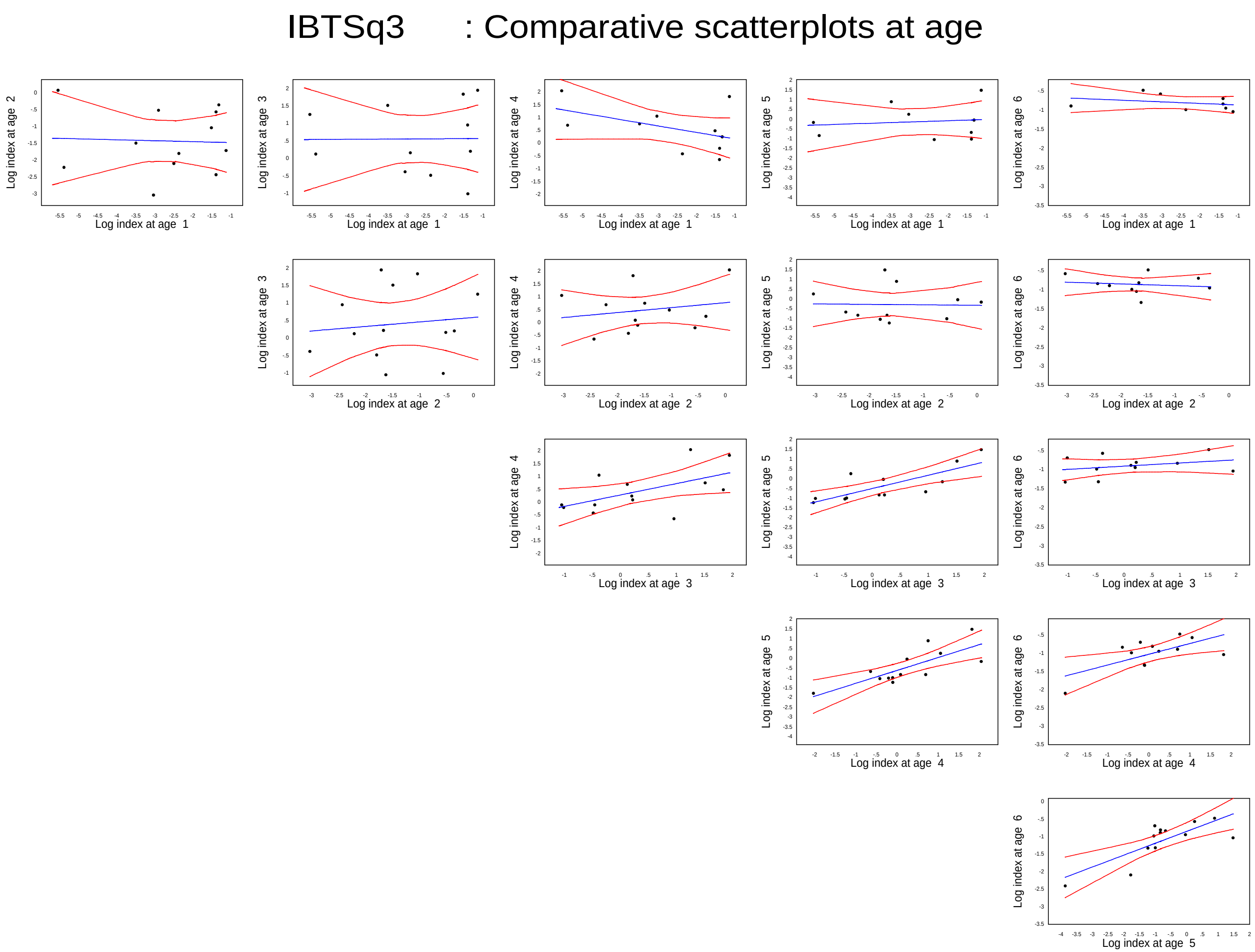


Fig. 6.3.4. (Cont'd). Saithe in Sub-Areas IV and VI and division IIIa. Comparative scatterplots at age for NORACU.

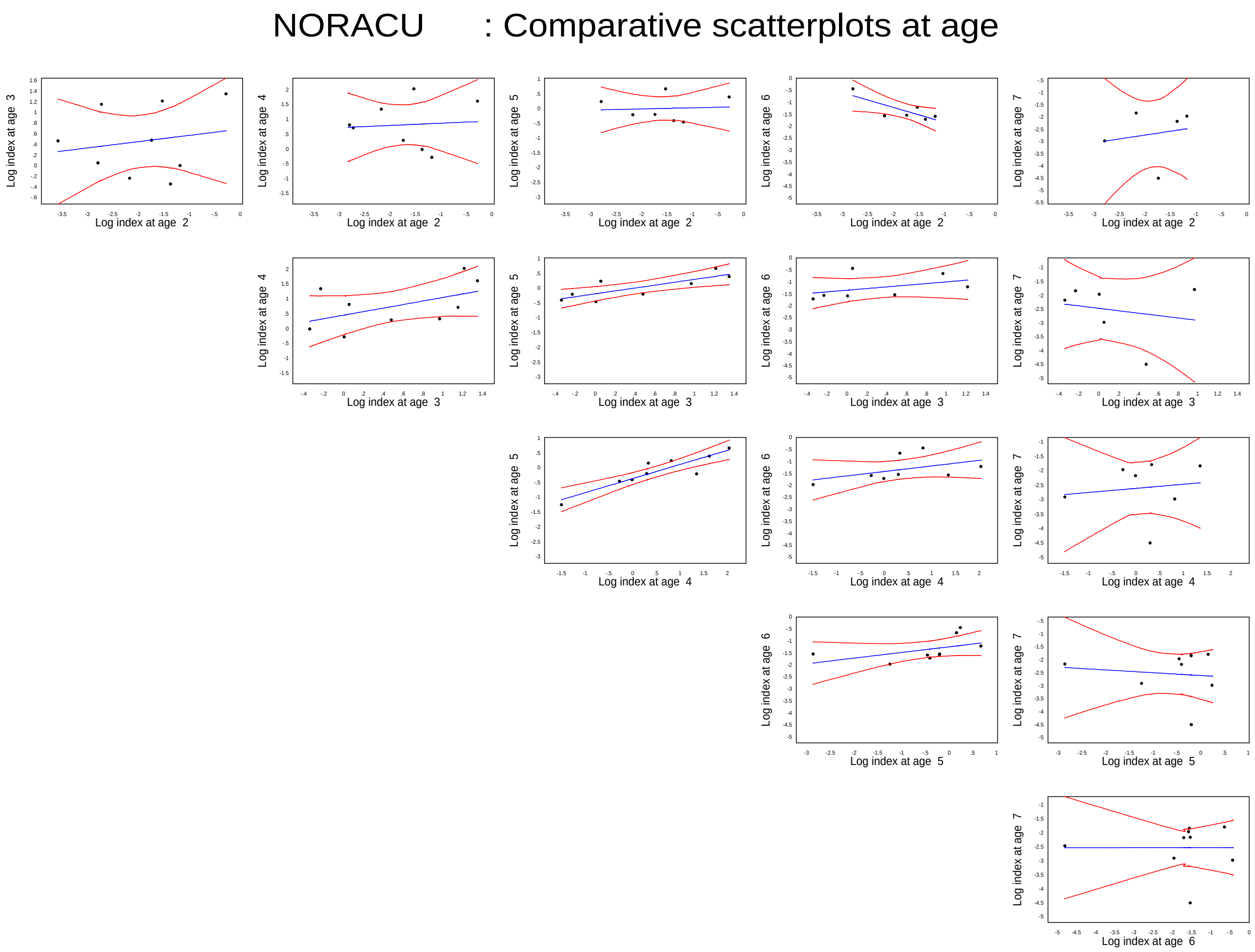
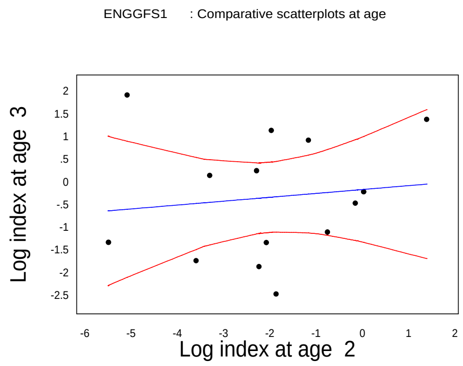


Fig. 6.3.4. (Cont'd). Saithe in Sub-Areas IV and VI and division IIIa. Comparative scatterplots at age for ENGGFS1 (1977-191) and ENGGFS2 (1992-2004).



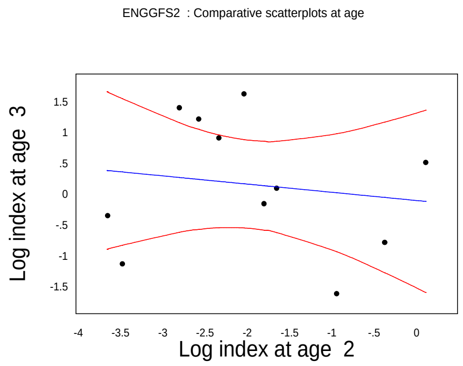
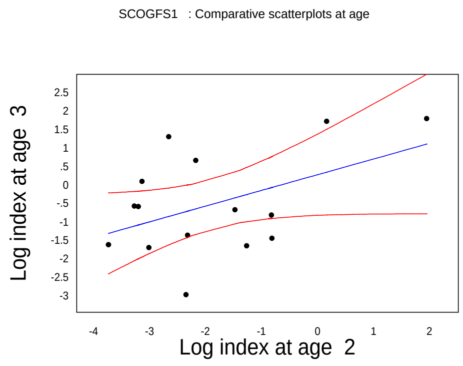


Fig. 6.3.4. (Cont'd). Saithe in Sub-Areas IV and VI and division IIIa. Comparative scatterplots at age for SCOGFS1 (1982-1997) and SCOGFS2 (1998-2004).



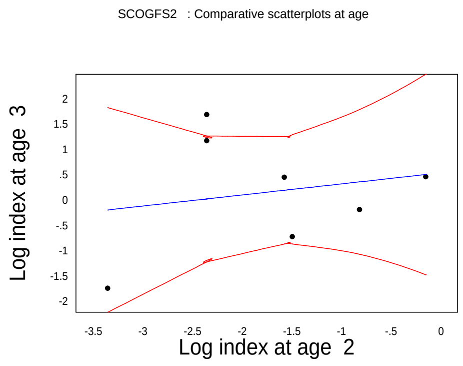
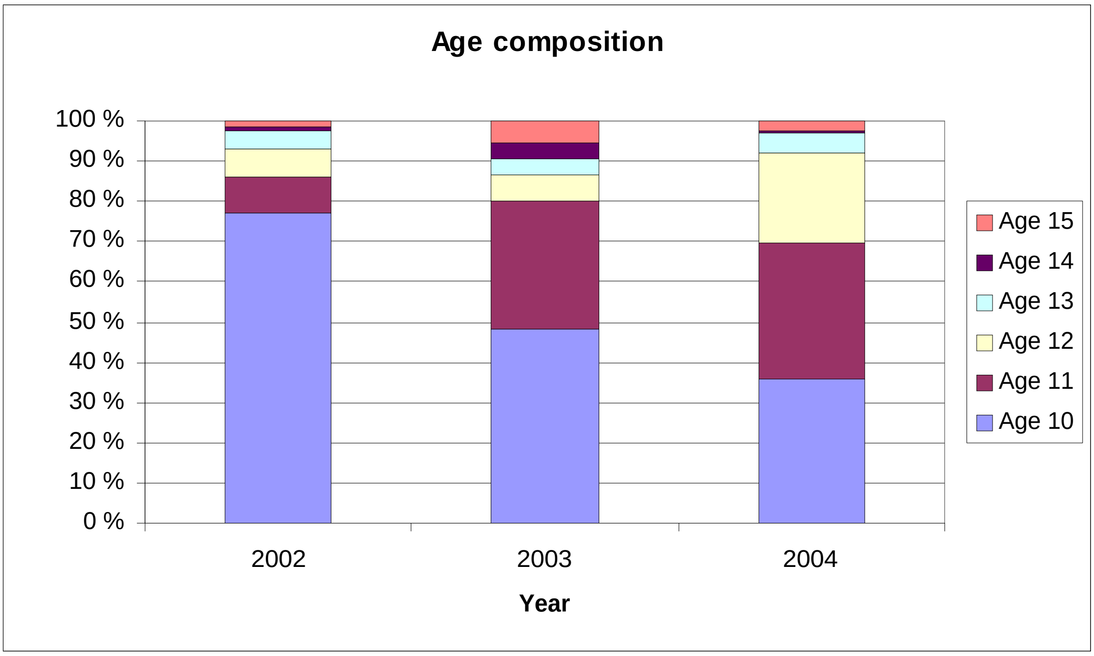


Figure 6.3.5. Saithe in IV, IIIa, and VI. Age composition in catches and weight at age in the plus group.



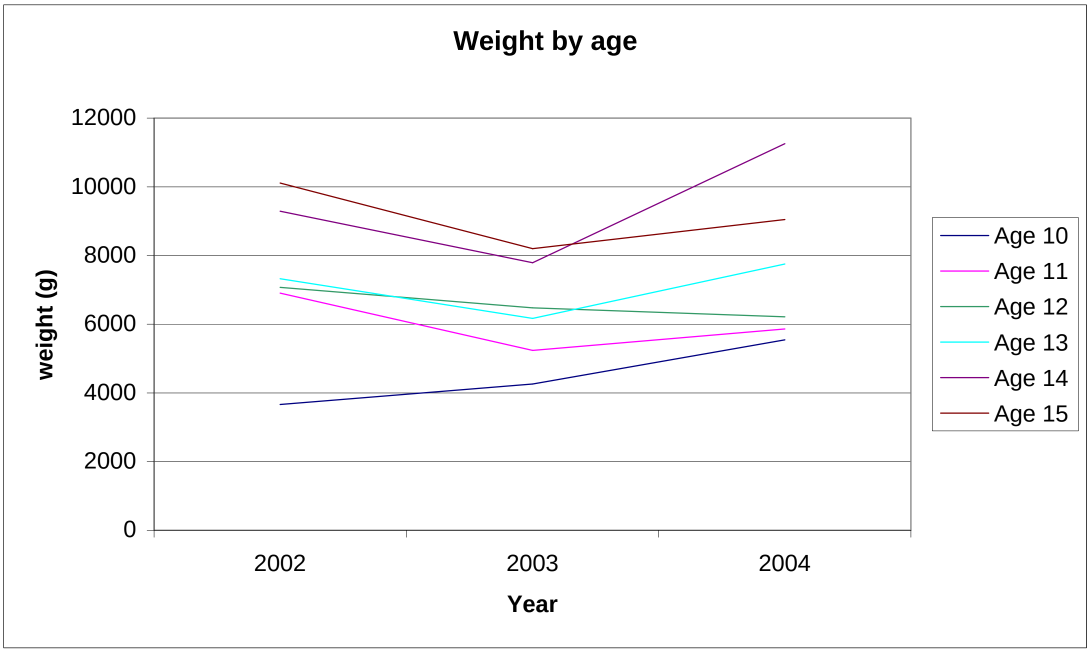
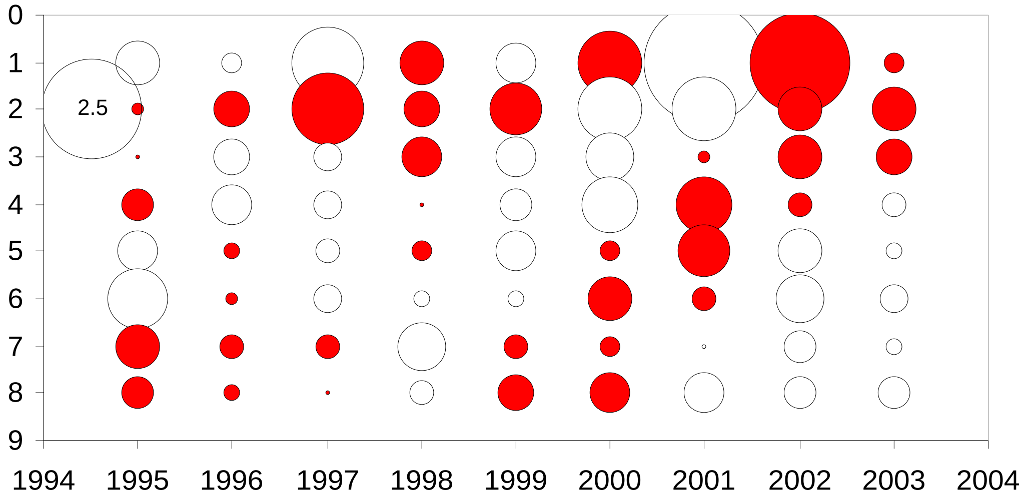


Figure 6.3.6. Saithe in IV, IIIa, and VI. Separable VPA residuals.



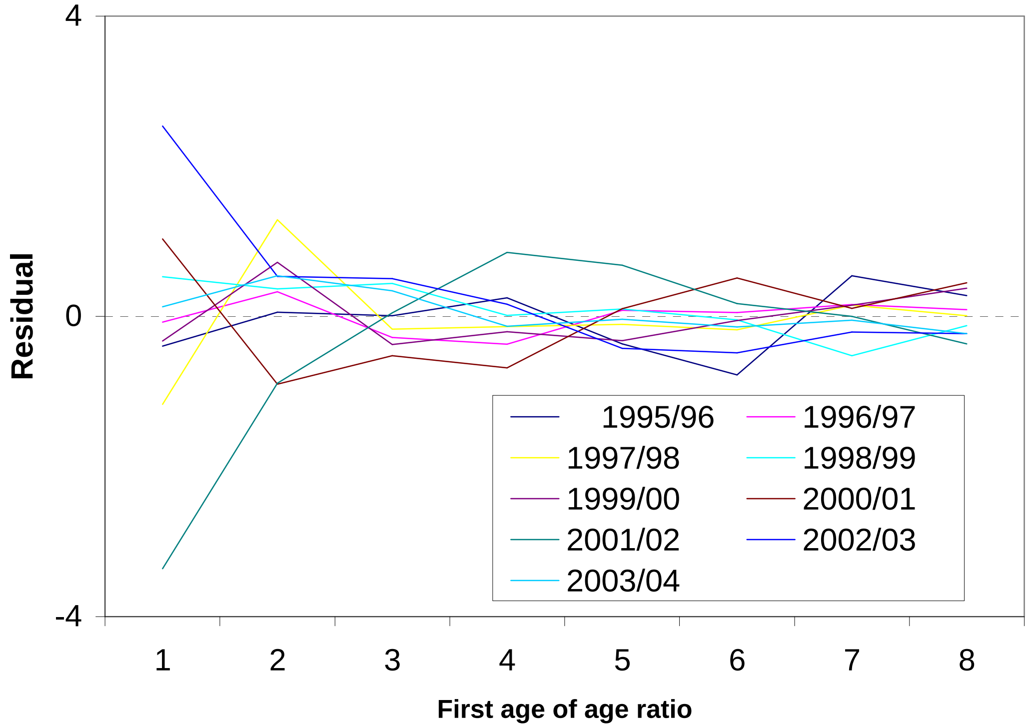


Figure 6.3.7. Saithe in IV, IIIa, and VI. Log catchability residuals from single-fleet Laurec-Shepherd runs.

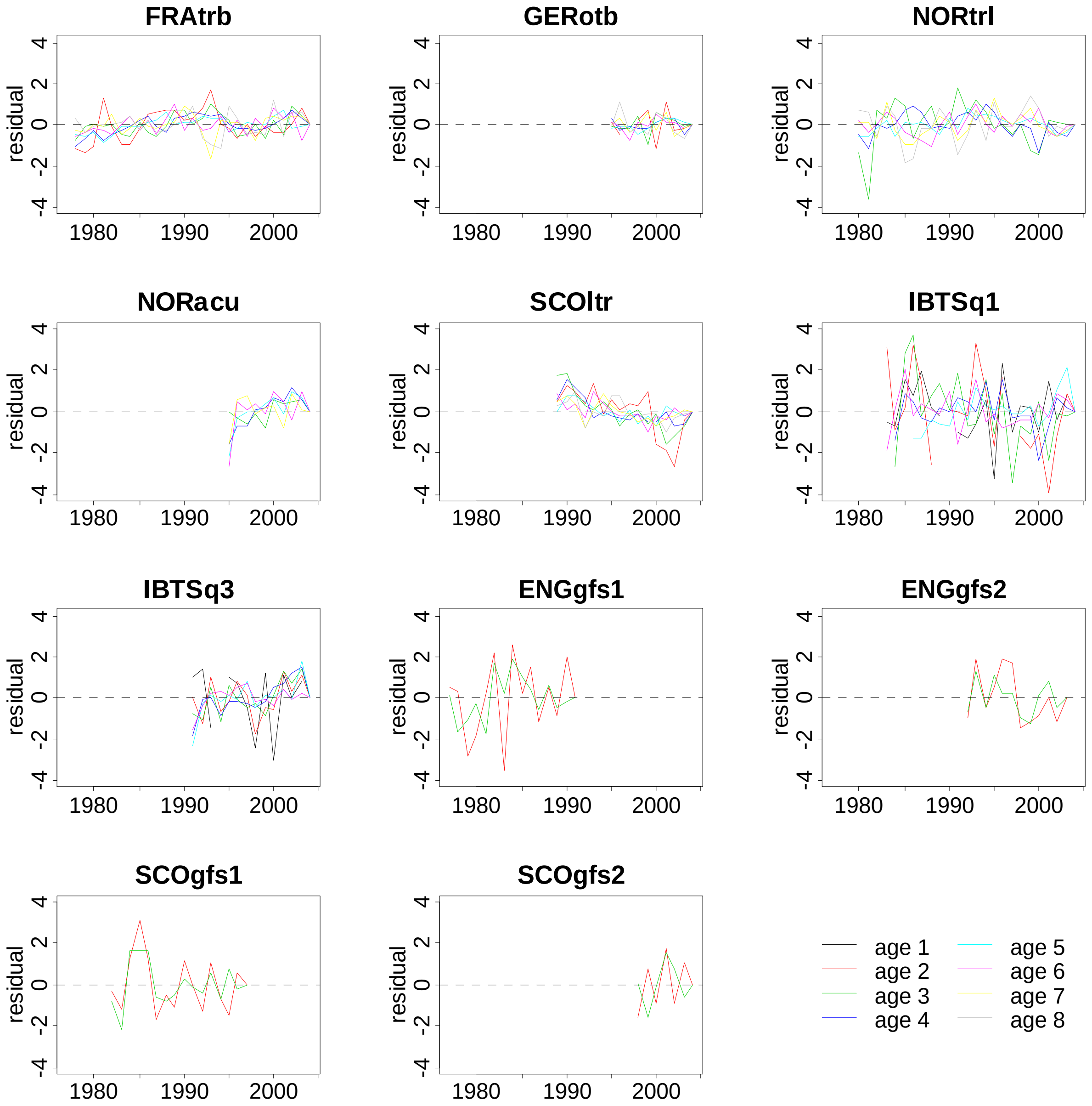


Figure 6.3.8. Saithe in IV, IIIa, and VI. Relative year class from XSA when using age 1 and age 3 as recruits.

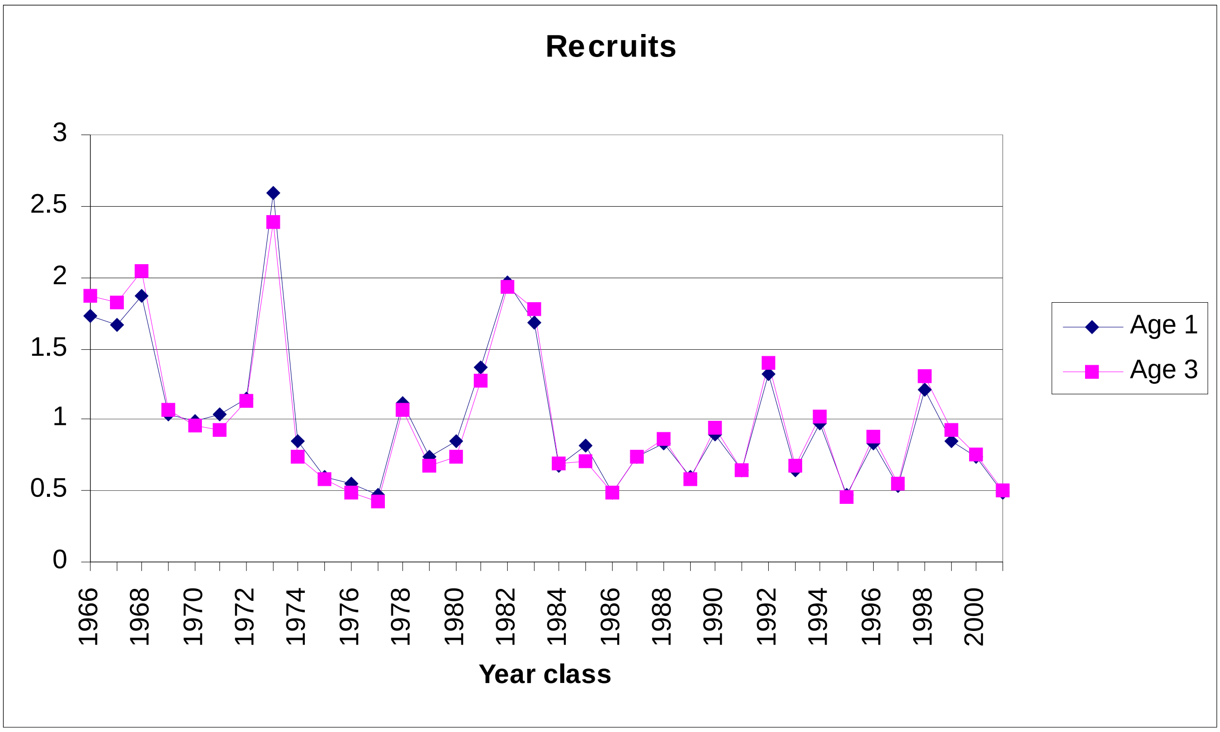


Figure 6.3.9. Saithe in IV, IIIa, and VI. Comparison of XSA runs using different combinations of tuning fleets.

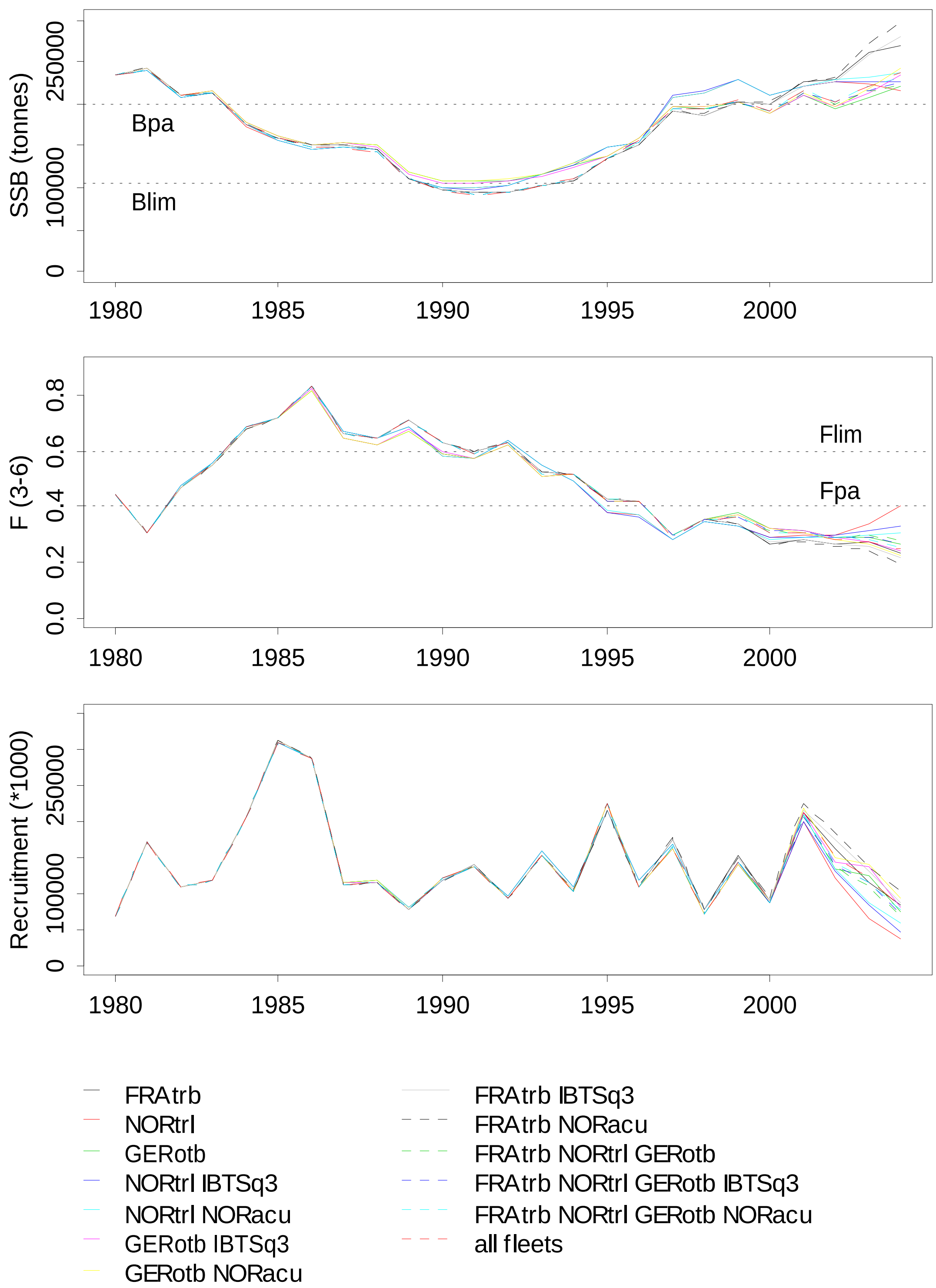


Figure 6.3.10. Saithe in IV, IIIa, and VI. XSA retrospectives for 3 different values of F-shrinkage.

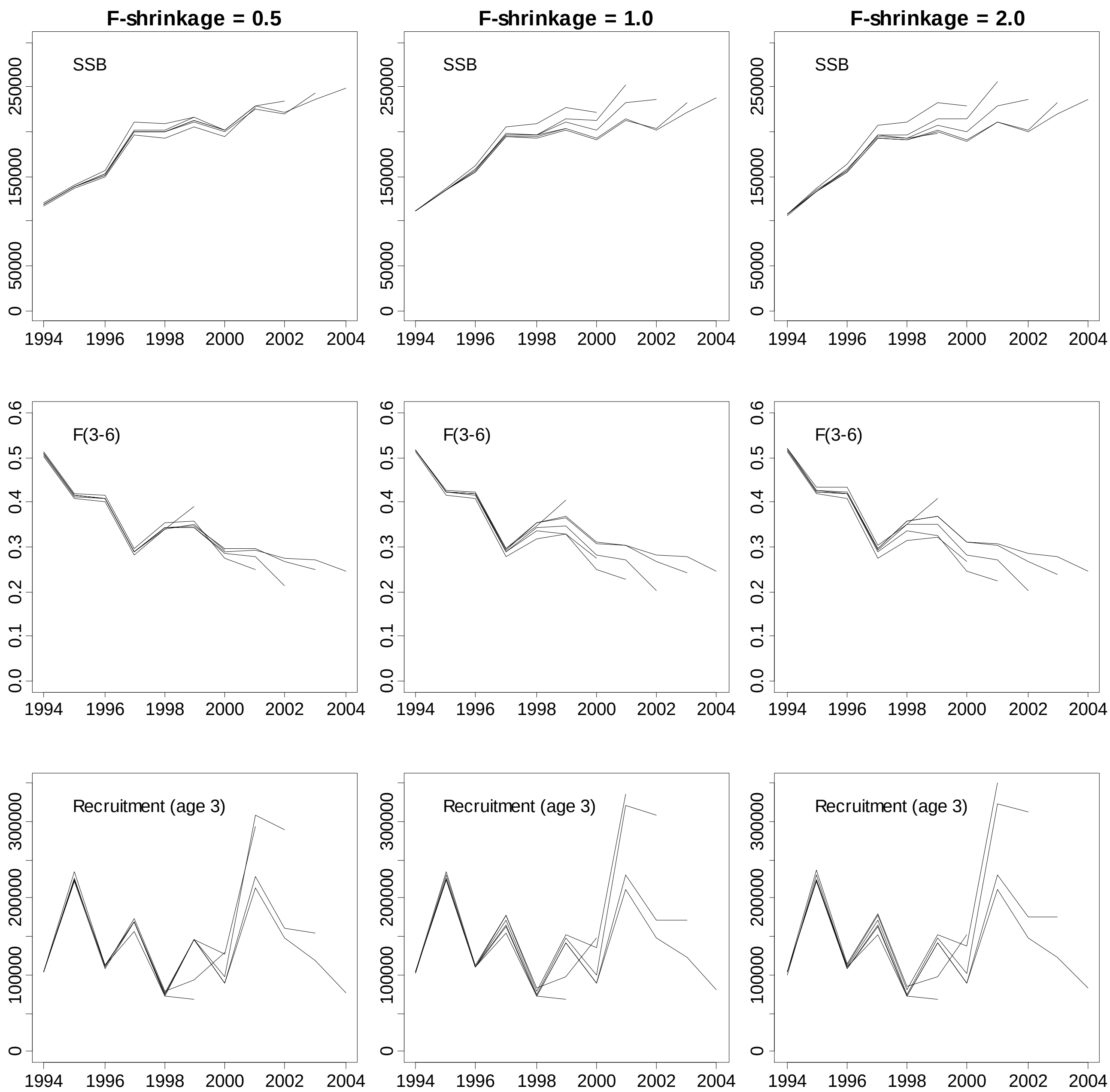


Figure 6.3.11. Saithe in IV, IIIa, and VI. XSA runs comparing 3 different values of F-shrinkage.

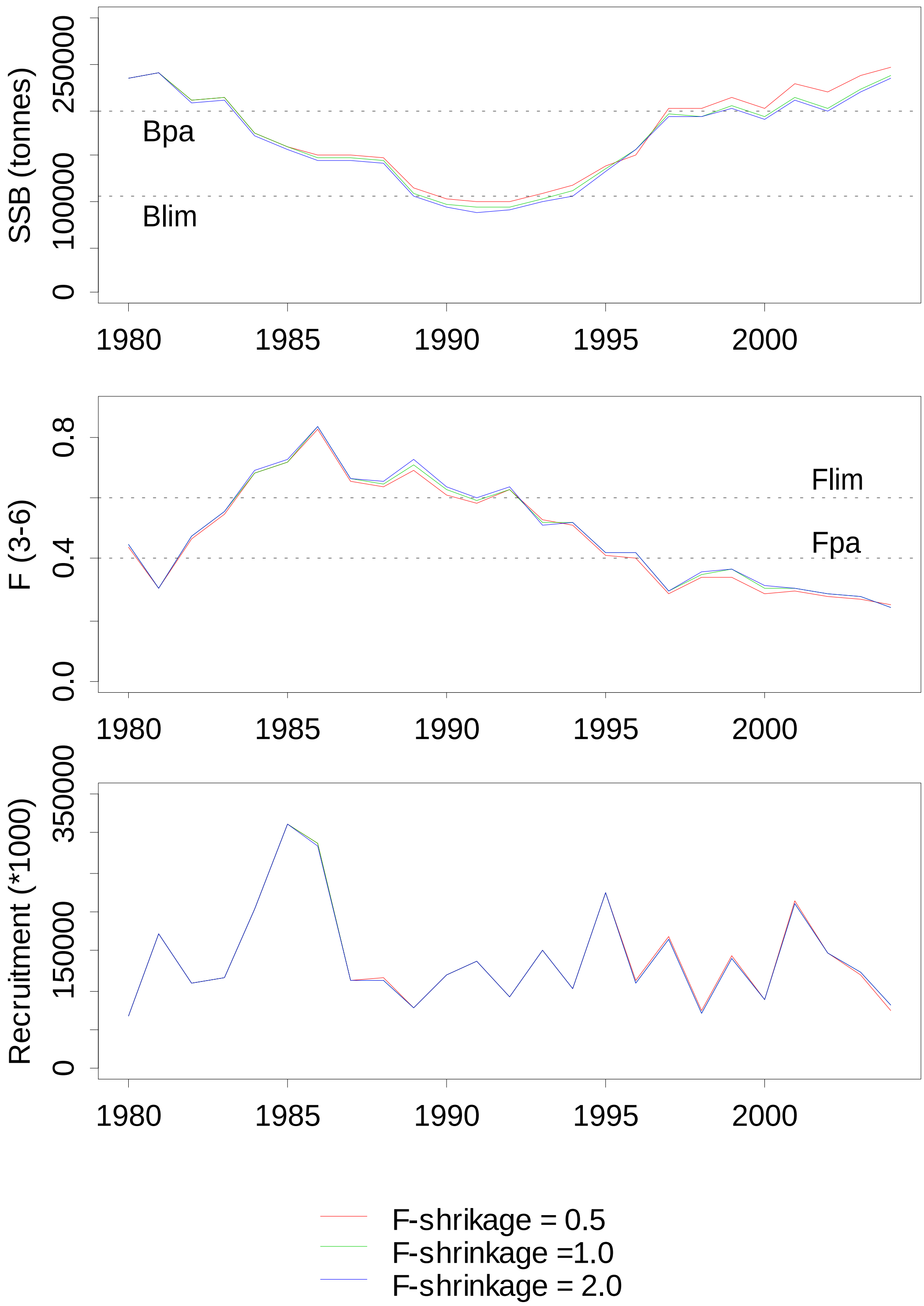


Figure 6.3.12. Saithe in Sub-Areas IV and VI and Division IIIa. Summary of a SURBA run with IBTSq3 and NORACU.

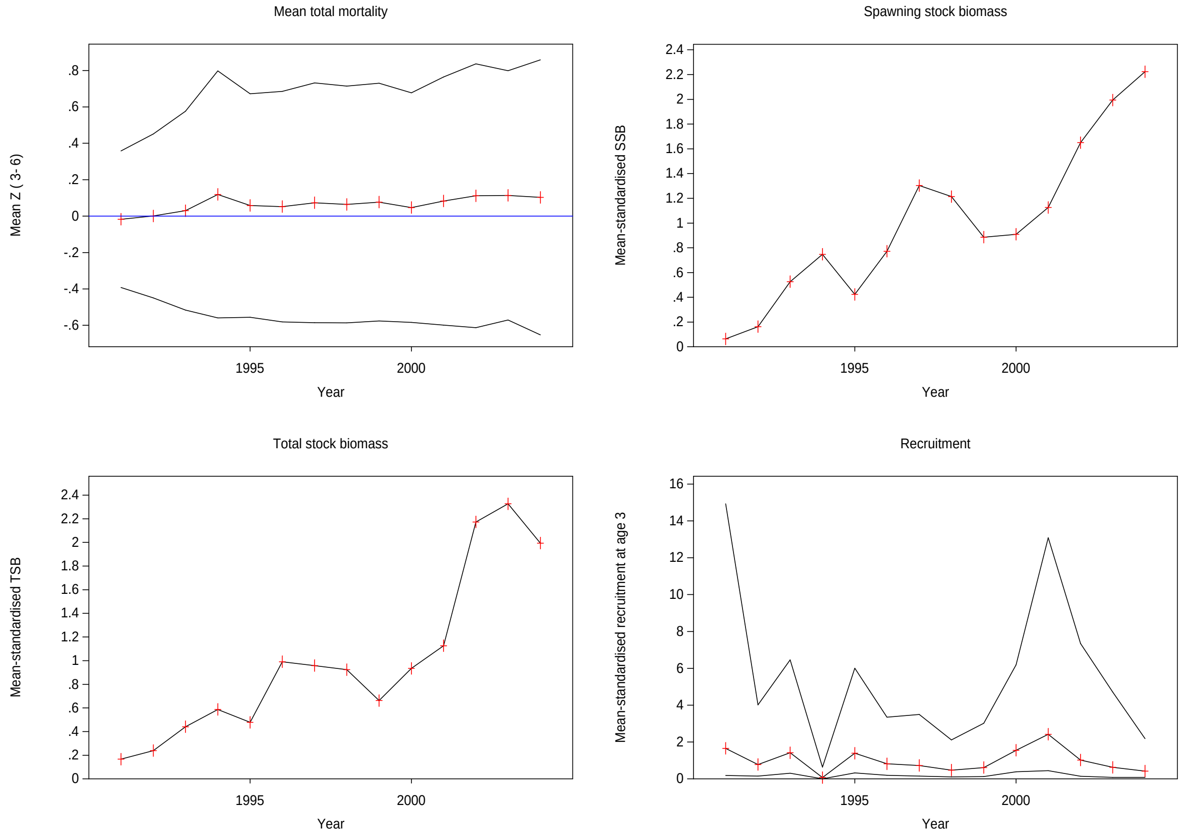


Figure 6.3.13. Saithe in Sub-Areas IV and VI and Division IIIa. Comparision of relative SSB from XSA (all "accepted" tuning fleets) and SURBA (only surveys).

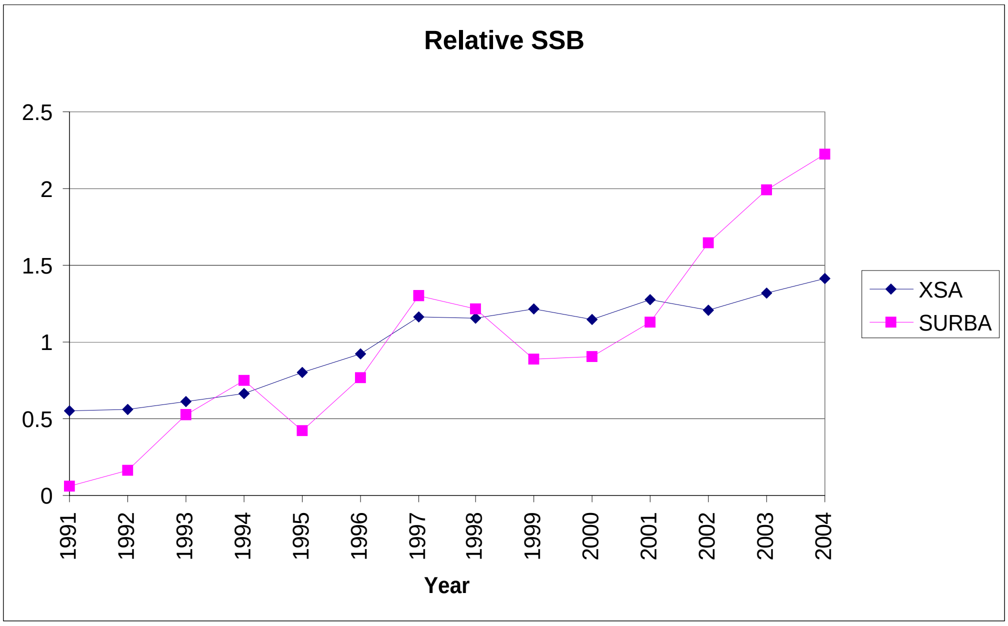


Figure 6.4.1. Saithe in IV, IIIa, and VI. Log catchability residuals from the final run.

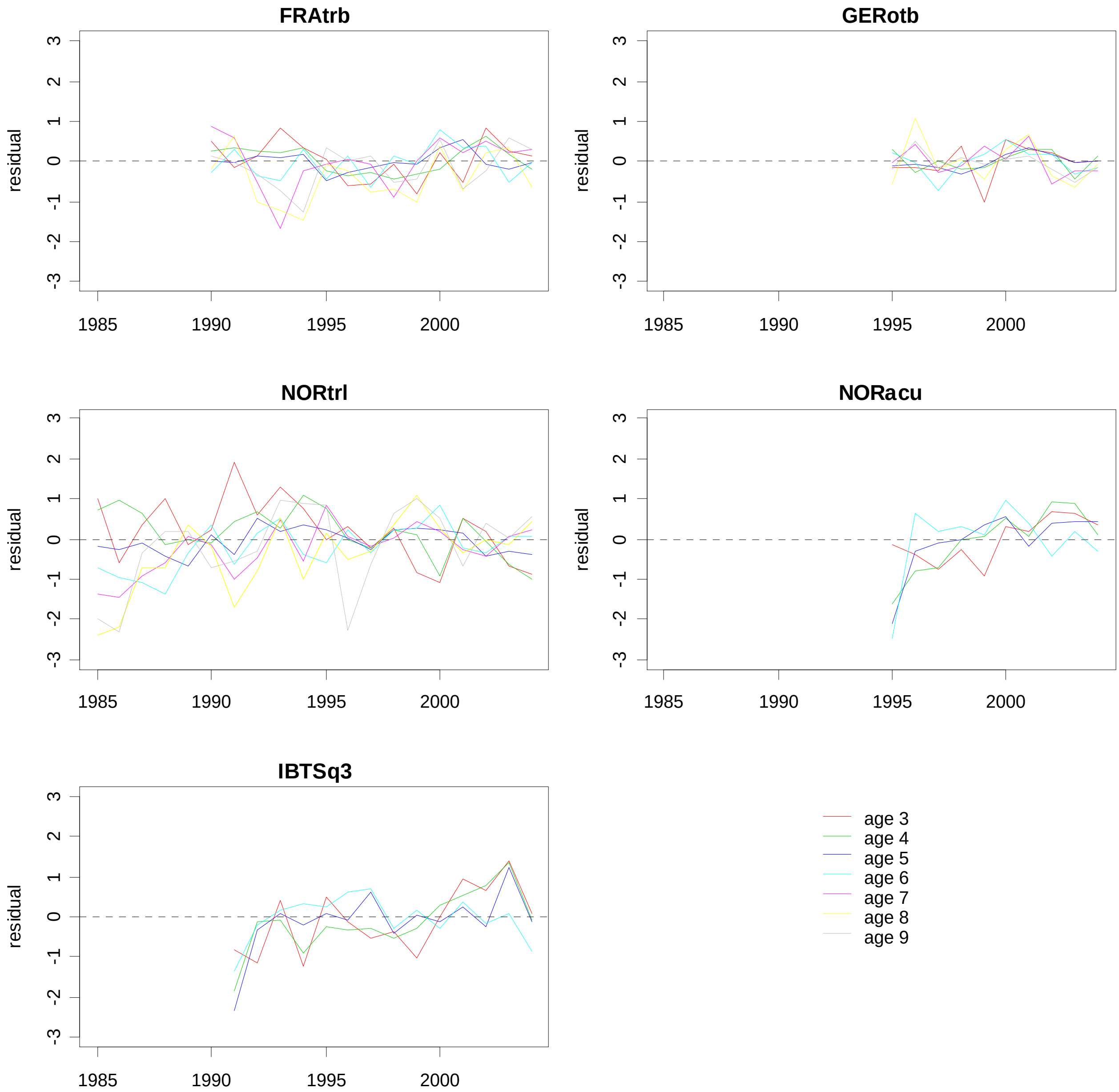


Figure 6.4.2. Saithe in IV, IIIa, and VI. Relative weights of F-shrinkage and tuning fleets in the final XSA run.

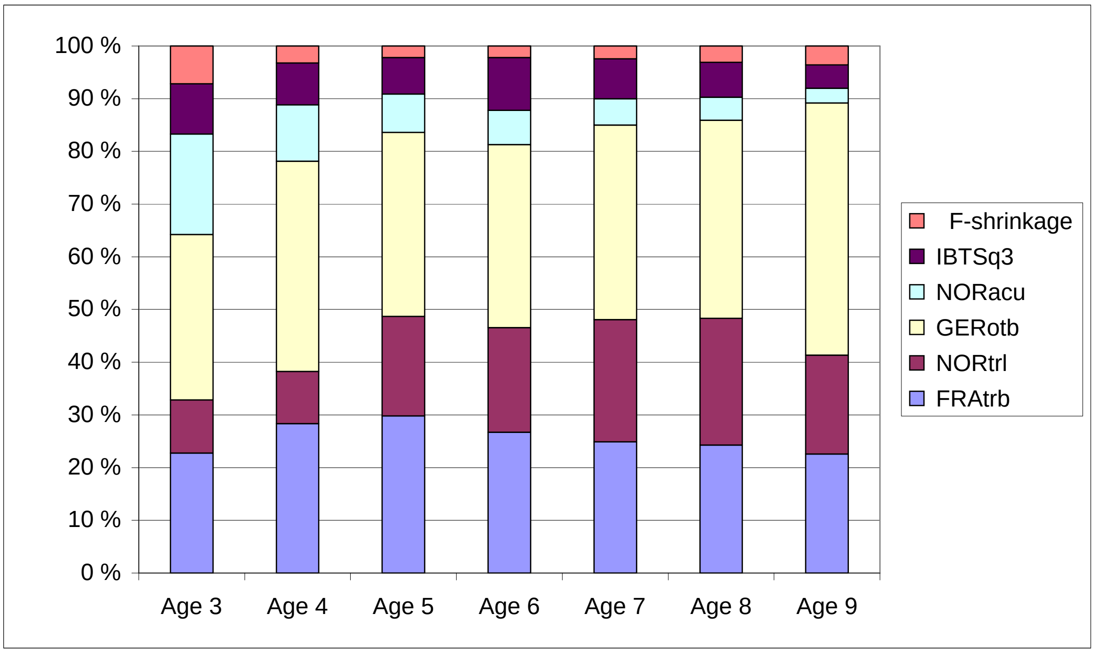


Figure 6.4.3. Saithe in IV, IIIa, and VI. Assessments generated in successive working groups.. Recruitment is only shown for the four last years since the recruitment age was changed from age 1 to age 3.

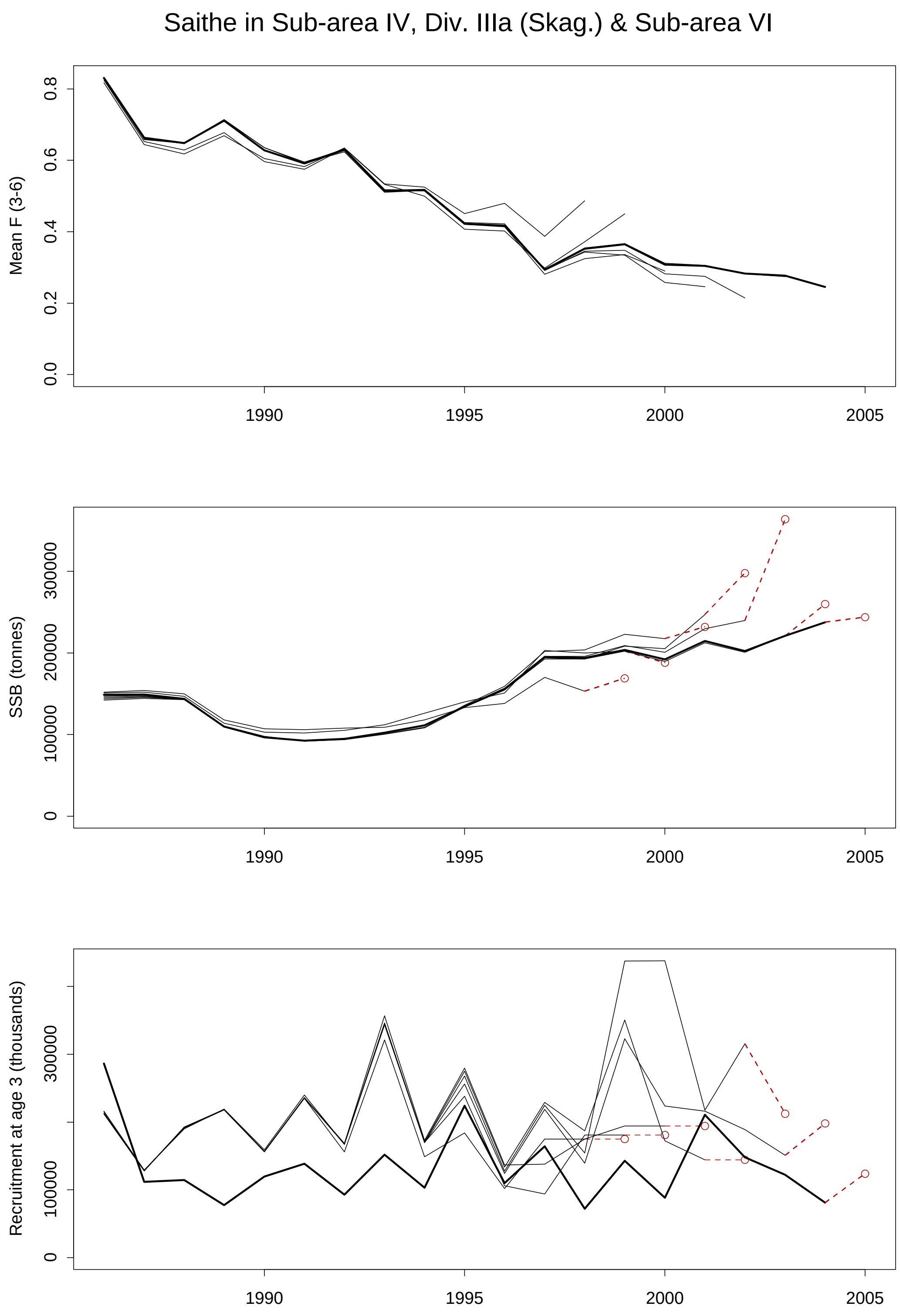


Figure 6.6.1. Saithe in IV, IIIa, and VI. Stock summary.

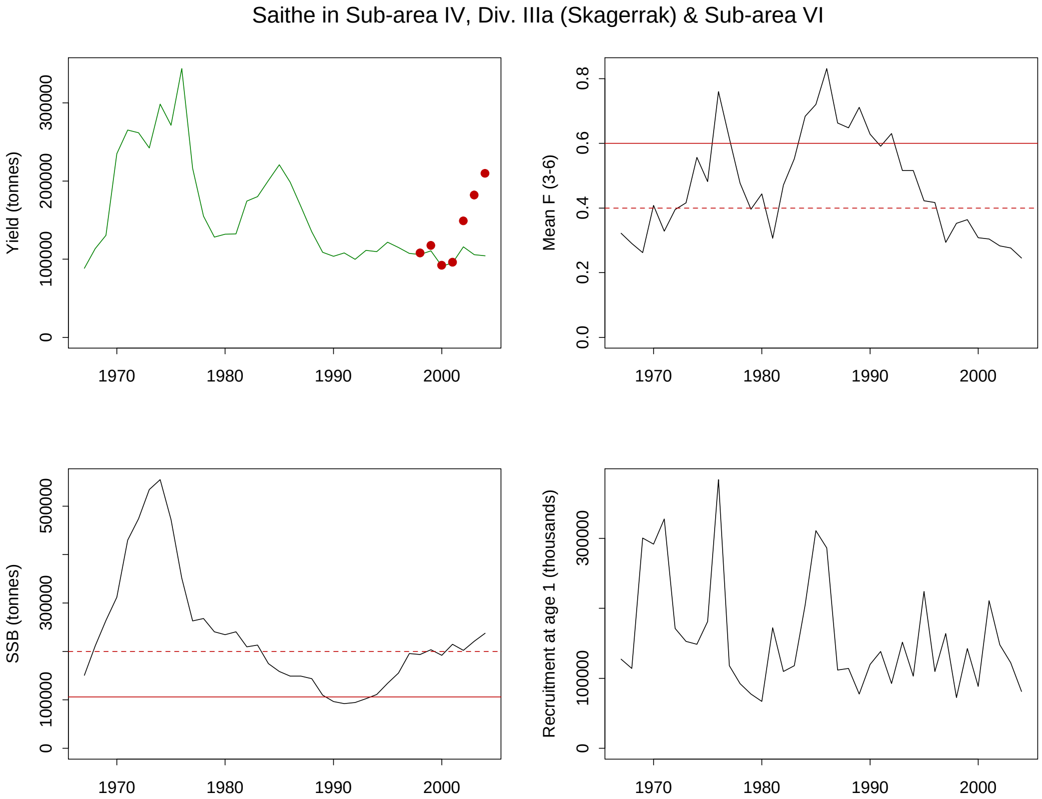


Figure 6.7.1. Saithe in IV, IIIa, and VI. Short term forecast.

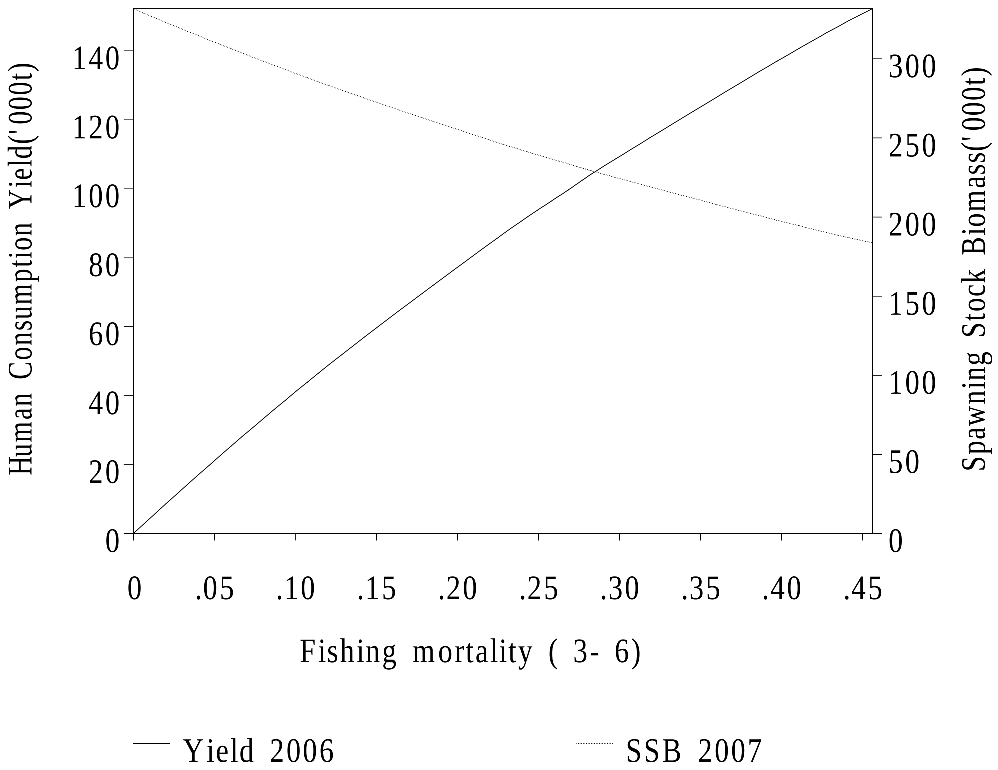


Figure 6.7.2. Saithe in IV, IIIa, and VI. Probability profiles for short term forecast.

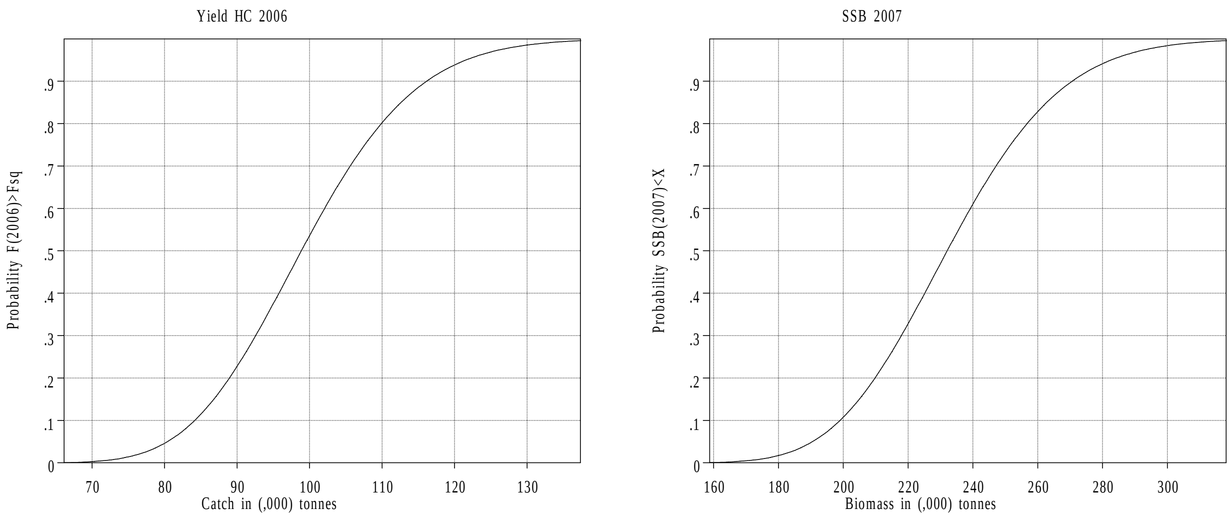


Figure 6.7.3. Saithe in IV, IIIa, and VI. Sensivity analysis of the short-term forecast.

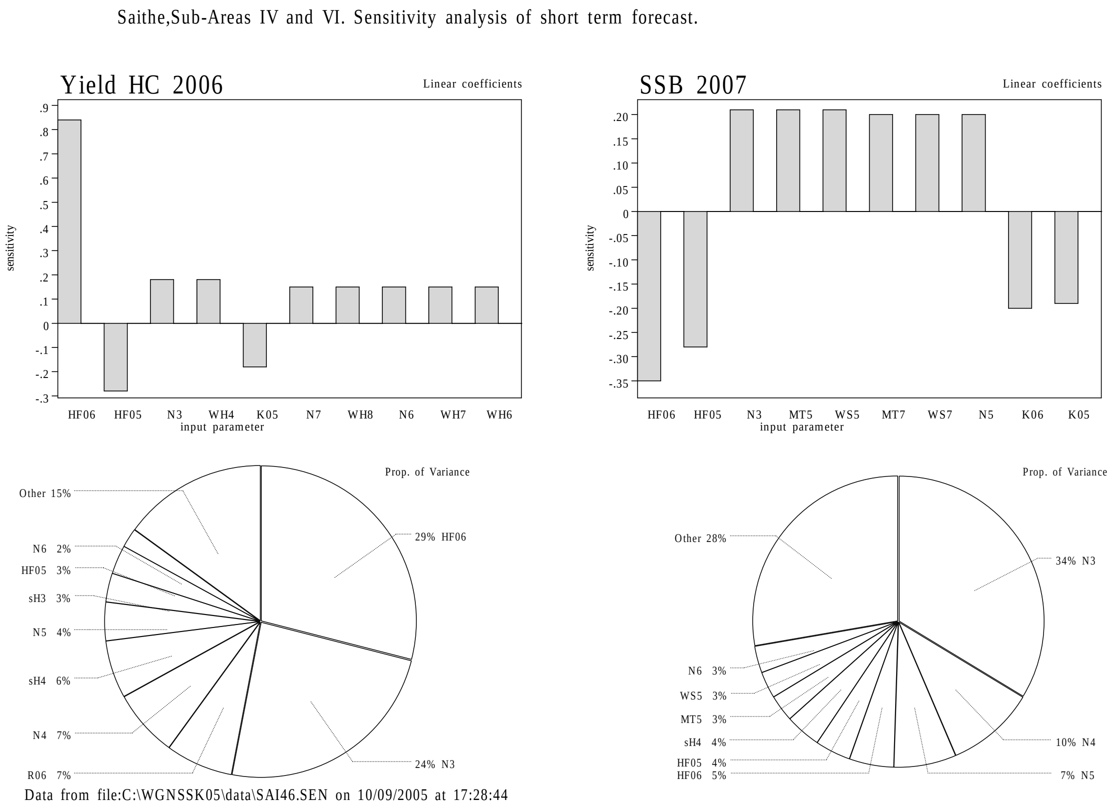
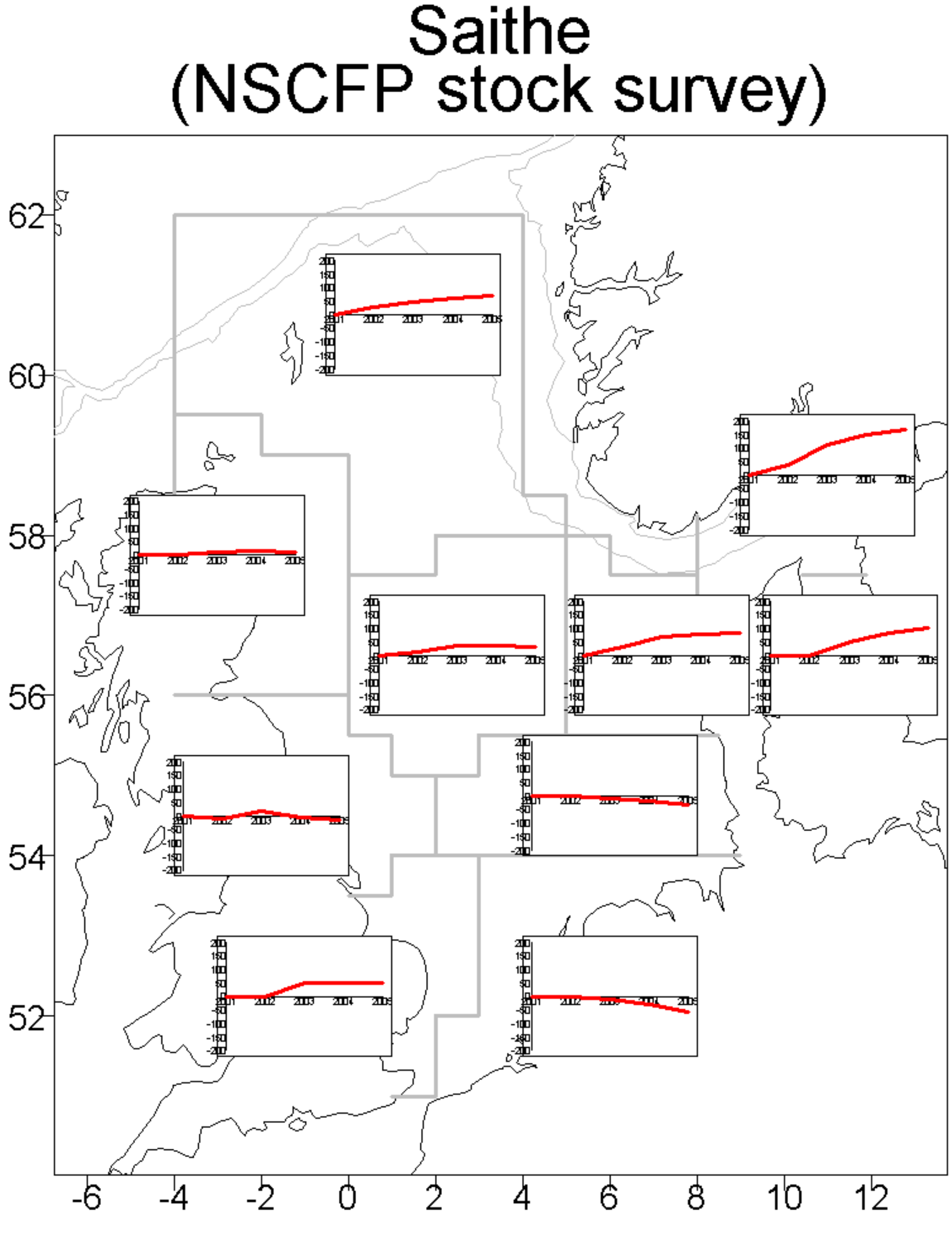


Figure 6.9.1. Saithe in IV, IIIa, and VI. Results from fishermen's survey for saithe in different areas of the North Sea from 2001 to 2005.



7 Sole in Sub-Area IV

The assessment of sole in Sub-Area IV is presented as an update assessment. The most recent benchmark assessment was carried out in 2003.

7.1 General

7.1.1 Ecosystem aspects

Changes in growth of sole in relation to changes in environmental factors were analysed (Rijnsdorp et al., 2004) to explore changes in the productivity of the southeastern North Sea. Based on market sampling data, Rijnsdorp et al. concluded that both length at age and condition factors of sole increased since the mid 1960s to a high point in the mid 1970s. Since the mid 1980s, length at age and condition have been intermediate between the low around 1960 and the high in the mid 1970s. Growth rate of the juvenile age groups was negatively affected by intra-specific competition. Length of 0-group fish in autumn showed a positive relationship with the temperature in the 2nd and 3rd quarter, but for the older fish no temperature effect could be detected. The overall pattern of the increase in growth and the later decline correlated with the temporal patterns in eutrophication, in particular the discharge of dissolved phosphates by the Rhine. Trends in the stock indicators e.g. SSB and recruitment did however not coincide with the observed patterns in eutrophication.

In recent years a change in the spatial distribution of juvenile plaice to more offshore areas was observed (Grift et al., 2004; Van Keeken et al., 2004), while this change was not observed in the distribution of sole (Grift et al., 2004). In recent years, age-1 plaice have disappeared from the Wadden Sea during the period annual sampling takes place, while for juvenile sole this has not occurred. For adult sole, no major changes in spatial distribution have been detected (Grift et al., 2004, Verver et al, 2001). The proportion of undersized sole (<24 cm) inside the Plaice Box did not change after closure and remained stable at 60-70% (Grift et al., 2004). The different length groups showed however different patterns in abundance. Sole of around 5 cm showed a decrease in abundance from 2000 onwards, while the groups of 10 and 15 cm seemed rather stable. The largest groups showed a declining trend in abundance, which had already set in years before the closure.

7.1.2 Fisheries

Sole is mainly taken by beam trawlers in a mixed fishery with plaice in the southern and central part of the North Sea. A large portion of the fishing effort for sole in the North Sea is taken by the Dutch beam trawl fleet fishing for sole and plaice, using 80 mm mesh size. Effort of the Dutch fleet increased up to the mid 1990s but is currently at the same level as it was in the early 1980s. However, because of implementation of days-at-sea regulation, currently high oil prices, and decreasing TAC for plaice and relatively stable TAC for sole, the effort of the Dutch fleet is directed more towards the southern part of the exploitation area, showing decreasing effort in the northern part (Figure 7.1.1). In 2005 a voluntary reorganisation programme for vessels older than 10 years and larger than 15 metres will be taken into effect.

In the English beam trawl fishery fishing for plaice with 120 mm mesh, sole was taken as by-catch prior to 2002, but these vessels do not participate in the fishery anymore. The English fleet consists currently of a large number of small otter trawlers fishing in the southern North Sea for sole mainly in the 2nd and 3rd quarters of the year. For the other countries targeting North Sea sole, most catches are taken by gillnet fisheries or as by-catch in other fisheries. A description of these fisheries is given in the stock annex.

In 2005 experimental fishing with an electric beam trawl using electric pulses instead of tickler chains to disturb sole from the sediment is explored. Because of the lighter gear, fuel consumption is lower and it is believed that this gear causes less physical damage on the bottom than a beam trawl with tickler chains, resulting in lower by-catches of benthic animals and better quality fish. These assumptions are currently investigated.

7.1.3 ICES advice

In 2004, based on the most recent estimate of SSB and fishing mortality, ICES classified the stock as having full reproductive capacity, but it is at risk of unsustainable harvesting. However there were no explicit management objectives for this stock.

ICES noted that several other stocks are at risk of being harvested unsustainably (North Sea plaice, Eastern Channel plaice, Division IIIa plaice, North Sea sole), sometimes in combination with risk of reproductive capacity (plaice in the North Sea and plaice in Eastern Channel). For these stocks, reductions in fishing mortality are recommended as follows:

- North Sea plaice: F = $\mathbf{F}_{sq}$*0.5 (in order to rebuild to above $\mathbf{B}_{pa}$)
- Eastern Channel plaice: F = $\mathbf{F}_{sq}$*0.68 (in order to rebuild to above $\mathbf{B}_{pa}$)
- Skagerak-Kattegat (Division IIIa) plaice: recent average landings
- North Sea sole: F = $\mathbf{F}_{sq}$ * 0.91.

Fishing mortality is related to fishing effort; as a first proxy it is assumed that these are proportional. Fishing at $\mathbf{F}_{sq}$ therefore represents current fishing pressure and a reduction in fishing mortality over $\mathbf{F}_{sq}$ implies a similar reduction in fishing effort, e.g. for North Sea plaice fishing effort should be halved.

Furthermore ICES noted that fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2004 be managed according to the following rules, which should be applied simultaneously:

- Demersal fisheries with minimal bycatch or discards of cod;
- Implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised; within the precautionary exploitation limits for all other stocks.

7.1.4 Management

The TAC for area II and IV in 2005 was set at 18,600 t, which is an increase to 2004 when the TAC was set at 17,000 t (Table 7.2.1).

The current Multi-annual guidance program (MAGP-IV) has defined national targets for EU fleet reductions in fleet capacity and/or days at sea. The minimum landing size of North Sea sole is 24 cm. A closed area has been in operation since 1989 (the plaice box) and since 1995 this area has been closed in all quarters. The closed area applies to vessels using towed gears, but vessels smaller than 300 HP are exempted from the regulation. An additional technical measure concerning the fishing gear is the restriction of the aggregated beam length of beam trawlers to 24 m. In the 12 nautical mile zone and in the plaice box the maximum aggregated beam-length is 9m.

Effort has been restricted because of implementation of days-at-sea regulation for the cod recovery plan (EC Comm. Reg. No. 2056/2001; EC Comm. Reg. 27/2005). In 2004 a beam trawl vessel was restricted to 181 days at sea (16 in January, 15 in February-December), with one day at sea being a time frame of 24 hours (EC Comm. Reg. 27/2005). This restriction, currently high oil prices, and different changes in TAC between plaice and sole induced a more coastal fishing pattern in the southern North Sea, which is the area where sole and juvenile plaice are abundant. This could lead to increased discarding of plaice.

Technical measures applicable to the flatfish beam trawl fishery before 2000 were an exemption to use 80 mm mesh cod-end when fishing south of 55° North. From January 2000, the exemption area extends from 55° North to 56° North, east of 5° East latitude. Fishing with this mesh size is permitted within that area provided that the landings comprise at least 70% of a mix of species, which are defined in the technical measures of the EU (EC Comm. Reg. 1543/2000). From January 2002 the cod recovery plan was installed, allowing a maximum cod by-catch of 20% of the total catch. In the area extending from 55° North to 56° North, east of 5° East latitude, a maximum cod by-catch of 5% is allowed. Minimum cod-end mesh in this area is 100 mm, while above 56° North the minimum cod-end mesh is 120 mm (EC Comm. Reg. 2056/2001).

7.2 Data

7.2.1 Landings and discards

Landings data by country and TACs are presented in Table 7.2.1 and Figure 7.2.1. The discards percentages observed in the Dutch discards sampling programme sampling beam trawl vessels fishing for sole with 80 mm mesh size (Table 7.2.7) were much lower for sole (between 13%-17% in numbers, Table 7.2.8) then for plaice (75%-80% in numbers). No clear trends in discards percentages for North Sea sole were observed as was seen for North Sea plaice (see section 9). Inclusion of a stable time series of discards in the assessment will have no major effect on the relative trends in stock indications (Kraak et al. 2002; Van Keeken et al. 2003). Also due to gaps in the sampling programmes of North Sea sole, a complete time series of sole discards could not be obtained. The WG concluded not to include discards into the assessment. The spatial distribution of reported sole landings in the North Sea and adjoining areas is summarised in Figure 7.2.4.

7.2.2 Age compositions

Discards at age are only partly available and inclusion of discards at age in the sole assessment is expected to increase the noise in the assessment. Thus the assessment has been carried out on the basis of landings, rather than catches. Age compositions and mean length at age in the landings were available on a quarterly basis from The Netherlands (by sex), UK (England and Wales) and France (sexes combined). Age compositions on an annual basis were available from Belgium and Germany (sexes combined). Overall, the samples are thought to be representative of around 93% of the total landings in 2004. The age compositions were combined separately by sex on a quarterly basis and then raised to the annual international total. The age composition of the landings is presented in Table 7.2.2.

7.2.3 Weight at age

Weights at age in the landings (Table 7.2.3, Figure 7.2.1) are measured weights from the various national market sampling programmes. Weights at age in the stock (Table 7.2.4, Figure 7.2.1) are the 2nd quarter landings weights. No clear trends are evident over the last years. Over the entire time series, weights were higher during the 1980’s compared to the 1960-1970’s and recent period. Weights for older ages became more variable because of lower number of samples due to decreasing numbers of older animals in the stock.

7.2.4 Maturity and natural mortality

As in all previous assessments, a knife-edged maturity-ogive was used in all years, assuming full maturation at age 3. The maturity-ogive is based on market samples of females from observations in the sixties and seventies.

Natural mortality in the period 1957-1999 has been assumed constant over all ages at 0.1, except for 1963 where a value of 0.9 was used to take into account the effect of the severe winter (ICES CM 1979/G:10). In 1996 additional natural mortality was observed in the cold winter of 1995/1996 (ICES 1997/Assess:6), but in the absence of a precise estimate, the standard value of 0.1 has been retained.

7.2.5 Catch, effort and research vessel data

One commercial and two survey tuning-series were used to tune the assessment. Effort for the Dutch commercial beam trawl is expressed as total HP effort days. Effort nearly doubled between 1978 and 1994, but since 1996 the effort showed a decline and is currently around the same level as it was in the early 1980’s (Table 7.2.5 and 7.2.6, Figure 7.2.2).

Trends in commercial CPUE by area and fleet component are shown in Figure 7.2.3. The data are based on landings into the Netherlands. There is a clear separation in CPUE between areas, with the southern area given a substantially higher CPUE than the Northern area. The overall pattern indicates a gradual decrease in CPUE over the time-series.

The BTS (Beam Trawl Survey) is carried out in the southern and south-eastern North Sea in August and September using an 8-m beam trawl. The SNS (Sole Net Survey) is a coastal survey with a 6-m beam trawl carried out in the 3rd quarter. In 2003 this survey was carried out during the 2nd quarter and data from this year were omitted (Table 7.2.6).

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 using a 3-m and a 6-m beam trawl. This survey is directed to 0 and 1-group plaice and sole (Table 7.2.6). The combined international DFS index is only used for RCT3 analysis and not for tuning the VPA.

7.3 Data analyses

7.3.1 Exploratory catch-at-age based analyses

A catch at age analysis was carried out using the same settings as last year. Exploration of the log catchability residuals showed negative residuals for the BTS in the last year over all ages, while the SNS showed positive residuals in the last year (Figure 7.3.1). For the preceding years however no patterns in residuals were observed for both surveys. No clear patterns in residuals were observed for the Dutch commercial beam trawl.

7.3.2 Exploratory survey based analyses

The VPA is tuned with a commercial tuning series that is derived from the fleet that takes most of the landings. SURBA (section 1.3.4) was used to explore trends in relative SSB, independent of landings at age data and commercial tuning series. Figure 7.3.2 shows the mean standardized index for the BTS and SNS. The assessment was performed with setting the reference age to 2, q1 to 1 and lambda to 1. The stock summary from the SURBA exploratory run is shown in Figure 7.3.3. During 1975-1990 the SSB was low compared to the early 1990s. After 1994 the SSB was, except for 1999, lower than during the early 1990s. The pattern in SSB from the SURBA assessment is in agreement with the pattern in SSB from the XSA assessment.

To explore the effect of different parameters on the estimate of SSB, different runs were performed with Lambda set to 0, 0.5, 1, 2 and 3, reference age to 2, 3 and 4, and q1 to 0.1, 0.5 and 1 (Figure 7.3.4). Most combinations of settings showed agreement in the pattern of high SSB in the 1990s and increased SSB in the final year.

7.3.3 Conclusions

The assessment for this stock is an update assessment. Exploration of the log catchability residuals did not show trends over time for the three tuning fleet time series. Exploration of a survey based assessment showed agreement in relative SSB with the exploratory XSA assessment. For the final assessment the same settings as last year were used.

7.3.4 Final assessment

Catch at age analysis was carried out using the same settings as last year's assessment, using XSA. Results of the analysis are presented in Tables 7.3.1 (diagnostics), 7.3.2 (Fishing mortality at age) and 7.3.3 (population numbers at age).

Retrospective patterns in mean F, SSB en recruitment are shown in Figure 7.3.5. Retrospective patterns suggest that F has been underestimated in previous years, and SSB slightly overestimated.

A bootstrap analysis of the North Sea sole assessment was carried out using the FLR version of XSA to give insight into the uncertainty, which is associated with the model assumptions. In the bootstrap, catchability residuals of the tuning fleets were resampled with replacement. Bootstrapped tuning series were generated from the estimated stock numbers at age, the catchabilities and the bootstrapped residuals at age. The bootstrapped tuning series where then rescaled to the period of the survey. Bootstrapping age 1, which is estimated in XSA with a power model, could not be carried out, because the technique of reconstructing the survey indices from the slope and the intercept was not precisely specified. Several bootstrap analyses have been carried out, including bootstrap analyses, which were carried forward into the projection. In that case, each bootstrap result was carried forward with three random F multipliers, which were drawn between 0.2 and 2.0.

In this section the results of three different bootstrap analyses are presented, which aim to give insight into the uncertainty, which is associated with the model assumptions regarding the plus-group (age 10 or 15) and shrinkage (0.5 or 2.0). Figure 7.3.6 shows the sensitivity of the bootstrap results to the model assumptions. It appears that a bootstrap of the current assessment of North Sea sole (plus-group age 10, shrinkage 2.0) is associated with a high uncertainty in the terminal population and fishing mortality estimates in the recent years, but also further back in the historical series. This is likely to be due to the estimation of fishing mortality on the oldest age, which is not well specified with the combination of low shrinkage and a low plus-group in periods where substantial catches of older fish were generated. Increasing the plus-group to age 15 appears to remedy this situation for the historical period. The introduction of a high shrinkage gives the impression of a more precise assessment of terminal populations and fishing mortality. It should be noted that the latter could give rise to a bias in the perception of stock status and is generally not recommendable. The choice to reduce the plus-group to age 10 (ICES CM 2004/ACFM:07) needs further scrutiny at the next benchmark assessment (2006).

7.4 Historic stock trends

Table 7.4.1 and Figure 7.4.1 present the trends in landings, recruitment, mean F2–6 and SSB since 1957.

Reported landings increased to the end of the 1960s, showed a period of lower landings until the end of the 1980s and a period of higher landings during the early 1990s. In 2004 landings were estimated to be around 17 000 t.

Recruitment was high in 1959 and 1964 and SSB increased from the end of the 1950s to a peak in early 1960s, followed by a period of declining SSB until the 1990s. Recruitment was high in 1988 and 1992 and between 1990-1995 a period of higher SSB was observed. After 1995 the SSB decreased to a low in 1998. The SSB in 2004 increased compared to 2003, because of the strong 2001 year class coming into the adult population. The SSB in 2004 is the highest observed since 1995, and is estimated at 42 000 t. Recruitment in 2004 of the 2003 year class at the age of 1 was estimated at 65 million, the lowest observed since 1996.

Mean fishing mortality on ages 2-6 increased until the end of the 1980s, was lower in the beginning of the 1990s but increased rapidly to a high in 1996 of 0.70. In recent years fishing mortality has decreased gradually. In 2004 fishing mortality decreased markedly compared to 2003 and was estimated at 0.35, the lowest observed since 1966.

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 for age-1 and Table 7.5.2 for age-2, results are presented in Table 7.5.3 for age-1 and Table 7.5.4 for age-2. Average recruitment of 1-year-old-fish in the period 1957-2002 was around 97 million (geometric mean). Year class strength estimates used for the short-term forcast are underlined in the text table below.

Year Class	Age in 2005	XSA thousands	RCT3 thousands	GM(1957-2002) thousands
2003	2	58,466	<u>58,657</u>	84,107
2004	1		75,085	<u>97,039</u>
2005	Recruit			<u>97,039</u>

7.6 Short-term forecasts

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 (catch forecast table) and 7.6.3 (detailed forecast tables). Figure 7.6.1 show the probability profiles for the short term forecast. A scaled three-year mean was used for $\boldsymbol{F}_{sq}$, the exploitation pattern in the intermediate year (2005). On this basis, landings in 2005 are forecast to be 15 000 t, which is lower than the TAC in 2005. With F in 2006 set to $\boldsymbol{F}_{sq}$, the SSB in 2007 would be 39 000 t, which is slightly above $\boldsymbol{B}_{pa}$ (= 35 000 t).

A probabilistic forecast of North Sea sole was carried out based on the bootstrapped XSA of the final assessment. See section 7.3.4 for a description of the bootstrap settings. The results of the probabilistic forecast were hard to interpret because in general SSB and landings were slightly higher than the results from the deterministic forecast. The results in Table 7.6.4 are presented as an example of the output of the method, rather than as a basis for the advice.

7.7 Medium-term projections

No medium-term projections were done this year.

7.8 Yield per recruit

Yield per recruit, long-term yield and SSB, conditional on the present exploitation pattern and assuming status quo F in 2005 are given in Table 7.8.1 and Figure 7.6.2. $\mathbf{F}_{max}$ is estimated at 0.36. Long-term yield and SSB using recruitment geometric mean and $\mathbf{F}_{sq}$ are estimated at 17 000 t and 45 000 t respectively.

7.9 Biological reference points

The biological reference points and the basis for the management reference point are:

$\mathbf{B}_{lim}$=$\mathbf{B}_{loss}$=25 000 t. $\mathbf{B}_{pa}$ = 1.4 *$\mathbf{B}_{lim}$.

$\mathbf{F}_{pa}$ = 5th percentile (0.49) of $\mathbf{F}_{loss}$ implies Beq < ~ $\mathbf{B}_{pa}$,

F=0.4 implies Beq > $\mathbf{B}_{pa}$ and P(**SS**BMT < $\mathbf{B}_{pa}$) < 10%.

7.10 Quality of the assessment

This year's assessment of North Sea sole was carried out as an update assessment. Exploratory analysis with an assessment based on survey data only showed equal trends in stock indicators as the XSA assessment tuned with commercial and survey tuning indices.

Retrospective patterns suggest that F has been underestimated in previous years, and SSB overestimated. The historic performance of the assessment is summarised in Figure 7.10.1.

Three different bootstrap assessments have been presented in section 7.4. The bootstrap analysis aim to give insight into the uncertainty associated with the model assumptions regarding the plus-group and shrinkage. Current assessment is associated with a high uncertainty in the terminal population and fishing mortality estimates, which is likely to be due to the estimation of fishing mortality on the oldest age, which is not well specified with the combination of low shrinkage and a low plus-group in periods where substantial catches of older fish were generated. Increasing the plus-group to age 15 appears to remedy this situation for the historical period. The introduction of high shrinkage shows a more precise assessment of terminal populations and fishing mortality, but could give rise to a bias in the perception of stock status.

Discard percentages of sole observed in the Dutch sampling programmes are low compared to plaice, and appear to have remained stable over time. A complete time series of sole discards is not available and discards have not been used in the assessment.

From the North Sea fishers' survey (see Section 1 and Figure 7.10.2) there are indications that the abundance of sole increased in the Skagerrak (areas 7, 8, 9) compared to last year. For the North Sea no clear pattern could be detected. The abundance was reported to increase in the central North Sea (area 2), remained the same in the north-western, western and south-western areas (areas 1, 3, 4, 5) and decreased in the south-eastern area (area 6b). The XSA assessment showed an increase in SSB in 2004 compared to 2003, caused by the strong 2001 yearclass which was already picked up by the comments in the fishers' survey of 2003.

A recent study by Rijnsdorp et al. (submitted) investigating the use of FPUE (partial F per unit of effort) as indicator for effort management showed that the efficiency of the Dutch beam trawl fleet has increased over time, irrespective of engine power. According to this method, the catch efficiency could have had increased for sole by on average 3% annually during 1990-2003. This increase was mainly caused by 1) increase in efficiency during the time a vessel is in operation (contribution for sole of 42%), 2) vessel replacement (30%) and 3) engine upgrading (28%). The effort series of the Dutch beam trawl fleet that is used in the calibration of the assessment has not (yet) been corrected for the increase in technical efficiency because the methodology would need to be fully scrutinized by the WG before it can be adopted.

A benchmark assessment for North Sea sole is scheduled for 2007. During this benchmark, attention should be paid to the following issues:

- In 2003 the plus-group was set from age 15 to age 10. The choice to reduce the plus-group to age 10 needs further scrutiny.
- Changes in technical efficiency in the commercial fleets. In relation to this, investigate calibration with or without commercial fleet data
- Trends in mean weights and maturity and how that could affect the assessment and forecasts

7.11 State of the stock

Fishing mortality was estimated at 0.35 in 2004, the lowest observed since the 1960s. Fishing mortality appears to be below $\mathbf{F}_{pa}$ (=0.40). The SSB in 2004 was estimated at 42 000 t which is above $\mathbf{B}_{pa}$ (=35 000 t). The recent increase in SSB is driven by the strong 2001 year class.

7.12 Management considerations

Sole is mainly taken by beam trawlers in a mixed fishery with plaice in the southern and central part of the North Sea.

Fishing effort has been substantially reduced since 1995. The reduction in fishing effort appears to be reflected in recent estimates in fishing mortality. There are indications that technical efficiency has increased in this fishery, which can have counteracted the overall decrease in effort.

This assessment suggests that F has been underestimated in previous years, and SSB overestimated.

Technical measures applicable to the mixed flatfish fishery will affect both sole and plaice. The minimum mesh size of 80 mm in the beam trawl fishery selects sole at the minimum landing size. However, this mesh size generates high discards of plaice which are selected from 17 cm with a minimum landing size of 27 cm. Mesh enlargement would reduce the catch of undersized plaice, but would also result in loss of marketable sole.

The combination of days-at-sea regulations, high oil prices, and decreasing TAC for plaice and relatively stable TAC for sole, appear to have induced a more coastal fishing pattern in the southern North Sea. This concentration of fishing effort could result to increased discarding of juvenile plaice that are mainly distributed in those areas.

The stock dynamics are heavily dependent on the occasional occurrence of strong year classes.

The mean age in the landings is currently just above age 3, but used to be around age 6 in the beginning of the time series. A lower exploitation level is expected to improve the survival of sole to the spawning population, which could enhance the stability in the catches.

Table 7.2.1. Sole in sub-area IV: Nominal landings and landings as estimated by the Working Group in tonnes

Year	Belgium	Denmark	France	Germany	Netherlands	UK (E/W/NI)	Other countries	Total reported	Unallocated landings	WG Total	TAC
1982	1927	522	686	290	17749	403		21174	405	21579	21000
1983	1740	730	332	619	16101	435		19522	5405	24927	20000
1984	1771	818	400	1034	14330	586	1	18354	8485	26839	20000
1985	2390	692	875	303	14897	774	3	19160	5088	24248	22000
1986	1833	443	296	155	9558	647	2	12287	5914	18201	20000
1987	1644	342	318	210	10635	676	4	13153	4215	17368	14000
1988	1199	616	487	452	9841	740	28	12623	8967	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	3335	29339	25000
1993	2783	1661	490	1379	22015	1149	298	29775	1716	31491	32000
1994	2935	1804	499	1744	22874	1137	298	31291	1711	33002	32000
1995	2624	1673	640	1564	20927	1040	312	28780	1687	30467	28000
1996	2555	1018	535	670	15344	848	229	21199	1452	22651	23000
1997	1519	689	99	510	10241	479	204	13741	1160	14901	18000
1998	1844	520	510	782	15198	549	339	19742	1126	20868	19100
1999	1919	828	357	1458	16283	645	501	21991	1484	23475	22000
2000	1806	1069	362	1280	15273	600	346	20736	1796	22532	22000
2001	1874	772	411	958	13345	597	395	18352	1592	19944	19000
2002	1437	644	266	759	12120	451	292	15969	976	16945	16000
2003	1605	703	264	749	12469	520	364	16674	1246	17920	15850
2004	1451	805	NA*	949	12869	534	541	17149	1609	18758	17000

*** Landings were provided to the WG, but not officially to ICES**

Table 7.2.2. Sole in sub-area IV: Landings numbers at age (thousands)

year	1	2	3	4	5	6	7	8	9	10
1957	0	1415	10148	12642	3762	2924	6518	1733	509	6288
1958	0	1854	8440	14169	9500	3484	3008	4439	2253	6557
1959	0	3659	12025	10401	8975	5768	1206	2025	2574	5615
1960	0	12042	14133	16798	9308	8367	4846	1593	1056	7901
1961	0	959	49786	19140	12404	4695	3944	4279	836	7254
1962	0	1594	6210	59191	15346	10541	4826	4112	2087	7494
1963	0	676	8339	8555	46201	8490	6658	2423	3393	8384
1964	55	155	2113	5712	3809	17337	3126	1810	818	3015
1965	0	47100	1089	1599	5002	2482	12500	1557	1525	3208
1966	0	12278	133617	990	1181	3689	744	6324	702	2450
1967	0	3686	25683	85127	1954	536	1919	760	5047	2913
1968	1037	17148	13896	24973	48571	462	245	1644	324	6523
1969	396	23922	21451	5326	12388	25139	331	244	1190	5272
1970	1299	6140	25993	8235	1784	3231	11960	246	140	5234
1971	420	33369	14425	12757	4485	1442	2327	7214	192	4594
1972	358	7594	36759	7075	4965	1565	523	1232	4706	2801
1973	703	12228	12783	16187	4025	2324	994	765	1218	5790
1974	101	15380	21540	5487	7061	1922	1585	658	401	4814
1975	264	22954	28535	11717	2088	3830	790	907	508	3445
1976	1041	3542	27966	14013	4819	966	1909	550	425	2663
1977	1747	22328	12073	15306	7440	1779	319	1112	256	2115
1978	27	25031	29292	6129	6639	4250	1738	611	646	1602
1979	9	8179	41170	16060	2996	3222	1747	816	241	1527
1980	637	1209	12511	17781	7297	1450	2197	1409	367	1203
1981	423	29217	3259	6866	8223	3661	948	886	766	908
1982	2660	26435	45746	1843	3535	4789	1678	615	605	1278
1983	389	34408	41386	21189	624	1378	1950	978	386	1176
1984	191	30734	43931	22554	8791	741	854	1043	524	894
1985	165	16618	43213	20286	9403	3556	209	379	637	975
1986	374	9363	18497	17702	7747	5515	2270	110	283	1682
1987	94	29053	22046	8899	6512	3119	1567	903	81	694
1988	10	13219	47182	15232	4381	3882	1551	891	524	317
1989	117	46387	18263	22654	4624	1653	1437	647	458	468
1990	863	11939	104454	9767	9194	3349	1043	1198	554	845
1991	120	13163	25420	77913	6724	3675	1736	719	730	1090
1992	980	6832	44378	16204	38319	2477	3041	741	399	1180
1993	54	50451	16768	31409	13869	24035	1489	1184	461	842
1994	718	7804	87403	13550	18739	5711	11310	464	916	908
1995	4801	12767	16822	68571	6308	7307	1995	6015	295	668
1996	172	18824	16190	16964	27257	3858	4780	943	3305	988
1997	1590	6047	23651	7325	5108	12793	1201	2326	333	1688
1998	244	56648	15141	14934	3496	1941	4768	794	1031	846
1999	287	15762	72470	8187	6111	1212	664	1984	331	812
2000	2351	15073	32738	42803	3288	2477	804	435	931	714
2001	884	25846	21595	19876	16730	1427	834	274	168	724
2002	1055	11053	32852	12290	8215	6448	673	597	89	364
2003	1048	32330	17498	16090	5820	3906	2430	400	128	451
2004	278	13972	46475	7033	6316	1486	799	677	169	154

Table 7.2.3. Sole in sub-area IV: Landings weights at age (kg)

year	1	2	3	4	5	6	7	8	9	10
1957	0.000	0.154	0.177	0.204	0.248	0.279	0.290	0.335	0.436	0.408
1958	0.000	0.145	0.178	0.220	0.254	0.273	0.314	0.323	0.388	0.413
1959	0.000	0.162	0.188	0.228	0.261	0.301	0.328	0.321	0.373	0.426
1960	0.000	0.153	0.185	0.235	0.254	0.277	0.301	0.309	0.381	0.418
1961	0.000	0.146	0.174	0.211	0.255	0.288	0.319	0.304	0.346	0.419
1962	0.000	0.155	0.165	0.208	0.241	0.295	0.320	0.321	0.334	0.412
1963	0.000	0.163	0.171	0.219	0.258	0.309	0.323	0.387	0.376	0.485
1964	0.153	0.175	0.213	0.252	0.274	0.309	0.327	0.346	0.388	0.480
1965	0.000	0.169	0.209	0.246	0.286	0.282	0.345	0.378	0.404	0.480
1966	0.000	0.177	0.190	0.180	0.301	0.332	0.429	0.399	0.449	0.501
1967	0.000	0.192	0.201	0.252	0.277	0.389	0.419	0.339	0.424	0.491
1968	0.157	0.189	0.207	0.267	0.327	0.342	0.354	0.455	0.465	0.508
1969	0.152	0.191	0.196	0.255	0.311	0.373	0.553	0.398	0.468	0.523
1970	0.154	0.212	0.218	0.285	0.350	0.404	0.441	0.463	0.443	0.533
1971	0.145	0.193	0.237	0.322	0.358	0.425	0.420	0.490	0.534	0.547
1972	0.169	0.204	0.252	0.334	0.434	0.425	0.532	0.485	0.558	0.629
1973	0.146	0.208	0.238	0.346	0.404	0.448	0.552	0.567	0.509	0.586
1974	0.164	0.192	0.233	0.338	0.418	0.448	0.520	0.559	0.609	0.653
1975	0.129	0.182	0.225	0.320	0.406	0.456	0.529	0.595	0.629	0.669
1976	0.143	0.190	0.222	0.306	0.389	0.441	0.512	0.562	0.667	0.665
1977	0.147	0.188	0.236	0.307	0.369	0.424	0.430	0.520	0.562	0.619
1978	0.152	0.196	0.231	0.314	0.370	0.426	0.466	0.417	0.572	0.666
1979	0.137	0.208	0.246	0.323	0.391	0.448	0.534	0.544	0.609	0.763
1980	0.141	0.199	0.244	0.331	0.371	0.418	0.499	0.550	0.598	0.684
1981	0.143	0.187	0.226	0.324	0.378	0.424	0.442	0.516	0.542	0.630
1982	0.141	0.188	0.216	0.307	0.371	0.409	0.437	0.491	0.580	0.656
1983	0.134	0.182	0.217	0.301	0.389	0.416	0.467	0.489	0.505	0.642
1984	0.153	0.171	0.221	0.286	0.361	0.386	0.465	0.555	0.575	0.634
1985	0.122	0.187	0.216	0.288	0.357	0.427	0.447	0.544	0.612	0.645
1986	0.135	0.179	0.213	0.299	0.357	0.407	0.485	0.543	0.568	0.610
1987	0.139	0.185	0.205	0.277	0.356	0.378	0.428	0.481	0.393	0.657
1988	0.127	0.175	0.217	0.270	0.354	0.428	0.484	0.521	0.559	0.712
1989	0.118	0.173	0.216	0.288	0.336	0.375	0.456	0.492	0.470	0.611
1990	0.124	0.183	0.227	0.292	0.371	0.413	0.415	0.514	0.476	0.620
1991	0.127	0.186	0.210	0.263	0.315	0.436	0.443	0.467	0.507	0.558
1992	0.146	0.178	0.213	0.258	0.298	0.380	0.409	0.460	0.487	0.556
1993	0.097	0.167	0.196	0.239	0.264	0.300	0.338	0.441	0.496	0.603
1994	0.143	0.180	0.202	0.228	0.257	0.300	0.317	0.432	0.409	0.510
1995	0.151	0.186	0.196	0.247	0.265	0.319	0.344	0.356	0.444	0.591
1996	0.163	0.177	0.202	0.234	0.274	0.285	0.318	0.370	0.390	0.594
1997	0.151	0.180	0.206	0.236	0.267	0.296	0.323	0.306	0.384	0.440
1998	0.128	0.182	0.189	0.252	0.262	0.289	0.336	0.292	0.335	0.504
1999	0.163	0.179	0.212	0.229	0.287	0.324	0.354	0.372	0.372	0.453
2000	0.145	0.170	0.200	0.248	0.290	0.299	0.323	0.368	0.402	0.427
2001	0.143	0.185	0.202	0.270	0.275	0.333	0.391	0.414	0.433	0.493
2002	0.140	0.183	0.211	0.243	0.281	0.312	0.366	0.319	0.571	0.536
2003	0.136	0.182	0.214	0.256	0.273	0.317	0.340	0.344	0.503	0.431
2004	0.139	0.187	0.212	0.261	0.278	0.297	0.406	0.414	0.389	0.589

Table 7.2.4. Sole in sub-area IV: Stock weights at age (kg)

year	1	2	3	4	5	6	7	8	9	10
1957	0.025	0.070	0.147	0.187	0.208	0.253	0.262	0.355	0.390	0.365
1958	0.025	0.070	0.164	0.205	0.226	0.228	0.297	0.318	0.393	0.422
1959	0.025	0.070	0.159	0.198	0.239	0.271	0.292	0.276	0.303	0.426
1960	0.025	0.070	0.163	0.207	0.234	0.240	0.268	0.242	0.360	0.431
1961	0.025	0.070	0.148	0.206	0.235	0.232	0.259	0.274	0.281	0.396
1962	0.025	0.070	0.148	0.192	0.240	0.301	0.293	0.282	0.273	0.441
1963	0.025	0.070	0.148	0.193	0.243	0.275	0.311	0.363	0.329	0.465
1964	0.025	0.070	0.159	0.214	0.240	0.291	0.305	0.306	0.365	0.474
1965	0.025	0.140	0.198	0.223	0.251	0.297	0.337	0.358	0.526	0.460
1966	0.025	0.070	0.160	0.149	0.389	0.310	0.406	0.377	0.385	0.505
1967	0.025	0.177	0.164	0.235	0.242	0.399	0.362	0.283	0.381	0.459
1968	0.025	0.122	0.171	0.248	0.312	0.280	0.629	0.416	0.410	0.486
1969	0.025	0.137	0.174	0.252	0.324	0.364	0.579	0.415	0.469	0.521
1970	0.025	0.137	0.201	0.275	0.341	0.367	0.423	0.458	0.390	0.554
1971	0.034	0.148	0.213	0.313	0.361	0.410	0.432	0.474	0.483	0.533
1972	0.038	0.155	0.218	0.313	0.419	0.443	0.443	0.443	0.508	0.602
1973	0.039	0.149	0.226	0.322	0.371	0.433	0.452	0.472	0.446	0.536
1974	0.035	0.146	0.218	0.329	0.408	0.429	0.499	0.565	0.542	0.618
1975	0.035	0.148	0.206	0.311	0.403	0.446	0.508	0.582	0.580	0.650
1976	0.035	0.142	0.201	0.301	0.379	0.458	0.508	0.517	0.644	0.665
1977	0.035	0.147	0.202	0.291	0.365	0.409	0.478	0.487	0.531	0.644
1978	0.035	0.139	0.211	0.290	0.365	0.429	0.427	0.385	0.542	0.644
1979	0.045	0.148	0.211	0.300	0.352	0.429	0.521	0.562	0.567	0.743
1980	0.039	0.157	0.200	0.304	0.345	0.394	0.489	0.537	0.579	0.645
1981	0.050	0.137	0.200	0.305	0.364	0.402	0.454	0.522	0.561	0.622
1982	0.050	0.130	0.193	0.270	0.359	0.411	0.429	0.476	0.583	0.642
1983	0.050	0.140	0.200	0.285	0.329	0.435	0.464	0.483	0.510	0.636
1984	0.050	0.133	0.203	0.268	0.348	0.386	0.488	0.591	0.567	0.664
1985	0.050	0.127	0.185	0.267	0.324	0.381	0.380	0.626	0.554	0.642
1986	0.050	0.133	0.191	0.278	0.345	0.423	0.495	0.487	0.587	0.686
1987	0.050	0.154	0.191	0.262	0.357	0.381	0.406	0.454	0.332	0.620
1988	0.050	0.133	0.193	0.260	0.335	0.409	0.417	0.474	0.486	0.654
1989	0.050	0.133	0.195	0.290	0.350	0.340	0.411	0.475	0.419	0.595
1990	0.050	0.148	0.203	0.294	0.357	0.447	0.399	0.494	0.481	0.653
1991	0.050	0.139	0.184	0.254	0.301	0.413	0.447	0.522	0.548	0.573
1992	0.050	0.156	0.194	0.257	0.307	0.398	0.406	0.472	0.500	0.540
1993	0.050	0.128	0.184	0.229	0.265	0.293	0.344	0.482	0.437	0.583
1994	0.050	0.143	0.174	0.209	0.257	0.326	0.349	0.402	0.494	0.459
1995	0.050	0.151	0.179	0.240	0.253	0.321	0.365	0.357	0.545	0.545
1996	0.050	0.147	0.178	0.208	0.274	0.268	0.321	0.375	0.402	0.546
1997	0.050	0.150	0.190	0.225	0.252	0.303	0.319	0.325	0.360	0.424
1998	0.050	0.140	0.173	0.234	0.267	0.281	0.328	0.273	0.336	0.455
1999	0.050	0.131	0.187	0.216	0.259	0.296	0.340	0.322	0.369	0.464
2000	0.050	0.139	0.185	0.226	0.264	0.275	0.287	0.337	0.391	0.376
2001	0.050	0.144	0.185	0.223	0.263	0.319	0.327	0.421	0.410	0.530
2002	0.050	0.145	0.197	0.245	0.267	0.267	0.299	0.308	0.435	0.435
2003	0.050	0.146	0.194	0.240	0.256	0.288	0.330	0.312	0.509	0.470
2004	0.050	0.137	0.195	0.240	0.245	0.305	0.316	0.448	0.356	0.585

Table 7.2.5. Sole in sub-area IV: Effort and CPUE series

Year	NL Beam HP days *million	NL Beam Landings * tonnes
1978	44.3	375.8
1979	44.9	423.2
1980	45.0	282.1
1981	46.3	267.8
1982	57.3	309.8
1983	65.6	319.9
1984	70.8	307.3
1985	70.3	276.3
1986	68.2	213.4
1987	68.5	204.5
1988	76.3	235.9
1989	61.6	272.7
1990	71.4	378.1
1991	68.5	350.9
1992	71.1	307.1
1993	76.9	306.4
1994	81.4	295.6
1995	81.2	275.1
1996	72.1	227.1
1997	72.0	151.7
1998	70.2	230.7
1999	67.3	257.9
2000	67.7	240.6
2001	61.4	220.1
2002	56.4	229.0
2003	51.6	260.9
2004	49.3	278.5

Table 7.2.6. Sole in sub-area IV: Tuning data. First two surveys (BTS and SNS) and the commercial series are used in assessment, last survey (DFS) only for recruitment estimates.

BTS

		1	2	3	4	5	6	7	8	9
1985	1	2.65	7.89	3.541	1.669	0.620	0.279	0.000	0.000	0.000
1986	1	7.88	4.49	1.726	0.826	0.590	0.216	0.101	0.002	0.021
1987	1	6.99	12.55	1.834	0.563	0.583	0.223	0.230	0.061	0.026
1988	1	81.23	12.81	2.776	0.997	0.131	0.154	0.121	0.095	0.013
1989	1	9.42	68.08	4.191	4.096	0.677	0.128	0.242	0.000	0.138
1990	1	22.62	22.36	20.090	0.611	0.682	0.511	0.078	0.055	0.013
1991	1	3.34	23.19	5.843	6.011	0.100	0.135	0.075	0.033	0.012
1992	1	74.22	23.20	9.879	2.332	2.903	0.061	0.142	0.065	0.016
1993	1	4.98	27.36	0.987	4.367	2.376	4.295	0.027	0.094	0.064
1994	1	5.88	4.99	15.422	0.134	1.407	0.097	0.995	0.014	0.004
1995	1	27.62	8.46	7.039	6.718	0.476	0.913	0.314	0.966	0.049
1996	1	3.51	6.17	1.909	1.488	2.493	0.309	0.408	0.054	0.290
1997	1	173.24	5.37	3.234	0.800	0.769	0.403	0.105	0.038	0.045
1998	1	14.12	29.21	1.998	1.346	0.079	0.016	0.424	0.000	0.000
1999	1	11.41	19.26	16.626	0.629	2.061	0.334	0.224	0.651	0.003
2000	1	12.89	6.53	4.093	1.597	0.284	0.155	0.064	0.008	0.162
2001	1	7.97	10.84	2.350	1.681	0.740	0.081	0.040	0.030	0.000
2002	1	21.46	4.24	3.412	0.930	0.354	0.355	0.022	0.060	0.000
2003	1	10.76	10.55	2.506	1.752	0.380	0.202	0.337	0.000	0.022
2004	1	3.69	4.40	3.603	0.636	0.659	0.127	0.079	0.087	0.000

SNS

		1	2	3	4
1970	1	4938	745	204	31.0
1971	1	613	1961	99	7.0
1972	1	1410	341	161	0.1
1973	1	4686	905	73	35.0
1974	1	1924	397	69	0.1
1975	1	597	887	174	44.0
1976	1	1413	79	187	70.0
1977	1	3724	762	77	85.0
1978	1	1552	1379	267	27.0
1979	1	104	388	325	60.0
1980	1	4483	80	99	45.0
1981	1	3739	1411	51	13.0
1982	1	5098	1124	231	7.0
1983	1	2640	1137	107	43.0
1984	1	2359	1081	307	102.0
1985	1	2151	709	159	59.0
1986	1	3791	465	67	30.0
1987	1	1890	955	59	15.0
1988	1	11227	594	284	81.0
1989	1	3052	5369	248	50.0
1990	1	2900	1078	907	100.0
1991	1	1265	2515	527	607.0
1992	1	11081	114	319	194.0
1993	1	1351	3489	46	166.0
1994	1	559	475	943	10.0
1995	1	1501	234	126	365.0
1996	1	691	473	27	48.0
1997	1	10132	143	231	51.0
1998	1	2876	1993	131	52.0
1999	1	1649	919	381	12.3
2000	1	1735	150	189	95.7
2001	1	949	638	99	32.0
2002	1	7093	361	174	0.0
2003	1	NA	NA	NA	NA
2004	1	1372	627	397	72.3

Table 7.2.6. continued

NL Beam Trawl

		2	3	4	5	6	7	8	9
1990	71.1	127.6	1190	101.9	92.6	23.5	8.93	11.52	5.288
1991	68.5	107.1	251	872.3	67.7	31.2	9.97	4.55	5.723
1992	71.1	71.0	477	156.6	419.6	20.5	29.27	6.27	3.080
1993	76.9	510.9	142	313.8	125.2	242.2	11.53	10.56	3.069
1994	81.4	66.2	858	91.1	159.8	38.1	109.74	2.33	6.437
1995	81.2	120.4	140	658.7	35.0	63.2	11.05	57.66	1.810
1996	72.1	219.7	126	154.9	294.2	21.8	44.01	6.55	38.474
1997	72.0	62.6	256	62.6	46.2	135.7	6.90	25.00	1.319
1998	70.2	720.4	129	158.4	26.0	16.3	48.36	3.01	4.801
1999	67.3	175.6	820	61.7	66.3	10.8	4.99	22.69	1.976
2000	67.7	181.8	437	321.2	30.2	23.3	6.72	4.76	9.468
2001	61.4	305.0	222	243.8	213.0	11.7	8.24	2.21	1.515
2002	56.4	159.7	440	140.7	107.0	90.1	7.52	6.81	0.957
2003	51.6	502.8	224	241.1	65.8	54.7	38.02	4.36	1.202
2004	49.3	227.0	755	114.3	102.6	24.1	12.98	10.99	2.738

DFS

	0	1
1975	168.84	2.86
1976	82.28	6.95
1977	33.80	9.69
1978	96.87	2.13
1979	392.08	2.27
1980	404.00	48.21
1981	289.72	13.90
1982	330.38	14.06
1983	115.96	25.87
1984	187.17	12.45
1985	292.92	3.32
1986	72.97	13.66
1987	527.45	6.19
1988	56.08	38.02
1989	62.77	12.62
1990	22.54	12.30
1991	360.44	8.52
1992	25.38	17.66
1993	25.01	10.60
1994	74.25	6.12
1995	18.82	9.46
1996	58.51	3.64
1997	53.35	19.92
1998	NA	NA
1999	NA	NA
2000	16.15	4.56
2001	86.41	3.07
2002	64.71	18.35
2003	18.77	5.34
2004	34.5	4.18

Table 7.2.7. Sole in sub-area IV: Overview of sampling effort of the Dutch discards sampling programme for 2002-2004

Year	Number trips	Number sampled hauls	Number length measurements landings	Numbers length measurements discards	Number age measurements discards
2002	8	241	4940	466	44
2003	10	332	5853	948	94
2004	10	310	3751	920	109

Table 7.2.8. Sole in sub-area IV: Overview of numbers and weight at age and discard percentages in the Dutch discards sampling programmes

		Numbers			Weight		
Period	N trips	Landings	Discards	%D	Landings	Discards	%D
1976-1979	21	116	8	6%	38	1	3%
1980-1983	22	84	23	21%	27	3	9%
1989-1990	6	286	83	22%	72	11	13%
1999-2001	20	92	21	19%	22	2	8%
2002	6	124	37	24%	18	3	13%
2003	9	95	32	25%	20	3	14%
2004	8	174	58	25%	28	5	17%

Table 7.3.1. Sole in sub-area IV: XSA diagnostics

Lowestoft VPA Version 3.1

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Extended Survivors Analysis
Sole in IV
CPUE data from file fleet.txt
Catch data for 48 years. 1957 to 2004. Ages 1 to 10.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
BTS ,	1985,	2004,	1,	9,	.660,	.750
SNS ,	1970,	2004,	1,	4,	.660,	.750
NL Beam Trawl ,	1990,	2004,	2,	9,	.000,	1.000
NL Beam Trawl (alt. ,	1990,	2004,	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 applied :

Fleet	Weight
BTS	1.00
SNS	1.00
NL Beam	1.00
NL Beam	.00

Tuning converged after 25 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,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004
1,	.054,	.004,	.006,	.002,	.004,	.019,	.014,	.005,	.012,	.005
2,	.306,	.275,	.154,	.280,	.173,	.244,	.271,	.215,	.206,	.201
3,	.445,	.695,	.578,	.619,	.609,	.570,	.576,	.576,	.545,	.452
4,	.763,	.978,	.697,	.789,	.718,	.793,	.724,	.672,	.547,	.389
5,	.609,	.698,	.803,	.759,	.783,	.627,	.739,	.665,	.697,	.380
6,	.532,	.837,	.742,	.729,	.572,	.760,	.542,	.628,	.685,	.334
7,	.786,	.710,	.599,	.604,	.520,	.833,	.551,	.470,	.452,	.251
8,	.484,	.977,	.811,	.915,	.481,	.682,	.674,	.872,	.501,	.193
9,	.956,	.475,	1.039,	.948,	1.170,	.386,	.540,	.423,	.400,	.362

XSA population numbers (Thousands)

	AGE								
YEAR ,	1,	2,	3,	4,	5,	6,	7,	8,	9,
1995 ,	9.61E+04,	5.10E+04,	4.93E+04,	1.35E+05,	1.45E+04,	1.86E+04,	3.85E+03,	1.65E+04,	5.04E+02,
1996 ,	4.93E+04,	8.24E+04,	3.40E+04,	2.86E+04,	5.70E+04,	7.15E+03,	9.89E+03,	1.59E+03,	9.18E+03,
1997 ,	2.71E+05,	4.45E+04,	5.67E+04,	1.53E+04,	9.73E+03,	2.57E+04,	2.80E+03,	4.40E+03,	5.42E+02,
1998 ,	1.15E+05,	2.44E+05,	3.45E+04,	2.88E+04,	6.91E+03,	3.94E+03,	1.11E+04,	1.39E+03,	1.77E+03,
1999 ,	8.12E+04,	1.04E+05,	1.67E+05,	1.68E+04,	1.18E+04,	2.93E+03,	1.72E+03,	5.47E+03,	5.04E+02,
2000 ,	1.29E+05,	7.32E+04,	7.92E+04,	8.22E+04,	7.42E+03,	4.89E+03,	1.49E+03,	9.25E+02,	3.06E+03,
2001 ,	6.72E+04,	1.14E+05,	5.19E+04,	4.06E+04,	3.37E+04,	3.58E+03,	2.07E+03,	5.88E+02,	4.23E+02,
2002 ,	2.03E+05,	6.00E+04,	7.89E+04,	2.64E+04,	1.78E+04,	1.45E+04,	1.89E+03,	1.08E+03,	2.71E+02,
2003 ,	9.01E+04,	1.83E+05,	4.38E+04,	4.01E+04,	1.22E+04,	8.28E+03,	7.03E+03,	1.07E+03,	4.08E+02,
2004 ,	6.49E+04,	8.05E+04,	1.34E+05,	2.29E+04,	2.10E+04,	5.50E+03,	3.78E+03,	4.05E+03,	5.84E+02,

Estimated population abundance at 1st Jan 2005
0.00E+00, 5.85E+04, 5.96E+04, 7.74E+04, 1.41E+04, 1.30E+04, 3.56E+03, 2.66E+03, 3.02E+03,

Taper weighted geometric mean of the VPA populations:
9.61E+04, 8.54E+04, 6.39E+04, 3.45E+04, 1.76E+04, 9.15E+03, 5.14E+03, 2.97E+03, 1.60E+03,

Table 7.3.1. Continued

```
Standard error of the weighted Log(VPA populations) :
.7627,    .8031,    .8322,    .8638,    .9031,    .9108,    .9741,   1.0192,   1.1066,

 Log catchability residuals.

 Fleet :    BTS
  Age  ,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992,  1993,  1994
     1 ,  -.64,  -.63,   .09,  -.19,  -.13,  -.06,  -.35,   .00,  -.08,   .22
     2 ,   .17,  -.65,  -.23,   .57,   .33,   .66,   .17,  1.11,  -.29,  -.39
     3 ,  -.11,  -.19,  -.50,  -.58,   .53,   .06,   .29,   .28, -1.08,   .16
     4 ,   .27,  -.43,  -.26,  -.01,   .92,  -.43,  -.22,   .26,   .42, -2.07
     5 ,  -.22,   .10,  -.05,  -.93,   .31,  -.09, -1.38,  -.27,  1.17,   .09
     6 ,   .21,  -.21,   .12,  -.43,  -.06,  1.00,  -.84,  -.81,  1.05,  -.77
     7 , 99.99,  -.25,   .21,  -.10,   .34,  -.22,  -.40,  -.31,  -.97,  -.02
     8 , 99.99, -1.65,   .04,  -.22, 99.99,  -.53,  -.38,   .17,  -.05,  -.83
     9 , 99.99,  -.15,  1.65,  -.56,   .55, -1.19, -1.29,  -.24,  1.01, -2.29

  Age  ,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004
     1 ,   .70,   .04,   .81,   .07,   .29,  -.09,   .25,  -.23,   .15,  -.21
     2 ,   .46,  -.36,   .03,   .11,   .47,  -.21,  -.13,  -.46,  -.67,  -.73
     3 ,   .94,   .18,   .11,   .16,   .69,   .01,  -.12,  -.17,   .09,  -.73
     4 ,   .44,   .64,   .44,   .40,   .12,  -.48,   .23,   .03,   .16,  -.41
     5 ,  -.02,   .33,  1.00,  -.96,  1.78,   .15,  -.32,  -.48,   .00,  -.22
     6 ,   .63,   .72,  -.36, -1.72,  1.50,   .35,  -.14,   .00,   .04,  -.26
     7 ,  1.08,   .35,   .18,   .20,  1.37,   .47,  -.52, -1.08,   .32,  -.65
     8 ,   .54,   .34, -1.14, 99.99,  1.25, -1.23,   .54,   .76, 99.99,  -.67
     9 ,  1.38,  -.08,  1.28, 99.99, -1.26,   .37, 99.99, 99.99,   .40, 99.99

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

   Age ,        2,        3,        4,        5,         6,        7,        8,        9
 Mean Log q,   -8.8768,   -9.4052,   -9.7388,   -9.8099,  -10.1057,   -9.8754,   -9.8754,   -9.8754,
 S.E(Log q),     .4973,     .4746,     .6234,     .7246,     .7550,     .6192,     .8175,    1.1410,

 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,     .63,    2.683,     10.00,     .75,     20,     .37,   -9.06,

 Ages with q independent of year class strength and constant w.r.t. time.
 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q
  2,    1.06,    -.316,      8.71,     .58,     20,     .54,   -8.88,
  3,     .99,     .055,      9.42,     .65,     20,     .48,   -9.41,
  4,     .93,     .354,      9.80,     .57,     20,     .59,   -9.74,
  5,     .96,     .183,      9.81,     .49,     20,     .71,   -9.81,
  6,     .86,     .660,      9.96,     .55,     20,     .66,  -10.11,
  7,     .95,     .272,      9.79,     .61,     19,     .60,   -9.88,
  8,     .77,    1.477,      9.49,     .74,     16,     .59,  -10.07,
  9,    1.77,   -1.392,     12.21,     .20,     15,    1.95,   -9.90,

 Fleet : SNS
  Age  ,  1970,  1971,  1972,  1973,  1974
     1 ,   .31,  -.07,  -.06,   .52,  -.18
     2 ,   .76,   .84,   .23,   .56,  -.62
     3 ,   .38,   .12,  -.18,   .19,  -.61
     4 ,   .30, -1.42, -5.30,  -.16, -4.79
     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  ,  1975,  1976,  1977,  1978,  1979,  1980,  1981,  1982,  1983,  1984
     1 ,  -.07,  -.44,   .08,   .50,  -.13,   .14,   .01,   .23,  -.20,   .41
     2 ,   .23, -1.31,   .05,   .41,   .21,  -.02,   .36,   .12,   .19,   .18
     3 ,  -.09,   .08,   .01,   .41,   .42,   .22,   .87,   .04,  -.82,   .40
     4 ,   .51,   .42,   .82,   .44,   .46,  -.02,  -.30,   .38,   .00,   .71
     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  ,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992,  1993,  1994
     1 ,   .21,  -.04,   .22,  -.27,   .18,  -.35,  -.06,  -.03,   .01,  -.46
     2 ,   .48,  -.20,  -.10,   .22,   .50,   .34,   .66, -1.49,   .36,  -.03
     3 ,  -.21,  -.43,  -.93,   .15,   .71,  -.03,   .89,  -.14, -1.14,   .37
     4 ,   .43,  -.25,  -.38,   .98,   .02,  1.26,   .99,  1.27,   .65, -1.17
     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
```

Table 7.3.1. Continued

```
    8 , No data for this fleet at this age
    9 , No data for this fleet at this age

 Age  ,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004
    1 ,  -.21,  -.16,   .17,   .07,   .00,  -.41,  -.22,   .20, 99.99,   .09
    2 ,  -.42,  -.22,  -.88,   .14,   .14, -1.27,  -.25,  -.21, 99.99,   .04
    3 ,  -.08, -1.07,   .48,   .44,  -.08,  -.06,  -.28,  -.13, 99.99,   .07
    4 ,  1.03,   .70,  1.19,   .64,  -.31,   .21,  -.23, 99.99, 99.99,   .92
    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,   -4.6807,   -5.5068,   -6.3327,
 S.E(Log q),     .5627,     .4967,    1.4488,

 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,    3.774,      5.64,     .88,     34,     .25,   -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,    1.973,      6.11,     .73,     34,     .42,   -4.68,
  3,    1.07,    -.480,      5.14,     .63,     34,     .54,   -5.51,
  4,     .60,    1.943,      7.96,     .43,     33,     .83,   -6.33,

 Fleet : NL Beam Trawl

 Age  ,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992,  1993,  1994
    1 , No data for this fleet at this age
    2 , 99.99, 99.99, 99.99, 99.99, 99.99,  -.38, -1.07,  -.54,  -.15,  -.59
    3 , 99.99, 99.99, 99.99, 99.99, 99.99,  -.17,  -.27,  -.16,  -.42,  -.15
    4 , 99.99, 99.99, 99.99, 99.99, 99.99,  -.15,  -.07,  -.35,  -.15,  -.41
    5 , 99.99, 99.99, 99.99, 99.99, 99.99,  -.12,   .15,  -.22,   .12,  -.14
    6 , 99.99, 99.99, 99.99, 99.99, 99.99,  -.28,  -.44,  -.10,   .00,   .03
    7 , 99.99, 99.99, 99.99, 99.99, 99.99,  -.21,  -.29,   .23,   .25,  -.05
    8 , 99.99, 99.99, 99.99, 99.99, 99.99,   .06,  -.23,  -.02,  -.07,  -.48
    9 , 99.99, 99.99, 99.99, 99.99, 99.99,   .06,   .09,   .20,   .06,   .24

 Age  ,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004
    1 , No data for this fleet at this age
    2 ,   .30,   .40,  -.29,   .51,  -.10,   .32,   .40,   .37,   .40,   .42
    3 ,  -.40,  -.01,   .13,  -.04,   .23,   .33,   .08,   .34,   .24,   .29
    4 ,   .13,   .33,  -.08,   .26,  -.17,  -.08,   .32,   .18,   .25,  -.01
    5 ,  -.67,   .13,   .09,  -.16,   .25,  -.14,   .35,   .27,   .17,  -.07
    6 ,  -.21,  -.19,   .32,   .07,  -.11,   .23,  -.24,   .43,   .52,  -.04
    7 ,  -.17,   .24,  -.40,   .18,  -.27,   .30,   .06,   .02,   .32,  -.23
    8 ,  -.10,   .28,   .53,  -.40,   .07,   .37,   .06,   .66,   .06,  -.49
    9 ,   .13,   .08,  -.22,  -.15,   .30,  -.27,  -.05,  -.12,  -.31,   .14

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

  Age ,        2,         3,         4,         5,         6,         7,         8,         9
 Mean Log q,   -6.1483,   -5.2100,   -5.0533,   -5.0233,   -5.1743,   -5.2773,   -5.2773,   -5.2773,
 S.E(Log q),     .4849,     .2571,     .2349,     .2581,     .2748,     .2466,     .3422,     .1898,

 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,     .97,     .155,      6.33,     .61,     15,     .49,   -6.15,
  3,     .99,     .061,      5.25,     .88,     15,     .27,   -5.21,
  4,    1.00,    -.009,      5.05,     .91,     15,     .24,   -5.05,
  5,    1.00,     .020,      5.03,     .90,     15,     .27,   -5.02,
  6,     .94,     .663,      5.40,     .91,     15,     .26,   -5.17,
  7,     .94,     .799,      5.46,     .93,     15,     .23,   -5.28,
  8,    1.04,    -.389,      5.15,     .86,     15,     .37,   -5.26,
  9,     .99,     .203,      5.28,     .96,     15,     .19,   -5.27,

 Fleet : NL Beam Trawl (alt.
 Age  ,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992,  1993,  1994
    1 , No data for this fleet at this age
    2 , 99.99, 99.99, 99.99, 99.99, 99.99,  -.17,  -.89,  -.39,  -.03,  -.50
    3 , 99.99, 99.99, 99.99, 99.99, 99.99,   .04,  -.09,  -.01,  -.30,  -.06
```

Table 7.3.1. Continued

```
    4 , 99.99, 99.99, 99.99, 99.99, 99.99,   .06,   .11,  -.20,  -.03,  -.32
    5 , 99.99, 99.99, 99.99, 99.99, 99.99,   .09,   .32,  -.07,   .24,  -.06
    6 , 99.99, 99.99, 99.99, 99.99, 99.99,  -.07,  -.27,   .05,   .12,   .12
    7 , 99.99, 99.99, 99.99, 99.99, 99.99,   .00,  -.11,   .38,   .37,   .04
    8 , 99.99, 99.99, 99.99, 99.99, 99.99,   .26,  -.05,   .13,   .05,  -.40
    9 , 99.99, 99.99, 99.99, 99.99, 99.99,   .27,   .27,   .35,   .18,   .33

 Age  ,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004
    1 , No data for this fleet at this age
    2 ,   .36,   .43,  -.29,   .48,  -.16,   .23,   .28,   .23,   .23,   .22
    3 ,  -.34,   .02,   .13,  -.07,   .17,   .24,  -.04,   .19,   .06,   .08
    4 ,   .19,   .36,  -.08,   .23,  -.23,  -.17,   .20,   .03,   .07,  -.22
    5 ,  -.61,   .16,   .09,  -.19,   .19,  -.23,   .23,   .12,   .00,  -.28
    6 ,  -.15,  -.16,   .32,   .04,  -.17,   .14,  -.36,   .28,   .34,  -.25
    7 ,  -.11,   .27,  -.40,   .15,  -.33,   .21,  -.06,  -.12,   .14,  -.43
    8 ,  -.04,   .30,   .53,  -.43,   .01,   .28,  -.06,   .51,  -.11,  -.70
    9 ,   .19,   .11,  -.22,  -.18,   .24,  -.36,  -.17,  -.27,  -.49,  -.07

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,  -6.3552,   -5.4170,   -5.2602,   -5.2302,   -5.3812,   -5.4842,   -5.4842,   -5.4842,
S.E(Log q),    .3930,     .1640,     .2003,     .2468,     .2239,     .2602,     .3425,     .2759,

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,     .259,      6.59,     .71,     15,     .39,   -6.36,
 3,     .94,    1.003,      5.77,     .96,     15,     .15,   -5.42,
 4,     .94,     .867,      5.58,     .94,     15,     .19,   -5.26,
 5,     .94,     .692,      5.50,     .92,     15,     .24,   -5.23,
 6,     .90,    1.671,      5.77,     .95,     15,     .19,   -5.38,
 7,     .91,    1.234,      5.75,     .93,     15,     .23,   -5.48,
 8,    1.01,    -.084,      5.44,     .86,     15,     .36,   -5.46,
 9,     .94,     .796,      5.56,     .93,     15,     .26,   -5.47,

Terminal year survivor and F summaries :

Age  1   Catchability dependent on age and year class strength

Year class = 2003

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
   BTS              ,     47568.,   .389,       .000,    .00,   1,  .338,     .006
SNS                 ,     63947.,   .300,       .000,    .00,   1,  .569,     .004
NL Beam Trawl       ,         1.,   .000,       .000,    .00,   0,  .000,     .000
NL Beam Trawl (alt. ,         1.,   .000,       .000,    .00,   0,  .000,     .000

  P shrinkage mean  ,     85398.,    .80,,,,                        .080,     .003

  F shrinkage mean  ,     23982.,   2.00,,,,                        .013,     .011

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    58466.,       .23,      .12,    4,    .517,   .005


Age  2   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              ,     50487.,   .304,       .419,   1.38,   2,  .593,     .234
SNS                 ,     61867.,   .571,       .000,    .00,   1,  .170,     .195
NL Beam Trawl       ,     91005.,   .501,       .000,    .00,   1,  .220,     .136
NL Beam Trawl (alt. ,         1.,   .000,       .000,    .00,   0,  .000,     .000

  F shrinkage mean  ,     53344.,   2.00,,,,                        .017,     .222

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    59561.,       .24,      .20,    5,    .852,   .201


Age  3   Catchability constant w.r.t. time and dependent on age

Year class = 2001
```

Table 7.3.1. Continued

```
Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
   BTS               ,     46982.,   .260,       .168,    .65,   3,  .318,     .663
SNS                  ,     90591.,   .259,       .057,    .22,   2,  .318,     .397
NL Beam Trawl        ,    106232.,   .258,       .047,    .18,   2,  .354,     .348
NL Beam Trawl (alt. ,         1.,   .000,       .000,    .00,   0,  .000,     .000

  F shrinkage mean  ,     56572.,   2.00,,,,                        .010,     .577

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    77407.,       .15,      .14,    8,    .957,   .452


Age  4   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
   BTS               ,     12977.,   .251,       .179,    .71,   4,  .270,     .416
SNS                  ,     12202.,   .266,       .199,    .75,   3,  .191,     .437
NL Beam Trawl        ,     15657.,   .204,       .103,    .50,   3,  .529,     .356
NL Beam Trawl (alt. ,         1.,   .000,       .000,    .00,   0,  .000,     .000

  F shrinkage mean  ,      6680.,   2.00,,,,                        .010,     .694

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    14070.,       .14,      .08,   11,    .601,   .389


Age  5   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
   BTS               ,     11826.,   .266,       .066,    .25,   5,  .210,     .411
SNS                  ,      9539.,   .237,       .086,    .36,   3,  .137,     .488
NL Beam Trawl        ,     14513.,   .182,       .106,    .58,   4,  .642,     .346
NL Beam Trawl (alt. ,         1.,   .000,       .000,    .00,   0,  .000,     .000

  F shrinkage mean  ,      5864.,   2.00,,,,                        .011,     .705

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    12997.,       .14,      .07,   13,    .509,   .380


Age  6   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
   BTS               ,      3310.,   .316,       .085,    .27,   6,  .173,     .356
SNS                  ,      2710.,   .236,       .318,   1.35,   3,  .074,     .420
NL Beam Trawl        ,      3771.,   .179,       .055,    .31,   5,  .741,     .318
NL Beam Trawl (alt. ,         1.,   .000,       .000,    .00,   0,  .000,     .000

  F shrinkage mean  ,      1577.,   2.00,,,,                        .012,     .640

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     3561.,       .15,      .06,   15,    .396,   .334


Age  7   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
   BTS               ,      1937.,   .350,       .155,    .44,   7,  .177,     .331
SNS                  ,      2762.,   .235,       .052,    .22,   4,  .041,     .243
NL Beam Trawl        ,      2895.,   .175,       .147,    .84,   6,  .771,     .233
```

Table 7.3.1. Continued

```
NL Beam Trawl (alt. ,         1.,   .000,       .000,    .00,   0,  .000,     .000

  F shrinkage mean  ,       995.,   2.00,,,,                        .011,     .568

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     2659.,       .15,      .09,   18,    .609,   .251


Age  8   Catchability constant w.r.t. time and age (fixed at the value for age)  7

Year class = 1996

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
   BTS              ,      2787.,   .366,       .180,    .49,   8,  .163,     .208
SNS                 ,      3357.,   .238,       .063,    .26,   4,  .023,     .175
NL Beam Trawl       ,      3119.,   .171,       .165,    .97,   7,  .803,     .188
NL Beam Trawl (alt. ,         1.,   .000,       .000,    .00,   0,  .000,     .000

  F shrinkage mean  ,       711.,   2.00,,,,                        .011,     .645

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     3017.,       .15,      .10,   20,    .668,   .193


Age  9   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
   BTS              ,       228.,   .336,       .228,    .68,   7,  .074,     .533
SNS                 ,       321.,   .236,       .235,   1.00,   4,  .019,     .406
NL Beam Trawl       ,       383.,   .162,       .047,    .29,   8,  .895,     .351
NL Beam Trawl (alt. ,         1.,   .000,       .000,    .00,   0,  .000,     .000

  F shrinkage mean  ,       442.,   2.00,,,,                        .013,     .310

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      368.,       .15,      .06,   20,    .374,   .362
```

Table 7.3.2. Sole in sub-area IV: Fishing mortality at age

year	1	2	3	4	5	6	7	8	9	10
1957	0.000	0.021	0.127	0.255	0.259	0.228	0.292	0.167	0.241	0.241
1958	0.000	0.017	0.149	0.235	0.276	0.361	0.345	0.295	0.303	0.303
1959	0.000	0.034	0.130	0.246	0.205	0.239	0.182	0.366	0.248	0.248
1960	0.000	0.029	0.158	0.241	0.323	0.267	0.289	0.344	0.294	0.294
1961	0.000	0.018	0.145	0.295	0.252	0.239	0.174	0.397	0.272	0.272
1962	0.000	0.019	0.141	0.229	0.363	0.313	0.367	0.247	0.304	0.304
1963	0.000	0.053	0.179	0.422	0.402	0.509	0.482	0.457	0.479	0.479
1964	0.000	0.020	0.326	0.250	0.486	0.365	0.516	0.325	0.390	0.390
1965	0.000	0.107	0.169	0.389	0.321	0.600	0.432	0.465	0.443	0.443
1966	0.000	0.124	0.438	0.204	0.490	0.369	0.318	0.360	0.349	0.349
1967	0.000	0.114	0.366	0.488	0.683	0.382	0.296	0.549	0.481	0.481
1968	0.011	0.308	0.696	0.643	0.506	0.296	0.268	0.395	0.423	0.423
1969	0.008	0.331	0.691	0.555	0.683	0.473	0.318	0.413	0.490	0.490
1970	0.010	0.155	0.637	0.549	0.321	0.332	0.383	0.367	0.392	0.392
1971	0.011	0.332	0.573	0.660	0.581	0.413	0.376	0.372	0.482	0.482
1972	0.005	0.242	0.654	0.544	0.514	0.362	0.229	0.311	0.393	0.393
1973	0.007	0.206	0.711	0.597	0.606	0.428	0.365	0.539	0.509	0.509
1974	0.001	0.183	0.590	0.676	0.501	0.578	0.514	0.390	0.534	0.534
1975	0.007	0.279	0.530	0.661	0.522	0.493	0.440	0.554	0.522	0.522
1976	0.010	0.107	0.567	0.478	0.555	0.431	0.433	0.553	0.484	0.484
1977	0.013	0.264	0.556	0.620	0.445	0.361	0.219	0.429	0.478	0.478
1978	0.001	0.236	0.575	0.541	0.530	0.437	0.633	0.730	0.421	0.421
1979	0.001	0.224	0.659	0.637	0.490	0.470	0.286	0.613	0.632	0.632
1980	0.004	0.131	0.553	0.590	0.593	0.413	0.602	0.350	0.545	0.545
1981	0.003	0.255	0.537	0.594	0.529	0.595	0.461	0.458	0.290	0.290
1982	0.018	0.230	0.697	0.587	0.620	0.596	0.531	0.545	0.578	0.578
1983	0.003	0.310	0.593	0.725	0.355	0.462	0.457	0.600	0.698	0.698
1984	0.003	0.290	0.718	0.668	0.670	0.820	0.514	0.419	0.667	0.667
1985	0.002	0.319	0.739	0.769	0.576	0.556	0.504	0.400	0.433	0.433
1986	0.002	0.145	0.622	0.684	0.671	0.704	0.743	0.479	0.520	0.520
1987	0.001	0.238	0.520	0.613	0.510	0.554	0.387	0.663	0.694	0.694
1988	0.000	0.238	0.660	0.736	0.616	0.577	0.522	0.352	0.924	0.924
1989	0.001	0.126	0.529	0.685	0.454	0.439	0.384	0.379	0.274	0.274
1990	0.005	0.137	0.407	0.531	0.582	0.616	0.485	0.565	0.574	0.574
1991	0.002	0.090	0.425	0.534	0.761	0.429	0.668	0.646	0.716	0.716
1992	0.003	0.120	0.435	0.467	0.484	0.624	0.674	0.596	0.815	0.815
1993	0.001	0.181	0.423	0.555	0.827	0.565	0.857	0.535	0.820	0.820
1994	0.013	0.140	0.480	0.635	0.672	0.879	0.503	0.629	0.929	0.929
1995	0.054	0.306	0.445	0.763	0.609	0.532	0.786	0.484	0.956	0.956
1996	0.004	0.275	0.695	0.978	0.698	0.837	0.710	0.977	0.475	0.475
1997	0.006	0.154	0.578	0.697	0.803	0.742	0.599	0.811	1.039	1.039
1998	0.002	0.280	0.619	0.789	0.759	0.729	0.604	0.915	0.948	0.948
1999	0.004	0.173	0.609	0.718	0.783	0.572	0.520	0.481	1.170	1.170
2000	0.019	0.244	0.570	0.793	0.627	0.760	0.833	0.682	0.386	0.386
2001	0.014	0.271	0.576	0.724	0.739	0.542	0.551	0.674	0.540	0.540
2002	0.005	0.215	0.576	0.672	0.665	0.627	0.470	0.872	0.423	0.423
2003	0.012	0.206	0.545	0.547	0.697	0.685	0.452	0.501	0.400	0.400
2004	0.005	0.201	0.452	0.389	0.380	0.334	0.251	0.193	0.362	0.362

Table 7.3.3. Sole in sub-area IV: Stock numbers at age (thousands)

year	1	2	3	4	5	6	7	8	9	10
1957	128907	72453	89306	59105	17318	15057	27046	11836	2500	30811
1958	128641	116640	64212	71154	41455	12092	10843	18272	9061	26295
1959	488747	116399	103776	50073	50905	28474	7627	6950	12311	26788
1960	61712	442236	101842	82462	35414	37524	20277	5754	4362	32545
1961	99472	55839	388697	78706	58636	23190	25994	13738	3691	31942
1962	22893	90006	49613	304350	53010	41257	16517	19769	8360	29932
1963	20425	20714	79925	38985	219083	33368	27304	10355	13976	32248
1964	538936	8304	7991	27178	10395	59613	8153	6856	2665	9787
1965	121921	487598	7366	5220	19158	5783	37449	4403	4482	9389
1966	39870	110318	396394	5630	3203	12577	2871	21995	2503	8708
1967	75119	36076	88141	231571	4152	1774	7871	1890	13886	7980
1968	99727	67970	29136	55323	128559	1898	1096	5297	988	19804
1969	50009	89250	45190	13145	26303	70123	1278	758	3229	14240
1970	138423	44873	58001	20485	6828	12016	39537	842	454	16916
1971	41521	124015	34762	27757	10702	4481	7799	24398	528	12568
1972	76609	37171	80472	17733	12980	5418	2683	4844	15214	9022
1973	107613	68978	26410	37848	9315	7022	3413	1930	3211	15193
1974	109711	96704	50783	11737	18848	4600	4143	2143	1019	12174
1975	40720	99175	72871	25460	5401	10338	2334	2241	1313	8863
1976	113030	36594	67902	38793	11892	2900	5711	1361	1165	7269
1977	140395	101284	29742	34839	21772	6176	1706	3352	708	5823
1978	47342	125373	70406	15428	16964	12623	3896	1240	1975	4878
1979	11489	42812	89632	35843	8129	9034	7379	1872	541	3406
1980	151665	10387	30957	41940	17155	4506	5110	5015	918	2994
1981	149962	136627	8248	16111	21035	8582	2698	2534	3197	3779
1982	152835	135289	95833	4363	8046	11211	4282	1539	1450	3046
1983	142293	135760	97269	43198	2195	3918	5589	2279	808	2446
1984	70818	128382	90111	48645	18932	1393	2234	3202	1132	1919
1985	80852	63897	86930	39747	22562	8768	555	1209	1905	2905
1986	159542	73001	42009	37552	16668	11470	4551	304	734	4341
1987	72562	144003	57148	20416	17140	7713	5133	1959	170	1448
1988	455183	65567	102664	30739	10009	9314	4012	3154	913	548
1989	108301	411857	46753	48013	13324	4889	4735	2155	2006	2044
1990	177827	97884	328539	24932	21895	7658	2851	2918	1334	2025
1991	70507	160083	77212	197914	13269	11066	3743	1588	1500	2226
1992	354241	63683	132328	45684	104967	5610	6517	1736	753	2210
1993	69307	319598	51124	77522	25923	58528	2720	3004	866	1570
1994	57078	62660	241194	30309	40268	10264	30096	1045	1592	1565
1995	96125	50963	49274	135101	14535	18610	3854	16473	504	1132
1996	49332	82410	33969	28583	57017	7152	9889	1590	9184	2734
1997	271498	44474	56662	15336	9726	25664	2801	4401	542	2721
1998	115350	244149	34490	28772	6909	3942	11053	1392	1770	1440
1999	81174	104141	167030	16805	11829	2926	1720	5465	504	1225
2000	128848	73176	79237	82199	7418	4890	1495	925	3058	2337
2001	67209	114351	51875	40555	33661	3585	2069	588	423	1815
2002	202833	59973	78883	26396	17789	14544	1886	1078	271	1105
2003	90082	182527	43752	40127	12194	8282	7026	1066	408	1432
2004	64906	80513	134404	22943	21003	5497	3778	4046	584	531
2005	NA	58465	59560	77405	14070	12996	3560	2658	3017	702

Table 7.4.1. Sole in sub-area IV: XSA summary

	recruitment thousands	ssb tonnes	catch tonnes	landings tonnes	discards tonnes	fbar2-6	Y/ssb
1957	128907	55107	12067	12067	0	0.18	0.22
1958	128641	60918	14287	14287	0	0.21	0.23
1959	488747	65579	13832	13832	0	0.17	0.21
1960	61712	73397	18620	18620	0	0.20	0.25
1961	99472	117096	23566	23566	0	0.19	0.20
1962	22893	116826	26877	26877	0	0.21	0.23
1963	20425	113622	26164	26164	0	0.31	0.23
1964	538936	37124	11342	11342	0	0.29	0.31
1965	121921	30026	17043	17043	0	0.32	0.57
1966	39870	84221	33340	33340	0	0.33	0.40
1967	75119	82926	33439	33439	0	0.41	0.40
1968	99727	72259	33179	33179	0	0.49	0.46
1969	50009	55212	27559	27559	0	0.55	0.50
1970	138423	50695	19685	19685	0	0.40	0.39
1971	41521	43675	23652	23652	0	0.51	0.54
1972	76609	47424	21086	21086	0	0.46	0.44
1973	107613	36674	19309	19309	0	0.51	0.53
1974	109711	35950	17989	17989	0	0.51	0.50
1975	40720	38731	20773	20773	0	0.50	0.54
1976	113030	40348	17326	17326	0	0.43	0.43
1977	140395	33194	18003	18003	0	0.45	0.54
1978	47342	37292	20280	20280	0	0.46	0.54
1979	11489	44138	22598	22598	0	0.50	0.51
1980	151665	34290	15807	15807	0	0.46	0.46
1981	149962	24362	15403	15403	0	0.50	0.63
1982	152835	32542	21579	21579	0	0.55	0.66
1983	142293	39854	24927	24927	0	0.49	0.63
1984	70818	43353	26839	26839	0	0.63	0.62
1985	80852	41234	24248	24248	0	0.59	0.59
1986	159542	34876	18201	18201	0	0.57	0.52
1987	72562	29249	17368	17368	0	0.49	0.59
1988	455183	38939	21590	21590	0	0.57	0.55
1989	108301	34392	21805	21805	0	0.45	0.63
1990	177827	89805	35120	35120	0	0.45	0.39
1991	70507	77642	33513	33513	0	0.45	0.43
1992	354241	76906	29341	29341	0	0.43	0.38
1993	69307	54855	31491	31491	0	0.51	0.57
1994	57078	74425	33002	33002	0	0.56	0.44
1995	96125	59075	30467	30467	0	0.53	0.52
1996	49332	38488	22651	22651	0	0.70	0.59
1997	271498	28116	14901	14901	0	0.59	0.53
1998	115350	20907	20868	20868	0	0.64	1.00
1999	81174	41894	23475	23475	0	0.57	0.56
2000	128848	39354	22641	22641	0	0.60	0.58
2001	67209	30697	19944	19944	0	0.57	0.65
2002	202833	32135	16945	16945	0	0.55	0.53
2003	90082	27157	17920	17920	0	0.54	0.66
2004	64906	42063	17147	17147	0	0.35	0.41

Table 7.5.1. Sole in sub-area IV: Input RCT3 – age 1

Sole North Sea - Age 1

8	37	2							
'yc'	'VPA-1'	'DFS-0'	'SNS-1'	'DFS-1'	'SNS-2'	'SNS-3'	'Solea-3'	'BTS-1'	'BTS-2'
1968	50009	-11	-11	-11	745	99	-11	-11	-11
1969	138427	-11	4938	-11	1961	161	-11	-11	-11
1970	41522	-11	613	-11	341	73	-11	-11	-11
1971	76610	-11	1410	-11	905	69	-11	-11	-11
1972	107639	-11	4686	-11	397	174	-11	-11	-11
1973	109711	-11	1924	-11	887	187	31.5	-11	-11
1974	40720	-11	597	2.86	79	77	16.3	-11	-11
1975	113030	168.84	1413	6.95	762	267	34.4	-11	-11
1976	140395	82.28	3724	9.69	1379	325	-11	-11	-11
1977	47342	33.8	1552	2.13	388	99	41.5	-11	-11
1978	11489	96.87	104	2.27	80	51	1.9	-11	-11
1979	151665	392.08	4483	48.21	1411	231	76.1	-11	-11
1980	149962	404	3739	13.9	1124	107	77.1	-11	-11
1981	152835	289.72	5098	14.06	1137	307	147.1	-11	-11
1982	142293	330.38	2640	25.87	1081	159	77.8	-11	-11
1983	70818	115.96	2359	12.45	709	67	10.8	-11	7.893
1984	80852	187.17	2151	3.32	456	59	29.8	2.651	4.494
1985	159542	292.92	3791	13.66	955	284	24.6	7.88	12.548
1986	72562	72.97	1890	6.19	594	248	20.3	6.993	12.807
1987	455183	527.45	11227	38.02	5369	907	66.9	81.23	68.084
1988	108301	56.08	3052	12.62	1078	527	86.4	9.419	22.363
1989	177827	62.77	2900	12.3	2515	319	54.1	22.623	23.187
1990	70507	22.54	1265	8.52	114	46	11.3	3.344	23.2
1991	354241	360.44	11081	17.66	3489	943	180.7	74.22	27.359
1992	69307	25.38	1351	10.6	475	126	-11	4.98	4.992
1993	57078	25.01	559	6.12	234	27	-11	5.879	8.456
1994	96125	74.25	1501	9.46	473	231	12.9	27.622	6.166
1995	49332	18.82	691	3.64	143	131	0.9	3.511	5.367
1996	271498	58.51	10132	19.92	1993	381	45.7	173.238	29.211
1997	115350	53.35	2875	-11	919	189	13.6	14.122	19.257
1998	81174	-11	1649	-11	150	99	-11	11.413	6.527
1999	128849	-11	1735	4.56	645	175	-11	12.888	10.837
2000	67210	16.15	958	3.07	361	-11	-11	7.973	4.238
2001	202833	86.41	7093	18.35	-11	397	-11	21.457	10.547
2002	90082	64.71	-11	5.34	627	-11	-11	10.759	4.399
2003	64907	18.47	1372	6.15	-11	-11	-11	3.693	-11
2004	-11	32.44	-11	-11	-11	-11	-11	-11	-11

Table 7.5.2. Sole in sub-area IV: Input RCT3 – age 2

Sole North Sea - Age 2

8	37	2							
'yc'	'VPA-2'	'DFS-0'	'SNS-1'	'DFS-1'	'SNS-2'	'SNS-3'	'Solea-3'	'BTS-1'	'BTS-2'
1968	44874	-11	-11	-11	745	99	-11	-11	-11
1969	124018	-11	4938	-11	1961	161	-11	-11	-11
1970	37171	-11	613	-11	341	73	-11	-11	-11
1971	68979	-11	1410	-11	905	69	-11	-11	-11
1972	96727	-11	4686	-11	397	174	-11	-11	-11
1973	99175	-11	1924	-11	887	187	31.5	-11	-11
1974	36594	-11	597	2.86	79	77	16.3	-11	-11
1975	101284	168.84	1413	6.95	762	267	34.4	-11	-11
1976	125373	82.28	3724	9.69	1379	325	-11	-11	-11
1977	42812	33.8	1552	2.13	388	99	41.5	-11	-11
1978	10387	96.87	104	2.27	80	51	1.9	-11	-11
1979	136627	392.08	4483	48.21	1411	231	76.1	-11	-11
1980	135289	404	3739	13.9	1124	107	77.1	-11	-11
1981	135760	289.72	5098	14.06	1137	307	147.1	-11	-11
1982	128382	330.38	2640	25.87	1081	159	77.8	-11	-11
1983	63897	115.96	2359	12.45	709	67	10.8	-11	7.893
1984	73001	187.17	2151	3.32	456	59	29.8	2.651	4.494
1985	144003	292.92	3791	13.66	955	284	24.6	7.88	12.548
1986	65567	72.97	1890	6.19	594	248	20.3	6.993	12.807
1987	411857	527.45	11227	38.02	5369	907	66.9	81.23	68.084
1988	97884	56.08	3052	12.62	1078	527	86.4	9.419	22.363
1989	160083	62.77	2900	12.3	2515	319	54.1	22.623	23.187
1990	63683	22.54	1265	8.52	114	46	11.3	3.344	23.2
1991	319598	360.44	11081	17.66	3489	943	180.7	74.22	27.359
1992	62660	25.38	1351	10.6	475	126	-11	4.98	4.992
1993	50963	25.01	559	6.12	234	27	-11	5.879	8.456
1994	82410	74.25	1501	9.46	473	231	12.9	27.622	6.166
1995	44474	18.82	691	3.64	143	131	0.9	3.511	5.367
1996	244149	58.51	10132	19.92	1993	381	45.7	173.238	29.211
1997	104141	53.35	2875	-11	919	189	13.6	14.122	19.257
1998	73176	-11	1649	-11	150	99	-11	11.413	6.527
1999	114351	-11	1735	4.56	645	175	-11	12.888	10.837
2000	59973	16.15	958	3.07	361	-11	-11	7.973	4.238
2001	182527	86.41	7093	18.35	-11	397	-11	21.457	10.547
2002	80513	64.71	-11	5.34	627	-11	-11	10.759	4.399
2003	58466	18.47	1372	6.15	-11	-11	-11	3.693	-11
2004	-11	32.44	-11	-11	-11	-11	-11	-11	-11

Table 7.5.3. Sole in sub-area IV: Output RCT3 – age 1

Analysis by RCT3 ver3.1 of data from file : s4rct1.csv
Sole North Sea - Age 1,,,,,,,,,
Data for 8 surveys over 37 years : 1968 - 2004
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 = 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	1.33	5.54	1.20	.287	25	4.19	11.09	1.282	.033
SNS-1									
DFS-1	1.31	8.49	.61	.613	26	1.85	10.90	.656	.127
SNS-2	.80	6.33	.43	.727	33	6.44	11.46	.451	.268
SNS-3									
Solea-									
BTS-1	.69	9.83	.38	.748	18	2.46	11.53	.419	.310
BTS-2	1.16	8.64	.54	.595	19	1.69	10.60	.609	.147
					VPA	Mean =	11.50	.693	.114

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	1.32	5.57	1.17	.288	26	2.97	9.49	1.300	.024
SNS-1	.76	5.71	.26	.882	33	7.22	11.17	.271	.558
DFS-1	1.30	8.52	.61	.609	27	1.97	11.08	.645	.098
SNS-2									
SNS-3									
Solea-									
BTS-1	.69	9.82	.38	.747	19	1.55	10.88	.419	.232
BTS-2									
					VPA	Mean =	11.49	.682	.088

Yearclass = 2004

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------				I	I-----------Prediction---------			I
DFS-0	1.25	5.94	1.13	.300	27	3.51	10.33	1.214	.237
SNS-1									
DFS-1									
SNS-2									
SNS-3									
Solea-									
BTS-1									
BTS-2									
					VPA	Mean =	11.48	.676	.763

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2002	78664	11.27	.23	.15	.44	90082	11.41
2003	65165	11.08	.20	.15	.55	64908	11.08
2004	73848	11.21	.59	.49	.68		

Table 7.5.4. Sole in sub-area IV: Output RCT3 – age 2

```
Analysis by RCT3 ver3.1 of data from file : s4rct2.csv
Sole North Sea - Age 2,,,,,,,,,
Data for    8 surveys over   37 years :  1968 - 2004
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 =   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     1.32   5.45   1.20   .288     25   4.19   10.98    1.277     .034
 SNS-1
 DFS-1     1.30   8.39    .61   .615     26   1.85   10.79     .653     .129
 SNS-2      .80   6.22    .43   .728     33   6.44   11.35     .449     .273
 SNS-3
 Solea-
 BTS-1      .69   9.71    .39   .739     18   2.46   11.42     .431     .297
 BTS-2     1.16   8.54    .53   .601     19   1.69   10.50     .602     .152

                                        VPA Mean =   11.39     .693     .115

 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     1.32   5.48   1.17   .290     26   2.97    9.39    1.295     .024
 SNS-1      .76   5.61    .25   .884     33   7.22   11.07     .268     .569
 DFS-1     1.30   8.42    .60   .611     27   1.97   10.97     .641     .099
 SNS-2
 SNS-3
 Solea-
 BTS-1      .70   9.69    .39   .738     19   1.55   10.77     .431     .220
 BTS-2
                                        VPA Mean =   11.39     .682     .088


 Yearclass =   2004

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

 DFS-0     1.25   5.85   1.13   .301     27   3.51   10.23    1.210     .238
 SNS-1
 DFS-1
 SNS-2
 SNS-3
 Solea-
 BTS-1
 BTS-2
                                        VPA Mean =   11.37     .676     .762


 Year     Weighted      Log     Int      Ext     Var      VPA      Log
 Class     Average      WAP     Std      Std    Ratio               VPA
          Prediction           Error    Error

 2002       70222     11.16     .23      .16      .44  80514     11.30
 2003       58657     10.98     .20      .15      .55  58467     10.98
 2004       66303     11.10     .59      .49      .68
```

Table 7.6.1. Sole in sub-area IV: Input data for catch forecast and linear sensitivity analysis

Table: Sole, North Sea
input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	97039	0.78	WS1	0.05	0.00
N2	58657	0.20	WS2	0.14	0.03
N3	59561	0.24	WS3	0.20	0.01
N4	77407	0.15	WS4	0.24	0.01
N5	14069	0.14	WS5	0.26	0.04
N6	12997	0.14	WS6	0.29	0.07
N7	3560	0.15	WS7	0.32	0.05
N8	2659	0.15	WS8	0.36	0.22
N9	3017	0.15	WS9	0.43	0.18
N10	701	0.15	WS10	0.50	0.16
H.cons selectivity			Weight in the HC catch		
sH1	0.01	0.45	WH1	0.14	0.02
sH2	0.15	0.24	WH2	0.18	0.01
sH3	0.38	0.13	WH3	0.21	0.01
sH4	0.39	0.09	WH4	0.25	0.04
sH5	0.43	0.09	WH5	0.28	0.01
sH6	0.40	0.15	WH6	0.31	0.03
sH7	0.29	0.10	WH7	0.37	0.09
sH8	0.38	0.51	WH8	0.36	0.14
sH9	0.29	0.19	WH9	0.49	0.19
sH10	0.29	0.19	WH10	0.52	0.16
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		
HF05	1.00	0.23	K05	1.00	0.10
HF06	1.00	0.23	K06	1.00	0.10
HF07	1.00	0.23	K07	1.00	0.10
Recruitment in 2006 and 2007					
R06	97039	0.78			
R07	97039	0.78			

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

Stock numbers in 2005 are VPA survivors.
These are overwritten at Age 2

Table 7.6.2. Sole in sub-area IV: Catch forecast table
MFDP version 1a
Run: sol4
Sole in IV
Time and date: 17:40 13-9-2005
Fbar age range: 2-6

2005

Biomass	SSB	FMult	FBar	Landings
54613	41393	1	0.3513	15057

2006					2007	
Biomass	SSB	FMult	FBar	Land	Biomass	SSB
54876	37566	0	0	0	71272	53893
.	37566	0.1	0.0351	1709	69564	52192
.	37566	0.2	0.0703	3359	67917	50552
.	37566	0.3	0.1054	4951	66327	48969
.	37566	0.4	0.1405	6489	64793	47442
.	37566	0.5	0.1757	7974	63313	45968
.	37566	0.6	0.2108	9408	61884	44546
.	37566	0.7	0.2459	10794	60505	43174
.	37566	0.8	0.281	12132	59174	41849
.	37566	0.9	0.3162	13424	57888	40571
.	37566	1	0.3513	14673	56648	39337
.	37566	1.1	0.3864	15880	55449	38146
.	37566	1.2	0.4216	17046	54292	36995
.	37566	1.3	0.4567	18173	53175	35885
.	37566	1.4	0.4918	19262	52096	34812
.	37566	1.5	0.527	20315	51053	33776
.	37566	1.6	0.5621	21333	50046	32776
.	37566	1.7	0.5972	22318	49073	31810
.	37566	1.8	0.6323	23270	48133	30876
.	37566	1.9	0.6675	24190	47224	29974
.	37566	2	0.7026	25081	46346	29103

Input units are thousands and kg - output in tonnes

Table 7.6.3. Sole in sub-area IV: Detailed forecast tables

MFDP version 1a
Run: sol4
Time and date: 17:40 13-9-2005
Fbar age range: 2-6

Year:	2005	F multiplier:		1	Fbar:	0.3513			
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0054	502	69	97039	4852	0	0	0	0
2	0.1521	7886	1451	58657	8368	0	0	0	0
3	0.3842	18139	3851	59561	11634	59561	11634	59561	11634
4	0.3929	24010	6082	77407	18707	77407	18707	77407	18707
5	0.4252	4654	1291	14070	3602	14070	3602	14070	3602
6	0.4021	4109	1268	12997	3726	12997	3726	12997	3726
7	0.2866	846	314	3561	1122	3561	1122	3561	1122
8	0.3827	807	290	2659	947	2659	947	2659	947
9	0.2896	724	353	3017	1307	3017	1307	3017	1307
10	0.2896	168	87	702	349	702	349	702	349
Total		61844	15057	329670	54613	173974	41393	173974	41393

Year:	2006	F multiplier:		1	Fbar:	0.3513			
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0054	502	69	97039	4852	0	0	0	0
2	0.1521	11740	2160	87328	12459	0	0	0	0
3	0.3842	13883	2948	45586	8905	45586	8905	45586	8905
4	0.3929	11384	2884	36701	8869	36701	8869	36701	8869
5	0.4252	15641	4338	47286	12105	47286	12105	47286	12105
6	0.4021	2631	812	8321	2385	8321	2385	8321	2385
7	0.2866	1870	693	7866	2478	7866	2478	7866	2478
8	0.3827	734	264	2419	861	2419	861	2419	861
9	0.2896	394	192	1641	711	1641	711	1641	711
10	0.2896	604	313	2519	1251	2519	1251	2519	1251
Total		59383	14673	336707	54876	152340	37566	152340	37566

Year:	2007	F multiplier:		1	Fbar:	0.3513			
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0054	502	69	97039	4852	0	0	0	0
2	0.1521	11740	2160	87328	12459	0	0	0	0
3	0.3842	20669	4389	67868	13257	67868	13257	67868	13257
4	0.3929	8713	2207	28090	6788	28090	6788	28090	6788
5	0.4252	7416	2057	22420	5739	22420	5739	22420	5739
6	0.4021	8841	2729	27966	8017	27966	8017	27966	8017
7	0.2866	1197	444	5036	1586	5036	1586	5036	1586
8	0.3827	1622	582	5344	1903	5344	1903	5344	1903
9	0.2896	358	175	1493	647	1493	647	1493	647
10	0.2896	676	350	2817	1399	2817	1399	2817	1399
Total		61734	15162	345402	56648	161035	39337	161035	39337

Input units are thousands and kg - output in tonnes

Table 7.6.4. Sole in sub-area IV: Example table of a probabilistic forecast of North Sea sole based on a bootstrapped XSA of the final assessment. This is presented as an EXAMPLE ONLY and cannot be used as a basis for advice because the differences between the probabilistic and deterministic forecast cannot (yet) be explained.

	fbar 2006			SSB 2007		
landings 2006	median	25%	75%	median	25%	75%
4000	0.0901	0.086	0.0966	49900	48300	51000
5000	0.106	0.0937	0.113	51800	47700	56800
6000	0.127	0.117	0.133	48800	46500	51200
7000	0.145	0.135	0.154	48400	47800	50600
8000	0.156	0.143	0.177	50700	45000	54600
9000	0.19	0.179	0.209	48700	45400	50300
10000	0.233	0.217	0.239	44400	42400	45700
11000	0.238	0.218	0.251	45900	42500	47900
12000	0.247	0.243	0.271	46100	42800	47000
13000	0.3	0.263	0.308	41700	39900	46200
14000	0.31	0.287	0.337	42100	39200	44900
15000	0.341	0.316	0.363	41200	39900	44000
16000	0.394	0.361	0.405	38700	36600	41200
17000	0.397	0.387	0.428	38900	35500	40200
18000	0.435	0.383	0.465	37600	34400	42500
19000	0.442	0.411	0.482	38300	34800	41100
20000	0.505	0.484	0.533	35200	33400	36300
21000	0.541	0.477	0.577	34200	32300	38900
22000	0.542	0.517	0.623	34900	30700	37000
23000	0.588	0.554	0.645	33500	30200	35800
24000	0.631	0.603	0.666	32000	29900	33200
25000	0.635	0.615	0.669	32600	30700	34000
26000	0.66	0.616	0.682	31800	31100	33700

Table 7.8.1. Sole in sub-area IV: Yield per recruit
MFYPR version 2a
Run: sol4
Time and date: 17:47 13-9-2005

Yield per results

FMult	Fbar	CatchN	Yield	StockN	Biomass	SpwnNJan	SSBJan	SpwnNSpwn	SSBSpwn
0	0	0	0	10.5083	3.5297	8.6035	3.3506	8.6035	3.3506
0.1	0.0351	0.2182	0.0785	8.3289	2.527	6.4245	2.348	6.4245	2.348
0.2	0.0703	0.3526	0.1193	6.9869	1.9301	5.0831	1.7511	5.0831	1.7511
0.3	0.1054	0.4429	0.1419	6.0869	1.5439	4.1835	1.365	4.1835	1.365
0.4	0.1405	0.5072	0.1549	5.4466	1.2793	3.5437	1.1005	3.5437	1.1005
0.5	0.1757	0.555	0.1625	4.9708	1.0901	3.0684	0.9114	3.0684	0.9114
0.6	0.2108	0.5918	0.1669	4.605	0.9502	2.7032	0.7715	2.7032	0.7715
0.7	0.2459	0.621	0.1694	4.3161	0.8438	2.4147	0.6652	2.4147	0.6652
0.8	0.281	0.6446	0.1707	4.0828	0.7609	2.1819	0.5824	2.1819	0.5824
0.9	0.3162	0.664	0.1714	3.8907	0.6951	1.9902	0.5167	1.9902	0.5167
1	0.3513	0.6803	0.1716	3.7299	0.642	1.83	0.4636	1.83	0.4636
1.1	0.3864	0.6942	0.1716	3.5936	0.5983	1.6941	0.42	1.6941	0.42
1.2	0.4216	0.7061	0.1714	3.4764	0.5619	1.5775	0.3836	1.5775	0.3836
1.3	0.4567	0.7165	0.1711	3.3747	0.5312	1.4763	0.353	1.4763	0.353
1.4	0.4918	0.7257	0.1708	3.2856	0.505	1.3876	0.3269	1.3876	0.3269
1.5	0.527	0.7337	0.1704	3.2068	0.4824	1.3093	0.3043	1.3093	0.3043
1.6	0.5621	0.741	0.17	3.1366	0.4627	1.2396	0.2847	1.2396	0.2847
1.7	0.5972	0.7475	0.1697	3.0736	0.4454	1.1771	0.2675	1.1771	0.2675
1.8	0.6323	0.7534	0.1693	3.0167	0.4301	1.1207	0.2523	1.1207	0.2523
1.9	0.6675	0.7587	0.169	2.9651	0.4165	1.0696	0.2387	1.0696	0.2387
2	0.7026	0.7636	0.1687	2.918	0.4042	1.023	0.2265	1.023	0.2265

Reference point	F multiplier	Absolute F
Fbar(2-6)	1	0.3513
$\mathbf{F}_{max}$	1.0308	0.3621
$\mathbf{F}_{0.1}$	0.3785	0.133
F35%SPR	0.3691	0.1296

Weights in kilograms

Figure 7.1.1. Fishing effort (days) per ICES rectangle of NL large cutters (>221 kW) using beam trawl gear.

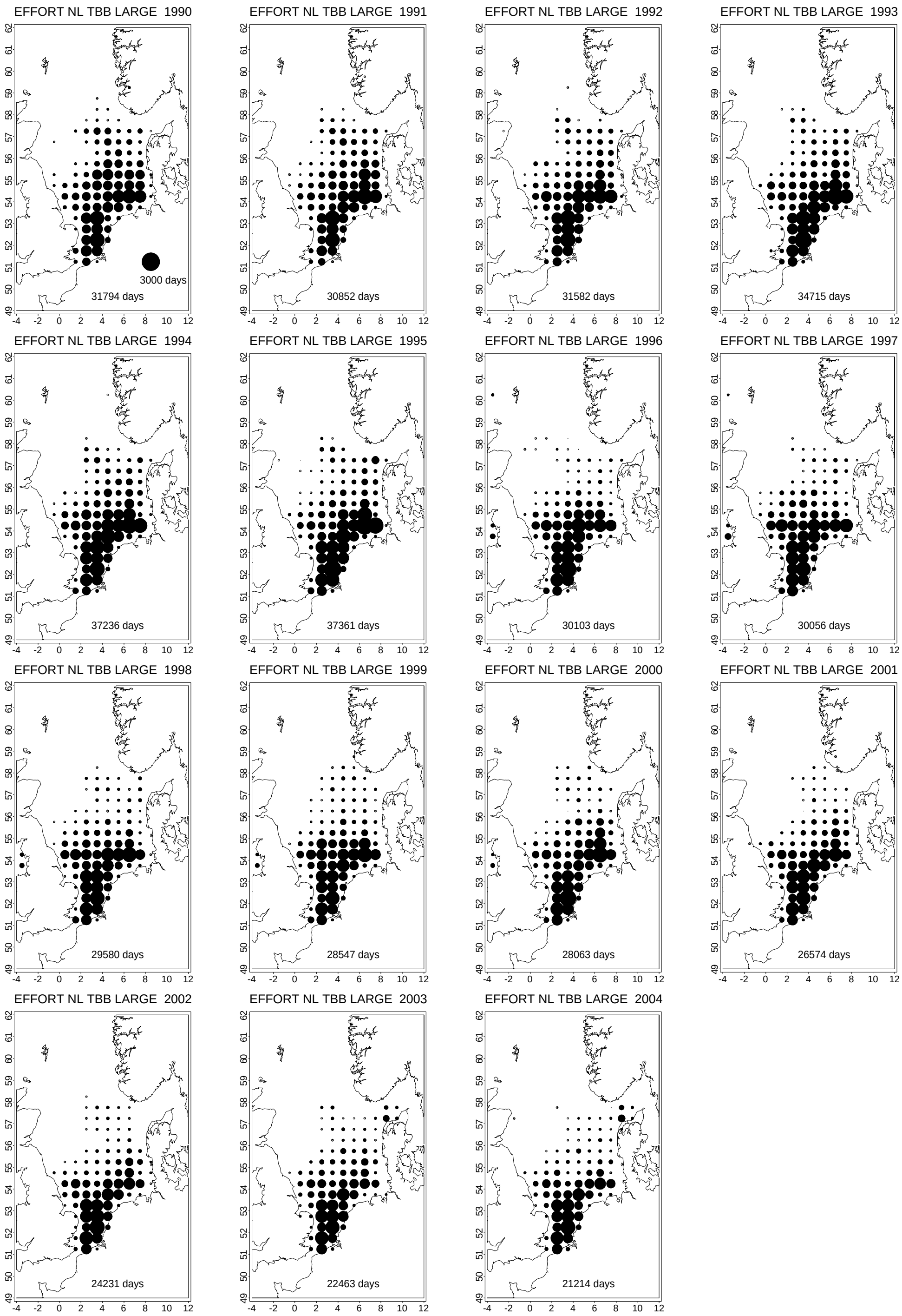


Figure 7.2.1. Sole in sub-area IV: Total landings, landings numbers at age, stock weight at age and landings weight at age.

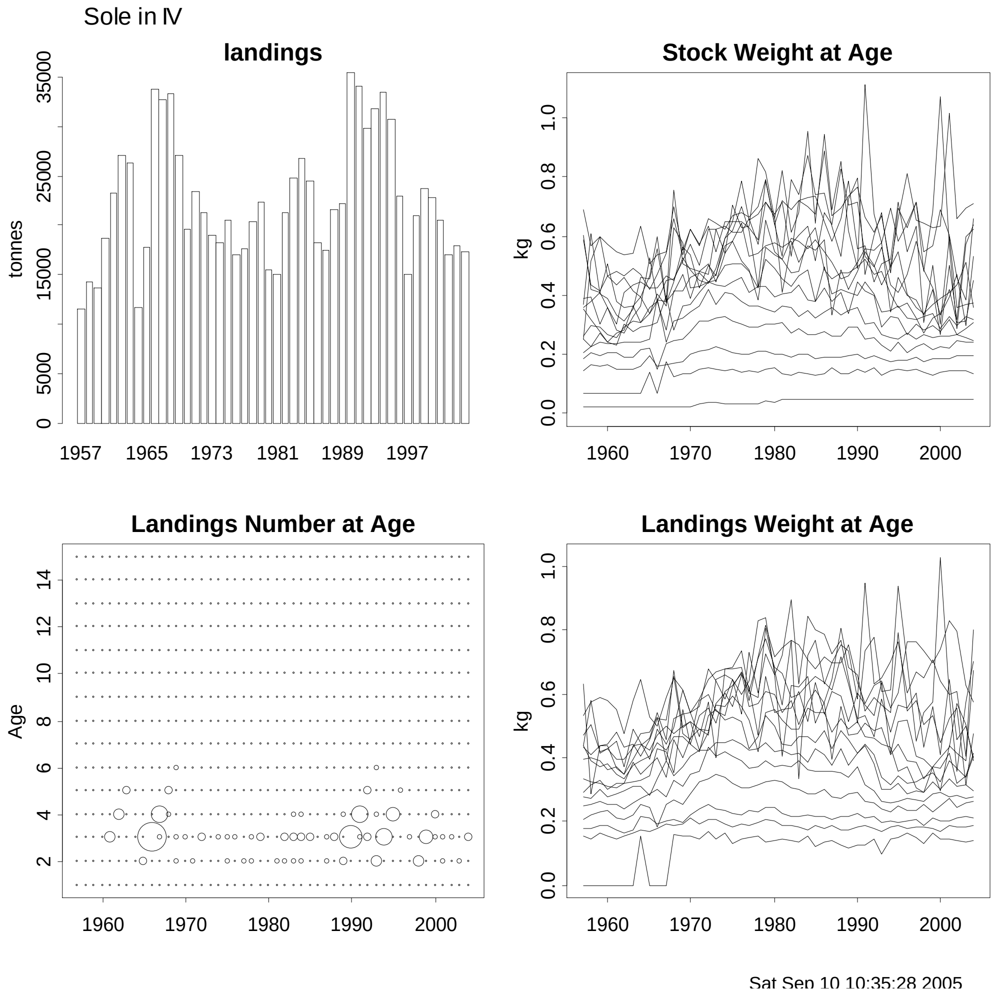
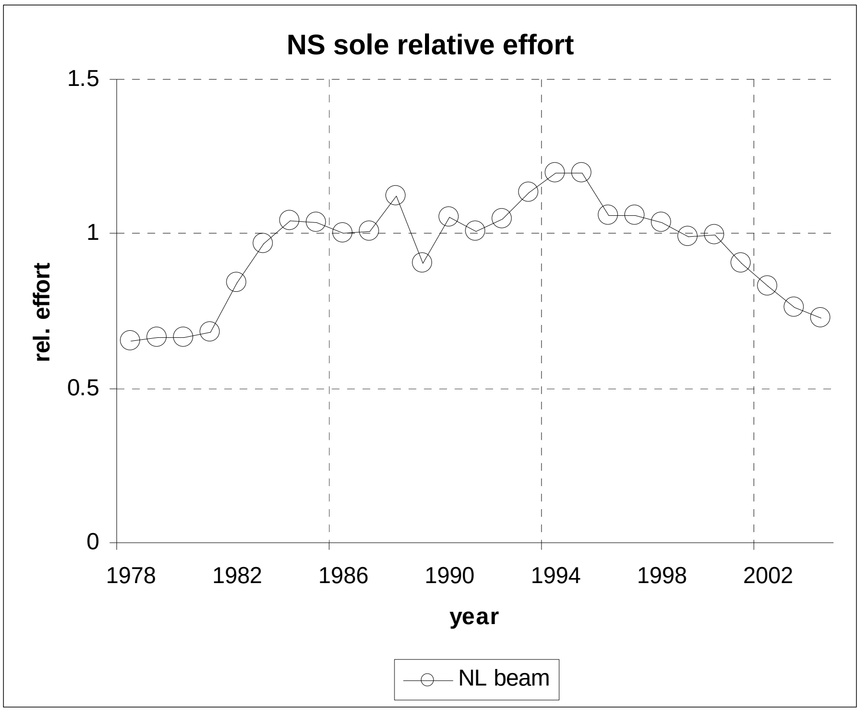


Figure 7.2.2. Sole in sub-area IV: Trends in relative effort and cpue



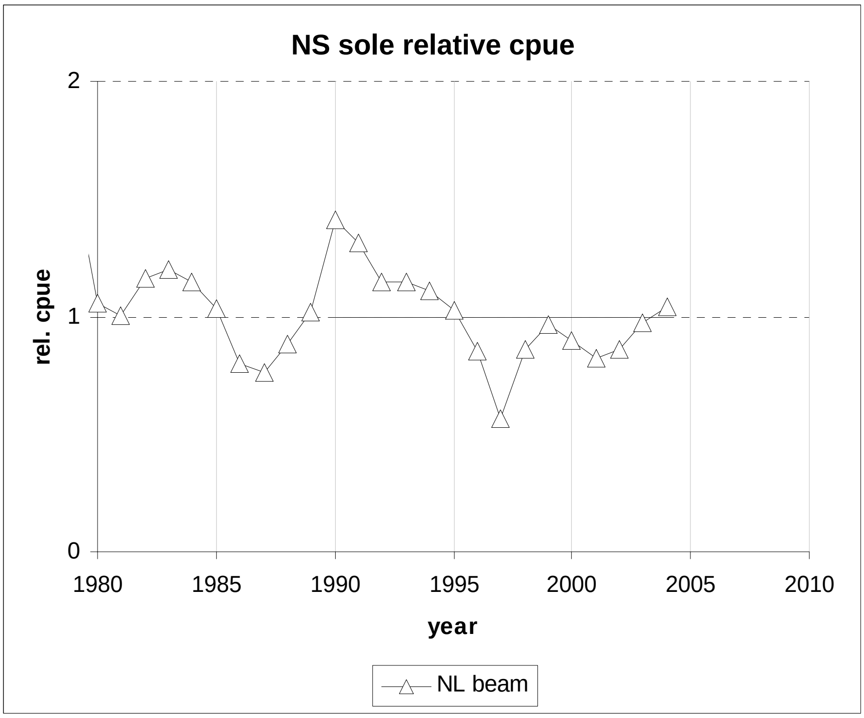


Figure 7.2.3. Sole in sub-area IV: CPUE trends in the Dutch beam trawl fleet (only large vessels, 2000 HP, 1471 kW) for the first half year, based on landings and effort records in the Dutch logbook database from vessels landings into the Netherlands. Three areas area considered: 5 (north North Sea), 6 (central North Sea) and 7 (southern North Sea). Black line indicates the overall trend in CPUE.

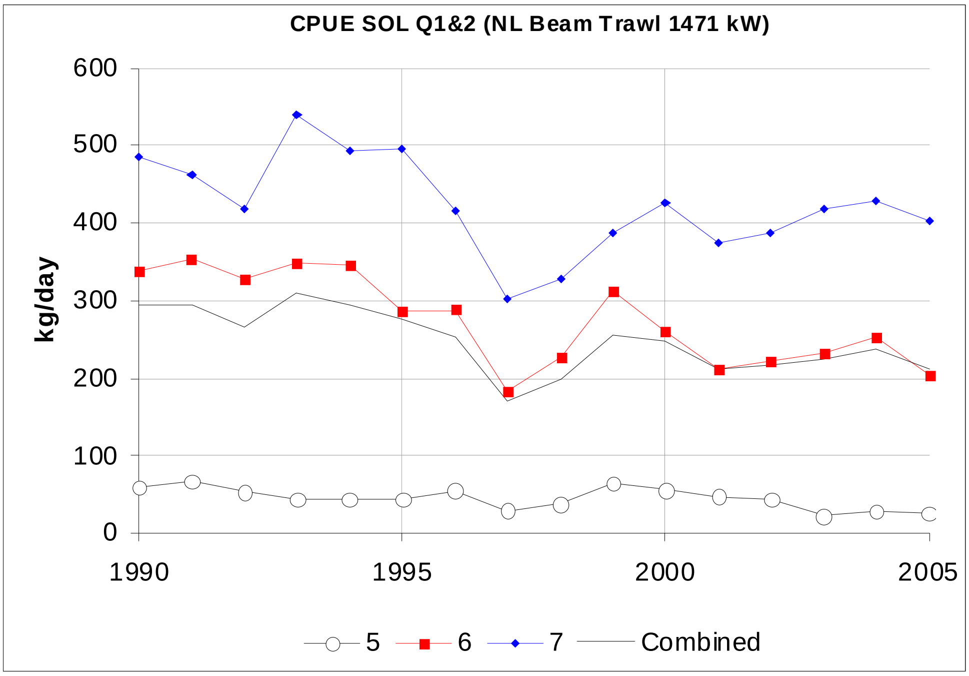
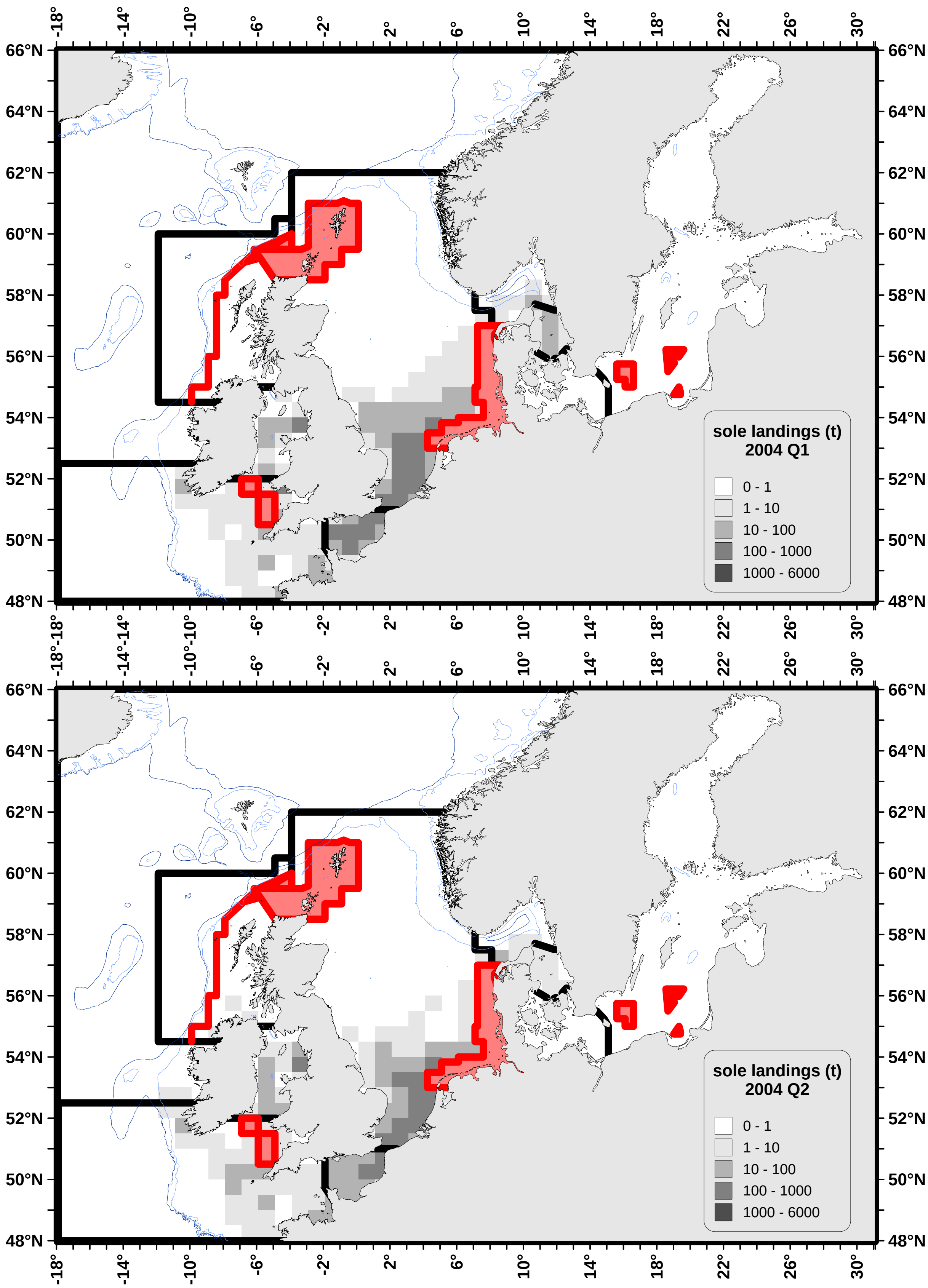
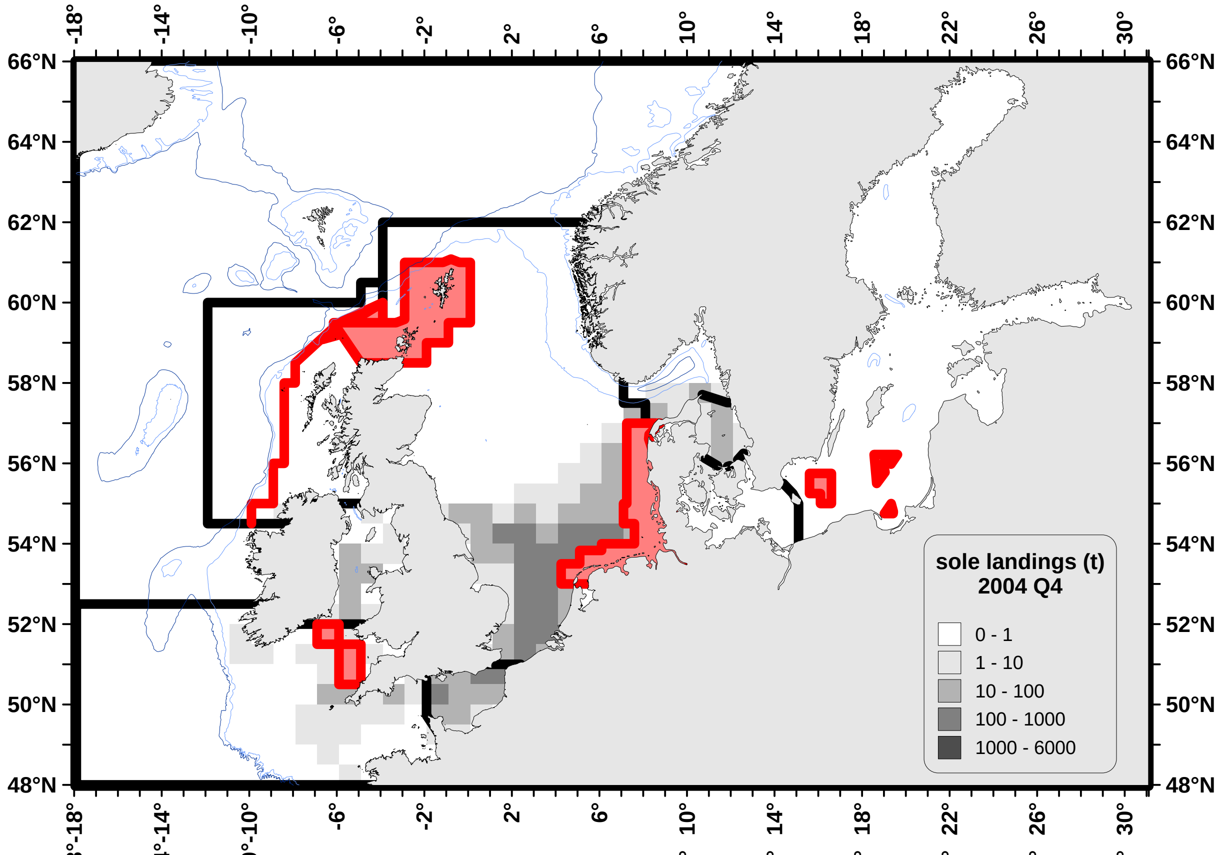


Figure 7.2.4. Reported landings of sole in 2004.




sole landings (t)
2004 Q4
0 - 1
1 - 10
10 - 100
100 - 1000
1000 - 6000

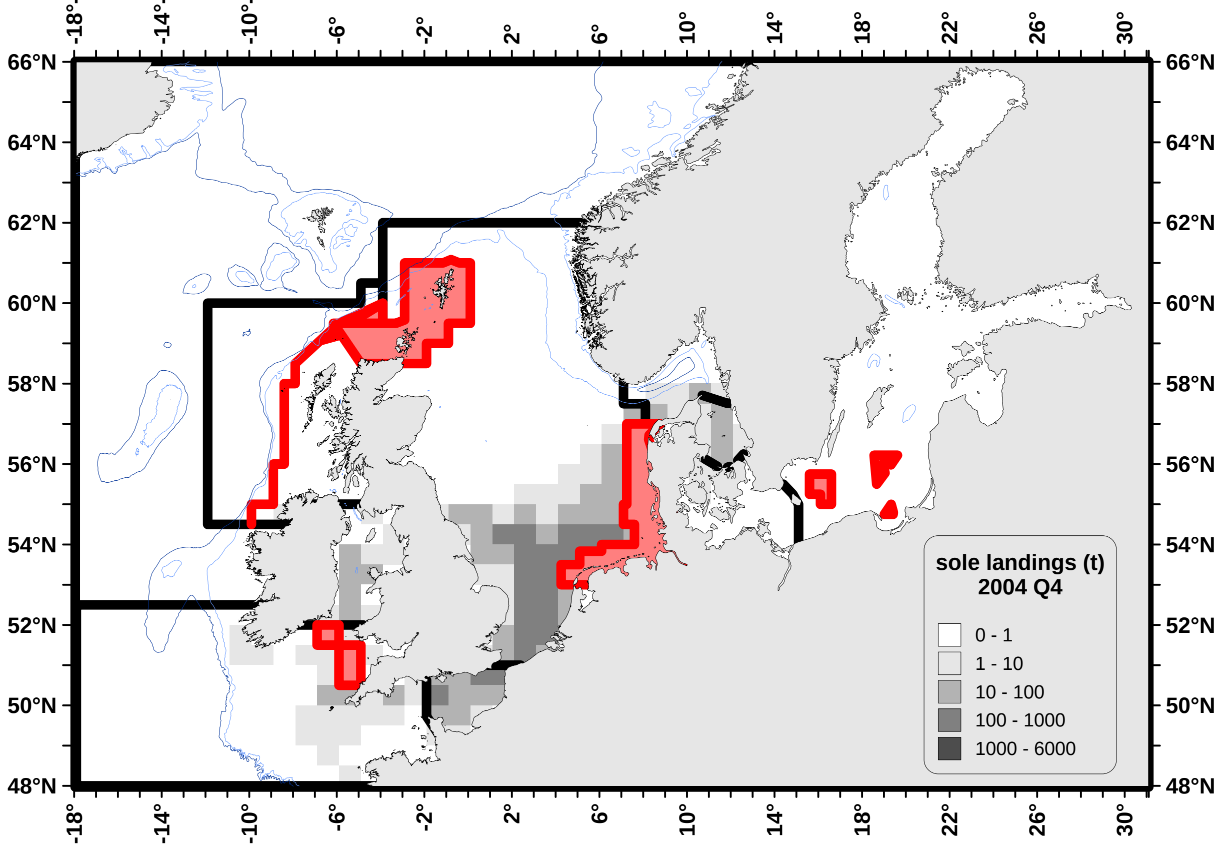

sole landings (t)
2004 Q4
0 - 1
1 - 10
10 - 100
100 - 1000
1000 - 6000

Figure 7.3.1. Sole in sub-area IV: log catchability residuals for BTS, SNS and NL beam trawl. White dots indicate positive residuals, dark dots indicate negative residuals.

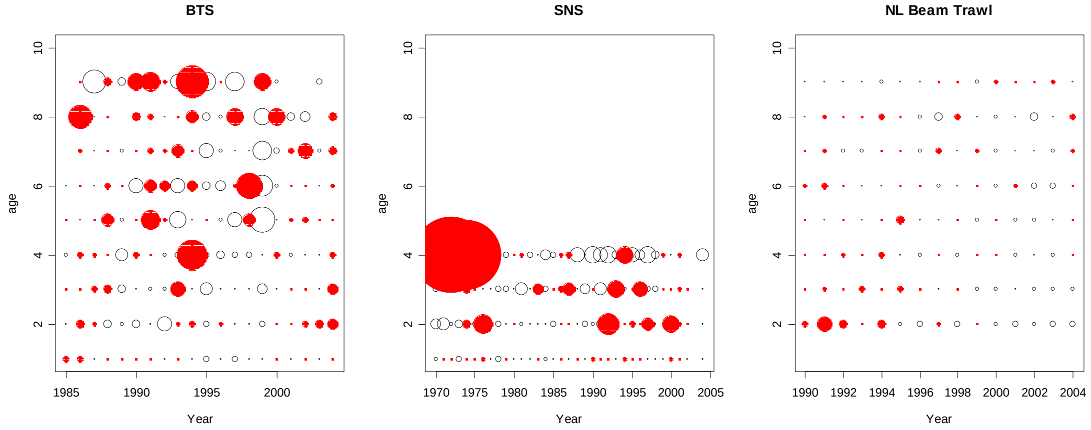


Figure 7.3.2. Sole in sub-area IV: Mean standardized index for BTS and SNS

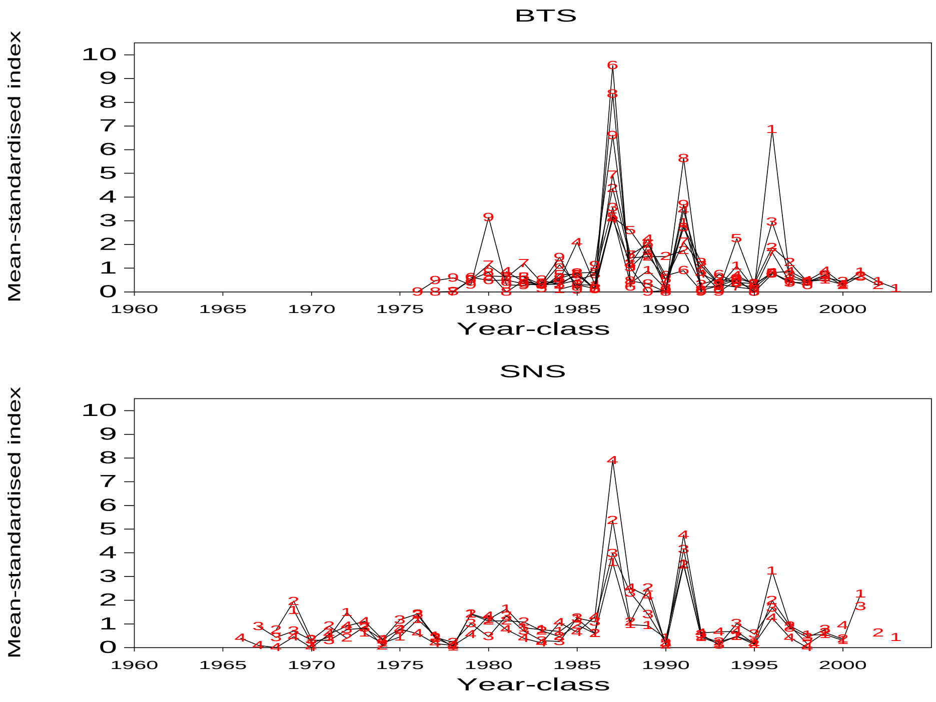


Figure 7.3.3. Sole in sub-area IV: SURBA stock summary

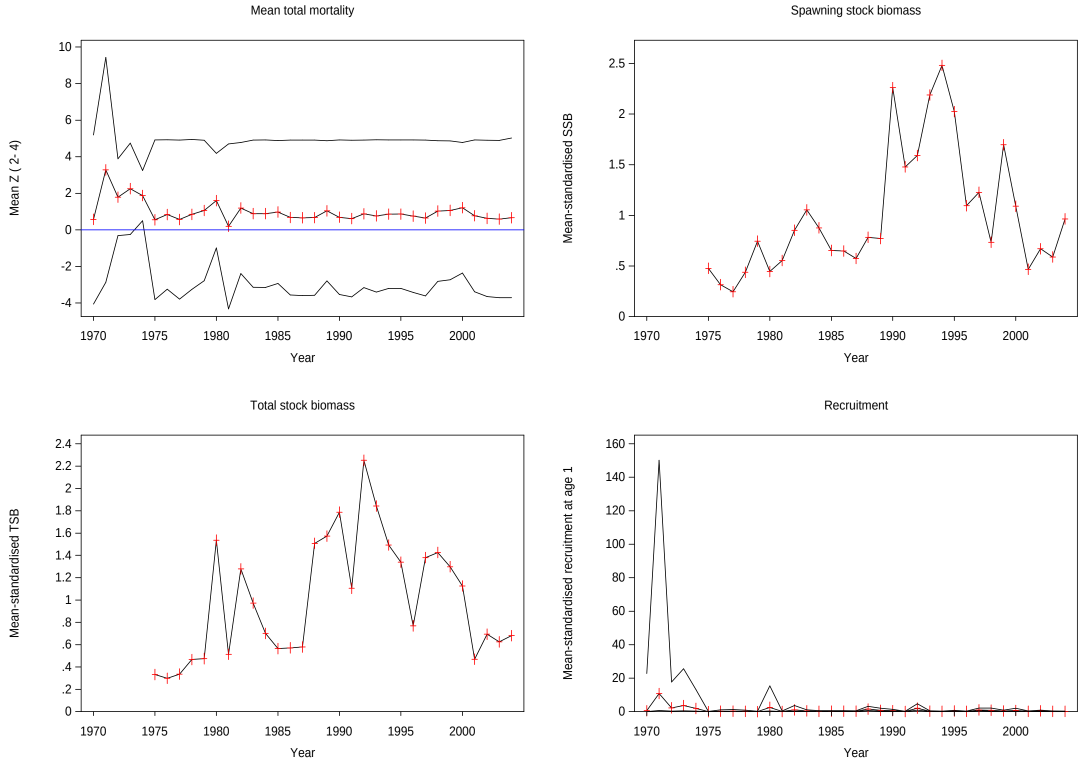


Figure 7.3.4. Sole in sub-area IV: Estimates of SSB from SURBA runs using different parameter settings. Lambda is set to 0, 0.5, 1, 2 and 3, reference age is set to 2, 3 and 4, q1 is set to 0.1 (dotted line), 0.5 (dashed line) and 1 (solid line).

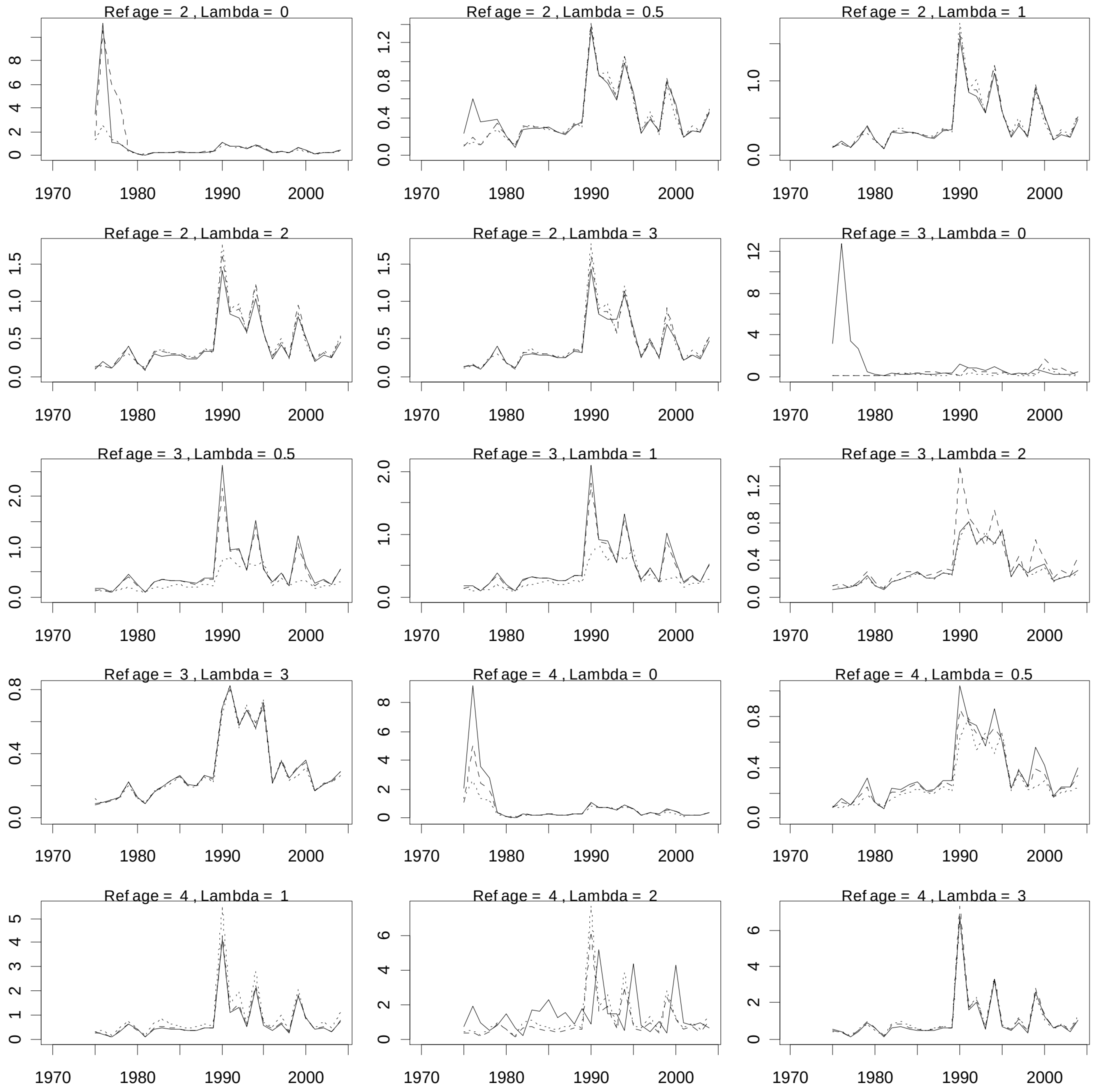


Figure 7.3.5. Sole in sub-area IV: Retrospective patterns of F, SSB and recruitment for 1999-2004

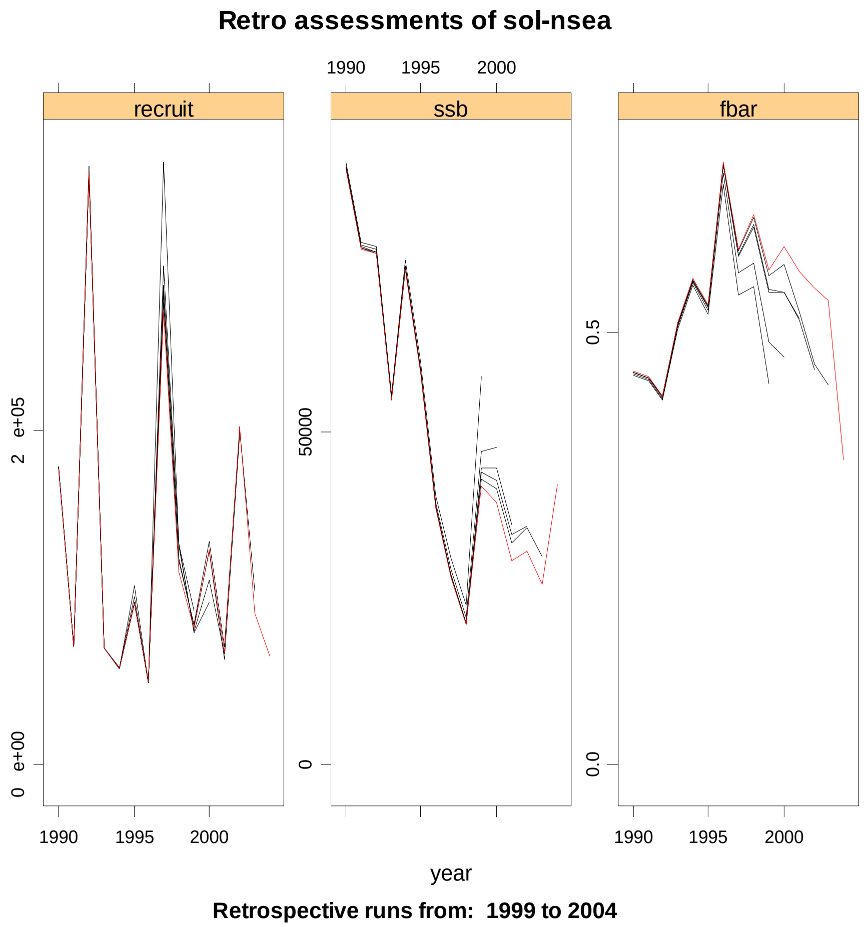


Figure 7.3.6. Sole in sub-area IV: Results of 100 bootstrap XSA runs using resampling of the catchability residuals.
Left: plusgroup=10 and shrinkage 0.5 (current WG settings), middle: plusgroup=15, shrinkage=2.0. Right: plusgroup=15 and shrinkage=0.5

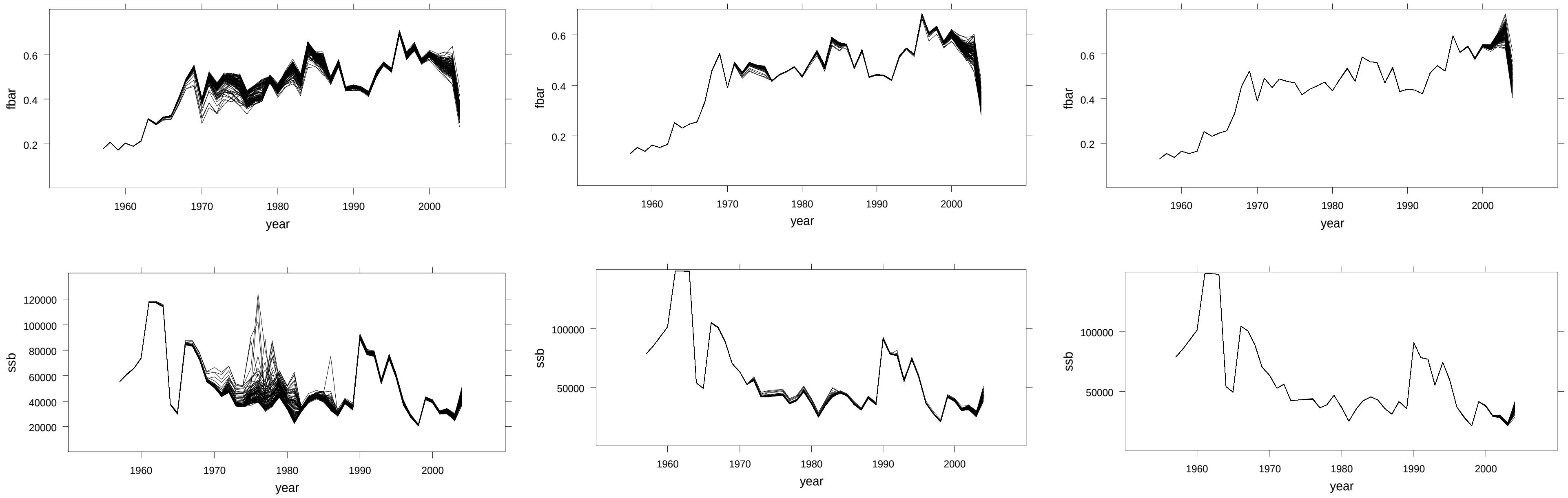


Figure 7.4.1. Sole in sub-area IV: XSA summary plots

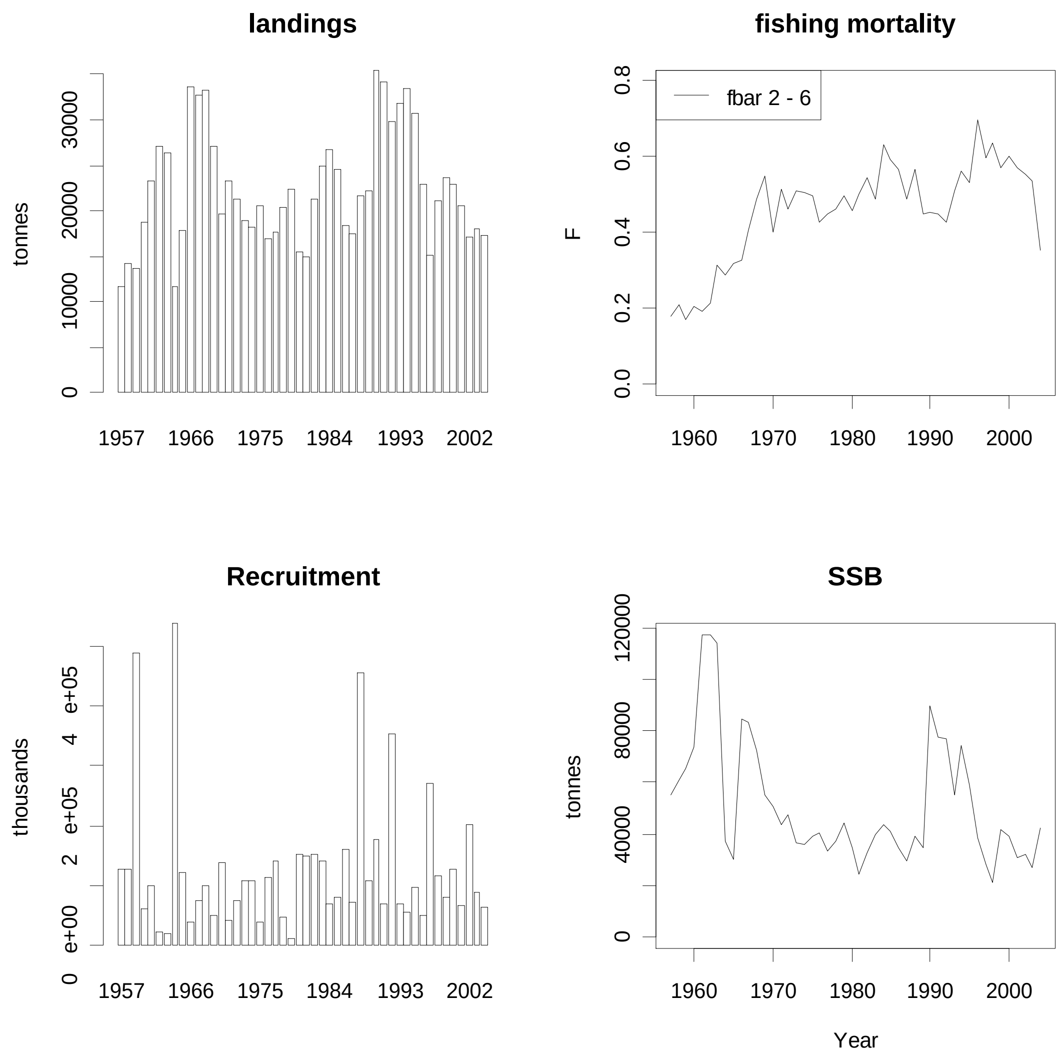


Figure 7.6.1. Sole in sub-area IV: Probability plots for short-term forecasts

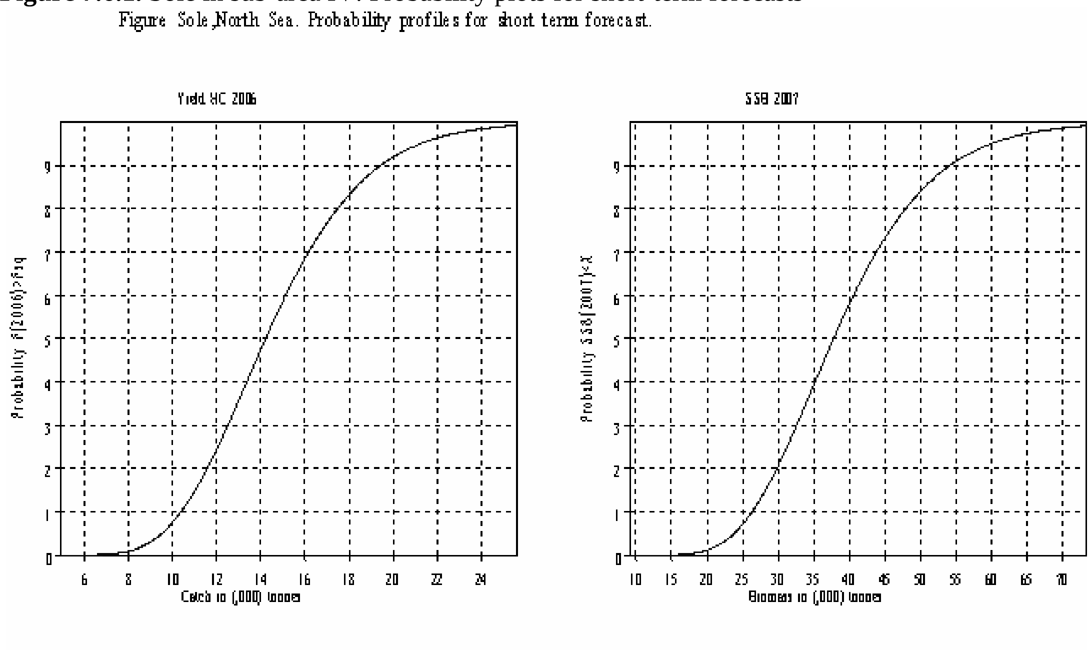
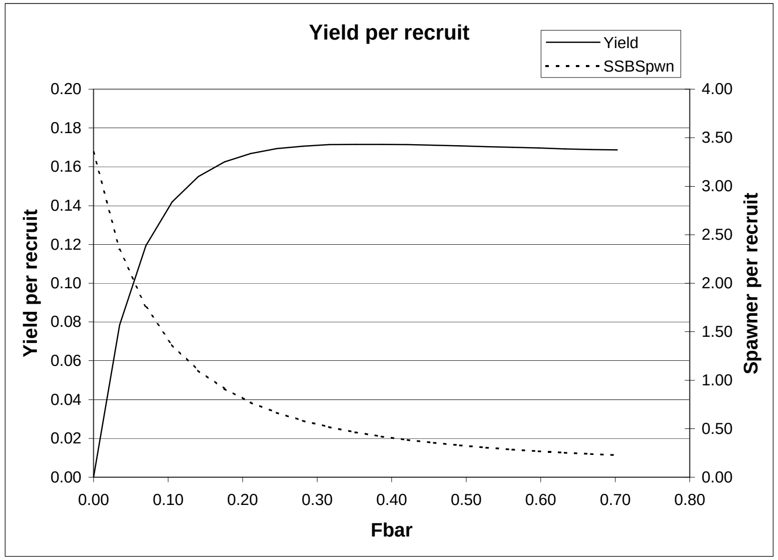
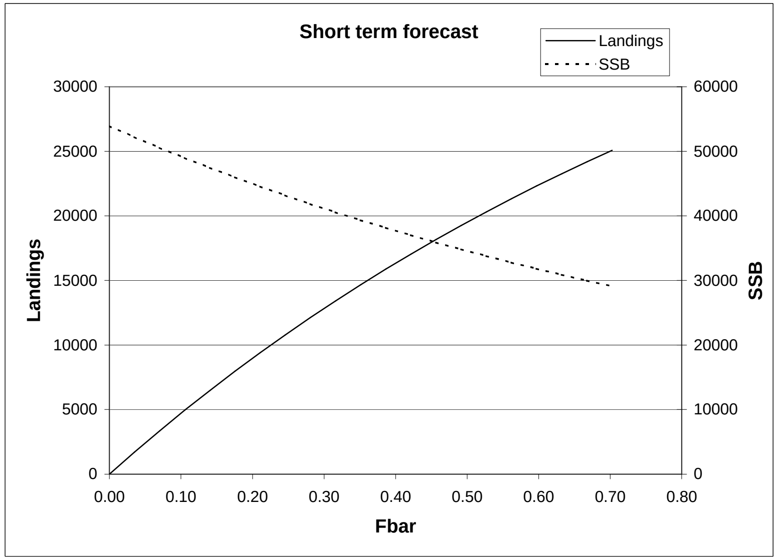


Figure 7.6.2. Sole in sub-area IV: Short-term forecast and yield per recruit





MFYPR version 2a
Run: sol4
Time and date: 17:47 13-9-2005

Reference point	F multiplier	Absolute F
Fbar(2-6)	1.0000	0.3513
FMax	1.0308	0.3621
F0.1	0.3785	0.1330
F35%SPR	0.3691	0.1296

Weights in kilograms

MFDP version 1a
Run: sol4
Sole in IV
Time and date: 17:40 13-9-2005
Fbar age range: 2-6

Input units are thousands and kg - output in tonnes

Figure 7.10.1. Sole in sub-area IV: historic performance of the assessments. Circles indicate forecast values.

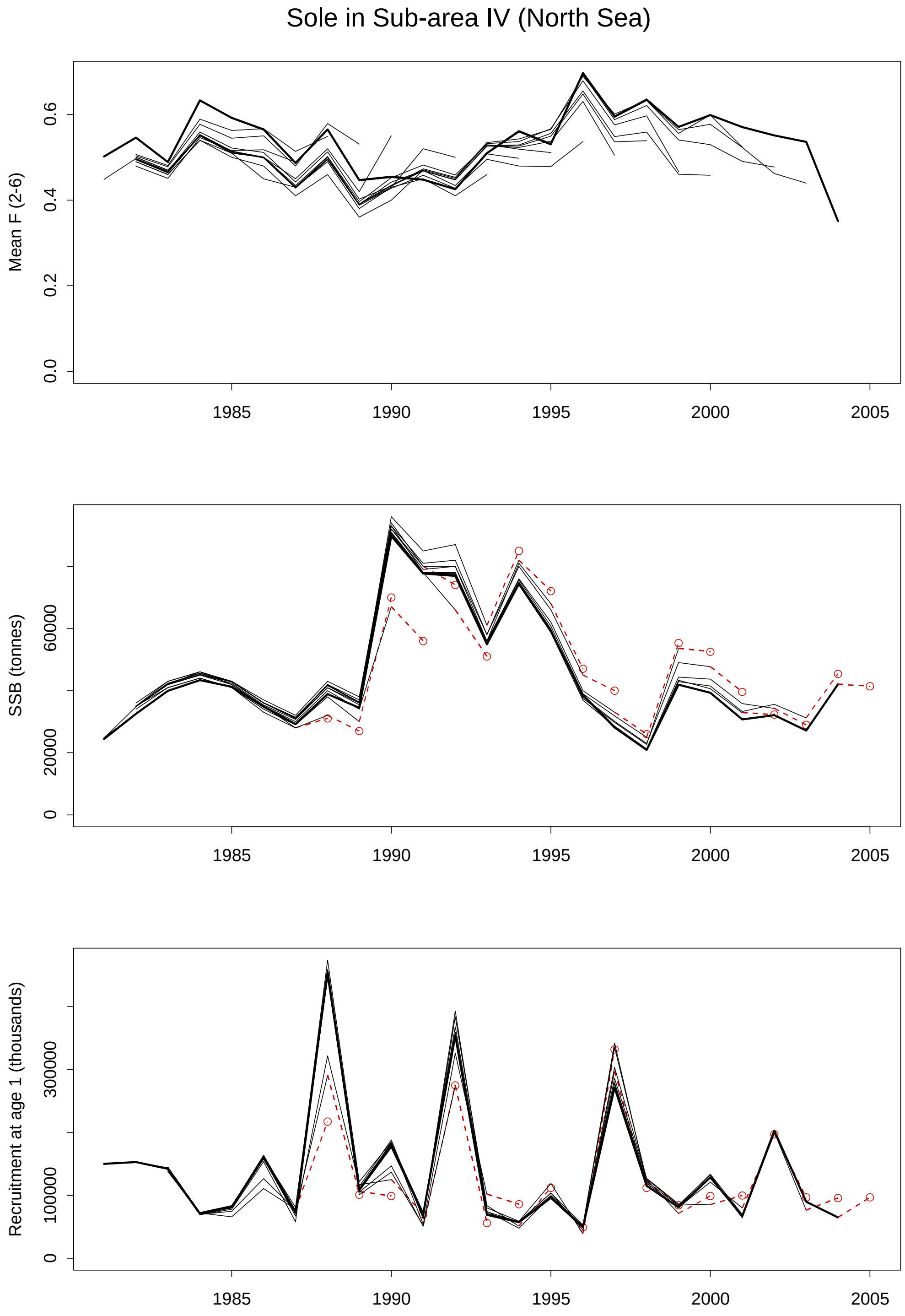
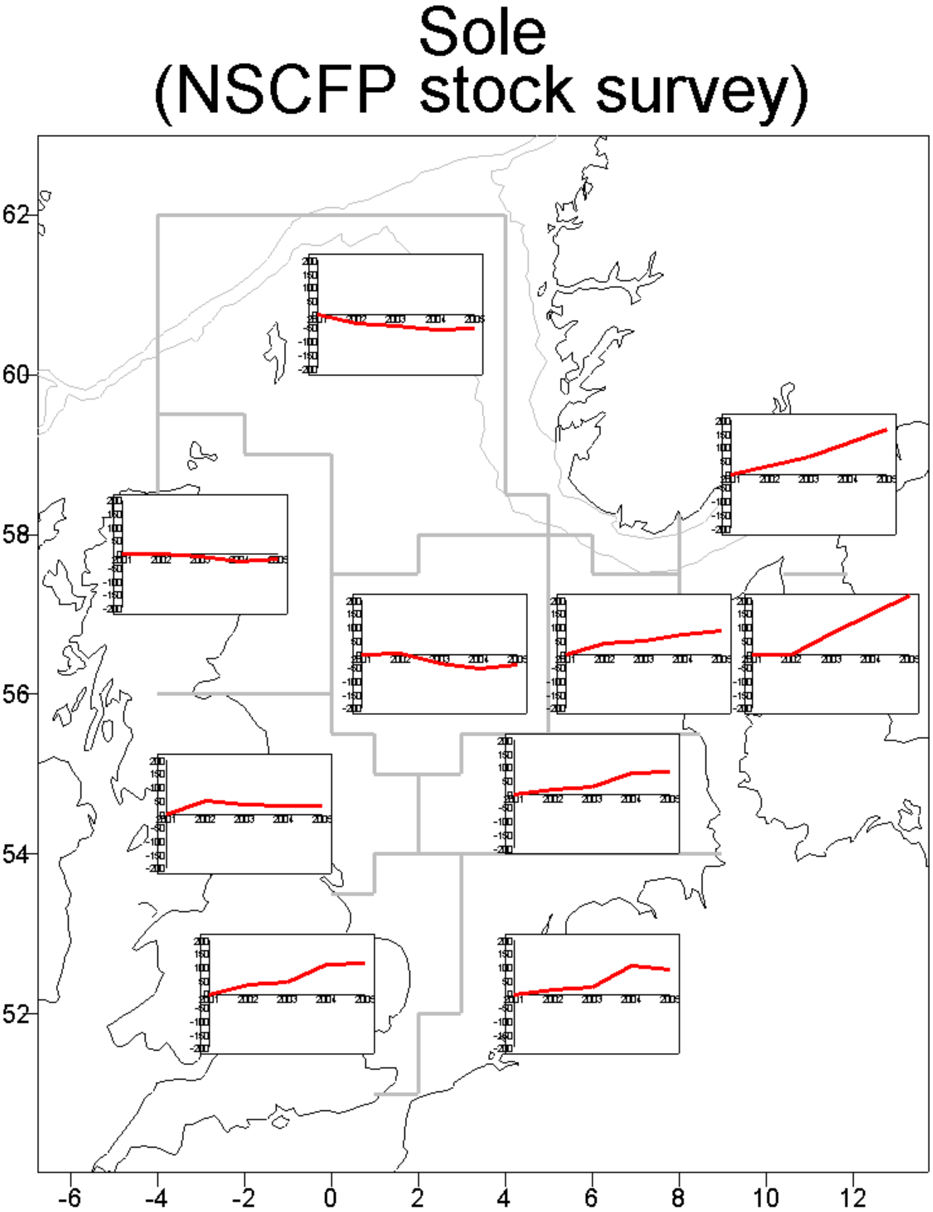


Figure 7.10.2. Sole in sub-area IV: Fishermen survey



8 Sole in Sub-area VIId

The assessment of sole in sub-area VIId is presented here as an update assessment.

Procedures and settings are the same as in last year's assessment

All the relevant biological and methodological information can be found in the Stock Annex dealing with this stock. Here, only the basic input and output from the assessment model will be presented.

8.1 General

8.1.1 Ecosystem aspects

No information on ecosystem aspects was available to the Working Group.

8.1.2 Fisheries

A detailed description of the fishery can be found in the Stock Annex .

It is likely that the high oil prices have had some impact on the fishing behavior of the Belgian and UK beam trawl fleets. For the French and UK inshore fleets however this will probably not be the case since they are constrained to the inshore areas.

Neither France, Belgium nor UK was able to take up their 2004 quota (see section 8.2.1).

8.1.3 ICES advice

In the advice for both 2004 and 2005 ICES considered the stock as having full reproductive capacity and being harvested sustainably. ICES recommended that fishing mortality should be maintained below the proposed $F_{pa,}$ corresponding to landings of less than 5900t in 2004 and of less than 5700t in 2005.

Because sole in the Eastern Channel is mainly taken in a mixed fishery with plaice, the following ICES advices for 2005 were also relevant to sole in Sub-area VIId.

ICES noted that several other stocks are at risk of being harvested unsustainably (North Sea plaice, Eastern Channel plaice, Division IIIa plaice, North Sea sole), sometimes in combination with risk of reproductive capacity (plaice in the North Sea and plaice in Eastern Channel). For these stocks, reductions in fishing mortality are recommended as follows:

- North Sea plaice: $F = F_{sq}$*0.5 (in order to rebuild to above B_{pa})
- Eastern Channel plaice: $F = F_{sq}$*0.68 (in order to rebuild to above B_{pa})
- Skagerak-Kattegat (Division IIIa) plaice: recent average landings
- North Sea sole: $F = F_{sq}$ * 0.91.

Furthermore ICES noted that fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel) should in 2004 and 2005 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries with minimal bycatch or discards of cod;

Implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised; within the precautionary exploitation limits for all other stocks.

8.1.4 Management

Management of sole in VIId is by TAC and technical measures. The agreed TACs in 2004 and 2005 are 5900t and 5700t respectively. Technical measures in force for this stock are minimum mesh sizes, minimum landing size. The minimum landing size for sole is 24cm. Demersal gears permitted to catch sole are 80mm for beam trawling and 80mm for otter trawlers. Fixed nets are required to use 100mm mesh since 2002 although an exemption to permit 90mm has been in force since that time.

EU regulation enforced in 2004 and 2005 is a limitation of 22 days at sea per month for trawlers with mesh size less than 99 mm, 14 days at sea for beam trawlers and gill-netters have a derogation of 20 days at sea in the Eastern Channel provided that their mesh size be less than 110 mm. However these effort limitation from the cod recovery plan are not likely to decrease the effort on sole in Division VIId

8.2 Data available

8.2.1 Landings and discards

The 2004 landings used by the Working Group were 4826t which is 18% below the agreed TAC of 5900t as well as the predicted landings at a status quo fishing mortality in 2004 (5931t). The contribution of Belgium and the UK to the landings in 2005 is 30% and 23% respectively. France did not submit any official landing figures but their contribution is assumed to be around 45% (Table 8.2.1).

Landing data reported to ICES are shown in Table 8.2.1 together with the total landings estimated by the Working Group. As in last years assessment, misreporting by UK beam trawlers from Division VIIe into VIId have been taken into account and corrected accordingly. It should be noted that there is also thought to be a considerable under-reporting by small vessels, which take up a substantial part of the landings in the eastern Channel. However, it has not been possible to quantify the level of these for inclusion in the assessment but the misreporting is thought to be stable through time and therefore not bias relative indicators of stock status.

Recent discard estimates are available for the UK static gear, several French inshore netting and trawl gear, and from the Belgian beam trawler fleet (Figure 8.2.1.a-c). Numbers are raised to the sampled trips. In some trips, discarding up to 40% in numbers and 20% in weight have been measured, however, the Working Group decided not to include discards in the assessment because in general discards for this high valued species are not substantial

8.2.2 Age compositions

Quarterly data for 2004 were available for landing numbers and weight at age, for the French, Belgian, and UK fleets. These comprise around 99% of the international landings. Age compositions of the landings are presented in Table 8.2.2.

8.2.3 Weight at age

Weight at age in the catch is presented in Table 8.2.3 and weight at age in the stock in Table 8.2.4. The procedure for calculating mean weights is described in the Stock Annex.

Sampling levels for those countries providing age compositions are given in Table 1.2.1.

8.2.4 Maturity and natural mortality

Maturity and natural mortality are assumed at fixed values (0.1).

8.2.5 Catch, effort and research vessel data

Available estimates of effort and LPUE are presented in Tables 8.2.5.a,b and Figures 8.2.2a,b. Effort for the Belgian beam trawl fleet has increased to a highest level in 2003 Although decreased in 2004, it is still the second highest value in the time series. The UK (E&W) beam trawl fleet has increased from the late 80's, reaching its peak in 1996. Since then, effort has decreased to its second lowest value.

LPUE for both UK (E&W) and Belgian beam trawl fleets have been increasing gradually since the late 90's.

Survey and commercial data used for calibration of the assessment are presented in Table 8.2.6.

8.3 Data

8.3.1 Exploratory catch at age analysis

Catch at age analysis was carried out according to the specifications in the Stock Annex. The model used was XSA. The results of exploratory XSA runs, which are not included in this report, are available in ICES files.

A preliminary inspection of the quality of international catch-at-age data was carried out using separable VPA with a reference age of 4, terminal F=0.5 and terminal S=0.8. As last year, the log-catch ratios for the fully recruited ages (3-10) did not show any patterns or large residuals.

The tuning data were examined for trends in catchability by carrying out XSA tuning runs (lightly shrunk (se=2.0), mean q model for all ages, full time series and un-tapered), using data for each of the four fleets individually. Apart from the first few years in the Belgian series (1982-1985, which were excluded from the analyses, as in previous assessments), there were no strong trends for any of the fleets. The Belgian beam trawl fleet had a somewhat noisier log catchability residual pattern, especially for age 2 and age 11. Year effects were noted for the UK(E&W) beam trawl survey (UK-BTS) in 1999 and 2000 (see also below in Surba exploratory runs)

The catchability residuals are shown in Figure 8.3.1 and the XSA tuning diagnostics are given in Table 8.3.1.

In general, estimates between fleets are consistent for ages 4 and above. The Belgian beam trawl fleet gave higher survivor estimates for age 2 and lower estimates for age 3, compared to the other fleets. For age 1, 96% of the survivors estimates are coming from the surveys (Young fish survey (YFS) and UK(E&W) beam trawl survey giving 81% and 16% respectively of the weighting). F shrinkage gets low weights for all ages (< 4%).

8.3.2 Exploratory survey based analysis

Exploratory SURBA-runs (v3.0) were carried out on the UK(E&W) Beam-trawl Survey (UK-BTS) (1988-2004) and the International Young fish survey (1988-2004) to investigate whether the surveys only analysis suggests different trends in Recruitment, SSB and fishing mortality (see Section 1.3.4).

Diagnostic plots of the mean standardised indices and comparative scatter plots of adjacent age classes are shown in Figure 8.3.2a and Figure 8.3.2b.Year class strengths are well estimated, and the surveys show a reasonably good internal consistency. Figure 8.3.2c show no apparent trend in the Mean Z (3-6) and therefore also in the fishing mortality. Moreover, the width of the confidence interval indicates that Z is poorly estimated by the surba-model. It should be noted that in the Surba-run the Fbar had to be adjusted to F(3-6) since the UK(E&W) survey had only ages 1 to 6. Therefore F(3-6) was also calculated from the final XSA Although slightly different in values, the trends of both Fbar's were very similar and could be used for the comparison exercise (Figure 8.3.3). Initially all catchabilities at age were set to 1 (Surba-cat1). Apart from the discrepancy in 1999, trends in recruitment and SSB from both XSA and surba appear to be very similar. Having noted in the single-fleet-XSA-runs the year-effect of the UK(E&W) beam trawl survey, an extra surba-run was carried out excluding the 1999 data from the survey (Surba-ex1999). The results of that run indicate even a better coherence with the final XSA trends in recruitment and SSB. A further trial-run, using catchabilities derived from the single-fleet-XSA-run (Surba-var_cat) indicates a highly variable fishing mortality (Figure 8.3.3c).

8.3.3 Conclusion

From the diagnostics on Mean Z (Figure 8.3.2c), it was concluded that the surveys could not estimate any trend in fishing mortality. Given that the SSB and recruitment trends from the two results showed similar patterns, the Working Group decided to accept the XSA as the final assessment.

8.3.4 Final assessment

The final settings used in this year's assessment are the same as in last year's assessment and are detailed below:

	2004 assessment			2005 assessment		
Fleets	Years	Ages	α-β	Years	Ages	α-β
BEL-BT commercial	86-03	2-10	0-1	86-04	2-10	0-1
UK-BT commercial	86-03	2-10	0-1	86-04	2-10	0-1
UK-BTS survey	88-03	1-6	0.5-0.75	88-04	1-6	0.5-0.75
YFS – survey	87-03	1-1	0.5-0.75	87-04	1-1	0.5-0.75

	2004 assessment	2005 assessment
-First data year	1982	1982
-Last data year	2003	2004
-First age	1	1
-Last age	11+	11+
Time series weights	None	None
-Model	No Power model	No Power model
-Q plateau set at age	7	7
-Survivors estimates shrunk towards mean F	5 years / 5 ages	5 years / 5 ages
-s.e. of the means	2.0	2.0
-Min s.e. for pop. Estimates	0.3	0.3
-Prior weighting	None	None

The final XSA output is given in Table 8.3.2 (fishing mortalities) and Table 8.3.3 (stock numbers). A summary of the XSA results is given in Table 8.3.4 and trends in yield, fishing mortality, recruitment and spawning stock biomass are shown in Figure 8.3.4.

Retrospective patterns for the final run are shown in Figure 8.3.5. There is a tendency to underestimate fishing mortality and overestimate SSB.

8.4 Recruitment estimates

For this years assessment the Working group, as last year, did not use, the RCT3 estimates for predictions, but the final XSA survivors-estimates.

The 2002 year class in 2003 was estimated by XSA to be around average with 23 million fish at age 1. 98% of the weight estimate comes from the tuning fleets, giving rather similar results. The XSA survivor estimates for this year class were used for further prediction.

The 2003 year class in 2004 was estimated by XSA to be 48 million one year olds, which is the second highest in the time serie. F shrinkage only gets 4% of the weight; the other 94% is coming from the surveys. The XSA survivor estimates for this year class were used for further prediction.

The long term GM recruitment (23 million, 1982-2002) was assumed for the 2004 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 XSA estimates hardly influenced by shrinkage.

The working group estimates of year-class strength used for prediction can be summarised as follows:

Year class	At age in 2005	**XSA**	**GM 82-02**	**RCT3**	Accepted Estimate
2002	3	14568	15258	-	XSA
2003	2	42518	19697	21709	XSA
2004	1	-	23050	31550	GM 1982-02
2005 & 2006	recruits	-	23050	-	GM 1982-02

8.5 Short term prognosis

The short term prognosis was carried out according to the specifications in the stock annex. As fishing mortality has hardly declined in the last four years, the selection pattern for prediction has been taken as a 3 year average. Weights at age in the catch and in the stock are averages for the years 2002-2004.

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, implies a catch in 2005 of 5990t (the agreed TAC is 5700t) and a catch of 5780t in 2006. Assuming *status quo* F will result in a SSB of 13570t in 2006 and 11890t in 2007.

Assuming *status quo* F, the proportional contributions of recent year classes to the landings in 2006 and SSB in 2007 are given in Table 8.5.4. The assumed GM recruitment accounts for 16 % of the landings in 2006 and 22 % of the 2007 SSB.

Result of a sensitivity analysis are presented in Figure 8.5.1 (probability profiles). The approximate 90% confidence intervals of the expected status quo yield in 2006 are 4500t and 7500t. There is a less than 5% probability that at current fishing mortality SSB will fall below the B_{pa} of 8000t in 2007.

8.6 Yield and biomass per recruit

Yield-per-recruit results, long-term yield and SSB, conditional on the present exploitation pattern and assuming *status quo* F in 2005, are given in Table 8.6.1 and Figure 8.6.1 (program used: MFYPR). F_{max} is estimated to be 0.31 (= 0.41 F_{sq}). Long term yield and SSB (using GM recruitment and F_{sq}) are estimated to be 3900t and 8400t respectively.

8.7 Quality of the assessment

- Sampling for sole in division VIId are considered to be at a reasonable level (Table 1.2.1).
- Discarding of sole is minor and the Working Group concludes that the lack of discard data would not notably affect the assessment results.
- The trends and estimates of fishing mortality, SSB and recruitment were consistent with last year's assessment.
- There is a tendency to underestimate fishing mortality and overestimate SSB.
- Year classes 1998 to 2002 are estimated to be at or above average which explains the increase in SSB since 1998.
- The historical performance of this assessment is rather noisy (Figure 8.7.1).
- There is no apparent stock/recruitment relationship for this stock and no evidence of reduced recruitment at low levels of SSB (Figure 8.7.2).

Workplan for benchmark.

- 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.
- In depth analysis of possible effects of under- and misreporting

The next benchmark assessment for this stock is foreseen in 2006

8.8 Management considerations

- Although taken into account in the assessment, there is a significant amount of misreporting into adjacent areas.
- Sole is taken in a beam-trawl fishery as part of a mixed demersal fishery. However, more than 50% of the reported landings come from small vessels (<10 m), using mainly fixed nets.
- There is a high probability that SSB will remain above B_{pa} in the short term Figure 8.5.1.
- EU regulation enforced since 2004 is a limitation of 22 days at sea per month for trawlers with mesh size less than 99 mm, 14 days at sea for beam trawlers and gill-netters have a derogation of 20 days at sea in the Eastern Channel provided that their mesh size be less than 110 mm. However these effort limitation from the cod recovery plan are not likely to decrease the effort on sole in Division VIId.

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
2004	1465	2734	***	1102		5300	-474	4826	5900

* Unallocated mainly due misreporting

** Preliminary

*** Data provided to the WG but not officially provided to ICES

Table 8.2.2 - Sole VIId - Landing numbers at age (kg)

Run title : Sole in VIId

At 31/08/2005 12:07

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1982	1983	1984
AGE			
1	155	0	24
2	2625	852	1977
3	5256	3452	3157
4	1727	3930	2610
5	570	897	1900
6	653	735	742
7	549	627	457
8	240	333	317
9	122	108	136
10	83	89	99
+gp	202	193	238
0 TOTALNUM	12182	11216	11657
TONSLAND	3190	3458	3575
SOPCOF %	97	99	99

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
1	49	49	9	95	163	1245	383	105	85	31
2	3693	1251	3117	2162	3484	2851	7166	4046	5028	694
3	5211	5296	3730	7174	3220	5580	4105	8789	6442	6203
4	1646	3195	3271	1602	4399	1151	4160	1888	5444	5902
5	1027	904	2053	1159	1434	1496	604	1993	1008	3404
6	1860	768	1042	856	840	301	996	288	563	584
7	144	1056	1090	388	571	390	257	368	162	567
8	158	155	784	255	201	260	247	135	188	109
9	156	190	111	256	166	129	258	171	116	147
10	69	212	163	83	224	126	92	95	62	93
+gp	128	372	459	275	282	489	382	231	129	258
0 TOTALNUM	14141	13448	15829	14305	14984	14018	18650	18109	19227	17992
TONSLAND	3837	3932	4791	3853	3805	3647	4351	4072	4299	4383
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Run title : Sole in VIId

At 31/08/2005 12:07

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE										
1	838	9	24	33	168	138	168	707	379	1030
2	2977	1825	1489	1376	3268	3586	6042	7011	10957	4254
3	4375	7764	6068	5609	8506	4852	6194	7513	5086	8623
4	4765	3035	5008	2704	3307	4395	1595	3767	3178	2545
5	2968	3206	2082	1636	1311	1076	2491	1414	1805	2272
6	1980	1823	1670	609	869	505	728	655	671	1108
7	375	1283	916	558	350	319	290	298	588	371
8	278	271	775	441	672	148	128	129	198	448
9	88	319	239	354	351	328	56	97	70	94
10	106	112	169	239	192	150	81	57	88	88
+gp	241	344	267	301	359	248	265	197	245	233
0 TOTALNUM	18991	19991	18707	13860	19353	15745	18038	21845	23265	21066
TONSLAND	4420	4797	4764	3363	4135	3476	4025	4733	5038	4826
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 8.2.3 - Sole VIId - Catch weights at age (kg)

Run title : Sole in VIId

At 31/08/2005 12:07

Table 2 Catch weights at age (kg)

YEAR	1982	1983	1984
AGE			
1	0.102	0	0.1
2	0.171	0.173	0.178
3	0.225	0.23	0.234
4	0.312	0.302	0.314
5	0.386	0.404	0.38
6	0.428	0.436	0.436
7	0.439	0.435	0.417
8	0.509	0.524	0.538
9	0.502	0.537	0.529
10	0.463	0.583	0.565
+gp	0.6729	0.6283	0.7135
0 SOPCOFAC	0.9713	0.991	0.9884

Table 2 Catch weights at age (kg)

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
1	0.09	0.135	0.095	0.102	0.106	0.12	0.114	0.103	0.085	0.099
2	0.182	0.18	0.175	0.152	0.154	0.178	0.161	0.153	0.147	0.15
3	0.23	0.212	0.236	0.226	0.192	0.238	0.208	0.203	0.197	0.186
4	0.281	0.306	0.295	0.278	0.271	0.289	0.266	0.267	0.247	0.235
5	0.368	0.363	0.353	0.36	0.293	0.349	0.354	0.29	0.335	0.288
6	0.394	0.387	0.407	0.409	0.358	0.339	0.394	0.403	0.384	0.355
7	0.516	0.437	0.411	0.459	0.388	0.47	0.421	0.391	0.537	0.381
8	0.543	0.52	0.482	0.514	0.472	0.465	0.43	0.462	0.553	0.505
9	0.594	0.502	0.465	0.553	0.515	0.487	0.434	0.459	0.515	0.484
10	0.595	0.523	0.538	0.563	0.547	0.518	0.478	0.463	0.766	0.496
+gp	0.8005	0.6015	0.6176	0.6647	0.7014	0.5621	0.5656	0.5661	0.6666	0.6156
0 SOPCOFAC	0.998	1.0006	1.0004	1.0001	0.9994	0.9995	1.0001	1.0001	1.0002	1.0001

Run title : Sole in VIId

At 31/08/2005 12:07

Table 2 Catch weights at age (kg)

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE										
1	0.129	0.142	0.139	0.132	0.13	0.145	0.108	0.12	0.114	0.12
2	0.176	0.165	0.153	0.159	0.151	0.142	0.152	0.162	0.17	0.179
3	0.179	0.178	0.188	0.172	0.189	0.176	0.211	0.204	0.208	0.205
4	0.23	0.229	0.233	0.235	0.215	0.223	0.283	0.253	0.257	0.255
5	0.255	0.269	0.292	0.286	0.26	0.332	0.288	0.316	0.277	0.296
6	0.333	0.324	0.343	0.343	0.28	0.377	0.334	0.375	0.357	0.304
7	0.357	0.361	0.39	0.383	0.29	0.424	0.367	0.376	0.381	0.348
8	0.385	0.405	0.404	0.417	0.341	0.427	0.374	0.393	0.438	0.403
9	0.49	0.435	0.503	0.484	0.358	0.384	0.493	0.469	0.482	0.492
10	0.494	0.465	0.474	0.435	0.374	0.459	0.511	0.42	0.494	0.509
+gp	0.6536	0.5854	0.6509	0.6162	0.5354	0.68	0.5445	0.5308	0.5274	0.525
0 SOPCOFAC	0.9997	0.9999	1	1.0013	0.9992	1.0009	1.0005	0.9995	1.0002	0.9983

Table 8.2.4 - Sole VIId - Stock weights at age (kg)

Run title : Sole in VIId

At 31/08/2005 12:07

Table 3 Stock weights at age (kg)

YEAR	1982	1983	1984
AGE			
1	0.059	0.07	0.067
2	0.114	0.135	0.131
3	0.167	0.197	0.192
4	0.217	0.255	0.249
5	0.263	0.309	0.304
6	0.306	0.359	0.355
7	0.347	0.406	0.403
8	0.384	0.448	0.448
9	0.418	0.487	0.49
10	0.45	0.522	0.529
+gp	0.53	0.6008	0.6265

Table 3 Stock weights at age (kg)

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
1	0.065	0.07	0.072	0.05	0.05	0.05	0.05	0.05	0.05	0.05
2	0.129	0.136	0.139	0.145	0.113	0.138	0.138	0.144	0.13	0.116
3	0.192	0.198	0.203	0.223	0.182	0.232	0.225	0.199	0.189	0.161
4	0.254	0.256	0.262	0.268	0.269	0.305	0.279	0.277	0.246	0.215
5	0.315	0.309	0.318	0.365	0.323	0.4	0.38	0.305	0.366	0.273
6	0.376	0.358	0.37	0.425	0.335	0.361	0.384	0.454	0.377	0.316
7	0.436	0.403	0.417	0.477	0.48	0.476	0.41	0.405	0.545	0.368
8	0.495	0.443	0.461	0.498	0.504	0.535	0.449	0.459	0.56	0.53
9	0.554	0.48	0.5	0.572	0.586	0.571	0.474	0.43	0.559	0.461
10	0.611	0.512	0.536	0.636	0.536	0.507	0.451	0.528	0.813	0.47
+gp	0.7798	0.5761	0.6156	0.7498	0.7135	0.5765	0.6203	0.5269	0.5664	0.6122

Run title : Sole in VIId

At 31/08/2005 12:07

Table 3 Stock weights at age (kg)

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE										
1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
2	0.126	0.155	0.139	0.14	0.128	0.122	0.127	0.136	0.151	0.137
3	0.129	0.176	0.165	0.158	0.18	0.148	0.157	0.179	0.207	0.185
4	0.22	0.258	0.22	0.233	0.205	0.208	0.216	0.209	0.249	0.236
5	0.234	0.286	0.264	0.299	0.253	0.402	0.226	0.258	0.314	0.265
6	0.333	0.308	0.317	0.374	0.277	0.44	0.223	0.254	0.376	0.267
7	0.357	0.366	0.376	0.363	0.298	0.395	0.231	0.301	0.399	0.273
8	0.33	0.391	0.404	0.357	0.324	0.554	0.253	0.234	0.418	0.331
9	0.614	0.438	0.563	0.45	0.336	0.443	0.256	0.326	0.446	0.504
10	0.382	0.466	0.494	0.372	0.323	0.42	0.301	0.404	0.444	0.409
+gp	0.6292	0.6304	0.6536	0.5768	0.5118	0.6822	0.4204	0.417	0.5032	0.4501

Table 8.2.5a **Sole in VIId. Indices of effort**

Year	France Beam trawl[1]	England & Wales Beam trawl[2]	Belgium Beam trawl[3]
1971			
1972			
1973			
1974			
1975			5.02
1976			6.56
1977			6.87
1978			8.22
1979			7.30
1980			12.81
1981			19.00
1982			23.94
1983			23.64
1984			28.00
1985			25.29
1986		2.79	23.54
1987		5.64	27.11
1988		5.09	38.52
1989		5.65	35.67
1990		7.27	30.33
1991	10.69	7.67	24.29
1992	10.52	8.78	21.99
1993	10.22	6.40	20.02
1994	10.61	5.43	25.17
1995	12.38	6.89	24.17
1996	14.09	10.31	25.00
1997	10.92	10.25	30.89
1998	11.71	7.31	18.12
1999	10.63	5.86	21.39
2000	13.78	5.65	30.54
2001	11.38	7.64	32.39
2002		7.90	33.68
2003		6.69	47.50
2004		4.90	41.60

[1]in Kg/1000 h*KW-04

[1] Beam trawl >= 10m in millions hp hrs >10% sole

[3]Fishing hours (x 10^3) corrected for fishing power using P = 0.000204 BHP^1.23

Table 8.2.5b **Sole in VIId. LPUE indices**

Year	France[1] Beam trawl	England & Wales[2] Beam trawl	Belgium[3] Beam trawl
1971			
1972			
1973			
1974			
1975			24.09
1976			27.28
1977			29.99
1978			26.27
1979			37.42
1980			23.26
1981			24.52
1982			23.65
1983			22.37
1984			21.61
1985			22.90
1986		39.48	33.48
1987		32.82	36.56
1988		27.67	15.89
1989		26.59	16.82
1990		26.88	25.94
1991	18.52	22.09	22.56
1992	18.12	25.29	29.11
1993	21.60	23.75	34.77
1994	17.78	31.83	27.89
1995	18.46	28.39	24.70
1996	19.79	25.79	29.80
1997	14.41	25.40	32.57
1998	17.33	25.71	23.51
1999	30.4	27.29	26.41
2000	19.1	27.46	24.49
2001	46.1	26.58	24.58
2002		31.63	27.33
2003		32.81	33.13
2004		38.80	30.86

[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 8.2.6 - Sole VIId - tuning files

Bolded numbers = used in XSA

SOLE	7d,TUNING													
104	1													
BEL	BT													
1980	2004													
1	1	0	1											
2	15													
12.8	69.3	46.1	298.7	189.6	57.4	24.7	10.3	5.1	8.6	3.1	5.5	2.4	2.6	37.9
19.0	640.7	161.4	82.1	312.8	229.6	44.7	32.9	33.1	6.9	9.0	18.4	9.3	0.8	51.9
23.9	148.7	980.9	128.0	93.4	155.9	112.6	38.8	60.1	15.2	14.0	7.4	12.5	5.9	54.3
23.6	190.4	373.0	818.9	65.5	54.0	81.7	73.2	23.5	20.2	27.0	5.0	1.0	7.1	33.0
28.0	603.8	347.2	311.2	436.0	53.7	38.5	104.9	59.9	25.4	23.2	25.3	9.0	8.2	42.4
25.3	382.9	612.1	213.0	209.1	260.2	58.2	34.1	48.0	31.0	16.9	19.6	9.2	7.7	21.3
23.4	215.0	1522.3	675.0	233.7	170.6	194.0	30.1	53.1	64.2	32.6	12.7	2.6	43.0	29.3
27.1	843.6	451.0	739.3	724.4	344.5	232.4	152.7	25.3	86.5	56.0	56.1	54.5	9.3	109.0
38.5	131.6	990.4	243.3	362.9	216.7	111.8	41.8	73.8	47.0	9.8	22.3	35.8	8.6	25.3
35.7	47.5	512.6	543.6	748.0	276.6	225.0	53.1	36.4	12.7	4.7	0.0	0.0	4.7	27.0
30.3	1011.4	1375.2	218.1	366.2	85.3	198.2	65.5	39.0	22.4	22.2	25.4	2.8	24.0	18.2
24.3	320.2	1358.6	710.1	125.6	283.9	60.6	56.2	21.0	19.8	22.2	18.0	5.6	0.3	21.4
22.0	499.3	1613.7	523.3	477.7	36.9	67.9	28.2	31.7	11.2	11.4	6.0	5.7	3.2	16.7
20.0	1654.5	1520.4	889.5	215.5	78.5	38.9	40.8	37.8	11.3	8.7	13.3	1.5	3.0	22.4
22.2	196.9	1183.2	1598.5	912.9	201.0	160.0	39.5	33.8	46.2	16.0	10.2	14.9	8.8	18.6
24.2	206.2	542.7	671.3	590.9	409.4	100.6	40.3	25.4	14.2	9.3	5.0	11.9	3.4	8.0
25.0	284.1	975.5	628.7	560.1	354.3	316.8	68.3	77.6	34.2	26.2	15.8	10.8	1.1	4.2
30.9	196.0	1282.3	966.1	500.2	422.3	301.1	144.7	56.6	29.3	25.8	12.1	12.6	3.4	1.4
18.1	254.1	450.3	375.4	175.1	54.8	116.1	95.9	59.1	12.4	16.0	7.7	2.9	4.4	19.2
21.4	367.7	1043.6	640.2	308.3	94.6	48.7	90.6	68.3	28.2	44.7	22.9	4.7	8.5	11.3
30.5	569.1	1170.7	1225.1	239.1	139.4	68.4	66.6	74.4	46.0	26.9	7.6	6.6	0.3	1.9
32.4	1055.5	1385.4	375.0	617.9	351.1	105.4	31.6	15.2	18.7	35.5	11.6	6.9	12.3	4.6
33.7	1267.7	1612.6	804.3	286.3	122.4	95.7	45.2	24.8	28.6	15.8	13.8	8.0	6.0	2.6
47.5	2157.2	1848.1	1368.5	737.0	395.3	191.8	97.9	15.0	47.9	33.5	30.8	37.9	0.0	1.2
41.6	959.7	1846.2	778.1	1050.9	331.1	82.3	93.5	30.7	51.2	22	34.8	0.7	8.3	0.7
UK	BT													
1986	2004													
1	1	0	1											
2	15													
2.8	30.0	144.8	100.5	28.0	28.8	39.4	1.2	2.4	5.2	2.5	2.8	1.5	1.7	5.3
5.6	251.8	106.0	143.5	99.2	18.6	14.6	37.6	1.4	0.4	3.3	1.1	1.5	3.3	2.4
5.1	112.3	281.3	56.4	62.9	39.6	9.0	11.5	16.2	2.0	0.2	4.6	4.9	0.0	0.2
5.7	162.3	78.1	144.2	18.2	31.7	23.1	5.1	4.2	16.3	1.0	0.6	2.2	2.7	12.9
7.3	112.6	327.4	47.7	66.1	14.1	15.1	15.1	4.1	7.4	22.2	1.9	0.4	3.4	7.6
7.7	349.0	139.2	195.2	8.4	30.7	5.1	7.4	10.9	2.7	1.9	8.4	0.3	0.0	5.0
8.8	240.1	516.6	81.3	167.5	11.1	20.3	6.4	14.6	4.9	2.2	1.5	3.3	0.1	2.5
6.4	174.9	222.5	218.9	34.6	52.7	5.2	10.7	4.5	3.0	3.3	1.1	1.3	2.1	2.8
5.4	33.6	260.9	144.1	113.3	27.5	45.5	4.4	10.5	3.2	4.1	3.7	2.4	1.6	9.3
6.9	181.1	106.9	220.4	107.6	94.6	18.3	37.5	5.4	9.4	2.0	4.3	4.4	0.9	7.7
10.3	295.8	251.3	79.5	169.0	84.6	67.4	17.5	33.2	4.1	8.8	4.2	5.4	3.6	11.9
10.3	268.5	331.1	158.5	42.4	125.2	50.8	48.7	11.6	23.0	2.7	7.1	1.1	3.8	7.6
7.3	252.6	169.4	97.5	65.2	22.1	51.7	28.8	22.4	5.8	12.5	2.0	5.3	1.5	9.0
5.9	170.0	300.0	105.6	43.6	31.8	12.3	26.3	12.9	7.3	3.4	3.8	0.7	2.5	4.1
5.7	152.1	178.8	171.4	54.7	25.8	18.2	6.9	21.6	9.7	5.7	2.3	4.2	0.6	7.9
7.6	284.3	268.0	101.0	111.9	44.0	19.0	19.6	5.8	14.7	12.1	5.0	1.4	3.0	4.7
7.9	314.6	449.0	222.2	71.7	54.9	22.9	18.6	6.0	3.1	5.2	2.3	2.4	0.4	2.9
6.7	386.0	220.8	149.5	64.8	27.2	32.0	15.0	5.6	5.8	0.9	4.2	2.8	1.9	5.1
4.9	119.6	470.6	110.3	66.5	34.9	10.3	19.4	4.6	3.4	3.1	0.6	3.5	1.3	4.5
UK	BTS													
1988	2004													
1	1	0.5	0.75											
1	6													
1	8.20	14.20	9.90	0.80	1.30	0.60								
1	2.60	15.40	3.40	1.70	0.60	0.20								
1	12.10	3.70	3.40	0.70	0.80	0.20								
1	8.90	22.80	2.20	2.30	0.30	0.50								
1	1.40	12.00	10.00	0.70	1.10	0.30								
1	0.50	17.50	8.40	7.00	0.80	1.00								
1	4.80	3.20	8.30	3.30	3.30	0.20								
1	3.50	10.60	1.50	2.30	1.20	1.50								
1	3.50	7.30	3.80	0.70	1.30	0.90								
1	19.00	7.30	3.20	1.30	0.20	0.50								
1	2.00	21.20	2.50	1.00	0.90	0.10								
1	28.10	9.40	13.20	2.50	1.70	1.30								
1	10.49	22.03	4.15	4.24	1.03	0.58								
1	9.09	21.01	8.36	1.20	1.91	0.54								
1	31.76	11.42	5.42	3.45	0.27	0.71								
1	6.47	28.48	4.13	2.46	1.58	0.30								
1	7.35	8.49	7.71	1.57	1.45	0.99								
YFS														
1981	2004													
1	1	0.5	0.75											
0	**1**													
1	1.88	-11.00												
1	2.66	0.20												
1	11.89	0.70												
1	-11.00	-11												
1	-11.00	-11												
1	-11.00	-11												
1	8.00	**0.66**												
1	1.19	**0.94**												
1	12.59	**0.36**												
1	3.33	**1.15**												
1	1.39	**1.87**												
1	1.28	**0.80**												
1	6.53	**0.62**												
1	8.10	**1.59**												
1	5.31	**1.46**												
1	0.99	**0.34**												
1	1.94	**0.52**												
1	9.37	**0.56**												
1	2.75	**0.85**												
1	1.85	**1.28**												
1	4.51	**0.84**												
1	2.52	**1.93**												
1	2.16	**0.82**												
1	8.59	**1.72**												

Table 8.3.1 - Sole VIId - XSA diagnostics

Lowestoft VPA Version 3.1

31/08/2005 12:06

Extended Survivors Analysis

Sole in VIId

CPUE data from file tun7d.txt

Catch data for 23 years. 1982 to 2004. Ages 1 to 11.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
BEL BT	1986	2004	2	10	0	1
UK BT	1986	2004	2	10	0	1
UK BTS	1988	2004	1	6	0.5	0.75
YFS	1987	2004	1	1	0.5	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

Terminal population estimation :

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

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

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

Prior weighting not applied

Tuning had not converged after 30 iterations

Total absolute residual between iterations
29 and 30 = .00693

Final year F values

Age	1	2	3	4	5	6	7	8	9	10
Iteration 29	0.0228	0.2452	0.3499	0.3776	0.4101	0.3998	0.5257	0.4636	0.2242	0.3194
Iteration 30	0.0228	0.2452	0.3498	0.3774	0.4097	0.3992	0.5245	0.4618	0.2233	0.3177

1

Regression weights

1	1	1	1	1	1	1	1	1	1

Table 8.3.1 - Sole VIId - XSA diagnostics - continued

Fishing mortalities

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0.046	0.001	0.001	0.002	0.007	0.005	0.007	0.015	0.017	0.023
2	0.14	0.122	0.097	0.06	0.246	0.174	0.25	0.373	0.292	0.245
3	0.437	0.568	0.645	0.554	0.548	0.612	0.45	0.494	0.45	0.35
4	0.419	0.545	0.788	0.591	0.658	0.539	0.366	0.48	0.355	0.377
5	0.444	0.489	0.797	0.567	0.566	0.408	0.593	0.567	0.396	0.41
6	0.406	0.477	0.452	0.501	0.594	0.391	0.473	0.268	0.512	0.399
7	0.306	0.445	0.414	0.237	0.532	0.4	0.362	0.319	0.364	0.525
8	0.19	0.337	0.468	0.319	0.439	0.398	0.246	0.241	0.323	0.462
9	0.357	0.308	0.494	0.359	0.401	0.353	0.229	0.266	0.179	0.223
10	0.295	0.926	0.238	1.225	0.299	0.266	0.123	0.341	0.364	0.318

XSA population numbers (Thousands)

AGE

XSA population numbers (Thousands)

AGE

YEAR	1.00E+00	2.00E+00	3.00E+00	4.00E+00	5.00E+00	6.00E+00	7.00E+00	8.00E+00	9.00E+00	1.00E+01
1995	1.94E+04	2.39E+04	1.30E+04	1.46E+04	8.71E+03	6.23E+03	1.50E+03	1.69E+03	3.08E+02	4.36E+02
1996	1.87E+04	1.67E+04	1.88E+04	7.59E+03	8.71E+03	5.05E+03	3.76E+03	9.97E+02	1.26E+03	1.95E+02
1997	2.75E+04	1.69E+04	1.34E+04	9.66E+03	3.99E+03	4.83E+03	2.84E+03	2.18E+03	6.44E+02	8.40E+02
1998	1.74E+04	2.49E+04	1.39E+04	6.37E+03	3.97E+03	1.63E+03	2.78E+03	1.70E+03	1.23E+03	3.56E+02
1999	2.63E+04	1.58E+04	2.12E+04	7.21E+03	3.19E+03	2.04E+03	8.91E+02	1.99E+03	1.12E+03	7.80E+02
2000	3.19E+04	2.36E+04	1.11E+04	1.11E+04	3.38E+03	1.64E+03	1.02E+03	4.74E+02	1.16E+03	6.76E+02
2001	2.63E+04	2.88E+04	1.80E+04	5.47E+03	5.85E+03	2.03E+03	1.00E+03	6.18E+02	2.88E+02	7.36E+02
2002	51000	23700	20300	10400	3430	2930	1150	632	437	207
2003	23100	45500	14800	11200	5810	1760	2030	754	449	303
2004	48100	20600	30700	8510	7100	3540	956	1270	494	340

Estimated population abundance at 1st Jan 2005

0	42500	14600	19600	5280	4270	2150	513	729	359

Taper weighted geometric mean of the VPA populations:

23800	20500	15700	8330	4510	2550	1490	919	571	358

Standard error of the weighted Log(VPA populations) :

0.4108	0.3827	0.3725	0.4234	0.4479	0.4765	0.5133	0.5133	0.512	0.5617

Log catchability residuals.

Fleet : BEL BT

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	: at this age								
2	0.07	0.61	-0.69	-2.53	1.16	-0.73	0.01	1.34	-0.26
3	0.65	-0.28	-0.51	-0.07	0.01	0.76	0.02	0.18	-0.1
4	0.13	0.3	-0.78	-0.46	-0.2	0.01	0.35	-0.1	0.51
5	-0.19	0.47	-0.34	0.91	-0.19	-0.14	0.13	-0.13	0.16
6	-0.17	0.86	-0.28	0.21	-0.23	0.58	-0.54	-0.91	0.36
7	-0.23	0.57	0.02	0.29	0.5	0.03	-0.27	-0.02	-0.02
8	0.02	-0.12	-0.78	-0.08	-0.3	-0.09	-0.18	-0.29	0.28
9	0.72	0.31	-0.75	-0.34	0.35	-0.7	-0.1	0.67	-0.22
10	0.07	2.19	1.46	-2.09	-0.08	0.6	-0.69	-0.64	1.4

Table 8.3.1 - Sole VIId - XSA diagnostics - continued

Age		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	1	: at this age									
	2	-0.72	-0.08	-0.68	-0.29	0.45	0.1	0.49	0.89	0.39	0.48
	3	-0.36	-0.12	0.31	-0.27	-0.03	0.4	-0.04	-0.03	0.07	-0.58
	4	-0.4	0.22	0.3	0.22	0.49	0.3	-0.31	-0.18	-0.12	-0.27
	5	-0.17	-0.23	0.36	-0.25	0.36	-0.37	0.05	-0.24	-0.24	0.05
	6	0.02	0.08	0.08	-0.32	-0.12	0.04	0.72	-0.83	0.62	-0.17
	7	-0.06	0.2	0.21	-0.28	-0.04	-0.24	0.12	-0.16	-0.36	-0.25
	8	-1.15	-0.06	-0.24	0.07	-0.26	0.49	-0.65	-0.36	-0.06	-0.44
	9	0.17	-0.18	0.05	-0.08	0.02	-0.31	-0.63	-0.58	-1.49	-0.71
	10	-0.79	1.14	-0.99	-0.03	-0.56	-0.29	-1.41	0.35	0.15	0.21

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	-7.1061	-5.7407	-5.6208	-5.4501	-5.6845	-5.6335	-5.6335	-5.6335	-5.6335
S.E(Log q)	0.8725	0.3506	0.3535	0.3321	0.488	0.262	0.4318	0.5793	1.0534

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age		Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
	2	0.85	0.323	7.53	0.22	19	0.76	-7.11
	3	1.35	-1.205	4.38	0.42	19	0.47	-5.74
	4	0.87	0.754	6.07	0.66	19	0.31	-5.62
	5	1.04	-0.232	5.32	0.62	19	0.36	-5.45
	6	1.02	-0.094	5.63	0.46	19	0.51	-5.68
	7	0.95	0.409	5.71	0.81	19	0.26	-5.63
	8	1.3	-1.515	5.56	0.59	19	0.46	-5.85
	9	1.28	-0.922	5.69	0.38	19	0.7	-5.83
	10	-2.67	-5.486	6.69	0.12	19	1.74	-5.63

Fleet : UK BT

Age		1986	1987	1988	1989	1990	1991	1992	1993	1994
	1	: at this age								
	2	-0.32	0.44	0.63	-0.01	-0.16	-0.04	-0.36	-0.31	-1.16
	3	0.54	-0.03	0.38	0	0.13	-0.25	-0.08	-0.48	-0.08
	4	0.56	0.44	-0.01	0.26	-0.09	0.08	-0.39	-0.16	-0.27
	5	0.3	0.55	0.42	-0.48	0.01	-1.21	0.49	-0.33	-0.02
	6	0.39	-0.27	0.25	0.09	-0.39	-0.28	-0.61	0.05	0
	7	0.64	-0.28	-0.14	0.19	-0.31	-0.95	-0.21	-0.55	0.48
	8	-0.73	0.4	0.3	-0.25	0	-0.63	-0.41	-0.14	-0.16
	9	0.09	-0.67	0.09	-0.32	-0.14	0.14	0.38	0.03	0.37
	10	0.02	-1.26	0.67	0.34	0.58	0.1	-0.25	-0.48	0.48

Age		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	1	: at this age									
	2	-0.14	0.3	0.18	0.06	0.42	-0.09	0.09	0.4	0.08	-0.01
	3	-0.61	-0.47	0.18	-0.22	0.14	0.33	-0.11	0.27	0.02	0.31
	4	-0.05	-0.76	-0.2	-0.01	0.19	0.22	0.03	0.2	-0.17	0.12
	5	-0.12	-0.05	-0.52	0.16	0.19	0.32	0.28	0.32	-0.22	-0.08
	6	0.02	-0.25	0.18	-0.1	0.29	0.24	0.31	0.03	0.12	-0.07
	7	-0.16	-0.12	-0.13	0.17	0.22	0.45	0.2	0.2	0.15	0.15
	8	0.38	-0.19	0.11	0.12	0.13	0.25	0.67	0.55	0.36	0.47
	9	0.22	0.2	-0.09	0.2	-0.02	0.47	0.2	-0.2	-0.17	-0.13
	10	0.4	0.25	0.21	0.46	-0.28	0.17	0.14	-0.08	0.34	-0.02

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	-6.5606	-5.8654	-5.8301	-5.9408	-5.8988	-5.9771	-5.9771	-5.9771	-5.9771
S.E(Log q)	0.3937	0.3104	0.3	0.4279	0.2646	0.3797	0.397	0.2764	0.4575

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.07	-0.284	6.31	0.46	19	0.43	-6.56
3	0.98	0.104	5.94	0.61	19	0.31	-5.87
4	0.99	0.074	5.87	0.67	19	0.3	-5.83
5	0.76	1.428	6.54	0.67	19	0.32	-5.94
6	0.85	1.286	6.18	0.82	19	0.22	-5.9
7	0.79	1.598	6.26	0.77	19	0.29	-5.98
8	0.81	1.44	6.09	0.77	19	0.31	-5.91
9	0.81	2.061	6.02	0.88	19	0.21	-5.94
10	1	-0.026	5.88	0.65	19	0.46	-5.88

Fleet : UK BTS

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	99.99	99.99	0.36	-0.35	0.23	0.15	-1.67	-2	-0.2
2	99.99	99.99	1.03	0.2	-0.75	0.11	-0.35	0.08	-1.01
3	99.99	99.99	0.65	0.63	-0.48	-0.36	0.12	0.06	0.12
4	99.99	99.99	-0.26	-0.02	0.06	0.07	-0.6	0.63	0.03
5	99.99	99.99	0.43	0.17	-0.14	-0.22	-0.08	0.02	0.4
6	99.99	99.99	0.09	-0.82	-0.28	0.07	0.35	0.31	-0.85
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	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	-0.18	-0.17	1.14	-0.66	1.58	0.4	0.45	1.04	0.24	-0.36
2	-0.22	-0.25	-0.27	0.39	0.14	0.55	0.35	0.01	0.22	-0.22
3	-0.97	-0.33	-0.11	-0.45	0.79	0.31	0.43	-0.09	-0.07	-0.25
4	-0.31	-0.76	-0.23	-0.2	0.63	0.66	-0.01	0.48	-0.01	-0.17
5	-0.41	-0.31	-1.21	0.16	1.01	0.36	0.54	-0.9	0.24	-0.04
6	0.21	-0.05	-0.6	-1.09	1.3	0.59	0.35	0.13	-0.07	0.36
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	-8.3517	-7.3531	-7.7635	-8.1292	-8.1357	-8.2281
S.E(Log q)	0.904	0.4813	0.4649	0.4105	0.5307	0.593

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	0.54	1.398	9.21	0.38	17	0.47	-8.35
2	0.9	0.334	7.61	0.44	17	0.45	-7.35
3	1	-0.004	7.76	0.4	17	0.48	-7.76
4	0.78	1.237	8.33	0.68	17	0.32	-8.13
5	1	0.006	8.14	0.43	17	0.55	-8.14
6	1.02	-0.071	8.24	0.39	17	0.63	-8.23

Fleet : YFS

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	99.99	0.54	0.04	-0.48	-0.28	0.44	-0.39	0.06	0.54
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	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0.79	-0.66	-0.62	-0.09	-0.08	0.14	-0.09	0.09	0.02	0.03
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	-10.1955
S.E(Log q)	0.4007

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.12	-0.446	10.2	0.45	18	0.46	-10.2

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 = 2003

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	29743	0.93	0	0	1	0.158	0.032
YFS	43993	0.412	0	0	1	0.807	0.022
F shrinkage mean	97283	2				0.035	0.01

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
42518	0.37	0.15	3	0.41	0.023

Age 2 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	23554	0.895	0	0	1	0.067	0.159
UK BT	14442	0.404	0	0	1	0.328	0.247
UK BTS	12889	0.437	0.193	0.44	2	0.279	0.273
YFS	14881	0.412	0	0	1	0.31	0.241
F shrinkage mean	13193	2				0.017	0.268

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
14568	0.23	0.08	6	0.337	0.245

Age 3 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	12143	0.335	0.3	0.9	2	0.24	0.516
UK BT	24895	0.252	0.109	0.43	2	0.4	0.285
UK BTS	20783	0.326	0.281	0.86	3	0.229	0.333
YFS	21334	0.412	0	0	1	0.12	0.325
F shrinkage mean	12253	2				0.01	0.512

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
19595	0.16	0.13	9	0.848	0.35

Table 8.3.1 - Sole VIId - XSA diagnostics - continued

Age 4 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	4800	0.253	0.185	0.73	3	0.283	0.408
UK BT	6012	0.203	0.083	0.41	3	0.423	0.338
UK BTS	4844	0.271	0.079	0.29	4	0.231	0.405
YFS	4820	0.412	0	0	1	0.056	0.407
F shrinkage mean	3916	2				0.008	0.481

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5283	0.13	0.06	12	0.471	0.377

Age 5 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	4253	0.211	0.063	0.3	4	0.355	0.411
UK BT	4194	0.19	0.1	0.52	4	0.379	0.416
UK BTS	4374	0.251	0.075	0.3	5	0.219	0.402
YFS	4893	0.412	0	0	1	0.039	0.366
F shrinkage mean	3267	2				0.008	0.508

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4272	0.12	0.04	15	0.33	0.41

Age 6 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	1802	0.205	0.036	0.18	5	0.308	0.461
UK BT	2048	0.176	0.064	0.37	5	0.464	0.415
UK BTS	3265	0.25	0.097	0.39	6	0.194	0.28
YFS	1987	0.412	0	0	1	0.026	0.425
F shrinkage mean	1859	2				0.008	0.449

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2152	0.12	0.06	18	0.529	0.399

Table 8.3.1 - Sole VIId - XSA diagnostics - continued

Age 7 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	459	0.194	0.141	0.72	6	0.431	0.57
UK BT	601	0.179	0.043	0.24	6	0.432	0.462
UK BTS	423	0.259	0.182	0.7	6	0.115	0.607
YFS	469	0.412	0	0	1	0.013	0.561
F shrinkage mean	725	2				0.009	0.397

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
513	0.12	0.07	20	0.568	0.525

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	527	0.181	0.115	0.63	7	0.425	0.593
UK BT	906	0.17	0.07	0.41	7	0.462	0.386
UK BTS	1147	0.266	0.117	0.44	6	0.093	0.316
YFS	391	0.412	0	0	1	0.012	0.737
F shrinkage mean	1088	2				0.009	0.33

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
729	0.11	0.08	22	0.729	0.462

Age 9 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	304	0.182	0.142	0.78	8	0.366	0.258
UK BT	393	0.163	0.082	0.5	8	0.559	0.205
UK BTS	469	0.263	0.152	0.58	6	0.061	0.175
YFS	186	0.412	0	0	1	0.007	0.393
F shrinkage mean	270	2				0.007	0.286

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
359	0.11	0.07	24	0.598	0.223

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 = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	184	0.183	0.21	1.15	9	0.342	0.374
UK BT	244	0.156	0.088	0.57	9	0.592	0.295
UK BTS	324	0.272	0.222	0.81	6	0.053	0.23
YFS	495	0.412	0	0	1	0.006	0.156
F shrinkage mean	168	2				0.008	0.405

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
225	0.11	0.09	26	0.787	0.318

Table 8.3.2 - Sole VIId - Fishing mortality (F) at age

Run title : Sole in VIId

At 31/08/2005 12:07

Table 8 Fishing mortality (F) at age

YEAR	1982	1983	1984
AGE			
1	0.0129	0.0000	0.0012
2	0.1868	0.0823	0.1139
3	0.3119	0.3545	0.4328
4	0.4890	0.3603	0.4394
5	0.2305	0.4495	0.2636
6	0.2300	0.4610	0.7316
7	0.4690	0.3207	0.5149
8	0.4126	0.5127	0.2373
9	0.3480	0.2930	0.36
10	0.3390	0.4088	0.423
+gp	0.3390	0.4088	0.423
0 FBAR 3- 8	0.3572	0.4098	0.4366

Table 8 Fishing mortality (F) at age

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
1	0.0040	0.0020	0.0009	0.0039	0.0103	0.0300	0.0117	0.0033	0.0053	0.0012
2	0.2223	0.1201	0.1521	0.2605	0.1714	0.2228	0.2155	0.1472	0.1912	0.0496
3	0.4331	0.5017	0.5458	0.5410	0.6730	0.4017	0.5062	0.3944	0.3273	0.3387
4	0.3741	0.4578	0.5882	0.4225	0.6662	0.4769	0.5232	0.4079	0.4019	0.4977
5	0.2744	0.3221	0.5315	0.3762	0.7343	0.4398	0.4376	0.4525	0.3527	0.4183
6	0.3950	0.3024	0.6618	0.3904	0.4555	0.2896	0.5217	0.3415	0.1968	0.3158
7	0.2631	0.3623	0.8069	0.4879	0.4340	0.3511	0.3813	0.3281	0.2917	0.2772
8	0.2975	0.4431	0.4436	0.3869	0.4464	0.3195	0.3487	0.3140	0.2475	0.2902
9	0.1575	0.6170	0.5820	0.2250	0.4153	0.5093	0.5324	0.3845	0.4312	0.2779
10	0.2783	0.2959	1.6561	1.0571	0.2797	0.5654	0.7413	0.3370	0.2081	0.6495
+gp	0.2783	0.2959	1.6561	1.0571	0.2797	0.5654	0.7413	0.3370	0.2081	0.6495
0 FBAR 3- 8	0.3395	0.3982	0.5963	0.4342	0.5682	0.3798	0.4531	0.3731	0.3030	0.3563

Run title : Sole in VIId

At 31/08/2005 12:07

Table 8 Fishing mortality (F) at age

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	FBAR 02-04
AGE											
1	0.0465	0.0005	0.0009	0.0020	0.0067	0.0046	0.0067	0.0147	0.0174	0.0228	0.0183
2	0.1401	0.1217	0.0973	0.0599	0.2460	0.1737	0.2496	0.3730	0.2922	0.2452	0.3035
3	0.4369	0.5681	0.6452	0.5540	0.5479	0.6117	0.4496	0.4938	0.4501	0.3498	0.4312
4	0.4190	0.5449	0.7880	0.5912	0.6583	0.5389	0.3660	0.4805	0.3545	0.3774	0.4041
5	0.4438	0.4894	0.7968	0.5672	0.5656	0.4079	0.5931	0.5673	0.3955	0.4097	0.4575
6	0.4064	0.4768	0.4516	0.5007	0.5944	0.3912	0.4725	0.2682	0.5116	0.3992	0.3930
7	0.3058	0.4448	0.4144	0.2368	0.5323	0.3996	0.3622	0.3192	0.3641	0.5245	0.4026
8	0.1901	0.3365	0.4683	0.3191	0.4393	0.3982	0.2457	0.2415	0.3231	0.4618	0.3421
9	0.3573	0.3085	0.4942	0.3588	0.4014	0.3532	0.2289	0.2656	0.1789	0.2233	0.2226
10	0.2948	0.9265	0.2377	1.2253	0.2994	0.2656	0.1229	0.3415	0.3639	0.3177	0.3410
+gp	0.2948	0.9265	0.2377	1.2253	0.2994	0.2656	0.1229	0.3415	0.3639	0.3177	
0 FBAR 3- 8	0.3670	0.4767	0.5940	0.4615	0.5563	0.4579	0.4148	0.3951	0.3998	0.4204	

Table 8.3.3 - Sole VIId - Stock numbers at age

Run title : Sole in VIId

At 31/08/2005 12:07

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

YEAR	1982	1983	1984
AGE			
1	12691	21332	21555
2	16195	11336	19302
3	20619	12157	9447
4	4694	13658	7716
5	2911	2604	8620
6	3341	2092	1503
7	1542	2402	1194
8	746	873	1577
9	436	447	473
10	303	279	302
+gp	736	602	723
0 TOTAL	64217	67782	72411

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

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
1	12891	25720	10962	25804	16753	44261	34737	33672	16765	26494
2	19481	11618	23226	9910	23258	15004	38865	31067	30367	15089
3	15584	14114	9322	18051	6911	17730	10864	28350	24262	22695
4	5545	9145	7733	4887	9509	3190	10735	5925	17292	15825
5	4499	3451	5235	3886	2898	4419	1792	5757	3566	10468
6	5992	3094	2263	2784	2413	1258	2576	1047	3313	2267
7	654	3652	2069	1056	1705	1385	852	1383	673	2462
8	646	455	2300	836	587	999	882	527	902	455
9	1126	434	264	1336	513	340	657	563	348	637
10	299	870	212	134	965	307	185	349	347	205
+gp	552	1522	588	439	1212	1184	762	846	720	565
0 TOTAL	67269	74076	64176	69122	66724	90078	102907	109485	98555	97161

Run title : Sole in VIId

At 31/08/2005 12:07

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

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	GMST 82-02	AMST 82-02
AGE													
1	19390	18673	27515	17447	26308	31921	26341	50986	23130	48063	0*	23050	24867
2	23943	16747	16887	24874	15755	23644	28752	23674	45461	20568	42518	19697	20905
3	12993	18833	13418	13864	21198	11147	17983	20269	14752	30712	14568	15258	16181
4	14635	7595	9656	6369	7209	11090	5471	10380	11193	8511	19595	8201	8965
5	8705	8709	3985	3973	3191	3377	5854	3433	5809	7105	5283	4357	4825
6	6233	5054	4831	1625	2039	1640	2032	2927	1761	3539	4272	2559	2873
7	1496	3757	2839	2783	891	1018	1003	1146	2025	956	2152	1499	1713
8	1688	997	2179	1697	1987	474	618	632	754	1273	513	913	1050
9	308	1263	644	1234	1116	1159	288	437	449	494	729	582	668
10	436	195	840	356	780	676	736	207	303	340	359	361	428
+gp	990	594	1323	443	1455	1115	2406	714	841	897	816		
0 TOTAL	90818	82417	84117	74665	81928	87260	91484	114805	106480	122458	90805		

[a] Replaced with GM in prediction

Table 8.3.4 - Sole VIId - Summary

Run title : Sole in VIId

At 31/08/2005 12:07

Table 16 Summary (without SOP correction)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 8
1982	12691	10376	7781	3190	0.41	0.3572
1983	21332	12549	9525	3458	0.363	0.4098
1984	21555	12894	8921	3575	0.4007	0.4366
1985	12891	13263	9913	3837	0.3871	0.3395
1986	25720	13895	10514	3932	0.374	0.3982
1987	10962	12970	8952	4791	0.5352	0.5963
1988	25804	12762	10035	3853	0.384	0.4342
1989	16753	11823	8357	3805	0.4553	0.5682
1990	44261	13818	9535	3647	0.3825	0.3798
1991	34737	15823	8722	4351	0.4988	0.4531
1992	33672	17345	11188	4072	0.364	0.3731
1993	16765	17936	13150	4299	0.3269	0.303
1994	26494	15588	12513	4383	0.3503	0.3563
1995	19390	15065	11078	4420	0.399	0.367
1996	18673	15634	12105	4797	0.3963	0.4767
1997	27515	14235	10512	4764	0.4532	0.594
1998	17447	12384	8030	3363	0.4188	0.4615
1999	26308	12278	8946	4135	0.4622	0.5563
2000	31921	12739	8258	3476	0.4209	0.4579
2001	26341	12445	7476	4025	0.5384	0.4148
2002	50986	14212	8443	4733	0.5606	0.3951
2003	23130	18230	10209	5038	0.4935	0.3998
2004	48063	17213	11992	4826	0.4024	0.4204
2005	23050[1]		11756[2]			0.4051[3]
Arith. Mean	25800	14151	9833	4120	0.4251	0.4326
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

[1] Geometric mean 1982-2002
[2] From forecast
[3] $F_{(02\text{-}04)}$ NOT rescaled to F_{2004}

Table 8.4.1 - Sole VIId – RCT3 input

Yearclass	XSA (Age 1)	XSA (Age 2)	yfs0	yfs1	bts1	bts2
1981	12691	11336	1.881	0.2005	-11	-11
1982	21332	19302	2.6555	0.695	-11	-11
1983	21555	19481	11.887	-11	-11	-11
1984	12891	11618	-11	-11	-11	-11
1985	25720	23226	-11	-11	-11	-11
1986	10962	9910	-11	0.6595	-11	14.2
1987	25804	23258	7.995	0.935	8.2	15.4
1988	16753	15004	1.1875	0.356	2.6	3.7
1989	44261	38865	12.588	1.152	12.1	22.8
1990	34737	31067	3.3285	1.8695	8.9	12
1991	33672	30367	1.3865	0.796	1.4	17.5
1992	16765	15089	1.281	0.615	0.5	3.2
1993	26494	23943	6.534	1.591	4.8	10.6
1994	19390	16747	8.1035	1.4635	3.5	7.4
1995	18673	16887	5.3135	0.339	3.5	7.3
1996	27515	24874	0.9865	0.5205	19	21.23
1997	17447	15755	1.942	0.559	2	9.44
1998	26308	23644	9.3725	0.854	28.14	22.03
1999	31921	28752	2.7455	1.282	10.49	21.01
2000	26341	23674	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	8.49
2003	-11	-11	2.16	1.72	7.35	5.04
2004	-11	-11	8.59	-11	25.00	-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 24 years : 1981 - 2004

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 = 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
yfs0	1.61	7.59	1.05	.090	17	1.26	9.62	1.162	.040
yfs1	2.45	8.57	.48	.389	17	.60	10.04	.526	.193
bts1	.63	8.92	.46	.325	14	2.01	10.20	.510	.205
bts2	1.08	7.32	.51	.370	14	2.25	9.76	.574	.162
						VPA Mean =	10.01	.365	.400

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
yfs0	1.61	7.59	1.05	.090	17	1.15	9.44	1.167	.041
yfs1	2.45	8.57	.48	.389	17	1.00	11.02	.568	.173
bts1	.63	8.92	.46	.325	14	2.12	10.27	.511	.214
bts2	1.08	7.32	.51	.370	14	1.80	9.27	.602	.154
						VPA Mean =	10.01	.365	.418

Yearclass = 2004

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

yfs0	1.61	7.59	1.05	.090	17	2.26	11.23	1.195	.061
yfs1									
bts1	.63	8.92	.46	.325	14	3.26	10.99	.555	.284
bts2									

VPA Mean = 10.01 .365 .655

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2002	21924	10.00	.23	.08	.11		
2003	24368	10.10	.24	.27	1.26		
2004	31550	10.36	.30	.35	1.38		

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 24 years : 1981 - 2004

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 = 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
yfs0	1.68	7.37	1.10	.083	17	1.26	9.49	1.216	.036
yfs1	2.48	8.45	.49	.378	17	.60	9.93	.537	.185
bts1	.63	8.82	.45	.326	14	2.01	10.09	.507	.207
bts2	1.06	7.25	.50	.378	14	2.25	9.65	.562	.169
					VPA Mean =		9.90	.364	.403

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**
yfs0	**1.68**	**7.37**	**1.10**	**.083**	**17**	**1.15**	**9.31**	**1.222**	**.037**
yfs1	**2.48**	**8.45**	**.49**	**.378**	**17**	**1.00**	**10.92**	**.579**	**.166**
bts1	**.63**	**8.82**	**.45**	**.326**	**14**	**2.12**	**10.16**	**.508**	**.216**
bts2	**1.06**	**7.25**	**.50**	**.378**	**14**	**1.80**	**9.17**	**.589**	**.160**
					VPA Mean =		**9.90**	**.364**	**.421**

Yearclass = 2004

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

yfs0	1.68	7.37	1.10	.083	17	2.26	11.17	1.251	.056
yfs1									
bts1	.63	8.82	.45	.326	14	3.26	10.88	.552	.286
bts2									

VPA Mean = 9.90 .364 .659

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2002	19664	9.89	.23	.08	.11		
2003	**21709**	**9.99**	**.24**	**.26**	**1.26**		
2004	28224	10.25	.30	.35	1.38		

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	23050	0.40	WS1	0.05	0.00
N2	42517	0.37	WS2	0.14	0.06
N3	14568	0.23	WS3	0.19	0.08
N4	19595	0.16	WS4	0.23	0.09
N5	5283	0.13	WS5	0.28	0.11
N6	4272	0.12	WS6	0.30	0.22
N7	2152	0.12	WS7	0.32	0.20
N8	512	0.12	WS8	0.33	0.28
N9	728	0.11	WS9	0.43	0.21
N10	359	0.11	WS10	0.42	0.05
N11	816	0.11	WS11	0.46	0.10
H.cons selectivity			Weight in the HC catch		
sH1	0.02	0.19	WH1	0.12	0.03
sH2	0.30	0.24	WH2	0.17	0.05
sH3	0.43	0.20	WH3	0.21	0.01
sH4	0.40	0.19	WH4	0.26	0.01
sH5	0.46	0.23	WH5	0.30	0.07
sH6	0.39	0.31	WH6	0.35	0.11
sH7	0.40	0.23	WH7	0.37	0.05
sH8	0.34	0.29	WH8	0.41	0.06
sH9	0.22	0.21	WH9	0.48	0.02
sH10	0.34	0.09	WH10	0.47	0.10
sH11	0.34	0.09	WH11	0.53	0.01
Natural mortality			Proportion mature		
M1	0.1	0.1	MT1	0	0
M2	0.1	0.1	MT2	0	0.1
M3	0.1	0.1	MT3	1	0.1
M4	0.1	0.1	MT4	1	0
M5	0.1	0.1	MT5	1	0
M6	0.1	0.1	MT6	1	0
M7	0.1	0.1	MT7	1	0
M8	0.1	0.1	MT8	1	0
M9	0.1	0.1	MT9	1	0
M10	0.1	0.1	MT10	1	0
M11	0.1	0.1	MT11	1	0
Relative effort in HC fihery			Year effect for natural mortality		
HF05	1	0.04	K05	1	0.1
HF06	1	0.04	K06	1	0.1
HF07	1	0.04	K07	1	0.1
Recruitment in 2005 and 2006					
R06	23050	0.4			
R07	23050	0.4			

Table 8.5.2 Sole in VIId - Management option table

MFDP version 1a
Run: S7d_fin
Sole in VIId
Time and date: 15:31 07/09/2005
Fbar age range: 3-8

2005				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
18918	11756	1.0000	0.4051	5992

2006					2007	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
17620	13573	0.0000	0.0000	0	21754	17654
.	13573	0.1000	0.0405	686	21062	16967
.	13573	0.2000	0.0810	1345	20396	16307
.	13573	0.3000	0.1215	1979	19757	15673
.	13573	0.4000	0.1620	2588	19143	15064
.	13573	0.5000	0.2026	3174	18553	14480
.	13573	0.6000	0.2431	3737	17986	13918
.	13573	0.7000	0.2836	4279	17442	13379
.	13573	0.8000	0.3241	4799	16918	12861
.	13573	0.9000	0.3646	5300	16416	12364
.	13573	1.0000	0.4051	5781	15933	11886
.	13573	1.1000	0.4456	6244	15468	11427
.	13573	1.2000	0.4861	6689	15022	10986
.	13573	1.3000	0.5266	7117	14593	10562
.	13573	1.4000	0.5671	7529	14181	10156
.	13573	1.5000	0.6077	7925	13785	9765
.	13573	1.6000	0.6482	8306	13404	9389
.	13573	1.7000	0.6887	8673	13039	9029
.	13573	1.8000	0.7292	9025	12687	8682
.	13573	1.9000	0.7697	9365	12349	8349
.	13573	2.0000	0.8102	9691	12023	8029

Input units are thousands and kg - output in tonnes

Table 8.5.3 Sole in VIId. Detailed results

MFDP version 1a
Run: S7d_fin
Time and date: 15:31 07/09/2005
Fbar age range: 3-8

Year: 2005		F multiplier: 1		Fbar: 0.4051					
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
1	0.0183	398	47	23050	1153	0	0	0	0
2	0.3035	10617	1808	42518	6009	0	0	0	0
3	0.4312	4874	1002	14568	2773	14568	2773	14568	2773
4	0.4041	6220	1586	19595	4533	19595	4533	19595	4533
5	0.4575	1853	549	5283	1474	5283	1474	5283	1474
6	0.393	1325	458	4272	1277	4272	1277	4272	1277
7	0.4026	681	251	2152	698	2152	698	2152	698
8	0.3421	142	58	513	168	513	168	513	168
9	0.2226	139	67	729	310	729	310	729	310
10	0.341	99	47	359	150	359	150	359	150
11	0.341	225	119	816	373	816	373	816	373
Total		26572	5992	113855	18918	48287	11756	48287	11756

Year: 2006		F multiplier: 1		Fbar: 0.4051					
Age	**F**	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0183	398	47	23050	1153	0	0	0	0
2	0.3035	5114	871	20478	2894	0	0	0	0
3	0.4312	9502	1954	28402	5406	28402	5406	28402	5406
4	0.4041	2719	693	8564	1981	8564	1981	8564	1981
5	0.4575	4151	1230	11836	3302	11836	3302	11836	3302
6	0.393	939	324	3025	905	3025	905	3025	905
7	0.4026	826	304	2609	846	2609	846	2609	846
8	0.3421	360	148	1302	427	1302	427	1302	427
9	0.2226	63	30	330	140	330	140	330	140
10	0.341	146	69	528	221	528	221	528	221
11	0.341	208	110	756	345	756	345	756	345
Total		24424	5781	100881	17620	57352	13573	57352	13573

Year: 2007		F multiplier: 1		Fbar: 0.4051					
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
1	0.0183	398	47	23050	1153	0	0	0	0
2	0.3035	5114	871	20478	2894	0	0	0	0
3	0.4312	4576	941	13680	2604	13680	2604	13680	2604
4	0.4041	5300	1352	16697	3863	16697	3863	16697	3863
5	0.4575	1814	538	5173	1443	5173	1443	5173	1443
6	0.393	2103	726	6778	2027	6778	2027	6778	2027
7	0.4026	585	215	1848	599	1848	599	1848	599
8	0.3421	436	180	1579	517	1579	517	1579	517
9	0.2226	159	77	837	356	837	356	837	356
10	0.341	66	31	239	100	239	100	239	100
11	0.341	228	120	826	377	826	377	826	377
Total		20779	5097	91183	15933	47655	11886	47655	11886

Input units are thousands and kg - output in tonnes

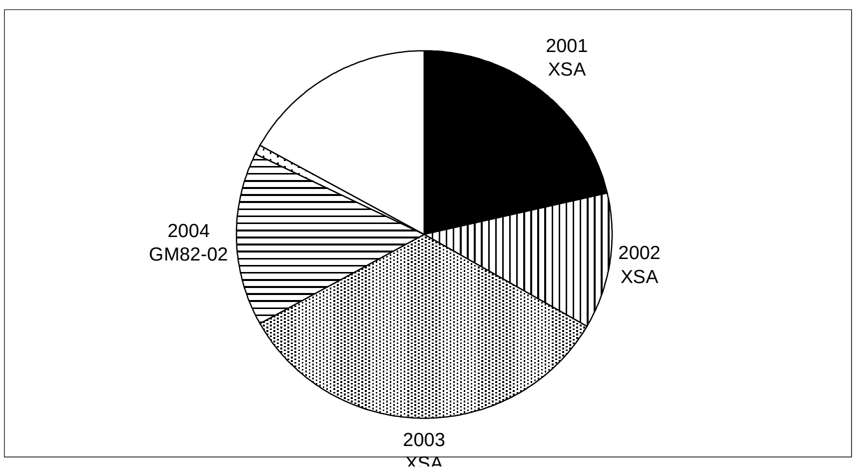
Table 8.5.4 **Sole VIId**
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class	2001	2002	2003	2004	2005
Stock No. (thousands) of 1 year-olds	50986	23130	48063	22326	22326
Source	XSA	XSA	XSA	GM82-02	GM82-02
Status Quo F:					
% in 2005 landings	26.5	16.7	30.2	0.8	-
% in 2006 landings	21.3	12.0	33.8	15.1	0.8
% in 2005 SSB	38.6	23.6	0.0	0.0	-
% in 2006 SSB	24.3	14.6	39.8	0.0	0.0
% in 2007 SSB	17.1	12.1	32.5	21.9	0.0

GM : geometric mean recruitment

Sole VIId : Year-class % contribution to

a) 2006 landings



b) 2007 SSB

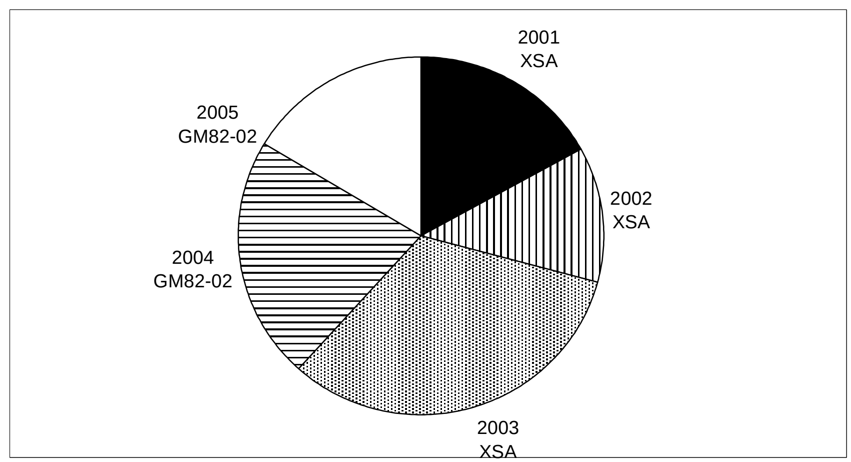


Table 8.6.1 - Sole in VIId Yield per recruit summary table

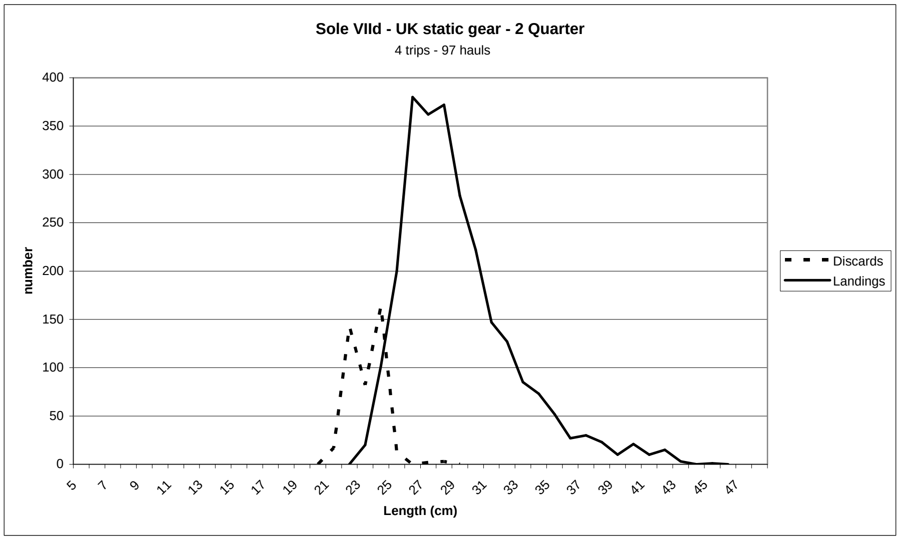
MFYPR version 2a
Run: S7d_y_fin
Time and date: 15:38 07/09/2005
Yield per results

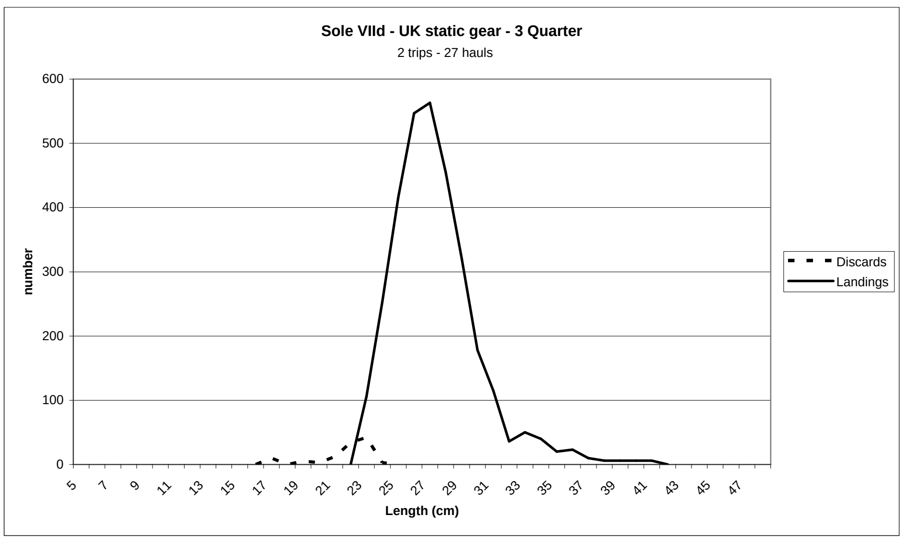
FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	10.5083	3.3415	8.6035	3.1636	8.6035	3.1636
0.1000	0.0405	0.2428	0.0866	8.0826	2.3146	6.1795	2.1369	6.1795	2.1369
0.2000	0.0810	0.3855	0.1278	6.6590	1.7336	4.7575	1.5562	4.7575	1.5562
0.3000	0.1215	0.4788	0.1489	5.7292	1.3685	3.8293	1.1913	3.8293	1.1913
0.4000	0.1620	0.5441	0.1599	5.0783	1.1226	3.1800	0.9456	3.1800	0.9456
0.5000	0.2026	0.5923	0.1656	4.5994	0.9486	2.7028	0.7719	2.7028	0.7719
0.6000	0.2431	0.6292	0.1683	4.2339	0.8207	2.3389	0.6442	2.3389	0.6442
0.7000	0.2836	0.6582	0.1694	3.9466	0.7238	2.0533	0.5476	2.0533	0.5476
0.8000	0.3241	0.6816	0.1694	3.7154	0.6486	1.8237	0.4726	1.8237	0.4726
0.9000	0.3646	0.7008	0.1690	3.5257	0.5889	1.6356	0.4131	1.6356	0.4131
1.0000	0.4051	0.7169	0.1682	3.3674	0.5406	1.4789	0.3651	1.4789	0.3651
1.1000	0.4456	0.7306	0.1672	3.2333	0.5010	1.3465	0.3256	1.3465	0.3256
1.2000	0.4861	0.7423	0.1662	3.1184	0.4679	1.2333	0.2928	1.2333	0.2928
1.3000	0.5266	0.7525	0.1652	3.0189	0.4401	1.1353	0.2652	1.1353	0.2652
1.4000	0.5671	0.7615	0.1642	2.9318	0.4163	1.0498	0.2416	1.0498	0.2416
1.5000	0.6077	0.7694	0.1632	2.8549	0.3958	0.9746	0.2213	0.9746	0.2213
1.6000	0.6482	0.7765	0.1623	2.7865	0.3779	0.9078	0.2037	0.9078	0.2037
1.7000	0.6887	0.7829	0.1614	2.7253	0.3622	0.8482	0.1883	0.8482	0.1883
1.8000	0.7292	0.7886	0.1606	2.6702	0.3484	0.7947	0.1746	0.7947	0.1746
1.9000	0.7697	0.7938	0.1598	2.6202	0.3360	0.7463	0.1625	0.7463	0.1625
2.0000	0.8102	0.7986	0.1590	2.5748	0.3250	0.7024	0.1517	0.7024	0.1517

Reference point	F multiplier	Absolute F
Fbar(3-8)	1.0000	0.4051
FMax	0.7589	0.3074
F0.1	0.3257	0.132
F35%SPR	0.3302	0.1338

Weights in kilograms

Figure 8.2.1a - Sole VIId - UK Length distributions of discarded and retained fish from discard sampling studies





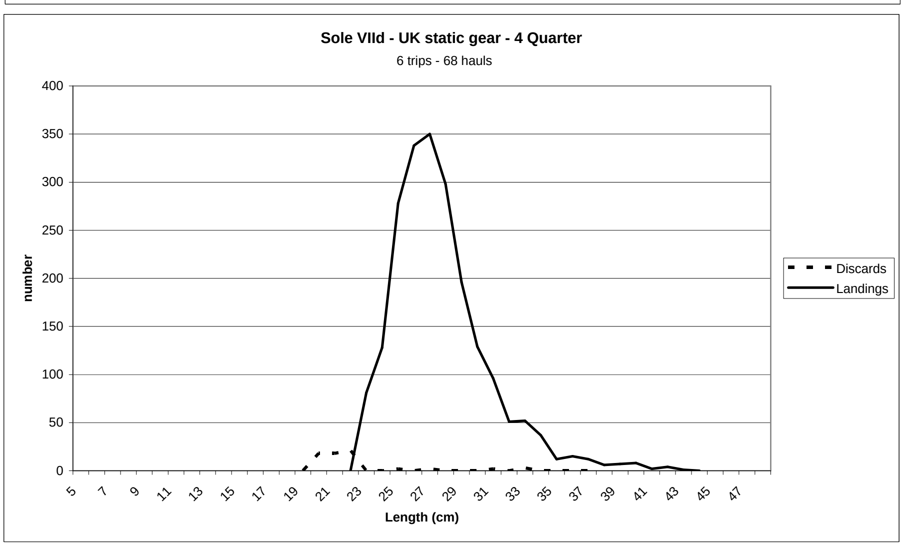


Figure 8.2.1b - Sole VIId - French Length distributions of discarded and retained fish from discard sampling studies

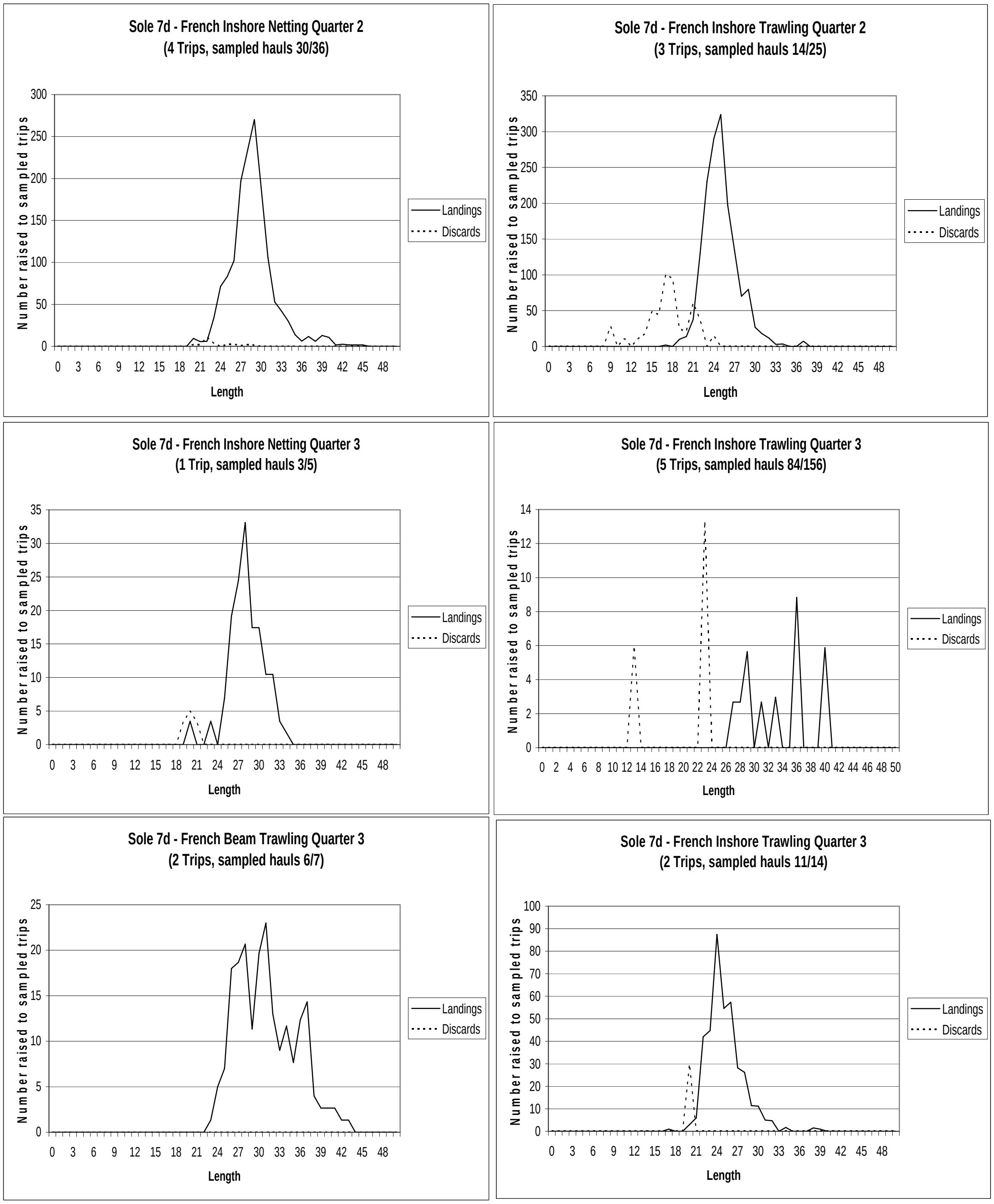


Figure 8.2.1c - Sole VIId - Belgian Length distributions of discarded and retained fish from discard sampling studies

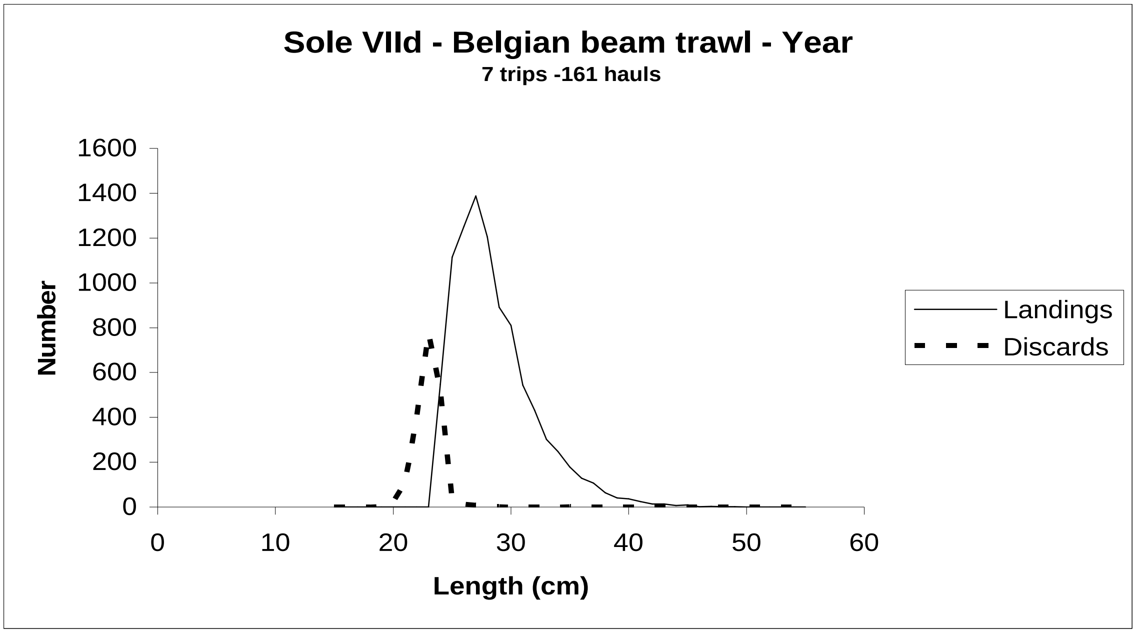


Figure 8.2.2a **Sole VIId - Commercial Effort series**

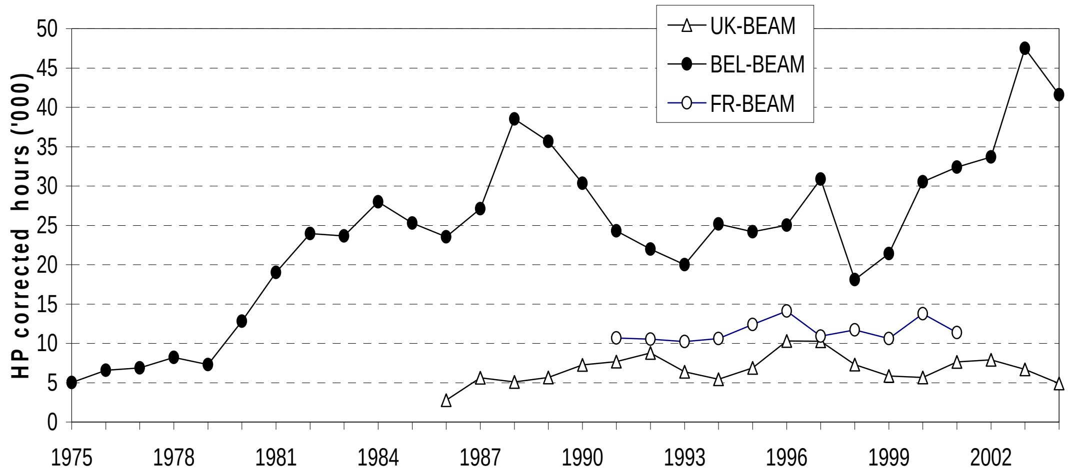


Figure 8.2.2b **Sole VIId - Commercial Relative LPUE series**

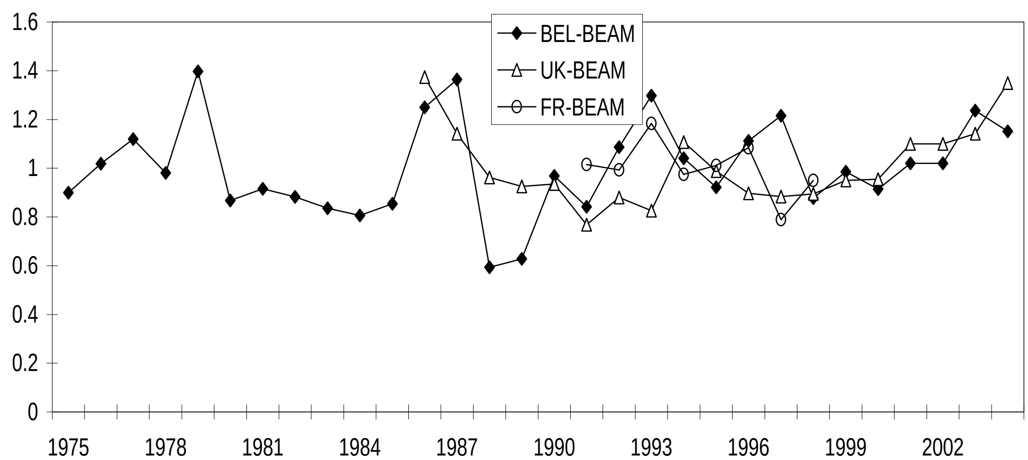
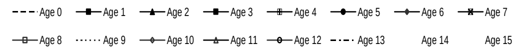


Figure 8.3.1 - VIId SOLE LOG CATCHABILITY RESIDUAL PLOTS - Final XSA



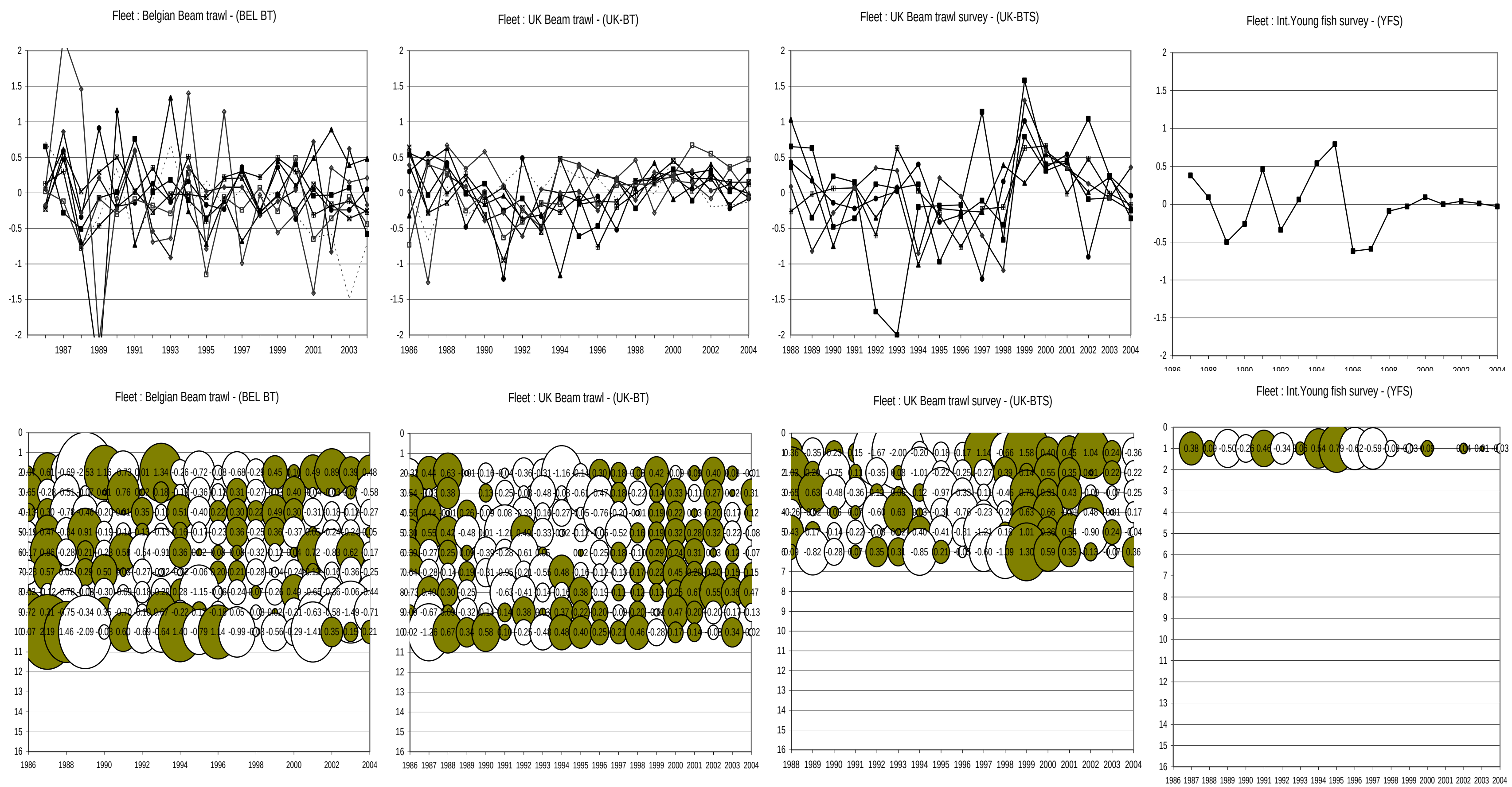


Figure 8.3.2a - Sole VIId - Results from Surba analysis for UK(E&W) Beam trawl survey (UK BTS) and the International young fish survey (YFS)

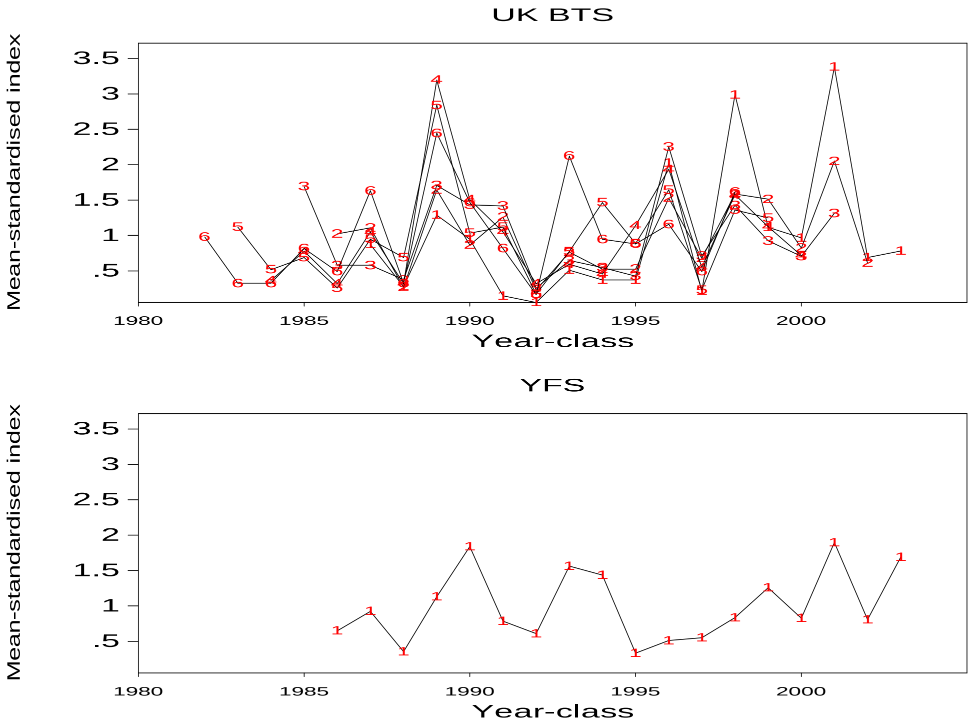


Figure 8.3.2b - Sole VIId - Results from Surba analysis for UK(E&W) Beam trawl survey (UK BTS)

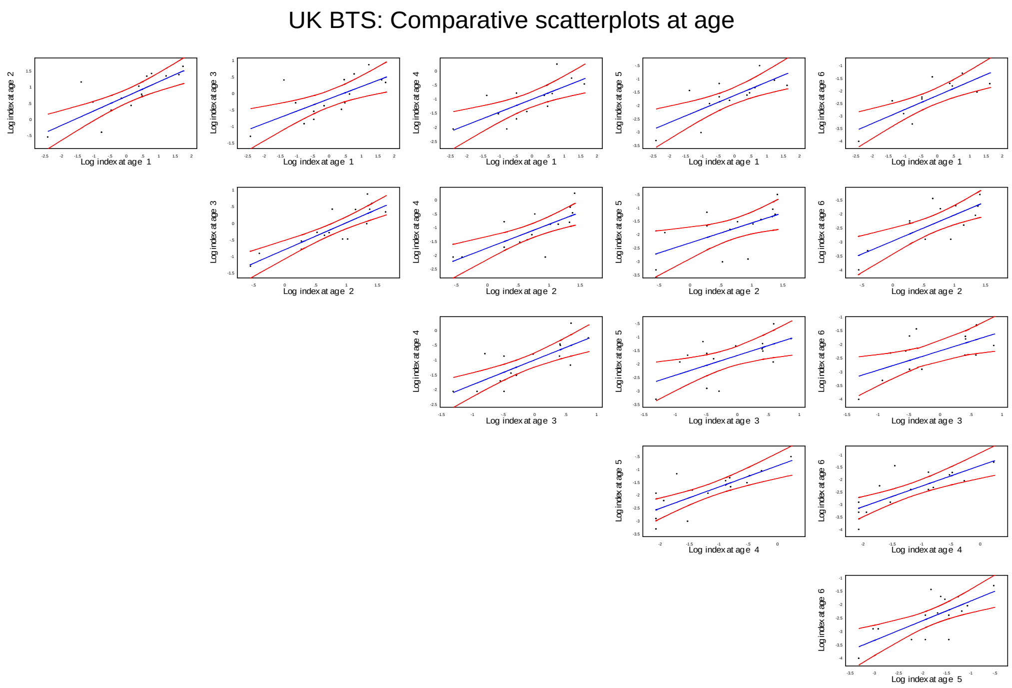


Figure 8.3.2c - Sole VIId - Results from Surba analysis for UK(E&W) Beam trawl survey (UK BTS)

Figure 8.3.3 Sole in VIId. XSA-Surba camparison

Surba-cat1 : Catchability for al ages set to 1

Surba-ex1999 : year 1999 removed from survey index

Surba-var_cat : Catchability set to MeanlogQ's of single survey XSA-run

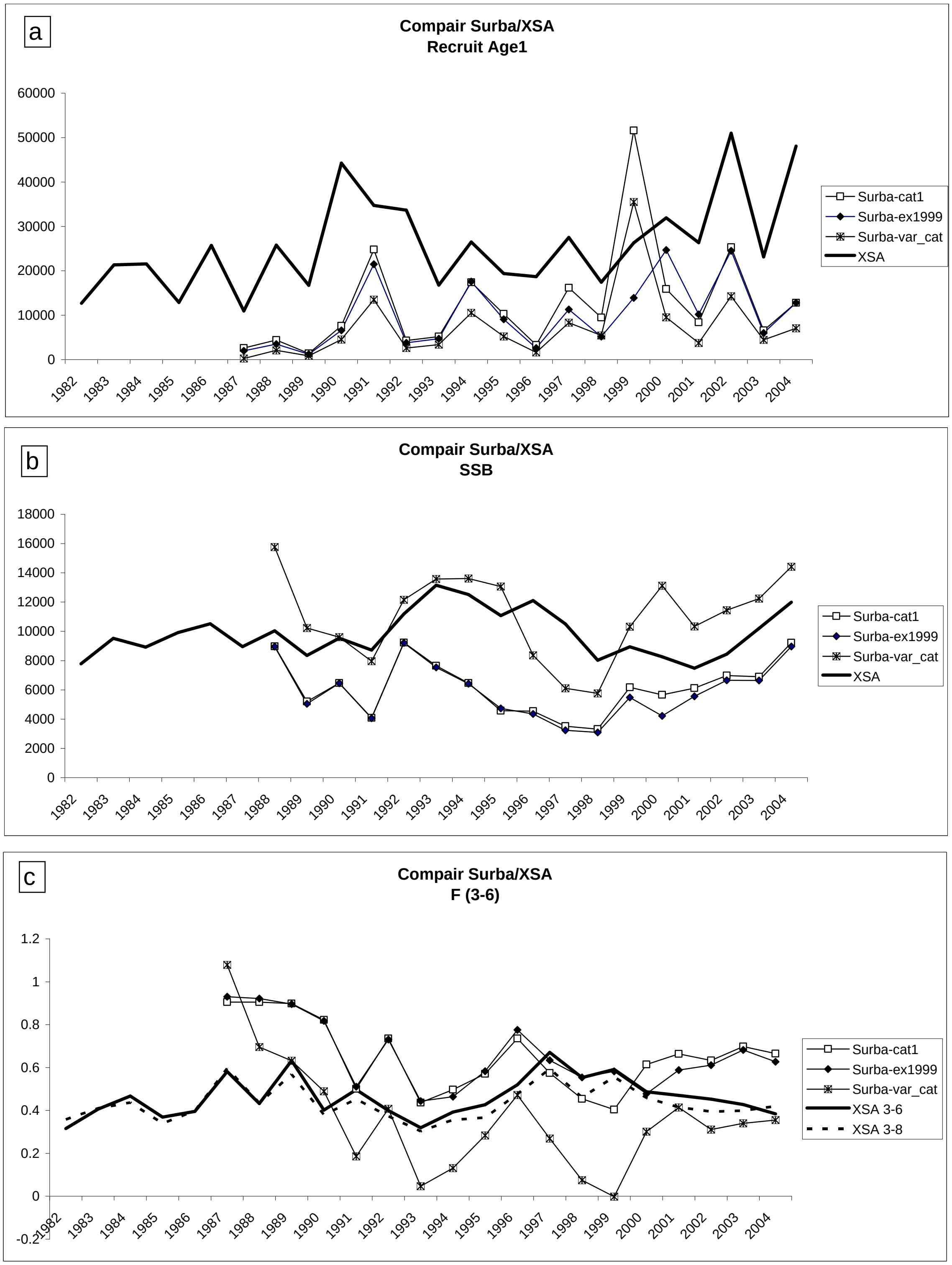


Figure 8.3.4 Sole in VIId. Summary plots

Recruitment in 2005 = GM 82-02 (shaded)
SSB in 2005 from forecast (square in graph)

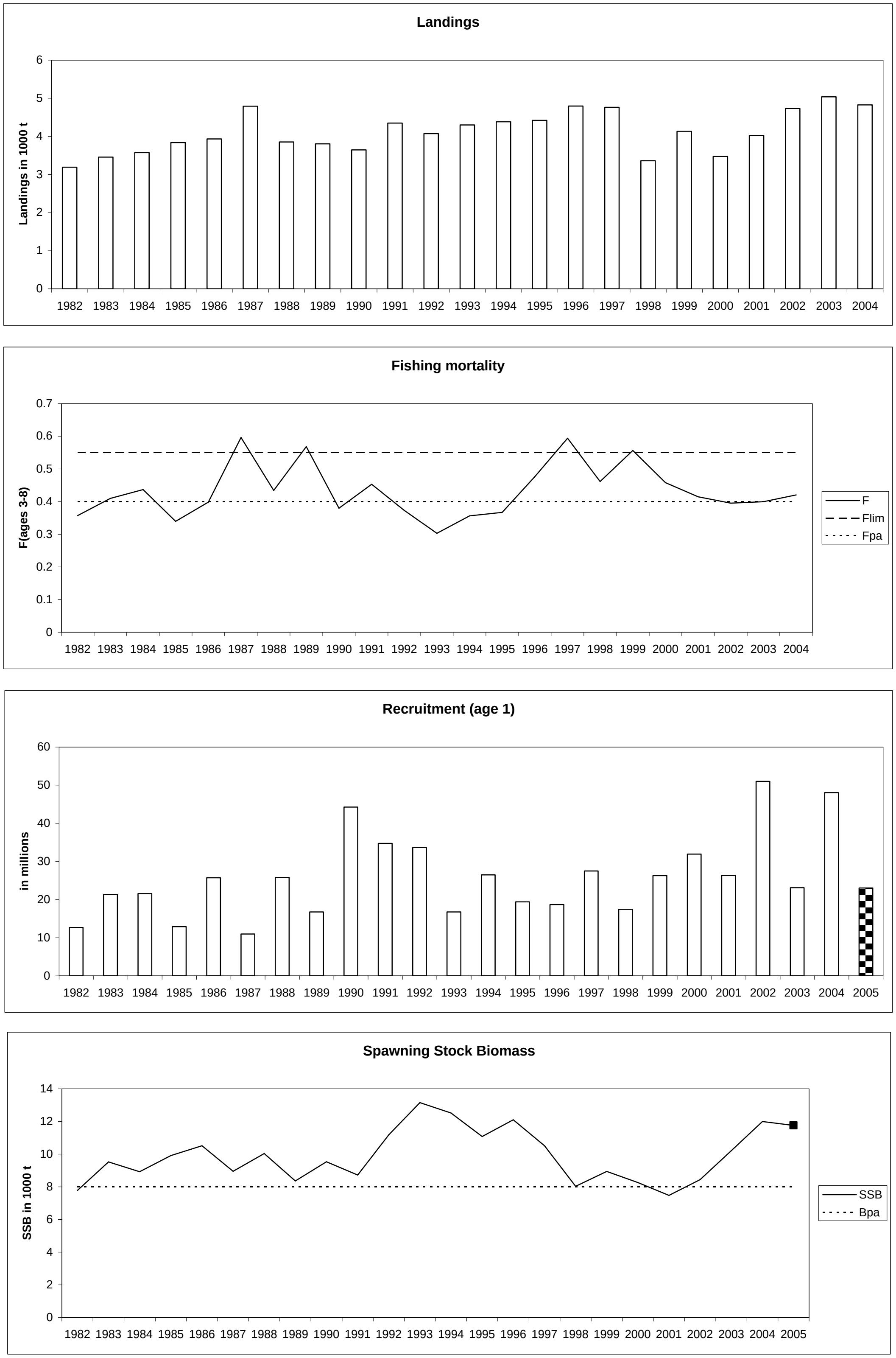


Figure 8.3.5 - Sole VIId retrospective XSA analysys (shinkage SE=2.0)

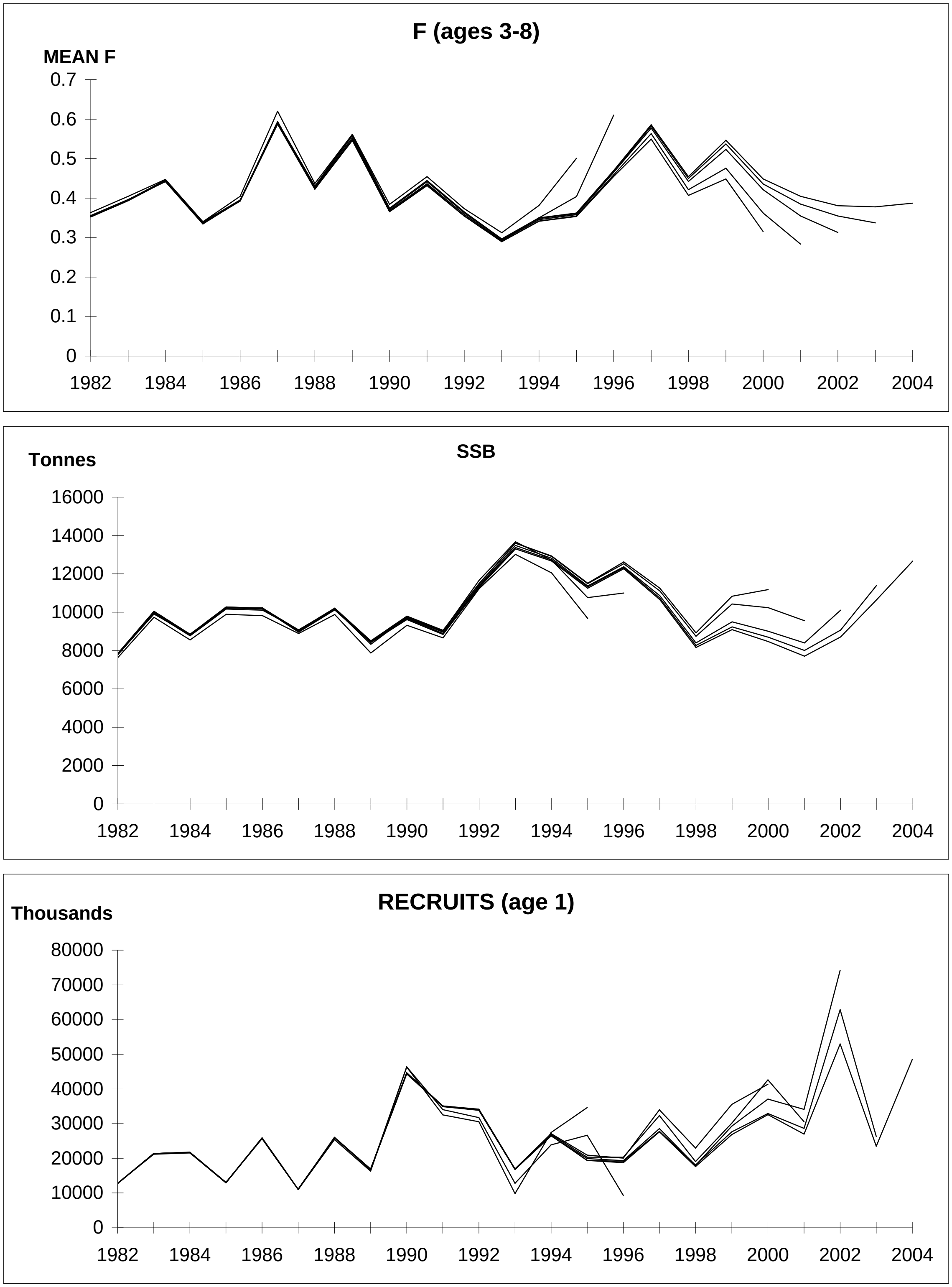
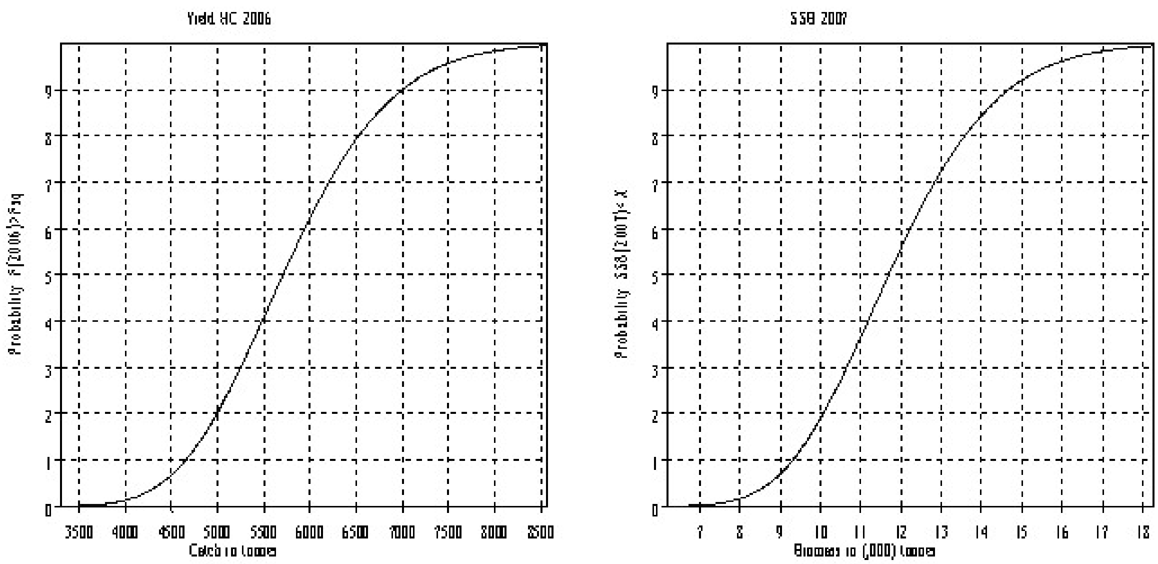
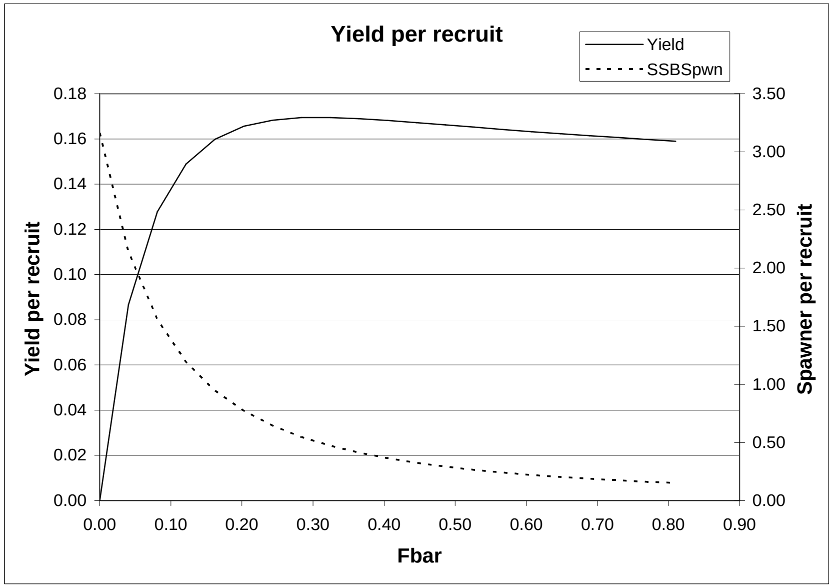


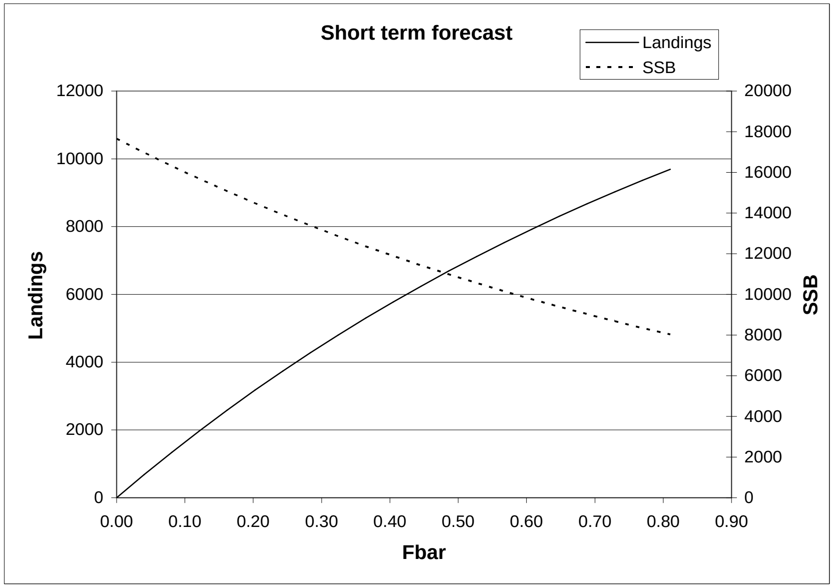
Figure 8.5.1 - Sole VIId - Probability profiles for short term forecast.



Data from file:D:\2005\North_Sea\Prediction\Sensetivity_imem\Pie & profile\SOL

Figure 8.6.1 - Sole in VIId Yield per recruit and short term forecast plots





MFYPR version 2a
Run: S7d_y_fin
Time and date: 15:38 07/09/2005

Reference point	F multiplier	Absolute F
Fbar(3-8)	1.0000	0.4051
FMax	0.7589	0.3074
F0.1	0.3257	0.1320
F35%SPR	0.3302	0.1338

Weights in kilograms

MFDP version 1a
Run: S7d_fin
Sole in VIId
Time and date: 15:31 07/09/2005
Fbar age range: 3-8

Input units are thousands and kg - output in tonnes

Figure 8.7.1. Sole in VIId. Historical performance of the assessment. Circles indicate forecasts.

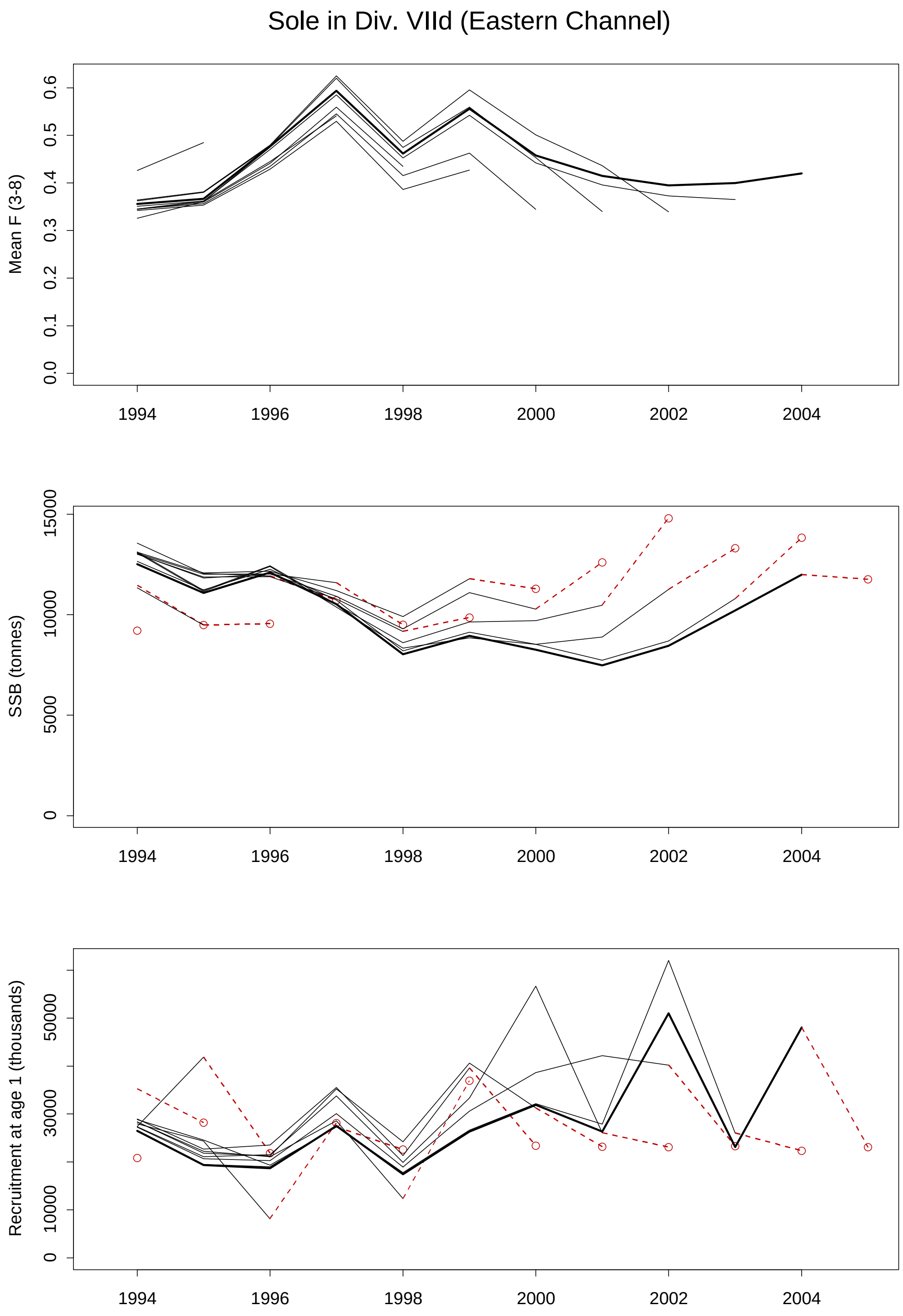
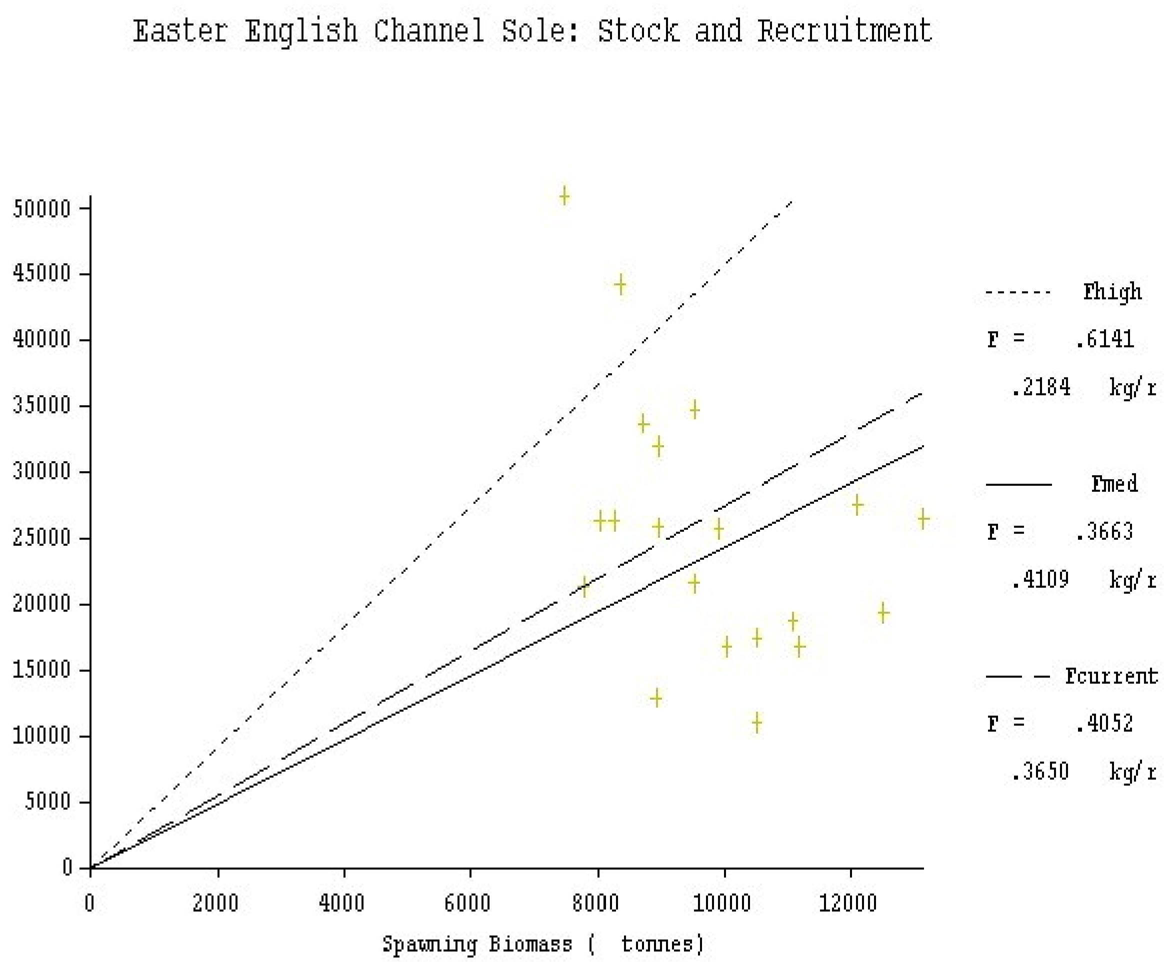


Figure 8.7.2 - Sole VIId Stock/recruitment plot



9 Plaice in Sub-Area IV

9.1 General

The assessment of North Sea plaice is on the ACFM observation list, which means that a benchmark assessment is carried out every year. The assessment of the stock will be subject to a brief review 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.

9.1.1 Ecosystem aspects

Adult North Sea plaice have an annual migration cycle between spawning and feeding grounds. The spawning grounds are located in the central and Southern North Sea, overlapping with the distribution area of Sole. The feeding grounds are located more northerly than the sole distribution areas.

Juvenile stages are concentrated in shallow inshore waters and move gradually offshore as they become larger. The nursery areas on the eastern side of the North Sea contribute most of the total recruitment. Sub-populations have strong homing behaviour to specified spawning grounds and rather low mixing rate with other sub-populations during the feeding season (De Veen, 1978; Rijnsdorp and Pastoors, 1995). Genetically, North Sea and Irish Sea plaice are weakly distinguishable from Norway, Baltic and Bay of Biscay stocks using mitochondrial DNA (Hoarau et al., 2004).

Juvenile plaice were distributed more offshore in recent years. Surveys in the Wadden Sea have shown that 1-group plaice is almost absent from the area where it was very abundant in earlier years. This could be linked to environmental changes in the productivity or changes in the temperature of the southern North Sea, but these links have not been shown conclusively.

9.1.2 Fishery description

North Sea plaice is taken mainly in a mixed flatfish fishery by beam trawlers in the southern and south-eastern North Sea. Directed fisheries are also carried out with seines, gill nets, and twin trawls, and by beam trawlers in the central North Sea. Due to the minimum mesh size enforced (80 mm in the mixed beam trawl fishery), large numbers of (undersized) plaice are discarded. Fleets exploiting North Sea plaice have generally decreased in number of vessels in the last 10 years. However, in some instances, reflagging vessels to other countries has partly compensated these reductions.

The Dutch beam trawl fleet, one of the major operators in the mixed flatfish fishery in the North Sea, has seen a shift towards more inshore fishing grounds (see figure 7.2.1 in the North Sea sole section). This shift may be caused by a number of factors, such as the implementation of fishing effort restrictions, the increase in fuel prices and changes in the TACs for the target species. However, the contribution of each of these factors is yet unknown.

The Dutch beam trawl fleet has reduced in number of vessels and shifted towards two categories of vessels: 2000HP (the maximum engine power allowed) and 300 HP (the maximum engine power for vessels that are allowed to fish within the 12 mile coastal zone and the plaice box). Approximately 85% of plaice landings from the UK (England and Scotland) is landed into the Netherlands by Dutch vessels fishing on the UK register. Vessels fishing under foreign registry are referred to as flag vessels. As described in the 2001 report of this WG (ICES CM 2002/ACFM:01), the fishing pattern of flag vessels can be very different from that of other fleet segments.

A study has been carried out into the increase in technical efficiency of the Dutch beam trawl fleet (Rijnsdorp et al, submitted). This study suggested an average increase in technical efficiency for plaice of around 1.5% by year (1990-2004). The results of the study are still being analysed and have not been used in this WG yet.

9.1.3 Advice

For 2005 ICES advised that the stock assessment and projections results were not comparable to biomass reference values cited in the EU-Norway agreement because of the inclusion of discards in the 2004 assessment. The EU-Norway agreement refers to biomass values and equates these to the ICES PA reference points and cites the actual values as they were estimated at the time of adopting the EU-Norway agreement in 1999. ICES advised that managers should reconsider the role of 0.3 fishing mortality in the EU-Norway agreement, because this fishing mortality was only generated by the human consumption fishery.

Following this interpretation of the EU-Norway agreement, human consumption catches in 2005 should be at 35 000 t, which was expected to allow an increase in SSB to 230 000 t in 2006. Fishing at Fmax (=0.17) was expected to lead to landings in 2005 of around 20 000 t and SSB in 2006 of around 260 000 tonnes. The exploitation boundaries in relation to precautionary limits implied human consumption landings of 35 000 t in 2005, which was expected to lead to an SSB of 230 000 t in 2006.

With respect to mixed fisheries aspects, ICES advised that fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea), and in Division VIId (Eastern Channel) should be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- with minimal bycatch or discards of cod;
- Implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised;
- within the precautionary exploitation limits for all other stocks;

9.1.4 Management applicable to 2004 and 2005

The TAC in 2004 was agreed at 61,000 tonnes. For 2005 the TAC was set at 59,000 tonnes.

In 1999, the EU and Norway agreed to implement a long-term management plan for the plaice stock, which is consistent with the precautionary approach and is intended to constrain harvesting within safe biological limits and designed to provide for sustainable fisheries and greater potential yield. The plan is re-instigated every year and consists of the following elements:

1. Every effort shall be made to maintain a minimum level of SSB greater than 210,000 tonnes (Blim)
2. For 2000 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality of 0.3 for appropriate age groups as defined by ICES.
3. Should the SSB fall below a reference point of 300,000 tonnes (Bpa), the fishing mortality referred to under paragraph 2, shall be adapted in the light of scientific estimates of the conditions then prevailing. Such adaptation shall ensure a safe and rapid recovery of SSB to a level in excess of 300,000 tonnes.

4. In order to reduce discarding and to enhance the spawning biomass of plaice, the Parties agreed that the exploitation pattern shall, while recalling that other demersal species are harvested in these fisheries, be improved in the light of new scientific advice from, inter alia, ICES.

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

The management plan is currently under revision.

Fishing effort has been restricted for demersal fleets as part of the cod recovery plan (EC, 2004; EC, 2005). In 2004 a beam trawl vessel was restricted to 181 days at sea (16 in January, 15 in February-December), with one day at sea being a time frame of 24 hours (EC, 2005).

Several technical measures are applicable to the plaice fishery in the North Sea: mesh size regulations, minimum landing size, gear restrictions and a closed area (the plaice box).

Mesh size regulations for towed trawl gears require that vessels fishing North of 55 N (or 56°N east of 5°E, since January 2000) should have a minimum mesh size of 100 mm, while to the south of this limit, where the majority the plaice fishery takes place, an 80 mm mesh is allowed. In the fishery with fixed gears a minimum mesh size of 100mm is required. In addition to this, since 2002 a small part of North Sea plaice fishery is affected by the additional cod recovery plan (EU regulation 2056/2001) that prohibits trawl fisheries with a mesh size <120mm in the area to the north of 56°N.

The minimum landing size of North Sea plaice is 27 cm. The maximum aggregated beam length of beam trawlers is 24 m. In the 12 nautical mile zone and in the plaice box the maximum aggregated beam-length is 9m. A closed area has been in operation since 1989 (the plaice box). Since 1995 this area was closed in all quarters. The closed area applies to vessels using towed gears, but vessels smaller than 300 HP are exempted from the regulation. An evaluation of the plaice box (Grift et al, 2004) has indicated that: "From trends observed it was inferred that the Plaice Box has likely had a positive effect on the recruitment of Plaice but that its overall effect has decreased since it was established. There are two reasons to assume that the Plaice Box has a positive effect on the recruitment of Plaice: 1) at present, the Plaice Box still protects the majority of undersized Plaice. Approximately 70 % of the undersized Plaice are found in the Plaice Box and Wadden Sea, and despite the changed distribution, densities of juvenile Plaice inside the Box are still higher than outside; 2) In the 80 mm fishery, discard percentages in the Box are higher than outside. Because more than 90 % of the Plaice caught in the 80 mm fishery in the Box are discarded, any reduction in this fishery would reduce discard mortality. There is, however, no proof of a direct relationship between total discard mortality and recruitment."

9.2 Data available

9.2.1 Landings and discards

Total landings of North Sea plaice in 2004 (Table 9.2.1) were estimated by the WG at 61 500 t, which is 5000 t less than the 2003 landings. The TAC was taken in 2004. The national uptake rates in 2005 by the Netherlands (the main plaice landing country) indicate that approximately 49% of the national quota was taken by the beginning of August 2005. The spatial distribution of reported plaice landings in the North Sea and adjoining areas is summarised in Figure 9.2.10.

Discard sampling programmes indicate 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. Discard sampling programmes started in the late 1990s obtain discard estimates from several fleets fishing for flatfish. These sampling programmes give information on discard rates from 1999 but not for the historical time series. Observations indicate that the proportions of plaice catches discarded at present are high (80% in numbers and 50% in weight: Van Keeken et al. 2004) and have increased since the 1970s (51% in numbers and 27% in weight: Van Beek 1998).

In the WGNSSK 2004 assessment, the discards time series was derived from Dutch discards observations for 1999-2003, while the discard time series for 1957-1998 was derived from a discard reconstruction (ICES CM 2005/ACFM:07 Section 9.2.3). To reconstruct the number of plaice discards at age, catch numbers at age are calculated from fishing mortality at age corrected for discard fractions, using a reconstructed population and selection and distribution ogives (ICES CM 2005/ACFM:07 Appendix 1).

This year, discard observations at age are available from the Dutch and the UK discard sampling programme. The sampling effort in these programmes is given in Table 9.2.2. Discards data were also provided by Denmark and Germany but these were not length or age based, and could not be incorporated in the raising procedures described below.

The Dutch sampling programme mainly focuses on beam trawl vessels fishing with 80 mm mesh size, while the UK sampling programme includes different fleet segments fishing with different mesh sizes. However annual sampling of each fleet segment did not take place and the patterns in discard rates within fleets could not be detected. Therefore the different fleet segments of the UK fleet were raised as one fleet. The discard percentages in the Dutch discard programme were on average higher than in the UK programme, because the mesh size in the UK sampling was on average larger than in the Dutch sampling and effort is distributed over areas with less undersized plaice.

The quality of the estimation of total discards numbers at age depends on the quality of the available discards data. The discards estimates are derived from scanty discards observations.

Four approaches to raising the UK and NL discards samples to the total international fleet level have been explored. In all cases the historical reconstruction (1957-1998) was kept the same.

A. Raise discards at age numbers from the Dutch sampling programme with the ratio of total international landings numbers to total landings numbers over sampled trips. This is the same method as used by WGNSSK 2004.

B. Raise discards at age from the Dutch and UK sampling programmes by effort ratio. Discards at age for the other fleets were calculated as a weighted average of the NL and UK discards at age and raised to the proportion in landings (tonnes).

C. Calculate discards ogives from the Dutch and UK sampling programmes, and apply those to the total landings numbers at age per fleet. Since for some years no landings at age 1 were available, this method only gave discards estimates from and 2 and older.

D. Discards at age estimates taken from the model used to reconstruct the discards at age for 1957-1998. This method is described in detail in the WG report from last year (ICES 2004, Appendix 1).

9.2.2 Age compositions

Market sampling programmes (Table 1.2.1) supplied age distributions for the official landings in 2004. Age compositions by sex and quarter were available for the Dutch landings. Combined age compositions by quarter were available from Germany, Belgium, Denmark and

France. Landings from countries that do not provide age compositions were raised to the international age composition.

Until 2002 an age composition of the UK beam trawl fleet was provided, but since 2003 this fleet has ceased to exist. As the UK fleet historically fished further north than the other fleets, a larger proportion of their catches consisted of older animals.

From 2002 onwards, following EU regulation (1639/2001), each country is obliged to sample landings from foreign vessels that land in their country. Since many flagvessels still bring the catches to the Dutch auctions, a sizeable sampling of these vessels exists in the Netherlands. These samples have so far been included in the Dutch age composition. A separate age composition for foreign vessels could not be generated because the sampling programme is based on sampling by market category and category information for the foreign vessels is not available. The landing numbers at age are presented in Table 9.2.3. No SOP-correction was applied to the results of the assessment.

The discard numbers at age were calculated using the discards raising procedure B described above. The resulting discard numbers-at-age are presented in Table 9.2.4. Catch numbers-at-age are calculated as the sum of landings and discards numbers at age (Table 9.2.5.)

9.2.3 Weight at age

The stock weights of age groups 1-4 in the final assessment are calculated using modeled mean lengths from survey and back-calculation data (see ICES CM 2005/ACFM:07 Appendix 1) and converted to mean weight using a fixed length-weight relationship. Stock weights of the older ages are based on the market samples in the first quarter. Stock weights at age are presented in Table 9.2.6. and Figure 9.2.1. Stock weight at age has varied considerably over time. Discard, landing and catch weight-at-age are derived from discard and market sampling programmes, and presented in Table 9.2.7, 9.2.8 and 9.2.9 respectively.

9.2.4 Natural mortality

Natural mortality is assumed to be 0.1 for all age groups and constant over time. A fixed maturity ogive (Table 9.2.10) is generally used for the estimation of SSB in North Sea plaice, but maturity at-age is not likely to be constant over time. However, a study of the effect of the fluctuations of natural mortality on the SSB by the WG in 2004 showed that incorporating the historic fluctuations had little effect on SSB estimates in the last 5 years.

9.2.5 Catch, effort and research vessel data

Survey indices that have been used as tuning fleets (Table 9.2.11):

- Beam Trawl Survey RV Isis (BTS-isis)
- Beam Trawl Survey RV Tridens (BTS-tri)
- Sole Net Survey in September-Oktober (SNS)

Additional Survey indices that can be used for recruitment estimates (Table 9.2.12):

- Demersal Young Fish Survey (DFS)

The Beam Trawl Survey (BTS-isis & BTS-tri) was initiated in 1985 and was set up to obtain indices of the younger agegroups of plaice and sole. However, due to its spatial distribution the BTS surveys also catches considerable numbers of older plaice and sole. Initially, the survey only covered the south-eastern part of the North Sea (RV Isis). Since 1996 the survey area of the BTS surveys has been extended. The RV Tridens now covers the 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. Previously age groups 1 to 4 were used for tuning the North Sea plaice assessment, but the age range has been extended to 1 to 9 in the revision done by ACFM in October 2001.

The Sole Net Survey (SNS & SNSQ2) was carried out with RV Tridens until 1995 and then continued with the RV Isis. Until 1990 this survey was carried out in both spring and autumn. The gear used is a 6 m beam trawl with 40 mm stretched mesh cod-ends. The stations fished are on transects along or perpendicular to the coast. This survey is directed to juvenile plaice and sole. Ages 1 to 3 are used for tuning the North Sea plaice assessment; the 0-group index is used in the RCT3. In an attempt to solve the problem of not having the survey indices in time for the WG, the SNS was moved to spring in 2003. However, because of the gap in the spring series these data could not be used in the plaice assessment or in RCT3. In 2004, the SNS was moved back to autumn as before, based on the recommendation of the WGNSSK in 2004.

The mean standardised CPUE of the tuning surveys are plotted by age for ages 1-4 in Figure 9.2.2. The 2001 year-class appears to be strong based on the SNS survey at age 0 and the BTS-Isis 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 (Fig. 9.2.3.) 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 9.2.4; Grift et al., 2004).

The following commercial LPUE series are available:

- NL beam trawl LPUE (1989-2004)
- UK beam-trawl LPUE, excluding all flag vessels (1990-2002)

The effort and LPUE in biomass of the two commercial fleets are presented in Figures 9.2.5 and 9.2.6, and Table 9.2.13. Effort has decreased in the NL and UK beam trawl fleets since the early/mid 1990s. The relative LPUE of the NL beam trawl fleet appear to be more or less at the same level since 1995. The LPUE for the two commercial fleets is presented in numbers at age in Figure 9.2.9 and Table 9.2.14. The age-classes available in both fleets generally show equal trends in time. The increase in LPUE in 2004 at age 3 suggests that the 2001 year-class is recruiting to this fleet as a relatively strong year-class.

Trends in commercial LPUE by area and fleet component are shown in figures 9.2.7 and 9.2.8. The data are based on landings into the Netherlands. The UK fleet and the Dutch fleet show different trends in LPUE by area. In the southern North Sea, the UK fleet shows an increase in LPUE where the Dutch fleet shows a decrease in LPUE. Overall, the UK fleet appears to show a slight increase in LPUE where the Dutch fleet shows a rather stable LPUE pattern over recent years. The LPUE pattern of the Dutch fleet appears to correspond well with the stock dynamics of the XSA assessment, but the UK LPUE does not agree with the assessment.

The trends in LPUE have not been corrected for potential increases in technical efficiency (see section 9.1.2)

9.3 Data analyses

9.3.1 Exploratory catch-at-age analyses

The assessment of North Sea plaice has been carried by using the FLR version of XSA (see section 1.3.4). A comparison has been carried out using the FLR version and the Fortran version of XSA, and they were found to give the same results (within 1%).

The following exploratory analysis have been carried out:

1. explore sensitivity to different discards raising procedures
2. explore sensitivity to different combinations of tuning series
3. explore sensitivity to different structural model assumption in XSA
4. explore sensitivity to the tuning series by bootstrapping

Different discards raising procedures

Different discards raising procedures have been explored (see section 9.2.1). The XSA settings used were the same as in WGNSSK 2004. The discard estimates from the different raising procedure is summarized in Figures 9.3.1 and 9.3.2. (note: in method C, age 2 was the first age in XSA owing to the raising procedure). The Fishing mortalities estimated by the XSA runs are shown in Figure. 9.3.3 and the SSB estimates in Figure 9.3.4. The results indicate some effects of the raising procedure on estimates of SSB, recruitment and fishing mortality. However, the trends appear to be relatively similar. Results of raising procedures A and B show closest resemblance, probably because the procedures use the same underlying assumptions. Because method B uses most of the data available (discards patterns of both the UK and Dutch fleets, age 1 landings and discards), the WG has chosen to use this method for further catch-at-age based assessments.

Different combinations of tuning series

A series of XSA runs was carried out with all possible permutations of the available tuning fleets (including two commercial fleets). The settings of the XSA model were the same as in WGNSSK 2004. The results (Figure 9.3.5) indicate that the selection of tuning fleets does affect our perception of SSB, F and recruitment; The variance in the SSB estimates for the terminal year as a result of the permutations is high. The inclusion of the two commercial index series would result in a SSB estimate for 2004, combined with a higher Fbar estimate.

Structural model assumptions

A series of XSA runs was carried out with all possible combinations of shrinkage set to 0.5 or 2.0, plusgroup set to 10 or 15 and incorporation or leaving out of the discards in the catch-at-age matrix. The different structural assumptions have a large effect on the XSA outcome (Figure 9.3.6). All runs excluding discards show lower levels of recruitment and lower fishing mortality. Other parameters have very small effects on recruitment estimates. Fbar estimates are sensitive to all assumptions. In contrast, the differences in SSB estimates are caused by different parameters in different parts of the time series. The differences in SSB from 1985 to 1990 are mainly caused by the inclusion of discards and the differences between 1970 and 1980 are associated with low shrinkage and a plus group at age 10. The age at which the plus group is set has no effect on any of the estimates in the last few years of the assessment.

Bootstrap XSA

In order to analyse the sensitivity of the XSA stock assessment to the uncertainty in the survey indices, a bootstrap analysis was carried out (see Section 1.3.4). In this analysis, the catchability residuals from the survey indices were randomly resampled with replacement, stratifying the data by age. The resampled residuals where subsequently used to calculate index series using estimated population numbers and average catchability estimates. This resampling procedure was repeated 500 times. The survey indices generated by the bootstrap were used in an XSA with last years settings. The variance in the XSA estimates of SSB, mean F and recruitment from the bootstraps increases towards the most recent period of the assessment (Figure 9.3.7). This increase in uncertainty of the XSA outcomes towards the most recent period results from the fact that the tuning series have more influence on the assessment in this period. The median and mean of the distributions of terminal SSB and Fbar estimates do not agree with the XSA run using the unresampled index series (figure 9.3.8). This result may stem from the high shrinkage used in this assessment, and the reweighting of the resampled index in the XSA and needs to be resolved, before the bootstrapped XSA could be put forward as an assessment of the state of the stock.

9.3.2 Exploratory research-vessel survey and other tuning data analyses

Complementary to the catch-at-age based assessments, SURBA was used to analyse the trends in relative SSB from surveys indices. SURBA is a survey-only method, which fits survey indices assuming a separable F selection pattern. (see Section 1.3.4). The implicit assumption in the default catchability settings for SURBA is that the survey is equally efficient in catching each age, which is unlikely to be true. However, this can be modified by the user. Three parameters have to be set in the SURBA, being lambda (a year-effect smoothing parameter), a reference age, and q1 (the catchability of the first age in the surveys, relative to the other ages). A SURBA run was done using all three available survey indices. The estimated fit of the model with respect to SSB (Figure. 9.3.9) and Z (Figure. 9.3.10) appeared highly sensitive to the input parameters and could therefore not be used as a confirmation of the age based assessments.

9.3.3 Conclusions

Because of a lack of objective criteria for structural parameters and the high sensitivity of the model, the results of SURBA were not taken into consideration for this stock assessment. Discard estimates from the Dutch and Netherlands sampling programmes have been incorporated in the catch-at-age stock assessment. It has been shown that the XSA is also sensitive to a number of structural assumptions and to the combination of tuning series. The bootstrap estimates have indicated that the assessment with the same settings as last year gives a similar trend in the stock compared to last year, but the estimates of SSB and F in the recent years are very uncertain. However, due to some technical issues in the bootstrap methodology (bias correction, cohort-based resampling), the results of the boostrap have not been used as the basis for a final assessment. More work needs to be done to resolve the technical issues.

The final assessment is thus presented using the same settings as in WGNSSK 2004.

9.3.4 Final assessment

The settings for the final assessment, compared to the settings in earlier years are given below:

```
Year                                       2004                                 2005

Catch-at-age                         landings +                           landings +
                        (reconstructed) discards             (reconstructed) discards
                    based on NL beam trawl fleet                based on NL+UK fleets

                          years age alpha  beta                years age alpha  beta
fleets    BTS-isis 1985-2003 1-9 0.660 0.750   BTS-isis 1985-2004 1-9 0.660 0.750
               SNS 1982-2002 1-3 0.660 0.750        SNS 1982-2004 1-3 0.660 0.750
           BTS-tri 1996-2003 2-9 0.660 0.750    BTS-tri 1996-2004 2-9 0.660 0.750

Plus group                                   10                                   10
first tuning year                          1982                                 1982
last data year                             2003                                 2004
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
```

A summary of the input data is given in Figure 9.3.11. 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, due to age-reading problems in that year. Figure 9.3.12 shows the log catchability residuals for the tuning fleets in the final run. Figures 9.3.13 (a-c) show the timeseries of the estimated stock numbers-at-age in comparison to the tuning series. Fishing mortality and stock numbers are shown in Tables 9.3.1 and 9.3.2. The SSB in 2004 was estimated at 169 000 t. Mean F ages 2-6 was estimated at 0.58. Recruitment of the 2003 year class, in 2004 at the age of 1, was estimated at 1 323 million in the XSA.

9.4 Historical stock trends

Table 9.4.1 and Figure 9.4.1 present the trends in landings, mean F2-6, 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 show a slow decline in the most recent years. Fishing mortality increased until the late 1990s and reached its highest observed level during 1997-1998. Overall F and FHC have decreased after 1998, but Fdiscards has increased in the most recent years, with a drop in 1999 and 2000. Current fishing mortality is estimated at 0.58 (FHC = 0.35, Fdiscards 2-3 = 0.48). 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 estimated to be relatively strong, while the 2000 and 2002 year-class are relatively weak.

9.5 Recruitment estimates

Predictions for North Sea Plaice at age 1 and 2 in 2005 can be derived from several sources: RCT3, geometric means from XSA age 1 and 2 timeseries and estimated survivors from XSA.

Age 1 plaice has moved from the shallower areas earlier in its life during the last few years. This may be the cause for the low catches of age 1 plaice in the DFS survey during the last few years, and the conflicting signal between the DFS and BTS-Isis/SNS surveys for the large 2001 year class at age 1. Because of this, the DFS survey was not used in the RCT3 analysis. Input to the RCT3 analysis is presented in table 9.5.1. Estimates from the RCT3 analysis of age 1 recruitment are presented in table 9.5.2 and age 2 estimates are presented in table 9.5.3. RCT3 analysis estimates the 2004 year class to be 639 million in 2005 (at age 1), and the 2003 year class to be 638472 (at age 2).
The geometric mean (GM) of age 1 is estimated to be 910 million, of age 2 it is estimated to be 666 million. The
The 2003 year class in 2005 (at age 2). The recruitment estimates from the different sources are summarized in the text table below.

Yearclass	At age in 2005	XSA	RCT3	GM 1957-2002	Accepted estimate
2003	2	940 451	**638 472**	662 644	RCT3
2004	1		639 187	**913 747**	GM 1957-2002
2005	Recruits			**913 747**	GM 1957-2002

9.6 Short-term forecasts

Short-term prognoses have been carried out with the same model settings as last year. 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 2004. 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 (1957-2002). Input to the short term forecast is presented in table 9.6.1.The management options are given in Table 9.6.2. F in 2005 is set at the status quo level. The detailed table for a forecast based on Fsq is given in Table 9.6.3. At status quo fishing mortality in 2005 and 2006, SSB is expected to be at **193** 000 tonnes in 2006 and **197** 000 tonnes in 2007. The yield at Fsq is expected to be around **66** 000 tonnes in 2005, which is close to the predicted value for 2005 from last years status quo forecast. The landings in 2006 are predicted to be around **65**,000 tonnes at Fsq.

A probabilistic forecast of North Sea plaice was carried out based on the bootstrapped XSA of the final assessment. See section 9.3.1 for a description of the bootstrap settings. The results of the probabilistic forecast were hard to interpret because the median level of SSB in the bootstrapped XSA was different from the deterministic assessment and are not presented in this report.

9.7 Medium term projections

No medium term projections were done for this stock

9.8 Biological reference points

The stock-recruitment relationship for North Sea plaice does not show a clear breakpoint where recruitment starts to diminish at lower spawning stocks. Therefore, ICES considered that $\mathbf{B_{lim}}$ can be set at 160 000 t. $\mathbf{B_{pa}}$ can then be set at 230 000 t using the default multiplier of 1.4. $\mathbf{F_{lim}}$ can be set at $\mathbf{F_{loss}}$ (0.74). $\mathbf{F_{pa}}$ is proposed to be set at 0.6 which is the 5th percentile of $\mathbf{F_{loss}}$ and gives a 50% probability that SSB is around $\mathbf{B_{pa}}$ in the medium term. Equilibrium analysis suggest that F of 0.6 is consistent with an SSB of around 230 000 t.

	ICES considers that:	**ICES proposed that:**
Precautionary Approach reference points	$\mathbf{B_{lim}}$ is 160 000 t.	$\mathbf{B_{pa}}$ be set at 230 000 t
	$\mathbf{F_{lim}}$ is 0.74	$\mathbf{F_{pa}}$ be set at 0.60.
Target reference points		$\mathbf{F}_y$ undefined

9.9 Quality of the assessment

The assessment presented by the WG incorporates discards. WGNSSK noted in 2002 (ICES 2003) that not considering discard catches in stock assessments could introduce bias and affect estimates of F and stock biomass, particularly when discard patterns vary over time. The discards estimates since 1999 have been derived under EC project 98/097 and under the EC data regulation (EC 2001). Because of the different sampling strategies by the different countries, only data from the UK and the Netherlands were used in this assessment. These countries contribute to approximately half of the landings. Total sampling effort of the discards is low, and data is scanty.

A retrospective analysis of the assessment shows no clear recurring bias (Figure 9.9.1). An overestimation of the SSB is found in three of the five years, but this bias is far smaller than the variance in the SSB timeseries of the last assessment of those five years.

The historical performance of the North Sea plaice assessment is shown in Figure 9.9.2.

The outcome of the XSA model used for this assessment is sensitive to the assumptions made in the model (parameter settings and choice of tuning series), and to the variance in the tuning series.

9.10 State of the stock

SSB in 2005 is estimated around 205 thousand tonnes which is between Bpa and Blim. Fishing mortality is estimated to have decreased over recent years and for 2004 is estimated at 0.57 which is just below the new proposed Fpa.

9.11 Management considerations

Plaice is mainly taken by beam trawlers in a mixed fishery with sole in the southern and central part of the North Sea. In recent year, the bycatches of cod have been relatively low in the central North Sea. Some bycatches still occur in the chainmat beamtrawl fishery in the most southern part of the North Sea although the extend of these bycatches cannot be quantified due to the lack of gear resolution in the logbook database. The bycatch of cod in the (Dutch) beamtrawl fishery was around 1700 tonnes in 2004. Discards of cod in the beam trawl fishery cannot be estimated due to the low catches in the sampled trips.

Fishing effort has been substantially reduced since 1995. The reduction in fishing effort appears to be reflected in recent estimates of fishing mortality. There are indications that technical efficiency has increased in this fishery, which can have counteracted the overall decrease in effort.

Technical measures applicable to the mixed flatfish fishery will affect both sole and plaice. The minimum mesh size of 80 mm in the beamtrawl fishery selects sole at the minimum landing size. However, this mesh size generates high discards of plaice which are selected from 17 cm with a minimum landing size of 27 cm. Recent discards estimates indicate 50% discards in weight. Mesh enlargement would reduce the catch of undersized plaice, but would also result in loss of marketable sole.

The combination of days-at-sea regulations, high oil prices, and the decreasing TAC for plaice and the relatively stable TAC for sole, appear to have induced a more coastal fishing pattern in the southern North Sea. This concentration of fishing effort could result to increased discarding of juvenile plaice that are mainly distributed in those areas. This process could be aggravated by the more off-shore distribution of the juvenile plaice in recent years where they become more susceptible to the fishery.

An evaluation of the plaice box has indicated that: “From trends observed it was inferred that the Plaice Box has likely had a positive effect on the recruitment of Plaice but that its overall effect has decreased since it was established. There are two reasons to assume that the Plaice Box has a positive effect on the recruitment of Plaice: 1) at present, the Plaice Box still protects the majority of undersized Plaice. Approximately 70 % of the undersized Plaice are found in the Plaice Box and Wadden Sea, and despite the changed distribution, densities of juvenile Plaice inside the Box are still higher than outside; 2) In the 80 mm fishery, discard percentages in the Box are higher than outside. Because more than 90 % of the Plaice caught in the 80 mm fishery in the Box are discarded, any reduction in this fishery would reduce discard mortality. There is, however, no proof of a direct relationship between total discard mortality and recruitment.” (Grift et al. 2004)

The stock dynamics are dependent on the occurrence of strong year classes. The mean age in the landings is currently just around age 4, but used to be around age 5 in the beginning of the time series. Plaice are known to mature from age 2 onwards. This change is may be caused by the high exploitation levels, but also by the shift in the spatial distribution of fishing effort towards inshore waters. A lower exploitation level is expected to improve the survival of plaice to the spawning population, which could enhance the stability in the catches.

The assessment is considered to be uncertain mainly because discards form a substantial part of the total catch but cannot be well estimated from the scanty sampling trips.

YEAR	Belgium	Denmark	France	Germany	Nether-lands	Norway	Sweden	UK E/W/NI	UK Scotland	Others	Total	Unallocated	WG estimate	TAC
1980	7005	27057	711	4319	39782	15	7	18687	4345		101928	38023	139951	
1981	6346	22026	586	3449	40049	18	3	17129	4390		93996	45700	139697	105000
1982	6755	24532	1046	3626	41208	17	6	16385	4355		97930	56616	154546	140000
1983	9716	18749	1185	2397	51328	15	22	13241	4159		100812	43218	144030	164000
1984	11393	22154	604	2485	61478	16	13	12681	4172		114996	41153	156149	182000
1985	9965	28236	1010	2197	90950	23	18	11335	4577		148311	11527	159838	200000
1986	7232	26332	751	1809	74447	21	16	12428	4866		127902	37445	165347	180000
1987	8554	21597	1580	1794	76612	12	7	14891	5747		130794	22876	153670	150000
1988	11527	20259	1773	2566	77724	21	2	17613	6884	43	138412	16063	154475	175000
1989	10939	23481	2037	5341	84173	321	12	20413	5691		152408	17410	169818	185000
1990	13940	26474	1339	8747	78204	1756	169	18810	6822		156261	-21	156240	180000
1991	14328	24356	508	7926	67945	560	103	18267	9572		143565	4438	148003	175000
1992	12006	20891	537	6818	51064	836	53	21049	10228		123482	1708	125190	175000
1993	10814	16452	603	6895	48552	827	7	20586	10542		115278	1835	117113	175000
1994	7951	17056	407	5697	50289	524	6	17806	9943		109679	713	110392	165000
1995	7093	13358	442	6329	44263	527	3	15801	8594		96410	1946	98356	115000
1996	5765	11776	379	4780	35419	917	5	13541	7451		80033	1640	81673	81000
1997	5223	13940	254	4159	34143	1620	10	13789	8345		81483	1565	83048	91000
1998	5592	10087	489	2773	30541	965	2	11473	8442	1	70365	1169	71534	87000
1999	6160	13468	624	3144	37513	643	4	9743	7318		78617	2045	80662	102000
2000	7260	13408	547	4310	35030	883	3	13131	7579		82151	-1001	81150	97000
2001	6369	13797	429	4739	33290	1926	3	11025	8122		79700	2147	81847	78000
2002	4859	12552	548	3927	29081	1996	2	8504	8236		69705	512	70217	77000
2003	4570	13742	343	3800	27353	1967	2	7135	6757		65669	820	66489	73250
2004	4314	12123	231*	3649	23662	1744	1	7542	7742		61008	428	61436	61000

Table 9.2.1 North Sea plaice. Nominal landings (tonnes) in Sub-Area IV as officially reported to ICES and the WG estimates, 1997-2004.

*WG estimate

Table 9.2.2 North Sea plaice. Sampling effort (hours) for the NL and UK discards sampling programmes used for estimating discards-at-age in the assessment

year	NL hours	UK hours	sum hours
1999	178	413	591
2000	771	609	1380
2001	235	617	852
2002	342	505	847
2003	494	551	1045
2004	479	974	1453

Table 9.2.3 North Sea plaice. Landing numbers-at-age

2005-09-10 16:32:29 units= thousands

	age									
year	1	2	3	4	5	6	7	8	9	10
1957	0	4315	59818	44718	31771	8885	11029	9028	4973	10859
1958	0	7129	22205	62047	34112	19594	8178	8000	6110	13148
1959	0	16556	30427	25489	41099	22936	13873	6408	6596	16180
1960	0	5959	61876	51022	21321	27329	14186	9013	5087	15153
1961	0	2264	33392	67906	32699	12759	14680	9748	5996	14660
1962	0	2147	35876	66779	50060	20628	9060	9035	5257	12801
1963	0	4340	21471	76926	54364	31799	12848	6833	7047	16592
1964	0	14708	40486	64735	57408	37091	15819	6595	3980	16886
1965	0	9858	42202	53188	43674	30151	18361	8554	4213	17587
1966	0	4144	65009	51488	36667	27370	16500	10784	6467	14928
1967	0	5982	30304	112917	41383	22053	16175	8004	6728	11175
1968	0	9474	40698	38140	123619	17139	10341	10102	3925	13365
1969	3	15017	45187	36084	35585	102014	10410	6086	8192	16092
1970	76	17294	51174	56153	40686	35074	78886	6311	4185	14840
1971	19	29591	48282	33475	26059	22903	16913	29730	6414	16910
1972	2233	36528	62199	52906	23043	16998	14380	10903	18585	15651
1973	1268	31733	59099	73065	42255	13817	8885	9848	6084	23978
1974	2223	23120	55548	42125	41075	19666	8005	6321	5568	21980
1975	981	28124	61623	31262	25419	21188	11873	5923	4106	19695
1976	2820	33643	77649	96398	13779	9904	9120	6391	2947	12552
1977	3220	56969	43289	66013	83705	9142	5912	5022	4061	9191
1978	1143	60578	62343	54341	50102	35510	5940	3352	2419	7468
1979	1318	58031	118863	48962	47886	39932	24228	4161	2807	9288
1980	979	64904	133741	77523	24974	17982	13761	8458	1864	5377
1981	253	100927	122296	57604	35745	12414	9564	8092	4874	5903
1982	3334	47776	209007	69544	28655	16726	7589	5470	4482	8653
1983	1214	119695	115034	99076	29359	12906	8216	4193	3013	8287
1984	108	63252	274209	53549	37468	13661	6465	5544	2720	6565
1985	121	73552	144316	185203	32520	15544	6871	3650	2698	5798
1986	1674	67125	163717	93801	84479	24049	9299	4490	2733	6950
1987	0	85123	115951	111239	64758	34728	11452	4341	2154	5478
1988	0	15146	250675	74335	47380	25091	16774	5381	3162	6233
1989	1261	46757	105929	231414	52909	19247	10567	7561	2120	5580
1990	1550	32533	97766	110997	159814	26757	8129	4216	3451	3808
1991	1461	43266	83603	116155	72961	77557	14910	5233	3141	5591
1992	3410	43954	85120	72494	72703	33406	29547	6970	3200	6928
1993	3461	53949	98375	72286	51405	29001	13472	11272	3645	5883
1994	1394	45148	101617	80236	38542	20388	15323	6399	5368	5433
1995	7751	36575	81398	78370	36499	17953	9772	4366	2336	3753
1996	1104	42496	64382	46359	32130	14460	10605	4528	2624	4892
1997	892	42855	86948	43669	22541	13518	6362	3632	2179	4181
1998	196	30401	68920	56329	16713	6432	4986	2506	1761	3119
1999	549	8689	155971	39857	24112	6829	2783	2246	1521	3093
2000	2634	15819	39550	164330	14993	9343	2130	1030	940	2097
2001	4509	35886	52480	48238	89949	6836	4418	1127	637	2309
2002	1233	15596	58262	48361	36551	37877	4644	1788	742	1586
2003	694	42594	47802	48894	27126	15999	17069	1608	650	859
2004	543	10317	102332	35165	20527	11293	4787	4555	412	540

Table 9.2.4 North Sea plaice. Discards numbers-at-age

2005-09-10 16:42:53 units= thousands

year	age 1	2	3	4	5	6	7	8	9	10
1957	32356	45596	9220	909	961	25	0	0	0	0
1958	66199	73552	23655	2572	2137	65	0	0	0	0
1959	116086	127771	46402	11407	4737	106	0	0	0	0
1960	73939	167893	44948	997	1067	519	0	0	0	0
1961	75578	144609	89014	538	1612	130	0	0	0	0
1962	51265	181321	87599	21716	799	186	0	0	0	0
1963	90913	136183	129778	9964	2112	188	0	0	0	0
1964	66035	153274	64156	33825	3011	323	0	0	0	0
1965	43708	426021	59262	3404	923	267	0	0	0	0
1966	38496	163125	349358	14399	1402	125	0	0	0	0
1967	20199	133545	87532	152496	623	260	0	0	0	0
1968	73971	72192	46339	26530	22436	58	0	0	0	0
1969	85192	67378	16747	19334	773	2024	0	0	0	0
1970	123569	152480	27747	1287	5061	161	0	0	0	0
1971	69337	96968	42354	2675	426	81	0	0	0	0
1972	70002	55470	33899	5714	567	73	0	0	0	0
1973	132352	49815	4008	673	1289	67	0	0	0	0
1974	211139	308411	3652	285	611	109	0	0	0	0
1975	244969	280130	190536	4807	253	123	0	0	0	0
1976	183879	140921	71054	18013	174	41	0	0	0	0
1977	256628	103696	79317	33552	9317	129	0	0	0	0
1978	226872	154113	27257	10775	1244	570	0	0	0	0
1979	293166	215084	57578	18382	589	310	0	0	0	0
1980	226371	122561	932	687	193	86	0	0	0	0
1981	134142	193241	1850	373	431	55	0	0	0	0
1982	411307	204572	4624	1109	216	98	0	0	0	0
1983	261400	436331	30716	2235	804	72	0	0	0	0
1984	310675	313490	52651	24529	1492	69	0	0	0	0
1985	405385	229208	35566	2221	200	78	0	0	0	0
1986	1117345	490965	48510	26470	1451	146	0	0	0	0
1987	361519	1374202	180969	1427	1348	248	0	0	0	0
1988	348597	608109	459385	61167	882	177	0	0	0	0
1989	213291	485845	193176	85758	7224	115	0	0	0	0
1990	145314	279298	168674	28102	5011	177	0	0	0	0
1991	183126	301575	141567	40739	5528	939	0	0	0	0
1992	138755	219619	94581	34348	4307	880	0	0	0	0
1993	96371	154083	48088	11966	1635	216	0	0	0	0
1994	62122	95703	35703	1038	822	144	0	0	0	0
1995	118863	82676	15753	860	663	120	0	0	0	0
1996	111250	331065	27606	3930	451	116	0	0	0	0
1997	128653	510918	193828	588	271	108	0	0	0	0
1998	104538	646250	191631	53354	297	33	0	0	0	0
1999	29826	54539	44355	944	62	15	0	6	0	10
2000	102360	187611	47757	52789	463	48	23	10	0	0
2001	29888	391400	207084	64719	50227	95	0	0	0	0
2002	378412	249340	105875	22125	1490	1913	8	0	0	0
2003	93927	734877	49605	19664	3424	114	677	0	0	0
2004	269002	180183	125884	2885	1863	1732	0	0	0	0

Table 9.2.5 North Sea plaice. Catch numbers-at-age

2005-09-10 16:56:26 units= thousands

year	age 1	2	3	4	5	6	7	8	9	10
1957	32356	49911	69038	45627	32732	8910	11029	9028	4973	10859
1958	66199	80681	45860	64619	36249	19659	8178	8000	6110	13148
1959	116086	144327	76829	36896	45836	23042	13873	6408	6596	16180
1960	73939	173852	106824	52019	22388	27848	14186	9013	5087	15153
1961	75578	146873	122406	68444	34311	12889	14680	9748	5996	14660
1962	51265	183468	123475	88495	50859	20814	9060	9035	5257	12801
1963	90913	140523	151249	86890	56476	31987	12848	6833	7047	16592
1964	66035	167982	104642	98560	60419	37414	15819	6595	3980	16886
1965	43708	435879	101464	56592	44597	30418	18361	8554	4213	17587
1966	38496	167269	414367	65887	38069	27495	16500	10784	6467	14928
1967	20199	139527	117836	265413	42006	22313	16175	8004	6728	11175
1968	73971	81666	87037	64670	146055	17197	10341	10102	3925	13365
1969	85195	82395	61934	55418	36358	104038	10410	6086	8192	16092
1970	123645	169774	78921	57440	45747	35235	78886	6311	4185	14840
1971	69356	126559	90636	36150	26485	22984	16913	29730	6414	16910
1972	72235	91998	96098	58620	23610	17071	14380	10903	18585	15651
1973	133620	81548	63107	73738	43544	13884	8885	9848	6084	23978
1974	213362	331531	59200	42410	41686	19775	8005	6321	5568	21980
1975	245950	308254	252159	36069	25672	21311	11873	5923	4106	19695
1976	186699	174564	148703	114411	13953	9945	9120	6391	2947	12552
1977	259848	160665	122606	99565	93022	9271	5912	5022	4061	9191
1978	228015	214691	89600	65116	51346	36080	5940	3352	2419	7468
1979	294484	273115	176441	67344	48475	40242	24228	4161	2807	9288
1980	227350	187465	134673	78210	25167	18068	13761	8458	1864	5377
1981	134395	294168	124146	57977	36176	12469	9564	8092	4874	5903
1982	414641	252348	213631	70653	28871	16824	7589	5470	4482	8653
1983	262614	556026	145750	101311	30163	12978	8216	4193	3013	8287
1984	310783	376742	326860	78078	38960	13730	6465	5544	2720	6565
1985	405506	302760	179882	187424	32720	15622	6871	3650	2698	5798
1986	1119019	558090	212227	120271	85930	24195	9299	4490	2733	6950
1987	361519	1459325	296920	112666	66106	34976	11452	4341	2154	5478
1988	348597	623255	710060	135502	48262	25268	16774	5381	3162	6233
1989	214552	532602	299105	317172	60133	19362	10567	7561	2120	5580
1990	146864	311831	266440	139099	164825	26934	8129	4216	3451	3808
1991	184587	344841	225170	156894	78489	78496	14910	5233	3141	5591
1992	142165	263573	179701	106842	77010	34286	29547	6970	3200	6928
1993	99832	208032	146463	84252	53040	29217	13472	11272	3645	5883
1994	63516	140851	137320	81274	39364	20532	15323	6399	5368	5433
1995	126614	119251	97151	79230	37162	18073	9772	4366	2336	3753
1996	112354	373561	91988	50289	32581	14576	10605	4528	2624	4892
1997	129545	553773	280776	44257	22812	13626	6362	3632	2179	4181
1998	104734	676651	260551	109683	17010	6465	4986	2506	1761	3119
1999	30375	63228	200326	40801	24174	6844	2783	2252	1521	3103
2000	104994	203430	87307	217119	15456	9391	2153	1040	940	2097
2001	34397	427286	259564	112957	140176	6931	4418	1127	637	2309
2002	379645	264936	164137	70486	38041	39790	4652	1788	742	1586
2003	94621	777471	97407	68558	30550	16113	17746	1608	650	859
2004	269545	190501	228217	38050	22390	13025	4787	4555	412	540

Table 9.2.6 North Sea plaice. Stock weights-at-age

2005-09-16 14:15:07 units= kg

	age									
year	1	2	3	4	5	6	7	8	9	10
1957	0.040	0.100	0.162	0.247	0.325	0.485	0.719	0.682	0.844	1.143
1958	0.043	0.091	0.185	0.278	0.303	0.442	0.577	0.778	0.793	1.112
1959	0.047	0.103	0.178	0.270	0.329	0.470	0.650	0.686	0.908	1.042
1960	0.040	0.108	0.187	0.278	0.364	0.469	0.633	0.726	0.845	1.090
1961	0.039	0.095	0.190	0.312	0.337	0.483	0.579	0.691	0.779	1.067
1962	0.037	0.094	0.178	0.307	0.424	0.573	0.684	0.806	0.873	1.303
1963	0.043	0.101	0.181	0.279	0.378	0.540	0.663	0.788	0.882	1.252
1964	0.026	0.111	0.189	0.302	0.373	0.477	0.645	0.673	0.845	1.232
1965	0.033	0.066	0.204	0.301	0.333	0.430	0.516	0.601	0.722	0.909
1966	0.033	0.097	0.130	0.312	0.403	0.455	0.503	0.565	0.581	0.984
1967	0.030	0.101	0.184	0.209	0.442	0.528	0.585	0.650	0.703	0.985
1968	0.057	0.092	0.180	0.293	0.344	0.532	0.592	0.362	0.667	0.887
1969	0.049	0.154	0.193	0.271	0.344	0.390	0.565	0.621	0.679	0.857
1970	0.049	0.113	0.246	0.279	0.369	0.410	0.468	0.636	0.732	0.896
1971	0.053	0.107	0.262	0.352	0.413	0.489	0.512	0.583	0.696	0.877
1972	0.058	0.155	0.227	0.412	0.473	0.534	0.579	0.606	0.655	0.929
1973	0.038	0.130	0.245	0.319	0.468	0.521	0.566	0.583	0.617	0.804
1974	0.051	0.103	0.227	0.425	0.437	0.524	0.570	0.629	0.652	0.852
1975	0.066	0.139	0.195	0.397	0.483	0.544	0.610	0.668	0.704	0.943
1976	0.085	0.166	0.236	0.314	0.484	0.550	0.593	0.658	0.694	0.931
1977	0.067	0.180	0.277	0.318	0.405	0.551	0.627	0.690	0.667	0.938
1978	0.067	0.148	0.333	0.382	0.411	0.467	0.547	0.630	0.704	0.943
1979	0.064	0.175	0.269	0.373	0.414	0.459	0.543	0.667	0.764	1.004
1980	0.051	0.160	0.302	0.438	0.444	0.524	0.582	0.651	0.778	1.058
1981	0.043	0.137	0.249	0.431	0.473	0.536	0.570	0.624	0.707	1.033
1982	0.050	0.126	0.261	0.359	0.490	0.589	0.631	0.679	0.726	0.981
1983	0.047	0.125	0.253	0.389	0.494	0.559	0.624	0.712	0.754	0.917
1984	0.050	0.127	0.225	0.422	0.464	0.571	0.649	0.692	0.787	1.029
1985	0.050	0.145	0.239	0.325	0.452	0.536	0.635	0.656	0.764	1.011
1986	0.045	0.125	0.254	0.316	0.440	0.533	0.692	0.779	0.888	1.092
1987	0.037	0.103	0.205	0.382	0.401	0.503	0.573	0.711	0.747	0.984
1988	0.038	0.096	0.178	0.270	0.426	0.467	0.547	0.644	0.706	0.973
1989	0.041	0.100	0.198	0.250	0.362	0.484	0.553	0.616	0.759	0.884
1990	0.046	0.109	0.186	0.268	0.343	0.422	0.555	0.647	0.701	0.972
1991	0.051	0.132	0.192	0.268	0.342	0.401	0.463	0.633	0.652	0.826
1992	0.048	0.123	0.205	0.274	0.318	0.403	0.500	0.573	0.683	0.834
1993	0.053	0.117	0.215	0.326	0.330	0.391	0.490	0.587	0.633	0.811
1994	0.055	0.143	0.221	0.296	0.360	0.404	0.462	0.533	0.653	0.798
1995	0.052	0.141	0.262	0.341	0.399	0.448	0.509	0.584	0.678	0.804
1996	0.044	0.117	0.235	0.374	0.390	0.462	0.488	0.554	0.660	0.815
1997	0.033	0.116	0.188	0.374	0.439	0.492	0.521	0.543	0.627	0.852
1998	0.040	0.080	0.207	0.337	0.474	0.577	0.581	0.648	0.656	0.812
1999	0.045	0.090	0.154	0.320	0.437	0.524	0.586	0.644	0.664	0.780
2000	0.052	0.106	0.170	0.223	0.408	0.467	0.649	0.695	0.656	0.787
2001	0.063	0.121	0.208	0.237	0.331	0.452	0.560	0.641	0.798	0.830
2002	0.049	0.118	0.220	0.305	0.319	0.403	0.446	0.612	0.685	0.873
2003	0.062	0.112	0.228	0.269	0.344	0.391	0.464	0.600	0.714	0.787
2004	0.048	0.116	0.207	0.303	0.384	0.430	0.489	0.495	0.780	0.875

Table 9.2.7 North Sea plaice. Discards weights-at-age

2005-09-10 16:42:59 units= kg

year	age 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	NA	NA
1958	0.050	0.094	0.159	0.186	0.197	0.244	0.244	0.244	NA	NA
1959	0.054	0.105	0.156	0.184	0.193	0.231	NA	NA	NA	NA
1960	0.047	0.110	0.160	0.186	0.199	0.210	0.231	NA	NA	NA
1961	0.046	0.098	0.161	0.192	0.199	0.212	0.211	0.244	NA	NA
1962	0.045	0.096	0.156	0.191	0.211	0.219	0.219	0.220	NA	NA
1963	0.050	0.103	0.157	0.186	0.203	0.231	0.220	0.231	NA	NA
1964	0.034	0.112	0.161	0.191	0.199	0.219	0.231	0.231	NA	NA
1965	0.040	0.071	0.166	0.190	0.205	0.220	0.220	0.244	NA	NA
1966	0.040	0.099	0.128	0.192	0.203	0.231	0.220	0.231	NA	NA
1967	0.038	0.103	0.158	0.168	0.211	0.212	0.231	0.231	NA	NA
1968	0.063	0.094	0.157	0.189	0.189	0.244	0.211	0.244	NA	NA
1969	0.055	0.143	0.162	0.185	0.205	0.210	0.244	0.220	NA	NA
1970	0.056	0.114	0.179	0.186	0.192	0.244	0.212	0.231	NA	NA
1971	0.059	0.109	0.183	0.198	0.210	NA	NA	0.231	NA	NA
1972	0.064	0.144	0.174	0.205	0.204	0.244	NA	NA	NA	NA
1973	0.045	0.127	0.179	0.193	0.204	0.231	0.244	NA	NA	NA
1974	0.057	0.105	0.174	0.210	0.211	0.231	0.244	NA	NA	NA
1975	0.070	0.134	0.163	0.204	0.220	0.244	0.231	NA	NA	NA
1976	0.088	0.150	0.176	0.192	0.219	0.244	0.244	0.244	NA	NA
1977	0.071	0.157	0.186	0.193	0.195	0.211	NA	NA	NA	NA
1978	0.072	0.140	0.196	0.203	0.205	0.211	0.220	NA	NA	NA
1979	0.069	0.155	0.184	0.202	0.219	0.231	0.219	0.231	NA	NA
1980	0.057	0.146	0.190	0.211	0.220	0.244	0.244	NA	NA	NA
1981	0.050	0.132	0.180	0.210	0.219	0.244	NA	NA	NA	NA
1982	0.057	0.124	0.182	0.198	0.231	0.231	0.244	NA	NA	NA
1983	0.054	0.123	0.180	0.203	0.204	0.244	0.244	NA	NA	NA
1984	0.055	0.124	0.173	0.210	0.203	NA	0.244	NA	NA	NA
1985	0.056	0.137	0.177	0.193	0.231	0.244	NA	NA	NA	NA
1986	0.051	0.122	0.180	0.192	0.211	0.244	0.231	NA	NA	NA
1987	0.044	0.104	0.166	0.202	0.210	0.231	NA	NA	NA	NA
1988	0.045	0.097	0.155	0.184	0.211	0.231	NA	NA	NA	NA
1989	0.048	0.101	0.163	0.180	0.192	0.244	0.244	NA	NA	NA
1990	0.054	0.112	0.160	0.184	0.205	0.231	NA	NA	NA	NA
1991	0.058	0.130	0.162	0.184	0.198	0.219	0.220	0.220	NA	NA
1992	0.055	0.124	0.168	0.186	0.199	0.205	0.220	0.231	NA	NA
1993	0.060	0.119	0.172	0.196	0.205	0.231	0.231	0.244	NA	NA
1994	0.062	0.141	0.175	0.192	0.211	0.231	0.244	0.220	NA	NA
1995	0.061	0.140	0.186	0.198	0.212	0.231	0.231	0.244	NA	NA
1996	0.053	0.122	0.178	0.203	0.219	0.231	NA	0.244	NA	NA
1997	0.042	0.118	0.160	0.202	0.220	0.244	NA	NA	NA	NA
1998	0.049	0.086	0.168	0.196	0.211	NA	0.244	NA	NA	NA
1999	0.057	0.109	0.148	0.173	0.163	0.154	NA	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	NA
2001	0.018	0.066	0.126	0.126	0.136	0.200	0.218	0.218	NA	NA
2002	0.070	0.085	0.117	0.168	0.189	0.225	0.197	0.196	0.196	NA
2003	0.045	0.073	0.130	0.124	0.162	0.191	0.181	NA	NA	NA
2004	0.057	0.117	0.167	0.190	0.195	0.211	NA	NA	NA	NA

Table 9.2.8 North Sea plaice. Landing weights-at-age

2005-09-10 16:37:35 units= kg

	age									
year	1	2	3	4	5	6	7	8	9	10
1957	0.000	0.165	0.201	0.258	0.353	0.456	0.533	0.589	0.396	0.998
1958	0.000	0.198	0.221	0.259	0.337	0.453	0.513	0.615	0.665	0.992
1959	0.000	0.218	0.246	0.293	0.362	0.473	0.592	0.623	0.750	1.000
1960	0.000	0.200	0.236	0.289	0.386	0.485	0.601	0.683	0.724	1.094
1961	0.000	0.191	0.233	0.302	0.412	0.509	0.604	0.671	0.812	1.071
1962	0.000	0.211	0.248	0.300	0.400	0.541	0.570	0.692	0.777	1.127
1963	0.000	0.253	0.286	0.319	0.399	0.533	0.624	0.667	0.715	1.028
1964	0.000	0.250	0.273	0.312	0.388	0.487	0.628	0.700	0.737	1.005
1965	0.000	0.242	0.282	0.321	0.385	0.471	0.539	0.663	0.726	0.887
1966	0.000	0.232	0.270	0.348	0.436	0.484	0.559	0.624	0.690	0.933
1967	0.000	0.232	0.279	0.322	0.425	0.547	0.597	0.662	0.738	0.978
1968	0.000	0.267	0.298	0.331	0.366	0.517	0.590	0.596	0.686	0.911
1969	0.217	0.294	0.310	0.333	0.359	0.412	0.573	0.655	0.658	0.893
1970	0.315	0.286	0.318	0.356	0.419	0.443	0.499	0.672	0.744	0.892
1971	0.256	0.318	0.356	0.403	0.448	0.514	0.542	0.607	0.699	0.891
1972	0.246	0.296	0.352	0.428	0.493	0.541	0.608	0.646	0.674	0.939
1973	0.272	0.316	0.344	0.405	0.486	0.539	0.605	0.627	0.677	0.842
1974	0.285	0.311	0.354	0.405	0.476	0.554	0.609	0.693	0.707	0.926
1975	0.249	0.300	0.330	0.420	0.495	0.587	0.636	0.703	0.783	1.019
1976	0.265	0.295	0.338	0.375	0.513	0.594	0.641	0.705	0.741	0.980
1977	0.254	0.323	0.353	0.380	0.418	0.556	0.647	0.721	0.715	0.978
1978	0.244	0.315	0.369	0.397	0.438	0.491	0.609	0.687	0.776	0.950
1979	0.235	0.311	0.349	0.388	0.429	0.474	0.550	0.675	0.796	0.960
1980	0.238	0.286	0.344	0.401	0.473	0.545	0.588	0.662	0.772	1.013
1981	0.237	0.274	0.329	0.416	0.505	0.558	0.604	0.642	0.725	1.007
1982	0.279	0.262	0.311	0.424	0.514	0.608	0.664	0.712	0.738	0.984
1983	0.200	0.250	0.300	0.383	0.515	0.604	0.677	0.771	0.815	0.984
1984	0.233	0.263	0.283	0.375	0.491	0.613	0.684	0.725	0.837	1.035
1985	0.247	0.264	0.290	0.337	0.462	0.577	0.678	0.729	0.804	1.021
1986	0.221	0.269	0.304	0.347	0.425	0.488	0.675	0.751	0.853	1.013
1987	0.221	0.249	0.300	0.351	0.402	0.504	0.583	0.728	0.829	0.990
1988	0.221	0.254	0.278	0.352	0.453	0.512	0.608	0.699	0.813	1.014
1989	0.236	0.280	0.309	0.332	0.392	0.533	0.603	0.670	0.792	0.943
1990	0.271	0.285	0.298	0.317	0.366	0.447	0.597	0.692	0.761	1.004
1991	0.227	0.286	0.294	0.306	0.365	0.455	0.528	0.671	0.747	0.921
1992	0.251	0.263	0.290	0.318	0.341	0.425	0.531	0.605	0.715	0.891
1993	0.249	0.273	0.289	0.326	0.356	0.423	0.518	0.631	0.721	0.856
1994	0.229	0.263	0.286	0.339	0.397	0.449	0.502	0.611	0.732	0.907
1995	0.272	0.277	0.301	0.338	0.402	0.454	0.528	0.611	0.734	0.908
1996	0.240	0.280	0.307	0.355	0.420	0.486	0.499	0.589	0.720	0.858
1997	0.208	0.271	0.313	0.364	0.457	0.524	0.603	0.616	0.683	0.924
1998	0.152	0.260	0.310	0.394	0.497	0.607	0.633	0.695	0.700	0.914
1999	0.245	0.253	0.280	0.355	0.455	0.547	0.630	0.682	0.752	0.813
2000	0.228	0.267	0.284	0.314	0.432	0.500	0.684	0.710	0.751	0.887
2001	0.238	0.267	0.292	0.309	0.365	0.482	0.592	0.708	0.795	0.801
2002	0.237	0.264	0.289	0.316	0.348	0.445	0.511	0.692	0.761	0.900
2003	0.232	0.253	0.287	0.326	0.371	0.414	0.487	0.654	0.766	0.855
2004	0.214	0.247	0.283	0.328	0.398	0.437	0.510	0.557	0.797	0.869

Table 9.2.9 North Sea plaice. Catch weights-at-age

2005-09-17 13:28:53 units= kg

year	age 1	2	3	4	5	6	7	8	9	10
1957	0.047	0.107	0.194	0.256	0.349	0.455	0.533	0.589	0.396	0.998
1958	0.050	0.103	0.189	0.256	0.329	0.452	0.513	0.615	0.665	0.992
1959	0.054	0.118	0.192	0.259	0.345	0.472	0.592	0.623	0.750	1.000
1960	0.047	0.113	0.204	0.287	0.377	0.480	0.601	0.683	0.724	1.094
1961	0.046	0.099	0.181	0.301	0.402	0.506	0.604	0.671	0.812	1.071
1962	0.045	0.097	0.183	0.273	0.397	0.538	0.570	0.692	0.777	1.127
1963	0.050	0.108	0.175	0.304	0.392	0.531	0.624	0.667	0.715	1.028
1964	0.034	0.124	0.204	0.270	0.379	0.485	0.628	0.700	0.737	1.005
1965	0.040	0.075	0.214	0.313	0.381	0.469	0.539	0.663	0.726	0.887
1966	0.040	0.102	0.150	0.314	0.427	0.483	0.559	0.624	0.690	0.933
1967	0.038	0.109	0.189	0.234	0.422	0.543	0.597	0.662	0.738	0.978
1968	0.063	0.114	0.223	0.273	0.339	0.516	0.590	0.596	0.686	0.911
1969	0.055	0.171	0.270	0.281	0.356	0.408	0.573	0.655	0.658	0.893
1970	0.056	0.132	0.269	0.352	0.394	0.442	0.499	0.672	0.744	0.892
1971	0.059	0.158	0.275	0.388	0.444	0.512	0.542	0.607	0.699	0.891
1972	0.070	0.204	0.289	0.406	0.486	0.540	0.608	0.646	0.674	0.939
1973	0.047	0.201	0.334	0.403	0.478	0.538	0.605	0.627	0.677	0.842
1974	0.059	0.119	0.343	0.404	0.472	0.552	0.609	0.693	0.707	0.926
1975	0.071	0.149	0.204	0.391	0.492	0.585	0.636	0.703	0.783	1.019
1976	0.091	0.178	0.261	0.346	0.509	0.593	0.641	0.705	0.741	0.980
1977	0.073	0.216	0.245	0.317	0.396	0.551	0.647	0.721	0.715	0.978
1978	0.073	0.189	0.316	0.365	0.432	0.487	0.609	0.687	0.776	0.950
1979	0.070	0.188	0.295	0.337	0.426	0.472	0.550	0.675	0.796	0.960
1980	0.058	0.194	0.343	0.399	0.471	0.544	0.588	0.662	0.772	1.013
1981	0.050	0.181	0.327	0.415	0.502	0.557	0.604	0.642	0.725	1.007
1982	0.059	0.150	0.308	0.420	0.512	0.606	0.664	0.712	0.738	0.984
1983	0.055	0.150	0.275	0.379	0.507	0.602	0.677	0.771	0.815	0.984
1984	0.055	0.147	0.265	0.323	0.480	0.610	0.684	0.725	0.837	1.035
1985	0.056	0.168	0.268	0.335	0.461	0.575	0.678	0.729	0.804	1.021
1986	0.051	0.140	0.276	0.313	0.421	0.487	0.675	0.751	0.853	1.013
1987	0.044	0.112	0.218	0.349	0.398	0.502	0.583	0.728	0.829	0.990
1988	0.045	0.101	0.198	0.276	0.449	0.510	0.608	0.699	0.813	1.014
1989	0.049	0.117	0.215	0.291	0.368	0.531	0.603	0.670	0.792	0.943
1990	0.056	0.130	0.211	0.290	0.361	0.446	0.597	0.692	0.761	1.004
1991	0.059	0.150	0.211	0.274	0.353	0.452	0.528	0.671	0.747	0.921
1992	0.060	0.147	0.226	0.276	0.333	0.419	0.531	0.605	0.715	0.891
1993	0.067	0.159	0.251	0.308	0.351	0.422	0.518	0.631	0.721	0.856
1994	0.066	0.180	0.257	0.337	0.393	0.447	0.502	0.611	0.732	0.907
1995	0.074	0.182	0.282	0.336	0.399	0.453	0.528	0.611	0.734	0.908
1996	0.055	0.140	0.268	0.343	0.417	0.484	0.499	0.589	0.720	0.858
1997	0.043	0.130	0.207	0.362	0.454	0.522	0.603	0.616	0.683	0.924
1998	0.049	0.094	0.206	0.298	0.492	0.604	0.633	0.695	0.700	0.914
1999	0.060	0.129	0.251	0.351	0.454	0.546	0.630	0.681	0.752	0.811
2000	0.049	0.094	0.186	0.271	0.428	0.499	0.681	0.706	0.751	0.887
2001	0.047	0.083	0.160	0.204	0.283	0.478	0.592	0.708	0.795	0.801
2002	0.071	0.096	0.178	0.270	0.342	0.434	0.510	0.692	0.761	0.900
2003	0.046	0.083	0.207	0.268	0.348	0.412	0.475	0.654	0.766	0.855
2004	0.057	0.124	0.219	0.318	0.381	0.407	0.510	0.557	0.797	0.869

Table 9.2.10 North Sea plaice. Natural mortality-at-age and maturity-at-age vector used in assessments

2005-09-10 16:29:14

metric	age 1	2	3	4	5	6	7	8	9	10
natural mortality	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
maturity	0	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 9.2.11 North Sea plaice. Survey tuning fleets catches (numbers per hour)

BTS-Isis Age

Year	eff	1	2	3	4	5	6	7	8	9
1985	1	116	179.9	38.8	11.84	1.371	1.048	0.362	0.167	0.098
1986	1	660	131.8	51.0	8.89	3.285	0.428	0.338	0.129	0.038
1987	1	226	764.3	33.1	4.77	2.039	1.017	0.352	0.087	0.072
1988	1	577	140.1	173.7	9.24	2.594	0.775	0.421	0.036	0.115
1989	1	429	319.3	38.7	47.31	5.850	0.822	0.289	0.661	0.144
1990	1	112	102.6	55.7	22.78	5.572	0.801	0.205	0.379	0.261
1991	1	185	122.1	28.6	11.86	4.264	5.691	0.259	0.231	0.118
1992	1	172	125.9	27.3	5.62	3.184	2.662	1.136	0.259	0.053
1993	1	125	179.1	38.4	6.12	0.931	0.812	0.636	0.444	0.173
1994	1	145	64.2	35.2	10.88	2.857	0.638	0.861	0.957	0.401
1995	1	252	43.6	14.2	8.11	1.195	0.868	0.357	1.135	0.223
1996	1	218	212.1	22.9	4.83	3.717	0.919	0.047	0.173	0.131
1997	1	NA	NA	19.9	2.79	0.219	0.390	0.171	0.121	0.000
1998	1	338	436.2	47.4	8.91	1.440	0.755	0.145	0.078	0.105
1999	1	306	130.0	182.5	3.66	2.109	0.137	0.139	0.029	0.032
2000	1	279	75.2	31.6	24.21	0.613	0.174	0.539	0.029	0.019
2001	1	226	78.9	19.6	10.05	9.525	0.294	0.150	0.041	0.043
2002	1	569	45.5	15.4	5.50	2.683	1.427	0.083	0.140	0.000
2003	1	126	170.1	10.8	5.94	1.525	1.214	0.684	0.112	0.101
2004	1	226	41.8	66.6	6.62	2.650	1.603	1.021	3.054	0.000

BTS-Tridens Age

Year	eff	2	3	4	5	6	7	8	9
1996	1	5.58	4.39	3.31	2.39	1.84	0.830	0.479	0.177
1997	1	NA	10.36	3.96	2.84	1.93	0.463	1.123	0.447
1998	1	30.79	9.97	5.52	2.71	1.35	0.899	0.782	0.327
1999	1	8.29	36.93	6.46	2.65	2.13	0.600	0.764	0.333
2000	1	9.45	12.74	17.23	2.94	1.89	1.076	0.954	0.247
2001	1	6.93	9.05	7.22	7.65	1.20	0.691	0.480	0.593
2002	1	14.40	10.72	7.61	4.26	4.13	0.519	0.629	0.358
2003	1	34.84	11.91	8.57	4.75	2.72	3.973	0.702	0.720
2004	1	11.03	28.58	7.66	4.10	2.17	1.222	2.342	0.394

SNS Age

Year	eff	1	2	3
1982	1	70108	8503	1146
1983	1	34884	14708	308
1984	1	44667	10413	2480
1985	1	27832	13789	1584
1986	1	93573	7558	1155
1987	1	33426	33021	1232
1988	1	36672	14429	13140
1989	1	37238	14952	3709
1990	1	24903	7287	3248
1991	1	57349	11149	1507
1992	1	48223	13742	2257
1993	1	22184	9484	988
1994	1	18225	4866	884
1995	1	24900	2786	415
1996	1	24663	10377	1189
1997	1	NA	NA	1393
1998	1	33391	29431	5739
1999	1	35188	9235	14347
2000	1	23028	2489	905
2001	1	10193	2416	356
2002	1	30265	1047	263
2003	1	NA	NA	NA
2004	1	18208	1354	1088

Table 9.2.12 North Sea plaice. DFS index catches (numbers per hour)

DFS		Age	
Year	eff	0	1
1970	1	121.6	52.08
1971	1	83.3	16.87
1972	1	44.6	47.72
1973	1	79.4	123.20
1974	1	111.6	43.95
1975	1	72.3	85.41
1976	1	243.0	81.34
1977	1	185.8	159.43
1978	1	221.9	83.31
1979	1	365.2	176.05
1980	1	147.9	252.32
1981	1	633.5	153.85
1982	1	456.5	286.65
1983	1	432.4	160.16
1984	1	263.3	116.62
1985	1	717.7	100.94
1986	1	345.1	268.55
1987	1	465.1	188.55
1988	1	330.7	105.29
1989	1	462.7	135.02
1990	1	468.2	128.61
1991	1	495.6	150.72
1992	1	356.8	131.09
1993	1	263.0	74.09
1994	1	444.9	30.50
1995	1	184.5	37.74
1996	1	572.4	116.73
1997	1	156.6	152.64
1998	1	NA	NA
1999	1	NA	NA
2000	1	184.6	13.92
2001	1	499.6	5.21
2002	1	212.9	19.22
2003	1	361.1	11.08
2004	1	93.4	13.05

Table 9.2.13 North Sea plaice. Effort and LPUE trends for the NL and UK commercial fleets

	Effort		LPUE	
year	NL BT	UK BT	NL BT	UK BT
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	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	578	45
2000	67.7	57.8	536	68
2001	61.4	54.1	570	61
2002	56.4	30.6	531	NA
2003	51.6		547	
2004	49.3		496	

Table 9.2.14 North Sea plaice. Commercial tuning fleets (not used in the final assessment)

NL Beam Trawl numbers per hour

		Age							
Year	eff	2	3	4	5	6	7	8	9
1989	72.5	557.8	1016	1820	318.1	132.9	72.3	37.45	13.06
1990	71.1	308.8	844	701	1076.2	171.4	51.8	25.18	16.33
1991	68.5	401.5	619	776	448.1	497.7	100.4	28.53	16.60
1992	71.1	341.4	623	448	382.1	171.9	133.4	34.66	13.97
1993	76.9	358.3	605	407	256.2	142.8	78.5	46.96	13.33
1994	81.4	370.9	591	441	188.8	97.5	75.8	35.21	23.70
1995	81.2	277.3	536	417	178.0	81.0	42.1	19.08	11.47
1996	72.1	368.9	383	290	193.9	73.7	50.5	18.95	13.09
1997	72.0	320.8	634	252	95.6	60.2	28.0	13.54	6.39
1998	70.2	217.8	463	381	91.0	32.6	19.4	9.53	4.47
1999	67.3	64.5	1134	271	164.3	44.6	14.8	12.38	7.52
2000	67.7	132.5	251	1067	85.5	57.3	10.9	4.96	3.16
2001	61.4	264.3	367	321	664.6	44.7	28.6	6.35	3.19
2002	56.4	177.9	578	385	252.2	293.7	18.6	10.02	2.77
2003	51.6	372.8	387	406	186.4	103.8	129.1	6.03	5.02
2004	49.3	100.0	903	223	146.8	72.0	29.9	43.43	1.91

English Beam trawl excl Flag-vessels numbers per hour

		Age							
Year	eff	4	5	6	7	8	9	10	11	12
1990	102.3	27.0	92.7	17.46	11.08	7.06	8.23	2.45	1.662	0.958
1991	123.6	21.9	28.6	53.39	10.72	6.77	3.45	4.94	1.828	1.481
1992	151.5	19.2	29.3	18.40	24.25	6.39	3.68	3.20	3.281	1.096
1993	146.6	23.4	20.9	17.26	6.30	12.80	4.33	2.73	2.435	1.739
1994	131.4	23.1	22.0	13.49	9.53	4.51	6.47	3.28	1.438	1.218
1995	105.0	34.0	15.8	14.05	9.71	5.90	3.16	3.60	2.733	1.362
1996	82.9	13.3	19.0	10.74	10.08	6.55	4.68	2.50	3.305	1.966
1997	76.3	16.4	11.1	13.97	7.85	8.99	6.62	2.77	1.940	3.001
1998	68.8	23.6	13.0	8.97	8.69	5.04	6.03	4.61	1.948	1.599
1999	68.6	14.7	15.2	6.66	4.77	5.35	3.76	3.27	2.813	1.429
2000	57.8	63.2	15.0	9.95	4.41	2.44	3.48	1.87	1.782	2.526
2001	54.1	14.7	45.0	8.89	6.21	2.48	1.72	2.07	0.906	1.682
2002	30.6	23.4	20.8	29.61	5.13	4.12	1.41	1.73	1.503	1.340

Table 9.3.1 North Sea plaice. Fishing mortality estimates in the final XSA run.

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year	age 1	2	3	4	5	6	7	8	9	10
1957	0.077	0.225	0.253	0.296	0.344	0.202	0.253	0.267	0.261	0.261
1958	0.105	0.248	0.296	0.354	0.360	0.318	0.257	0.263	0.260	0.260
1959	0.151	0.310	0.351	0.366	0.405	0.364	0.345	0.292	0.320	0.320
1960	0.108	0.315	0.353	0.379	0.351	0.409	0.354	0.351	0.354	0.354
1961	0.096	0.288	0.339	0.356	0.409	0.312	0.348	0.390	0.370	0.370
1962	0.096	0.317	0.372	0.390	0.433	0.413	0.334	0.333	0.335	0.335
1963	0.149	0.362	0.415	0.432	0.410	0.473	0.429	0.402	0.417	0.417
1964	0.032	0.399	0.445	0.463	0.536	0.463	0.401	0.362	0.383	0.383
1965	0.068	0.266	0.396	0.407	0.348	0.502	0.385	0.350	0.369	0.369
1966	0.071	0.353	0.386	0.429	0.468	0.334	0.495	0.364	0.431	0.431
1967	0.054	0.349	0.399	0.405	0.474	0.489	0.298	0.421	0.360	0.360
1968	0.198	0.285	0.339	0.353	0.363	0.320	0.390	0.274	0.333	0.333
1969	0.148	0.313	0.324	0.334	0.306	0.422	0.291	0.372	0.332	0.332
1970	0.222	0.433	0.493	0.498	0.449	0.483	0.579	0.257	0.419	0.419
1971	0.195	0.331	0.385	0.390	0.399	0.379	0.399	0.395	0.399	0.399
1972	0.231	0.380	0.399	0.410	0.422	0.429	0.383	0.431	0.408	0.408
1973	0.113	0.393	0.431	0.538	0.537	0.417	0.368	0.436	0.403	0.403
1974	0.220	0.398	0.488	0.512	0.590	0.441	0.401	0.431	0.417	0.417
1975	0.354	0.499	0.528	0.550	0.592	0.605	0.459	0.516	0.489	0.489
1976	0.333	0.405	0.423	0.430	0.376	0.425	0.500	0.425	0.464	0.464
1977	0.324	0.471	0.491	0.494	0.658	0.409	0.427	0.501	0.466	0.466
1978	0.305	0.429	0.464	0.465	0.453	0.509	0.442	0.406	0.426	0.426
1979	0.427	0.640	0.668	0.674	0.669	0.685	0.679	0.563	0.623	0.623
1980	0.238	0.469	0.670	0.626	0.506	0.497	0.465	0.470	0.469	0.469
1981	0.177	0.485	0.577	0.604	0.589	0.447	0.473	0.485	0.481	0.481
1982	0.241	0.514	0.695	0.675	0.610	0.532	0.477	0.482	0.481	0.481
1983	0.237	0.518	0.561	0.747	0.606	0.541	0.476	0.467	0.473	0.473
1984	0.300	0.553	0.582	0.590	0.638	0.543	0.502	0.607	0.557	0.557
1985	0.262	0.473	0.493	0.694	0.466	0.503	0.509	0.523	0.596	0.596
1986	0.285	0.608	0.633	0.637	0.709	0.663	0.563	0.652	0.841	0.841
1987	0.220	0.647	0.676	0.730	0.779	0.624	0.677	0.494	0.669	0.669
1988	0.232	0.634	0.671	0.669	0.711	0.690	0.614	0.699	0.723	0.723
1989	0.211	0.580	0.633	0.639	0.629	0.615	0.615	0.549	0.581	0.581
1990	0.162	0.474	0.570	0.605	0.721	0.568	0.501	0.469	0.460	0.460
1991	0.239	0.607	0.661	0.694	0.731	0.812	0.631	0.622	0.678	0.678
1992	0.215	0.557	0.655	0.675	0.784	0.735	0.735	0.606	0.875	0.875
1993	0.223	0.490	0.612	0.652	0.754	0.691	0.637	0.613	0.657	0.657
1994	0.166	0.495	0.618	0.728	0.645	0.657	0.862	0.631	0.588	0.588
1995	0.122	0.469	0.670	0.787	0.780	0.615	0.670	0.563	0.438	0.438
1996	0.103	0.553	0.714	0.789	0.785	0.718	0.801	0.670	0.698	0.698
1997	0.077	0.894	0.950	0.809	0.923	0.801	0.706	0.625	0.709	0.709
1998	0.215	0.617	1.394	1.153	0.753	0.644	0.687	0.591	0.626	0.626
1999	0.041	0.174	0.328	0.743	0.751	0.691	0.563	0.679	0.778	0.778
2000	0.117	0.368	0.343	0.624	0.619	0.654	0.425	0.374	0.595	0.595
2001	0.061	0.821	0.989	0.878	0.964	0.553	0.654	0.366	0.367	0.367
2002	0.218	0.769	0.776	0.706	0.742	0.712	0.795	0.533	0.388	0.388
2003	0.208	0.800	0.635	0.780	0.676	0.723	0.716	0.623	0.333	0.333
2004	0.241	0.721	0.507	0.483	0.556	0.608	0.428	0.352	0.281	0.281

Table 9.3.2 North Sea plaice. Stock number estimates in the final XSA run.

2005-09-12 09:05:44 units= thousands

year	age 1	2	3	4	5	6	7	8	9	10
1957	460650	260380	324321	187128	118244	51320	51837	40466	22772	49596
1958	698409	386035	188125	227787	125919	75856	37961	36413	28027	60156
1959	870209	568976	272553	126599	144643	79455	49937	26569	25338	61964
1960	758653	676973	377543	173534	79455	87278	49976	31989	17945	53276
1961	864419	616125	447177	240001	107538	50598	52482	31726	20371	49633
1962	591497	710266	417783	288187	152056	64667	33522	33524	19434	47171
1963	689152	486444	468155	260573	176583	89207	38714	21714	21739	50987
1964	2237755	537092	306483	279732	153123	106057	50291	22809	13148	55582
1965	699828	1961990	326191	177778	159359	81079	60375	30458	14365	59757
1966	591142	591654	1360661	198634	107029	101772	44429	37164	19422	44655
1967	403510	498269	376240	837019	117058	60631	65933	24506	23370	38684
1968	433664	345897	318130	228347	504897	65961	33637	44272	14560	49421
1969	650729	322032	235298	205064	145101	317918	43326	20599	30450	59625
1970	651801	507764	213010	153993	132834	96708	188700	29301	12850	45387
1971	411090	472159	297950	117668	84700	76678	53988	95704	20509	53870
1972	367677	305996	306841	183381	72083	51446	47518	32762	58317	48924
1973	1314405	263976	189365	186230	110169	42765	30312	29317	19273	75674
1974	1135886	1062220	161284	111316	98366	58264	25489	18976	17159	67476
1975	867139	824836	645774	89623	60381	49352	33909	15448	11157	53278
1976	692949	550665	453122	344459	46785	30215	24384	19388	8344	35389
1977	987569	449413	332212	268551	202849	29060	17880	13388	11464	25835
1978	911346	646414	253816	183971	148286	95060	17476	10555	7337	22562
1979	891156	607725	380680	144432	104524	85333	51693	10162	6362	20933
1980	1128414	526229	290097	176617	66628	48466	38933	23728	5237	15043
1981	870249	804770	297830	134386	85414	36348	26667	22138	13424	16187
1982	2032996	659594	448364	151396	66448	42874	21028	15032	12334	23708
1983	1306992	1445112	356784	202485	69782	32662	22791	11808	8398	22999
1984	1259596	932809	778683	184190	86846	34449	17209	12807	6696	16081
1985	1850266	844104	485673	393663	92392	41521	18111	9421	6314	13497
1986	4736957	1288460	475783	268346	177918	52475	22710	9851	5053	12755
1987	1922902	3221732	634976	228629	128404	79247	24467	11703	4643	11737
1988	1772259	1396026	1526991	292111	99701	53303	38436	11245	6460	12654
1989	1185701	1272011	670318	706249	135419	44305	24195	18822	5056	13239
1990	1035258	868779	644336	322012	337337	65332	21671	11841	9839	10811
1991	911293	797039	489481	329574	159053	148449	33494	11876	6704	11861
1992	773844	648988	393168	228712	148969	69256	59654	16124	5768	12394
1993	524073	564971	336510	184816	105316	61538	30052	25871	7960	12772
1994	436686	379238	313321	165167	87086	44841	27890	14377	12687	12773
1995	1155106	334712	209167	152882	72139	41354	21043	10660	6922	11076
1996	1206464	924744	189425	96849	62967	29924	20227	9745	5493	10177
1997	1842940	984779	481401	83897	39796	25983	13212	8215	4510	8600
1998	569882	1544334	364300	168507	33814	14310	10549	5903	3978	7006
1999	799079	416025	753721	81788	48138	14416	6798	4802	2957	5992
2000	997139	694143	316291	491439	35194	20562	6534	3504	2203	4888
2001	609982	802375	434578	203143	238142	17143	9672	3864	2181	7880
2002	2038954	519215	319572	146318	76363	82140	8918	4549	2424	5163
2003	530432	1483793	217790	133029	65345	32910	36474	3645	2416	3182
2004	1322724	389948	603038	104409	55155	30067	14451	16123	1768	2311
2005	NA	940450	171629	328564	58278	28608	14815	8522	10255	2786

Table 9.4.1 North Sea plaice. Stock summary table

year	recruitment	ssb	catch	landings	discards	fbar2-6	Y/ssb
1957	460650	289595	78463	70563	7900	0.26	0.24
1958	698409	309305	88254	73354	14900	0.32	0.24
1959	870209	310943	109261	79300	29961	0.36	0.26
1960	758653	318039	117183	87541	29642	0.36	0.28
1961	864419	328458	118415	85984	32431	0.34	0.26
1962	591497	388941	125208	87472	37736	0.39	0.22
1963	689152	380355	148391	107118	41273	0.42	0.28
1964	2237755	378357	147411	110540	36871	0.46	0.29
1965	699828	353602	139871	97143	42728	0.38	0.27
1966	591142	367138	167319	101834	65485	0.39	0.28
1967	403510	427491	162978	108819	54159	0.42	0.25
1968	433664	409729	139524	111534	27990	0.33	0.27
1969	650729	386051	142845	121651	21194	0.34	0.32
1970	651801	343555	160862	130342	30520	0.47	0.38
1971	411090	323138	136974	113944	23030	0.38	0.35
1972	367677	326691	142514	122843	19671	0.41	0.38
1973	1314405	280551	143837	130429	13408	0.46	0.46
1974	1135886	288974	157807	112540	45267	0.49	0.39
1975	867139	300976	195345	108536	86809	0.55	0.36
1976	692949	312539	167002	113670	53332	0.41	0.36
1977	987569	322362	176761	119188	57573	0.50	0.37
1978	911346	308364	159800	113984	45816	0.46	0.37
1979	891156	301424	213422	145347	68075	0.67	0.48
1980	1128414	276339	171134	139951	31183	0.55	0.51
1981	870249	265234	172481	139747	32734	0.54	0.53
1982	2032996	267914	204492	154547	49945	0.61	0.58
1983	1306992	317007	217986	144038	73948	0.59	0.45
1984	1259596	326374	226669	156147	70522	0.58	0.48
1985	1850266	347348	220730	159838	60892	0.53	0.46
1986	4736957	373808	296385	165347	131038	0.65	0.44
1987	1922902	447054	343163	153670	189493	0.69	0.34
1988	1772259	394289	311835	154475	157360	0.67	0.39
1989	1185701	417500	277466	169818	107648	0.62	0.41
1990	1035258	373942	228595	156240	72355	0.59	0.42
1991	911293	339040	229560	148004	81556	0.70	0.44
1992	773844	271499	183370	125190	58180	0.68	0.46
1993	524073	233602	152233	117113	35120	0.64	0.50
1994	436686	199125	134392	110392	24000	0.63	0.55
1995	1155106	180977	120450	98356	22094	0.66	0.54
1996	1206464	178152	133796	81673	52123	0.71	0.46
1997	1842940	185503	179957	83048	96909	0.88	0.45
1998	569882	198799	174948	71534	103414	0.91	0.36
1999	799079	145232	95047	80662	14385	0.54	0.56
2000	997139	209194	112772	81148	31624	0.52	0.39
2001	609982	244631	149430	81963	67467	0.84	0.34
2002	2038954	180806	134716	70217	64499	0.74	0.39
2003	530432	202391	133838	66502	67336	0.72	0.33
2004	1322724	169225	120125	61436	58689	0.58	0.36

Table 9.5.1 North Sea plaice. Input to RCT3 analysis

yc	VPA-1	VPA-2	SNS0	SNS1	SNS2	SNS3	SNS4	BTS1	BTS2	BTS3	BTS4	DFS0
1967	433664	322032	-11	-11	-11	2813	156	-11	-11	-11	-11	-11
1968	650729	507764	-11	-11	9450	1008	70	-11	-11	-11	-11	-11
1969	651801	472159	-11	8032	23848	4484	795	-11	-11	-11	-11	-11
1970	411090	305996	3678	18101	9584	1631	258	-11	-11	-11	-11	-11
1971	367677	263976	6705	6437	4191	1261	33	-11	-11	-11	-11	-11
1972	1314405	1062220	9242	57238	17985	10744	185	-11	-11	-11	-11	-11
1973	1135886	824836	5451	15648	9171	791	591	-11	-11	-11	-11	-11
1974	867139	550665	2193	9781	2274	1720	136	-11	-11	-11	-11	-11
1975	692949	449413	1151	9037	2900	435	159	-11	-11	-11	-11	-11
1976	987569	646415	11544	19119	12714	1577	110	-11	-11	-11	-11	-11
1977	911346	607725	4378	13924	9540	456	34	-11	-11	-11	-11	-11
1978	891156	526229	3252	21681	12084	785	93	-11	-11	-11	-11	-11
1979	1128414	804770	27835	58049	16106	1146	78	-11	-11	-11	-11	-11
1980	870249	659594	4039	19611	8503	308	16	-11	-11	-11	-11	-11
1981	2032996	1445112	31542	70108	14708	2480	351	-11	-11	-11	12	634
1982	1306992	932810	23987	34884	10413	1584	145	-11	-11	39	9	457
1983	1259596	844104	36722	44667	13789	1155	198	-11	180	51	5	432
1984	1850266	1288460	7958	27832	7558	1232	1357	116	132	33	9	263
1985	4736957	3221733	47385	93573	33021	13140	4034	660	764	174	47	718
1986	1922902	1396026	8818	33426	14429	3709	828	226	140	39	23	345
1987	1772259	1272011	21270	36672	14952	3248	1161	577	319	56	12	465
1988	1185701	868779	15598	37238	7287	1507	612	429	103	29	6	331
1989	1035258	797039	24198	24903	11149	2257	98	112	122	27	6	463
1990	911293	648988	9559	57349	13742	988	78	185	126	38	11	468
1991	773844	564971	17120	48223	9484	884	96	172	179	35	8	496
1992	524073	379238	5398	22184	4866	415	42	125	64	14	5	357
1993	436686	334712	9226	18225	2786	1189	34	145	44	23	3	263
1994	1155106	924744	27901	24900	10377	1393	41	252	212	20	9	445
1995	1206464	984779	13029	24663	-11	5739	1040	218	-11	47	4	184
1996	1842940	1544334	91713	-11	29431	14347	982	-11	436	183	24	572
1997	569882	416025	15363	33391	9235	905	196	338	130	32	10	157
1998	799079	694143	22720	35188	2489	356	58	305	75	20	6	-11
1999	997139	802375	39201	23028	2416	263	-11	279	79	15	6	-11
2000	609982	519215	24185	10193	1047	-11	51	226	45	11	7	185
2001	-11	-11	101291	30265	-11	1087	-11	569	170	67	-11	500
2002	-11	-11	29905	-11	1354	-11	-11	126	42	-11	-11	213
2003	-11	-11	-11	18208	-11	-11	-11	226	-11	-11	-11	362
2004	-11	-11	13545	-11	-11	-11	-11	-11	-11	-11	-11	93

Table 9.5.2 North Sea plaice. Results from RCT3 age 1 analysis

Analysis by RCT3 ver3.1 of data from file : p4rct1.csv

Plaice North Sea - 1-Y-Rcr.,,,,,,,,,,,
Data for 10 surveys over 38 years : 1967 - 2004
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	
SNS-0	1.11	3.40	.97	.237	31	11.53	16.18	1.096	.048
SNS-1	1.21	1.51	.62	.431	31	10.32	14.01	.648	.137
SNS-3	1.09	5.85	.98	.238	33	6.99	13.46	1.029	.054
BTS-1	2.26	1.51	1.08	.247	16	6.35	15.84	1.290	.035
BTS-2	.95	9.21	.41	.690	17	5.14	14.11	.453	.280
BTS-3	1.05	10.15	.51	.567	19	4.22	14.60	.563	.181
DFS	2.32	.26	.84	.344	18	6.22	14.67	.927	.067
					VPA	Mean =	13.78	.538	.199

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	1.11	3.40	.97	.237	31	10.31	14.83	1.036	.080
SNS-2	1.19	3.05	.80	.317	32	7.21	11.61	.902	.106
BTS-1	2.26	1.51	1.08	.247	16	4.84	12.45	1.244	.055
BTS-2	.95	9.21	.41	.690	17	3.76	12.79	.483	.368
DFS	2.32	.26	.84	.344	18	5.37	12.70	.955	.094
					VPA	Mean =	13.78	.538	.297

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-1	1.21	1.51	.62	.431	31	9.81	13.40	.650	.307
BTS-1	2.26	1.51	1.08	.247	16	5.42	13.76	1.194	.091
DFS	2.32	.26	.84	.344	18	5.89	13.92	.915	.155
					VPA	Mean =	13.78	.538	.448

Yearclass = 2004

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------	Prediction		---------I	
SNS-0	1.11	3.40	.97	.237	31	9.51	13.95	1.022	.185
DFS	2.32	.26	.84	.344	18	4.54	10.79	1.142	.148
					VPA	Mean =	13.78	.538	.668

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2001	1590327	14.28	.24	.24	.97		
2002	486409	13.09	.29	.37	1.59		
2003	874975	13.68	.36	.11	.10		
2004	639187	13.37	.44	.76	3.00		

Table 9.5.3 North Sea plaice. Results from RCT3 age 2 analysis

Analysis by RCT3 ver3.1 of data from file : p4rct2.csv

Plaice North Sea - 2-Y-Rcr.,,,,,,,,,,,
Data for 10 surveys over 38 years : 1967 - 2004
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/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.95	4.58	.78	.323	31	11.53	15.53	.884	.071
SNS-1	1.16	1.67	.58	.457	31	10.32	13.69	.608	.149
SNS-3	1.05	5.83	.93	.259	33	6.99	13.15	.976	.058
BTS-1	2.09	2.13	1.00	.260	16	6.35	15.42	1.185	.039
BTS-2	.93	9.02	.42	.665	17	5.14	13.82	.462	.259
BTS-3	1.03	9.94	.51	.545	19	4.22	14.30	.566	.172
DFS	2.34	-.16	.86	.317	18	6.22	14.38	.954	.061
					VPA	Mean =	13.47	.536	.192

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	.95	4.58	.78	.323	31	10.31	14.37	.835	.120
SNS-2	1.25	2.19	.86	.285	32	7.21	11.19	.969	.089
BTS-1	2.09	2.13	1.00	.260	16	4.84	12.27	1.144	.064
BTS-2	.93	9.02	.42	.665	17	3.76	12.53	.492	.347
DFS	2.34	-.16	.86	.317	18	5.37	12.39	.983	.087
					VPA	Mean =	13.47	.536	.292

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-1	1.16	1.67	.58	.457	31	9.81	13.09	.610	.331
BTS-1	2.09	2.13	1.00	.260	16	5.42	13.49	1.097	.102
DFS	2.34	-.16	.86	.317	18	5.89	13.62	.942	.139
					VPA	Mean =	13.47	.536	.428

Yearclass = 2004

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
SNS-0	.95	4.58	.78	.323	31	9.51	13.62	.825	.259
DFS	2.34	-.16	.86	.317	18	4.54	10.46	1.176	.128
					VPA	Mean =	13.47	.536	.613

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2001	1194360	13.99	.23	.24	1.01		
2002	390578	12.88	.29	.38	1.70		
2003	638472	13.37	.35	.11	.11		
2004	500151	13.12	.42	.72	2.94		

Table 9.6.1 North Sea plaice. Input to the short term forecast

2005

age	stock.n	catch.wt	landings.wt	discards.wt	mat	M	F	Fdisc	Flandings
1	913747	0.06	0.23	0.06	0	0.1	0.19	0.19	0.00
2	638000	0.10	0.25	0.09	0.5	0.1	0.65	0.61	0.04
3	171629	0.20	0.29	0.14	0.5	0.1	0.54	0.31	0.23
4	328564	0.29	0.32	0.16	1	0.1	0.56	0.13	0.43
5	58278	0.36	0.37	0.18	1	0.1	0.56	0.04	0.51
6	28608	0.42	0.43	0.21	1	0.1	0.58	0.04	0.54
7	14816	0.50	0.50	0.13	1	0.1	0.55	0.01	0.54
8	8523	0.63	0.63	0.07	1	0.1	0.43	0.00	0.43
9	10256	0.77	0.77	0.07	1	0.1	0.28	0.00	0.28
10	2787	0.87	0.87	0.00	1	0.1	0.28	0.00	0.28

2006

age	stock.n	catch.wt	landings.wt	discards.wt	mat	M	F	Fdisc	Flandings
1	913747	0.06	0.23	0.06	0	0.1	0.19	0.19	0.00
2		0.10	0.25	0.09	0.5	0.1	0.65	0.61	0.04
3		0.20	0.29	0.14	0.5	0.1	0.54	0.31	0.23
4		0.29	0.32	0.16	1	0.1	0.56	0.13	0.43
5		0.36	0.37	0.18	1	0.1	0.56	0.04	0.51
6		0.42	0.43	0.21	1	0.1	0.58	0.04	0.54
7		0.50	0.50	0.13	1	0.1	0.55	0.01	0.54
8		0.63	0.63	0.07	1	0.1	0.43	0.00	0.43
9		0.77	0.77	0.07	1	0.1	0.28	0.00	0.28
10		0.87	0.87	0.00	1	0.1	0.28	0.00	0.28

2007

age	stock.n	catch.wt	landings.wt	discards.wt	mat	M	F	Fdisc	Flandings
1	913747	0.06	0.23	0.06	0	0.1	0.19	0.19	0.00
2		0.10	0.25	0.09	0.5	0.1	0.65	0.61	0.04
3		0.20	0.29	0.14	0.5	0.1	0.54	0.31	0.23
4		0.29	0.32	0.16	1	0.1	0.56	0.13	0.43
5		0.36	0.37	0.18	1	0.1	0.56	0.04	0.51
6		0.42	0.43	0.21	1	0.1	0.58	0.04	0.54
7		0.50	0.50	0.13	1	0.1	0.55	0.01	0.54
8		0.63	0.63	0.07	1	0.1	0.43	0.00	0.43
9		0.77	0.77	0.07	1	0.1	0.28	0.00	0.28
10		0.87	0.87	0.00	1	0.1	0.28	0.00	0.28

Table 9.6.2 North Sea plaice. Results from Short Term Forecast.

2005							
fmult	f2-6	fdisc2-3	fhc2-6	landings	discards	catch	ssb
0	0.58	0.46	0.35	66472	44387	110682	205152

2006								2007
fmult	f2-6	fdisc2-3	fhc2-6	landings	discards	catch	ssb	ssb
0	0	NA	NA	0	0	0	193217	322928
0.1	0.06	0.05	0.04	8178	5962	14127	193217	307016
0.2	0.12	0.09	0.07	15928	11611	27515	193217	291954
0.3	0.17	0.14	0.11	23274	16966	40205	193217	277695
0.4	0.23	0.18	0.14	30237	22042	52234	193217	264194
0.5	0.29	0.23	0.18	36837	26857	63639	193217	251409
0.6	0.35	0.28	0.21	43095	31425	74455	193217	239301
0.7	0.40	0.32	0.25	49027	35760	84713	193217	227832
0.8	0.46	0.37	0.28	54652	39875	94443	193217	216968
0.9	0.52	0.41	0.32	59985	43782	103676	193217	206675
1	0.58	0.46	0.35	65043	47494	112437	193217	196922
1.1	0.63	0.50	0.39	69840	51021	120753	193217	187679
1.2	0.69	0.55	0.42	74389	54374	128647	193217	178918
1.3	0.75	0.60	0.46	78704	57562	136143	193217	170613
1.4	0.81	0.64	0.49	82797	60594	143262	193217	162738
1.5	0.86	0.69	0.53	86680	63480	150025	193217	155272
1.6	0.92	0.73	0.56	90364	66227	156450	193217	148190
1.7	0.98	0.78	0.60	93860	68843	162555	193217	141472
1.8	1.04	0.83	0.63	97177	71335	168359	193217	135099
1.9	1.09	0.87	0.67	100325	73710	173877	193217	129052
2	1.15	0.92	0.70	103313	75974	179124	193217	123312

Table 9.6.3 North Sea plaice. Detailed results from Short Term Forecast at status quo fishing mortality.

age	Fmult	f2-6	fdisc2-3	fhc2-6	discards.n	landings.n	catch.n	discards	landings	catch	stock.n	TSB	SSB
	2005												
1	1.0	0.19	0.19	0.00	148626	627	149253	8521	143	8657	913747	48429	0
2	1.0	0.65	0.61	0.04	274139	16243	290382	25129	4137	29329	638000	73583	36791
3	1.0	0.54	0.31	0.23	38988	29576	68564	5380	8469	13804	171629	37472	18736
4	1.0	0.56	0.13	0.43	30189	103680	133869	4850	33523	38197	328564	96050	96050
5	1.0	0.56	0.04	0.51	1859	21929	23789	338	8165	8493	58278	20339	20339
6	1.0	0.58	0.04	0.54	751	11227	11978	157	4850	5003	28608	11672	11672
7	1.0	0.55	0.01	0.54	79	5887	5966	10	2959	2973	14816	6909	6909
8	1.0	0.43	0.00	0.43	0	2821	2821	0	1789	1789	8523	4849	4849
9	1.0	0.28	0.00	0.28	0	2407	2407	0	1865	1865	10256	7449	7449
10	1.0	0.28	0.00	0.28	0	654	654	0	572	572	2787	2355	2355
	2006												
1	1.0	0.19	0.19	0.00	148626	627	149253	8521	143	8657	913747	48429	0
2	1.0	0.65	0.61	0.04	294377	17442	311819	26985	4442	31494	685100	79015	39507
3	1.0	0.54	0.31	0.23	68751	52155	120906	9488	14934	24342	302651	66079	33039
4	1.0	0.56	0.13	0.43	8306	28525	36830	1334	9223	10509	90395	26426	26426
5	1.0	0.56	0.04	0.51	5442	64193	69635	990	23901	24860	170594	59537	59537
6	1.0	0.58	0.04	0.54	793	11858	12651	166	5123	5284	30218	12329	12329
7	1.0	0.55	0.01	0.54	78	5782	5860	10	2906	2920	14551	6786	6786
8	1.0	0.43	0.00	0.43	0	2568	2568	0	1629	1629	7758	4415	4415
9	1.0	0.28	0.00	0.28	0	1183	1183	0	916	916	5039	3660	3660
10	1.0	0.28	0.00	0.28	0	2089	2089	0	1827	1827	8897	7518	7518
	2007												
1	1.0	0.19	0.19	0.00	148626	627	149253	8521	143	8657	913747	48429	0
2	1.0	0.65	0.61	0.04	294377	17442	311819	26985	4442	31494	685100	79015	39507
3	1.0	0.54	0.31	0.23	73826	56005	129831	10188	16036	26139	324994	70957	35478
4	1.0	0.56	0.13	0.43	14646	50300	64946	2353	16264	18531	159403	46599	46599
5	1.0	0.56	0.04	0.51	1497	17661	19158	272	6576	6839	46934	16380	16380
6	1.0	0.58	0.04	0.54	2322	34711	37034	485	14995	15468	88454	36089	36089
7	1.0	0.55	0.01	0.54	82	6107	6190	10	3070	3084	15370	7167	7167
8	1.0	0.43	0.00	0.43	0	2522	2522	0	1600	1600	7620	4336	4336
9	1.0	0.28	0.00	0.28	0	1077	1077	0	834	834	4587	3332	3332
10	1.0	0.28	0.00	0.28	0	2232	2232	0	1952	1952	9507	8033	8033

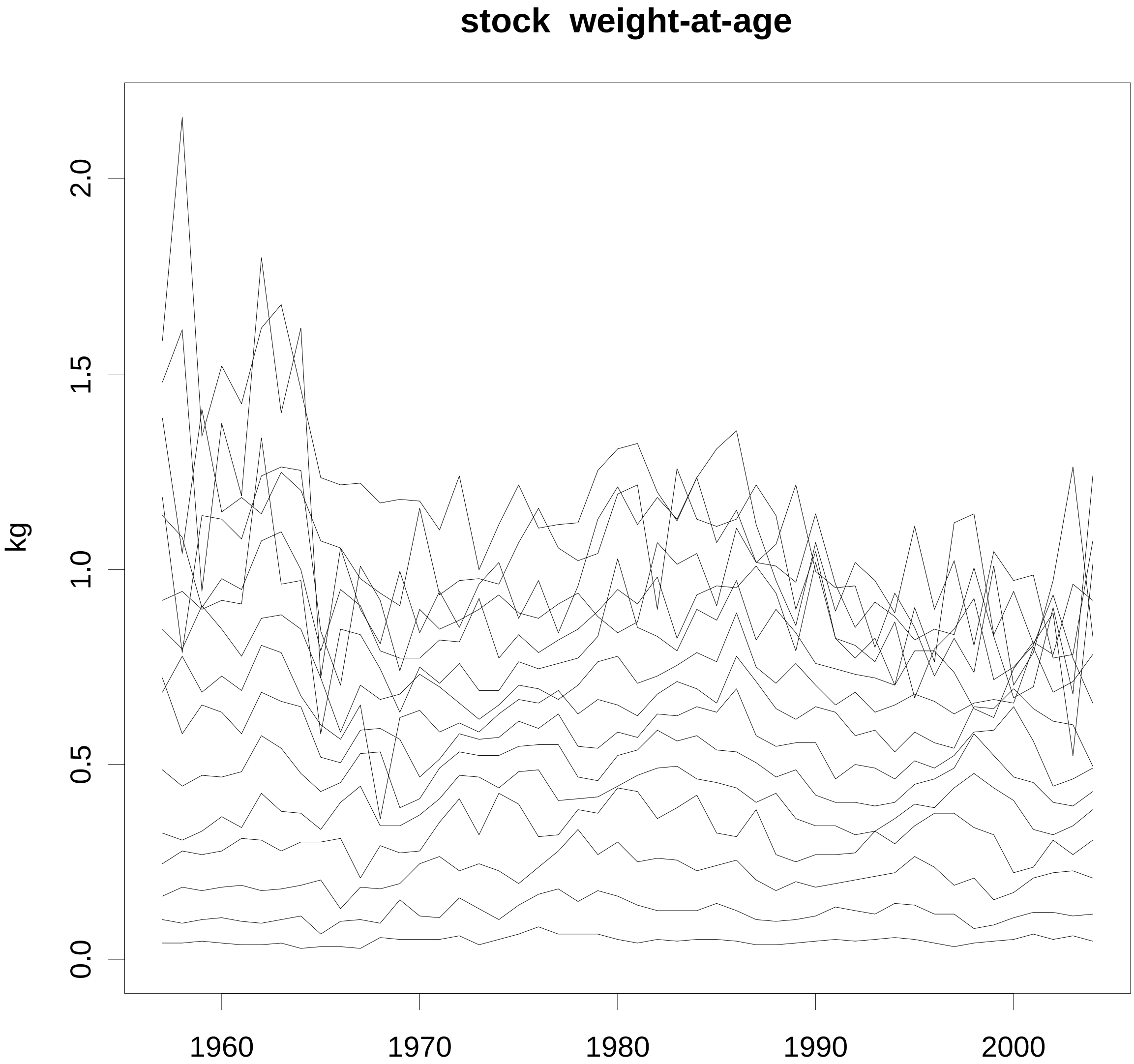

Figure 9.2.1 North Sea plaice. Stock weights-at-age

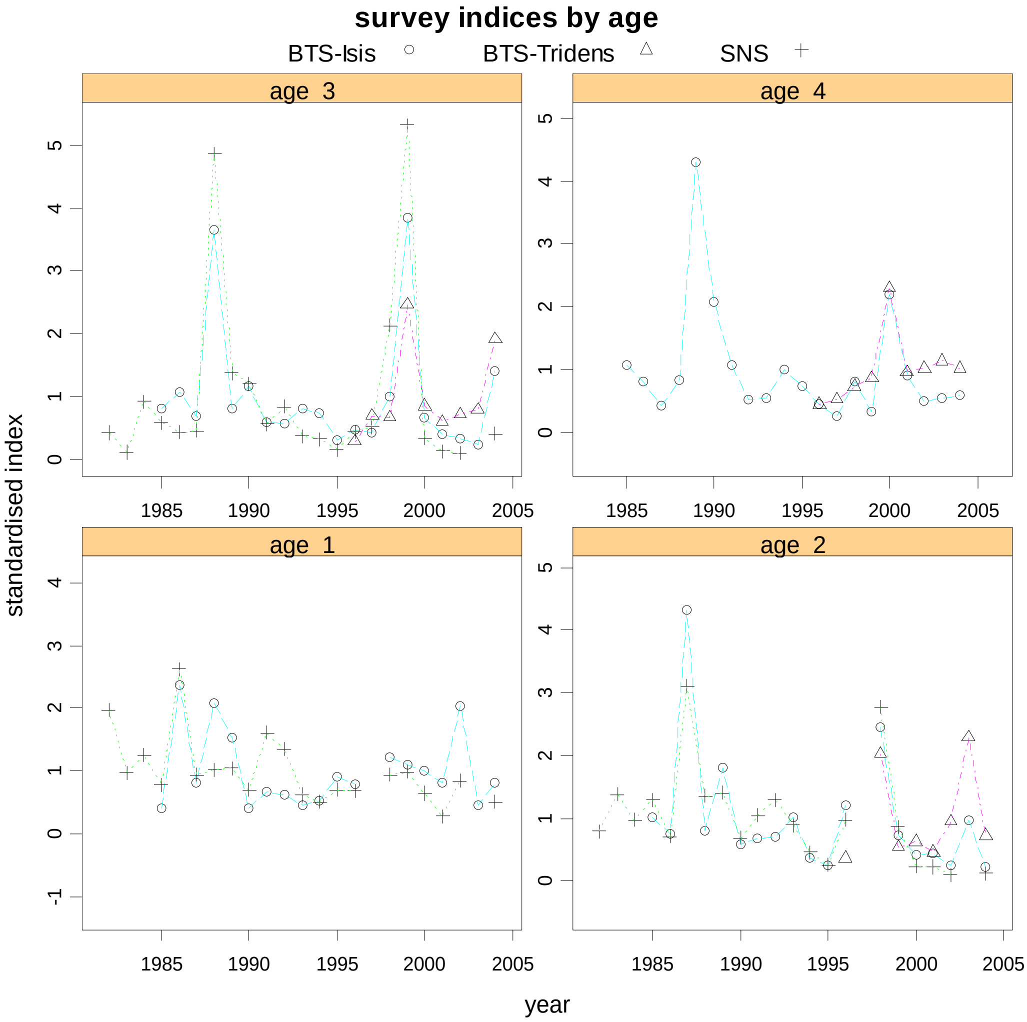

Figure 9.2.2 North Sea plaice. Standardised survey indices used for tuning (ages 1-4).

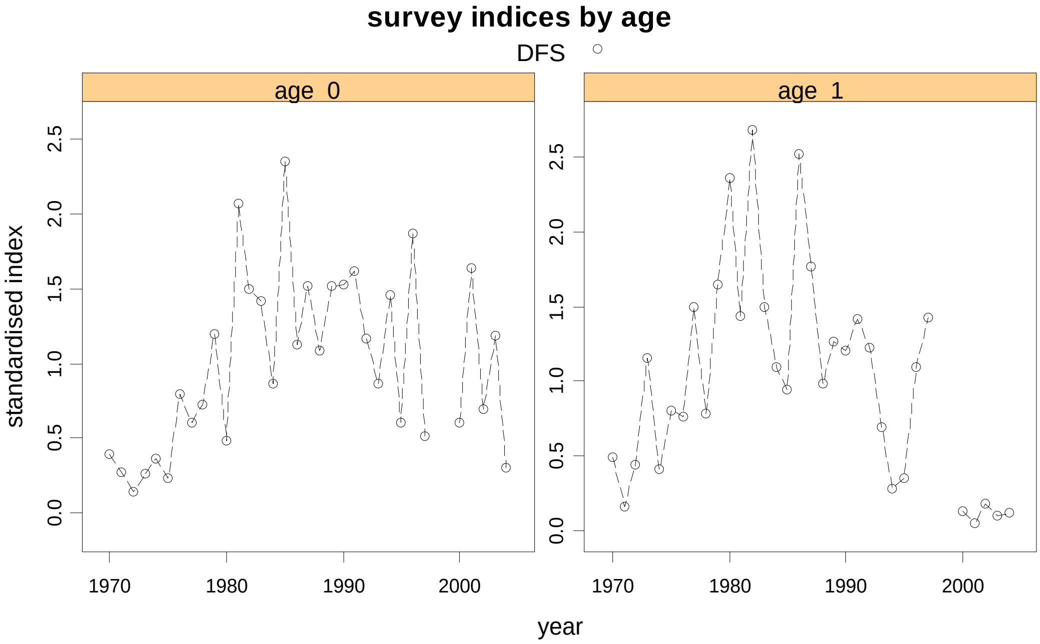

Figure 9.2.3 North Sea plaice. Standardised DFS survey index (age0- 1). Age 0 index was used in RCT3 analysis.

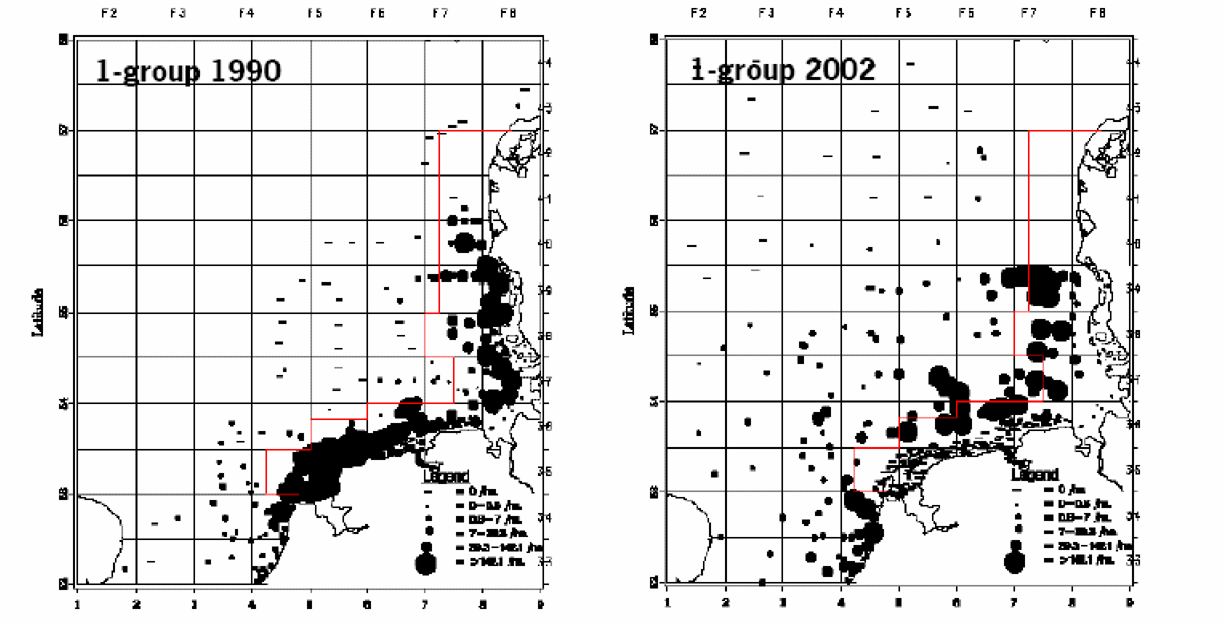

Figure 9.2.4 North Sea plaice. Spatial distribution of plaice age1 (taken from Grift et al., 2004) in the DFS survey. Age 0 index was used in RCT3 analysis.

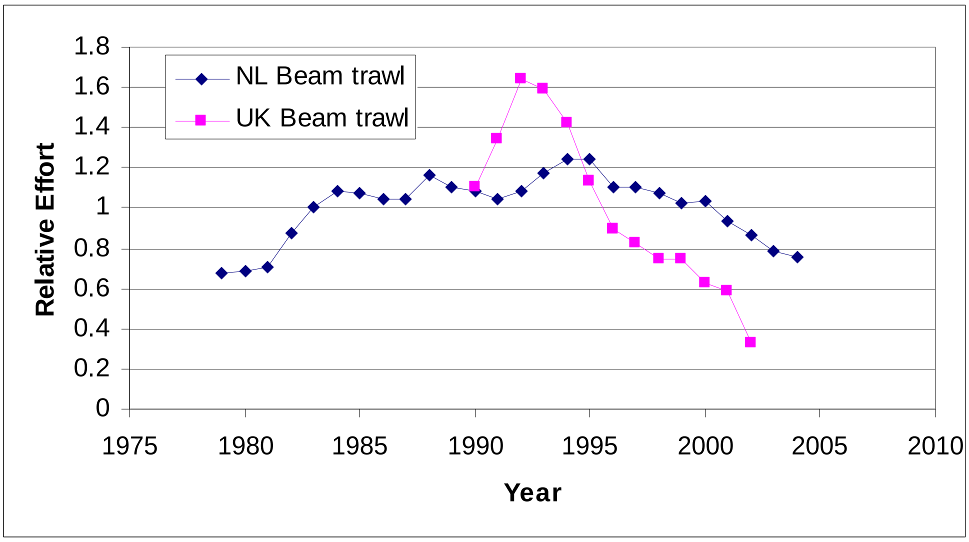

Figure 9.2.5. North Sea plaice. Timeseries of relative effort of the commercial tuning series.

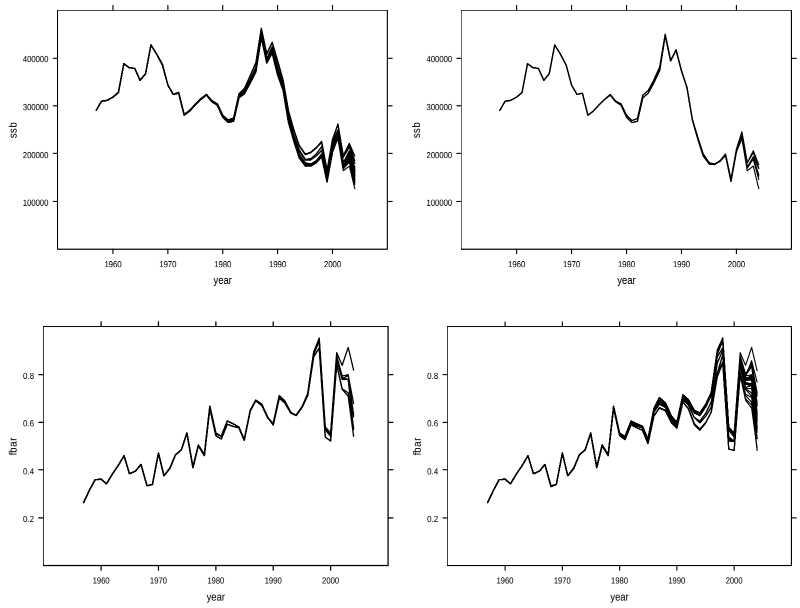

Figure x.x North Sea plaice. XSA assessment with all different permutations of the available tuning fleets. Left: permutations of 3 surveys and 2 commerical CPUE series. Right: 3 surveys only.

Figure 9.2.6. North Sea plaice. Timeseries of relative LPUE (in biomass) of the commercial tuning series.

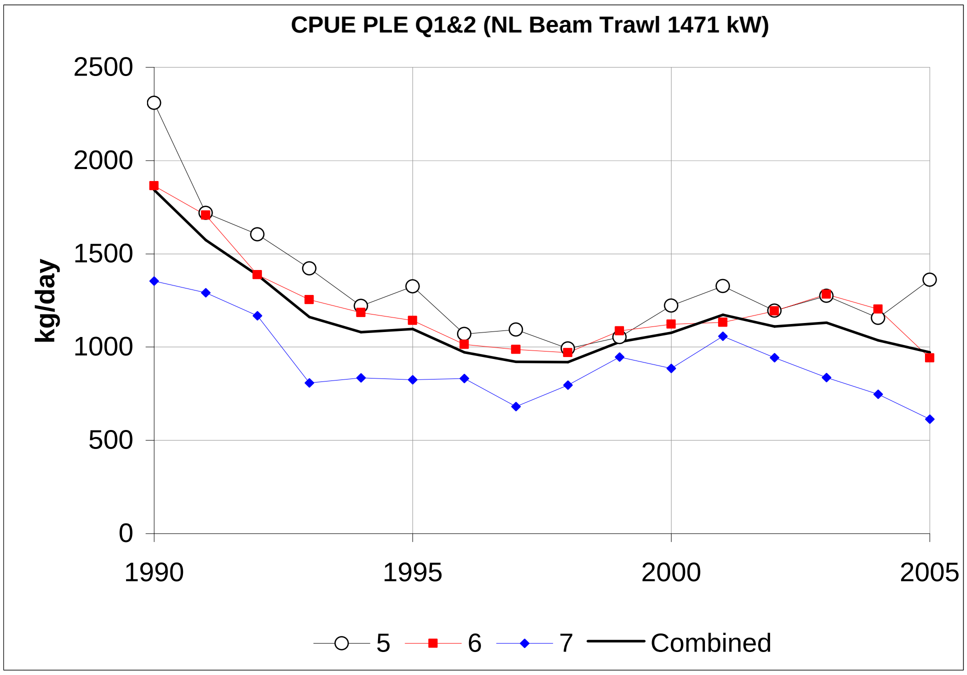

Figure 9.2.7. North Sea plaice. CPUE trends in the Dutch Beam trawl fleet. Based on landings and effort records in the Dutch logbook database from vessels landings into the Netherlands. Only for large beamtrawl vessels (2000 HP, 1471 kW). Three areas: 5 (north North Sea), 6 (central North Sea) and 7 (southern North Sea). Black line indicates the overall trend in CPUE.

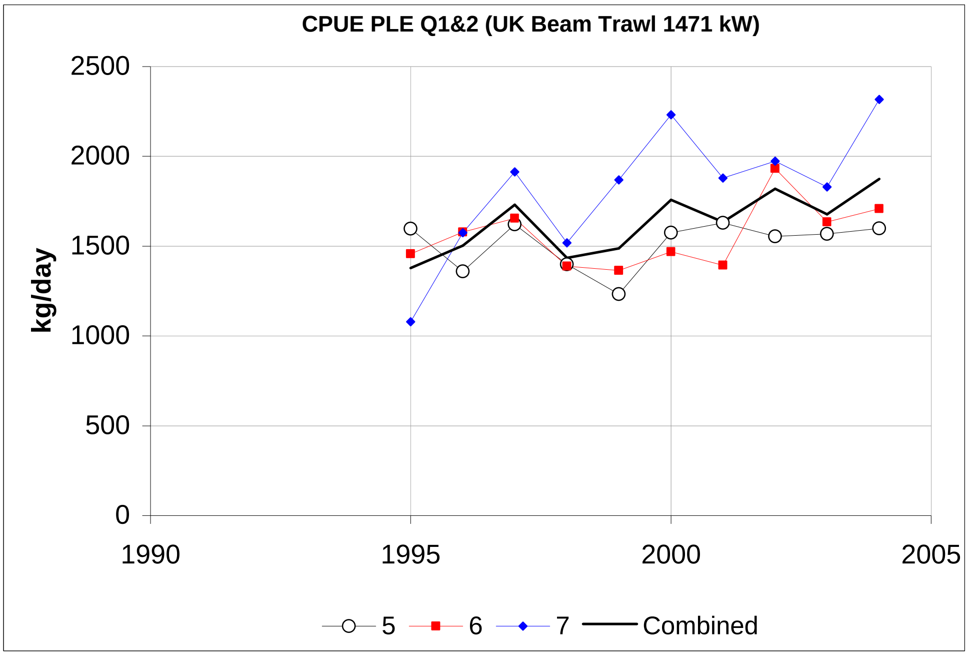

Figure 9.2.8. North Sea plaice. CPUE trends in the UK Beam trawl fleet. Based on landings and effort records in the Dutch logbook database from vessels landings into the Netherlands. Only for large beamtrawl vessels (2000 HP, 1471 kW). Three areas: 5 (north North Sea), 6 (central North Sea) and 7 (southern North Sea). Black line indicates the overall trend in CPUE.

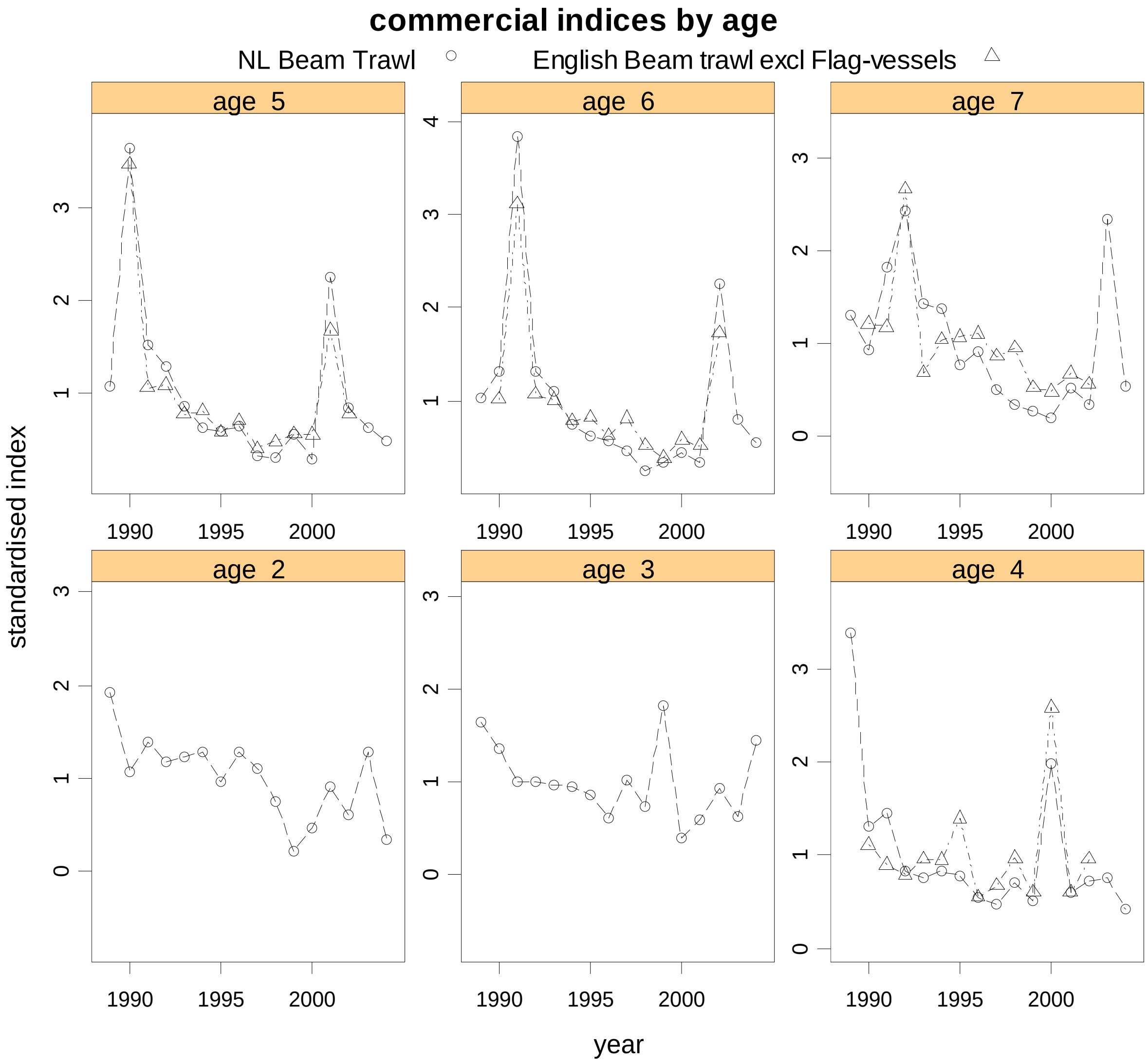

Figure 9.2.9 North Sea plaice. Mean standardised landings-at-age (ages 2-7) for the two commercial tuning series (not used in the assessment).

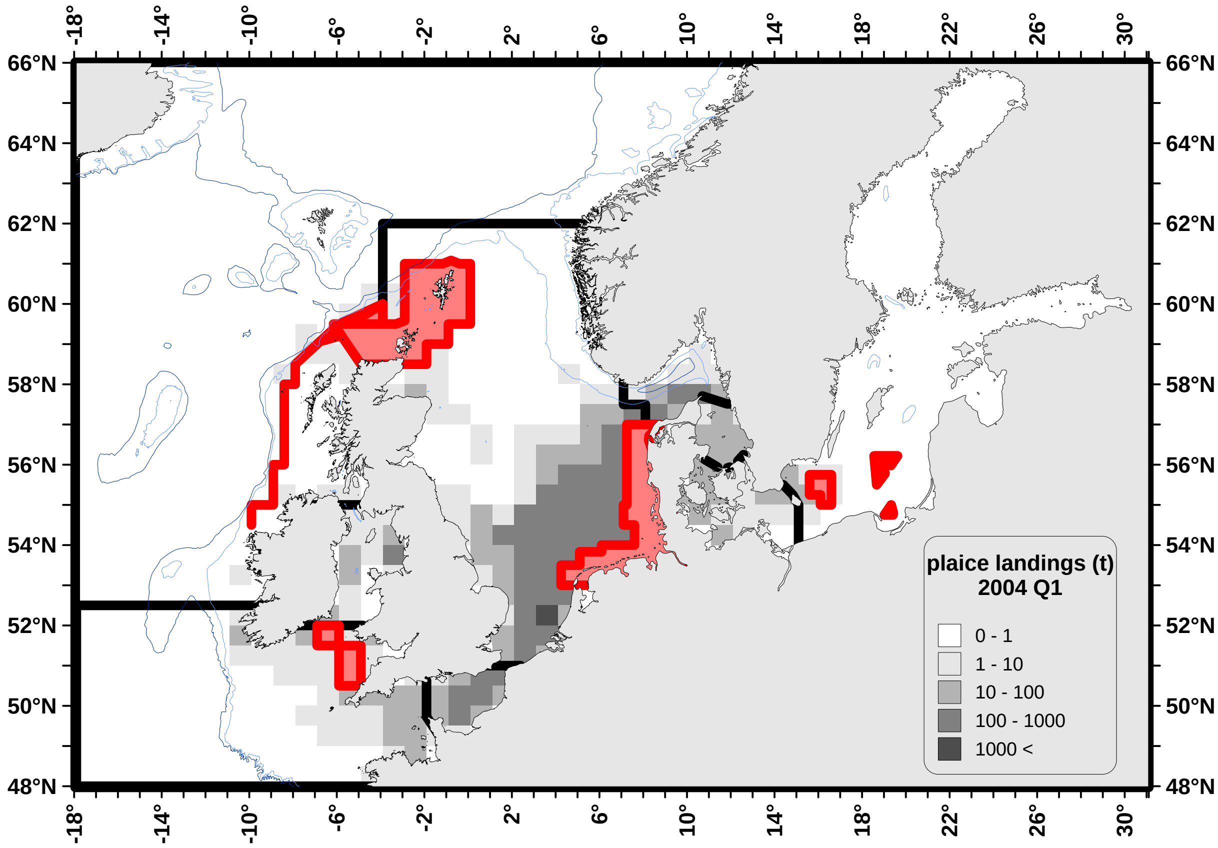

Figure 9.2.10. Reported landings of plaice in 2004.

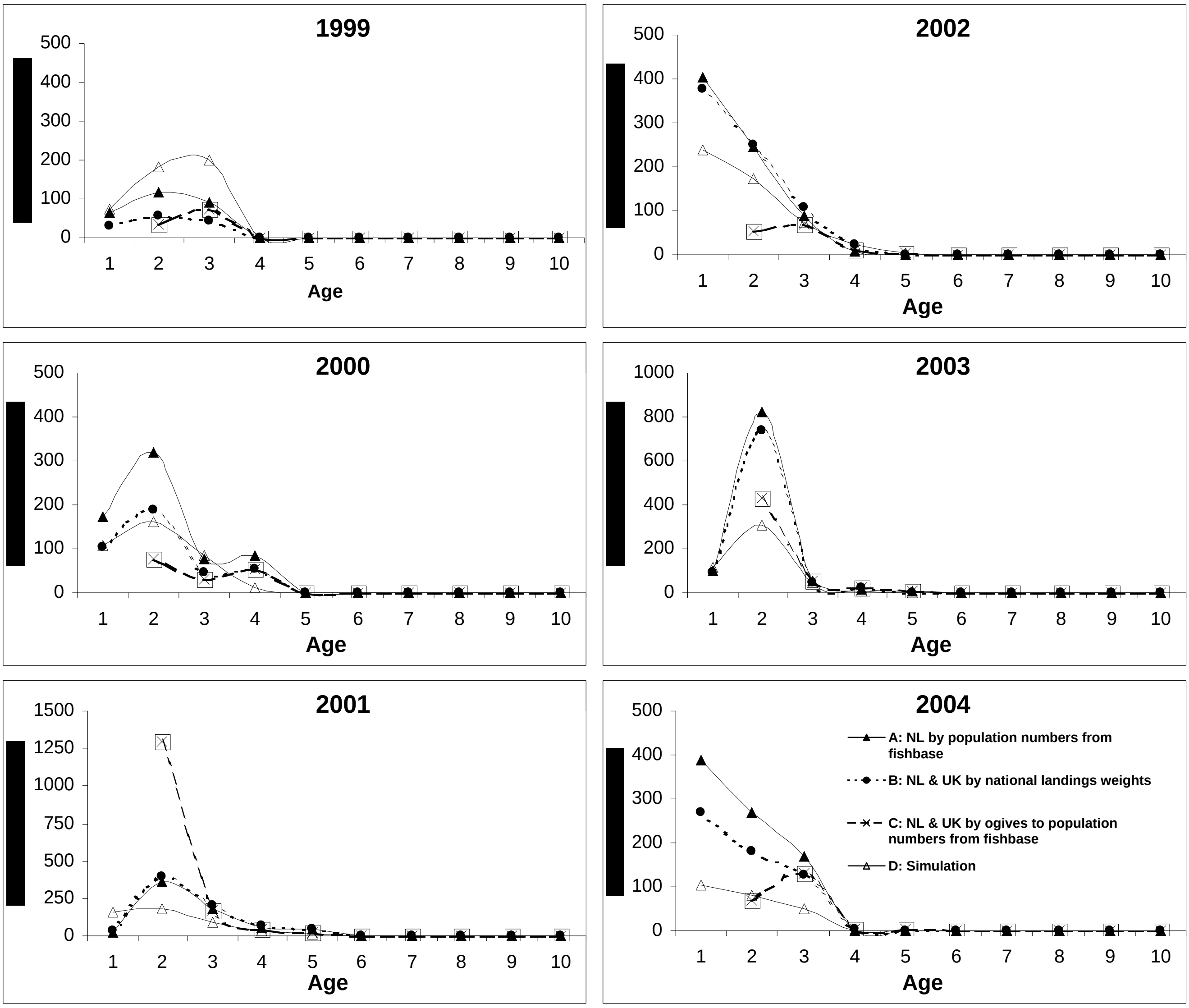

Figure 9.3.1 North Sea plaice. Discard estimates using different raising procedures (see text) .

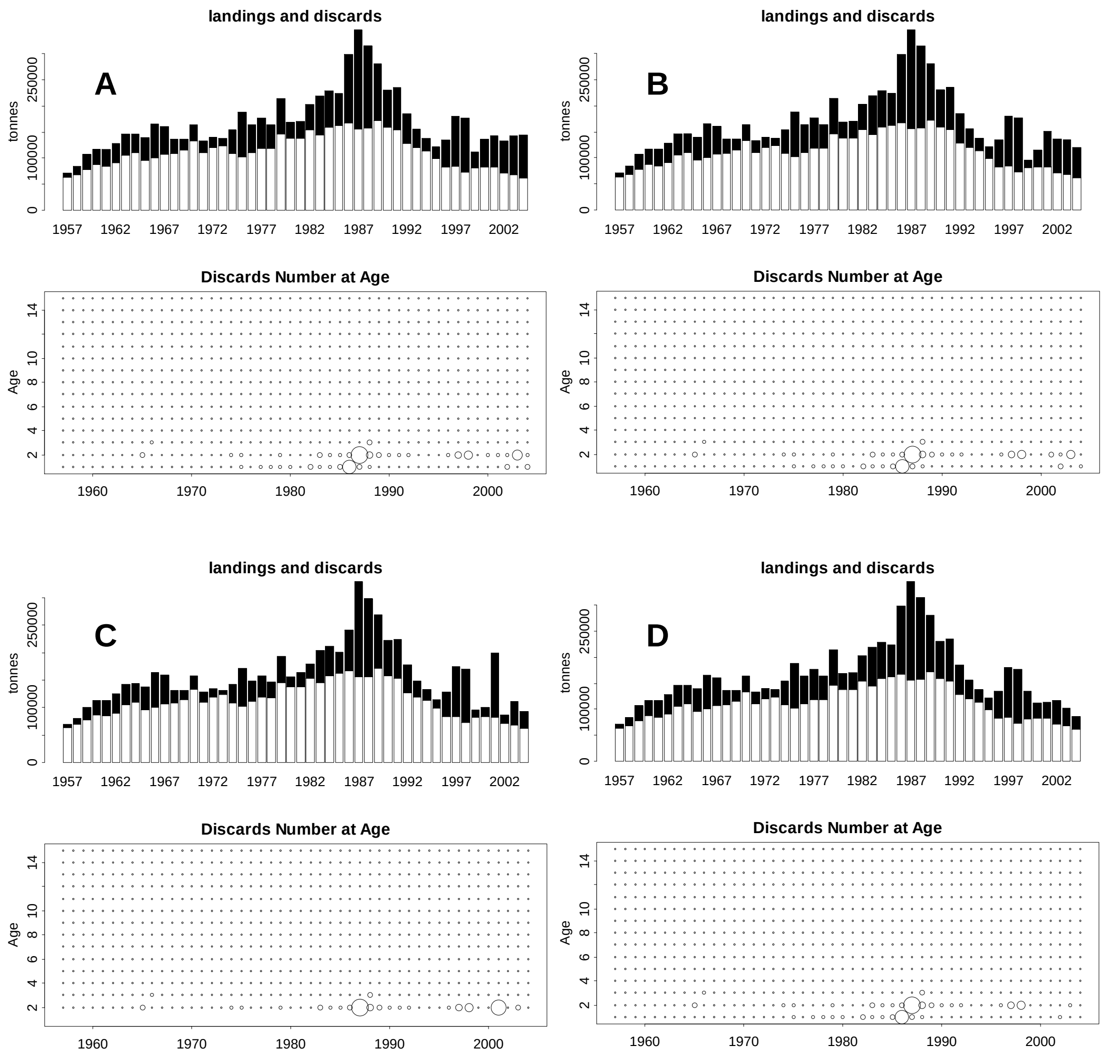

Figure 9.3.2 North Sea plaice. Estimated landings (□), discards (■) and discards-at age for the different raising procedures.

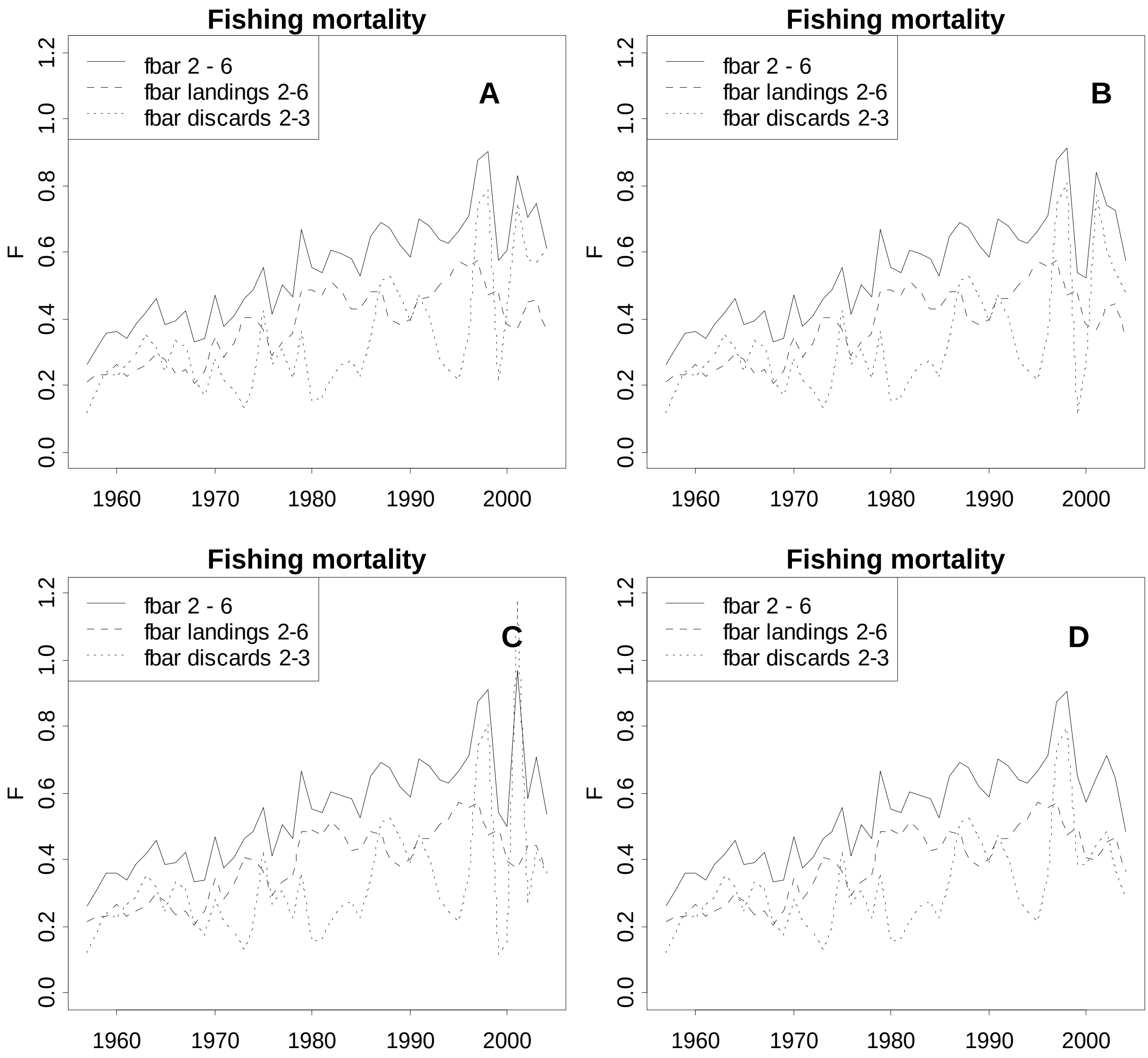

Fig. 9.3.3 North Sea plaice. Estimated Fbar for the different raising procedures for discards using XSA with the same settings as last year (ICES CM 2005/ACFM:07).

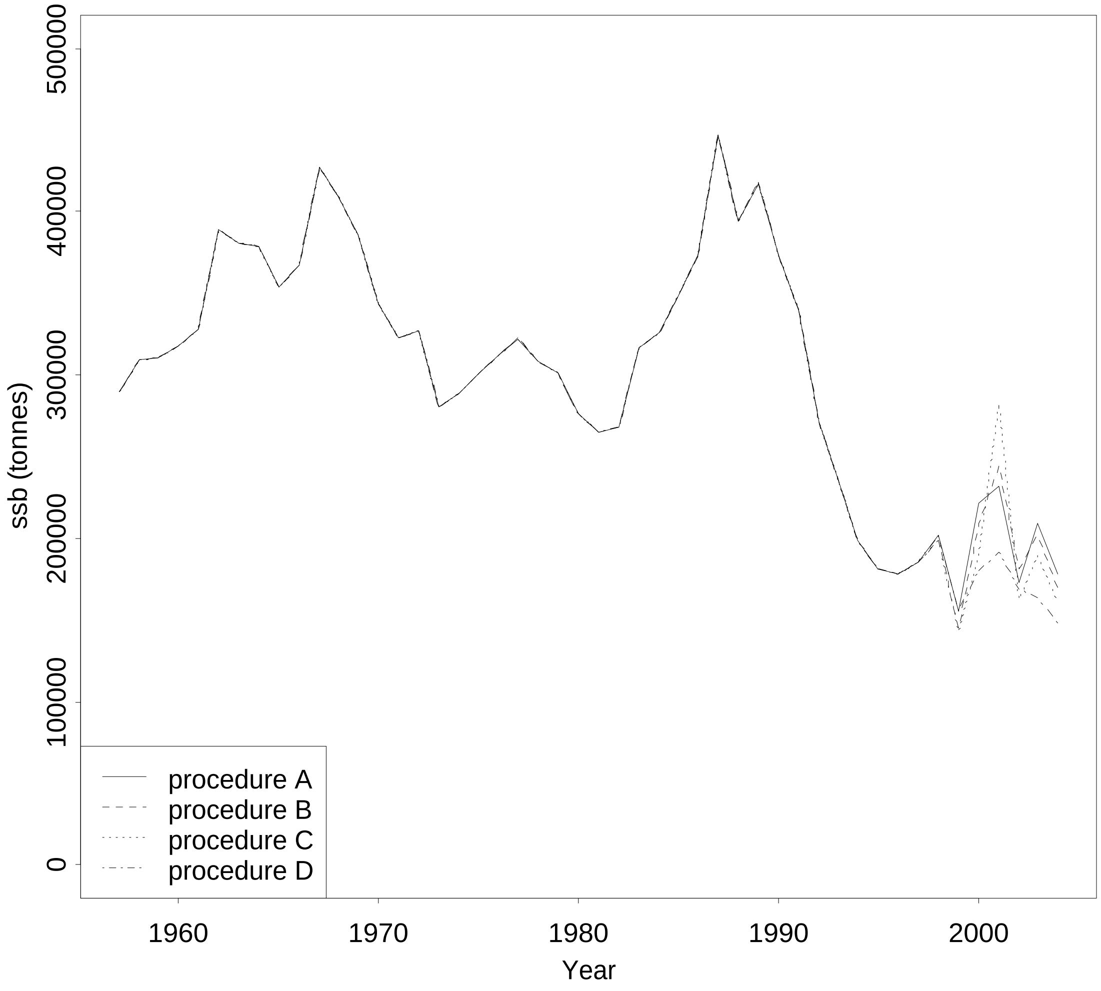

Fig. 9.3.4 North Sea plaice. Estimated SSB for the different raising procedure using XSA with the same settings as last year (ICES CM 2005/ACFM:07).

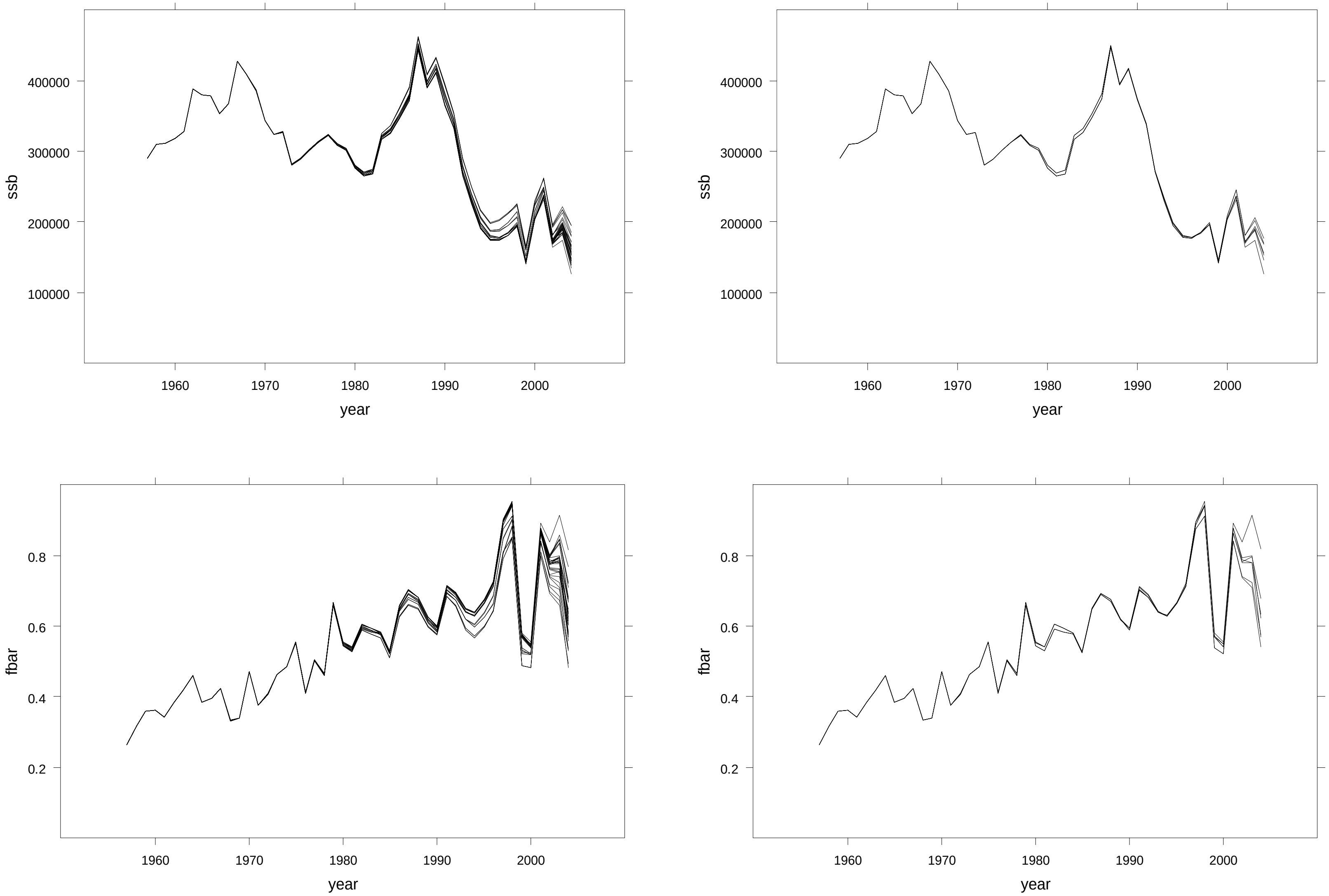

Figure 9.3.5. North Sea plaice. XSA assessment with all different permutations of the available tuning fleets. Left: permutations of 3 surveys and 2 commercial CPUE series. Right: 3 surveys only.

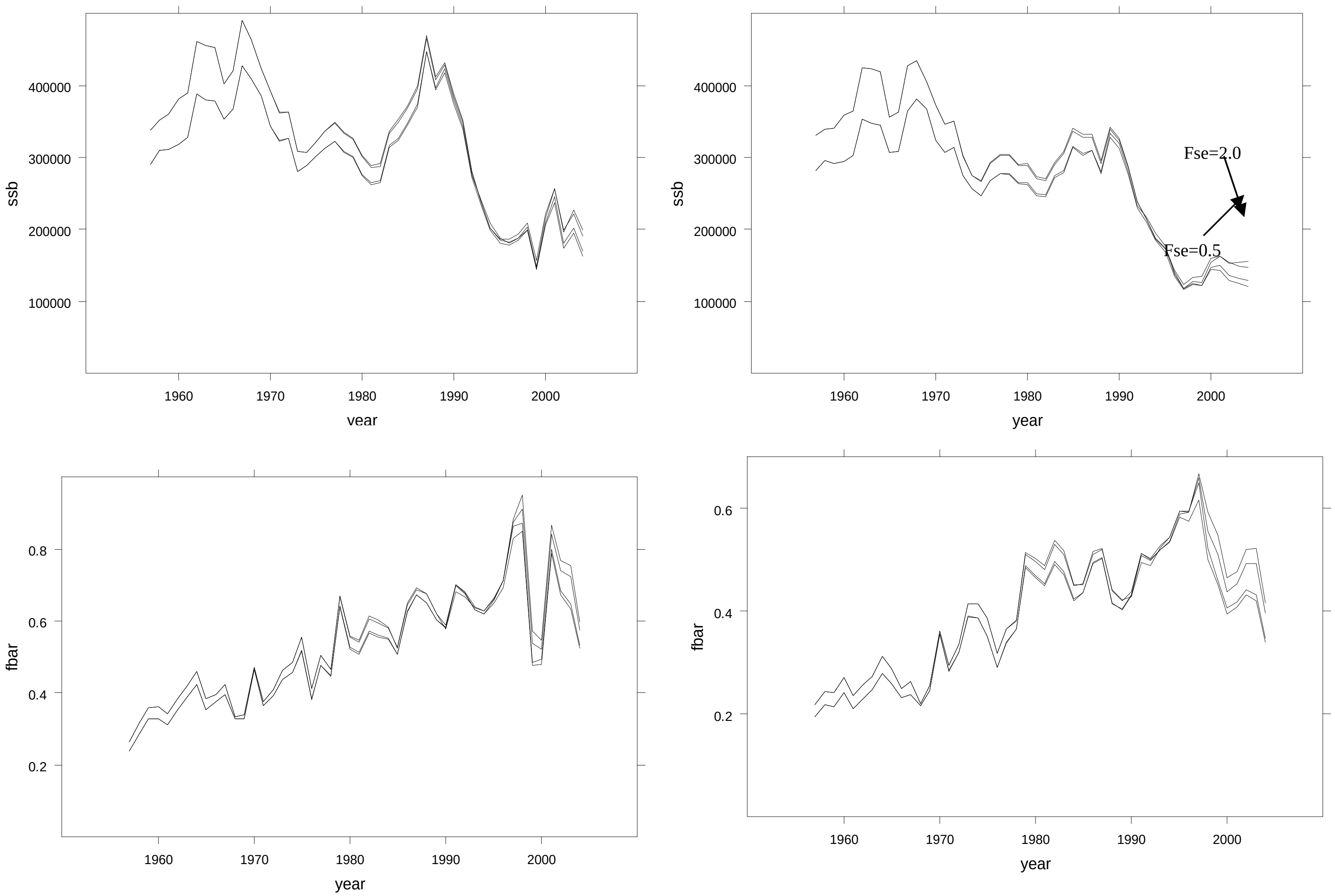

Figure 9.3.6 North Sea plaice. XSA assessments with different assumptions for the plusgroup (10 or 15) and F-shrinkage (0.5 or 2.0). Left: including discards in the catch at age matrix. Right: without discards in the catch at age matrix.

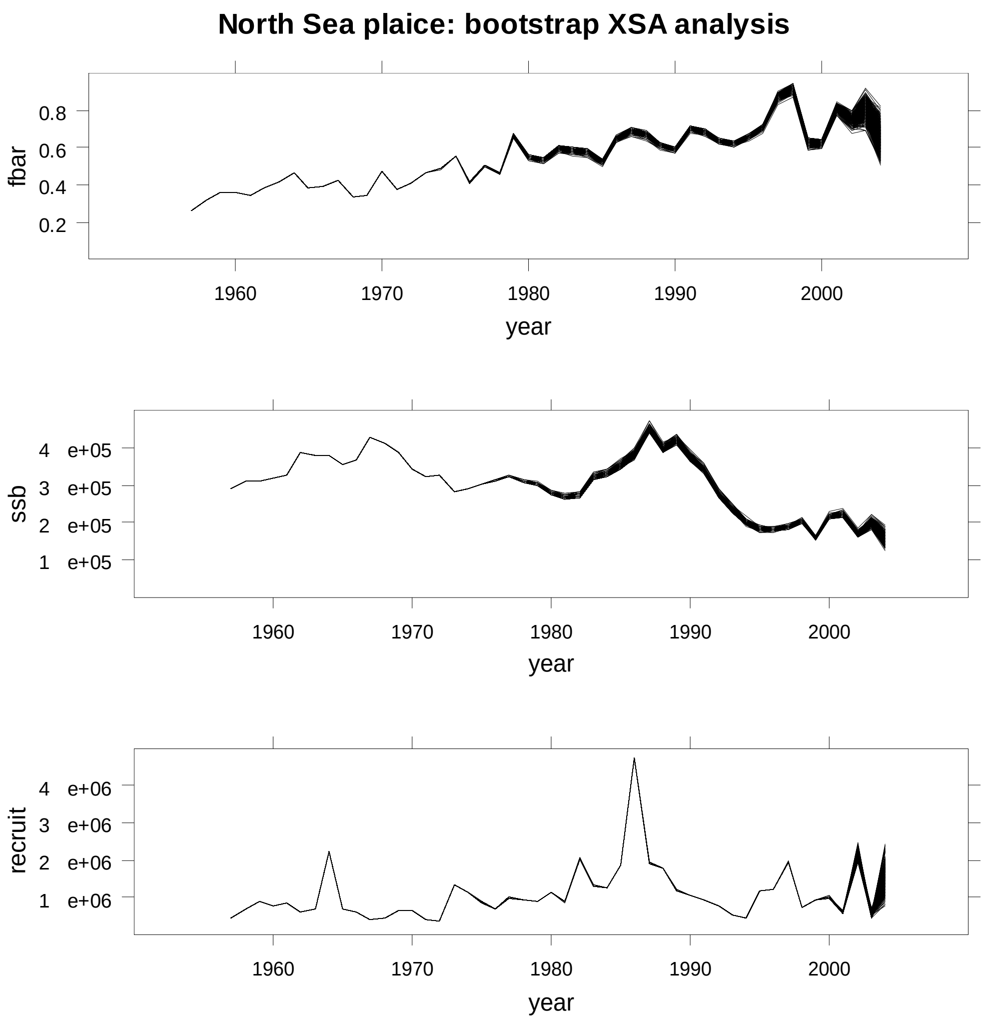

Figure 9.3.7 North Sea plaice. Estimates of mean F, SSB and recruitment from XSA bootstraps.

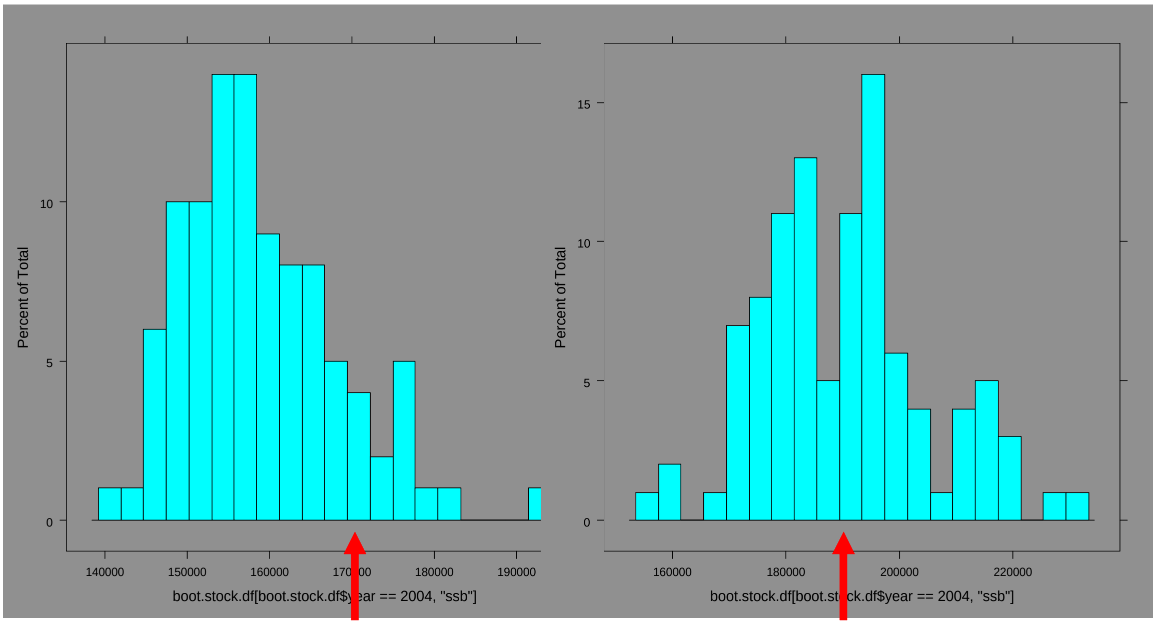

Figure 9.3.8. North Sea plaice. SSB in 2004 results of two bootstrap XSA analysis using F shrinkage of 0.5 (left) and 2.0 (right). Bootstraps generated with 100 resamples (illustration purposes only). The red arrow indicates the results of the deterministic XSA assessments.

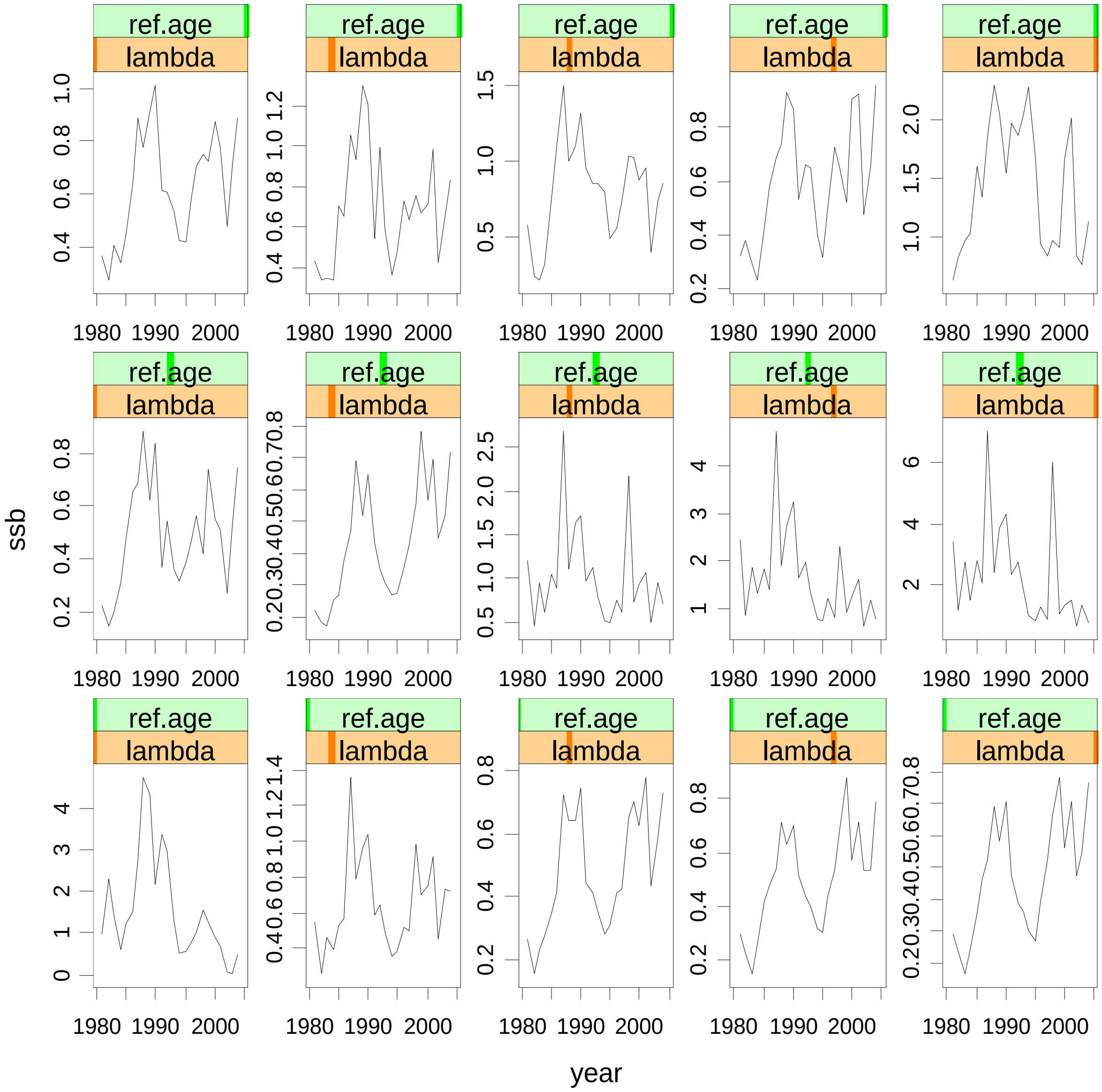

Fig. 9.3.9 North Sea plaice. Analysis of SSB estimates from SURBA runs with respect to the different parameter settings. Lambda values are set to 0, 0.5, 1, 2 and 3. reference age is set to 2,3 and 4. q1 is set to 0.5. Drawn lines represent estimates.

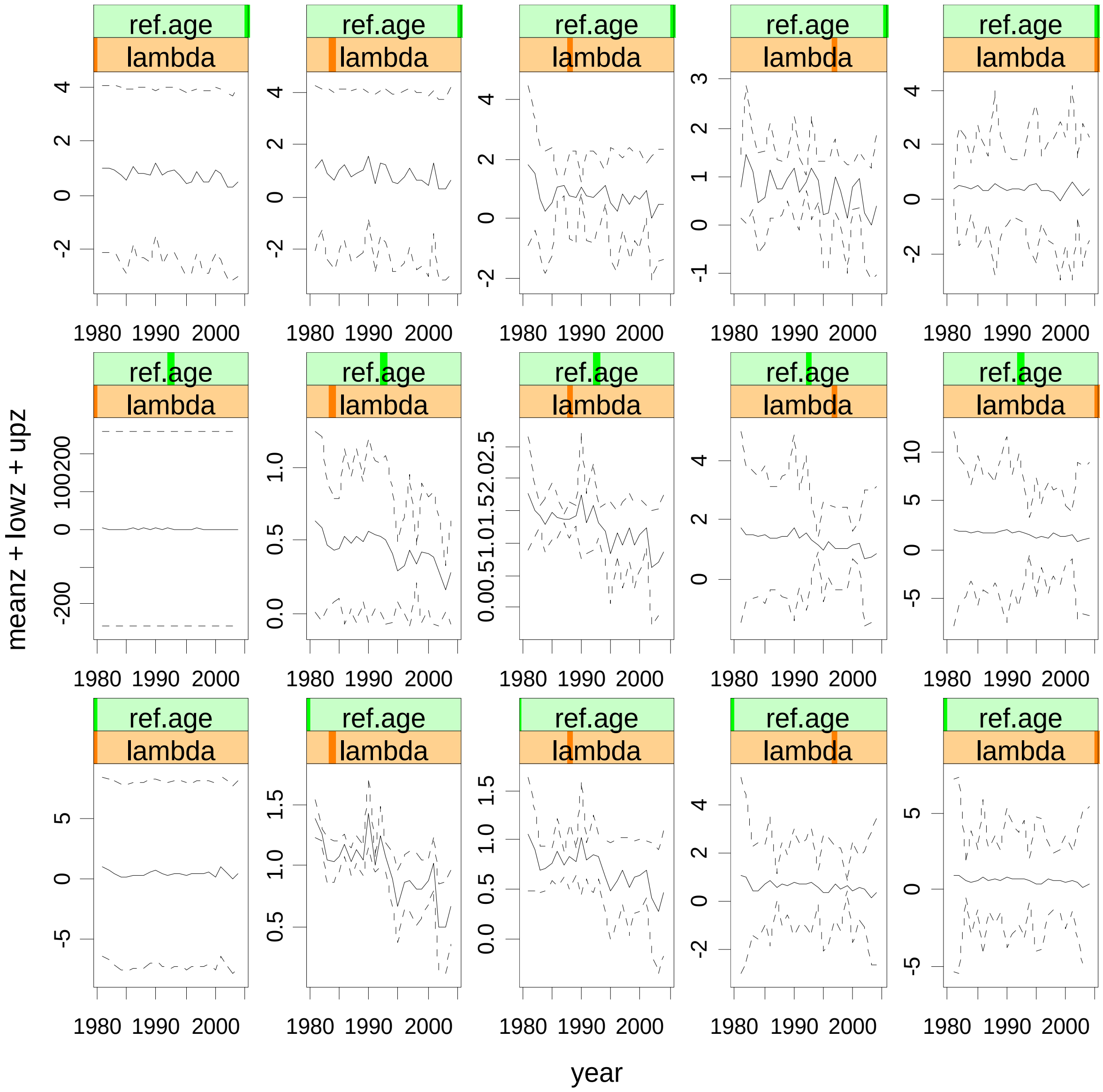

Fig. 9.3.10 North Sea plaice. Analysis of Z estimates from SURBA runs with respect to the different parameter settings. Lambda values are set to 0, 0.5, 1, 2 and 3. reference age is set to 2,3 and 4. q1 is set to 0.5. Drawn lines represent estimates, dashed line represents 95% confidence interval of estimates

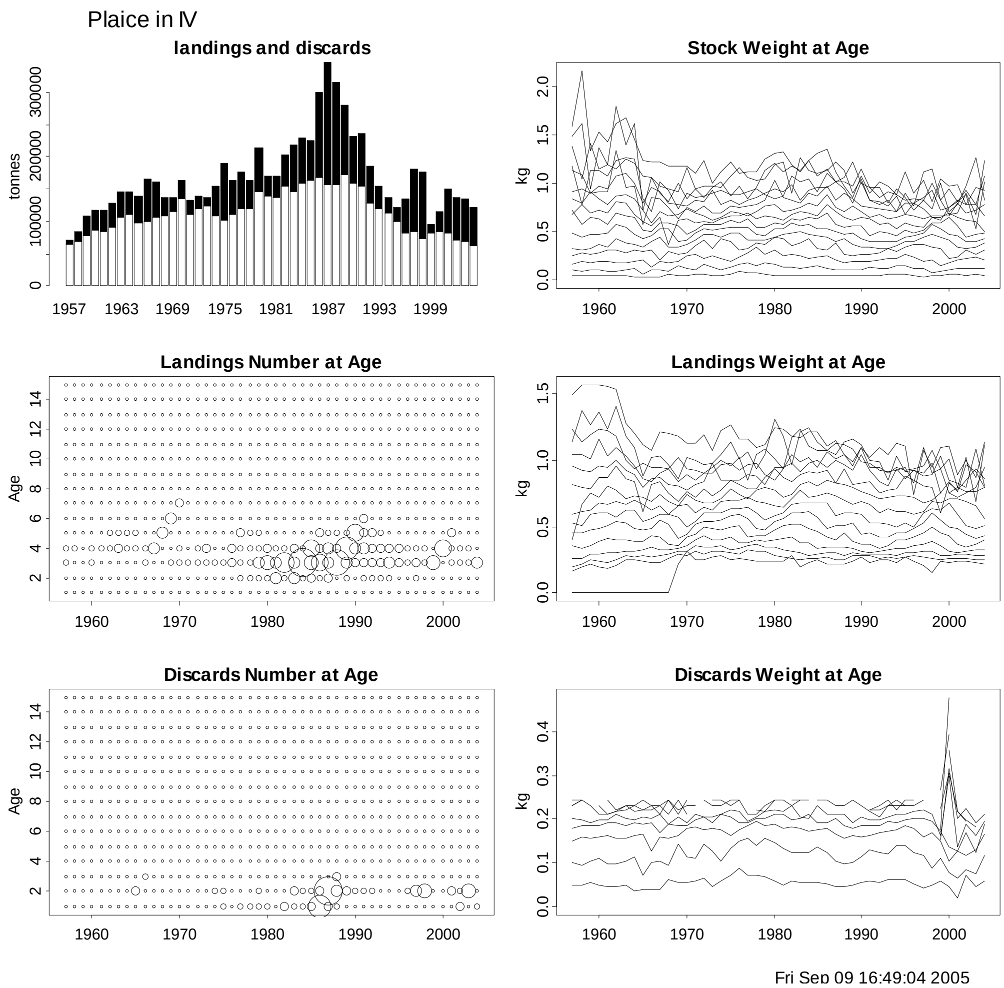

Figure 9.3.11 North Sea plaice. Summary of the catch input data

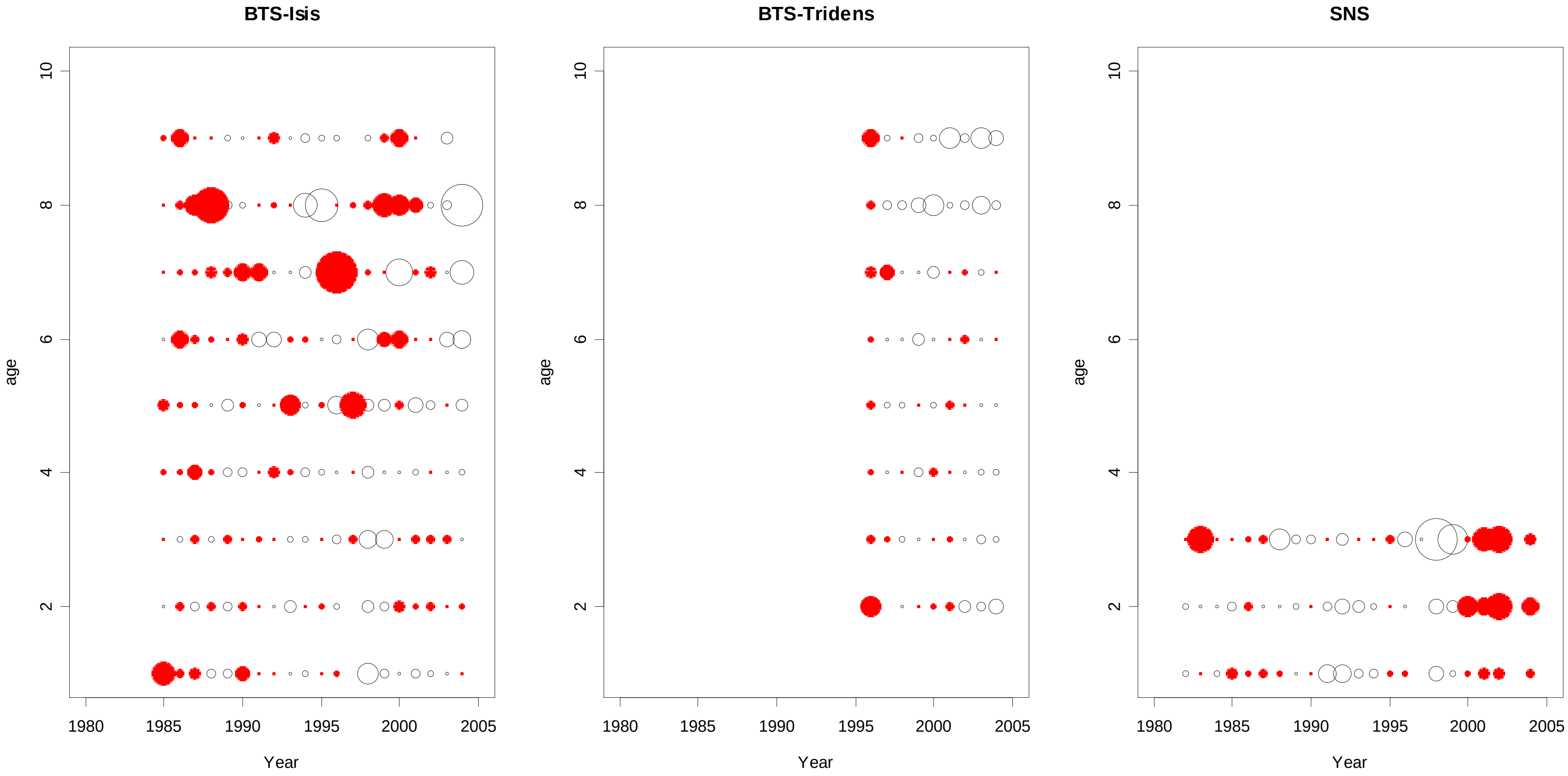

Figure 9.3.12. North Sea plaice Log residual plots of final XSA run using all survey fleets

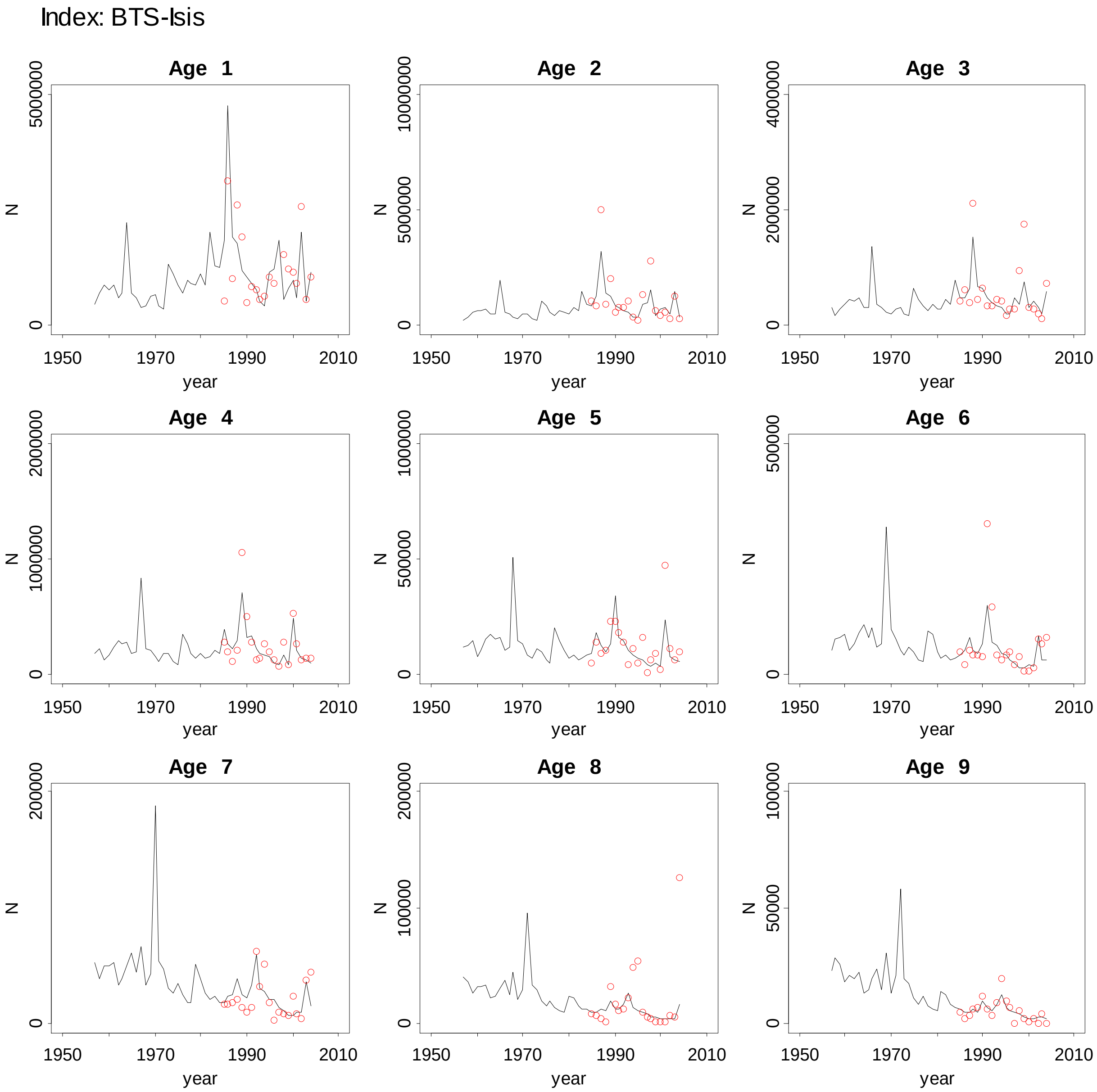

Figure 9.3.13.a North Sea plaice. Time series of stock numbers from the XSA assessment (drawn line) and BTS-Isis survey data scaled to the population level (○) by age.

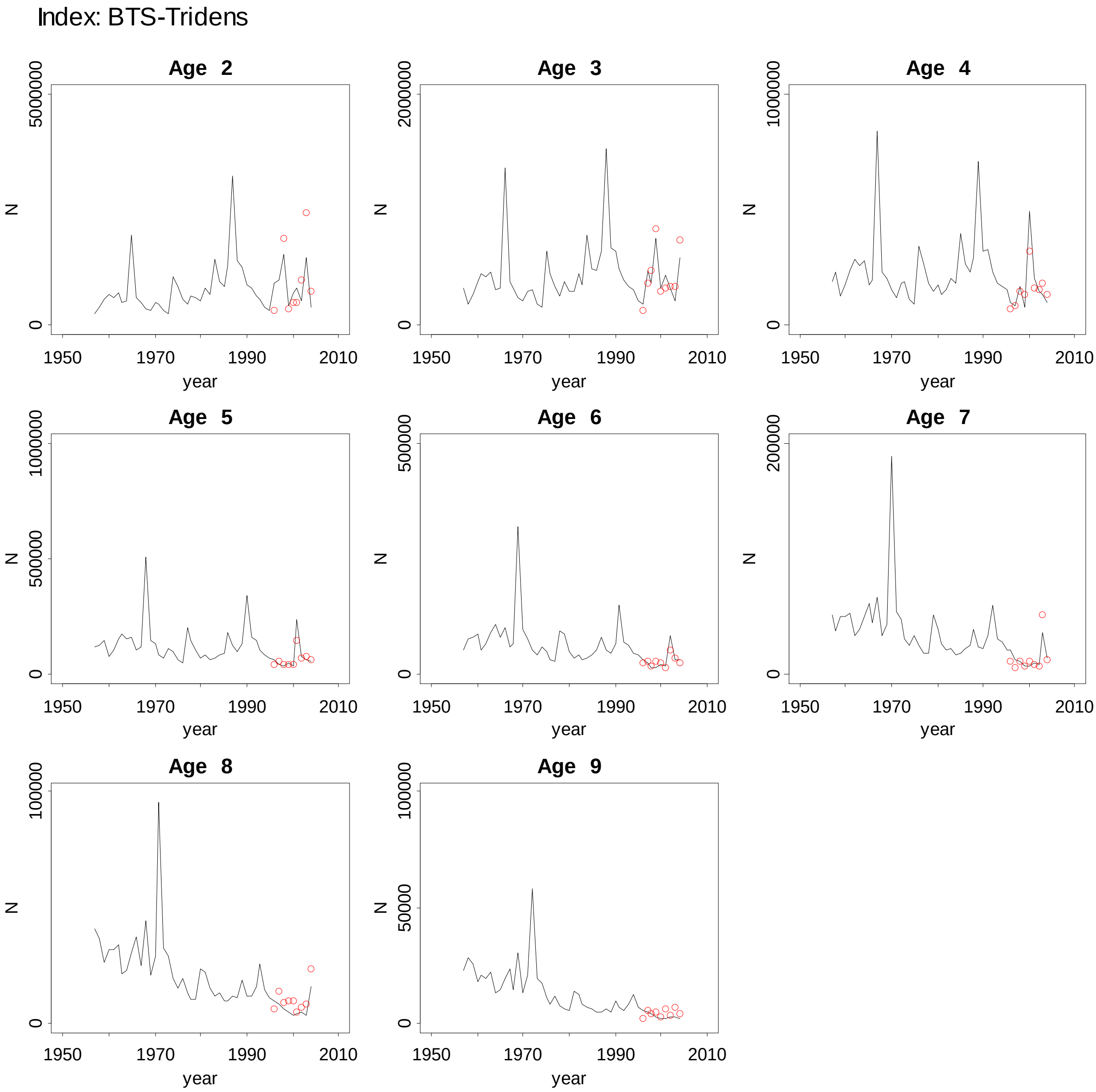

Figure 9.3.13.b North Sea plaice. Time series of stock numbers from the XSA assessment (drawn line) and BTS-Tridens survey data scaled to the population level (○) by age.

Figure 9.3.13.c North Sea plaice. Time series of stock numbers from the XSA assessment (drawn line) and SNS survey data scaled to the population level (○) by age.

Figure 9.4.1 North Sea plaice. Stock summary of North Sea plaice.

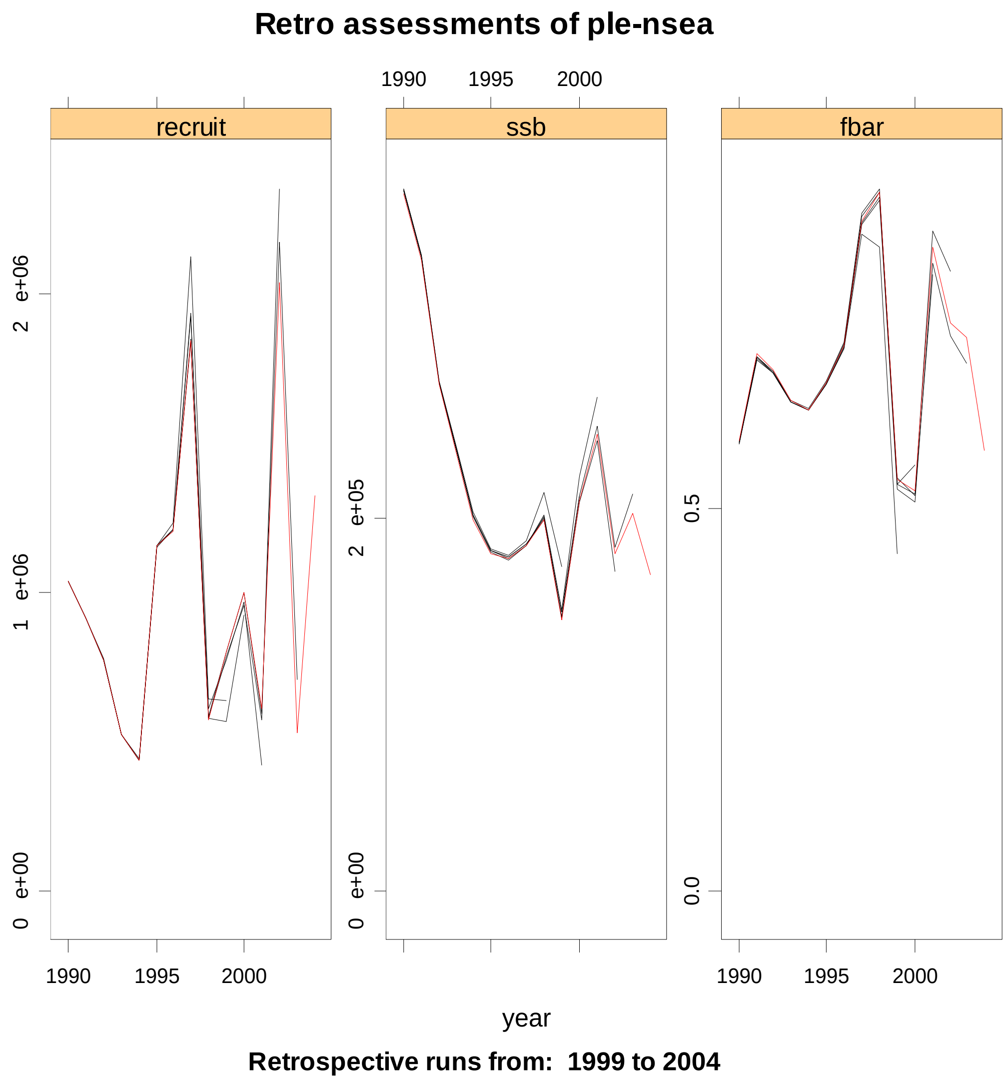

Figure 9.9.1 North Sea plaice. Retrospective analysis of the XSA model.

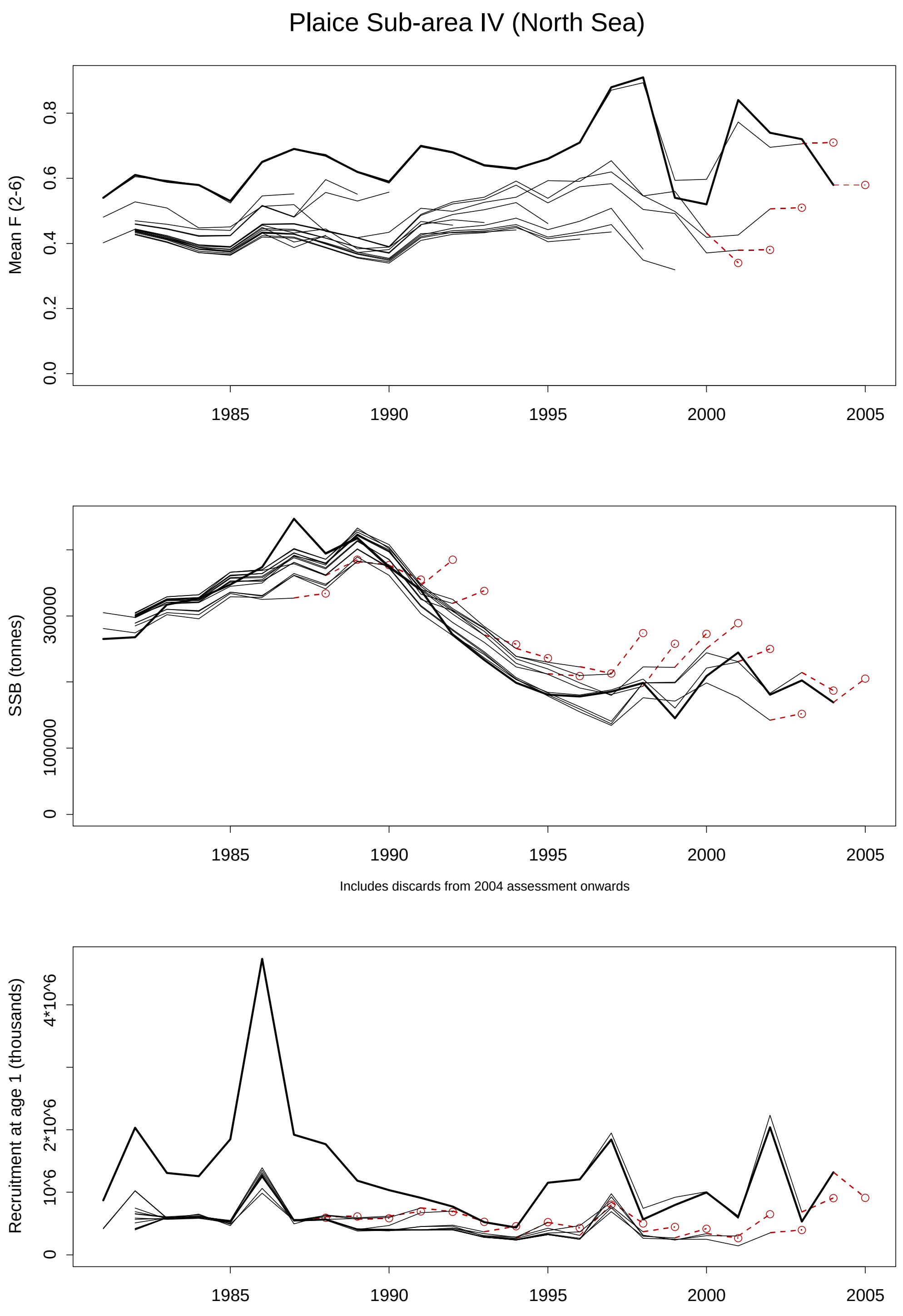

Figure 9.9.2. North Sea plaice. Historical performance of the assessment. Circles indicate forecasts.

10 PLAICE IN DIVISION IIIA

The assessment of plaice in Division IIIa was planned as an update assessment. However, concerns about the assessment consistency rose during preliminary runs. Thus, in addition to the update assessment several exploratory analyses were conducted. All the relevant biological and methodological information can be found in the stock annex.

10.1 General

10.1.1 Ecosystem aspects

Recent modeling results predicted a significant large impact of the increase of macro algal bed on plaice recruitment along the Skagerrak coasts due to eutrophication (Pihl et al., 2005). According to this study, up to 45 x 10^6 individuals could be lost in years with large settlement due to algal blooms. However, those results were not supported by recent year classes, which are estimated to be the largest in the time series since 1978.

Also, there are no indications of major contracting/expanding of the distribution area of plaice in correspondence of high stock abundance in the Skagerrak-Kattegat (Casini et al., 2005). This would support the CPUE from survey as a reliable age class estimator.

A preliminary analysis of trends in weight at age in the stock as estimated using IBTS Q1 data, showed a clear decrease in all age classes. This information is in contrast to catch data, which show larger weight at age in the last years. Moreover, a significant density dependent effect in weight was evident when the mean weights at age in the stock were regressed against yearly number of individuals as estimated by the SURBA analysis. The presence of a clear density dependent effect in correspondence of large stock size would tend to support the robustness of stock weight estimated from the survey and raise concern on the reliability of weights at age estimated from catch data.

10.1.2 The fishery in 2004

A general description of the fishery is given in the stock annex. An overview of the distribution of the fishery for plaice in all ICES areas is given in Figure 9.2.10.

The fishery is dominated by Denmark and it is conducted from spring to autumn by Danish seiners, flatfish gillnetters and beam trawlers with Danish landings usually accounting for more than 90% of the total catch. Plaice is also caught within a mixed cod-plaice fishery by otter trawlers, and as by-catch of other gillnet fisheries .Plaice is also caught as by-catch in the directed Nephrops fishery. According to official tables (Belgian, German landings) and national statistics (Danish, Swedish and Dutch landings) total landings in 2004 were estimated to be close to those in 2003, around 9000 t (Table 10.1.1). Danish landings in 2005 are considerably lower than those obtained at the same time of the year in 2004 (Fig 10.1.2). In 2004, the Danish share of total landings remained unchanged at 78%. Since 2003 a Dutch beam-trawl fishery began in Skagerrak (IIIa), with annual catches of about 1500 tonnes. No quantitative information on mis-reporting is yet 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 those areas.

10.1.3 ICES advice applicable to 2004 and 2005

ICES recommended for 2004 that fishing mortality should be less than Fpa, which was to the current levels of exploitation. ICES noted that attention should be paid to the mixed fisheries context, where both North Sea and Kattegat cod stocks, which are caught together with plaice, are well below Blim.

ICES noted in 2004 that fishing mortality ($\mathbf{F}_{sq}$) was above rates that would lead to high long-term yields ($\mathbf{F}_{max}$=0.18). There was no basis for an analytical forecast. Fishing mortality in 2005 should not be allowed to increase which may be achieved by allowing landings of less than 9 500 t in 2005, which is the average of landings of the last four years.

10.1.4 Management applicable in 2004 and 2005

TAC in 2004 was 11 363 t and in 2005 9 500 t.

Management measures for the plaice fishery in IIIa remained largely unchanged from 2003 to 2004.

10.2 Data available

10.2.1 Landings

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. Sampling from the commercial fishery for plaice in IIIa in 2004 was conducted by Denmark, Sweden and Netherlands (Table 1.2.1).

10.2.2 Age compositions

Age compositions of the landings are presented in Table 10.2.2. Age-disagregated Swedish and Dutch samples were available for 2004 and were included in the total catch at age estimation. The 2001 year-class is consistently strong in all catch samplings.

10.2.3 Weight at age

Weights at age in the stock were assumed equal to those in the catch due to missing reliable stock weights. Weight at age data is presented in Table 10.2.3.1. The procedure for calculating mean weights is described in the stock annex. Weight at age in the stock matrix is also available from IBTS Q1 and is under compilation to be used in the next year assessment. However, a preliminary data matrix was available at the WG and used only in some of the SURBA analysis (Table 10.2.3.2).

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. Due to missing reliable maturity data a knife-edge maturity distribution was assumed: age group 2 was considered immature whereas age 3 and older plaice were considered mature. Maturity at age in the stock matrix (both sexes combined) is also available from IBTS Q1 and is under compilation to be used in the next year assessment. However, a preliminary data matrix was available at the WG and used only in some of the SURBA analyses (Table 10.2.4).

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 (Figures 10.2.5.1 and 10.2.5.2). All research vessel data (two Danish Havfisken survey and two IBTS) are revised back in time in 2004. The Danish surveys are revised due to a general data inspection of the Danish database and following correction of errors. The IBTS in IIIa is now managed by ICES and the CPUE estimates of the IBTS series are altered due to a change in estimation method of CPUE's. In previous years catch rates for IBTS (q1 and q3) were compiled as overall arithmetic means of all hauls in IIIa, while the new data are compiled as arithmetic means of means by rectangle, as also done for other species in IBTS (cod, sole e.g.). The revision of the series has only caused minor changes and has not affected the overall trends. Figure 10.2.5.3 compares the former survey indices with the revised series.

No Danish discard information is presently available for 2004. Preliminary Swedish discard data suggest higher discard rates than those presented in the 2004 report (50% by weight). This possible increase could be due to the strong incoming year-classes. Discard data are being compiled for this stock by Denmark and Sweden, and is expected to be available for a benchmark assessment in 2006.

10.3 Data analysis

10.3.1 Exploratory catch at age analysis

A separable analysis was used to explore the consistency in the catch matrix. The analysis was run with a terminal F of 1.6 at age 6 and a terminal s of 1.0. The residuals (Figure 10.3.1.1) do not indicate any trends in catchability neither any extreme values.

The internal consistency in the catch matrix is outlined in Figure 10.3.1.2.-3 as catch curves and a matrix plot of cohorts between years. The plots indicate that cohorts in general are tracked well in the catch matrix for ages older than 3 years while it performed badly for the younger ages.

Catch at age analysis was carried out according to the specifications in the stock annex. The model used was XSA with the same settings in the 2004 stock assessment. The XSA tuning diagnostics is given in Table 10.3.1.1 and plots of log q residuals is shown in Figure 10.3.1.4. In general the XSA tuning performed poorly, with high s.e. of log q's (>0.5 for most abundant age groups) and missing (or negative) regressions between tuning fleets and catch for several ages. Further, for most tuning fleets an increase in catchability over time is observed from the plots of catch residuals (Figure 10.3.1.4.) For the commercial series the change occurs gradually over time while for the surveys the shift occurs over few years. No information from the fishery or in survey design supports such a change. The default setting of shrinkage (s.e. of 0.5 to the mean), has the effect that ages older than 7 are mainly estimated from the F shrinkage mean due to a higher weighing in the XSA. F shrinkage mean is considerably higher for nearly all ages, which means that the 2004 point estimate of F estimates are raised towards higher recent values than if no shrinkage is applied.

Fishing mortality and stock number at age is shown in Table 10.3.1.2.-3, and stock summary is provided in Table 10.3.1.4 and Figure 10.3.1.5. Historical performance of the assessment is shown in Figure 10.3.1.6 and retrospective analyses of the baseline assessment in Figure 10.3.1.7.

The strong 2001 year-class in combination with an increase in mean weight-at-age and an assumption of a knife-edge maturity ogive at age 3, result in a dramatic increase in SSB from 2003 to 2004. Fishing mortality decrease accordingly from a record high in 2003 (1.6) to 0.8

in 2004. In the years since 1997 fishing mortality has changed considerably from year to year with changes of up to 100% between years. The retrospective analysis show a consistent pattern of underestimation of F and overestimation of SSB.

The consistent retrospective pattern along with the variation in recent years Fbar and the poor tuning diagnostics, lead the group to conclude that the 2004 point estimates of the population and fishing mortality were poorly estimated and therefore not applied to any projection of catch and population.

A number of exploratory excercises were conducted in order to improve the assessment and to explore input data and the effect of changes in input data.

10.3.1.1 Improvement of XSA approach

The 2004 point estimates from the update XSA run (Section 10.3.1) were for the older ages mainly driven by the shrinkage to the mean (0.5) setting in the run. As the F pattern by age for the F shrinkage (increasing until age 6 and thereafter flat) differs considerably from the F pattern of the tuning fleets (flat until age 6 thereafter increases), this argues for using no shrinkage in the XSA tuning. Using less shrinkage (i.e. 1.5) only result in lower F's in recent years (0.3 vs 0.8), and the strong retrospective pattern is still apparent.

The Fbar is based on average of ages 4-8. Catch in number for ages 7-8 are low in recent years and these age classes contribute therefore relatively much to the noise in recent years Fbar. However, running the XSA with an Fbar based on ages 3-6 did not remove the strong variation between recent years as well as the retrospective pattern.

10.3.1.2 SMS approach

The SMS model (for description see section 1.3.3) was used as an alternative approach. Outcome of the retrospective analyses is given in Figure 10.3.1.2.1. The trend and estimates of F and SSB are similar to those from the XSA with no shrinkage

10.3.2 Exploratory survey based assessment

Internal consistency of indices available is illustrated in Figure 10.3.2.1 by means of catch curves and matrix scatterplots for the 3 commercial and the 4 survey tuning series. In general, the survey series perform better with respect to tracking cohorts while the commercial series in many cases have no or weak correlation between the years of a cohort. The 1st quarter survey series perform better than the 3rd and 4th quarter survey series.

Sensivity analyses showed that the effect of revision of IBTS and Havfisken survey time series on the perception of SSB and F in recent years (by use of XSA and SURBA) was negligible.

The survey based assessment tool, SURBA, was used to explore trends in F and SSB based on surveys only. The 3rd and 4th quarter surveys (IBTS and Havfisken) were omitted from the analyses, as they previously showed to have poor internal consistency. This omission improved the uncertainty on the F estimates considerably. Summary plots and retrospective analyses with only IBTS Q1 and Havfisken Q1 surveys is given in Figures 10.3.2.2.-3. A comparison of the XSA run with only surveys as tuning fleets and the SURBA run with the two surveys (IBTS Q1 and Havfisken Q1) are shown in Figure 10.3.2.4. The two approaches agrees well with respect to development of SSB and recruitment while the F pattern is highly variable for both methods and recent F trend is not obvious.

The effect of substituting the knife-edge maturity ogives by preliminary maturity data compiled using IBTS Q1 survey was explored. The knife-edge maturity ogives assume that age group 1 - 2 is immature and age 3 and older plaice are assumed mature, while estimated maturity ogives from IBTS Q1gives around 57, 74, 88, 93 and 92% (average of the last 5 years) for age 2 to 6 respectively. In case of large year classes entering the adult population (as in the last 5 years), a knife edge maturity ogives has the effect to provoke quick changes of the SSB while estimated maturity ogives give a more smoothed increase or decrease of the adult biomass. However, the general SSB trend appears to be very similar although at the small time scale (i.e. 1 year) the trend tends to diverge.

The preliminary weight at age in the stock matrix compiled using individual data from IBTS Q1 shows a different trend when compared to weight at age in the catch. Data from the survey are showing a decreasing trend in weight at age from 1998 and onwards while weights at age in the catch are stable with a large increase in the last year (2004). The use of survey stock weight at age has a substantial effect on the level of SSB, with a smaller increase in SSB in the last five years compared to SSB trend obtained using catch stock weight at age.

10.3.3 Summary of the various observation data and analyses

CPUE from the principal commercial fleets and indices from all surveys show an increase from 2003 to 2004. A strong 2001 year-class entering the fishery is supported by information from surveys.

The catch at age data seem internally consistent, but is subject to an unknown proportion of misreporting from area 22 and also preliminary discard data indicate substantial discard. Exploratory XSA and SMS runs both show clear retrospective patterns of underestimating the fishing mortality and overestimating the biomass. This in combination with a highly variable F between years in the last 7-8 years leads to unreliable point estimates of the stock and F, and therefore a final assessment based on catch at age analysis is rejected.

An assessment based on surveys was run, restricts using 2 of 4 available surveys (Q1) due to short time series and weak internal consistency in two survey series (Q4). Estimates of fishing mortality from the surveys are too imprecise an estimate for current exploitation and as basis for a final assessment. All approaches that use survey data show improved recruitment in recent 5-6 years and a corresponding increase in biomass.

In conclusion, all data suggest that biomass is increasing in recent years probably due to improved recruitment in the years after 1999. There are no reliable estimates of trends in fishing mortality.

10.4 Management considerations

Plaice is taken both in a directed fishery and as an important bycatch in a mixed cod-plaice fishery. The stock area for North Sea cod, which is estimated to be well below $\mathbf{B}_{lim}$, includes the Skagerrak (Division IIIaN). Kattegat cod is also well below $\mathbf{B}_{lim}$ (Division IIIa South). Management of plaice in IIIa must therefore take account for state of the cod stocks.

A mismatch between the biological entity of the stock and the defined management area might exist for this stock and this will affect the quality of the assessment. Migration of plaice outside the assessment area (The Belt Sea and the North Sea) is one of the reasons that could explain the large and probably unrealistic fluctuations in the estimated fishing mortality."

10.5 Issues to be addressed in a forthcoming benchmark assessment

The data exploration in 2004 and 2005 was limited as the assessment of plaice in Division IIIa was regarded as an update assessment. Some comments were, however, provided on possible ways to improve the assessment of the stock in a forthcoming benchmark assessment that is scheduled for 2006.

Current commercial tuning series are considered questionable as measures of age class abundance. 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. At the same time, the use of targeting fleets as tuning indices is also of concern since it could lead to a hyper stability of CPUE and an overestimation of the abundance of age classes.

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 gear type and fishing area, is applied to the catch by market categories of the fleets. This results in poor precision of fleet-specific age composition of catches and an auto-correlation between the commercial tuning fleets and the catch-at-age matrix. Onboard sampling data by fleet should be explored for potential improvement of age composition of the fleet-specific catches.

However, commercial tuning fleets showed in general a relatively poor internal inconsistency and capacity to follow year classes compared to surveys (see SURBA exploratory analysis). Thus, more accurate commercial tuning fleet definitions and estimation should be considered if those should be used into stock assessment. In any case, the inclusion of commercial tuning series in the assessment should be carefully 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. 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. Also, the use of stock weight at age and maturity data available from Swedish IBTS, Q1 and 3, should be attempted in future assessments, as well as the inclusion of the Danish maturity data available for the recent years. Moreover, taken into account the recent studies showing problems linked with the use of macroscopic maturity ogives (Vitale et al., 2005), a pilot study on the histological analysis of the plaice gonads should be initiated. For IBTS biological data, a preliminary stock weight and maturity at age matrix has been provided at the WG and the possible effect on SSB trend has been evaluated (see SURBA exploratory analysis).

Abundance indices from a Danish 0-group survey with R/V "Havkatten" since 1957 should be explored for possible inclusion into assessment as a recruitment estimator.

Also, the catch at age matrix should be carefully checked for area misreporting since there are anecdotal information of relatively large catch of North Sea plaice reported into IIIa.

Available discard numbers for 2003 and 2004 in the plaice fishery in Division IIIa showed higher discarding rates than previously assumed, especially for younger ages. Further work should be attempted to derive discard estimates for previous years to be included in the next benchmark assessment that is scheduled for 2006.

Table 10.1.1 Plaice in IIIa. Official landings in tonnes as reported to ICES and WG estimates, 1972-2004

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	7 133	7 112	317	316	77	77			80	80	1455	1511	9 062		9 096	11 173
2005																9 500

Table 10.2.1 Plaice in Kattegat. Landings in tonnes Working Group estimates, 1972-2004

Year	Denmark	Sweden	Germany	Belgium	Norway	Total
1972	15 504	348	77			15 929
1973	10 021	231	48			10 300
1974	11 401	255	52			11 708
1975	10 158	296	39			10 493
1976	9 487	177	32			9 696
1977	11 611	300	32			11 943
1978	12 685	312	100			13 097
1979	9 721	333	38			10 092
1980	5 582	313	40			5 935
1981	3 803	256	42			4 101
1982	2 717	238	19			2 974
1983	3 280	334	36			3 650
1984	3 252	388	31			3 671
1985	2 979	403	4			3 386
1986	2 470	202	2			2 674
1987	2 846	307	3			3 156
1988	1 820	210	0			2 030
1989	1 609	135	0			1 744
1990	1 830	202	2			2 034
1991	1 737	265	19			2 021
1992	2 068	208	101			2 377
1993	1 294	175	0			1 469
1994	1 547	227	0			1 774
1995	1 254	133	0			1 387
1996	2 337	205	0			2 542
1997	2 198	255	25			2 478
1998	1 786	185	10			1 981
1999	1 510	161	20			1 691
2000	1 644	184	10			1 838
2001	2 069	260				2 329
2002	1 806	198	26			2 030
2003	2 037	253	6			2 296
2004	1 395	137	77			1 609

* years 1972-1990 landings refers to IIIA

Table 10.2.2. Plaice in Skagerrak. Landings in tonnes. Working Group estimates, 1972-2004

Year	Denmark	Sweden	Germany	Belgium	Norway	Netherlands	Total
1972	5 095	70			3		5 168
1973	3 871	80			6		3 957
1974	3 429	70			5		3 504
1975	4 888	77			6		4 971
1976	9 251	51		717	6		10 025
1977	12 855	142		846	6		13 849
1978	13 383	94		371	9		13 857
1979	11 045	67		763	9		11 884
1980	9 514	71		914	11		10 510
1981	8 115	110		263	13		8 501
1982	7 789	146		127	11		8 073
1983	6 828	155		133	14		7 130
1984	7 560	311		27	22		7 920
1985	9 646	296		136	18		10 096
1986	10 645	202		505	26		11 378
1987	11 327	241		907	27		12 502
1988	9 782	281		716	41		10 820
1989	5 414	320		230	33		5 997
1990	8 729	779		471	69		10 048
1991	5 809	472	15	315	68		6 679
1992	8 514	381	16	537	106		9 554
1993	9 125	287	37	326	79		9 854
1994	8 783	315	37	325	91		9 551
1995	8 468	337	48	302	224		9 379
1996	7 304	260	11		428		8 003
1997	7 306	244	14		249		7 813
1998	6 132	208	11		98		6 449
1999	6 473	233	7		336		7 049
2000	6 680	230	5		67		6 982
2001	9 045	125			61		9 231
2002	6 470	140	3		58		6 671
2003	4 847	143	8		74	1 584	6 656
2004	5 717	179			80	1 511	7 487

Table 10.2.2. Plaice in IIIa. Catch numbers at age (Numbers*10**-3)

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1978	1979	1980	1981	1982	1983	1984
AGE							
2	489	1105	362	190	526	1481	2154
3	15692	9789	4772	4048	2067	9715	12620
4	39531	29655	16353	13098	9204	8630	11140
5	24919	20807	12575	10970	10602	8026	4463
6	8011	7646	6033	4306	5554	2673	2183
7	620	2514	2393	1427	1851	925	985
8	63	170	949	546	758	531	904
9	63	75	203	213	301	257	695
10	48	50	54	119	113	96	337
+gp	60	55	50	97	48	106	120
0 TOTALNUM	89496	71866	43744	35014	31024	32440	35601
TONSLAND	26953	21976	16445	12602	11047	10780	11591
SOPCOF %	102	104	106	103	102	101	100

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
2	1400	375	623	101	1012	3147	2309	904	1038	1411
3	8641	4366	4227	3052	3844	8748	8611	3858	3505	6919
4	21798	14749	12400	12037	7102	8623	9583	11759	10088	8016
5	6232	19193	17710	13783	6255	9718	4663	17427	13233	9859
6	1715	4477	10205	6860	2708	3222	2893	4297	6891	8002
7	698	633	2089	2745	1171	981	892	1033	1657	2780
8	260	274	373	946	549	481	306	296	376	448
9	197	154	242	322	254	349	156	115	104	111
10	168	141	125	136	136	155	87	27	47	38
+gp	156	98	190	156	236	273	137	115	69	55
0 TOTALNUM	41265	44460	48184	40138	23267	35697	29637	39831	37008	37639
TONSLAND	13482	14052	15658	12850	7741	12082	8700	11931	11323	11325
SOPCOF %	100	100	100	100	100	100	100	100	100	100

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE										
2	446	4527	529	563	687	1223	3981	364	3481	1719
3	2277	5353	4733	6710	2704	3937	9172	5008	4686	17765
4	6606	7971	6379	8219	8432	8302	9399	8861	9098	4259
5	11530	5283	9465	6856	8520	11212	11001	7528	9279	4044
6	6622	4751	5104	2971	7419	3599	4744	4843	4330	1988
7	4929	1812	3072	791	1301	888	410	1766	969	264
8	853	1355	1369	385	380	139	102	448	138	97
9	137	151	849	234	77	17	19	51	19	11
10	65	23	114	170	106	7	14	17	11	11
+gp	51	45	36	64	43	29	33	12	5	7
0 TOTALNUM	33516	31271	31650	26963	29669	29353	38875	28898	32016	30165
TONSLAND	10766	10545	10291	8430	8740	8820	11560	8701	8952	9096
SOPCOF %	100	101	100	100	100	101	100	100	100	100

Table 10.2.3.1. Plaice in IIIa. Catch weight at age (kg).

1

Run title : Plaic 2005 WG ANON COMBSEX PLUSGROUP

At 8/09/2005 10:11

	YEAR	1978	1979	1980	1981	1982	1983	1984
	AGE							
	2	0.236	0.222	0.261	0.23	0.27	0.285	0.282
	3	0.248	0.255	0.274	0.263	0.301	0.274	0.299
	4	0.268	0.267	0.306	0.296	0.286	0.293	0.304
	5	0.322	0.297	0.345	0.357	0.318	0.356	0.372
	6	0.417	0.378	0.414	0.432	0.386	0.423	0.403
	7	0.598	0.451	0.579	0.537	0.544	0.483	0.406
	8	0.752	0.655	0.64	0.671	0.704	0.531	0.383
	9	0.818	0.922	0.753	0.813	0.813	0.647	0.36
	10	0.914	1.02	0.811	0.912	0.912	0.986	0.443
	+gp	0.843	1.044	0.91	0.999	0.986	1.184	1.061
0	SOPCOFAC	1.0159	1.039	1.0625	1.0268	1.0184	1.006	1.0009

	YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
	AGE										
	2	0.278	0.25	0.322	0.252	0.274	0.292	0.263	0.309	0.267	0.275
	3	0.282	0.277	0.28	0.267	0.263	0.288	0.27	0.31	0.272	0.263
	4	0.308	0.284	0.281	0.268	0.282	0.294	0.259	0.272	0.271	0.272
	5	0.354	0.31	0.292	0.29	0.32	0.337	0.274	0.28	0.295	0.289
	6	0.437	0.384	0.363	0.35	0.376	0.397	0.365	0.336	0.338	0.33
	7	0.544	0.531	0.527	0.475	0.466	0.498	0.492	0.5	0.441	0.381
	8	0.68	0.707	0.711	0.567	0.635	0.684	0.584	0.646	0.566	0.516
	9	0.737	0.85	0.904	0.755	0.741	0.775	0.67	0.817	0.712	0.658
	10	0.755	0.903	1.036	0.833	0.825	0.951	0.882	0.804	0.802	0.766
	+gp	0.914	1.099	1.084	1.193	1.002	1.15	1.08	0.976	1.168	0.979
0	SOPCOFAC	1.0012	0.9997	0.9996	1.0002	0.9999	1.0004	1.0006	0.9999	0.9991	1.0001

1

	YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	AGE										
	2	0.263	0.266	0.3	0.26	0.271	0.257	0.257	0.246	0.243	0.24
	3	0.301	0.268	0.294	0.25	0.271	0.262	0.272	0.271	0.252	0.276
	4	0.303	0.294	0.283	0.28	0.29	0.276	0.29	0.27	0.271	0.32
	5	0.289	0.384	0.299	0.327	0.29	0.302	0.322	0.287	0.29	0.347
	6	0.328	0.399	0.341	0.398	0.294	0.355	0.31	0.338	0.298	0.378
	7	0.368	0.436	0.41	0.464	0.336	0.388	0.425	0.402	0.4	0.523
	8	0.499	0.43	0.465	0.515	0.37	0.517	0.589	0.595	0.464	0.786
	9	0.736	0.561	0.445	0.587	0.656	0.857	0.836	0.794	0.605	0.844
	10	0.752	0.87	0.531	0.641	0.567	0.97	0.679	1.148	0.642	0.567
	+gp	1.022	0.957	0.76	0.863	0.831	0.967	0.818	1.15	1.29	0.892
0	SOPCOFAC	1.0015	1.0113	1.0003	1.0016	1	1.0061	1.0014	1.0016	1.0002	1.0029

Table 10.2.3.2. Plaice in IIIa. Preliminary weight at age data for the stock derived from IBTS Q1.

Plaice in IIIa WEST (combined sex)						
Age	1	2	3	4	5	6
1990	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.014	0.079	0.183	0.201	0.188	0.412
1992	0.009	0.092	0.169	0.226	0.278	0.447
1993	0.018	0.086	0.175	0.216	0.273	0.276
1994	0.012	0.089	0.166	0.256	0.311	0.353
1995	0.018	0.081	0.192	0.305	0.345	0.355
1996	0.016	0.097	0.168	0.286	0.353	0.491
1997	0.005	0.127	0.167	0.263	0.376	0.445
1998	0.016	0.070	0.148	0.280	0.391	0.471
1999	0.011	0.093	0.150	0.232	0.265	0.423
2000	0.020	0.061	0.129	0.210	0.277	0.291
2001	0.012	0.084	0.126	0.209	0.295	0.251
2002	0.015	0.063	0.114	0.147	0.221	0.282
2003	0.012	0.091	0.109	0.157	0.157	0.242
2004	0.018	0.071	0.121	0.169	0.173	0.169
2005	0.019	0.090	0.120	0.174	0.183	0.152

Table 10.2.4.1. Plaice in IIIa. Preliminary maturity at age data derived from IBTS Q1.

Plaice in IIIa MAT (combined sex)						
Age	1	2	3	4	5	6
1990	0.00	0.00	0.00	0.00	0.00	0.00
1991	0.00	0.52	0.30	0.44	0.34	0.87
1992	0.00	0.75	0.75	0.73	0.74	0.82
1993	0.00	0.32	0.41	0.46	0.55	0.60
1994	0.17	0.74	0.76	0.83	0.83	0.78
1995	0.00	0.44	0.78	0.86	0.84	0.88
1996	0.00	0.82	0.86	0.90	0.94	1.00
1997	0.00	0.52	0.87	0.97	1.00	1.00
1998	0.00	0.27	0.67	0.95	1.00	1.00
1999	0.04	0.68	0.75	0.96	0.99	1.00
2000	0.00	0.52	0.74	0.91	0.95	1.00
2001	0.00	0.74	0.88	0.95	1.00	1.00
2002	0.00	0.52	0.74	0.84	0.78	0.69
2003	0.28	0.42	0.55	0.82	0.92	0.92
2004	0.04	0.66	0.78	0.86	0.99	1.00
2005	0.00	0.21	0.52	0.68	0.81	0.93

Table 10.2.5. Plaice IIIa. Tuning data by fleet

Danish Gillnetters										
1987	2004									
1	1	0	1							
2	11									
4135	20592	169059	650916	1071313	803165	286784	58777	33991	18818	24877
3962	27444	168504	529771	606818	410016	309311	134000	55393	19492	23977
3776	18882	63447	175206	186617	129661	111415	85514	44764	24564	43810
4198	64308	246880	272984	362432	157274	62094	42383	38230	20604	41001
3787	43034	181507	242271	148622	168826	68492	32399	14923	11663	17809
4851	67456	350855	854331	1065380	260669	108795	39021	18755	5675	21064
5598	4846	80411	339540	652443	591404	199282	42122	12860	3774	2597
11233	93332	788950	992744	1280086	1145581	443000	78443	26304	7859	14155
9719	93997	320239	744931	1661991	911912	979462	185418	30434	13976	10309
9482	431700	632571	858288	762350	711940	291167	215022	22193	3298	8388
7919	67268	468037	544401	912161	684171	509591	271094	101874	19323	7745
6986	52000	481000	803000	854000	380000	112000	63000	42000	31000	15000
6881	62000	183000	698000	841000	1001000	206000	70000	21000	13000	9000
7337	44000	250000	847000	1044000	439000	93000	19000	4000	1000	6000
7703	257408	421089	734508	1514962	901478	101935	32356	4397	3983	4543
6636	36711	451342	573342	561560	555556	336972	105617	16792	4906	5391
4374	167981	194691	516690	611548	386308	135177	21817	3105	1903	753
3514	67491	909017	350691	394163	229080	48052	22687	3139	1804	1969
Danish Trawlers										
1987	2004									
1	1	0	1							
2	11									
33440	255915	1177661	2468347	2379126	1046122	215078	50415	32514	24420	37438
30657	108178	839066	1906117	1819047	700988	226895	75481	23885	20953	22426
33979	430316	927355	1291748	1026225	456678	165557	71803	37576	18121	35819
38866	1181442	2311097	2020630	2065160	631904	200416	85590	45586	22634	42975
37887	660031	2459249	2424238	1085399	580774	151470	52786	31364	18475	27441
35119	324054	1244765	2463167	3594631	910595	232058	62318	14226	3014	12454
30056	172192	866648	2265364	2200206	1312213	455227	82231	15921	12071	15309
29411	506609	1815439	1886714	2177012	1785146	732729	113303	17909	12336	11983
26139	262364	791718	1217689	2119319	1052643	706432	144496	23084	11096	8823
28116	1044742	1432920	1503021	1053244	772862	329651	235696	24501	4352	9874
26060	166014	1234787	1637715	1843447	841073	352324	143468	96237	15809	6255
25271	210000	1613000	1953000	1285000	495000	120000	54000	36000	23000	9000
26798	223000	761000	1739000	1403000	1024000	212000	58000	10000	11000	8000
29033	514000	1392000	2182000	2529000	762000	168000	25000	6000	3000	6000
27575	1213134	2297369	2297400	2241237	982424	99667	19672	6921	4216	5405
27731	132625	1517394	2419247	1910112	1210114	368511	82071	7932	3153	1656
23672	671758	892952	2041035	1670860	741923	177271	31289	4085	3534	1377
22862	426018	3500002	1047884	1234737	601134	87815	25644	2373	1960	1793
Danish Seiners										
1987	2004									
1	1	0	1							
2	11									
7897	97426	1157332	4050596	5227390	2536790	426009	72398	40925	20944	22943
6959	466750	1343996	3116463	3368983	1446989	521283	158464	47106	16431	19006
9579	334835	1483241	3030013	2733969	1193297	477612	171227	76749	33563	39868
9369	1116082	3542256	3431384	3748325	1097119	299716	116328	81119	32922	60674
8912	515012	2426848	3289407	1838074	1057052	265606	88516	42174	17972	28587
8767	106267	791895	4199036	6819566	1725235	324760	77400	27070	4686	17868
7367	139121	509253	1721085	2800822	1649545	413535	89601	21958	5718	3978
7249	336892	1620907	1883228	2514844	1977352	552285	69993	19937	4536	4288
6802	195908	569871	1348638	2282155	1664669	1118605	153081	23915	11391	8384
6384	949342	1363113	1878662	980782	913661	327089	230807	22762	3019	6502
5769	165538	1193786	1794123	2572264	1359436	909634	392850	278160	26736	5420
5508	144000	2251000	2489000	2044000	884000	231000	109000	61000	49000	14000
6041	173000	721000	2487000	2755000	2425000	367000	103000	16000	36000	9000
5893	286000	1240000	2954000	4300000	1202000	334000	46000	3000	1000	3000
6138	1534686	3619758	3159809	3377381	1347729	137169	33892	5948	4204	4928
5518	109606	1732101	3339718	2960753	1745554	566533	131577	11847	3376	2136
4406	945600	1403590	2707165	2618571	1210328	230619	32943	2658	1506	658

Table 10.2.5. cont. Plaice IIIa. Tuning data by fleet

Havfisken_q4

1994	2004					
1	1.0	0.83	0.92			
1	6					
1	1.76	12.15	4.07	0.36	0.28	0.05
1	2.47	11.08	2.76	0.23	0.47	0.07
1	6.75	38.24	8.60	0.76	0.21	0.07
1	7.38	10.28	7.21	2.30	0.96	0.63
1	21.85	12.88	3.94	2.72	0.09	0.11
1	91.39	50.40	5.83	0.90	0.45	0.33
1	118.21	106.04	22.55	0.38	0.25	0.71
1	53.47	97.16	32.74	6.05	0.24	0.21
1	45.38	21.46	26.22	10.24	1.46	0.09
1	39.02	61.07	16.67	7.17	3.81	0.49
1	13.33	56.06	78.22	28.58	16.81	9.24

Havfisken_q1_shifted

1995	2004					
1	1	0.99	1			
1	6					
1	22.09	26.76	7.66	1.24	0.44	0.00
1	11.02	19.86	4.23	1.12	0.42	0.14
1	-9.00	-9.00	-9.00	-9.00	-9.00	-9.00
1	29.45	19.78	4.43	1.06	0.30	0.00
1	199.94	55.21	10.30	1.21	1.17	0.00
1	141.64	60.84	9.53	1.09	0.37	0.08
1	48.71	81.61	22.95	1.14	0.30	0.09
1	144.61	42.74	32.33	5.97	0.07	0.05
1	69.10	82.04	28.27	12.71	3.65	0.68
1	166.61	98.55	17.15	7.01	3.17	0.61

IBTSQ1_Shifted

1990	2004					
1	1	0.99	1			
1	6					
1	9.55	21.07	11.16	3.75	0.30	0.09
1	9.21	18.67	12.31	2.86	0.39	0.11
1	14.57	13.39	13.48	12.10	4.56	0.54
1	19.29	13.76	3.92	2.36	2.54	0.58
1	10.12	21.41	8.91	2.44	1.74	0.79
1	47.74	30.49	9.77	3.34	0.74	0.35
1	20.89	46.75	9.57	3.34	0.18	0.07
1	15.73	17.19	9.50	3.27	0.78	0.24
1	44.60	19.46	5.92	5.68	0.31	0.19
1	131.44	72.73	14.98	5.36	3.37	0.31
1	55.16	91.76	20.41	3.22	2.09	0.79
1	15.57	66.06	44.18	10.80	1.93	1.62
1	95.55	50.85	46.20	33.62	6.34	1.05
1	40.79	116.21	33.60	27.50	25.38	1.61
1	116.97	85.32	51.19	21.26	31.59	9.20

IBTSQ3

1997	2004					
1	1	0.83	0.92			
1	6					
1	16.39	17.39	8.42	2.23	0.79	0.45
1	27.92	19.96	5.26	3.68	0.42	0.00
1	77.47	59.45	14.35	1.53	1.70	0.31
1	-9.00	-9.00	-9.00	-9.00	-9.00	-9.00
1	19.31	109.31	63.62	9.13	3.78	1.03
1	66.31	54.15	33.33	24.21	4.28	0.39
1	14.98	40.93	6.95	9.84	9.28	1.11
1	51.94	39.96	41.37	3.77	5.49	3.95

Table 10.3.1.1. Plaice in IIIa. Diagnostic from XSA tuning.

Lowestoft VPA Version 3.1

6/09/2005 17:26

Extended Survivors Analysis

Plaice IIIa VPA data 2005 WG ANON COMBSEX PLUSGROUP

CPUE data from file PLE3aFL1.dat

Catch data for 27 years. 1978 to 2004. Ages 2 to 11.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
Danish Gillnetters	1987	2004	2	10	0	1
Danish Trawlers	1987	2004	2	10	0	1
Danish Seiners	1987	2004	2	10	0	1
KASU_q4	1994	2004	1	6	0.83	0.92
KASU_q1_backshifted	1995	2004	1	6	0.99	1
IBTSQ1_backshifted	1990	2004	1	6	0.99	1
IBTSQ3	1997	2004	1	6	0.83	0.92

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

1

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	0.012	0.126	0.012	0.015	0.021	0.03	0.089	0.011	0.028	0.024
3	0.082	0.181	0.169	0.189	0.084	0.141	0.295	0.138	0.173	0.171
4	0.392	0.402	0.302	0.435	0.34	0.354	0.511	0.456	0.353	0.211
5	0.786	0.551	1.046	0.542	0.978	0.905	0.971	0.894	1.103	0.233
6	0.95	0.785	1.539	1.024	1.974	1.487	1.167	1.602	2.498	0.647
7	1.001	0.653	1.912	0.985	1.994	1.717	0.564	2.408	2.088	1.393
8	1.255	0.74	1.466	1.601	2.219	1.383	0.868	2.463	2.065	1.522
9	1.483	0.675	1.425	0.993	2.076	0.52	0.6	1.441	0.7	0.933
10	1.303	0.999	1.627	1.199	1.903	1.205	0.97	1.677	1.466	1.047

1

XSA population numbers (Thousands)

YEAR \ AGE	2	3	4	5	6	7	8	9	10
1995	3.81E+04	3.04E+04	2.14E+04	2.23E+04	1.14E+04	8.19E+03	1.25E+03	1.86E+02	9.38E+01
1996	4.02E+04	3.41E+04	2.53E+04	1.31E+04	9.18E+03	3.97E+03	2.72E+03	3.24E+02	3.83E+01
1997	4.59E+04	3.21E+04	2.57E+04	1.53E+04	6.83E+03	3.79E+03	1.87E+03	1.18E+03	1.49E+02
1998	3.95E+04	4.10E+04	2.45E+04	1.72E+04	4.87E+03	1.33E+03	5.07E+02	3.91E+02	2.56E+02
1999	3.54E+04	3.52E+04	3.07E+04	1.44E+04	9.06E+03	1.58E+03	4.48E+02	9.26E+01	1.31E+02
2000	4.30E+04	3.14E+04	2.93E+04	1.98E+04	4.89E+03	1.14E+03	1.95E+02	4.41E+01	1.05E+01
2001	4.92E+04	3.78E+04	2.47E+04	1.86E+04	7.24E+03	1.00E+03	1.85E+02	4.43E+01	2.37E+01
2002	3.46E+04	4.08E+04	2.55E+04	1.34E+04	6.38E+03	2.04E+03	5.15E+02	7.02E+01	2.20E+01
2003	1.35E+05	3.10E+04	3.21E+04	1.46E+04	4.96E+03	1.16E+03	1.66E+02	3.97E+01	1.50E+01
2004	7.58E+04	1.19E+05	2.36E+04	2.04E+04	4.39E+03	3.69E+02	1.30E+02	1.91E+01	1.78E+01

Estimated population abundance at 1st Jan 2005

0.00E+00	6.70E+04	9.03E+04	1.73E+04	1.46E+04	2.08E+03	8.30E+01	2.58E+01	6.78E+00

Taper weighted geometric mean of the VPA populations:

4.79E+04	4.00E+04	2.81E+04	1.78E+04	6.99E+03	1.79E+03	4.86E+02	1.26E+02	5.01E+01

Standard error of the weighted Log(VPA populations) :

0.403	0.3849	0.2088	0.2778	0.4005	0.7834	0.9434	1.1931	1.0821

1

Table 10.3.1.1 XSA tuning diagnostics.

Log catchability residuals.

Fleet : Danish Gillnetters

Age	1987	1988	1989	1990	1991	1992	1993	1994
2	-0.49	-0.13	-1.14	-0.11	-0.04	0.26	-2.26	0.02
3	-0.09	0.01	-0.87	-0.29	-0.57	0.18	-1.35	0.58
4	0.36	0.57	-0.58	-0.12	-0.9	0.04	-0.68	-0.25
5	0.38	0.38	-0.5	-0.09	-0.93	0.07	-0.75	-0.38
6	0.08	0.02	-0.56	-0.49	-0.38	-0.55	-0.39	-0.92
7	-0.09	0.12	-0.25	-0.68	-0.4	-0.38	-0.14	-0.61
8	-0.75	-0.04	-0.26	-0.44	-0.4	-0.36	-0.66	-0.7
9	-0.38	-0.04	-0.11	-0.16	0.01	-0.19	-0.56	-0.85
10	-0.16	0.14	0.15	0.02	0.01	0.22	-0.82	-0.64

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	0.07	1.62	-0.25	-0.23	0.08	-0.52	1.09	-0.39	0.19	0.07
3	-0.25	0.39	0.33	0.24	-0.61	-0.22	0.14	0.21	0.08	0.5
4	0.09	0.09	-0.25	0.38	-0.02	0.16	0.22	0.06	0.1	0.17
5	0.14	-0.19	0.22	-0.05	0.32	0.12	0.53	-0.01	0.49	-0.45
6	-0.45	-0.53	0.21	-0.12	0.6	0.16	0.31	0.27	0.87	0.01
7	-0.37	-0.98	0.29	-0.4	0.43	-0.2	-0.49	0.84	0.8	0.88
8	-0.29	-1.1	-0.02	0	0.46	-0.37	-0.04	0.84	0.68	0.99
9	-0.1	-1.27	-0.55	-0.38	0.78	-0.8	-0.73	0.65	-0.35	0.71
10	-0.26	-0.9	-0.07	-0.18	-0.1	-0.47	-0.04	0.66	0.44	0.27

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	-8.2935	-6.4904	-5.4827	-4.5944	-3.8692	-3.5257	-3.296	-3.296	-3.296
S.E(Log q)	0.8051	0.4875	0.3082	0.3983	0.4957	0.6182	0.6283	0.6867	0.4635

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	0.77	0.49	8.87	0.3	18	0.64	-8.29
3	0.8	0.63	7.3	0.5	18	0.4	-6.49
4	3.95	-1.842	-8.56	0.04	18	1.1	-5.48
5	1.52	-0.773	1.9	0.18	18	0.62	-4.59
6	2.37	-1.677	-2.97	0.13	18	1.09	-3.87
7	1.55	-1.608	1.33	0.46	18	0.9	-3.53
8	1.64	-2.311	1.43	0.56	18	0.88	-3.3
9	1.24	-1.224	3.21	0.72	18	0.78	-3.53
10	1.1	-0.706	3.34	0.83	18	0.51	-3.39
1							

Fleet : Danish Trawlers

Age	1987	1988	1989	1990	1991	1992	1993	1994
2	-0.26	-1	-0.41	0.38	0.19	-0.34	-0.56	0.55
3	-0.2	-0.39	-0.34	-0.23	-0.22	-0.49	-0.61	0.49
4	-0.06	0.14	-0.44	-0.01	-0.56	-0.54	-0.13	-0.23
5	-0.27	0.06	-0.36	0.06	-0.61	-0.06	-0.58	-0.17
6	-0.79	-0.54	-0.55	-0.37	-0.5	-0.33	-0.33	-0.49
7	-1.25	-1.02	-0.83	-0.52	-0.69	-0.39	0.22	0.14
8	-1.54	-1.21	-1.19	-0.51	-0.76	-0.43	-0.22	0.15
9	-1.06	-1.48	-1.04	-0.76	-0.11	-0.99	-0.58	-0.75
10	-0.54	-0.38	-0.9	-0.66	-0.39	-0.94	0.11	0.3

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	-0.09	1.22	-0.73	-0.31	-0.2	0.37	1.17	-0.73	-0.3	-0.15
3	-0.29	0.17	0.15	0.21	-0.5	0.17	0.61	0.04	-0.04	0.01
4	-0.07	-0.1	0	0.32	-0.13	0.07	0.42	0.41	0.12	-0.27
5	0.03	-0.32	0.37	-0.29	0.11	0.27	0.29	0.42	0.44	-0.54
6	-0.34	-0.58	0.17	-0.19	0.21	0.28	0.07	0.57	0.79	0.05
7	-0.47	-0.73	-0.05	-0.4	0.31	0.23	-0.57	0.71	0.6	0.83
8	-0.08	-0.65	-0.4	0.01	0.36	-0.03	-0.37	0.61	0.81	0.69
9	0.08	-0.81	-0.35	-0.37	0.13	-0.32	-0.1	-0.08	-0.32	0.01
10	-0.03	-0.26	-0.02	-0.31	-0.18	0.71	0.19	0.24	0.82	-0.07

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	-8.098	-6.5331	-5.8213	-5.2308	-4.8178	-4.7403	-4.7455	-4.7455	-4.7455
S.E(Log q)	0.6463	0.3494	0.2859	0.3676	0.4289	0.562	0.5424	0.4992	0.4561

Table 10.3.1.1 XSA tuning 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
2	1.06	-0.117	7.93	0.26	18	0.72	-8.1
3	1.07	-0.237	6.24	0.52	18	0.39	-6.53
4	3.43	-1.897	-4.9	0.06	18	0.88	-5.82
5	1.82	-1.143	1.49	0.16	18	0.66	-5.23
6	2.05	-1.727	0.58	0.21	18	0.81	-4.82
7	1.49	-1.626	3.4	0.53	18	0.78	-4.74
8	1.52	-2.354	4	0.67	18	0.69	-4.75
9	1.18	-1.882	5.12	0.91	18	0.39	-5.07
10	1.39	-2.839	5.03	0.84	18	0.49	-4.71
1							

Fleet : Danish Seiners

Age	1987	1988	1989	1990	1991	1992	1993	1994
2	-1.16	0.57	-0.77	0.37	0.02	-1.45	-0.75	0.17
3	-0.37	-0.03	-0.21	0.01	-0.39	-1.15	-1.34	0.18
4	0.11	0.35	-0.09	0.18	-0.58	-0.39	-0.77	-0.6
5	0.07	0.27	0	0.19	-0.52	0.08	-0.82	-0.52
6	-0.42	-0.29	-0.28	-0.35	-0.41	-0.26	-0.65	-0.94
7	-1.03	-0.61	-0.41	-0.6	-0.59	-0.57	-0.37	-0.64
8	-1.61	-0.86	-0.92	-0.65	-0.67	-0.69	-0.6	-0.8
9	-1.26	-1.19	-0.93	-0.64	-0.23	-0.83	-0.72	-1.11
10	-1.12	-1.02	-0.89	-0.73	-0.84	-0.98	-1.1	-1.17

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	-0.41	1.23	-0.6	-0.54	-0.34	0	1.53	-0.69	0.34	0.53
3	-0.87	0	0.02	0.46	-0.66	0.04	0.96	0.18	0.49	0.6
4	-0.39	-0.16	-0.17	0.31	-0.05	0.2	0.47	0.58	0.31	-0.05
5	-0.44	-0.8	0.32	-0.19	0.38	0.5	0.31	0.58	0.68	-0.64
6	-0.5	-0.89	0.2	-0.04	0.61	0.38	-0.07	0.59	1	-0.01
7	-0.57	-1.16	0.5	-0.12	0.45	0.61	-0.65	0.85	0.64	0.72
8	-0.55	-1.06	0.24	0.36	0.55	0.31	-0.19	0.82	0.67	0.64
9	-0.41	-1.27	0.35	-0.19	0.22	-1.29	-0.62	0.06	-0.94	0.05
10	-0.53	-1.02	0.14	0.09	0.62	-0.67	-0.18	0.05	-0.23	-0.56

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	-6.7218	-4.9318	-4.0529	-3.3409	-2.8621	-2.8364	-2.8732	-2.8732	-2.8732
S.E(Log q)	0.7888	0.6397	0.3993	0.5364	0.5807	0.6787	0.661	0.7708	0.6832

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	0.62	1.044	8.26	0.43	18	0.49	-6.72
3	0.73	0.72	6.45	0.42	18	0.48	-4.93
4	5.37	-1.478	-22.97	0.01	18	2.04	-4.05
5	3.62	-1.274	-13.55	0.02	18	1.89	-3.34
6	5.55	-2.175	-24.42	0.02	18	2.79	-2.86
7	1.7	-1.722	-0.44	0.37	18	1.07	-2.84
8	1.67	-2.229	0.64	0.52	18	0.95	-2.87
9	0.96	0.26	3.42	0.82	18	0.58	-3.37
10	0.91	0.637	3.33	0.83	18	0.51	-3.27
1							

Fleet : KASU_q4

Age	1987	1988	1989	1990	1991	1992	1993	1994
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.68
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.8
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-2.11
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-1.34
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-3.27
7	No data for this fleet at this age							
8	No data for this fleet at this age							
9	No data for this fleet at this age							
10	No data for this fleet at this age							

Table 10.3.1.1 XSA tuning diagnostics.

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	-0.88	0.4	-1.15	-0.77	0.71	1.27	1.1	-0.13	-0.43	0.06
3	-1.33	-0.22	-0.35	-1.18	-0.73	0.79	1.11	0.68	0.53	0.73
4	-2.04	-1	0	0.34	-1.08	-1.88	1.2	1.64	0.96	2.53
5	-0.63	-1.11	0.68	-2.24	-0.07	-1.04	-0.97	1.1	2.16	2.55
6	-2.24	-2.18	0.98	-0.88	0.43	1.38	-0.51	-0.85	1.88	3.32
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

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

Age	2	3	4	5	6
Mean Log q	-7.1601	-7.8169	-8.9746	-9.3567	-8.8334
S.E(Log q)	0.83	0.8709	1.6033	1.5639	1.9478

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	1.19	-0.233	6.47	0.16	11	1.04	-7.16
3	0.6	0.929	8.92	0.4	11	0.53	-7.82
4	-0.4	-0.872	10.67	0.05	11	0.65	-8.97
5	-1.41	-0.625	10.28	0.01	11	2.28	-9.36
6	-0.35	-3.634	8.84	0.48	11	0.45	-8.83
1							

Fleet : KASU_q1_backshifted

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	-0.35	-0.59	99.99	-0.69	0.45	0.37	0.58	0.21	-0.48	0.28
3	-0.28	-0.89	99.99	-1.03	-0.13	-0.04	0.81	0.92	1.09	-0.75
4	-0.4	-0.66	99.99	-0.65	-0.84	-0.88	-0.51	1.06	1.48	1.06
5	-0.55	-0.3	99.99	-0.91	1.06	-0.48	-0.56	-1.77	2.31	0.97
6	99.99	-1.22	99.99	99.99	99.99	-0.45	-1.04	-1.07	2.68	0.86
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	-6.7986	-7.8207	-8.8676	-9.405	-8.9924
S.E(Log q)	0.4966	0.8171	0.971	1.2757	1.5544

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	1.26	-0.489	5.76	0.36	9	0.66	-6.8
3	3.08	-0.974	2.01	0.03	9	2.53	-7.82
4	0.6	0.229	9.39	0.05	9	0.63	-8.87
5	1.6	-0.145	9.21	0.01	9	2.19	-9.4
6	-0.36	-1.767	8.57	0.31	6	0.46	-8.99
1							

Fleet : IBTSQ1_backshifted

Age	1987	1988	1989	1990	1991	1992	1993	1994
2	99.99	99.99	99.99	-1.09	-0.84	-1.09	-0.8	-0.34
3	99.99	99.99	99.99	-0.78	-0.76	-0.36	-1.51	-0.26
4	99.99	99.99	99.99	-0.3	-1.46	-0.07	-1.33	-1.27
5	99.99	99.99	99.99	-1.59	-1.7	0.26	-0.7	-0.65
6	99.99	99.99	99.99	-1.72	-1.7	-0.44	-0.91	-1.25
7	No data for this fleet at this age							
8	No data for this fleet at this age							
9	No data for this fleet at this age							
10	No data for this fleet at this age							

Table 10.3.1.1 XSA tuning diagnostics.

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	-0.1	0.38	-0.86	-0.59	0.85	0.9	0.49	0.5	-0.01	0.25
3	-0.33	-0.37	-0.33	-1.03	-0.05	0.43	1.17	0.98	0.97	0.05
4	-0.43	-0.58	-0.72	0.01	-0.37	-0.81	0.72	1.77	1.24	1.15
5	-1.29	-2.41	-0.61	-2.15	0.85	-0.02	0.03	1.47	2.98	2
6	-1.34	-2.9	-0.62	-1.03	-0.22	0.85	0.86	0.98	2.56	2.58
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	-6.9164	-7.5275	-7.8496	-8.1384	-8.0033
S.E(Log q)	0.667	0.7824	1.0197	1.6399	1.6408

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	1.12	-0.209	6.44	0.23	15	0.79	-6.92
3	1.3	-0.36	6.6	0.13	15	1.06	-7.53
4	-1.56	-1.116	13.97	0.02	15	1.57	-7.85
5	2.02	-0.264	6.45	0.01	15	3.48	-8.14
6	-0.75	-2.14	9.49	0.13	15	1.06	-8
1							

Fleet : IBTSQ3

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	99.99	99.99	-0.75	-0.46	0.74	99.99	1.08	0.67	-0.96	-0.41
3	99.99	99.99	-0.43	-1.13	-0.06	99.99	1.54	0.68	-0.58	-0.14
4	99.99	99.99	-0.9	-0.24	-1.43	99.99	0.73	1.63	0.4	-0.37
5	99.99	99.99	-0.91	-2.1	-0.14	99.99	0.4	0.78	1.65	0.03
6	99.99	99.99	-0.7	99.99	-0.97	99.99	-0.25	-0.72	1.36	1.14
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

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

Age	2	3	4	5	6
Mean Log q	-7.0297	-7.5806	-8.0972	-7.9623	-7.4976
S.E(Log q)	0.8253	0.8861	1.037	1.2021	1.0244

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	-44.82	-1.718	183.45	0	7	31.96	-7.03
3	1.01	-0.014	7.54	0.22	7	0.99	-7.58
4	-1.18	-0.483	12.64	0.01	7	1.31	-8.1
5	-0.79	-0.67	11.05	0.03	7	1	-7.96
6	-0.41	-3.855	9.25	0.66	6	0.21	-7.5
1							

Terminal year survivor and F summaries :

Age 2 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
Danish Gillnetters	72113	0.838	0	0	1	0.081	0.022
Danish Trawlers	57546	0.673	0	0	1	0.126	0.028
Danish Seiners	113401	0.821	0	0	1	0.085	0.014
KASU_q4	71038	0.871	0	0	1	0.075	0.023
KASU_q1_backshifted	88301	0.525	0	0	1	0.207	0.018
IBTSQ1_backshifted	86005	0.695	0	0	1	0.118	0.019
IBTSQ3	44449	0.884	0	0	1	0.073	0.036
F shrinkage mean	44983	0.5				0.234	0.036

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
66951	0.24	0.13	8	0.534	0.024

Table 10.3.1.1 XSA tuning diagnostics.

Age 3 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	137027	0.434	0.133	0.31	2	0.144	0.116
Danish Trawlers	85398	0.32	0.132	0.41	2	0.265	0.181
Danish Seiners	149283	0.517	0.127	0.25	2	0.101	0.107
KASU_q4	103138	0.63	0.579	0.92	2	0.068	0.152
KASU_q1_backshifted	51985	0.449	0.122	0.27	2	0.133	0.281
IBTSQ1_backshifted	91692	0.529	0.031	0.06	2	0.096	0.169
IBTSQ3	50942	0.647	0.407	0.63	2	0.064	0.286
F shrinkage mean	93224	0.5				0.13	0.167

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
90345	0.17	0.11	15	0.639	0.171

1

Age 4 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	19125	0.259	0.109	0.42	3	0.23	0.192
Danish Trawlers	13595	0.22	0.135	0.61	3	0.314	0.261
Danish Seiners	16878	0.325	0.242	0.74	3	0.145	0.215
KASU_q4	29183	0.592	0.621	1.05	3	0.04	0.13
KASU_q1_backshifted	30398	0.413	0.3	0.73	3	0.083	0.125
IBTSQ1_backshifted	38634	0.475	0.195	0.41	3	0.063	0.1
IBTSQ3	16450	0.561	0.399	0.71	3	0.046	0.22
F shrinkage mean	8136	0.5				0.08	0.404

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
17282	0.12	0.11	22	0.874	0.211

Age 5 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	14086	0.224	0.218	0.97	4	0.253	0.241
Danish Trawlers	13810	0.194	0.247	1.27	4	0.328	0.246
Danish Seiners	15818	0.287	0.357	1.25	4	0.152	0.218
KASU_q4	48182	0.569	0.379	0.67	4	0.033	0.077
KASU_q1_backshifted	34278	0.402	0.186	0.46	4	0.065	0.106
IBTSQ1_backshifted	38323	0.465	0.272	0.58	4	0.048	0.096
IBTSQ3	26067	0.527	0.224	0.43	4	0.041	0.138
F shrinkage mean	2329	0.5				0.081	0.975

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
14627	0.11	0.15	29	1.344	0.233

1

Age 6 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	2359	0.261	0.108	0.41	5	0.226	0.589
Danish Trawlers	2732	0.229	0.105	0.46	5	0.295	0.526
Danish Seiners	2834	0.332	0.175	0.53	5	0.148	0.511
KASU_q4	15382	0.728	0.457	0.63	5	0.022	0.116
KASU_q1_backshifted	4998	0.51	0.297	0.58	5	0.039	0.321
IBTSQ1_backshifted	12262	0.599	0.387	0.65	5	0.031	0.143
IBTSQ3	7829	0.716	0.134	0.19	4	0.036	0.216
F shrinkage mean	394	0.5				0.203	1.757

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2078	0.15	0.18	35	1.23	0.647

Table 10.3.1.1 XSA tuning diagnostics.

Age 7 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	177	0.489	0.135	0.28	6	0.122	0.882
Danish Trawlers	175	0.436	0.086	0.2	6	0.151	0.889
Danish Seiners	168	0.566	0.075	0.13	6	0.096	0.913
KASU_q4	253	0.664	0.231	0.35	5	0.003	0.689
KASU_q1_backshifted	126	0.467	0.659	1.41	5	0.006	1.098
IBTSQ1_backshifted	278	0.547	0.403	0.74	5	0.004	0.644
IBTSQ3	245	0.667	0.176	0.26	4	0.005	0.706
F shrinkage mean	52	0.5				0.613	1.766

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
83	0.32	0.16	38	0.494	1.393

1

Age 8 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	64	0.536	0.097	0.18	7	0.104	0.894
Danish Trawlers	49	0.468	0.069	0.15	7	0.138	1.058
Danish Seiners	48	0.582	0.054	0.09	7	0.091	1.073
KASU_q4	10	0.647	0.157	0.24	5	0.001	2.283
KASU_q1_backshifted	13	0.456	0.144	0.32	5	0.002	2.087
IBTSQ1_backshifted	24	0.533	0.323	0.61	5	0.001	1.592
IBTSQ3	17	0.642	0.232	0.36	4	0.001	1.851
F shrinkage mean	18	0.5				0.662	1.812

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
26	0.35	0.14	41	0.401	1.522

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 8

Year class = 1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Danish Gillnetters	14	0.61	0.027	0.04	8	0.125	0.57
Danish Trawlers	7	0.463	0.092	0.2	8	0.225	0.881
Danish Seiners	8	0.675	0.087	0.13	8	0.101	0.845
KASU_q4	3	0.661	0.134	0.2	5	0	1.635
KASU_q1_backshifted	3	0.681	0.122	0.18	4	0	1.553
IBTSQ1_backshifted	5	0.544	0.362	0.67	5	0	1.156
IBTSQ3	4	0.648	0.263	0.41	4	0	1.373
F shrinkage mean	5	0.5				0.548	1.074

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7	0.31	0.07	43	0.213	0.933

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Age 10 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	7	0.4	0.093	0.23	9	0.208	0.946
Danish Trawlers	5	0.354	0.058	0.16	9	0.248	1.133
Danish Seiners	3	0.527	0.114	0.22	9	0.111	1.482
KASU_q4	8	0.721	0.331	0.46	5	0	0.806
KASU_q1_backshifted	4	0.583	0.338	0.58	4	0	1.259
IBTSQ1_backshifted	8	0.595	0.231	0.39	5	0	0.84
IBTSQ3	4	0.683	0.087	0.13	3	0	1.228
F shrinkage mean	7	0.5				0.433	0.951

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6	0.25	0.05	45	0.194	1.047

Table 10.3.1.2. Plaice in IIIa. Fishing mortality (F) at age.

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Run title : Plaic 2005 WG ANON COMBSEX PLUSGROUP

At 6/09/2005 17:26

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1978	1979	1980	1981	1982	1983	1984
AGE							
2	0.0084	0.0257	0.0111	0.0078	0.0115	0.0166	0.0326
3	0.2335	0.2058	0.1326	0.1487	0.0988	0.2684	0.1721
4	0.7571	0.7969	0.5479	0.5626	0.5156	0.6521	0.4946
5	1.0753	1.0747	0.8464	0.7786	1.1257	1.0503	0.7456
6	1.0199	1.0636	0.9627	0.7008	1.077	0.868	0.818
7	0.595	0.9543	1.0673	0.5502	0.6586	0.4406	0.8275
8	0.2824	0.2829	1.0973	0.6559	0.5632	0.3503	0.9112
9	0.4844	0.5608	0.5647	0.6834	0.8316	0.3333	0.9333
10	0.6945	0.791	0.9124	0.6767	0.8555	0.611	0.8513
+gp	0.6945	0.791	0.9124	0.6767	0.8555	0.611	0.8513
0 FBAR 4- 8	0.746	0.8345	0.9043	0.6496	0.788	0.6722	0.7594

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
2	0.0305	0.0107	0.0191	0.0032	0.0162	0.0462	0.049	0.0212	0.0314	0.0432
3	0.1591	0.113	0.1434	0.1103	0.1454	0.1697	0.1544	0.0973	0.0961	0.2679
4	0.4438	0.3936	0.4706	0.664	0.3566	0.4911	0.2535	0.2903	0.3498	0.2945
5	0.5036	0.7845	1.0217	1.34	0.7794	1.0441	0.4764	0.8674	0.5427	0.6022
6	0.6356	0.7334	1.2039	1.4317	0.9471	1.1142	0.9305	0.9714	0.9248	0.6571
7	0.5931	0.4499	0.8167	1.1829	0.9188	0.9994	0.9845	0.9314	1.2026	1.1341
8	0.471	0.4327	0.4621	0.9998	0.6939	1.1514	0.8959	0.9541	0.9642	1.1901
9	0.4435	0.5005	0.7516	0.8218	0.7128	1.2163	1.4924	0.9216	0.9672	0.7538
10	0.5313	0.5825	0.8738	1.1904	0.9039	1.208	1.0619	1.0773	1.1504	1.0743
+gp	0.5313	0.5825	0.8738	1.1904	0.9039	1.208	1.0619	1.0773	1.1504	1.0743
0 FBAR 4- 8	0.5294	0.5588	0.795	1.1237	0.7392	0.96	0.7082	0.8029	0.7968	0.7756

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YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	FBAR **-**
AGE											
2	0.0124	0.126	0.0122	0.0151	0.0206	0.0303	0.0888	0.0111	0.0276	0.0241	0.0209
3	0.0821	0.1805	0.1686	0.1887	0.0842	0.1412	0.2947	0.1383	0.1732	0.1715	0.161
4	0.3917	0.4017	0.3019	0.4347	0.3402	0.3537	0.5113	0.4557	0.3534	0.2106	0.3399
5	0.7859	0.5513	1.0465	0.5424	0.9775	0.9053	0.9712	0.8935	1.1027	0.2335	0.7432
6	0.95	0.785	1.5388	1.0242	1.9744	1.487	1.1669	1.6017	2.4976	0.6472	1.5822
7	1.0012	0.653	1.9115	0.9854	1.994	1.7173	0.5639	2.408	2.0876	1.3925	1.9627
8	1.2549	0.7403	1.4662	1.6007	2.2194	1.383	0.8677	2.4634	2.0653	1.5219	2.0169
9	1.4829	0.6745	1.4246	0.9931	2.0757	0.5201	0.6	1.4415	0.7004	0.9334	1.0251
10	1.3026	0.9995	1.6274	1.1989	1.9029	1.205	0.9699	1.6768	1.4661	1.0473	1.3967
+gp	1.3026	0.9995	1.6274	1.1989	1.9029	1.205	0.9699	1.6768	1.4661	1.0473	
0 FBAR 4- 8	0.8767	0.6263	1.253	0.9175	1.5011	1.1693	0.8162	1.5644	1.6213	0.8011	

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Table 10.3.1.3. Plaice in IIIa. Stock numbers at age (start of year). Numbers 10*-3

Run title : Plai 2005 WG ANON COMBSEX PLUSGROUP

At 6/09/2005 17:26

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	1984
	AGE							
	2	61662	45794	34419	25733	48497	94309	70509
	3	79225	55329	40385	30799	23104	43382	83925
	4	78264	56759	40752	32003	24018	18939	30012
	5	39764	33213	23149	21318	16498	12977	8928
	6	13172	12276	10260	8985	8855	4843	4108
	7	1453	4298	3835	3545	4034	2729	1840
	8	269	725	1497	1193	1850	1889	1589
	9	173	184	495	452	560	953	1204
	10	101	96	95	254	207	221	618
	+gp	125	105	87	206	87	242	218
0	TOTAL	274207	208780	154975	124490	127710	180484	202952

	YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
	AGE										
	2	48963	37159	34602	33106	66174	73245	50789	45377	35301	35065
	3	61751	42972	33266	30717	29859	58914	63282	43759	40199	30955
	4	63934	47655	34730	26079	24890	23361	44986	49069	35925	33039
	5	16559	37115	29090	19629	12148	15766	12936	31589	33214	22910
	6	3833	9055	15326	9475	4651	5042	5022	7269	12006	17465
	7	1640	1837	3935	4160	2048	1632	1497	1792	2490	4309
	8	728	820	1060	1573	1153	739	544	506	639	677
	9	578	411	481	604	524	521	212	201	176	220
	10	428	336	226	205	240	232	140	43	72	61
	+gp	396	232	340	233	414	405	218	182	105	87
0	TOTAL	198810	177592	153056	125783	142101	179859	179624	179787	160128	144788
	1										

	YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	GMST 78-**	AMST 78-**
	AGE													
	2	38119	40195	45893	39517	35447	43031	49246	34623	134646	75799	0	44567	46671
	3	30386	34068	32064	41023	35221	31421	37772	40772	30982	118522	66951	40711	42982
	4	21427	25328	25734	24510	30736	29297	24686	25453	32129	23576	90345	32535	34863
	5	22270	13105	15336	17217	14360	19790	18612	13396	14602	20417	17282	19325	20836
	6	11352	9183	6832	4873	9057	4889	7242	6376	4960	4386	14627	7746	8458
	7	8192	3973	3790	1327	1583	1138	1000	2040	1163	369	2078	2441	2805
	8	1254	2723	1871	507	448	195	185	515	166	130	83	811	1006
	9	186	324	1175	391	93	44	44	70	40	19	26	294	411
	10	94	38	149	256	131	11	24	22	15	18	7	118	172
	+gp	73	74	46	95	52	43	55	15	7	11	9		
0	TOTAL	133354	129011	132890	129716	127128	129858	138866	123284	218710	243248	191407		

Table 10.3.1.4. Plaice in IIIa. Stock summary table.

Run title : Plaice IIIa 2005 WG ANON COMBSEX PLUSGROUP

At 6/09/2005 17:26

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	61662	74882	60329	26953	0.4468	0.746
1979	45794	56725	46559	21976	0.472	0.8345
1980	34419	48461	39477	16445	0.4166	0.9043
1981	25733	38494	32575	12602	0.3869	0.6496
1982	48497	39809	26715	11047	0.4135	0.788
1983	94309	54425	27547	10780	0.3913	0.6722
1984	70509	61372	41489	11591	0.2794	0.7594
1985	48963	60753	47141	13482	0.286	0.5294
1986	37159	52173	42883	14052	0.3277	0.5588
1987	34602	48138	36996	15658	0.4232	0.795
1988	33106	36316	27973	12850	0.4594	1.1237
1989	66174	41327	23196	7741	0.3337	0.7392
1990	73245	54947	33560	12082	0.36	0.96
1991	50789	49027	35670	8700	0.2439	0.7082
1992	45377	53820	39798	11931	0.2998	0.8029
1993	35301	45717	36292	11323	0.312	0.7968
1994	35065	41423	31780	11325	0.3564	0.7756
1995	38119	39746	29721	10766	0.3622	0.8767
1996	40195	39154	28462	10545	0.3705	0.6263
1997	45893	40454	26686	10291	0.3856	1.253
1998	39517	36315	26040	8430	0.3237	0.9175
1999	35447	35768	26162	8740	0.3341	1.5011
2000	43031	35721	24662	8820	0.3576	1.1693
2001	49246	38959	26303	11560	0.4395	0.8162
2002	34623	33664	25147	8701	0.346	1.5644
2003	134646	55531	22812	8952	0.3924	1.6213
2004	75799	67523	49331	9096	0.1844	0.8011
Arith. Mean	51008	47431	33900	12090	0.3594	0.8997
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

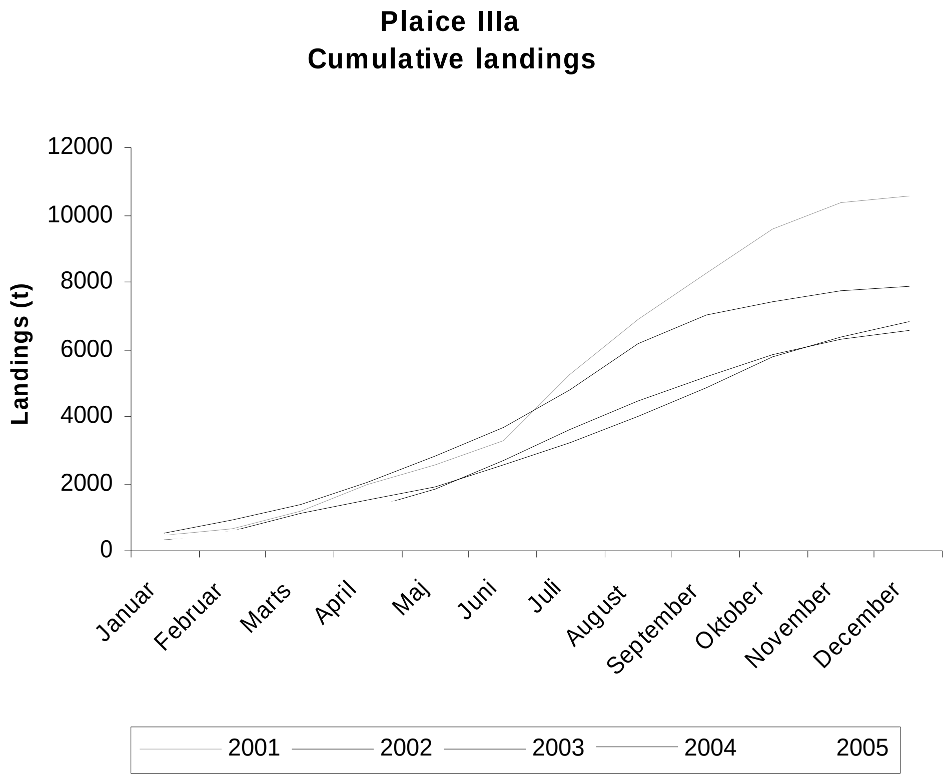


Figure 10.1.2. Plaice in IIIa. Cumulative landings from the Danish fishery by month in 2001-2005.

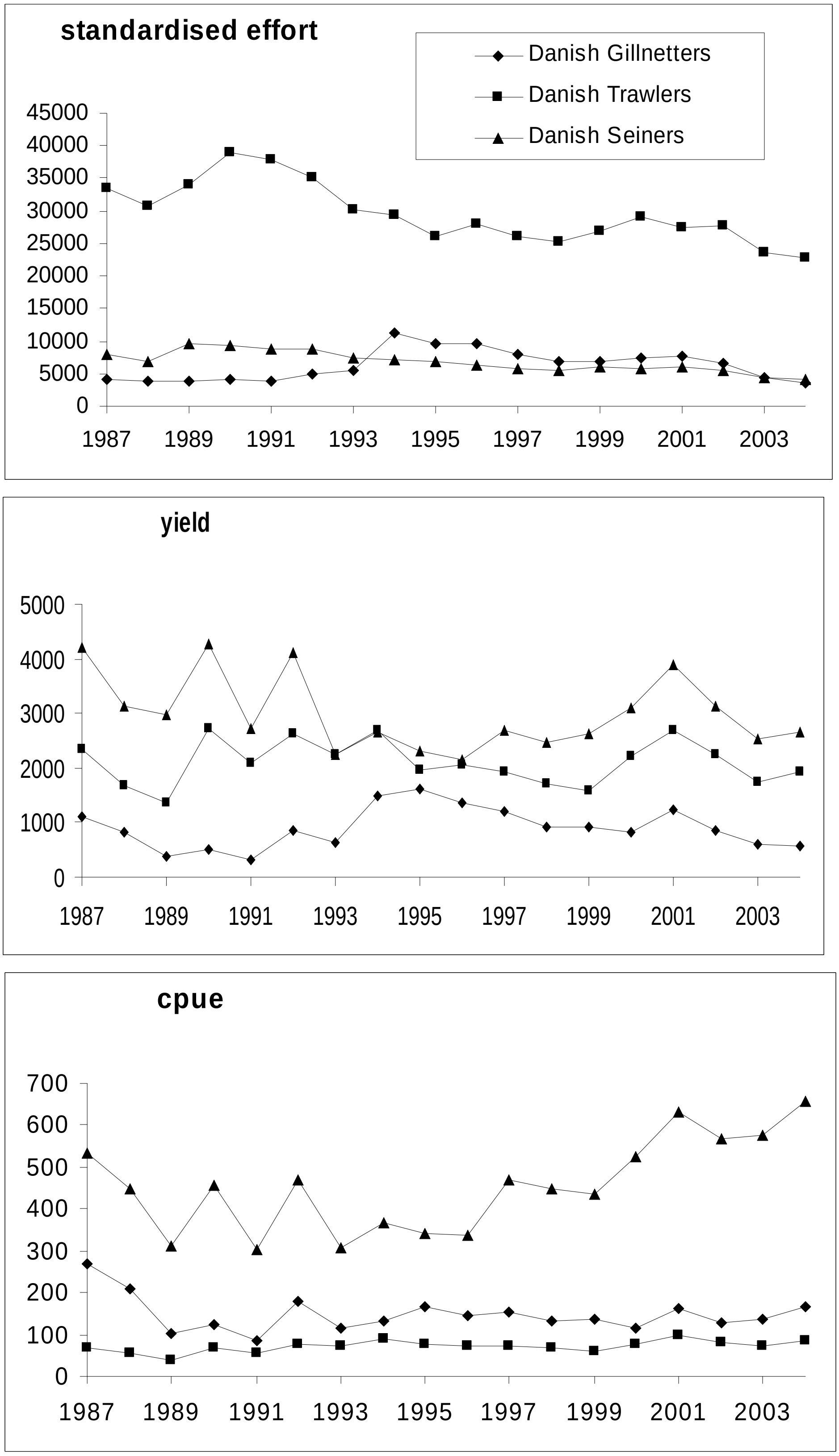
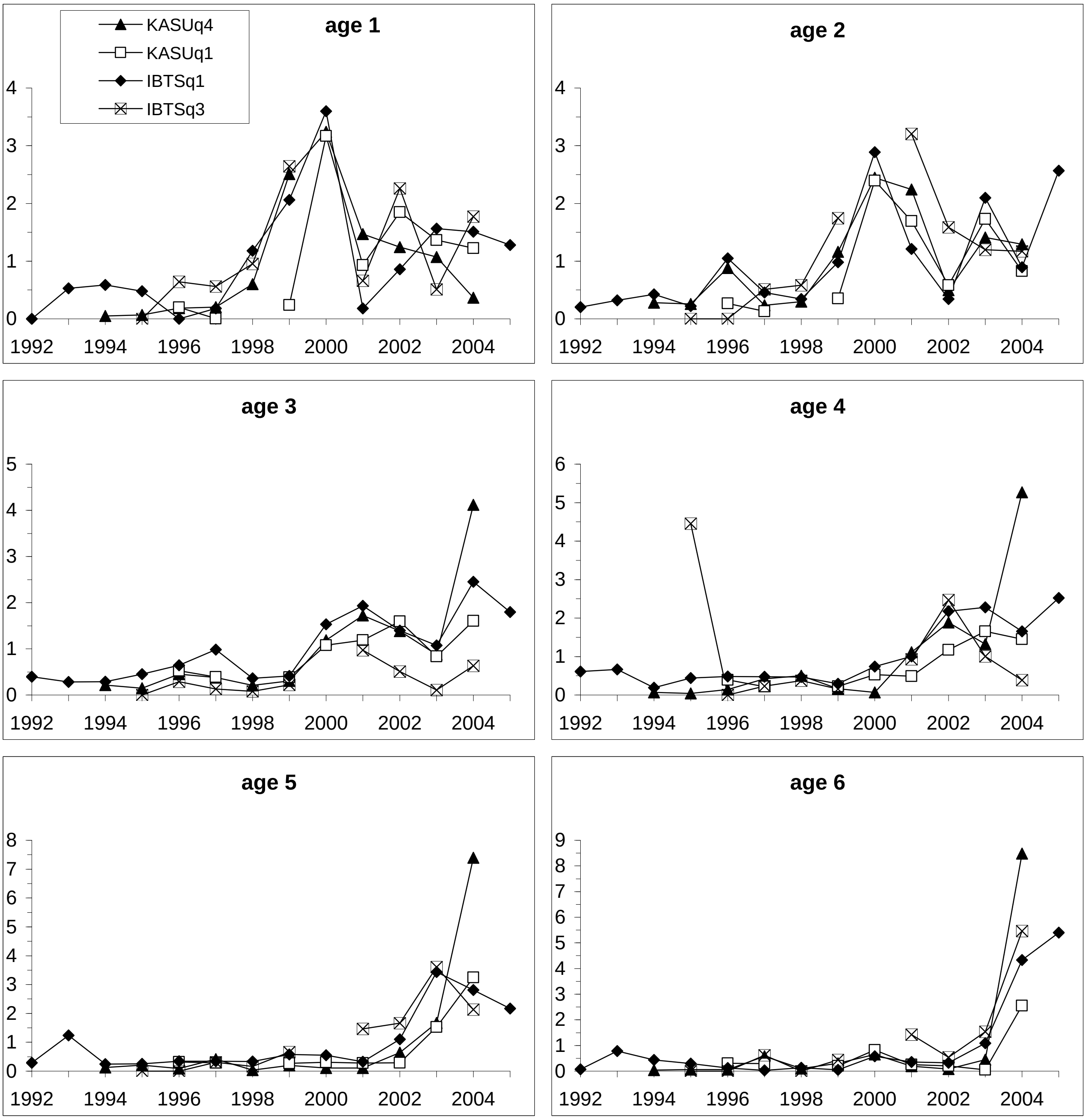


Figure 10.2.5.1. Plaice in IIIa. Commercial tuning fleets effort and CPUE.

Figure 10.2.5.2. Plaice in IIIa. Relative survey indices by age.



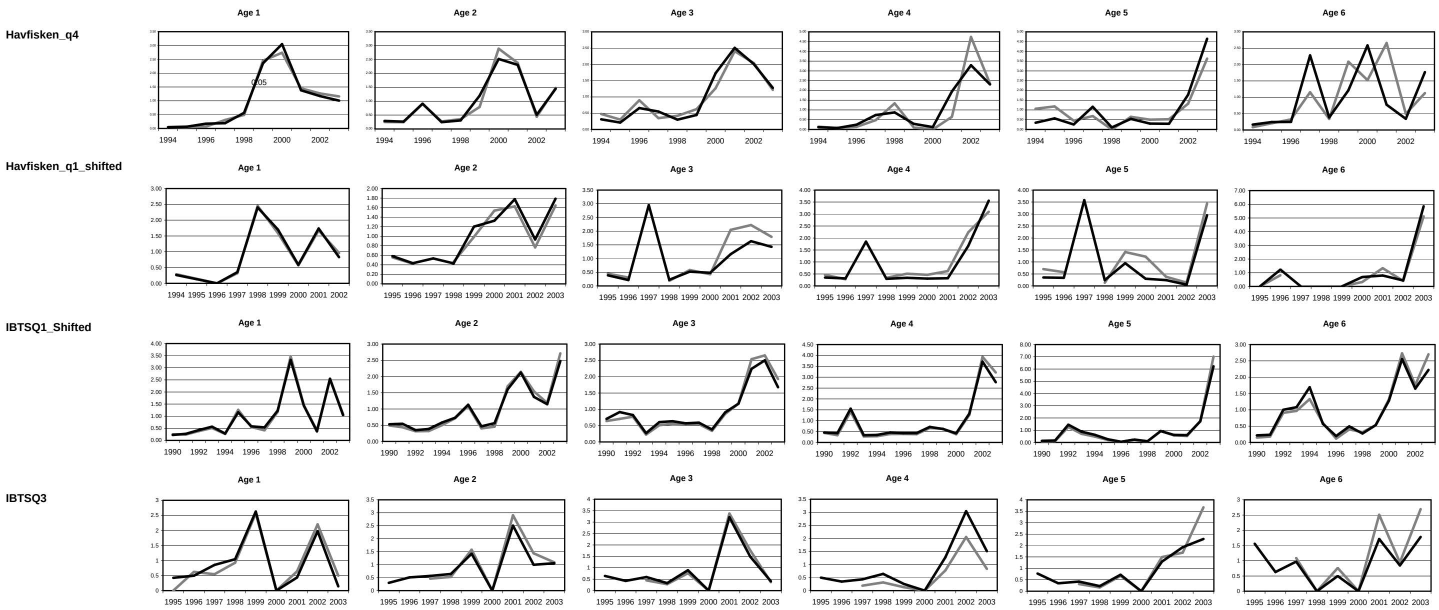


Figure 10.2.5.3. Plaice in IIIa. Comparison of former (grey curve) and revised survey indices (relative scale).

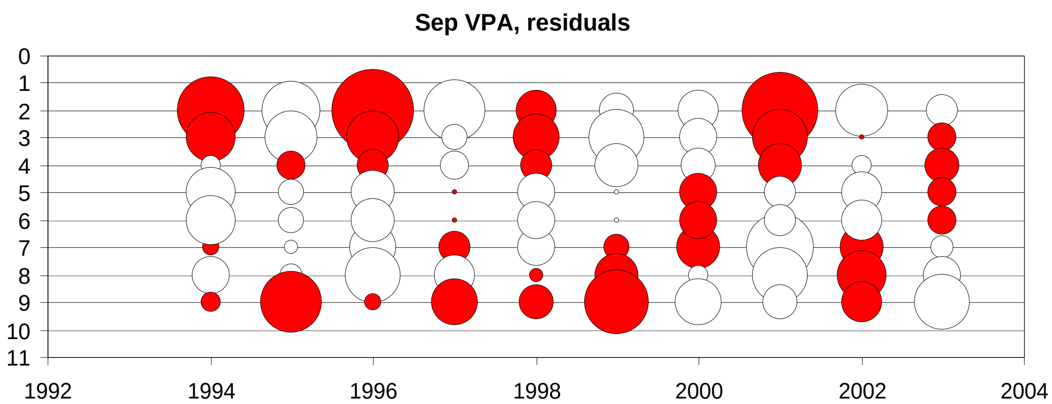


Figure 10.3.1.1. Plaice in IIIa. Residuals from a separable analysis.

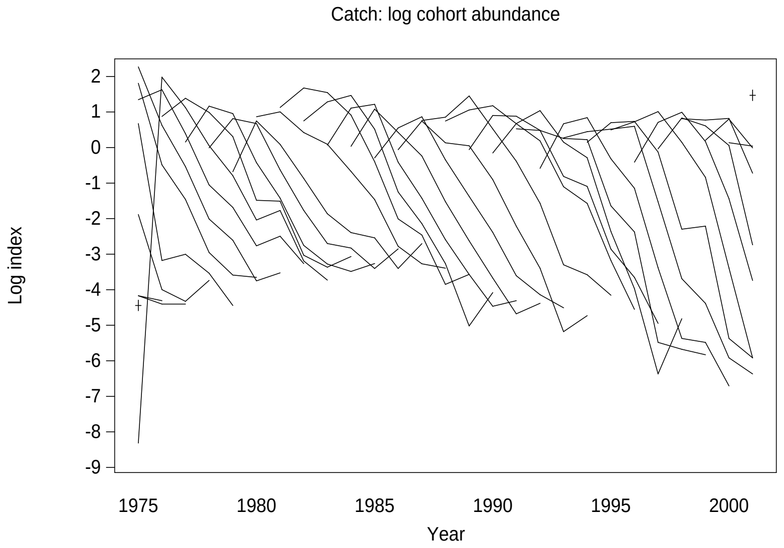


Figure 10.3.1.2. Plaice in IIIa. Catch curves of the catch in numbers (ages 3-11+).

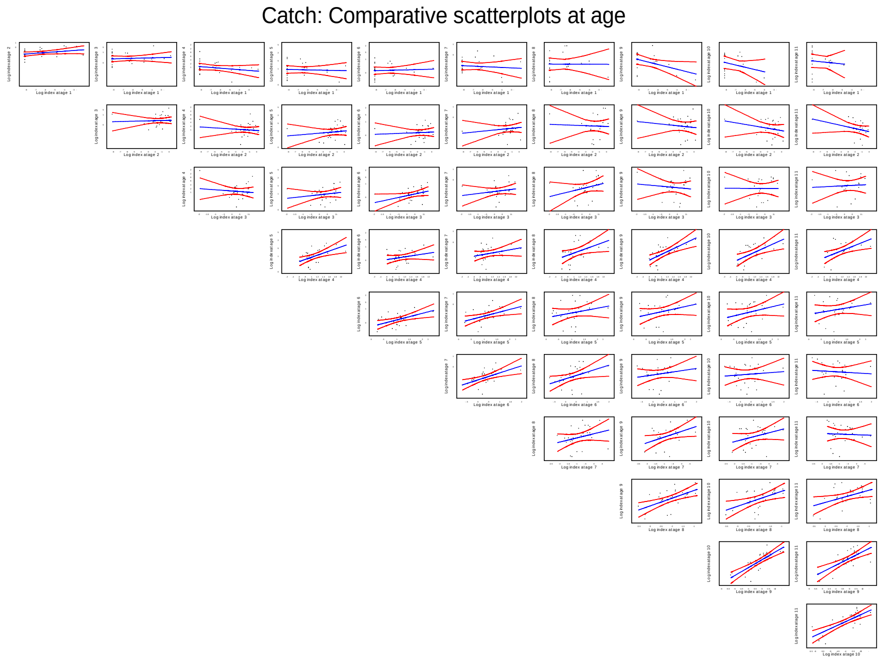


Figure 10.3.1.3. Plaice in IIIa. Cohort tracking plots of the catch matrix with linear regressions and 95% C.I. (ages 1-11+).

Fig.10.3.1.4. Plaice IIIa. XSA log catchability residuals by fleet.

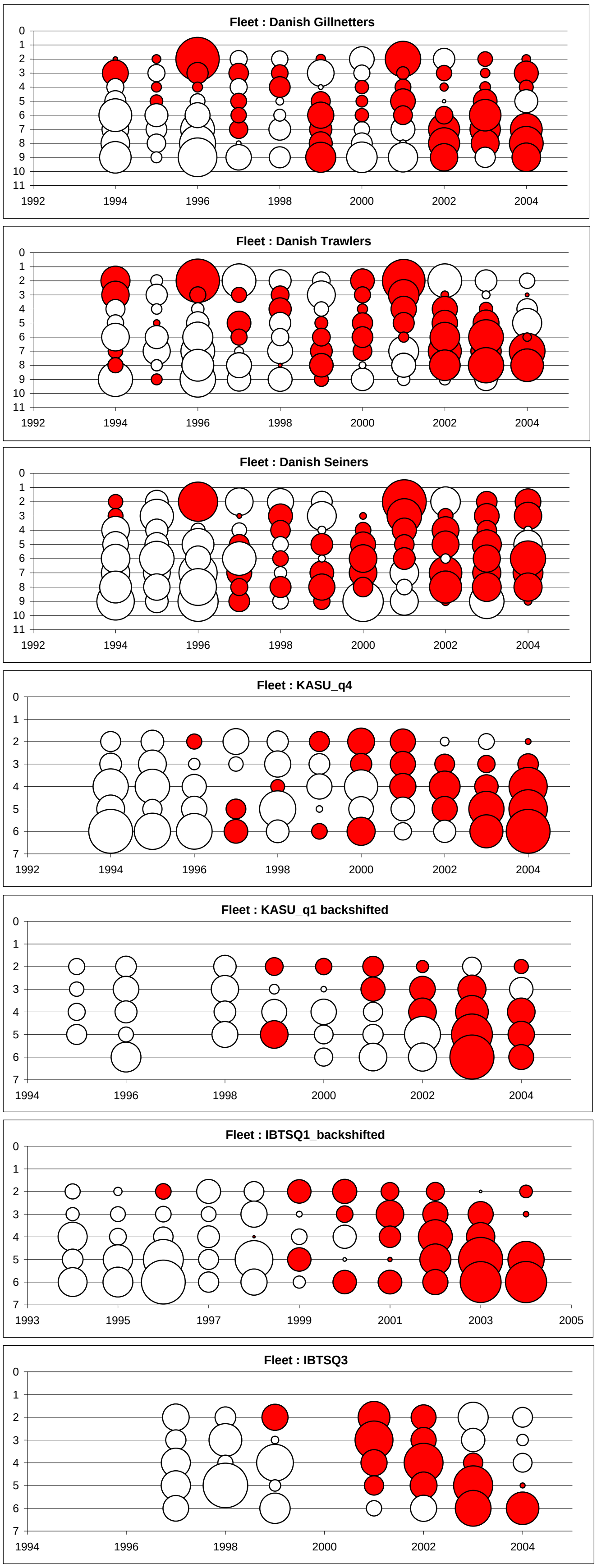


Figure 10.3.1.5 Plaice in IIIa. Stock summary plots.

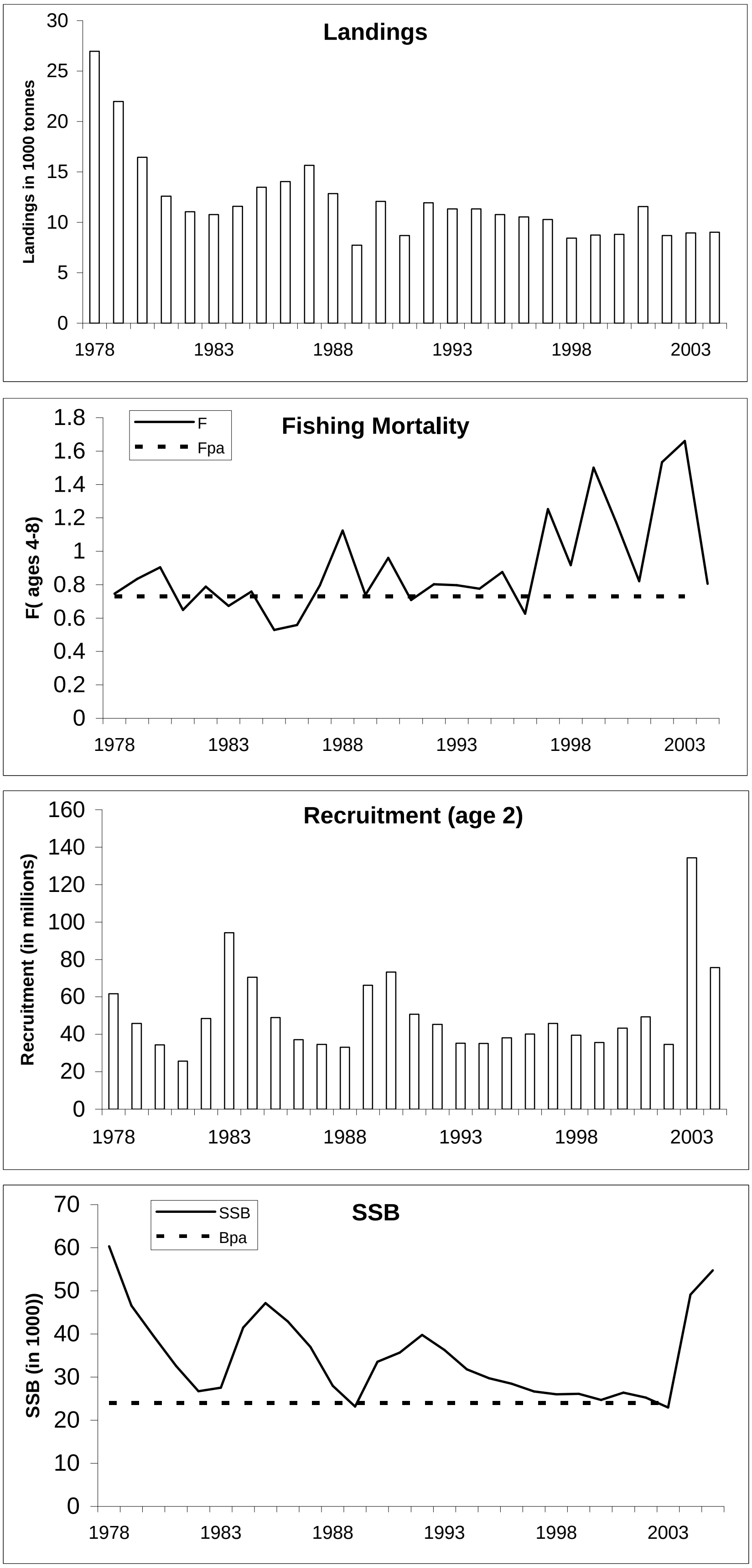


Figure 10.3.1.6. Plaice in IIIa. Historical performance of the assessment. There is no final 2005 assessment. Circles indicate forecasts.

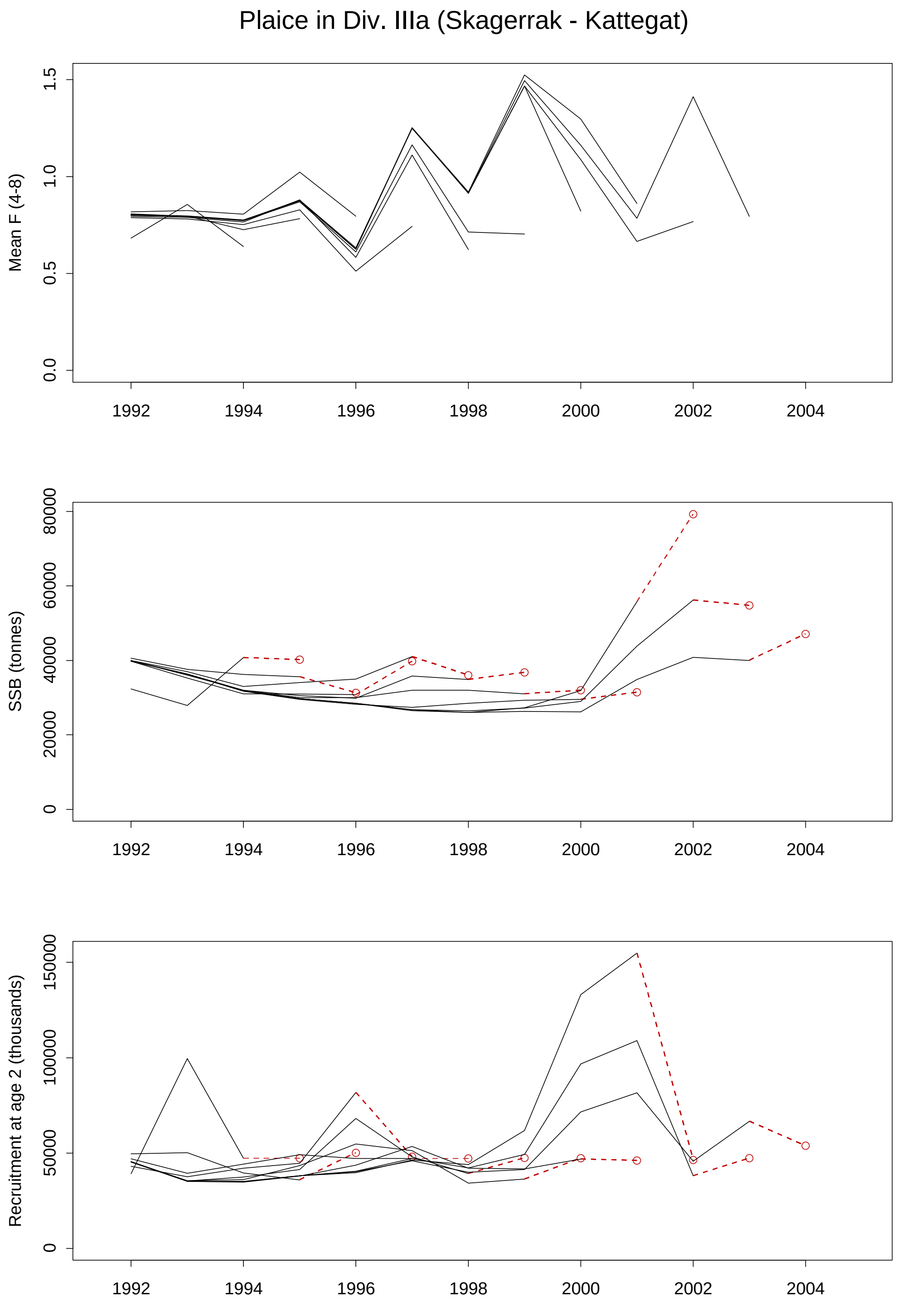


Figure 10.3.1.7. Plaice in IIIa. Retrospective analysis, XSA baseline assessment.

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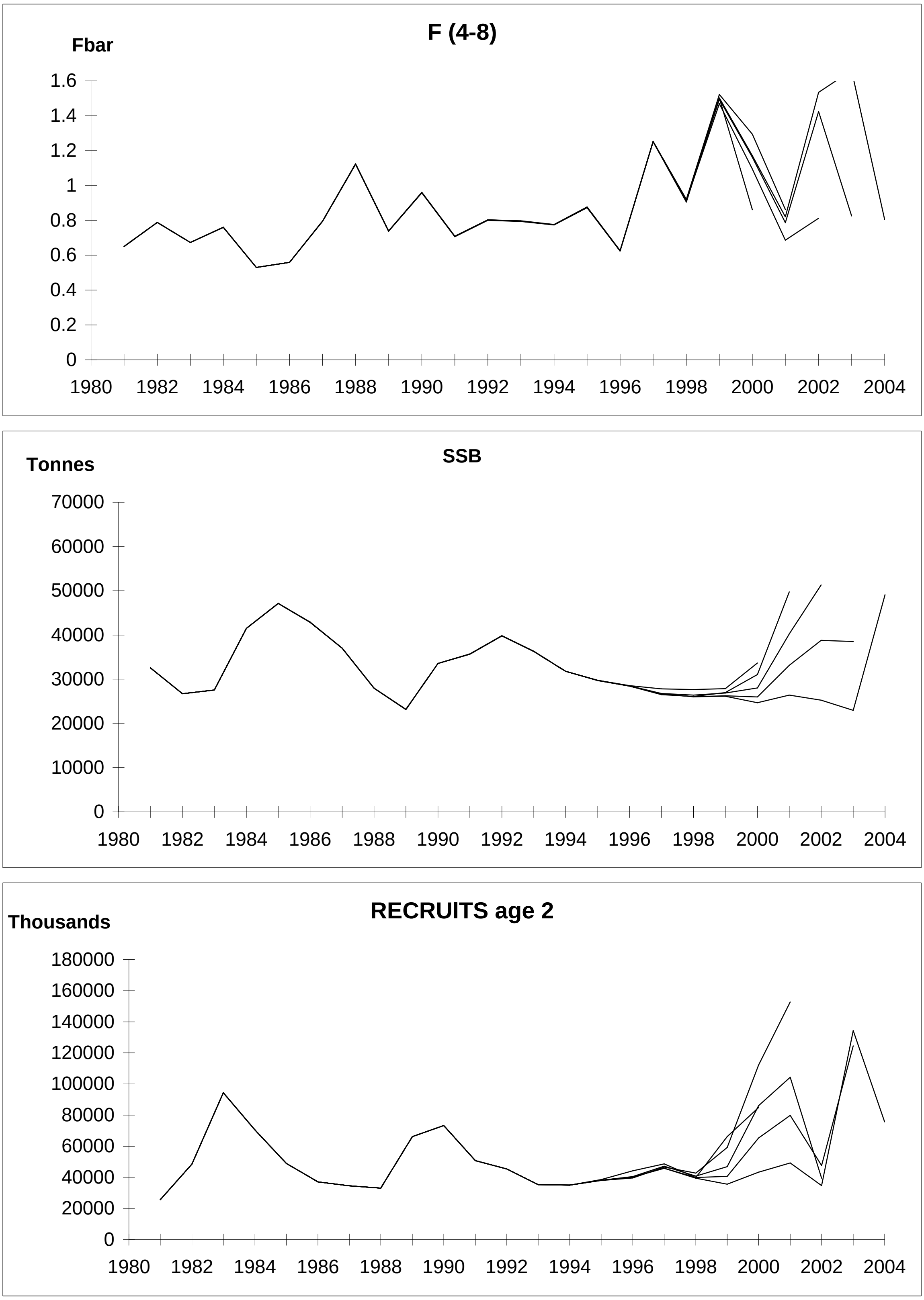


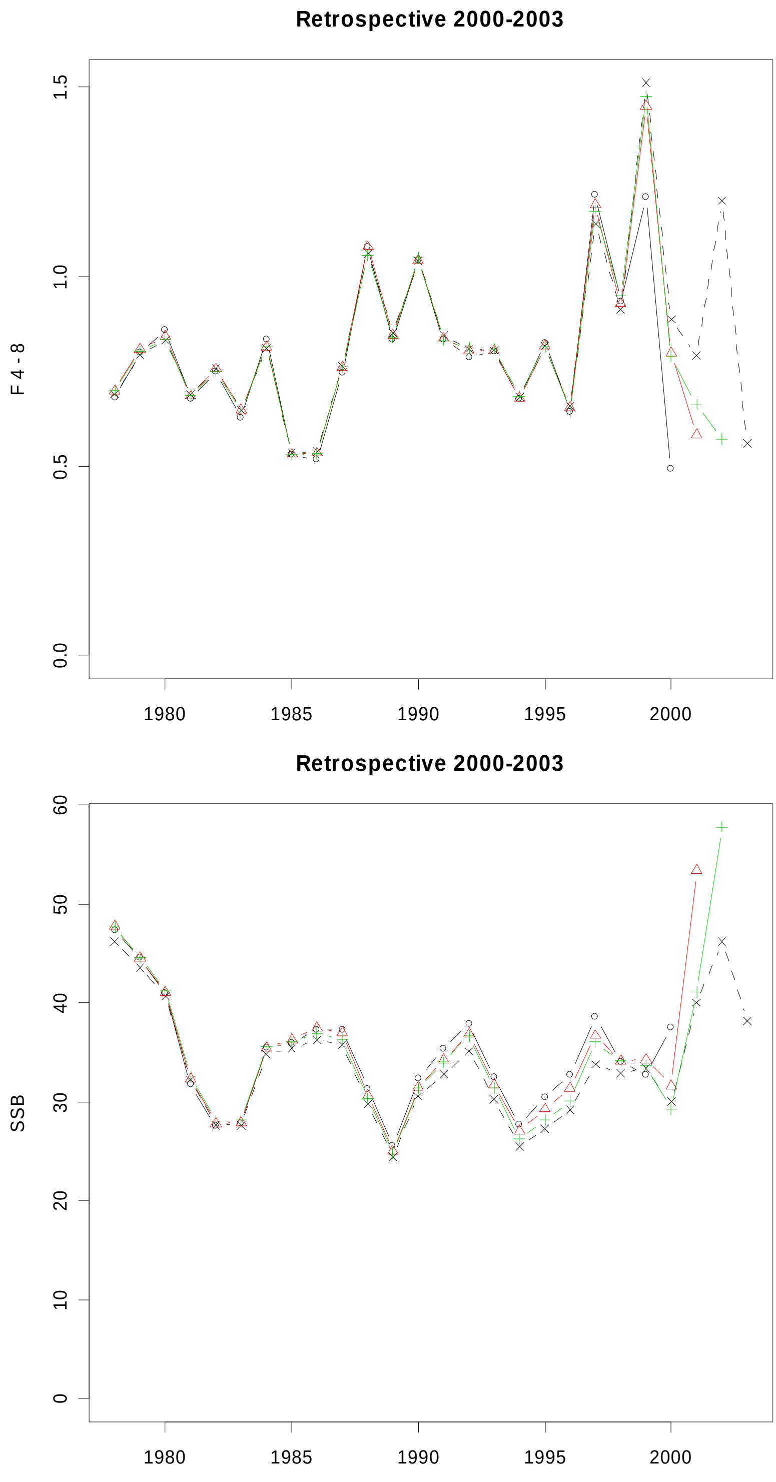
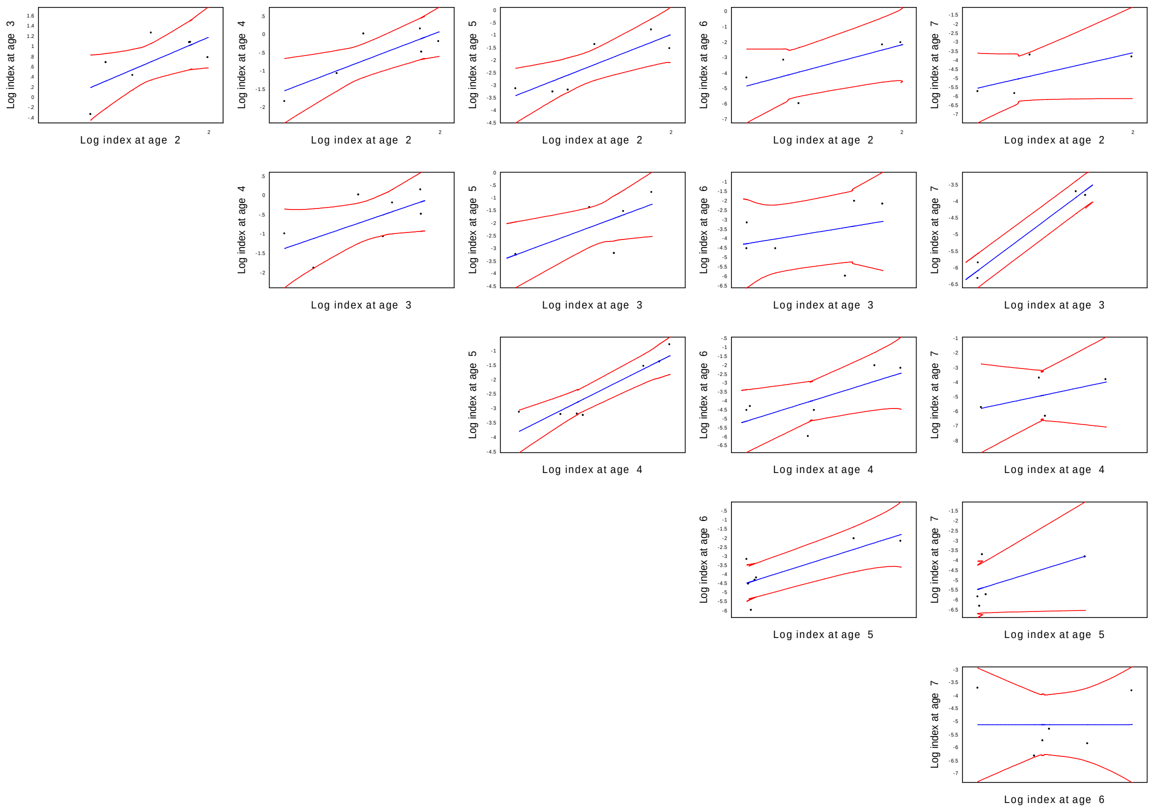


Figure 10.3.1.2.1. Plaice IIIa. Retrospective analysis using SMS approach.using 2004 WG data.

KASU_q1: Comparative scatterplots at age



KASU_q1: log cohort abundance

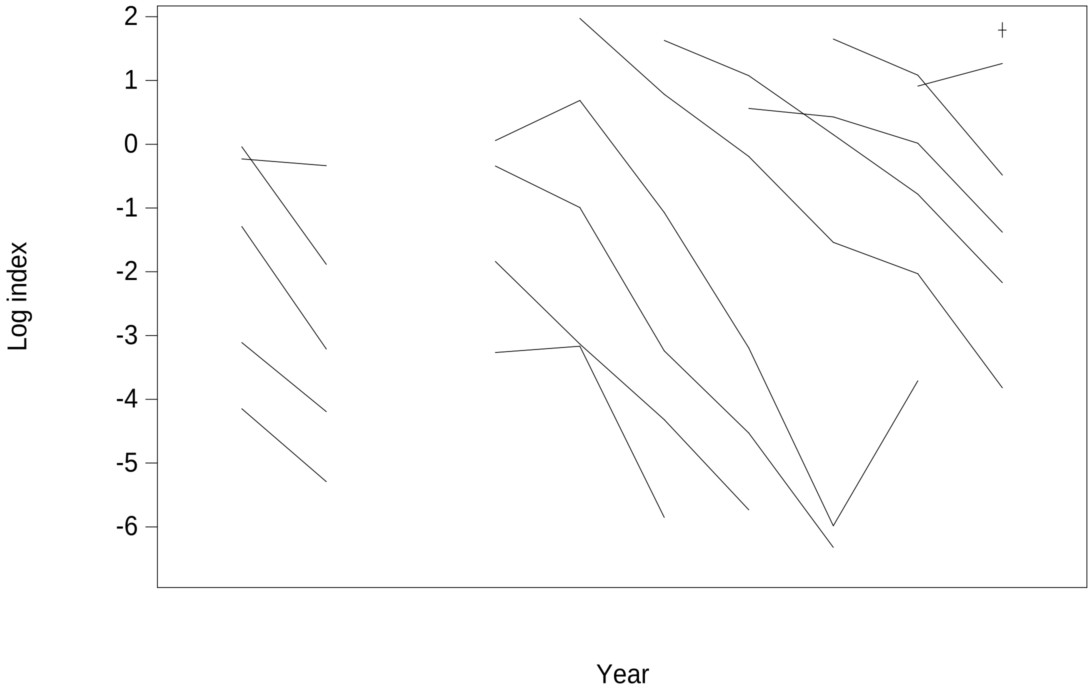
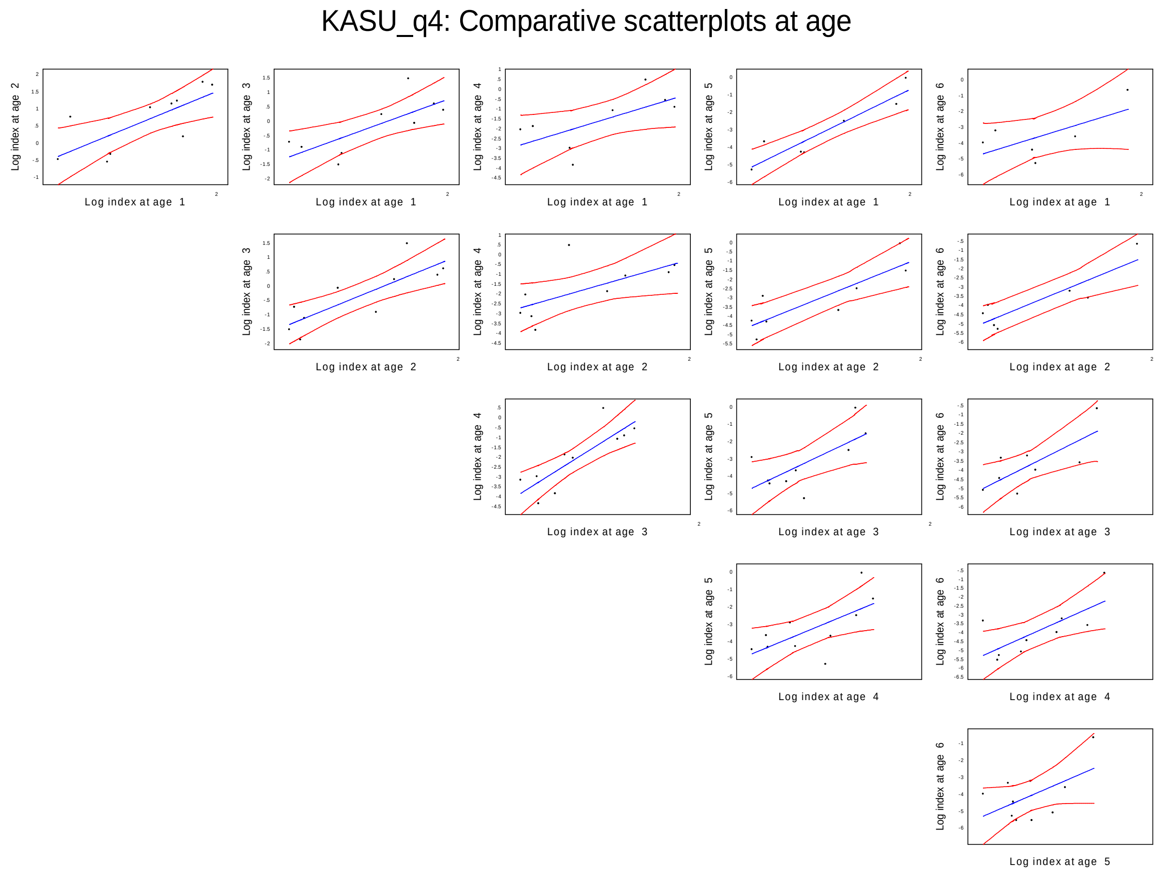


Figure 10.3.2.1. Plaice in IIIa. Matrix plots of internal consistency and catch curves for the survey indices.



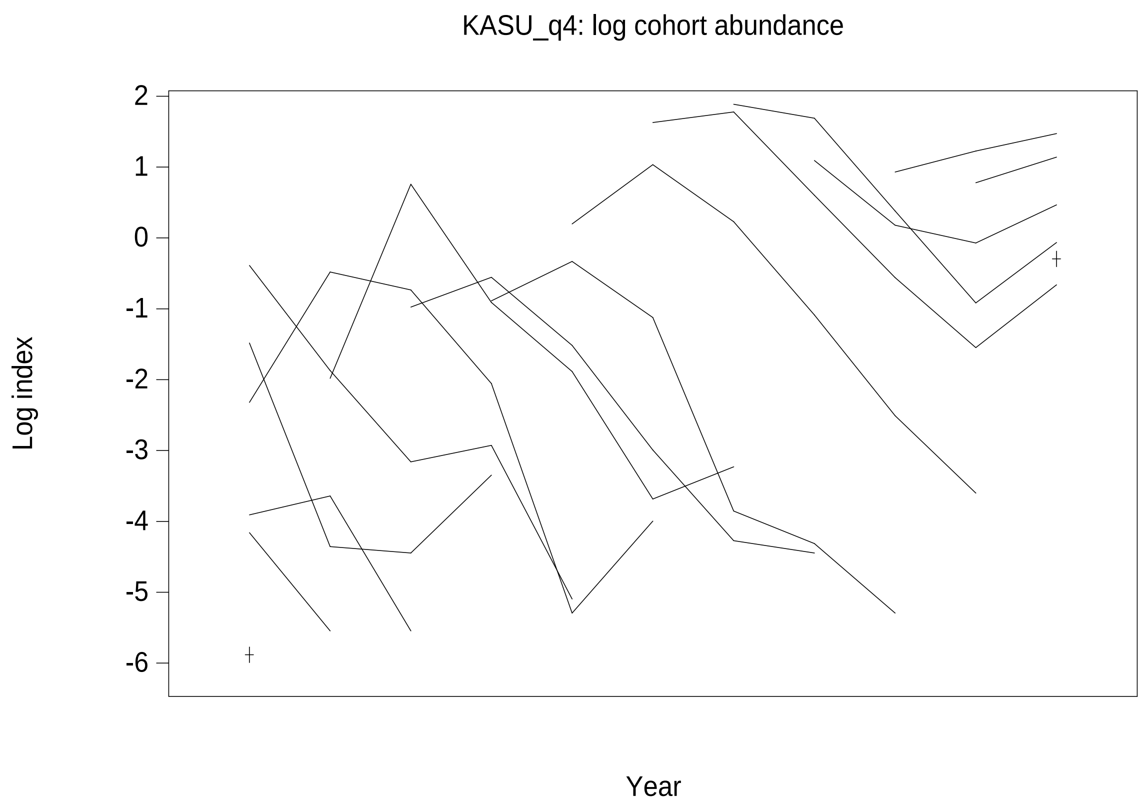
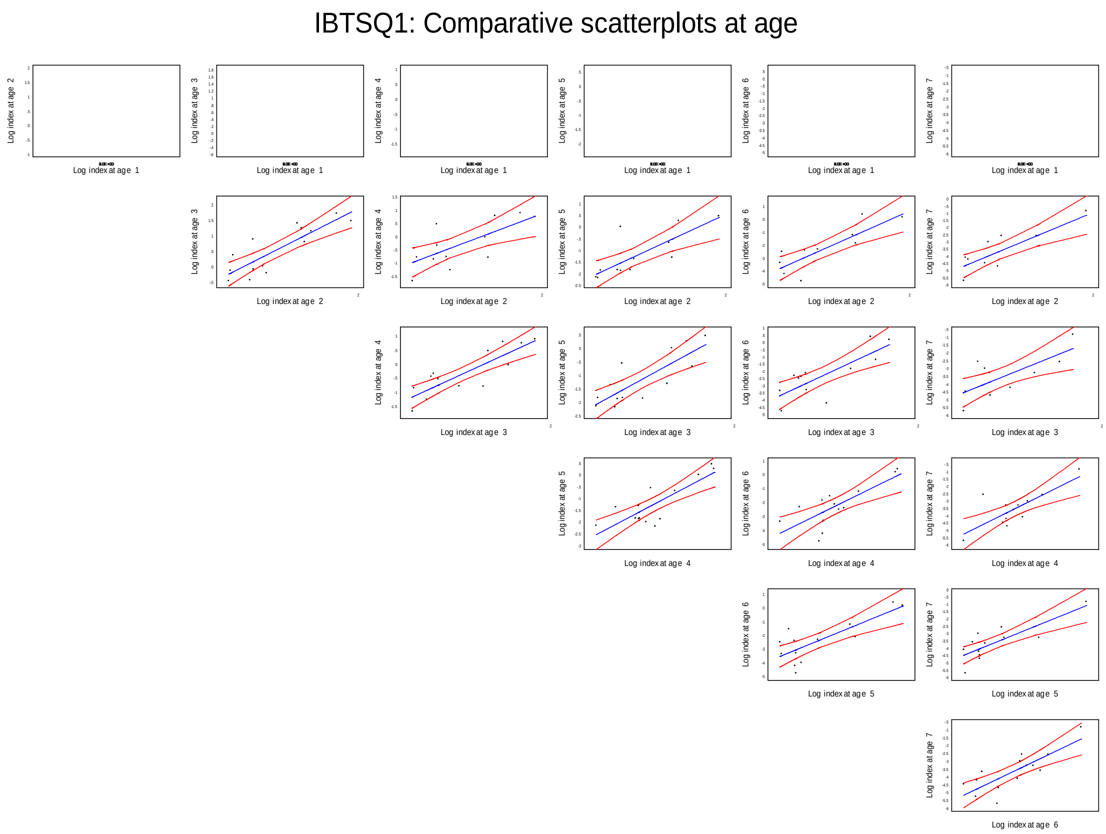


Figure 10.3.2.1. Cont' Plaice in IIIa. Matrix plots of internal consistency and catch curves for the survey indices.



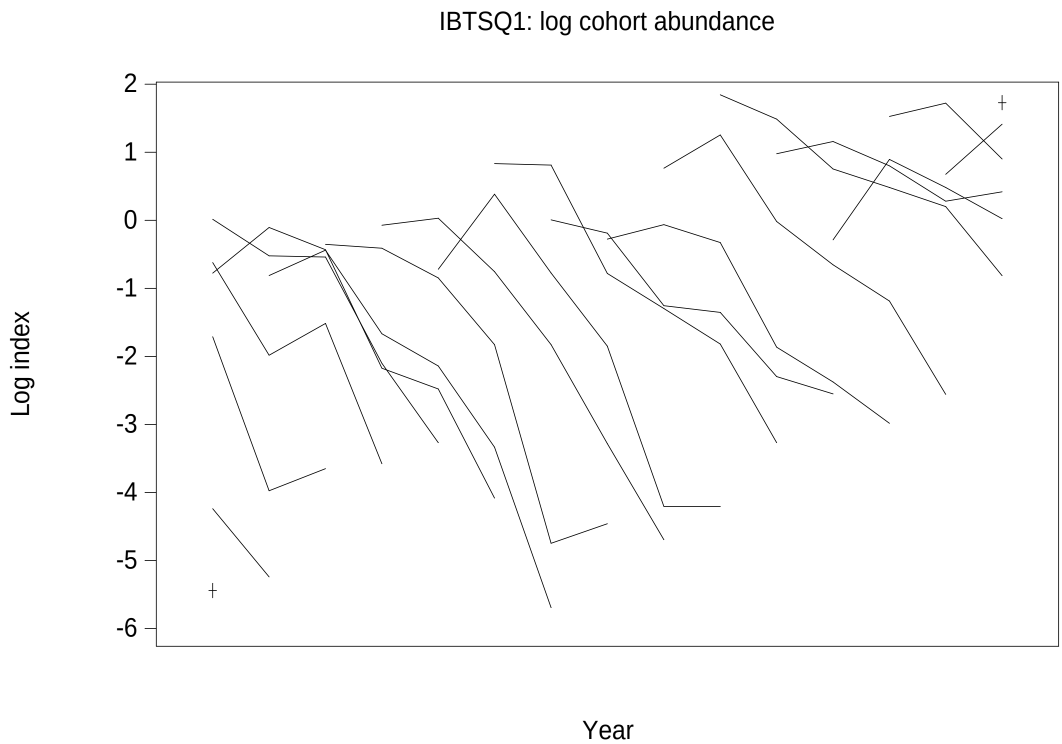
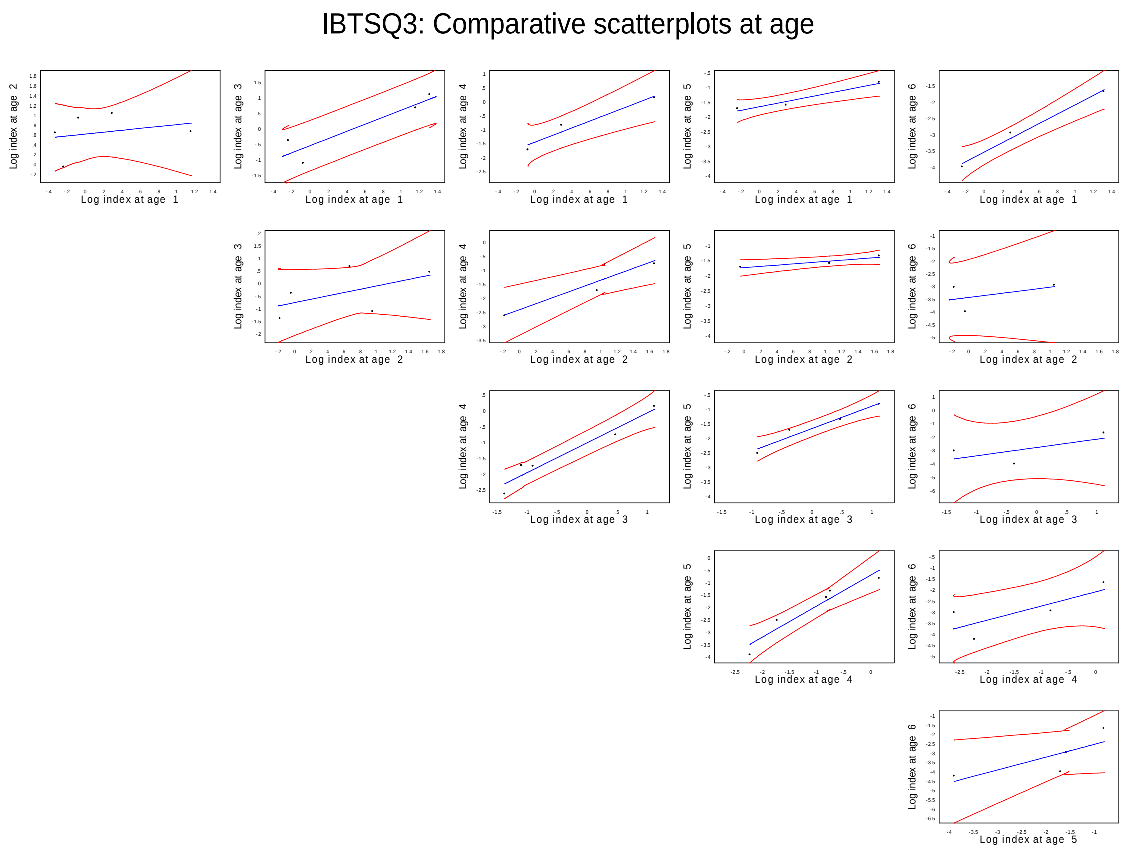


Figure 10.3.2.1. Cont' Plaice in IIIa. Matrix plots of internal consistency and catch curves for the survey indices.



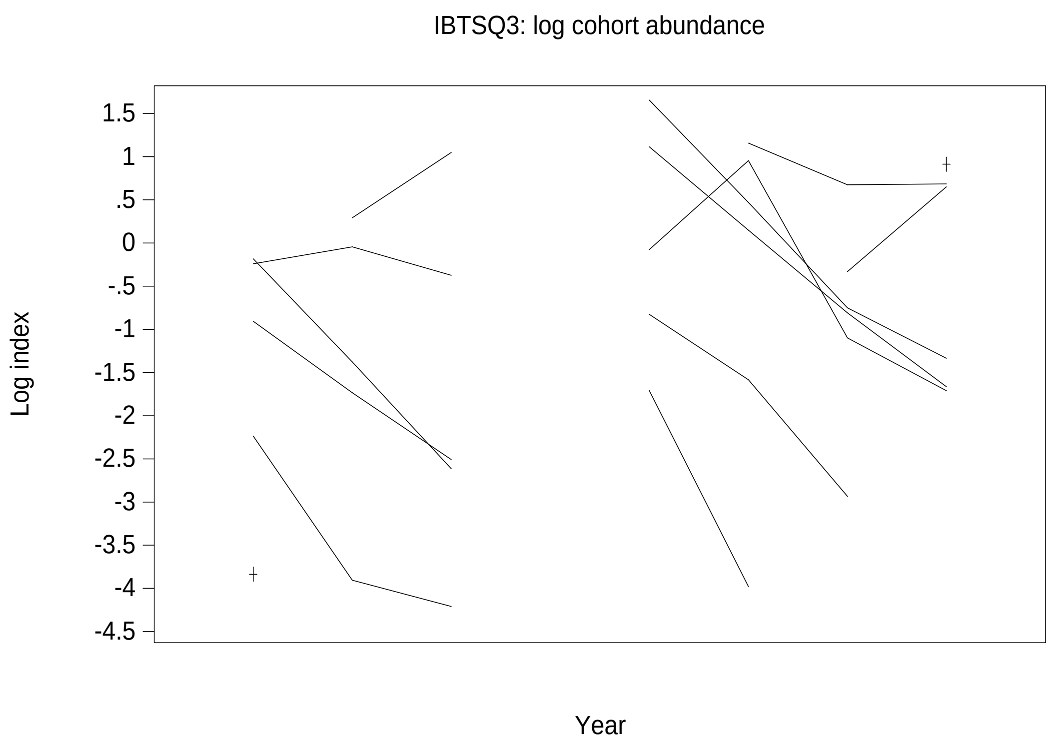


Figure 10.3.2.1. Cont' Plaice in IIIa. Matrix plots of internal consistency and catch curves for the survey indices.

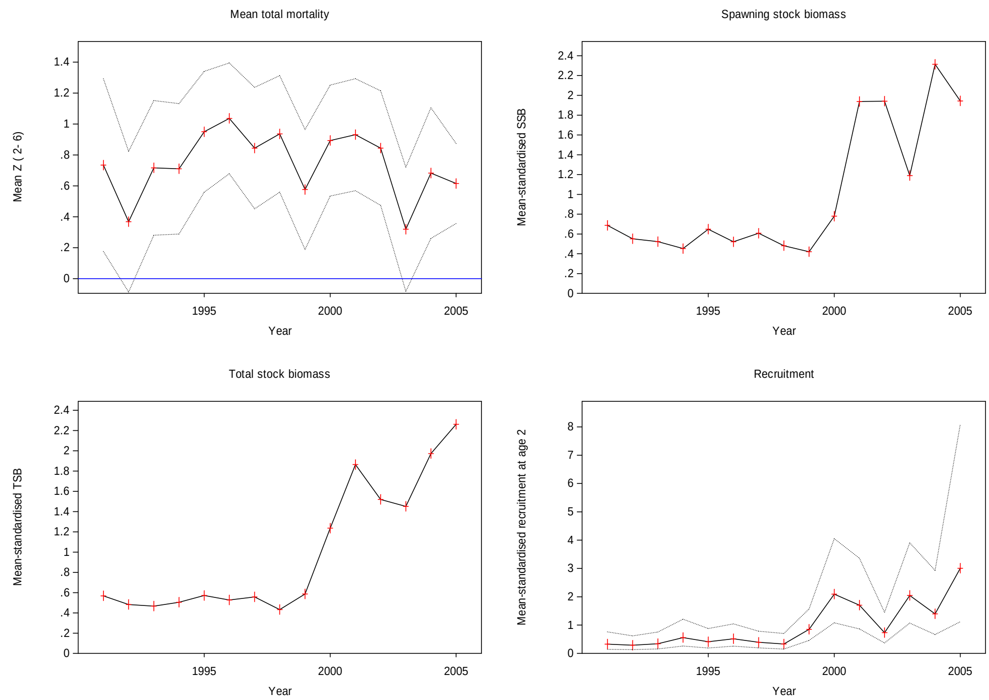


Figure 10.3.2.2. Plaice in IIIa. Stock summary plots using SURBA and the two surveys: IBTSQ1 and Havfisken Q1.

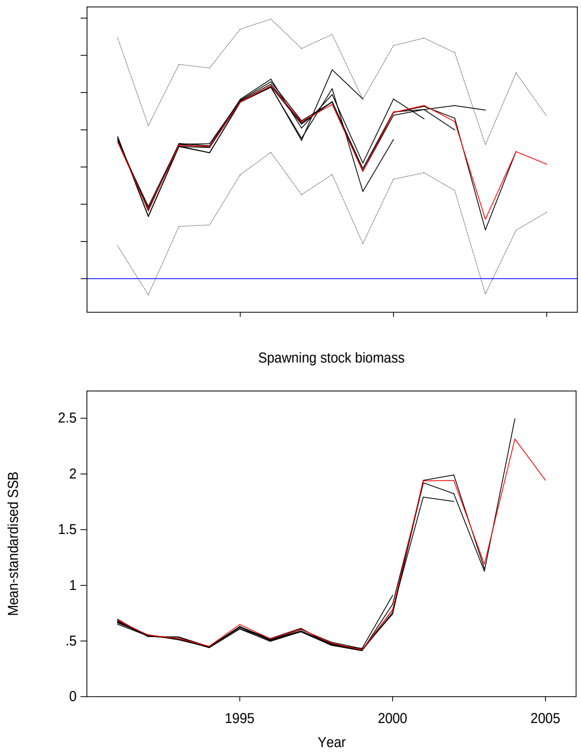
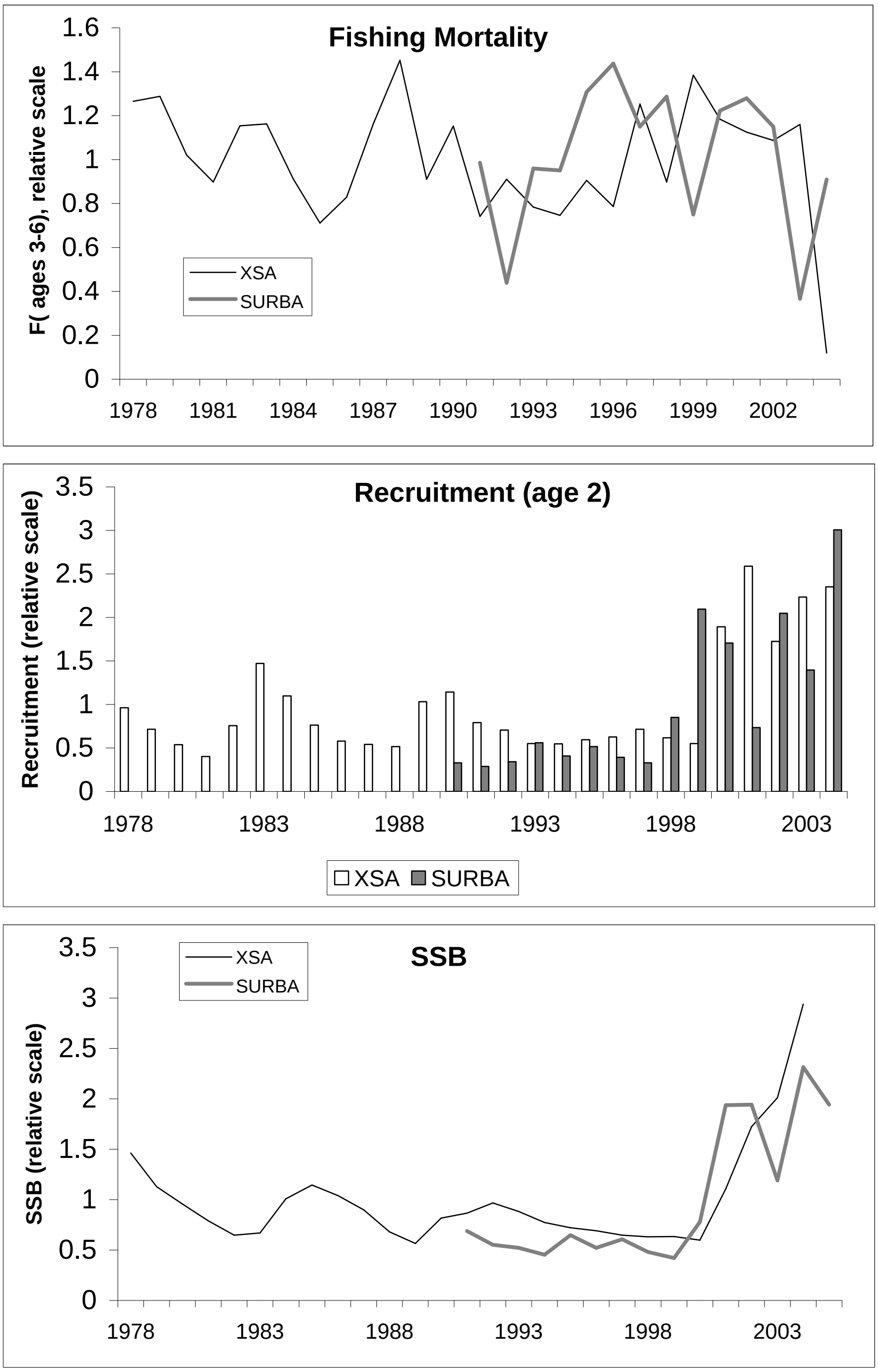


Figure 10.3.2.3. Plaice in IIIa. Retrospective analysis using SURBA.

Figure 10.3.2.4. Plaice in IIIa. Relative stock trends using XSA with survey tuning only and SURBA.



11 PLAICE IN DIVISION VIId

The assessment of plaice in Division VIId was initially on the list of update assessments but an exploratory analysis has been carried out to try to fix discrepancies observed in preliminary work. All the relevant biological and methodological information can be found in the Stock Annex dealing with this stock.

11.1 General

11.1.1 Ecosystem aspects

No information on ecosystem aspects was available to the Working Group.

11.1.2 Fisheries

Plaice is mainly caught in beam trawl fisheries for sole or in mixed demersal fisheries using otter trawls. There is also a directed fishery during parts of the year by inshore trawlers and netters on the English and French coasts. 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 first quarter is usually the most important for the fisheries but the relative part of the landings for this quarter has been decreasing from the early 1990s to a value around 30 – 35% of the total recently. In 2004, the beginning of the year remain predominant with the first semester corresponding to 63% of the total landings.

11.1.3 ICES advice

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

- No explicit management plans are settled for this stock.

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

- The current fishing mortality (Fsq) is estimated as 0.60, which is above rates that would lead to high long-term yields (Fmax=0.19). Fishing at Fmax is expected to lead to landings in 2005 of 2 000 t and SSB in 2006 of around 9 800 t.

Exploitation boundaries in relation to precautionary limits

- Fishing mortality in 2005 should be reduced to less than Fpa and to ensure that SSB will be above Bpa in 2006, corresponding to landings of less than 4 000 t.

Mixed fisheries considerations

Fisheries in Division IIIa (Skagerrak-Kattegat), in Subarea IV (North Sea) and in Division VIId (Eastern Channel)

should in 2004 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- with minimal bycatch or discards of cod;
- Implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised;
- within the precautionary exploitation limits for all other stocks.

11.1.4 Management

No explicit management plans are settled for this stock

The TAC in 2004 and 2005 were set respectively to 6060 t and 5151 t. for the combined ICES Division VIIde.

The minimum landing size is 27 cm and is not in accordance with the minimum mesh size (80 mm) in the beam trawl and otter trawl fisheries. Measures to reduce discarding in the sole fishery would benefit the plaice stock and future yield. Fixed nets are required to use 100 mm mesh size since 2002 although an exemption to permit 90 mm has been in force since that time.

An effort regulation has been enforced in 2004. Trawlers with mesh size less than 99 mm are limited to 22 days at sea per month, beam trawlers are limited to A4 days at sea per month and gill-netters have a derogation of 20 days at sea in the Eastern Channel provided that their mesh size is less than 110 mm.

11.2 Data available

11.2.1 Landings and discards

Landings data as reported to ICES together with the total landings estimated by the Working Group are shown in Table 11.2.1. From 1992 to 2002, the landings have remained steady between 5100 t and 6300 t. The 2004 landings of 4007 t. represents a second year of strong decrease 32% below the 5890 t. predicted at $\boldsymbol{F}_{sq}$ from last year's assessment. France contributed to 60% of the total landings in 2004 followed by Belgium (25%) and UK (15%).

Routine discard monitoring has recently begun following the introduction of the EU data collection regulations. Discards data for 2004 are available from all the countries contributing to the landings (Table 11.2.2 and Figure 11.2.1) though sampling levels are not high.. The percentage discarded per period, metiers and countries (Table 11.2.3) are highly variable and are all substantial. With a total number of trips sampled of 36 and 5 respectively, the trawlers have discarded 65% and the gillnetters 39%.of their catch over the year.

11.2.2 Age compositions

Age compositions of the landings are presented in Table 11.2.4. Sampling levels for those countries providing age compositions are given in the general section (Table 1.2.1).

11.2.3 Weight at age

Weight at age in the catch is presented in Table 11.2.5 and Figure 11.2.2 and weight at age in the stock in Table 11.2.6 and Figure 11.2.3. 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 11.2.4). All survey and commercial data available for calibration of the assessment are presented in Tables 11.2.7 and fully described in Stock Annex.

11.3 Data analyses

Although it is an update assessment, a series of exploratory analysis have been carried out to verify the consistency of the VPA based model because of concerns about the use of three commercial tuning fleets. In the following sections, the catch at age matrix and the tuning fleets are examined together with an historical performance of the assessment then an analysis of a survey based assessment with SURBA software enlights the WG on the possibility to avoid the use of commercial information for tuning the assessment.

11.3.1 Exploratory catch-at-age-based analyses

The log catch ratios residuals of the separable VPA (Figure 11.3.1) show no special pattern nor large values for the recent years of data, which suggests a relative consistency of the catch-at-age matrix.

The log catchability residuals from single fleet Laurec-Shefferd VPA model are shown Figure 11.3.2 for the six fleets used for calibration. The residuals from the two surveys covering the entire geographical area of the stock (UK BTS and French GFS) are increasing from the mid 90’s indicating a progressive divergence with the landings at age. This pattern can also been seen in the very last years of the UK commercial beam trawlers but is absent to the two other commercial fleets. The residuals from the French GFS are noisy and show some year effects while the span of the residuals from the International YFS is narrow suggesting a good performance of this fleet to estimate younger ages.

Results of the XSA analysis with the same settings as last year 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 graph of the contributions of the different fleets to the final estimators (Figure 11.3.3) indicate that the F shrinkage even set at the high value of 0.5 have a relative low contribution topping at 24% at age 1 and averaging at 18% over the whole ages.

A tendency to underestimate F and overestimate SSB appears in the last 5 years in the retrospective analysis (Figure 11.3.4).

11.3.2 Exploratory survey-based analyses

The survey-based analysis have been carried out with SURBA software. The parameters used for this exercise are a smoothing coefficient lambda set to 1.0 and a reference age set to 4, the range of F values for calculating the mean being 2 to 6 like the XSA analysis. The SURBA analysis proved to be unsensitive to the choice of the initial parameters in the neighborhood of those chosen here (Figure 11.3.5 to 11.3.7). Figures 11.3.8 and 11.3.9 show a good performance of the UK beam trawl survey and International YFS for tracking year classes through the time series unlike the French GFS. The internal consistencies (Figure 11.3.10 to 11.3.12) confirm this perception with the precise and significant slope for the indices from one year versus the indices of the immediate following year coming from the UK beam trawl survey.

The retrospective analysis (Figure 11.3.13) do not show the tendency of underestimating F and overestimating SSB as seen in the outcome of the XSA model. The confidence interval around mean Z is relatively narrow suggesting that the fishing mortalities perceived by the surveys are well-estimated throughout the time series.

The historical pattern of SSB show an increase for the period 1997-2002 followed by a slight decrease. This is not in agreement with the perception of the XSA estimates as shown figure 11.3.14.

11.3.3 Conclusions

A conflicting signal in SSB estimates appears between the XSA and the survey-based model, particularly in the most recent years. XSA model, mainly driven by the commercial fleets, perceives the SSB as having decreased from 1999 to its lowest level since the beginning of the series. The survey-based model, in line with the estimation of SSB by XSA up to 1999, perceives a steady SSB at the level of 1999 which was considered just above *Bpa*. The peak of 1999 is explained by the full recruitment of the 1996 year class but, since then, all recruitment have been weakest.

XSA and SURBA perceives the same peak in F in the mid 90’s followed by a decline, a slight increase and finally a decrease in the very last years. Even if there exists differences in levels and sometimes a one year lag in the pattern, the two perceptions are consistent together.

Concerning the recruitment estimates, the two models are consistent. This can be explained by the strong dependency of both estimates to the YFS survey.

At the end, the landings-at-age analysis is consistent with previous years, not subject to TAC constraint nor to under reporting problems. On the other hand, this analysis has a tendency of underestimating F and over estimating SSB, does not take into account the unknown historical discards pattern and is mainly driven by the commercial fleets. These commercial fleets corresponds all together to the major part of the landings-at-age matrix. Both landings-at-age and tuning fleets information are highly dependent on the accuracy of the spatially declaration of the fishing activity as an important component of the fisheries operates on the bordeline of ICES subdivision IVc (Figure 9.2.10).

The survey-based analysis is based on three surveys, two of them covering the complete geographical area of the stock and the remaining covering the main nursery grounds. The variance of Z estimates is acceptable and no retrospective pattern is apparent but the period of the surveys (August to October) immediately follows the main landings period (January to June) leading to the risk of perceiving the signal of a remaining stock instead of the signal of available stock. The analysis has also shown that one survey do not track well year classes so that the assessment of the main ages composing the stock relies on only one survey.

Waiting for next year benchmark assessment and intersessional work on the data and in absence of clear explanation on the conflict between surveys and commercial information, the WG has decided to present the two perceptions of the stock.

11.3.4 Final assessment

No final assessment has been carried out for this stock

11.4 Historical stock trends

The recent historical trends of the stock are not given to be reliable due to the discrepancy described above and will therefore not be commented.

11.5 Recruitment estimates

No recruitment estimates is available for this stock.

11.6 Short-term prognosis

No short-term prognosis is available for this stock.

11.7 Quality of the assessment

The historical performance of the assessment is summarised in Figure 11.7.1.

Suggested work plan for benchmark:

- Analyse the consistency and reliability of the tuning fleets (individual retrospective analysis, log catchabilities residuals, standardised CPUE, etc). Consider redefinition of the current tuning fleets (prior to the WG) and/or the integration of new ones. UK have provided beam-trawler data for this assessment but this new tuning fleet has not been used given that this was an update assessment.
- Integrate the ongoing discard estimation into the assessment.
- Investigate whether the problem of misreporting on sole could affect the reporting of plaice.
- Verify the consistency of the weights time series, with particular reference to the influence of an incorrect assumption about sex-ratios on mean weight calculations.
- Produce maps of catches per ICES rectangle for the recent years to investigate a possible shift in catch distribution.
- produce maps of distribution from the surveys

The next benchmark assessment for this stock is scheduled for 2006.

11.8 Management considerations

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

- The TAC is for Divisions VIId and VIIe combined. Plaice in VIIe is considered at risk of being harvested unsustainably and the current state of plaice VIId is unknown.
- The picture of the International landings per rectangle in 2004 (Figure 9.2.10) indicates more continuity between the landings from VIId and south IV than between VIId and VIIe. This perception confirms the statement on stock definition developed in the stock annex.

The plaice stock in VIId is mostly harvested in a mixed fishery with sole in VIId. Even if there exists a directed fishery on plaice that occurs in a limited period at the beginning of the year on the spawning grounds, plaice is mainly taken as by-catch by the demersal fisheries, especially targeting sole.

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

Table 11.2.1 - Plaice in VIId. Nominal landings (tonnes) as officially reported to ICES , 1976-2004

Year	Belgium	Denmark	France	UK(E+W)	Others	Total reported	Un-allocated	Total as used by WG
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
2004	987	-	2439(4)	580	-	4007	-	4007

1 Estimated by the Working Group from combined Division VIId+e
2 Includes Division VIIe
3 Preliminary
4 Data provided to the WG but not officially provided to ICES

Table 11.2.2 - Plaice VIId. Length structure of discards and landings collected by observations on board (numbers raised to sampled trips)

Lg	Fr trawl			Fr Gillnet		UK			Belgium
	Discards Q2	Discards Q3	Discards Q4	Discards Q2	Discards Q3	Discards Q2	Discards Q3	Discards Q4	Year
	3 trips	9 trips	5 trips	4 trips	1 trips	4 trips	2 trips	6 trips	10 trips
7	0	0	0	0	0	0	0	0	0
8	33	0	0	0	0	0	0	0	0
9	21	0	0	0	0	0	0	0	0
10	0	0	0	2	0	0	0	0	0
11	7	0	0	2	0	0	0	0	0
12	0	0	0	2	0	0	0	0	0
13	44	8	0	2	0	0	3	0	0
14	116	5	0	2	0	0	0	0	0
15	613	17	0	0	0	0	3	0	0
16	653	21	0	4	0	1	13	0	2
17	1258	61	0	4	0	21	52	0	4
18	1364	44	0	7	0	19	92	0	28
19	1340	47	0	22	3	23	103	21	64
20	1081	35	20	12	17	71	169	22	142
21	984	44	10	18	58	297	125	15	260
22	577	6	10	26	57	609	128	0	379
23	375	82	50	22	25	395	169	40	509
24	296	22	30	30	30	1141	242	66	680
25	81	18	20	26	13	1424	239	25	844
26	72	4	40	17	3	1917	233	38	876
27	14	0	30	14	2	2852	73	75	605
28	0	1	10	6	0	2682	18	3	235
29	0	0	0	2	0	3414	0	17	66
30	0	0	0	2	0	1640	0	20	19
31	0	0	0	2	0	1114	0	2	0
32	0	0	0	0	0	458	0	7	0
33	0	0	0	0	0	269	0	0	0
34	0	0	0	0	0	159	0	7	0
35	0	0	0	0	0	59	0	5	0
36	0	0	0	0	0	1	0	2	0
37	0	0	0	0	0	0	0	5	0
38	0	0	0	0	0	0	0	2	0
39	0	0	0	0	0	0	0	2	0
40	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	2	0
44	0	0	0	0	0	0	0	2	0
45	0	0	0	0	0	0	0	2	0
46	0	0	0	0	0	0	0	2	0
47	0	0	0	0	0	0	0	3	0
48	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	3	0
55	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0

Table 11.2.2 (cont.)- Plaice VIId. Length structure of discards and landings collected by observations on board (numbers raised to sampled trips)

Lg	Fr trawl			Fr Gillnet		UK			Belgium
	Landings Q2	Landings Q3	Landings Q4	Landings Q2	Landings Q3	Landings Q2	Landings Q3	Landings Q4	Year
7	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0
20	0	0	0	13	0	0	0	0	0
21	2	0	0	14	0	0	0	0	0
22	0	0	0	17	2	0	0	0	0
23	5	5	0	14	3	0	0	0	0
24	17	8	0	16	7	0	0	0	0
25	47	20	0	29	23	0	0	0	0
26	74	22	0	22	27	5	13	0	10
27	131	24	0	20	30	54	407	91	543
28	94	24	0	37	20	190	427	160	916
29	127	19	0	29	5	364	402	148	1071
30	77	29	0	34	5	595	312	93	1094
31	61	39	0	36	8	1055	345	139	920
32	43	32	21	31	2	1407	233	80	874
33	33	15	21	14	7	1323	214	88	761
34	27	27	21	30	0	1126	170	58	688
35	13	16	0	26	3	1080	134	71	626
36	7	20	0	23	2	884	111	69	495
37	5	16	0	12	2	658	64	31	449
38	6	10	0	19	0	549	69	14	367
39	5	13	21	21	0	506	40	39	309
40	2	16	0	21	0	295	35	17	238
41	0	2	0	9	0	328	32	16	176
42	0	9	0	12	2	274	24	15	174
43	2	5	0	5	0	190	40	13	128
44	0	6	21	0	0	188	20	3	127
45	0	6	0	2	0	157	9	20	88
46	0	8	0	5	0	117	11	10	69
47	0	8	21	0	0	103	15	18	58
48	0	6	0	0	0	38	15	11	62
49	0	1	0	2	0	98	4	14	33
50	0	7	0	3	0	41	9	10	32
51	0	4	0	0	0	22	0	0	28
52	3	3	0	1	0	42	0	0	15
53	0	4	0	0	0	10	7	3	11
54	0	1	0	0	0	5	0	0	11
55	2	1	0	0	0	0	5	0	8
56	0	0	0	0	0	0	0	3	7
57	0	3	0	0	0	3	3	0	0
58	0	0	0	0	0	1	0	0	3
59	0	0	0	0	0	0	0	0	4
60	0	4	0	0	0	0	0	1	0

Table 11.2.3. - Plaice VIId. Landings (L), discards (D) and percentage discards (%D) per period, métier and country in numbers raised to the sampled trips

Period	Métier	Country	Numbers Trips sampled	Hauls sampled	Landed	Discarded	%D
Quarter 2	Gillnet	France	4	30	514	220	30%
Quarter 2	Trawl	France	3	14	780	8928	92%
Quarter 2	Trawl	UK	4	97	11708	18566	61%
Quarter 3	Gillnet	France	1	3	147	208	59%
Quarter 3	Trawl	France	9	101	431	413	49%
Quarter 3	Trawl	UK	2	27	3170	1662	34%
Quarter 4	Trawl	France	5	7	123	219	64%
Quarter 4	Trawl	UK	6	68	1235	388	24%
2004	Gillnet	France	5	33	661	428	39%
2004	Trawl	France	17	122	1334	9560	88%
2004	Trawl	UK	12	192	16113	20616	56%
2004	Beam Trawl	Belgium	7	-	4713	10395	69%
2004	Gillnet		5	33	661	428	39%
2004	Trawl		36	314	22160	40571	65%

Table 11.2.4 - Plaice VIId. Landings in numbers (thousands**)**

	1	2	3	4	5	6	7	8	9	10+
1980	53	2644	1451	540	490	75	45	44	4	103
1981	16	2446	6795	2398	290	159	51	42	56	200
1982	265	1393	6909	3302	762	206	96	62	21	88
1983	92	3030	3199	5908	931	226	92	122	4	101
1984	350	1871	7310	2814	1874	533	236	101	34	100
1985	142	5714	6195	4883	413	612	164	99	139	50
1986	679	4884	7034	3663	1458	562	254	69	19	34
1987	25	8499	7508	3472	1257	430	442	154	105	77
1988	16	5011	18813	4900	1118	541	439	127	105	174
1989	826	3638	7227	9453	2672	588	288	179	81	197
1990	1632	2627	8746	5983	3603	801	243	203	178	231
1991	1542	5860	5445	4524	2437	1681	286	120	113	125
1992	1665	6193	4450	1725	1187	1044	698	200	116	118
1993	740	7606	3817	1259	542	468	334	287	102	152
1994	1242	3633	6968	3111	850	419	312	267	275	312
1995	2592	4340	2933	2928	922	228	277	225	122	258
1996	1119	4847	3606	1547	1436	488	179	176	165	347
1997	550	4246	7189	3434	1080	752	464	199	114	306
1998	464	4400	8629	3419	537	143	136	81	52	188
1999	741	1758	12104	6460	1043	171	86	81	38	111
2000	1383	6214	4284	7241	1652	307	82	27	42	98
2001	2682	4159	4380	2141	1985	310	87	22	13	78
2002	902	7204	5191	1907	1565	888	234	62	25	92
2003	646	4874	5668	1864	424	373	333	75	50	62
2004	967	4964	5471	894	389	152	133	133	38	48

Table 11.2.5 - Plaice in VIId. Weights in the landings

	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
2004	0.217	0.243	0.295	0.421	0.483	0.61	0.636	0.933	1.093	1.348

Table 11.2.6 -Plaice in 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
2004	0.172	0.183	0.268	0.408	0.471	0.521	0.616	0.892	1.102	1.287

Table 11.2.7. - Plaice in VIId. Tuning fleets

FLT01: UK INSHORE TRAWL METIER <40 trawl lands all trawl age comps fleet (Catch: Unknown)

1985 2004

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
653	216.9	46.4	24.9	5.1	4.1	6.9	5.1	0.3	0.3
661	84.6	127.5	13.5	5.4	2.3	1.9	3.8	1.7	0.5

FLT02: BELGIAN BEAM TRAWL(HP corr) all gears age comp [rev: 05/08/04-WD] (Catch: Unknown)

1981 2004

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
39.1	317.8	1329.4	313.9	154.7	48.8	68.3	51.5	13.3	23.4

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
12647	1984.9	2715.5	701.5	129.6	82.8	75.1	17.8	16.3	11.2
9613	3107.1	2308.6	284.8	110.4	50.1	22.3	24.4	5.9	6.7

Table 11.2.7.(continued) - Plaice in VIId. Tuning fleets

```
FLT04: UK BEAM TRAWL SURVEY   true age 6 [rev: 15/08/04-RM] (Catch: Unknown) (Effort:
Unknown)
(Effort: Unknown)
1988 2004
1 1 0.50 0.75
1 6
   1   26.5   31.3   43.8    7.0    4.6    1.5
   1    2.3   12.1   16.6   19.9    3.3    1.5
   1    5.2    4.9    5.8    6.7    7.5    1.8
   1   11.8    9.1    7.0    5.3    5.4    3.2
   1   16.5   12.5    4.2    4.2    5.6    4.9
   1    3.2   13.4    5.0    1.7    1.9    1.6
   1    8.3    7.5    9.2    5.6    1.9    0.8
   1   11.3    4.1    3.0    3.7    1.5    0.6
   1   13.2   11.9    1.3    0.7    1.3    0.9
   1   33.1   13.5    4.2    0.6    0.3    0.3
   1   11.4   27.3    7.0    3.1    0.3    0.2
   1   11.3   14.1   15.9    2.9    1.0    0.2
   1   13.2   21.0   14.4   13.8    3.5    0.9
   1   17.9   13.0   10.0    7.1   10.9    1.9
   1   20.7   15.9    7.7    3.5    1.8    3.5
   1    6.2   22.8    6.0    2.9    1.6    0.8
   1    36.2    15.0   13.2    3.4   0.9     0.2

FLT05: French GFS [option 2]  true age 5 [rev: 01/09/04-JV] (Catch: Unknown) (Effort:
Unknown)
(Effort: Unknown)
1988 2004
1 1 0.75 1.00
0 5
1       1.9    8.0   17.6    9.9    1.7    0.6
1       1.6    3.5    7.4    2.7    1.1    0.1
1       0.1    3.9    1.2    2.7    1.9    1.6
1       0.1    2.5    2.1    0.8    0.6    0.4
1       0.9   34.4    3.6    1.9    0.3    0.2
1       6.6   28.7   13.4    6.3    1.4    0.6
1       5.3    6.5    3.0    1.1    0.2    0.1
1       2.1    7.9    4.4    1.1    0.7    0.2
1      30.5    6.6    3.1    0.3    0.1    0.2
1      10.2   40.9   10.9    3.8    0.3    0.1
1      10.0   16.4   18.4    4.1    0.5    0.1
1       1.0   10.3    5.6    8.0    1.3    0.2
1      19.3   12.5   15.6    4.3    3.1    0.8
1       6.0    9.7    4.6    1.6    0.8    0.3
1       0.5   11.2    9.4    4.4    0.4    0.2
1      11.1    3.2   10.8    5.0    4.1    2.1
1       2.4   10.4   10.0    4.9    1.0    0.1
FLT06: Intl YFS [rev: 01/09/04-JV] (Catch: Unknown) (Effort: Unknown)
1987 2004
1 1 0.50 0.75
0 1
   1   11.68    1.44
   1   5.56     1.32
   1   3.97     0.58
   1   3.42     0.71
   1   4.36     0.62
   1   4.04     1.78
   1   3.70     0.84
   1   8.69     0.79
   1   6.87     1.68
   1   4.07     0.66
   1   2.23     0.82
   1   5.30     0.8
   1   3.81     0.76
   1   5.14     0.48
   1   3.74     0.83
   1   0.67     0.92
   1   4.86     0.65
   1   6.10     0.78
```

Table 11.3.1 Plaice in VIId. Tuning diagnostic

```
Lowestoft VPA Version 3.1

   6/09/2005  18:21

 Extended Survivors Analysis

 Plaice in VIId (run: XSAAEDB01/X01)

 CPUE data from file C:\VPA2\DATA\FLEET.DAT

 Catch data for  25 years. 1980 to 2004. Ages  1 to  10.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                      ,   year, year,  age ,  age
 FLT01: UK INSHORE TR,   1985, 2004,   2,     9,   .000,  1.000
 FLT02: BELGIAN BEAM ,   1981, 2004,   2,     9,   .000,  1.000
 FLT03: FRENCH TRAWLE,   1989, 2004,   2,     9,   .000,  1.000
 FLT04: UK BEAM TRAWL,   1988, 2004,   1,     6,   .500,   .750
 FLT05: French GFS [o,   1988, 2004,   0,     5,   .750,  1.000
 FLT06: Intl YFS [rev,   1987, 2004,   0,     1,   .500,   .750

 Time series weights :

      Tapered time weighting not applied


 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    7

 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   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,  .0456,  .3415,  .4533,  .4969,  .4789,  .3919,  .3680,  .2579,  .2455
 Iteration 30,  .0456,  .3415,  .4533,  .4969,  .4789,  .3919,  .3680,  .2579,  .2455

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,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004

      1,  .114,  .039,  .015,  .033,  .045,  .088,  .139,  .037,  .033,  .046
      2,  .378,  .288,  .184,  .147,  .152,  .552,  .367,  .585,  .258,  .341
      3,  .612,  .548,  .794,  .606,  .655,  .582,  .852,  .943, 1.178,  .453
      4,  .678,  .677, 1.462, 1.015, 1.167,  .945,  .573, 1.041,  .975,  .497
      5,  .513,  .746, 1.374,  .851,  .900,  .982,  .648,  .980,  .598,  .479
      6,  .310,  .497, 1.026,  .566,  .639,  .643,  .425,  .599,  .577,  .392
      7,  .492,  .379, 1.130,  .443,  .705,  .643,  .332,  .582,  .415,  .368
      8,  .436,  .591,  .835,  .518,  .457,  .438,  .311,  .372,  .328,  .258
      9,  .417,  .586,  .859,  .473,  .434,  .403,  .347,  .613,  .513,  .245
```

Table 11.3.1 (continued) – Plaice in VIId. Tuning diagnostic

1

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
1995	2.52E+04	1.45E+04	6.74E+03	6.25E+03	2.42E+03	8.99E+02	7.50E+02	6.69E+02	3.76E+02
1996	3.05E+04	2.03E+04	8.98E+03	3.31E+03	2.87E+03	1.31E+03	5.96E+02	4.15E+02	3.91E+02
1997	3.80E+04	2.65E+04	1.38E+04	4.70E+03	1.52E+03	1.23E+03	7.21E+02	3.69E+02	2.08E+02
1998	1.50E+04	3.39E+04	2.00E+04	5.64E+03	9.85E+02	3.48E+02	4.00E+02	2.11E+02	1.45E+02
1999	1.78E+04	1.31E+04	2.65E+04	9.86E+03	1.85E+03	3.81E+02	1.79E+02	2.32E+02	1.13E+02
2000	1.72E+04	1.54E+04	1.02E+04	1.24E+04	2.78E+03	6.80E+02	1.82E+02	8.00E+01	1.33E+02
2001	2.17E+04	1.42E+04	8.03E+03	5.16E+03	4.38E+03	9.42E+02	3.24E+02	8.65E+01	4.67E+01
2002	2.59E+04	1.71E+04	8.94E+03	3.10E+03	2.63E+03	2.07E+03	5.57E+02	2.10E+02	5.74E+01
2003	2.06E+04	2.26E+04	8.61E+03	3.15E+03	9.90E+02	8.94E+02	1.03E+03	2.82E+02	1.31E+02
2004	2.28E+04	1.80E+04	1.58E+04	2.40E+03	1.07E+03	4.93E+02	4.54E+02	6.15E+02	1.84E+02

Estimated population abundance at 1st Jan 2005

, 0.00E+00, 1.97E+04, 1.16E+04, 9.07E+03, 1.32E+03, 6.02E+02, 3.01E+02, 2.84E+02, 4.30E+02,

Taper weighted geometric mean of the VPA populations:

, 2.29E+04, 1.97E+04, 1.32E+04, 5.84E+03, 2.34E+03, 1.04E+03, 5.50E+02, 3.01E+02, 1.41E+02,

Standard error of the weighted Log(VPA populations) :

, .3405, .3545, .4518, .5615, .5516, .6546, .6895, .7302, 1.0104,

1

Log catchability residuals.

Fleet : FLT01: UK INSHORE TR

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	No data for this fleet at this age									
2	.70	-.14	-.56	-.05	-1.83	-.93	.28	.24	.00	.13
3	.36	.38	.04	.08	-.54	-.50	.29	.37	-.21	-.17
4	.38	.37	.25	-.30	.49	-.56	.26	.62	-.01	-.08
5	-.79	.24	-.09	.22	.47	-.03	.00	.38	.11	.16
6	99.99	-1.04	-.24	.10	.72	.33	.07	.40	.00	-.10
7	99.99	-.52	-.77	-.14	.46	.42	-.20	.38	.22	-.02
8	99.99	-.24	-.02	-.56	-.37	.42	-.43	.57	.30	-.17
9	1.81	99.99	.37	.19	-.59	.48	-.73	-.36	.58	.39

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	No data for this fleet at this age									
2	.06	.39	.02	-.44	-.22	.43	-.23	.88	.97	.28
3	-.15	-.65	.09	-.51	.22	-.15	-.28	.72	.27	.36
4	-.24	-.85	-.90	-.04	-.62	.44	-.34	.38	.64	.08
5	-.07	-.43	-.65	-.24	-.05	.31	.24	-.05	.18	.09
6	-.17	-.38	-.27	-.08	-.54	.48	.03	.60	.08	.00
7	-.29	-.88	.21	.70	-.71	.53	-.10	.15	.53	.03
8	-.10	-.21	.27	.35	.17	.48	.80	.65	1.49	.37
9	.12	-.37	.30	.55	-.15	.64	.34	.45	-.50	.77

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	-11.9244	-11.4064	-11.4720	-11.6039	-11.6295	-11.7739	-11.7739	-11.7739
S.E(Log q)	.6338	.3770	.4760	.3248	.4136	.4732	.5388	.6363

Table 11.3.1 (continued) – Plaice in VIId. Tuning diagnostic

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	1.54,	-.901,	13.01,	.13,	20,	.98,	-11.92,
3,	1.08,	-.379,	11.56,	.56,	20,	.42,	-11.41,
4,	.98,	.116,	11.41,	.59,	20,	.48,	-11.47,
5,	.86,	1.193,	11.09,	.81,	20,	.28,	-11.60,
6,	.87,	.974,	11.03,	.76,	19,	.36,	-11.63,
7,	.92,	.463,	11.36,	.67,	19,	.45,	-11.77,
8,	1.37,	-1.655,	13.70,	.54,	19,	.65,	-11.58,
9,	1.05,	-.218,	11.85,	.54,	19,	.64,	-11.55,

1

Fleet : FLT02: BELGIAN BEAM

Age	1981	1982	1983	1984
1	No data for this fleet at this age			
2	.09	-.08	.56	-1.17
3	.36	-.30	.01	.00
4	.39	.01	.32	-.03
5	-.62	.07	-.31	.06
6	-.65	-.32	-.15	.20
7	-.17	-.36	-.67	.43
8	.18	.49	.87	-.40
9	.18	.34	.33	-.29

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	No data for this fleet at this age									
2	.56	.65	.48	.22	-1.87	.45	1.10	1.38	.59	1.04
3	-.08	.04	-.42	-.13	-.34	.47	.81	.55	-.14	.13
4	-.03	-.30	-.40	-.51	-.14	.04	.11	-.28	-.47	.61
5	-1.21	-.39	-.53	-.79	.31	-.16	.58	-.30	-.18	.16
6	.34	.05	-1.08	-.77	.15	-.09	.62	.33	-.21	.04
7	.02	-.10	.41	-.32	-.07	-.67	-.03	-.13	-.24	.03
8	.76	-1.01	-.39	-.27	-.28	-.21	-.23	.16	-.49	.16
9	-1.35	-.18	-.01	-.23	-.01	-1.08	.68	.88	-.91	.19

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	No data for this fleet at this age									
2	-1.56	-.09	99.99	-.80	-1.41	-1.28	.58	.45	.04	.07
3	.11	-.08	-1.48	-.27	-.06	-.95	.89	.54	.57	-.22
4	.11	.18	.49	.25	.39	-1.18	.18	.34	.23	-.30
5	.28	.42	1.24	.44	.78	-.34	.08	.51	-.04	-.08
6	-.12	.08	.94	.50	.83	-.48	.03	-.56	.54	-.21
7	.72	-.23	.83	.37	.68	-.40	-.41	.00	.07	.24
8	.28	.30	.03	.26	-.32	-.38	-.15	-1.00	-.33	-.40
9	-.30	.09	.32	.62	.42	-.34	.28	-.25	.20	-.55

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	-7.5655	-5.6609	-5.1129	-5.2512	-5.5337	-5.5757	-5.5757	-5.5757
S.E(Log q)	.9092	.5262	.3978	.5349	.5002	.4102	.4774	.5465

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2,	.89,	.238,	7.83,	.17,	23,	.82,	-7.57,
3,	1.69,	-1.678,	3.00,	.21,	24,	.86,	-5.66,
4,	1.22,	-1.128,	4.33,	.55,	24,	.48,	-5.11,
5,	1.05,	-.235,	5.12,	.48,	24,	.57,	-5.25,
6,	1.06,	-.299,	5.45,	.55,	24,	.54,	-5.53,
7,	1.01,	-.086,	5.57,	.71,	24,	.42,	-5.58,
8,	1.14,	-.947,	5.67,	.67,	24,	.53,	-5.67,
9,	1.14,	-1.000,	5.70,	.69,	24,	.62,	-5.62,

1

Table 11.3.1 (continued) – Plaice in VIId. Tuning diagnostic

Fleet : FLT03: FRENCH TRAWLE

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	No data for this fleet at this age									
2	99.99	99.99	99.99	99.99	-.22	-.38	.43	.19	.10	.09
3	99.99	99.99	99.99	99.99	-.32	-.13	.03	.17	-.40	.09
4	99.99	99.99	99.99	99.99	-.04	.00	.30	-.44	-.62	-.51
5	99.99	99.99	99.99	99.99	.48	.11	-.23	-.18	-1.35	-.05
6	99.99	99.99	99.99	99.99	.03	.36	-.16	.32	-.59	-.37
7	99.99	99.99	99.99	99.99	-.09	.16	-.33	.17	-.32	-.33
8	99.99	99.99	99.99	99.99	.31	.22	-.49	-.44	-.81	.17
9	99.99	99.99	99.99	99.99	1.04	1.04	-.47	-.32	-.26	-.38

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	No data for this fleet at this age									
2	-.06	-.78	-.60	-.90	-.09	.56	.48	.62	-.20	.78
3	-.57	-.41	.56	.04	.35	-.23	.37	-.29	.78	-.02
4	-.57	-.59	.85	.71	.78	.43	-.20	-.34	.41	-.15
5	-1.13	-.16	.19	.73	.43	.92	.32	-.22	.08	.06
6	-1.41	-.33	.79	.04	.27	.72	.01	-.04	.05	.33
7	-.98	-.15	.97	-.28	.95	.48	-.02	-.09	.00	-.14
8	-.54	.04	.97	.27	.52	-.03	-1.45	-.56	-.18	-.41
9	-.21	.13	.73	-.32	-.45	.19	-.97	-.34	.58	-.62

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	-11.5000	-10.8065	-10.8690	-11.2305	-11.5501	-11.8162	-11.8162	-11.8162
S.E(Log q)	.5032	.3764	.5134	.5913	.5273	.4856	.6028	.6015

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	9.77	-2.321	26.37	.00	16	4.32	-11.50
3	.89	.492	10.65	.60	16	.34	-10.81
4	.78	1.285	10.38	.71	16	.39	-10.87
5	1.03	-.117	11.34	.50	16	.63	-11.23
6	1.12	-.524	12.11	.56	16	.61	-11.55
7	1.42	-1.632	14.07	.52	16	.65	-11.82
8	.92	.404	11.50	.66	16	.55	-11.97
9	.84	.889	10.82	.69	16	.51	-11.86

1

Fleet : FLT04: UK BEAM TRAWL

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	99.99	99.99	99.99	.58	-1.35	-.65	.02	.09	-.80	-.11
2	99.99	99.99	99.99	.39	-.42	-.75	-.06	.06	-.16	.01
3	99.99	99.99	99.99	.59	.16	-.60	.25	-.09	-.35	.12
4	99.99	99.99	99.99	-.07	.42	-.20	.02	.34	-.48	.35
5	99.99	99.99	99.99	.57	-.12	.02	.20	.64	-.10	.13
6	99.99	99.99	99.99	.05	.22	.18	-.03	.97	.01	-.36
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 VIId. Tuning diagnostic

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	-.15	-.23	.45	.32	.15	.37	.47	.38	-.60	1.07
2	-.87	-.20	-.40	.03	.32	.81	.29	.45	.33	.18
3	-.32	-1.49	-.59	-.57	.00	.81	.85	.54	.47	.21
4	-.19	-1.22	-1.24	-.05	-.58	.61	.59	.68	.44	.57
5	-.43	-.60	-1.04	-.93	-.33	.57	1.04	-.04	.58	-.15
6	-.38	-.23	-.94	-.37	-.41	.51	.80	.73	.08	-.82
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	-7.4235	-7.0015	-6.9496	-6.7597	-6.5713	-6.6784
S.E(Log q)	.5940	.4384	.6062	.6011	.5706	.5400

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	.52	1.797	8.63	.49	17	.29	-7.42
2	1.01	-.018	6.98	.32	17	.46	-7.00
3	.97	.101	7.03	.41	17	.61	-6.95
4	.96	.179	6.85	.52	17	.59	-6.76
5	.75	1.465	6.88	.69	17	.41	-6.57
6	.74	1.777	6.77	.76	17	.38	-6.68

1

Fleet : FLT05: French GFS

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	99.99	99.99	99.99	-.42	-.71	-.71	-1.31	1.04	1.61	-.13
2	99.99	99.99	99.99	.48	-.25	-1.49	-.78	-.46	.56	-.19
3	99.99	99.99	99.99	.12	-.69	-.34	-.86	.17	.86	-.97
4	99.99	99.99	99.99	.09	-.87	.14	-.52	-.73	.87	-1.36
5	99.99	99.99	99.99	.49	-1.59	.45	-.41	-.74	.65	-.83
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	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	-.28	-.72	.87	.90	.27	.54	.10	-.02	-1.05	.03
2	-.09	-.85	.05	.29	.06	1.27	-.04	.69	.26	.48
3	-.32	-1.96	.36	-.10	.33	.60	.09	1.07	1.44	.18
4	-.27	-1.58	-.15	-.21	.32	.77	-.03	.19	2.45	.89
5	-.50	-.47	.02	.00	.11	1.16	-.57	-.18	2.82	-.41
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 VIId. Tuning diagnostic

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


    Age ,         1,         2,         3,         4,         5
 Mean Log q,   -7.6007,   -7.5951,   -7.7787,   -8.1512,   -8.3652,
 S.E(Log q),     .7999,     .6562,     .8246,     .9462,     .9711,



 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,    1.80,    -.602,      5.70,     .04,     17,    1.47,   -7.60,
  2,     .65,    1.015,      8.38,     .36,     17,     .42,   -7.60,
  3,    1.12,    -.253,      7.57,     .22,     17,     .95,   -7.78,
  4,    1.56,    -.894,      7.85,     .14,     17,    1.49,   -8.15,
  5,    2.49,   -1.529,      9.20,     .07,     17,    2.32,   -8.37,
1
```

Fleet : FLT06: Intl YFS

```
  Age  ,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992,  1993,  1994
     1 , 99.99, 99.99,   .13,   .21,  -.10,  -.01,  -.30,   .49,   .49,   .17
     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  ,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004
     1 ,   .57,  -.60,  -.62,   .29,   .08,  -.32,   .03,  -.11,  -.23,  -.14
     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,  -10.0501,
 S.E(Log q),     .3448,

 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,    1.73,   -1.473,     10.09,     .20,     18,     .58,  -10.05,
1
```

Table 11.3.1 (continued) – Plaice in VIId. Tuning diagnostic

Terminal year survivor and F summaries :

Age 1 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
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,	57409.,	.611,	.000,	.00,	1,	.164,	.016
FLT05: French GFS [o,	20419.,	.823,	.000,	.00,	1,	.091,	.044
FLT06: Intl YFS [rev,	17103.,	.354,	.000,	.00,	1,	.489,	.052
F shrinkage mean ,	12941.,	.50,,,,				.257,	.069

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
19736.,	.25,	.30,	4,	1.191,	.046

Age 2 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,	15364.,	.649,	.000,	.00,	1,	.075,	.268
FLT02: BELGIAN BEAM ,	12481.,	.929,	.000,	.00,	1,	.037,	.321
FLT03: FRENCH TRAWLE,	25381.,	.519,	.000,	.00,	1,	.117,	.171
FLT04: UK BEAM TRAWL,	10636.,	.363,	.374,	1.03,	2,	.237,	.367
FLT05: French GFS [o,	10262.,	.522,	.751,	1.44,	2,	.114,	.379
FLT06: Intl YFS [rev,	9207.,	.354,	.000,	.00,	1,	.243,	.414
F shrinkage mean ,	10095.,	.50,,,,				.178,	.384

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
11601.,	.18,	.16,	9,	.857,	.341

Age 3 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,	14810.,	.334,	.252,	.75,	2,	.181,	.301
FLT02: BELGIAN BEAM ,	7703.,	.467,	.101,	.22,	2,	.092,	.516
FLT03: FRENCH TRAWLE,	8403.,	.313,	.083,	.26,	2,	.202,	.482
FLT04: UK BEAM TRAWL,	12283.,	.316,	.047,	.15,	3,	.177,	.353
FLT05: French GFS [o,	10664.,	.448,	.082,	.18,	3,	.089,	.397
FLT06: Intl YFS [rev,	8137.,	.354,	.000,	.00,	1,	.126,	.494
F shrinkage mean ,	3911.,	.50,,,,				.133,	.846

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
9074.,	.14,	.12,	14,	.851,	.453

Table 11.3.1 (continued) – Plaice in VIId. Tuning diagnostic

Age 4 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,	1597.,	.332,	.139,	.42,	3,	.192,	.427
FLT02: BELGIAN BEAM ,	1130.,	.346,	.228,	.66,	3,	.211,	.561
FLT03: FRENCH TRAWLE,	1667.,	.332,	.313,	.94,	3,	.180,	.412
FLT04: UK BEAM TRAWL,	2233.,	.376,	.032,	.08,	4,	.134,	.323
FLT05: French GFS [o,	3193.,	.545,	.213,	.39,	4,	.060,	.236
FLT06: Intl YFS [rev,	1358.,	.354,	.000,	.00,	1,	.034,	.486
F shrinkage mean ,	541.,	.50,,,,				.189,	.945

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
1321.,	.16,	.14,	19,	.899,	.497

Age 5 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: UK INSHORE TR,	744.,	.264,	.143,	.54,	4,	.314,	.404
FLT02: BELGIAN BEAM ,	663.,	.331,	.119,	.36,	4,	.166,	.444
FLT03: FRENCH TRAWLE,	675.,	.341,	.144,	.42,	4,	.143,	.437
FLT04: UK BEAM TRAWL,	657.,	.368,	.143,	.39,	5,	.133,	.447
FLT05: French GFS [o,	927.,	.562,	.559,	1.00,	5,	.052,	.336
FLT06: Intl YFS [rev,	438.,	.354,	.000,	.00,	1,	.020,	.612
F shrinkage mean ,	288.,	.50,,,,				.171,	.825

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
602.,	.15,	.11,	24,	.698,	.479

Age 6 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
FLT01: UK INSHORE TR,	331.,	.243,	.071,	.29,	5,	.310,	.362
FLT02: BELGIAN BEAM ,	290.,	.314,	.145,	.46,	5,	.186,	.405
FLT03: FRENCH TRAWLE,	370.,	.333,	.113,	.34,	5,	.162,	.330
FLT04: UK BEAM TRAWL,	254.,	.349,	.324,	.93,	6,	.153,	.451
FLT05: French GFS [o,	1618.,	.576,	.621,	1.08,	5,	.027,	.086
FLT06: Intl YFS [rev,	326.,	.354,	.000,	.00,	1,	.009,	.367
F shrinkage mean ,	184.,	.50,,,,				.153,	.579

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
301.,	.14,	.10,	28,	.714,	.392

Table 11.3.1 (continued) – Plaice in VIId. Tuning diagnostic

Age 7 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
FLT01: UK INSHORE TR,	285.,	.246,	.045,	.18,	6,	.275,	.367
FLT02: BELGIAN BEAM ,	378.,	.279,	.124,	.44,	6,	.255,	.289
FLT03: FRENCH TRAWLE,	255.,	.305,	.042,	.14,	6,	.200,	.403
FLT04: UK BEAM TRAWL,	338.,	.331,	.103,	.31,	6,	.089,	.318
FLT05: French GFS [o,	330.,	.437,	.191,	.44,	5,	.017,	.325
FLT06: Intl YFS [rev,	382.,	.354,	.000,	.00,	1,	.012,	.286
F shrinkage mean ,	178.,	.50,,,,				.153,	.537

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
284.,	.14,	.06,	31,	.405,	.368

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1996

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: UK INSHORE TR,	660.,	.239,	.061,	.26,	7,	.284,	.175
FLT02: BELGIAN BEAM ,	334.,	.255,	.130,	.51,	7,	.289,	.321
FLT03: FRENCH TRAWLE,	384.,	.291,	.112,	.38,	7,	.207,	.285
FLT04: UK BEAM TRAWL,	869.,	.329,	.131,	.40,	6,	.062,	.136
FLT05: French GFS [o,	462.,	.495,	.294,	.59,	5,	.012,	.242
FLT06: Intl YFS [rev,	231.,	.354,	.000,	.00,	1,	.007,	.437
F shrinkage mean ,	272.,	.50,,,,				.141,	.382

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
430.,	.14,	.08,	34,	.568,	.258

Age 9 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,	245.,	.253,	.223,	.88,	8,	.270,	.138
FLT02: BELGIAN BEAM ,	99.,	.254,	.099,	.39,	7,	.303,	.312
FLT03: FRENCH TRAWLE,	102.,	.294,	.136,	.46,	8,	.224,	.303
FLT04: UK BEAM TRAWL,	223.,	.371,	.208,	.56,	6,	.041,	.150
FLT05: French GFS [o,	222.,	.531,	.326,	.61,	5,	.006,	.151
FLT06: Intl YFS [rev,	71.,	.354,	.000,	.00,	1,	.003,	.411

Table 11.3.2 - Plaice in VIId. Fishing mortality at age

AGE / YEAR	1980	1981	1982	1983	1984
1	0.0022	0.0013	0.0111	0.0048	0.0148
2	0.1684	0.1184	0.1344	0.1522	0.1155
3	0.2782	0.7362	0.4983	0.4543	0.5768
4	0.3612	0.8815	0.8778	0.9429	0.8189
5	0.6242	0.2987	0.6866	0.5763	0.7973
6	0.4110	0.3722	0.3192	0.3909	0.6795
7	0.3840	0.4813	0.3580	0.2053	0.8028
8	0.2365	0.6595	1.7756	0.9279	0.3236
9	0.3448	0.4703	0.7256	0.4302	0.6367
+gp	0.3448	0.4703	0.7256	0.4302	0.6367
FBAR 2- 6	0.3686	0.4814	0.5033	0.5033	0.5976

AGE / YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	0.0050	0.0119	0.0008	0.0006	0.0547	0.0955	0.0775	0.0646	0.0606	0.0784
2	0.3125	0.2135	0.1808	0.2061	0.1738	0.2203	0.5068	0.4427	0.4110	0.4141
3	0.5946	0.6912	0.5180	0.6633	0.4537	0.7019	0.8317	0.8072	0.4770	0.7228
4	0.8582	0.7568	0.7840	0.6724	0.7396	0.7450	0.8715	0.6054	0.4914	0.7996
5	0.2303	0.5950	0.5605	0.5509	0.8626	0.6186	0.6893	0.5161	0.3410	0.6416
6	0.5800	0.4934	0.3079	0.4424	0.5571	0.6045	0.5826	0.6345	0.3487	0.4264
7	0.4017	0.4472	0.8083	0.5223	0.3966	0.4163	0.3969	0.4507	0.3758	0.3672
8	0.8465	0.2612	0.4746	0.5026	0.3697	0.4767	0.3310	0.4725	0.2994	0.5159
9	0.8702	0.3319	0.6972	0.6118	0.6168	0.6766	0.4712	0.5433	0.4162	0.4615
+gp	0.8702	0.3319	0.6972	0.6118	0.6168	0.6766	0.4712	0.5433	0.4162	0.4615
FBAR 2- 6	0.5151	0.5500	0.4703	0.5070	0.5573	0.5780	0.6964	0.6012	0.4138	0.6009

AGE / YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	FBAR 02-04
1	0.1145	0.0393	0.0153	0.0331	0.0447	0.0883	0.1391	0.0373	0.0335	0.0456	0.0388
2	0.3781	0.2885	0.1842	0.1467	0.1517	0.5517	0.3666	0.5855	0.2576	0.3415	0.3948
3	0.6119	0.5481	0.7944	0.6056	0.6549	0.5820	0.8520	0.9435	1.1776	0.4533	0.8581
4	0.6780	0.6771	1.4622	1.0151	1.1670	0.9454	0.5729	1.0408	0.9745	0.4969	0.8374
5	0.5127	0.7460	1.3744	0.8509	0.8995	0.9815	0.6479	0.9803	0.5979	0.4789	0.6857
6	0.3101	0.4973	1.0259	0.5658	0.6390	0.6433	0.4247	0.5990	0.5773	0.3919	0.5227
7	0.4918	0.3791	1.1301	0.4427	0.7046	0.6426	0.3323	0.5823	0.4154	0.3680	0.4553
8	0.4364	0.5907	0.8354	0.5181	0.4566	0.4385	0.3110	0.3717	0.3284	0.2579	0.3193
9	0.4170	0.5860	0.8591	0.4733	0.4339	0.4029	0.3465	0.6126	0.5129	0.2455	0.4570
+gp	0.4170	0.5860	0.8591	0.4733	0.4339	0.4029	0.3465	0.6126	0.5129	0.2455	
FBAR 2- 6	0.4982	0.5514	0.9682	0.6368	0.7024	0.7408	0.5728	0.8298	0.7170	0.4325	

Table 11.3.3 - Plaice in VIId. Stocks numbers at age

AGE / YEAR	1980	1981	1982	1983	1984
1	25502	12885	25213	20017	25105
2	17930	23025	11644	22562	18025
3	6281	13709	18507	9211	17533
4	1873	4303	5941	10174	5291
5	1109	1181	1613	2234	3586
6	234	538	793	734	1136
7	148	140	335	521	450
8	220	91	78	212	384
9	14	157	43	12	76
+gp	370	558	178	302	222
TOTAL	53682	56587	64345	65980	71807

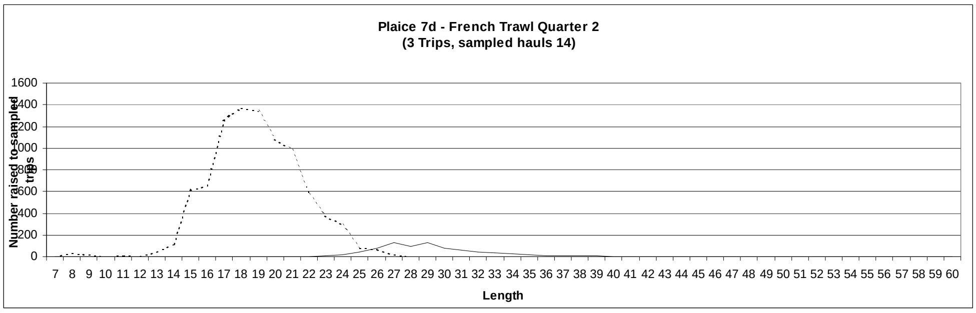
AGE / YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	29669	60409	31292	26511	16302	18840	21737	27973	13228	17321
2	22383	26710	54014	28290	23973	13965	15494	18201	23727	11265
3	14530	14818	19523	40789	20831	18231	10137	8446	10578	14234
4	8911	7254	6717	10523	19012	11975	8176	3993	3409	5941
5	2111	3418	3080	2775	4861	8211	5144	3095	1972	1887
6	1462	1517	1706	1591	1447	1856	4002	2336	1671	1269
7	521	741	838	1134	925	750	918	2023	1121	1067
8	182	316	428	338	609	563	448	558	1166	696
9	251	71	220	241	185	381	316	291	315	782
+gp	90	126	160	398	447	491	348	294	468	884
TOTAL	80109	115379	117977	112590	88592	75262	66721	67211	57655	55347

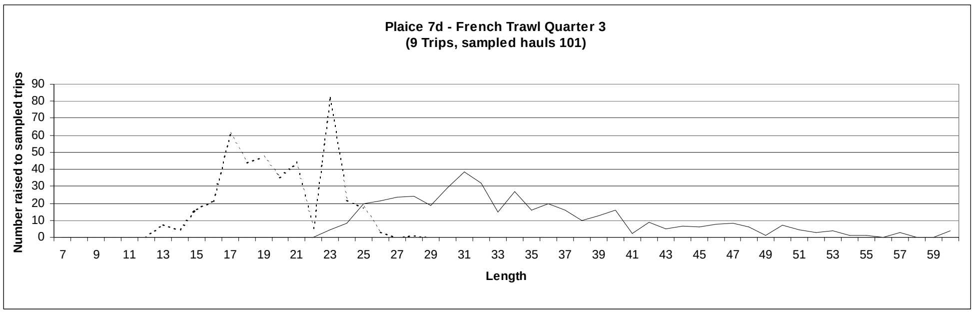
AGE / YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	GMST 80-02
1	25196	30500	38036	14998	17806	17200	21707	25884	20616	22828	0	22956
2	14491	20333	26533	33893	13129	15407	14247	17090	22563	18040	19736	19694
3	6737	8984	13787	19969	26483	10207	8030	8935	8611	15779	11601	13294
4	6252	3306	4699	5637	9861	12449	5161	3099	3147	2400	9074	6234
5	2416	2872	1520	985	1848	2778	4376	2633	990	1075	1321	2507
6	899	1309	1232	348	381	680	942	2072	894	493	602	1087
7	750	596	721	400	179	182	324	557	1030	454	301	540
8	669	415	369	211	232	80	87	210	282	615	284	293
9	376	391	208	145	113	133	47	57	131	184	430	140
+gp	792	818	554	522	330	309	279	210	162	231	294	
TOTAL	58579	69525	87660	77108	70363	59425	55199	60748	58426	62099	43644	

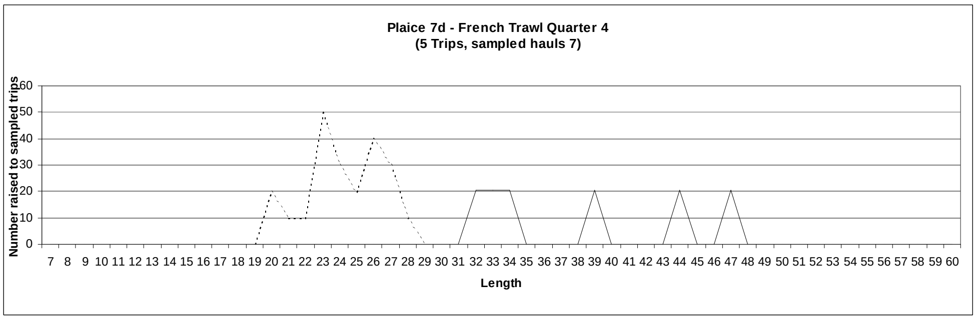
Table 11.3.4 - Plaice in VIId. Stock summary

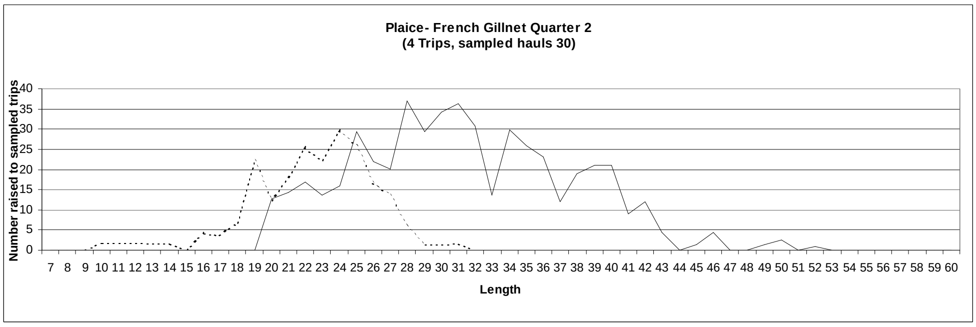
	RECRUITS (Age 1)	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2- 6
1980	25502	16436	5546	2650	0.4779	0.3686
1981	12885	14311	6552	4769	0.7278	0.4814
1982	25213	14991	7509	4865	0.6479	0.5033
1983	20017	15082	8066	5043	0.6252	0.5033
1984	25105	14038	7353	5161	0.7019	0.5976
1985	29669	15667	8028	6022	0.7501	0.5151
1986	60409	23110	10067	6834	0.6789	0.55
1987	31292	31739	13369	8366	0.6258	0.4703
1988	26511	24406	13126	10420	0.7938	0.507
1989	16302	21563	14266	8758	0.6139	0.5573
1990	18840	21971	14715	9047	0.6148	0.578
1991	21737	17747	10334	7813	0.756	0.6964
1992	27973	16318	8727	6337	0.7261	0.6012
1993	13228	16045	7890	5331	0.6757	0.4138
1994	17321	15231	8552	6121	0.7157	0.6009
1995	25196	14917	7633	5130	0.6721	0.4982
1996	30500	17224	6681	5393	0.8072	0.5514
1997	38036	15360	6852	6307	0.9205	0.9682
1998	14998	17302	7730	5762	0.7454	0.6368
1999	17806	14450	8459	6326	0.7478	0.7024
2000	17200	11172	6492	6015	0.9266	0.7408
2001	21707	12059	6441	5266	0.8175	0.5728
2002	25884	13054	6194	5777	0.9326	0.8298
2003	20616	11549	4713	4536	0.9624	0.717
2004	22828	14527	5768	3947	0.6843	0.4325
Arith. Mean	24271	16811	8443	6080	0.7339	0.5838
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Figure 11.2.1 - Plaice VIId - Length structure of discards and landings collected by observations on board (number raised to sample trip)









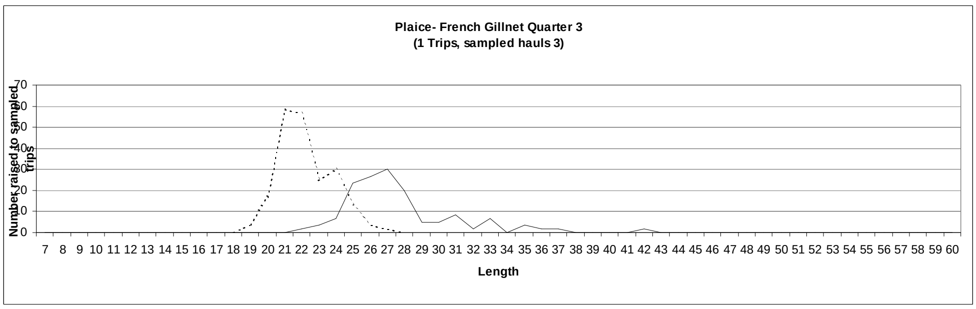
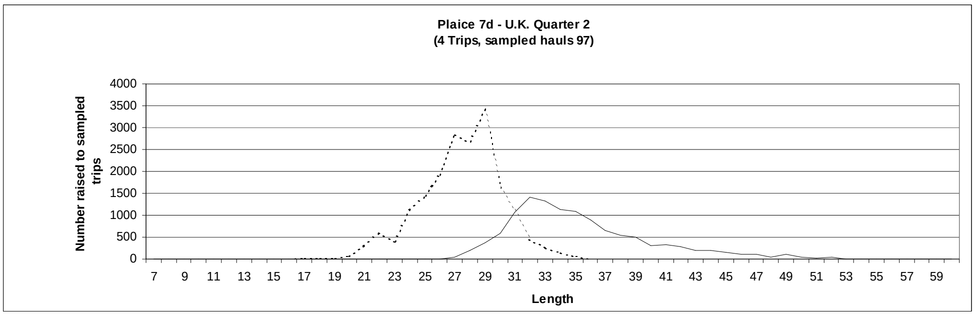
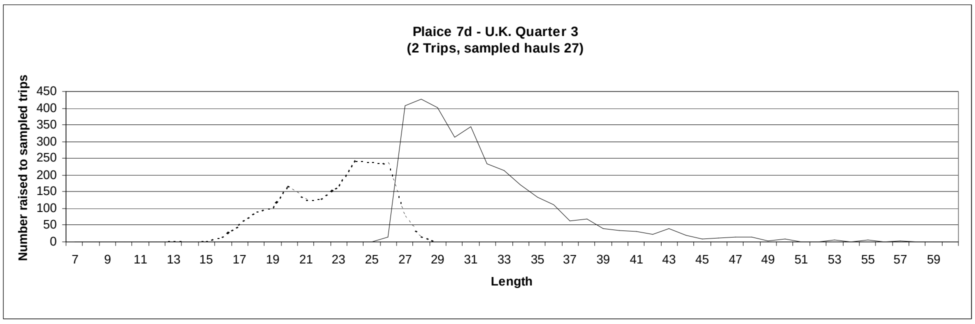
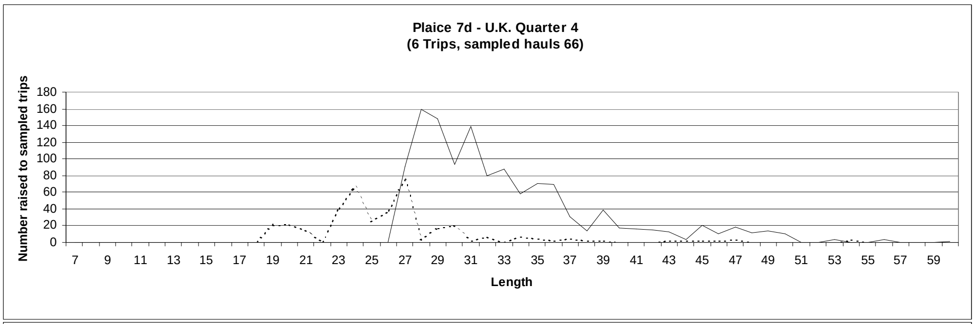


Figure 11.2.1 (cont) - Plaice VIId - Length structure of discards and landings collected by observations on board (number raised to sample trip)







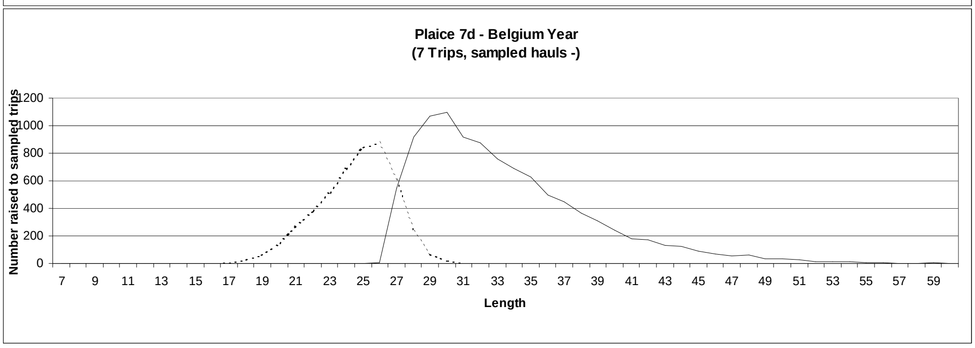


Figure 11.2.2 - Plaice VIId. Mean weights in the landings

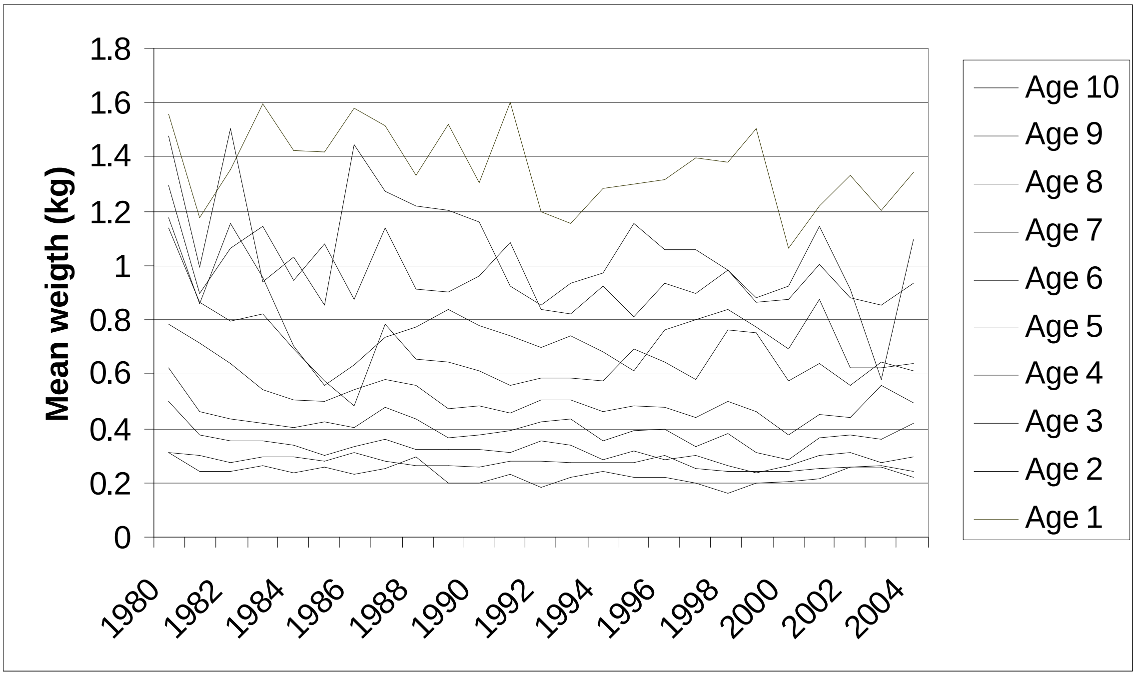


Figure 11.2.3 - Plaice VIId. Mean weights in the stock

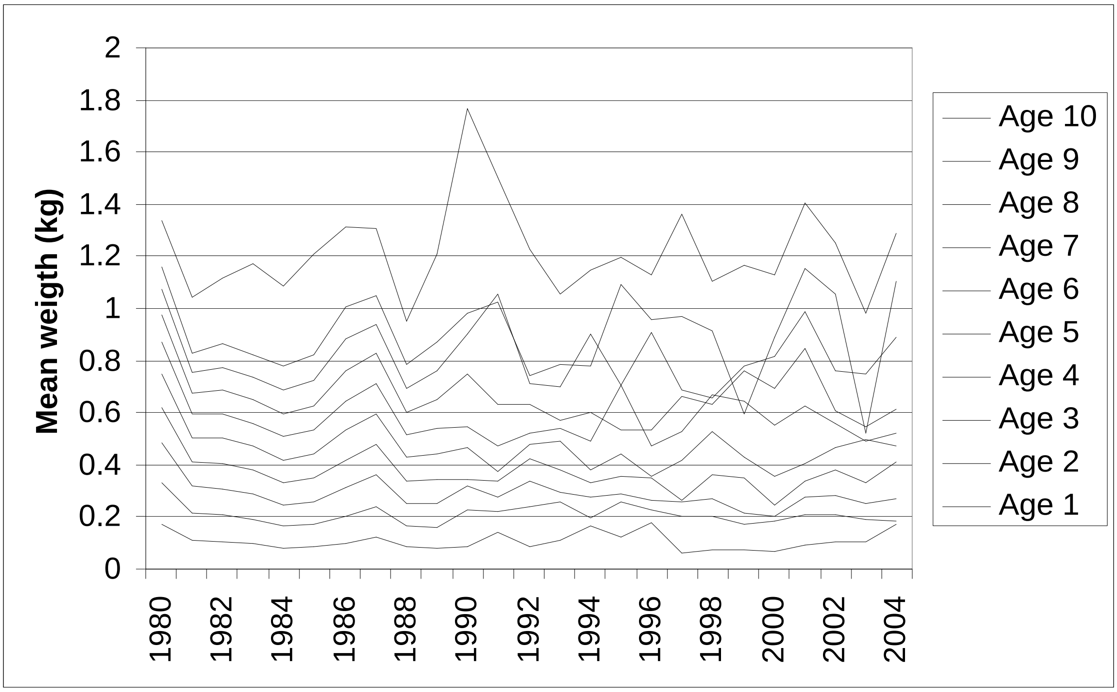
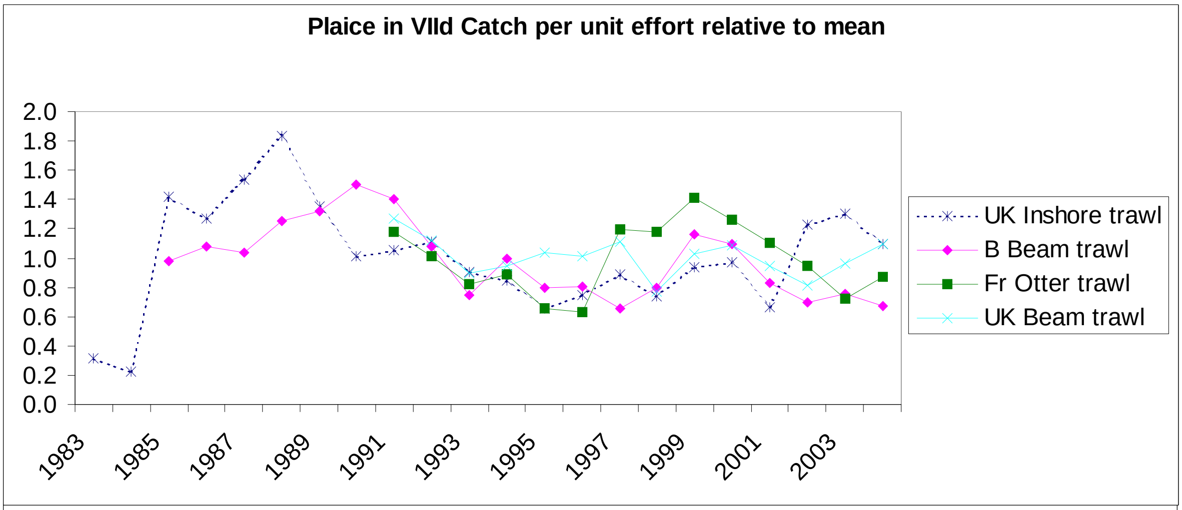


Figure 11.2.4 - Plaice in VIId. CPUE and effort



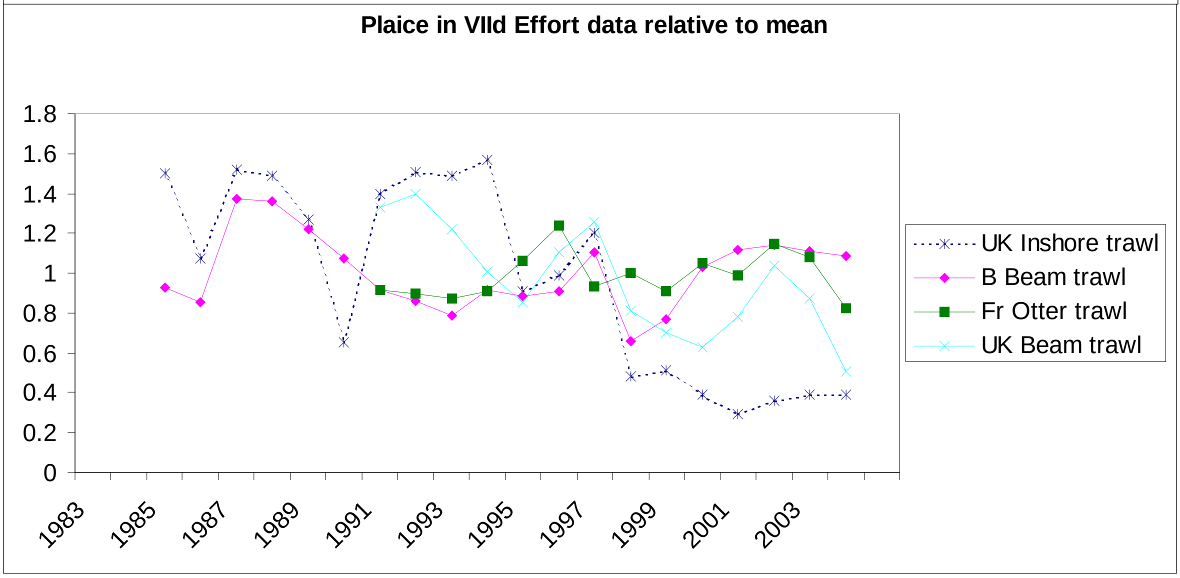
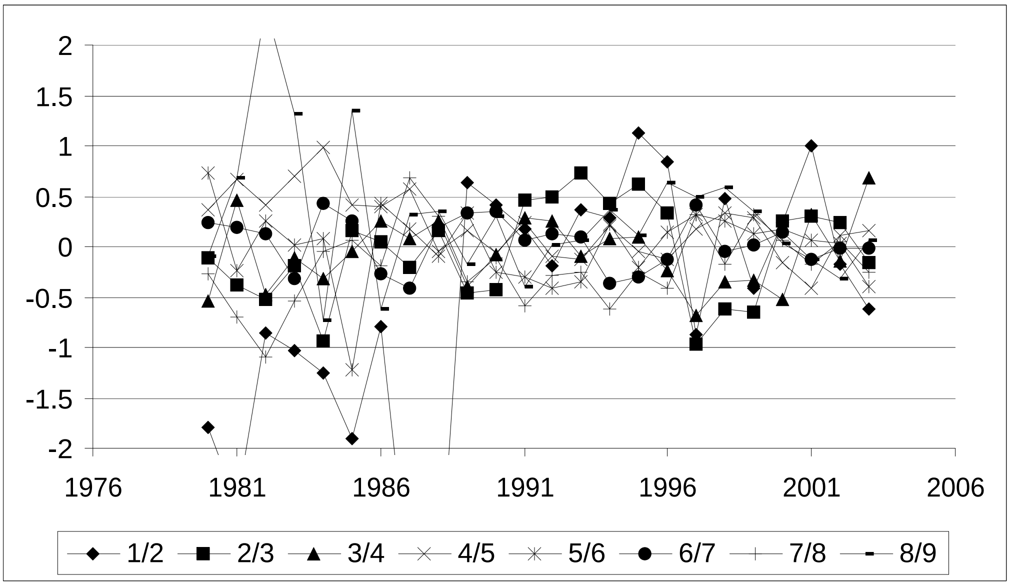


Figure 11.3.1. - Plaice in VIId. Separable VPA



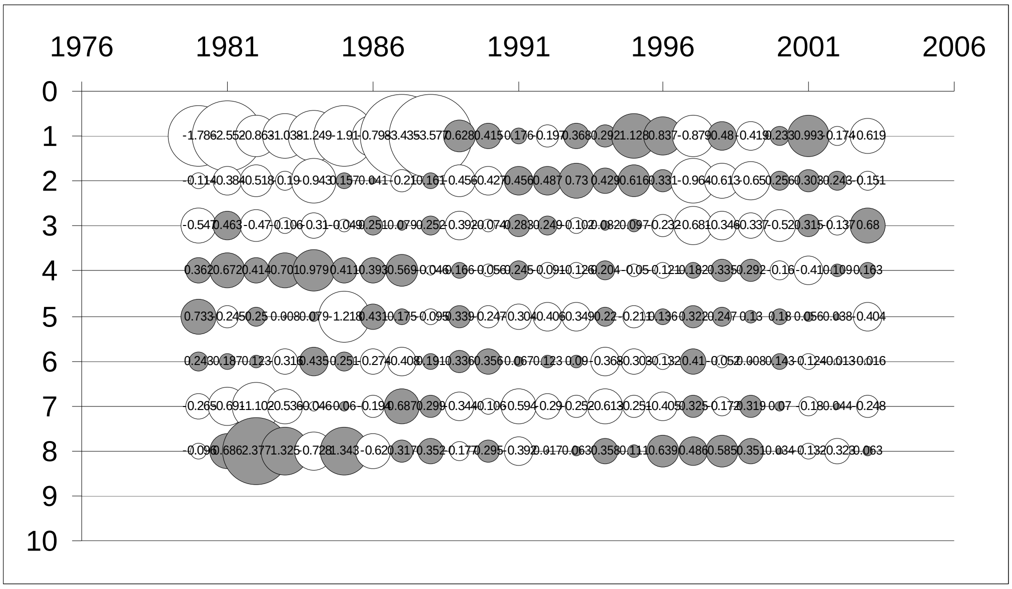


Figure 11.3.2 - Plaice in VIId. Log q residuals for the single fleet runs.

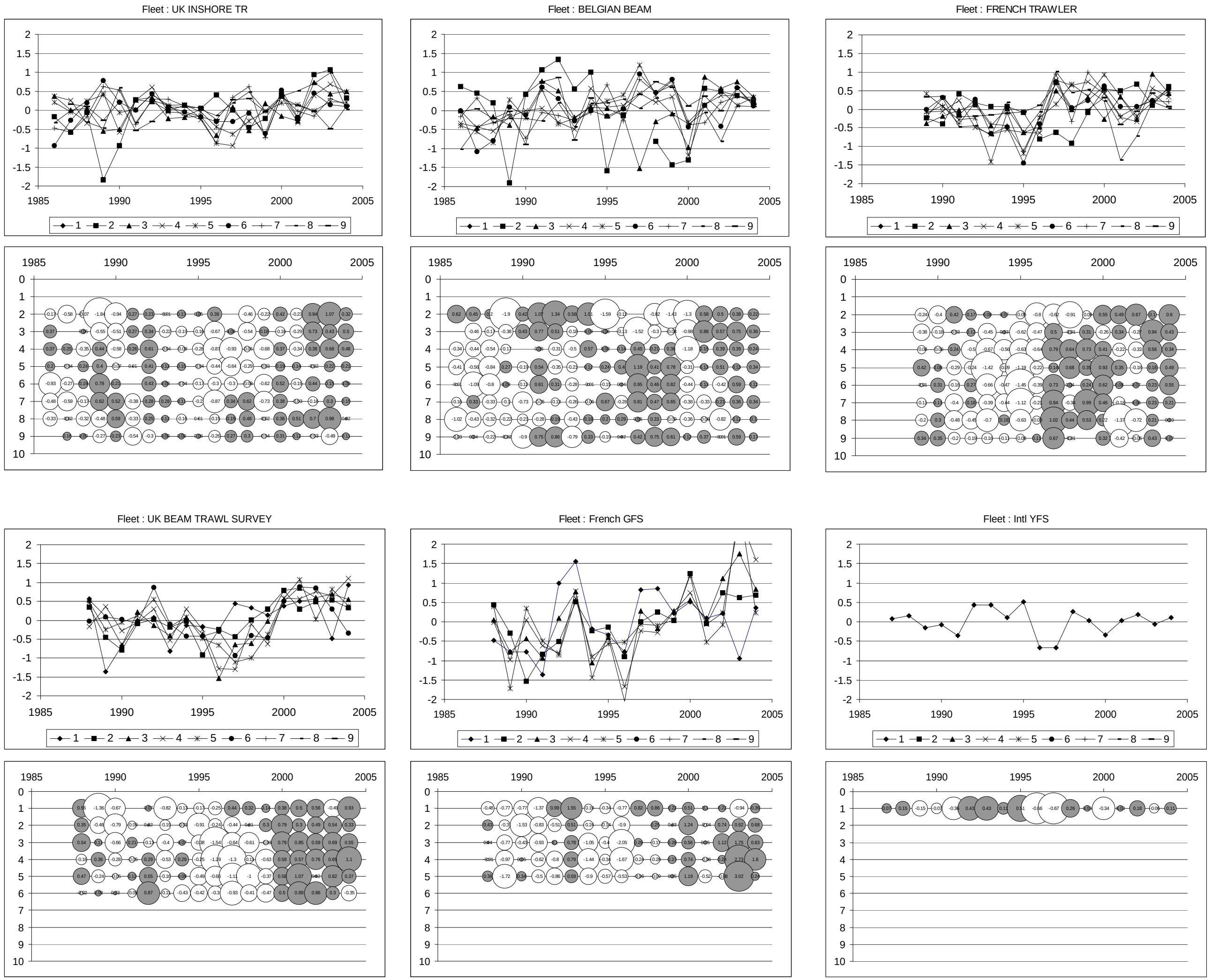


Figure 11.3.3. - Plaice VIId. Contributions of the different fleets to the estimators at age

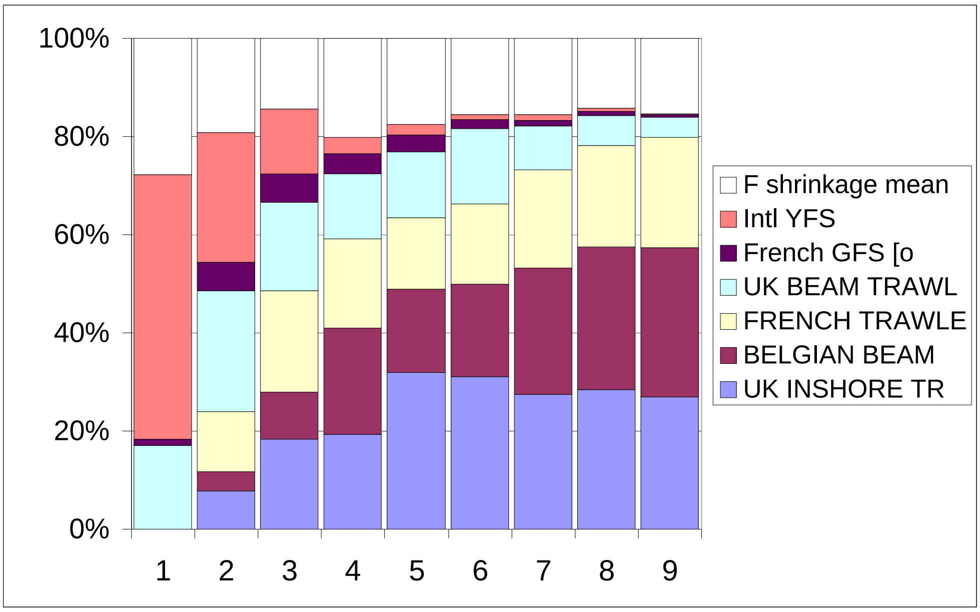
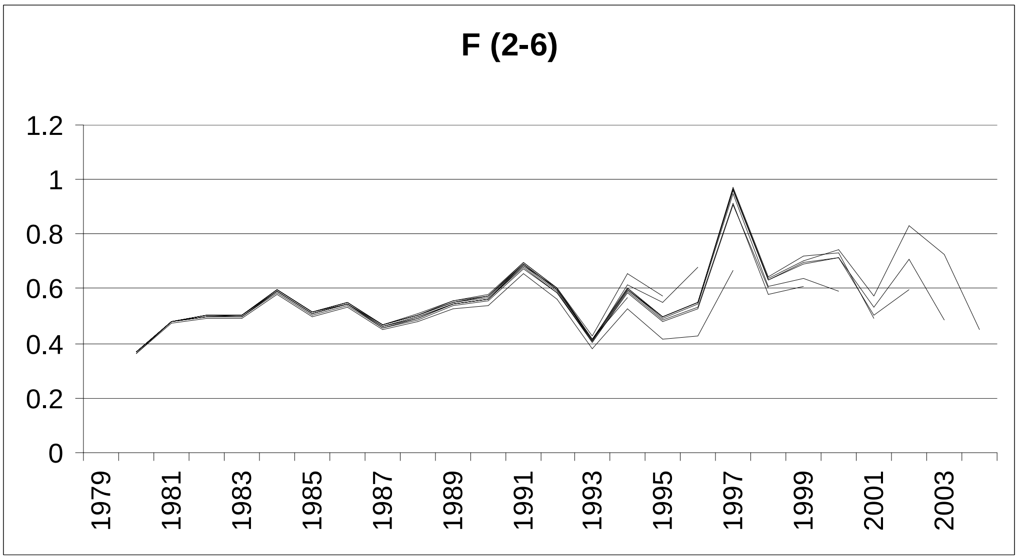
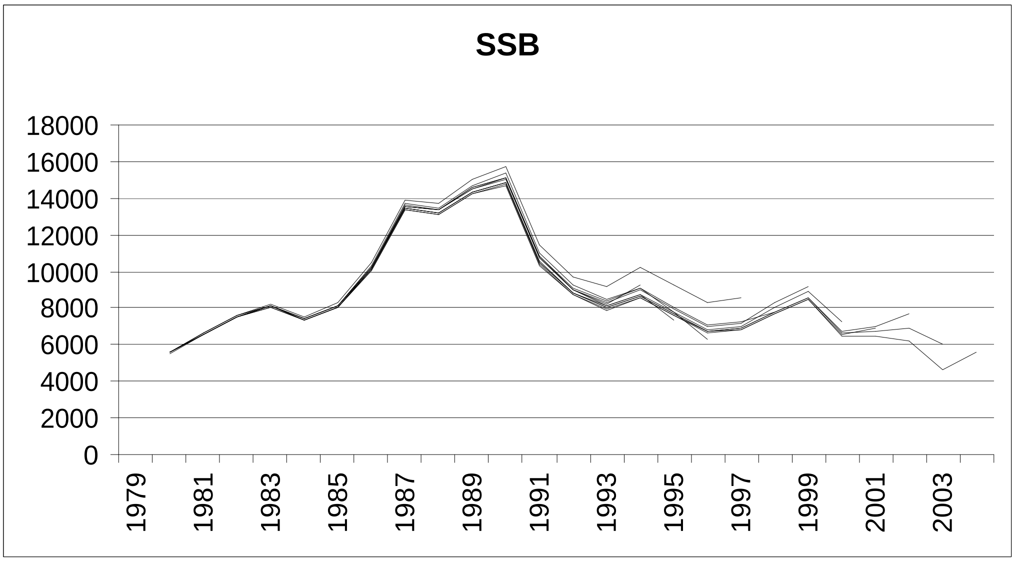


Figure 11.3.4 - Plaice in VIId. Retrospective analysis





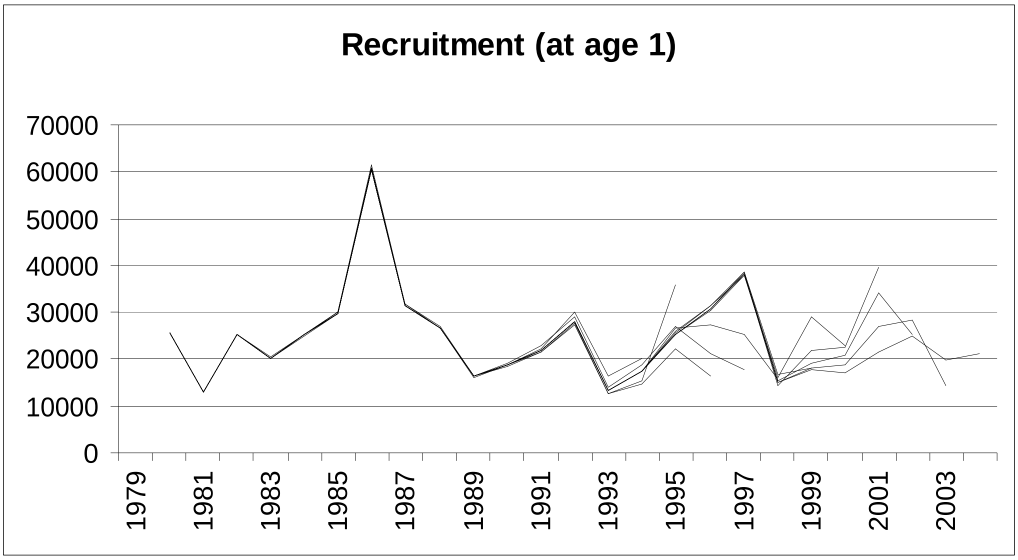


Figure 11.3.5. - Plaice VIId. Sensitivity analysis on SSB estimates from the SURBA model. Catchability values : 0.1 (Dotted lines), 0.5 (Dashed lines), 1 (plain lines).

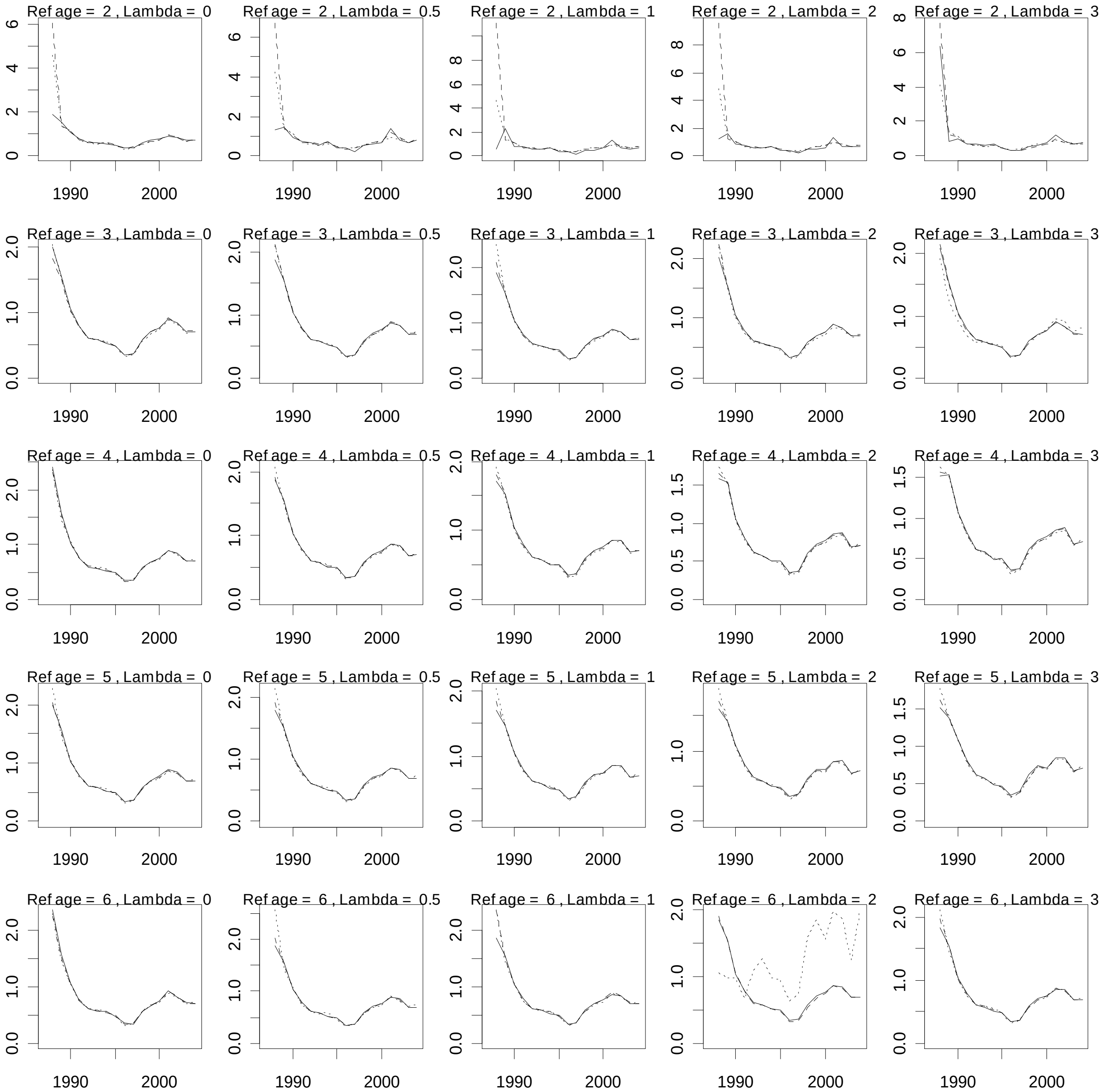


Figure 11.3.6. - Plaice VIId. Sensitivity analysis on mean Z estimates from the SURBA model. Catchability values : 0.1 (Dotted lines), 0.5 (Dashed lines), 1 (plain lines).

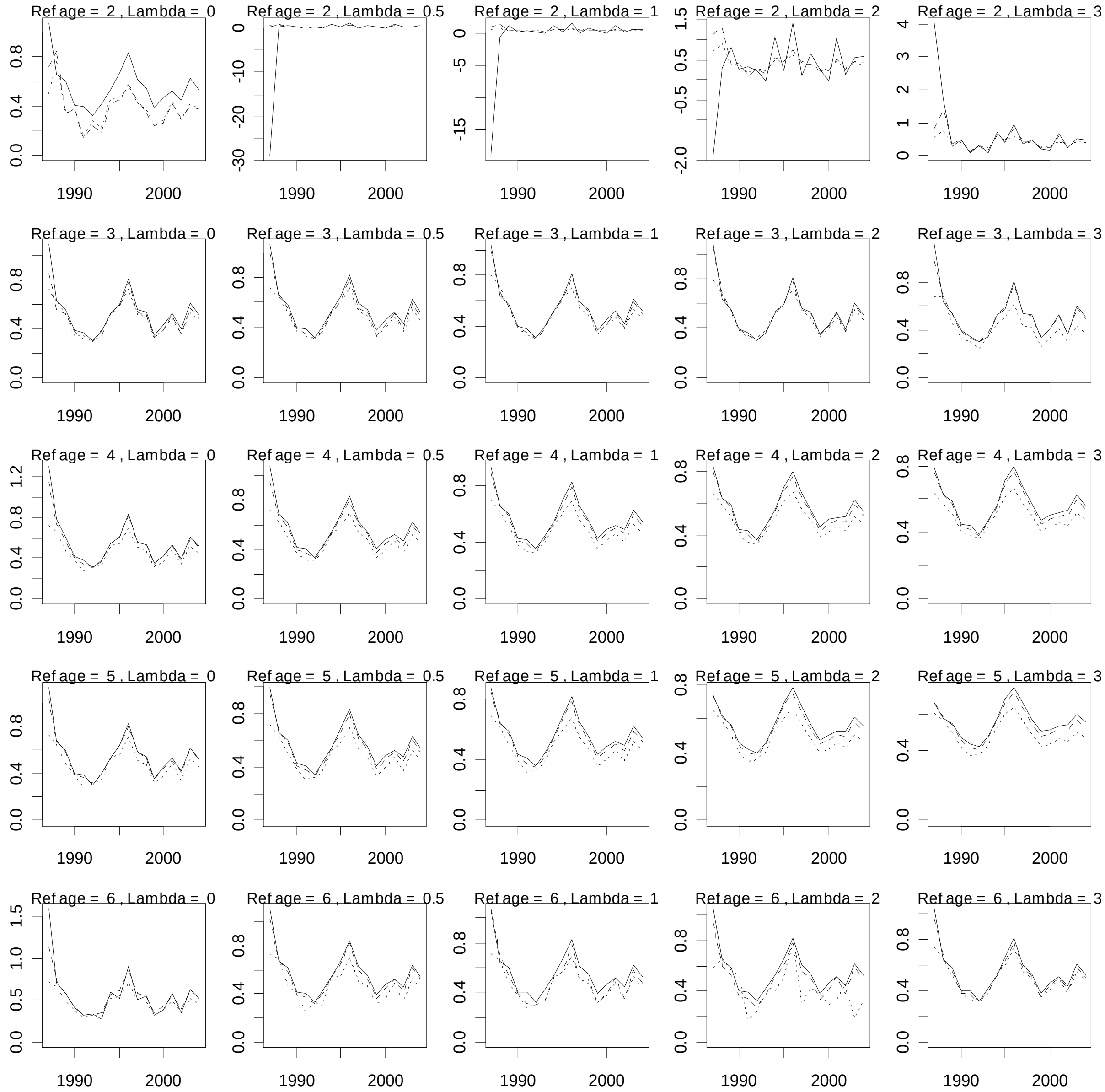


Figure 11.3.7. - Plaice VIId. Sensitivity analysis on the variance of mean Z from the SURBA model.

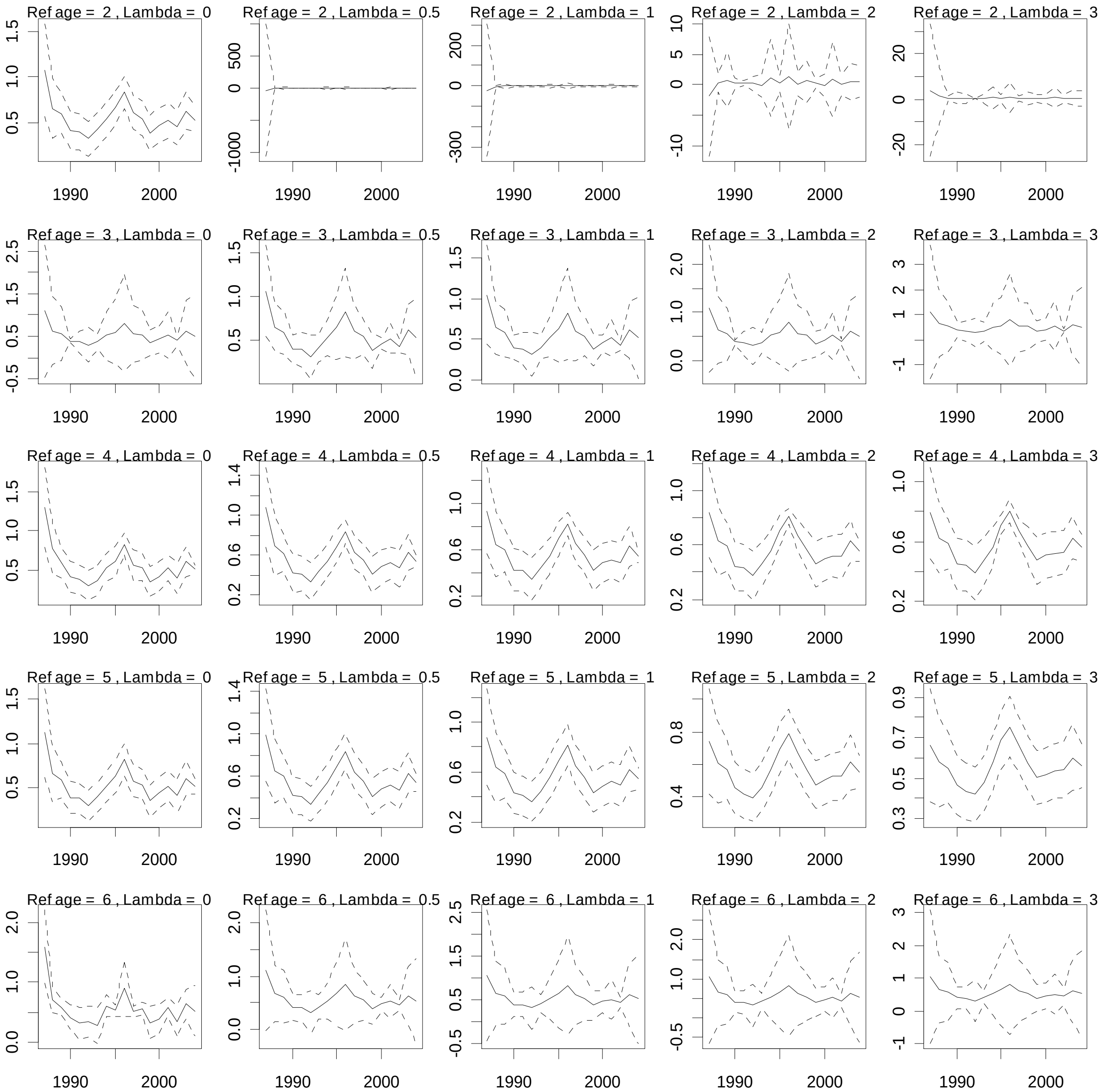


Figure 11.3.8. - Plaice VIId. Mean standardised indices by year class for each of the surveys

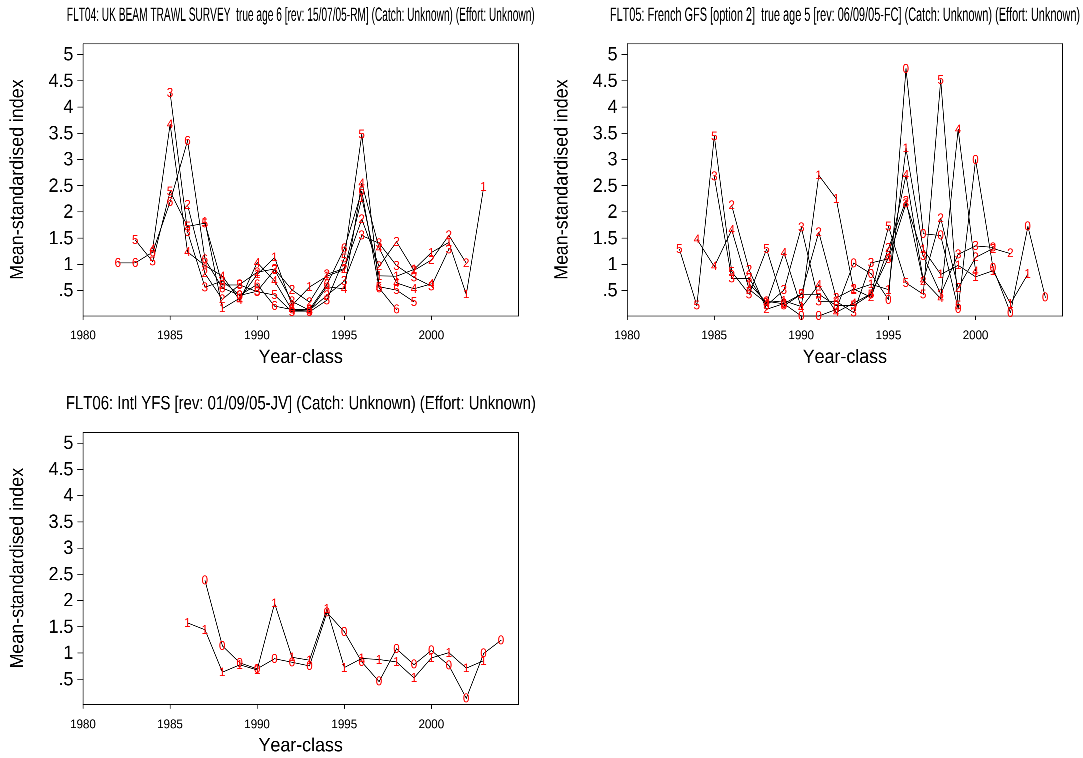


Figure 11.3.9 - Plaice VIID. Cohort curves for surveys

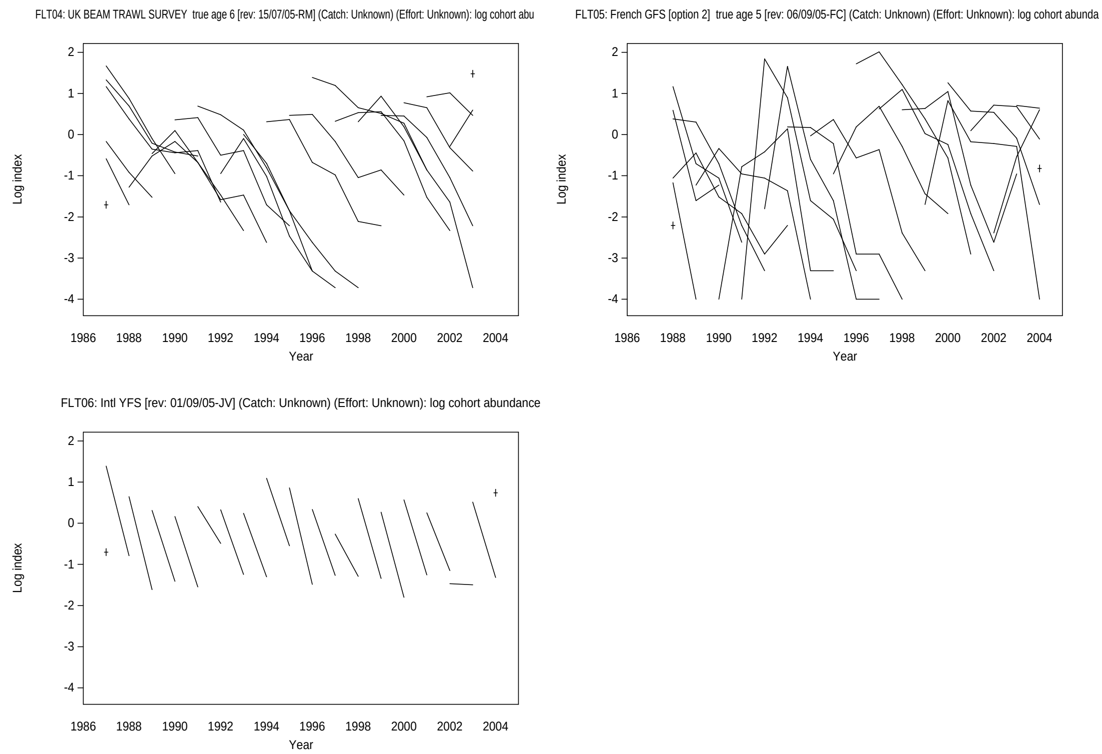


Figure 11.3.10. - Plaice 7d. Internal consistency of the UK Beam Trawl Survey

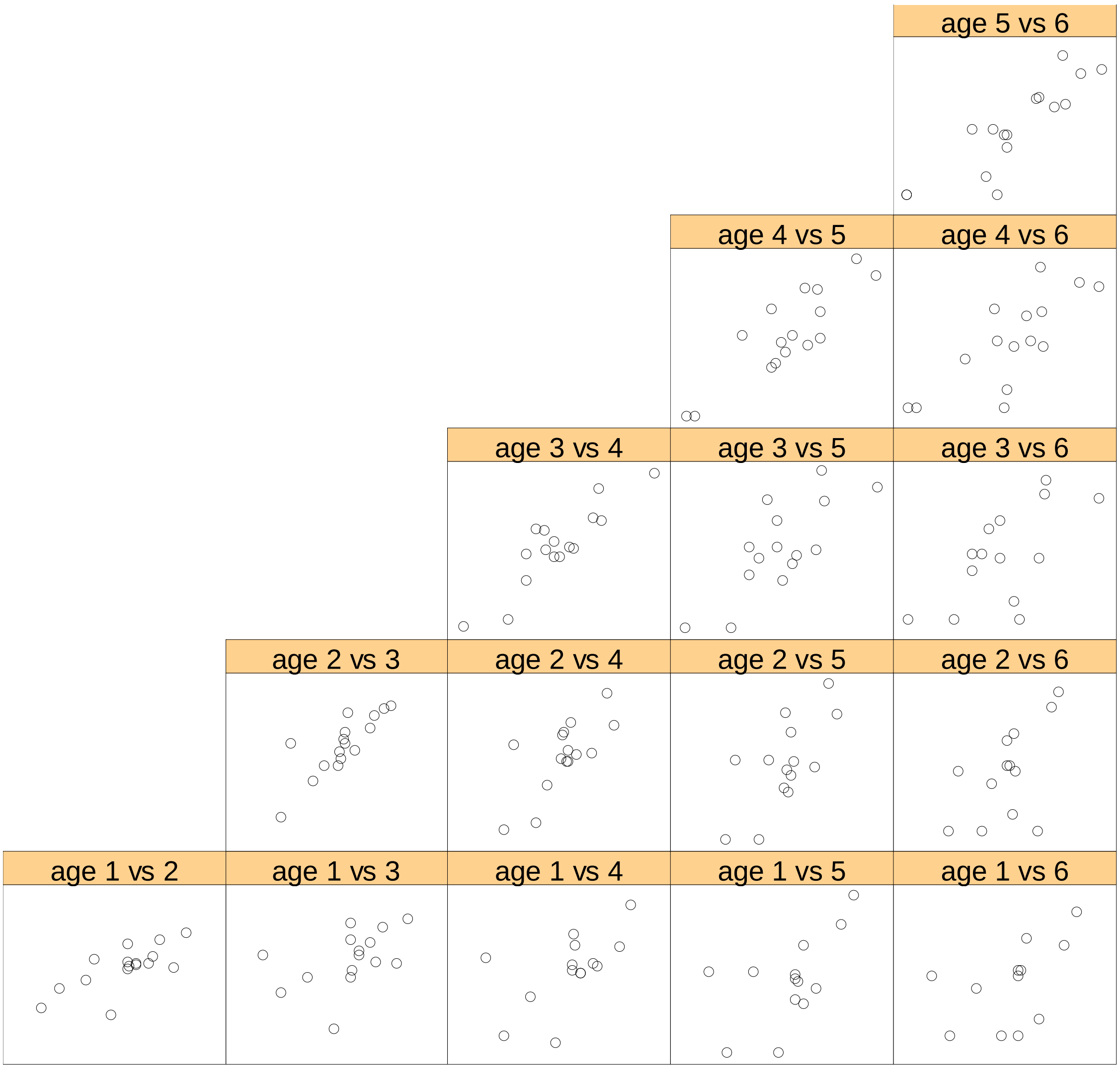


Figure 11.3.11. - Plaice 7d. Internal consistency of the French GFS

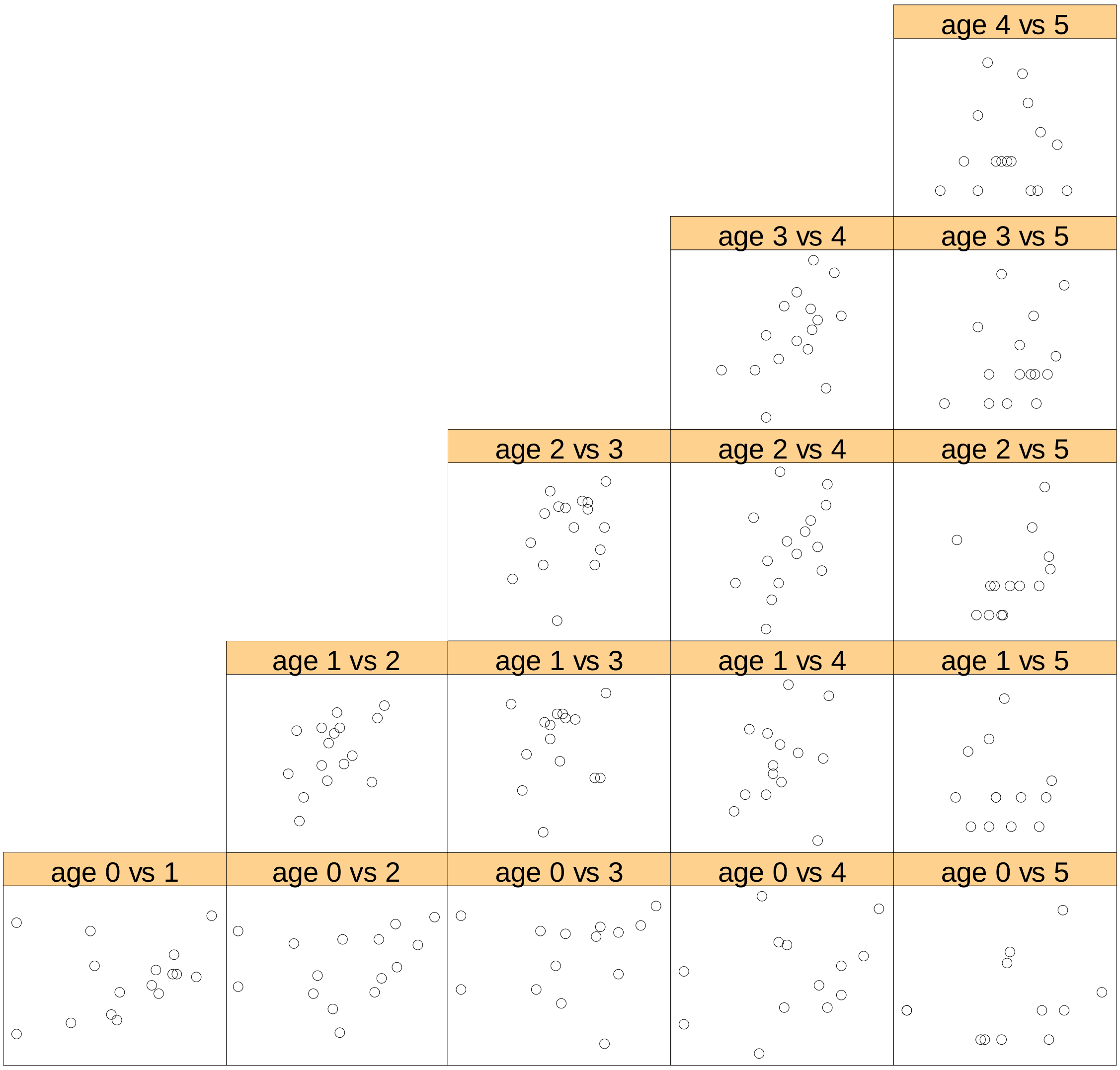


Figure 11.3.12. - Plaice 7d. Internal consistency of the International YFS

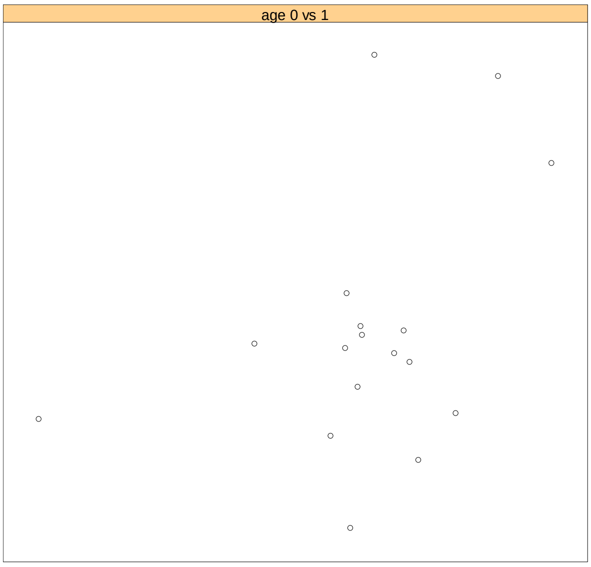


Figure 11.3.13. - Plaice VIId. Summary plots of the retrospective analysis

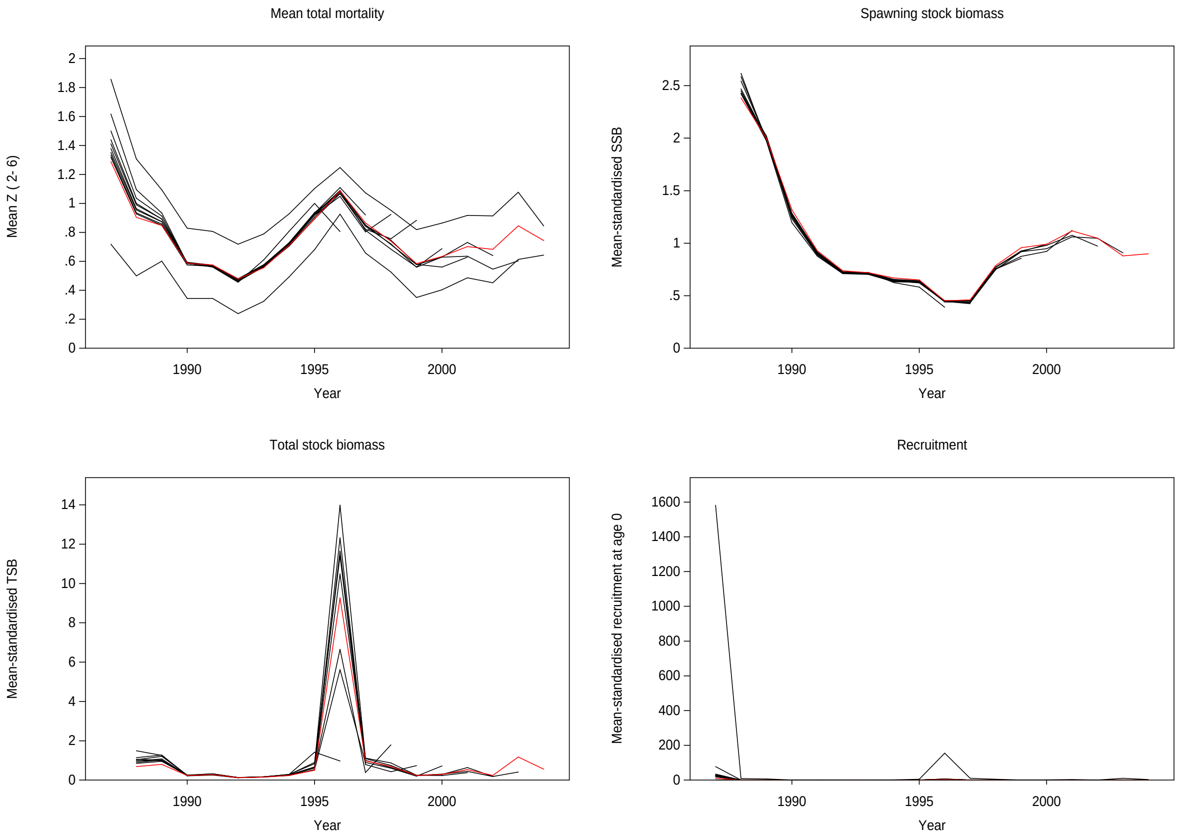


Figure 11.3.14. - Plaice VIID. Comparison of the mean standardised values of SSB, F and recruitment derived from XSA and SURBA models

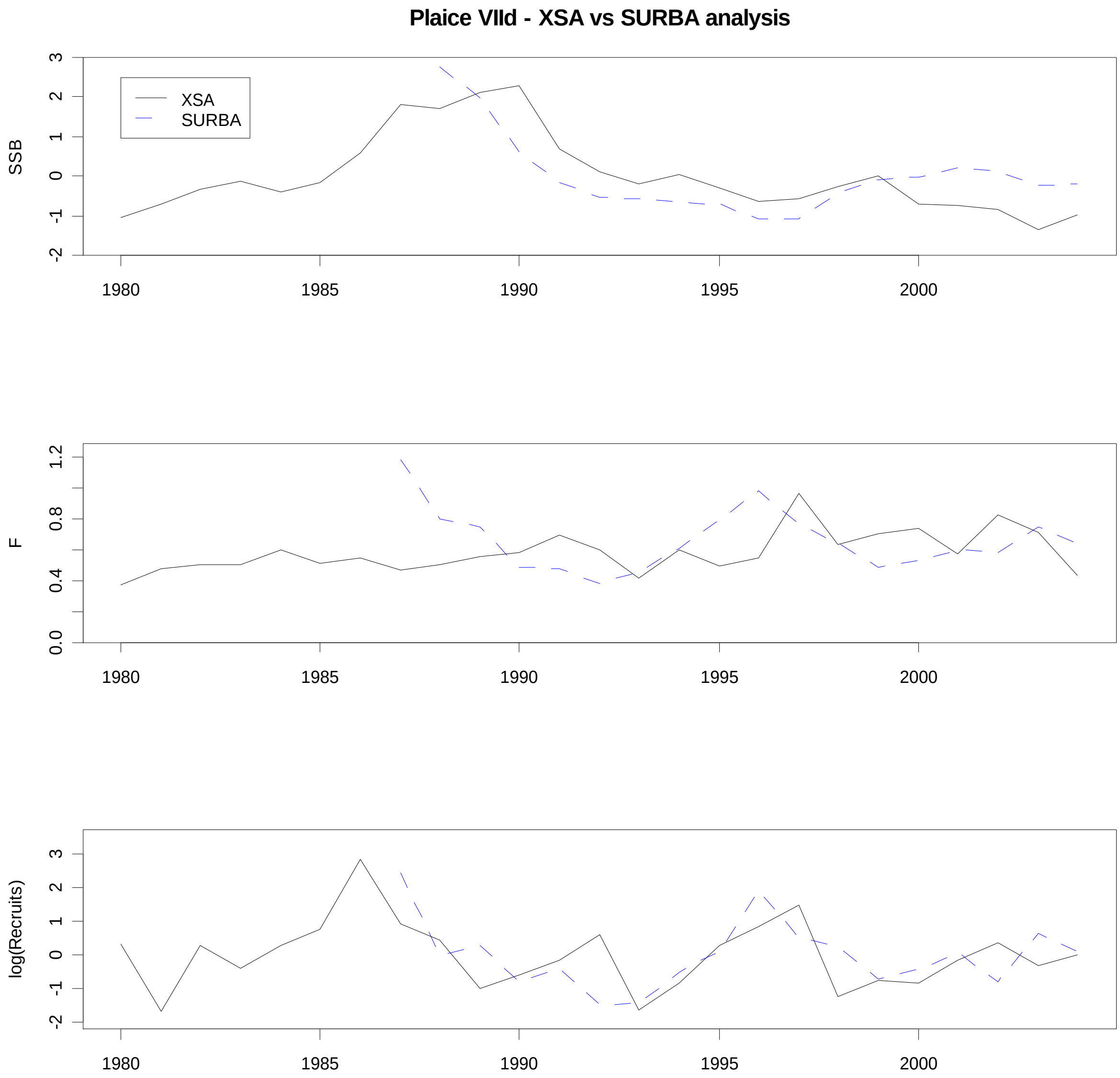
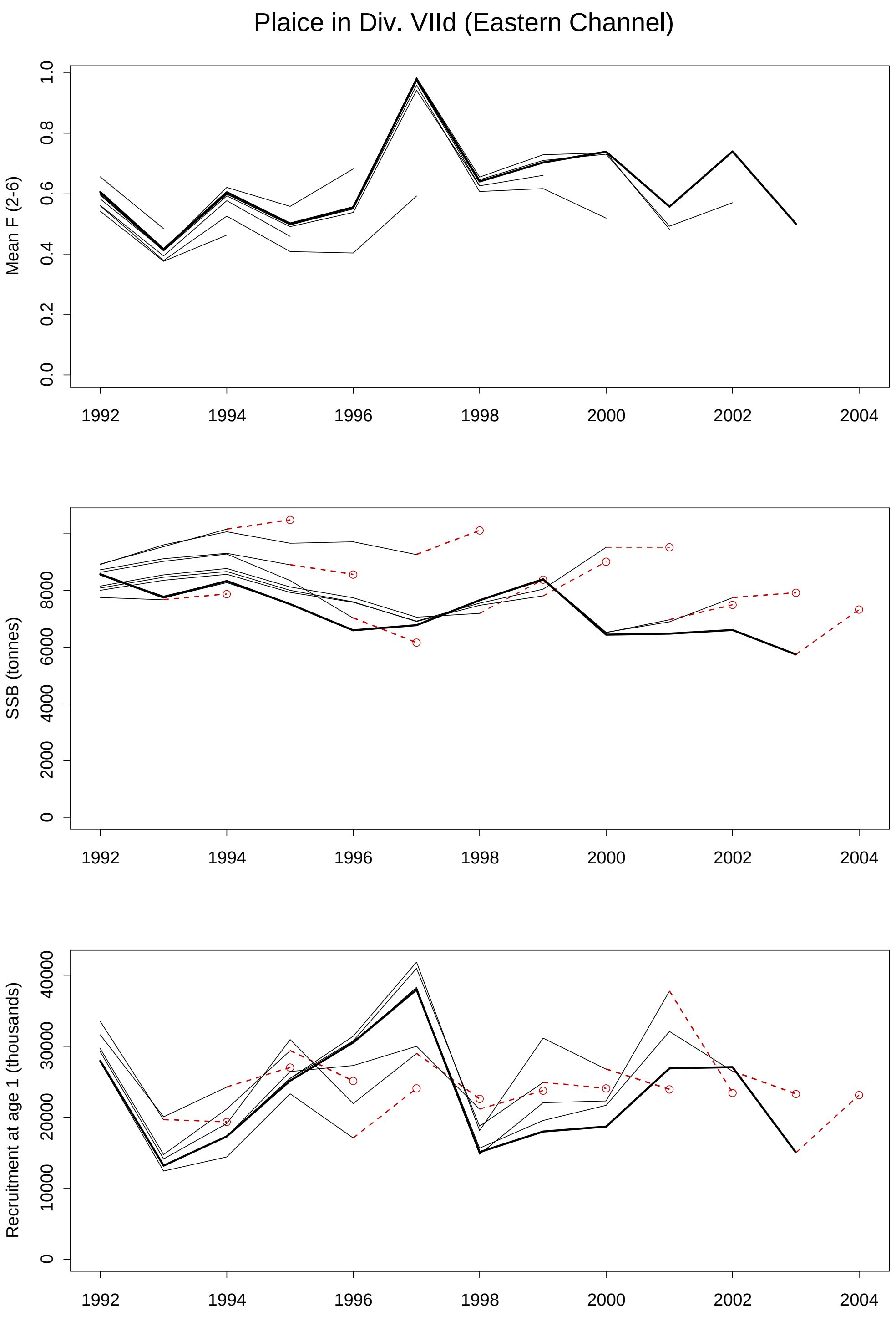


Figure 11.7.1. Plaice in VIId. Historical performance of the assessment. There is no final 2005 assessment. Circles indicate forecasts.



12 Norway pout in ices sub- area IV and division IIIa

The 2005 assessment of Norway pout in the North Sea and Skagerrak is an update assessment from the 2004 benchmark assessment. Due to closure of the Norway pout fishery and no catches in 2005 exploratory and comparative assessment runs have been carried out using different assessment parameter settings and models (SXSA, SMS and SURBA).

12.1 General

12.1.1 Ecosystem aspects

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

Around 10 % of the Norway pout reach maturity already at age 1, however, most individuals reach maturity at age 2.

Preliminary results from an analysis of regionalized survey data on Norway pout maturity, presented in 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.

The population dynamics of Norway pout in the North Sea and Skagerrak are very dependent on changes caused by recruitment variation and variation in predation mortality (or other natural mortality causes) (Sparholt et al. 2002a,b). Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species. With present fishing mortality levels in recent years the status of the stock is more determined by natural processes and less by the fishery. However, there is a need to ensure that the stock remains high enough to provide food for a variety of predator species. This stock is among other impotant as food source for other species (e.g. saithe, haddock and mackerel).

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. By-catches of other species should also be taken into account in management of the fishery. Existing technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been maintained.

12.1.2 Fisheries

The fishery is mainly performed by Danish and Norwegian (large) vessels using small mesh trawls in the north-western North Sea especially at the Fladen Ground and along the edge of the Norwegian Trench in the north-eastern part of the North Sea. Main fishing seasons are 3rd and 4th quarters of the year with also high catches in 1st quarter of the year especially previous to 1999. (See also stock quality handbook).

The spatial distribution of catches in tons by ICES statistical rectangle and season of year for 2004 from the Danish commercial fishery for Norway pout is shown in **Figure** 12.1.1. Ten year averages of the distribution of catches by year and quarter are shown in figures in the quality handbook for the stock.

Trends in yield are shown in **Figure**s 12.3.2-3. Landings have been low since 2001, and the 2003-2004 landings were on the lowest level ever recorded since 1961. The fishery has been closed for 2005, and there were no landings in the first two quarters of the year of 2005 except for 347 ton by-catch of Norway pout in the Norwegian blue whiting fishery in the North Sea mainly in the 2nd quarter of the year and 151 t from a Danish Norway pout trial fishery in the North Sea in the 2nd quarter of the year.

Effort in 2003 and 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 in 2002 at the same level as in the previous 8 years before 2001. In 2005 the fishery was closed, and there has been no directed effort for Norway pout in the first two quarters of 2005, except for a very small Danish trial fishery in the 2nd quarter of the year in the North Sea.

12.1.3 ICES advice

There is no specific management objective set for this stock. With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery.

The stock was in the first part of 2004 considered by ICES to be at the Blim-level. The stock forecast in the 2004 assessment indicated that even in the case of closure of the fishery (F=0) the stock in the start of 2005 would fall below B_{lim}. On that basis ACFM adviced a closure of the fishery (TAC=0 t).

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 B_{lim} = 90,000 t as the lowest observed biomass (in 1987) and B_{pa} = 150,000 t which should be maintained.

12.1.4 Management

In 2004 the TAC was set to 198,000 t in the EC zone and 50,000 t in the Norwegian zone.

On basis of the advice from ICES, EU and Norway agreed to close the directed Norway pout fishery in 2005. Accordingly, the TAC was in 2005 set to 0 in the EC zone and 5,000 t in the Norwegian zone – the latter to allow for by-catches of Norway pout in the directed Norwegian blue whiting fishery.

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

An overview of recent relevant management measures and regulations for the Norway pout fishery and the stock can be found in the Quality Handbook for Norway pout in the North Sea and Skagerrak, section f.

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. As the fishery has been closed there has been no landings of Norway pout in 2005, except for 347 ton by-catch of Norway pout in the Norwegian blue whiting fishery in the North Sea mainly in the 2nd quarter of the year and 151 t from a Danish Norway pout trial fishery in the North Sea in the 2nd quarter of the year. These landings have been so low that there has not been made biological sampling from them, and accordingly they have been ignored in the assessment.

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. The reason for mean weight at age in catch is not used as estimator of weight in the stock is mainly because of the smallest 0-group fish are not fully recruited to the fishery in 3rd quarter of the year because of likely strong effects of selectivity in the fishery.

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 2001-2002 assessments exploratory runs were made with revised input data for natural mortality by age based on the results from two papers presented to the working group in 2001, (*both papers published in ICES J. Mar. Sci. in 2002, Sparholt, Larsen and Nielsen 2002a,b).*

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 has been adopted by the working group each year since then. In this years up-date assessment a exploratory run with revised values for M is performed as well.

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 have each year been compared to those for the accepted run with standard settings (Figure 12.3.12). It appears that the implications of these revised input data are very significant (also for TSB (3rd quarter of year) – not shown). The results of the exploratory runs have been consistent throughout all years of exploratory runs.

On that basis the working group recommends that there is made a limited benchmark assessment for Norway pout in 2006 with specific reference to evaluation of effects of revised natural mortalities, and that the working group on this basis decides on which M1 mortalities to use in the assessment.

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. The same method of effort standardization as in previous years was used in the 2005 up-date assessment. The results of the standardization are also presented in the stock quality handbook.

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. and **Figure** 12.2.3.

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

The revision of the tuning fleets used in the benchmark 2004 assessment as used also in this 2005 up-date assessment is summarised in **Table** 12.3.1.

12.3 Catch at Age Data Analyses

12.3.1 Final Assessment

The SXSA (Seasonal Extended Survivors Analysis) was used to estimate quarterly stock numbers and fishing mortalities for Norway pout in the North Sea and Skagerrak in 2005. The catch at age analysis was carried out according to the specifications in the stock quality control handbook.

The 2005 assessment of Norway pout in the North Sea and Skagerrak is an update assessment from the 2004 benchmark assessment using the same tuning fleets and parameter settings. An overview of indices used in this year assessment is provided in **Table** 12.3.1. Recruitment season to the fishery was in 2004 backshifted from 3rd quarter of the year to 2nd quarter of the year in order to gain benefit from the most recent 0-group indices from the 3rd quarter surveys (SGFS and EGFS as explained above) in the assessment (**Table** 12.3.2).

Results of the analysis are presented in **Table** 12.3.3 (population numbers at age (recruitment), 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** 12.3.8 (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** 12.4.1. Retrospective plots of F, SSB and recruitment are shown in **Figure** 12.3.5. The summary of the results of the assessment is shown in **Table** 12.3.8 and **Figure** 12.3.2-3.

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 up to 2004 (**Figure** 12.3.4). Fishing mortality in the first and second quarter of the year 2005 has been zero due to closure of the Norway pout fishery in 2005.

Stock biomass (SSB) has since 2001 decreased continuously. In 2004, the stock biomass fell from a level around **B**lim (90,000 t) to around 60.000 t well below **B**lim in 2005 which is the lowest level ever recorded.

12.3.2 Exploratory catch at age analyses

Due to closure of the Norway pout fishery and no catches in 2005 there has been made a series of exploratory and comparative assessment runs using different assessment models (SXSA, SMS and SURBA) to evaluate the effect on the assessment of this situation. There were made 3 exploratory catch at age analyses in relation to the 2005 up-date assessment. This was by the working group considered necessary for the following reasons: The Norway pout assessment is made with the seasonal XSA method running the assessment up to and including the second quarter of the year of the assessment year. Because of the closure of the fishery in 2005 there are no catch data for Norway pout in first and second quarter of the year 2005. In order to run an up-date assessment using the same assessment model as in the benchmark assessment from 2004 it has, accordingly, been necessary to introduce artificial small catch numbers for the first and second quarter of the year for the terminal assessment year. To evaluate whether this would change the perception of the stock status and dynamics the following series of comparative, exploratory catch at age analyses were made to investigate the effect of using:

1. <u>SXSA assessment with the change of using catch numbers in the first and second quarter of 2005 corresponding to 50% of the 2004 quarter 1 and 2 catch numbers</u>. The results of these comparative runs are shown in **Figure** 12.3.7. The resulting outputs of these assessments were identical giving the same perception of the stock status and dynamics.
2. <u>SMS assessment using identical input data as the SXSA 2005 up-date assessment</u>. The diagnostics and results of the SMS assessment are shown in **Table** 12.3.6 and **Figures** 12.3.8.1-3. A comparison of the output to the SXSA assessment is shown in **Figure** 12.3.9. The SMS assessment performs also a quarterly based assessment like the SXSA, and the SMS is capable of running with no catch at age for the terminal assessment year (2005). As was also shown in the 2004 benchmark assessment, the SMS model results in a rather similar weighting of the catch at age data as well as the tuning fleets as the SXSA model does. The SMS model tends to estimate lower SSB and higher F compared to results of the SXSA model, however, the perception of the stock status and dynamics are very much similar from the results of both model runs.

Recruitment estimates of the two models can not be directly compared as the SMS gives recruitment in first quarter of the year while the SXSA gives recruitment in the second quarter of the year. This gives some of the explanation of the level of difference in recruitment indications of the two models.

3. SURBA assessment using identical tuning fleet data as the 2005 up-date assessment (including commercial fishery tuning fleets) but not using catch at age data. The SURBA performs an yearly based assessment. The diagnostics and results of the SURBA assessment are shown in **Table** 12.3.7 and **Figures** 12.3.10.1-2. The SURBA could only run when using F-refence ages 2-3 while SXSA and SMS used ages 1-2 as reference ages. The output of SURBA is total mortality Z and not F. Trends in Z for SURBA and F for SXSA has been comparatively scaled to show a comparison of trends in mortality in **Figure** 12.3.11. The two models show overall the same tendency in mortality for the stock over time, although the trends differ in the most recent years. The trends in SSB and recruitment, i.e. the perception of the stock and the developments in the population dynamics of the stock, are very much similar for the two models.

12.3.3 Conclusions of the explorative comparison runs:

The exploratory runs give very much similar results, and in general showed only small differences in the perception of the stock status and dynamics. On that basis it was decided that the final, accepted assessment continues to use the seasonal assessment method (SXSA) with inclusion of very small artificial catches for 1^{st} and 2^{nd} quarter of

12.3.4 Comparison with 2004 benchmark assessment:

The final, accepted assessment run was compared to the SXSA 2004 benchmark assessment. The results of this comparative run are shown in **Figure** 12.3.6. The resulting outputs of these assessments showed to be identical giving similar perception of stock status and dynamics.

12.3.5 Effect of new proposed natural mortalities:

Furthermore, the 2005-up-date-assessment was run with revised natural mortalities. Investigations on revised mortality rates of Norway pout (see Quality handbook and Section B.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 are estimated, while for ages 2 and 3, M is estimated to 0.75 and 0.95 (**Table** 12.2.3). Stock summary from the SXSA run using these new M values is given in **Figure** 12.3.12. Stock trends remain the same, but levels differ significantly. The group decided not to use the suggested higher M values in present assessment as this does not change the perception of stock dynamics developments. The group suggested to present this also this year as an exploratory assessment run in accordance with the decisions put forward in the 2001 and 2002 assessments. The group recommend that a specific benchmark assessment for Norway pout exploring revised natural mortalities should be made in 2006 because this changes the perception of the stock with respect to division between fishing mortality and natural mortality. For this 2005 up-date assessment the group decided to include the traditional used values for natural mortality in the final catch at age analysis.

12.4 Historical stock trends

Stock summary plots are given in Figure 12.3.2. Both SSB and mean F are estimated to be at their lowest ever levels. Recent recruitment has been poor.

12.5 Recruitment Estimates

The long-term average recruitment (age 0, 2nd quarter) is 119 billions (arithmetic mean) and 98 billions (geometric mean) for the period 1984-2004 (**Table** 12.3.8). Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species.

No strong year-classes have appeared in the period 2000-2004 since the strong 1999 year-class. The 2003 and 2004 year-classes are the lowest in the time series. The estimated recruitment in 2005 (112 billions) is indicated to be about long term average (geometric mean). However, this estimate from the assessment is only based on the Scottish Groundfish Survey (SGFS) in quarter 3 2005 as the English Groundfish Survey (EGFS) quarter 3 index is not available for 2005 which traditionally is included in the assessment according to the descriptions in the stock quality handbook.

12.6 Short-term prognoses

Deterministic short-term prognoses were performed for the Norway pout stock. The forecast was calculated as a stock projection up to 1st of January 2006. The projection up to 1st of January 2006 is based on the assessment estimate of recruitment in 2005. A management table is presented with forecast F being zero for 2005 (F-multiplier=0) (**Table** 12.6.1). Mean catch weight at age are averaged over the last three years. A range of 75-125% of estimated recruitment in 2005 (only based on the SGFS 0-group index) is evaluated. This sensitivity analysis is made because the recruitment estimate in 2005 is only based on one index. It can be seen that with no fishery in 2005 and present indication of average recruitment in 2005 the stock will still in the start of 2006 be below $\mathbf{B}_{\mathrm{lim}}$. With 125% recruitment level of the recruitment estimate in 2005 and no fishery in 2005 the stock will still be below $\mathbf{B}_{\mathrm{lim}}$ in the start of 2006.

12.7 Medium-term projections

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

12.8 Biological reference points

Precautionary Approach reference points (unchanged since 1997):

ICES considers that:	ICES proposes that:
B_{lim} is 90.000 t, the lowest observed biomass	B_{pa} be established at 150,000 t. Below this value the probability of below average recruitment increases.
Note: With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery.	

Technical basis:

$B_{lim} = B_{loss}$ = 90,000 t.	B_{pa} Below-average recruitment below: 150,000 t.
F_{lim} None advised.	F_{pa} None advised.

12.9 Quality of the assessment

Quality control diagrams of the assessment are presented in Figure 12.9.1.

The estimates of the SSB, recruitment and the average fishing mortality of the 1- and 2-group are consistent with the estimates of previous years assessment. This appears from the quality control diagrams made from the results of the assessment as well as from **Figures** 12.3.6-11 with among other the comparisons of the 2005 up-date assessment and the 2004 benchmark assessment. Comparative runs with the SXSA, SMS and SURBA assessment models gave consistent estimates of stock status and dynamics. Consequently, the accepted assessment using small artificial landings in the first and second quarter of the year 2005 does not introduce a new perception of the stock status and dynamics.

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, using seasonal based fishery independent information, and using most recent information about recruitment. The assessment provide stock status and year class strengths of all year classes in the stock up to the second quarter of the assessment year. Also it gives a good indication of the stock status the 1. January the following year based on projection of existing recruitment information in 3rd quarter of the assessment year included in the assessment.

Potential workplan and suggestions for investigations in relation to benchmark assessment:

1. The working group recommends that a specific benchmark assessment for Norway pout exploring revised natural mortalities should be made in 2006 because this changes the perception of the stock with respect to division between fishing mortality and natural mortality for a stock that is mainly driven by natural mortality and recruitment. For this 2005 up-date assessment the group decided to include the traditional used values for natural mortality in the final catch at age analysis.

In later benchmark assessment the following should be considered:

2. 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 dis-aggregation of Danish and Norwegian commercial tuning fleet time series taking into consideration the spatial behaviour of the fisheries.
3. 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) which should be obtained from estimates of total mortality from surveys for use within management of this stock.
4. 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.

12.10 State of the stock

Recruitment has been low since 2000 including historical minima in 2003-2004, however the assessed 2005 recruitment based on one 2005 3rd quarter survey index indicate a recruitment of 0-group Norway pout in 2005 corresponding to the long term geometric mean (**Table** 12.3.3 and **Table** 12.3.8). Stock biomass (SSB) is below $\mathbf{B}_{lim}$ and well below B_{pa} in 1st quarter of 2005 (**Table** 12.3.5). 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). Estimated fishing mortality has decreased in 2004 to the lowest level in the time series, and because of the fishery closure in 2005 the fishing mortality has been zero in 2005. Fishing effort has in general decreased in recent years reaching historically minima in 2001 and in 2003-2005.

12.11 Management considerations

12.11.1 There is no specific management objective set for this stock

The stock was in the first part of 2005 considered by ICES to be below the Blim-level. The stock is expected to still be below B_{lim} in 2006. Based on the advice from ICES, EU and Norway agreed to close the fishery in 2005.

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

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species.

In managing this fishery, by-catches of haddock, whiting, herring, and blue whiting should be taken into account and existing measures to protect these by-catch species should be maintained.

There is consistent quarterly based information available to perform real time monitoring and management of the stock. This can be carried out both with fishery independent and fishery dependent information as well as a combination of those.

12.12 Norway Pout in Division VIa

12.12.1 Catch trends and assessment

Landings of Norway pout from Division VIa as reported to ICES are given in **Table** 12.12.1 and **Figure** 12.12.1. Reported landings in 2004 were 2,300 t. This level of landings is well below the series average of around 10,000 t (1974-2004). 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.

12.12.2 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 1997-2004, as officially reported to ICES and EU.**

Norway pout ICES area IIIa

Country	1997	1998	1999	2000	2001	2002	2003	2004
Denmark	34 746	11 080	7 194	14 545	13 619	3 780	4 235	110
Faroe Islands	-	-	-	-	-	-	50	-
Norway	-	-	-	-	-	96	30	41
Sweden	2	-	-	133	780	-	-	-
Germany	-	-	-	-	-	-	-	54
Total	34 748	11 080	7 194	14 678	14 399	3 876	4 315	205

*Preliminary.

Norway pout ICES area IVa

Country	1997	1998	1999	2000	2001	2002	2003	2004
Denmark	106 958	42 154	39 319	133 149	44 818	68 858	12 223	10 762
Faroe Islands	7 033	4 707	2 534		49	3 367	2 199	-
Netherlands	35	-	-	-	-	-	-	-
Germany	-	-	-	-	-	-	-	27
Norway	39 006	22 213	44 841	48 061	17 158	23 657	11 357	4 958
Sweden	+	-	-	-	-	-	-	-
Total	153 032	69 074	86 694	181 210	62 025	95 882	25 779	15 747

*Preliminary.

Norway pout ICES area IVb

Country	1997	1998	1999	2000	2001	2002	2003	2004
Denmark	1 794	3 258	5 299	158	632	556	191	473
Germany	-	-	-	2	-	-	-	26
Netherlands	50	2	-	3	-	-	-	-
Norway	-	57	-	34	-	-	-	-
Sweden	-	-	-	-	-	-	-	2
UK (E/W/NI)	-	-	-	+	-	+	-	-
UK (Scotland)	+	-	-	-	-	-	-	-
Total	1 844	3 317	5 299	197	632	556	191	501

*Preliminary.

Norway pout ICES area IVc

Country	1997	1998	1999	2000	2001	2002	2003	2004
Denmark	-	-	514	182	304	-	-	-
Netherlands	-	-	+	-	-	-	-	-
UK (E/W/NI)	-	-	-	-	+	-	-	-
Total	0	0	0	0	0	0	0	0

*Preliminary.

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

Country	1997	1998	1999	2000	2001	2002	2003	2004
Denmark	143 498	56 492	51 812	147 852	59 069	73 194	16 649	11 345
Faroe Islands	7 033	4 707	2 534	0	49	3 367	2 249	0
Norway	39 006	22 270	44 841	48 095	17 158	23 753	11 387	4 999
Sweden	2	0	0	133	780	0	0	2
Netherlands	85	2	0	3	0	0	0	0
Germany	0	0	0	2	0	0	0	107
UK	0	0	0	0	0	0	0	0
Total nominal landings	189 624	83 471	99 187	196 085	77 056	100 314	30 285	16 453
By-catch of other species and other	-19 924	-3 671	-7 187	-11 685	-11 456	-23 614	-5 385	-2 953
WG estimate of total landings (IV+IIIaN)	169700	79800	92000	184400	65600	76700	24900	13500
Agreed TAC	220000	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 1961-2004 (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	-	85.0	154.2	2.1	26.7	3.3	735.8
1975	251.2	-	63.6	218.9	2.3	22.7	1	559.7
1976	244.9	-	64.6	108.9	+	17.3	1.7	437.4
1977	232.2	-	48.8	98.3	2.9	4.6	1	387.8
1978	163.4	-	18.5	80.8	0.7	5.5	-	268.9
1979	219.9	9	21.9	75.4	-	3	-	329.2
1980	366.2	11.6	34.1	70.2	-	0.6	-	482.7
1981	167.5	2.8	16.4	51.6	-	+	-	238.3
1982	256.3	35.6	12.3	88	-	-	-	392.2
1983	301.1	28.5	30.7	97.3	-	+	-	457.6
1984	251.9	38.1	19.11	83.8	-	0.1	-	393.01
1985	163.7	8.6	9.9	22.8	-	0.1	-	205.1
1986	146.3	4	2.5	21.5	-	-	-	174.3
1987	108.3	2.1	4.8	34.1	-	-	-	149.3
1988	79	7.9	1.3	21.1	-	-	-	109.3
1989	95.7	4.2	0.8	65.3	+	0.1	0.3	166.4
1990	61.5	23.8	0.9	77.1	+	-	-	163.3
1991	85	32	1.3	68.3	+	-	+	186.6
1992	146.9	41.7	2.6	105.5	+	-	0.1	296.8
1993	97.3	6.7	2.4	76.7	-	-	+	183.1
1994	97.9	6.3	3.6	74.2	-	-	+	182
1995	138.1	46.4	8.9	43.1	0.1	+	0.2	236.8
1996	74.3	33.8	7.6	47.8	0.2	0.1	+	163.8
1997	94.2	29.3	7.0	39.1	+	+	0.1	169.7
1998	39.8	13.2	4.7	22,1	-	-	+	57.7
1999	41	6.8	2.5	44.2	+	-	-	94.5
2000	127	9.3	-	48	0.1	-	+	184.4
2001	40.6	7.5	-	16.8	0.7	+	+	65.6
2002	50.2	2.8	3.4	23.6	-	-	-	80.0
2003	9.9	3.4	2.4	11.4	-	-	-	27.1
2004	8.1	0.3	-	5.0	-	-	0.1	13.5

Table 12.1.3 **NORWAY POUT, North Sea and Skagerak. National landings (t) by quarter of year 1992-2005.**
(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	316	-	316	87	650	-	-	737	1 053	989	989	2 042
	2	-	-	-	-	-	7	-	7	7	660	660	667
	3	14	-	14	289	1 195	9	-	1 493	1 507	2484	2484	3 991
	4	13	-	13	93	5 683	107	-	5 883	5 896	865	865	6 761
	Total	343	-	343	469	7 528	123	-	8 120	8 463	4 998	4 998	13 461
2005	1	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	-

Table 12.2.1 **NORWAY POUT in the North Sea and Skagerrak. Catch in numbers at age by quarter (millions). SOP is given in tonnes. Data for 1990 were estimated within the SXSA program used in the 1996 assessment.**

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

Table 12.2.2 NORWAY POUT in the North Sea and Skagerrak. Mean weights (grams) at age in catch, by quarter 1983-2005, from Danish and Norwegian catches combined. Data for 1974 to 1982 are assumed to be the same as in 1983.

Year	1983				1984				1985			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			4.00	6.00			6.54	6.54			8.37	6.23
1	7.00	15.00	25.00	23.00	6.55	8.97	17.83	20.22	7.86	12.56	23.10	26.97
2	22.00	34.00	43.00	42.00	24.04	22.66	34.28	35.07	22.7	28.81	36.52	40.90
3	40.00	50.00	60.00	58.00	39.54	37.00	34.10	46.23	45.26	43.38	58.99	
4									41.80			
Year	1986				1987				1988			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0				7.20			5.80	7.40			9.42	7.91
1	6.69	14.49	28.81	26.90	8.13	12.59	20.16	23.36	9.23	11.61	26.54	30.60
2	29.74	42.92	43.39	44.00	28.26	31.51	34.53	37.32	27.31	33.26	39.82	43.31
3	44.08	55.39	47.60		52.93			46.60	38.38			
4	82.51				63.09				69.48			
Year	1989				1990				1991			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			7.48	6.69			6.40	6.67			6.06	6.64
1	7.98	13.49	26.58	26.76	6.51	13.75	20.29	28.70	7.85	12.95	30.95	30.65
2	26.74	28.70	35.44	34.70	25.47	25.30	32.92	38.90	20.54	28.75	44.28	43.10
3	39.95	44.39		46.50	37.72	40.35	39.40	52.94	35.43	49.87	67.25	59.37
4					68.00				44.30			
Year	1992				1993				1994			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0		8.00	6.70	8.14			4.40	8.14			5.40	8.81
1	8.78	11.71	26.52	27.49	9.32	14.76	25.03	26.24	8.56	15.22	29.26	31.23
2	25.73	31.25	42.42	44.14	24.94	30.58	35.19	36.44	25.91	29.27	38.91	49.59
3	41.80	49.49	50.00	50.30	46.50	48.73	55.40	70.80	42.09	46.88	53.95	
4	43.90											
Year	1995				1996				1997			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			5.01	7.19			3.88	5.95			3.61	10.18
1	7.70	10.99	25.37	24.6	8.95	12.06	27.81	28.09	7.01	11.69	20.14	22.11
2	24.69	22.95	33.40	39.57	21.47	25.72	40.90	38.81	23.11	26.40	31.13	32.69
3	50.78	37.69	45.56	57.00	37.58	37.94	50.44	56.00	39.11	34.47	44.03	38.62
4												
Year	1998				1999				2000			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			4.82	8.32			2.84	7.56			7.21	13.86
1	8.76	12.55	23.82	24.33	8.98	12.40	22.16	25.60	10.05	15.65	23.76	22.98
2	22.16	25.27	31.73	30.93	25.84	24.15	32.66	37.74	19.21	25.14	38.90	34.48
3	34.84	32.18	44.92	33.24	36.66	35.24	43.98	51.63	32.10	41.30	39.61	50.04
4	42.40	40.00			46.57	46.57						
Year	2001				2002				2003			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			6.34	7.90			7.28	7.20			9.12	9.79
1	8.34	16.79	27.00	30.01	8.59	16.40	27.13	27.47	11.58	13.13	28.33	15.98
2	21.50	23.57	39.54	35.51	25.98	30.39	43.37	36.87	22.85	26.19	38.01	31.87
3	39.84	37.63	54.20	55.70	32.30	40.10	54.11	41.28	34.96	39.89	46.24	45.79
4											70.00	70.00
Year	2004				2005							
Quarter of year	1	2	3	4	1	2						
Age 0			9.80	7.89								
1	11.54	14.63	31.02	31.75	11.97	14.65						
2	27.41	26.22	38.44	39.31	27.90	26.24						
3	41.52	34.80	49.50	49.80	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 1988-2004. Non-standardized CPUE-data for the Danish part of the commercial tuning fleet. (Logbook information).**

Vessel GRT	1988	1989	1990	1991	1992	1993	1994	1995	1996
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	20.48
151-200	22.71	23.17	25.6	28.22	34.2	27.36	31.52	34.73	22.05
201-250	30.44	26.1	24.87	29.74	36	27.76	40.59	39.34	24.96
251-300	23.29	26.14	21.3	28.15	31.9	32.05	36.98	38.84	31.43
301-	38.81	28.58	24.96	36.48	42.6	34.89	44.91	57.9	39.14

1997	1998	1999	2000	2001	2002	2003	2004
20	-	-	-	-	-	-	-
22.68	-	-	-	-	-	-	-
27.45	16.85	12.43	29.13	-	20.45	-	-
30.59	19.68	26.69	48.55	25.35	17.09	12.94	8.88
32.55	17.48	23.98	45.92	20.02	21.73	10.8	5.50
43.01	32.32	31	64.33	52.95	46.36	30.86	37.14

Table 12.2.5 **NORWAY POUT. Effort in days fishing and average GRT of Norwegian vessels fishing for Norway pout by quarter, 1983-2005.**

	Quarter 1		Quarter 2		Quarter 3		Quarter 4	
Year	Effort	Aver. GRT	Effort	Aver. GRT	Effort	Aver. GRT	Effort	Aver. GRT
1983	293	167.6	1168	168.4	2039	159.9	552	171.7
1984	509	178.5	1442	141.6	1576	161.2	315	212.4
1985	363	166.9	417	169.1	230	202.8	250	221.4
1986	429	184.3	598	148.2	195	197.4	222	226.0
1987	412	199.3	555	170.5	208	158.4	334	196.3
1988	296	216.4	152	146.5	73	191.1	590	202.9
1989	132	228.5	586	113.5	1054	192.1	1687	178.7
1990	369	211.0	2022	171.7	1102	193.9	1143	187.6
1991	774	196.1	820	180.0	1013	179.4	836	187.7
1992	847	206.3	352	181.3	1030	202.2	1133	199.8
1993	475	227.5	1045	206.6	1129	217.8	501	219.8
1994	436	226.5	450	223.5	1302	212.0	686	211.4
1995	545	223.6	237	233.8	155	221.7	297	218.1
1996	456	213.6	136	219.9	547	208.3	132	207.2
1997	132	202.4	193	218.9	601	194.8	218	182.3
1998	497	192.6	272	213.6	263	176.8	203	193.8
1999	267	173.0	735	180.1	1165	187.4	229	166.9
2000	294	197.1	348	180.7	929	205.3	196	219.3
2001	252	203.4	297	192.9	130	165.0	65	219.4
2002	90	208.6	246	189.1	1022	211.7	205	182.2
2003	162	219.1	320	215.3	550	252.8	75	208.4
2004	94	214.6	85	196.7	210	220.9	99	197.0
2005	0	0.0	0	0.0				

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	151	246	87	36	122	222	65	287	102	95	197	510	347	857
2005	0	0	0	0	0	0									

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	.	26.8	189.0	34.9	.	28.8	130.4	45.5	0.0	176.1	177.6	24.0	289.1	505.5	394.6	8.6

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 3rd Quarter[1]			
	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group
1970	35	6	-	-	-		-	-	-	-	-	-	-		-
1971	1,556	22	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	3,425	653	-	-	-	-	-	-	-	-	-	-	-	-	-
1973	4,207	438	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	25,626	399	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	4,242	2,412	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	4,599	385	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	4,813	334	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	1,913	1,215	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	2,690	240	-	-	-	-	-	-	-	-	-	-	-	-	-
1980	4,081	611	-	-	-	-	-	-	1,928	346	12	-	-	-	-
1981	1,375	557	-	-	-	-	-	-	185	127	9	-	-	-	-
1982	3,315	403	-	6,594	2,609	39	77	8	991	44	22	-	-	-	-
1983	2,258	592	8	6,067	1,558	114	0.4	13	490	91	1	-	-	-	-
1984	5,000	976	76	457	3,605	359	14	2	615	69	9	-	-	-	-
1985	2,342	1,429	73	362	1,201	307	0	5	636	173	5	-	-	-	-
1986	2,070	383	20	285	717	150	80	38	389	54	9	-	-	-	-
1987	3,170	481	61	8	552	122	0.9	7	338	23	1	-	-	-	-
1988	124	722	15	165	102	134	21	14	38	209	4	-	-	-	-
1989	2,013	255	172	1,530	1,274	621	20	2	382	21	14	-	-	-	-
1990	1,295	748	39	2,692	917	158	23	58	206	51	2	7,301	-	-	-
1991	2,450	712	130	1,509	683	399	6	10	732	42	6	2,558	1,039	189	2
1992	5,080	877	31	2,885	6,193	1,069	157	12	1,715	221	24	4,104	4,319	633	48
1993	2,682	2,644	258	5,699	3,278	1,715	0	2	580	329	20	3,196	1,831	608	53
1994	1,839	374	66	7,764	1,305	112	7	136	387	106	6	2,856	705	102	14
1995	5,940	785	77	7,546	6,174	387	14	37	2,438	234	21	4,554	4,444	597	69
1996	923	2,631	228	3,456	1,332	319	3	127	412	321	8	490	763	362	12
1997	9,752	1,474	670	1,103	5,579	364	32	1	2,154	130	32	2,931	3,447	236	46
1998	1,010	5,336	265	2,684	411	248	0	2,628	938	1,027	5	7,844	801	748	12
1999	3,527	597	667	6,358	1,930	88	26	3,603	1,784	180	37	1,643	2,367	201	94
2000	8,095	1,535	65	2,005	6,261	141	2	2,094	6,656	207	23	2,088	7,868	282	11
2001	1,305	2,861	235	3,948	1,013	693	5	756	727	710	26	1,974	1,274	862	27
2002	1,795	809	880	9,737	1,784	61	21	2,559	1,192	151	123	1,812	766	64	48
2003	1,243	576	95	379	681	85	5	1,767	779	126	1	793	1,063	146	7
2004	893	379	34	564	542	90	7	731	719	175	19	n/a	633	168	16
2005	698	125	36	n/a	n/a	n/a	n/a	3,073	343	132	18		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 12.3.1 **Norway pout. Stock indices used in final 2004 benchmark assessment as well as in the 2005 assessment compared to the 2003 assessment.**

		2003 ASSESSMENT	2004 & 2005 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 2005

Run: Baseline2005 (Summary from SXSA2005_out_1)

The following parameters were used:

```
Year range:                                           1983 - 2005
Seasons per year:                                     4
The last season in the last year is season :          2
Youngest age:                                         0
Oldest age:                                           3
Plus age:                                             4
Recruitment in season:                                2
Spawning in season:                                   1
```

The following fleets were included:

```
Fleet  1: (Q1: Age 1-3; Q2: None; Q3: Age 1-3; Q4: 0-3)    commercial q134
Fleet  2:                                                  ibtsq1       (Age 1-3)
Fleet  3:                                                  egfsq2       (Age 0-1)
Fleet  4:                                                  sgfsq2       (Age 0-1)
Fleet  5:                                                  ibtsq3       (Age 2-3)
```

The following options were used:

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

Data were input from the following files:

```
Catch in numbers:                                     canum.qrt
Weight in catch:                                      weca.qrt
Weight in stock:                                      west.qrt
Natural mortalities:                                  natmor.qrt
Maturity ogive:                                       matprop.qrt
Tuning data (CPUE):                                   tun2005.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	*	221117.	148219.	98989.	*	119149.	79868.	53536.	*	85619.	57392.	38466.
	1	109038.	69646.	45190.	25523.	64167.	40753.	25474.	12744.	34060.	20977.	13360.	7809.
	2	13115.	7729.	4170.	1507.	13591.	7985.	4399.	1571.	5684.	2694.	1687.	482.
	3	116.	66.	36.	10.	699.	351.	15.	4.	452.	146.	87.	42.
	4+	6.	3.	0.	0.	1.	1.	0.	0.	3.	1.	1.	1.
SSN		24141.				20708.				9545.			
SSB		369863.				371937.				167121.			
TSN		122276.	298560.	197615.	126028.	78458.	168239.	109757.	67856.	40199.	109436.	72526.	46800.
TSB		1056803.	1310904.	1904110.	1244834.	776190.	900383.	1146403.	680539.	381698.	413604.	641323.	433100.

Year		1986				1987				1988			
Season		1	2	3	4	1	2	3	4	1	2	3	4
AGE													
	0	*	156495.	104902.	70318.	*	46362.	31078.	20825.	*	128131.	85889.	56966.
	1	25229.	16587.	10906.	6339.	42574.	26338.	16774.	9912.	13774.	9030.	5975.	3855.
	2	2786.	992.	594.	197.	2783.	1537.	981.	518.	4884.	2701.	1750.	968.
	3	180.	62.	39.	21.	100.	57.	39.	26.	156.	88.	59.	40.
	4+	29.	17.	11.	8.	19.	12.	8.	5.	17.	11.	7.	5.
SSN		5518.				7160.				6434.			
SSB		87773.				96134.				124275.			
TSN		28224.	174153.	116451.	76883.	45477.	74307.	48880.	31287.	18831.	139961.	93680.	61835.
TSB		246716.	286557.	720118.	577231.	364350.	450881.	588168.	376176.	211051.	232309.	571724.	473439.

Year		1989				1990				1991			
Season		1	2	3	4	1	2	3	4	1	2	3	4
AGE													
	0	*	135390.	90755.	60705.	*	126079.	84513.	56635.	*	244107.	163630.	109084.
	1	35610.	22449.	14492.	8346.	36718.	23106.	14031.	8610.	37150.	23674.	15348.	9044.
	2	2067.	1346.	793.	314.	4169.	2317.	1085.	576.	4805.	2127.	1095.	558.
	3	317.	208.	134.	86.	134.	74.	34.	18.	291.	119.	64.	25.
	4+	30.	20.	13.	9.	53.	28.	18.	12.	17.	6.	4.	3.
SSN		5975.				8029.				8828.			
SSB		84774.				125777.				144290.			
TSN		38025.	159413.	106188.	69460.	41075.	151603.	99681.	65851.	42263.	270033.	180142.	118713.
TSB		309119.	394019.	767514.	574365.	357100.	430578.	737496.	563047.	378337.	433733.	1089182.	887384.

Year		1992				1993				1994			
Season		1	2	3	4	1	2	3	4	1	2	3	4
AGE													
	0	*	102886.	68967.	45510.	*	72548.	48630.	32519.	*	310089.	207859.	138803.
	1	70267.	44190.	28375.	16190.	29725.	18335.	11625.	6853.	20836.	12350.	7974.	4502.
	2	5205.	2599.	1503.	689.	8573.	5175.	3082.	1319.	3734.	2019.	1120.	406.
	3	221.	52.	18.	11.	243.	151.	54.	20.	520.	303.	179.	62.
	4+	4.	0.	0.	0.	6.	4.	3.	2.	13.	9.	6.	4.
SSN		12456.				11795.				6351.			
SSB		172743.				219481.				118268.			
TSN		75696.	149727.	98862.	62400.	38547.	96213.	63393.	40713.	25103.	324770.	217138.	143777.
TSB		615425.	753822.	1050948.	675017.	406749.	458739.	620867.	409307.	249536.	269528.	1089682.	957028.

Year		1995				1996				1997			
Season		1	2	3	4	1	2	3	4	1	2	3	4
AGE													
	0	*	97673.	65472.	43314.	*	233318.	156398.	104243.	*	67308.	45118.	30155.
	1	89572.	56774.	36497.	22381.	27649.	18096.	11671.	6969.	67816.	44908.	30021.	17594.
	2	2078.	1197.	592.	359.	12261.	7587.	4921.	2478.	4139.	2508.	1574.	751.
	3	163.	105.	44.	27.	192.	117.	48.	2.	1389.	866.	483.	238.
	4+	44.	30.	20.	13.	25.	16.	11.	7.	6.	4.	3.	2.
SSN		11242.				15243.				12315.			
SSB		117400.				298157.				194419.			
TSN		91857.	155778.	102625.	66094.	40127.	259134.	173049.	113701.	73350.	115595.	77200.	48740.
TSB		681704.	899174.	1202415.	791287.	472346.	536174.	1131829.	889972.	621658.	802432.	1027698.	630943.

Year		1998				1999				2000			
Season		1	2	3	4	1	2	3	4	1	2	3	4
AGE													
	0	*	92452.	61972.	41465.	*	228064.	152876.	102442.	*	82369.	55213.	36951.
	1	19933.	13147.	8641.	5455.	27517.	18280.	11993.	6976.	67747.	44877.	29853.	18891.
	2	10220.	6286.	3960.	2382.	3222.	2055.	1198.	526.	4204.	2667.	1618.	867.
	3	333.	185.	109.	72.	1421.	893.	522.	322.	222.	146.	59.	23.
	4+	132.	82.	35.	24.	53.	35.	23.	16.	207.	139.	93.	62.
SSN		12680.				7448.				11408.			
SSB		259557.				149954.				160397.			
TSN		30619.	112152.	74717.	49398.	32213.	249326.	166612.	110282.	72380.	130198.	86836.	56794.
TSB		385134.	424785.	640731.	478483.	323313.	390660.	994150.	815857.	587200.	778928.	1040255.	693917.

Table 12.3.3 (Cont´d.).

Year	2001				2002				2003			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	72172.	48378.	32403.	*	51190.	34314.	22723.	*	23559.	15792.	10580.
1	24522.	16258.	10789.	7133.	21419.	13960.	9071.	5571.	14994.	10003.	6652.	4302.
2	8883.	5263.	3327.	2207.	4563.	2937.	1949.	1074.	3348.	2181.	1422.	854.
3	381.	226.	70.	46.	1120.	737.	490.	309.	436.	274.	164.	97.
4+	52.	35.	23.	16.	41.	27.	18.	12.	194.	130.	87.	58.
SSN	11768.				7865.				5477.			
SSB	230748.				162451.				112444.			
TSN	33838.	93954.	62588.	41805.	27142.	68852.	45842.	29690.	18972.	36147.	24117.	15892.
TSB	385237.	436082.	610491.	453852.	297391.	347653.	477235.	327525.	206907.	245209.	300463.	203936.

Year	2004				2005	
Season	1	2	3	4	1	2
AGE						
0	*	28164.	18879.	12643.	*	112093.
1	7091.	4742.	3176.	2087.	8428.	5649.
2	2840.	1858.	1233.	784.	1318.	882.
3	441.	288.	189.	121.	462.	305.
4+	77.	51.	34.	23.	95.	64.
SSN	4067.				2718.	
SSB	89375.				58692.	
TSN	10449.	35104.	23510.	15659.	10303.	118993.
TSB	134048.	151612.	219234.	163820.	111790.	133549.

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	0.284	0.391	0.084	0.051	0.135	0.589
2	0.127	0.212	0.578	0.355	0.130	0.192	0.588	0.763	0.335	0.067	0.769	0.548
3	0.167	0.191	0.764	1.419	0.281	1.602	0.888	0.000	0.671	0.116	0.308	0.000
4+	0.000	1.807	*	*	0.000	0.000	0.000	0.000	0.374	0.000	0.000	0.000
F (1- 2)	0.087	0.122	0.373	0.290	0.092	0.131	0.436	0.577	0.210	0.059	0.452	0.568

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.000	0.101	*	0.000	0.000	0.013	*	0.000	0.011	0.069
1	0.019	0.019	0.140	0.406	0.079	0.051	0.124	0.299	0.022	0.013	0.038	0.219
2	0.590	0.112	0.648	0.268	0.190	0.049	0.233	0.725	0.189	0.034	0.188	0.659
3	0.624	0.058	0.204	0.000	0.156	0.000	0.010	0.266	0.168	0.000	0.000	0.000
4+	0.134	0.000	0.000	0.000	0.065	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.305	0.065	0.394	0.337	0.135	0.050	0.179	0.512	0.105	0.023	0.113	0.439

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	0.061	0.037	0.149	0.286	0.063	0.098	0.087	0.180	0.050	0.033	0.127	0.150
2	0.029	0.127	0.500	0.429	0.184	0.347	0.228	0.275	0.398	0.257	0.268	0.498
3	0.023	0.036	0.043	0.199	0.197	0.365	0.239	0.313	0.471	0.213	0.525	1.469
4+	0.000	0.000	0.000	0.000	0.254	0.000	0.000	0.000	0.536	0.000	0.000	0.000
F (1- 2)	0.045	0.082	0.325	0.358	0.123	0.222	0.158	0.228	0.224	0.145	0.197	0.324

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.016	0.026	*	0.000	0.002	0.045	*	0.000	0.004	0.038
1	0.063	0.043	0.158	0.230	0.082	0.055	0.127	0.203	0.121	0.037	0.169	0.360
2	0.286	0.146	0.366	0.598	0.104	0.117	0.429	0.502	0.210	0.186	0.574	0.489
3	0.913	0.594	0.068	0.234	0.076	0.591	0.533	0.126	0.139	0.123	0.615	0.000
4+	1.709	0.000	0.000	0.000	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.175	0.094	0.262	0.414	0.093	0.086	0.278	0.353	0.166	0.111	0.371	0.424

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	0.030	*	0.000	0.003	0.014
1	0.055	0.041	0.088	0.198	0.024	0.038	0.114	0.119	0.012	0.003	0.132	0.141
2	0.150	0.295	0.100	0.220	0.079	0.033	0.278	0.176	0.100	0.065	0.329	0.395
3	0.042	0.443	0.086	0.143	0.091	0.477	1.609	0.196	0.071	0.180	0.299	0.192
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.103	0.168	0.094	0.209	0.051	0.035	0.196	0.148	0.056	0.034	0.231	0.268

Year	1998				1999				2000			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.002	0.010	*	0.000	0.000	0.013	*	0.000	0.002	0.010
1	0.016	0.020	0.059	0.125	0.009	0.021	0.140	0.105	0.012	0.008	0.057	0.343
2	0.085	0.061	0.107	0.115	0.049	0.138	0.405	0.442	0.055	0.099	0.219	0.405
3	0.186	0.126	0.018	0.250	0.064	0.134	0.083	0.091	0.015	0.490	0.521	0.372
4+	0.076	0.428	0.000	0.000	0.012	0.006	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.051	0.041	0.083	0.120	0.029	0.080	0.273	0.274	0.033	0.053	0.138	0.374

Table 12.3.4 (Cont´d.).

Year	2001				2002				2003			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.001	0.014	*	0.000	0.012	0.016	*	0.000	0.001	0.000
1	0.011	0.010	0.014	0.046	0.028	0.031	0.086	0.108	0.005	0.008	0.035	0.015
2	0.122	0.058	0.010	0.271	0.040	0.010	0.192	0.476	0.028	0.027	0.108	0.255
3	0.118	0.706	0.019	0.024	0.018	0.008	0.060	0.109	0.062	0.115	0.124	0.488
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.027
F (1- 2)	0.066	0.034	0.012	0.159	0.034	0.020	0.139	0.292	0.016	0.018	0.072	0.135

Year	2004				2005	
Season	1	2	3	4	1	2
AGE						
0	*	0.000	0.001	0.005	*	0.000
1	0.002	0.001	0.020	0.060	0.000	0.000
2	0.024	0.011	0.051	0.127	0.001	0.001
3	0.025	0.024	0.045	0.017	0.015	0.006
4+	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.013	0.006	0.036	0.093	0.001	0.001

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 1983-2005 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	11.585
1	10.727	*	9.877	9.211
2	9.254	*	8.814	8.425
3	9.254	*	8.814	8.425

Log inverse catchabilities, fleet no: 2 (ibtsq1)

Year 1983-2005 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	2.528	*	*	*
2	1.464	*	*	*
3	1.464	*	*	*

Log inverse catchabilities, fleet no: 3 (egfsq2)

Year 1992-2004(5) (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	*	3.201	*	*	*	*
1	*	2.120	*	*	*	*
2	*	*	*	*	*	*
3	*	*	*	*	*	*

Log inverse catchabilities, fleet no: 4 (sgfsq2)

Year 1998-2005 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	3.403	*	*
1	*	2.262	*	*
2	*	*	*	*
3	*	*	*	*

Table 12.3.5 (Cont´d.).

Log inverse catchabilities, fleet no: 5 (ibtsq3)

Year 1991-2004 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	*	*	*	*
2	*	*	1.516	*
3	*	*	1.516	*

Weighting factors for computing survivors:
Fleet no: 1 (commercial q134)

Year 1983-2005 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	1.057
1	1.321	*	3.077	2.122
2	2.131	*	1.869	1.231
3	1.287	*	0.851	0.895

Weighting factors for computing survivors:
Fleet no: 2 (ibtsq1)

Year 1983-2005 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	1.571	*	*	*
2	1.702	*	*	*
3	0.968	*	*	*

Weighting factors for computing survivors:
Fleet no: 3 (egfsq2)

Year 1992-2004(5) (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	*	1.268	*	*
1	*	2.095	*	*
2	*	*	*	*
3	*	*	*	*

Table 12.3.5 (Cont´d.).

Weighting factors for computing survivors:
Fleet no: 4 (sgfsq2)

Year 1998-2005 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4	1	2
AGE						
0	*	1.543	*	*	*	1.543
1	*	2.254	*	*	*	2.254
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	*	*	1.222	*
3	*	*	0.722	*

Table 12.3.6 NORWAY POUT. SMS Exploratory Run, Diagnostics

```
objective function, negative log likelihood:   96.4028

objective function contributions (total):
              Catch   CPUE     S/R
Species:1     80.3    16.0     3.9

objective function contributions (per observation):
           Catch   CPUE   S/R
Species:1   0.22   0.04   0.17


Contributions by fleet:
-----------------------
commercial q1  total:-12.170   mean:-0.184
commercial q3  total:4.916     mean:0.074
commercial q4  total:28.295    mean:0.322
ibts q1        total:-1.010    mean:-0.015
egfs q3        total:-4.259    mean:-0.164
sgfs q3        total:-6.901    mean:-0.431
ibts q3        total:7.176     mean:0.256


F, Year effect:
---------------
         sp.1
1983:    1.000
1984:    1.045
1985:    1.192
1986:    1.147
1987:    0.849
1988:    0.823
1989:    0.592
1990:    0.677
1991:    0.867
1992:    0.890
1993:    0.749
1994:    1.017
1995:    0.657
1996:    0.450
1997:    0.400
1998:    0.364
1999:    0.385
2000:    0.338
2001:    0.279
2002:    0.368
2003:    0.134
2004:    0.115
2005:    0.000

F, season effect:
-----------------
age: 0
    1983-2005:   0.000 0.000 0.015 0.250
age: 1
    1983-2005:   0.041 0.033 0.130 0.250
age: 2 - 3
    1983-2005:   0.076 0.065 0.153 0.250

F, age effect:
--------------
                0     1     2     3
1983-2005:   0.204 1.563 3.678 3.678
```

Table 12.3.6 NORWAY POUT. SMS diagnostic (continued)

sqrt(catch variance) ~ CV:

	season			
age	1	2	3	4
0			1.922	0.499
1	0.469	0.630	0.431	0.395
2	0.296	0.765	0.909	0.608
3	0.936	1.477	1.418	1.888

Survey catchability:

commercial q1		2.70e-008	1.29e-007	1.74e-007
commercial q3		6.46e-008	2.11e-007	1.15e-007
commercial q4	1.14e-008	1.28e-007	3.46e-007	1.05e-007
ibts q1		9.80e-005	3.09e-004	6.37e-004
egfs q3	7.65e-005	2.35e-004		
sgfs q3	6.60e-005	2.18e-004		
ibts q3			2.75e-004	3.02e-004

sqrt(CPUE variance) ~ CV:

commercial q1		0.65	0.23	0.84
commercial q3		0.33	0.63	1.33
commercial q4	0.89	0.42	0.80	1.63
ibts q1		0.53	0.48	0.85
egfs q3	0.72	0.37		
sgfs q3	0.60	0.26		
ibts q3			0.57	1.08

Recruit-SSB	alfa	beta	beta intern	recruit s2	recruit s
Species 1: Ricker:	9.421e+002	5.268e-006	5.268e+000	0.517	0.719

Variation on estimates:

Year	Parameter		CV %
2000	avg_F	4.5862e-01	22
2001	avg_F	3.7857e-01	22
2002	avg_F	4.9981e-01	19
2003	avg_F	1.8239e-01	22
2004	avg_F	1.5564e-01	21
2000	hist_SSB	1.2659e+05	11
2001	hist_SSB	2.3740e+05	14
2002	hist_SSB	1.0688e+05	14
2003	hist_SSB	7.4622e+04	14
2004	hist_SSB	6.3542e+04	13
2005	hist_SSB	4.1241e+04	15
age 1	term_N	5.6884e+06	25
age 2	term_N	1.1242e+06	19
age 3	term_N	3.1315e+05	17

Table 12.3.7. Norway pout, SURBA Exploratory Run, Diagnostics.

Age effects:

age	est	se	initial
0	-0.2696	0.1338	1.0000
1	-0.3483	0.0832	1.0000
2	1.0000	NA	1.0000
3	1.0000	NA	1.0000

Year effects:

year	est	se	initial
1982	3.4328	0.5389	1.0000
1983	3.3976	0.3662	1.0000
1984	2.9230	0.3068	1.0000
1985	3.3138	0.2950	1.0000
1986	3.4930	0.2964	1.0000
1987	3.2380	0.2983	1.0000
1988	3.3356	0.2971	1.0000
1989	2.4554	0.2973	1.0000
1990	2.7085	0.2777	1.0000
1991	2.7703	0.2711	1.0000
1992	2.4470	0.2693	1.0000
1993	2.6419	0.2598	1.0000
1994	2.5749	0.2563	1.0000
1995	2.2103	0.2557	1.0000
1996	2.1946	0.2531	1.0000
1997	1.9691	0.2530	1.0000
1998	1.9000	0.2513	1.0000
1999	1.8227	0.2461	1.0000
2000	1.8332	0.2424	1.0000
2001	1.9064	0.2420	1.0000
2002	1.7951	0.2416	1.0000
2003	2.0924	0.2416	1.0000
2004	2.4504	0.3048	1.0000
2005	2.1126	0.1703	1.0000

Cohort effects:

yc	est	se	initial
1979	-0.9300	0.5727	-2.4748
1980	0.1603	0.5902	-1.3089
1981	0.3318	0.3829	1.5040
1982	-0.7790	0.3944	-1.1383
1983	-0.6130	0.3842	-1.1383
1984	-0.9479	0.3358	-0.4581
1985	-1.5390	0.3627	-0.5926
1986	-0.6460	0.3815	-1.4032
1987	-2.4345	0.3559	0.3498
1988	-0.8097	0.3849	-1.9708
1989	-0.4843	0.3048	0.7838
1990	-0.4813	0.3226	0.6428
1991	-0.1272	0.3258	-0.3984
1992	-0.9694	0.2790	0.2643
1993	-0.8801	0.2933	-0.9537
1994	0.2944	0.2946	-0.1652
1995	-0.8307	0.2683	0.7702
1996	0.3254	0.2727	-0.2778
1997	-1.5015	0.2521	0.0932
1998	-0.5558	0.2377	-1.8131
1999	0.4217	0.2318	-0.5193
2000	-1.0732	0.2314	0.4295
2001	-0.7535	0.2391	-0.6784
2002	-0.9430	0.2272	-0.3777
2003	-2.4802	0.2489	0.0447
2004	-1.9237	0.3037	-2.8772
2005	0.1976	0.5366	-1.3975

RSS 1.2111E+02 IFAIL 5 (Good solution)

Table 12.3.8 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	221 117	369 863	1 904 110	457.6	0.872
1984	119 149	371 937	1 146 403	393.0	1.236
1985	85 616	167 121	641 323	205.1	1.289
1986	156 495	87 773	720 118	174.3	1.101
1987	46 362	96 134	588 168	149.3	0.876
1988	128 131	124 275	571 724	109.3	0.680
1989	135 390	84 774	767 514	166.4	0.810
1990	126 079	125 777	737 496	163.3	0.731
1991	244 107	144 290	1 089 182	186.6	0.887
1992	102 886	172 743	1 050 948	296.8	0.945
1993	75 548	219 481	620 867	183.1	0.810
1994	310 089	118 268	1 089 682	182.0	1.072
1995	97 673	117 400	1 202 415	236.8	0.574
1996	233 318	298 157	1 131 829	163.8	0.430
1997	67 308	194 419	1 027 698	169.7	0.589
1998	92 452	259 557	640 731	57.7	0.295
1999	228 064	149 954	994 150	94.5	0.656
2000	82 369	160 397	1 040 255	184.4	0.598
2001	72 172	230 748	610 491	65.6	0.271
2002	51 190	162 451	477 235	80.0	0.485
2003	23 559	112 444	300 463	27.1	0.241
2004	28 164	89 375	219 234	13.5	0.148
2005	112 093	58 692			
Arit mean	**119 339**	**175 334**	**844 183**		**0.709**
Geomean	**97 764**				

Table 12.6.1 Norway pout IIIa and IV. Short term forecast.

Method used for F forecast:
F = 0
Variable R in 2005 (75%-125% of estimated 2005 recruitment: R=R(2005)*0.75; R=R(2005)*1; R=R(2005)*1.25)

mR (2005)	1	R-multiplier	0.75	1	1.25
mF	0	F-multiplier	0	0	0
Fbar : Q1	0.000		0.000	0.000	0.000
Fbar : Q2	0.000		0.000	0.000	0.000
Fbar : Q3	0.000		0.000	0.000	0.000
Fbar : Q4	0.000		0.000	0.000	0.000
SSB start of					
2005	58692		58692	58692	58692
2006	77915		72007	77915	83823
Yield					
2005 Q3+Q4	0		0	0	0
2006 Q1+Q2	0		0	0	0
2006 Q3+Q4	0		0	0	0

Table 12.12.1 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	2004
Denmark	7186	4624	2005	3214	4815	6395	2281
Faroes	-	-	-	-	4	2	-
Germany	-	-	-	-	-	-	-
Netherlands	-	1	-	-	-	-	-
Norway	-	-	-	-	-	-	-
Poland	-	-	-	-	-	-	-
UK (E+W)	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	4
Total	7186	4625	2005	3214	4819	6397	2285

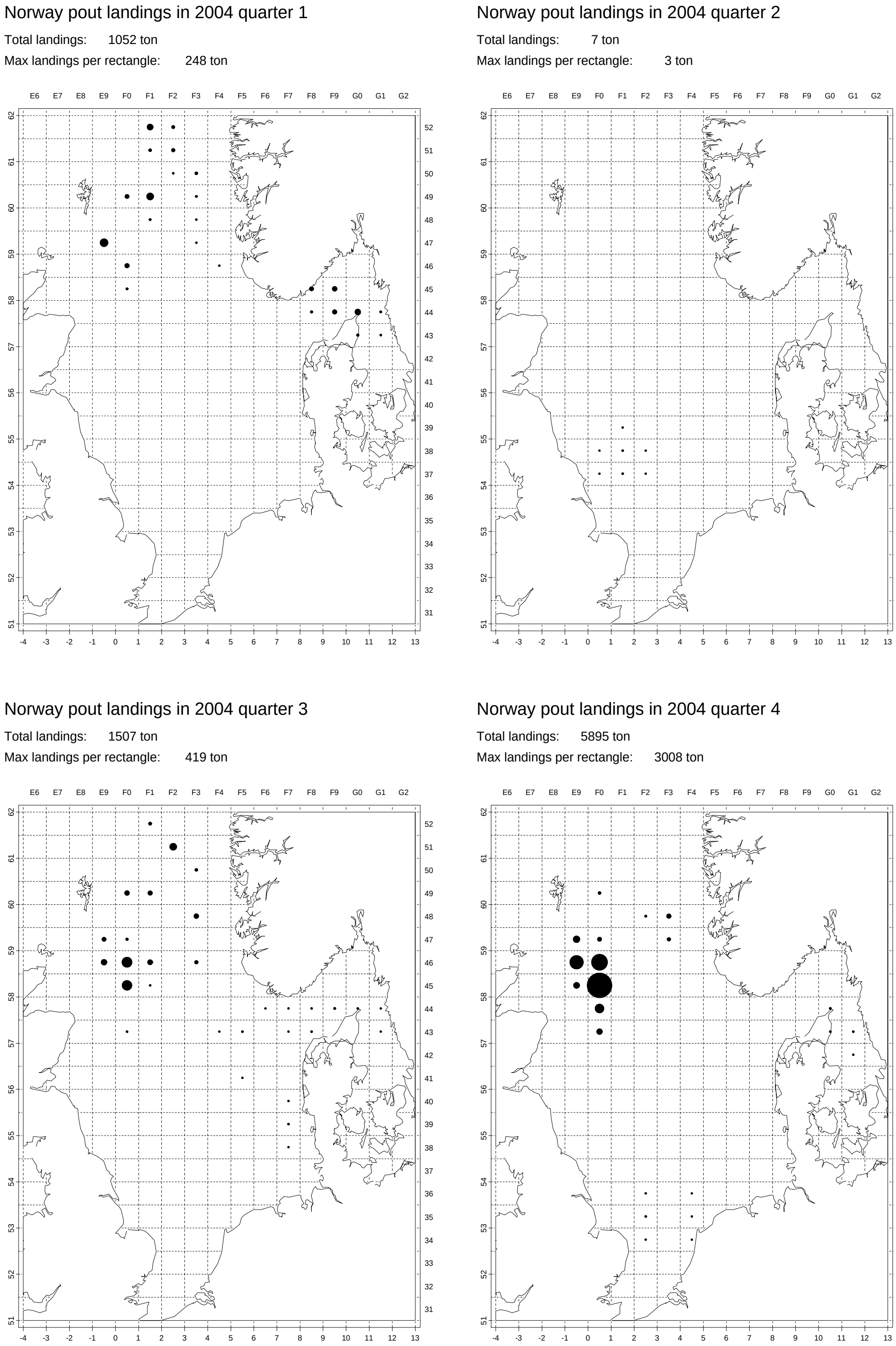


Figure 12.1.1 Spatial distribution of Danish Norway pout fishery. Catch in tons by area (ICES Statistical square) and season (quarter of year) in 2004 from the Danish commercial fishery for Norway pout in the North Sea, Skagerrak and Kattegat areas.

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 1982-2005.**

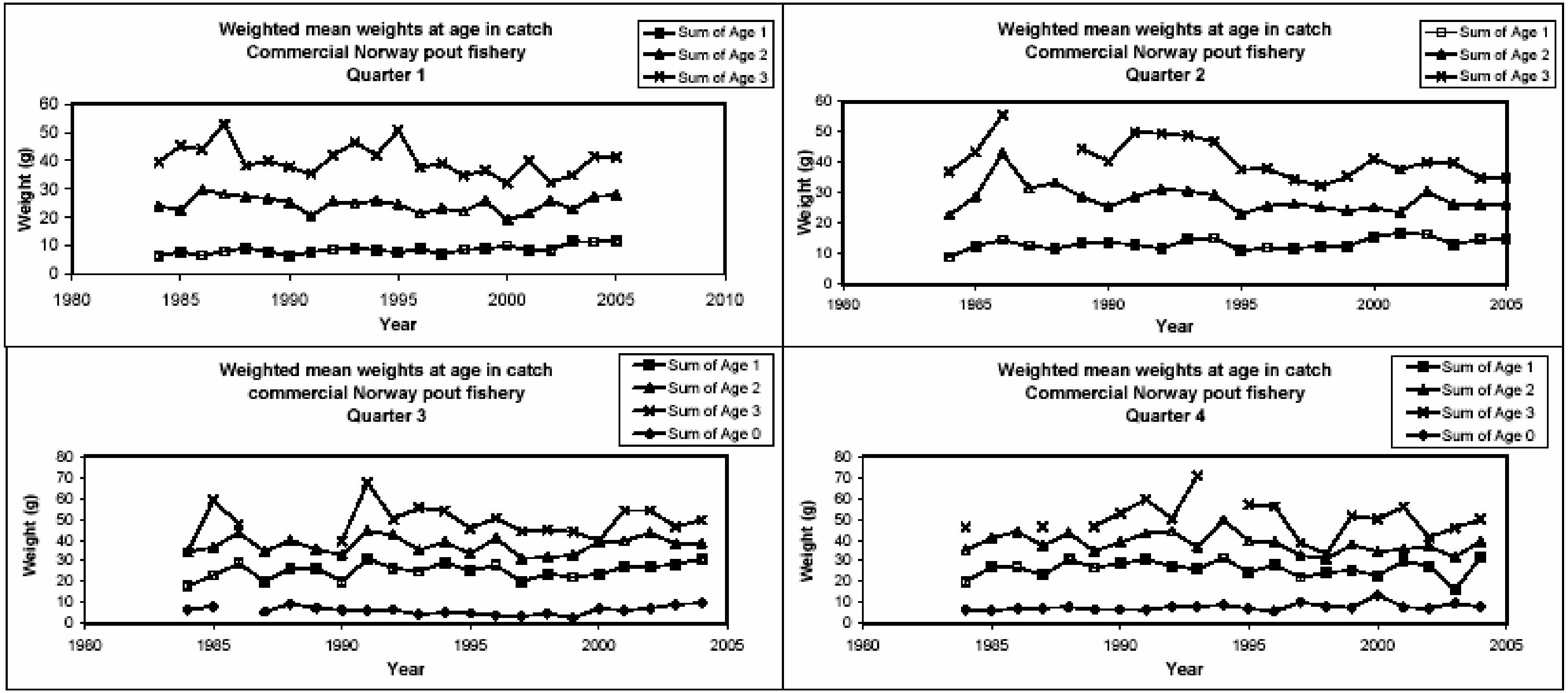


Figure 12.2.2 **NORWAY POUT. Trends in CPUE (normalized to unit mean) by quarterly commercial tuning fleet and survey tuning fleet used in the Norway pout SXSA Assessment for each age group and all age groups together.**

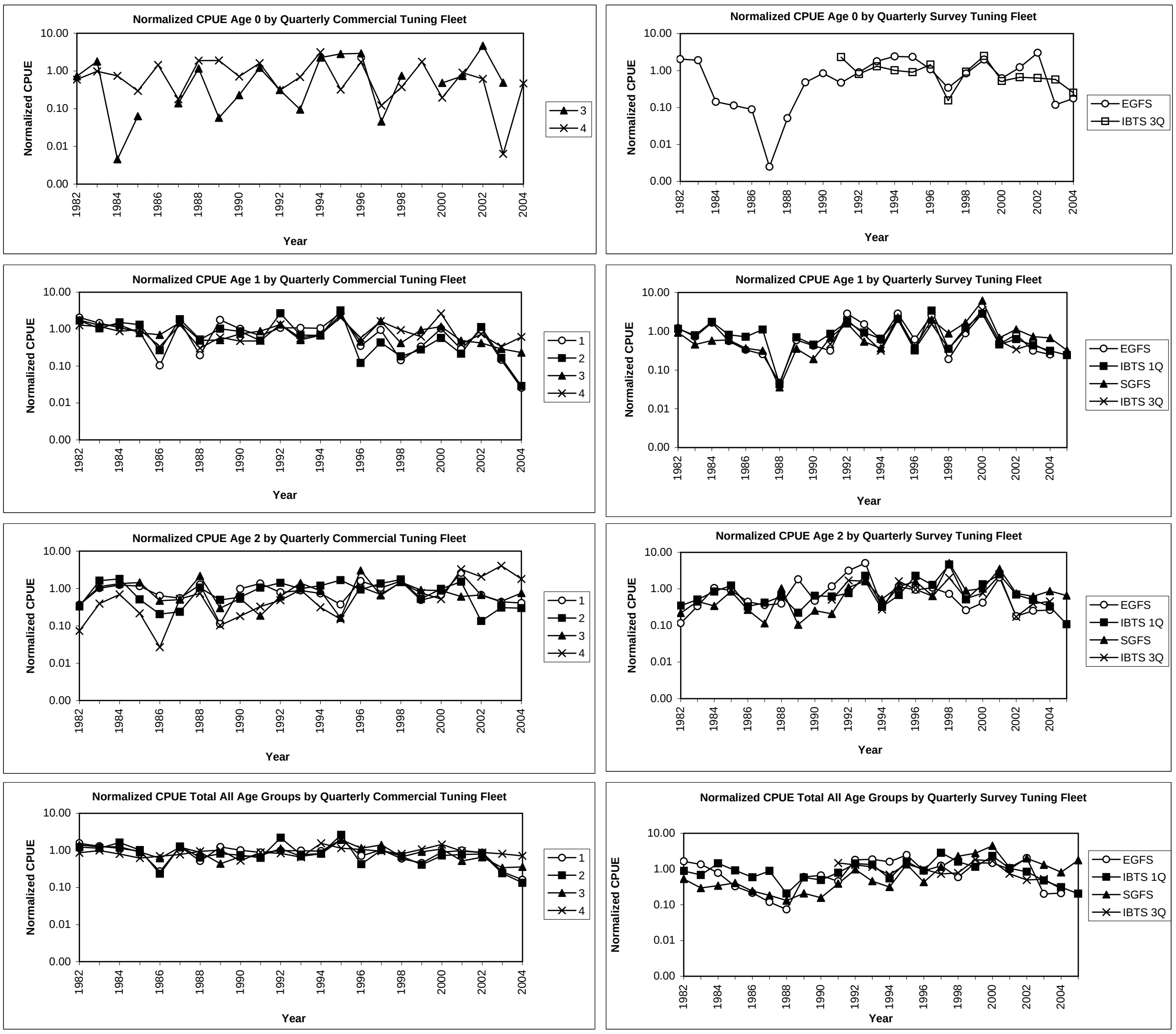


Figure 12.2.3. NORWAY POUT. Trends in CPUE (normalized from SURBA) for each tuning fleet used in the Norway pout assessment (for all ages).

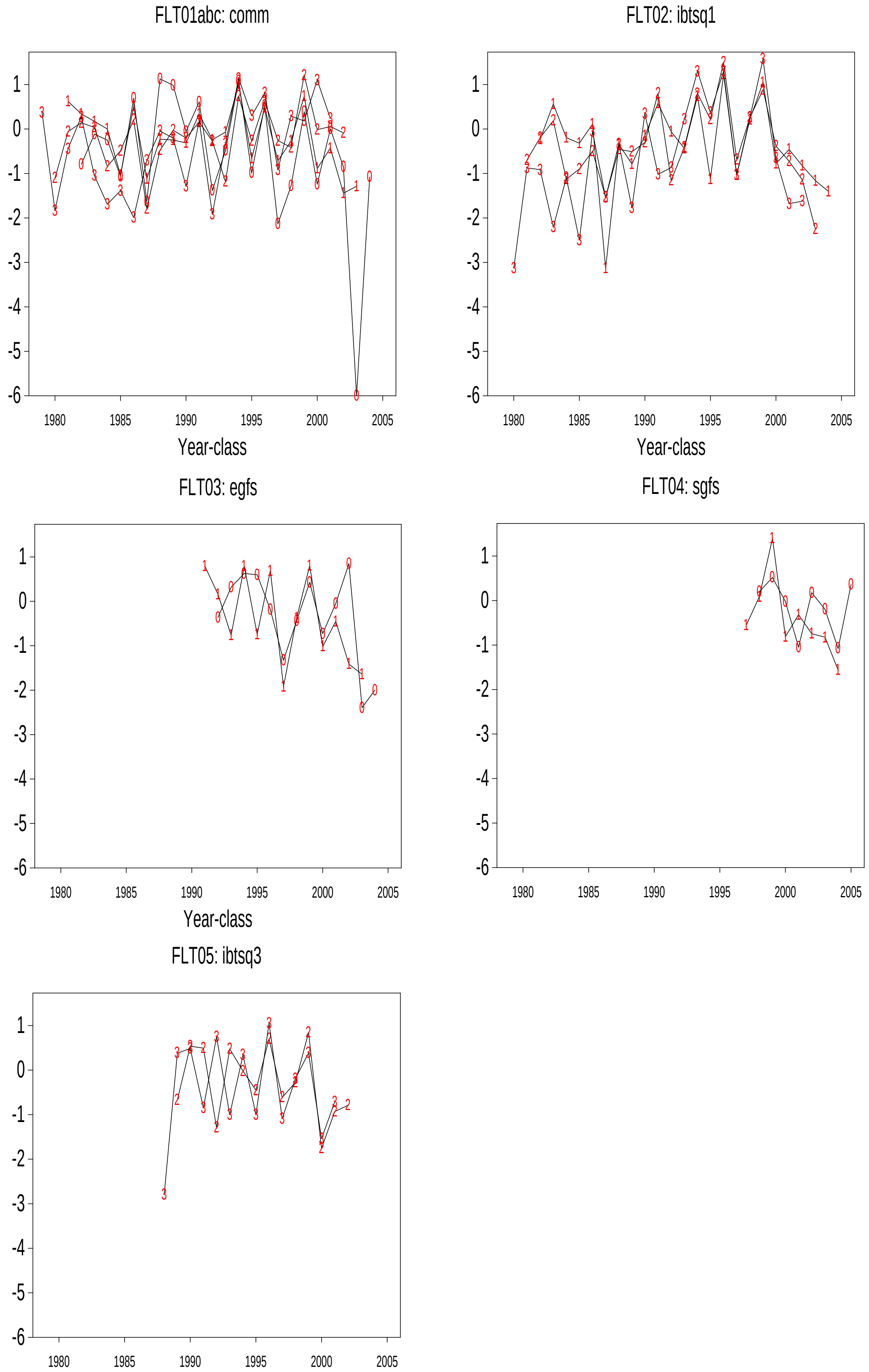


Figure 12.3.1 Log residual stock numbers (log (Nhat/N)) per age group divided by fleet and season.
SXSA-Norway pout in the North Sea and Skagerak.

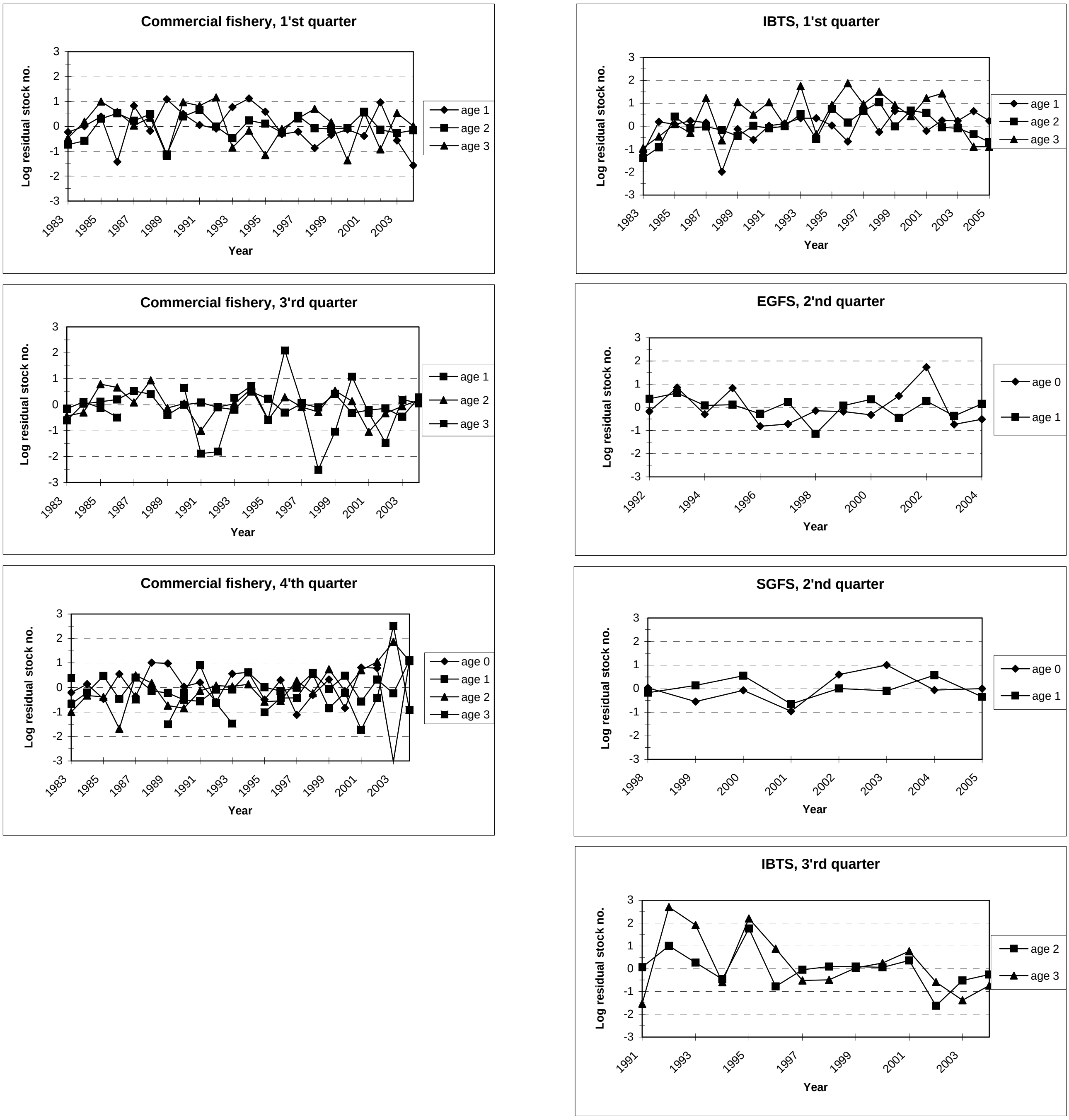


Figure 12.3.2 Norway Pout in the North Sea. Stock Summary Plots

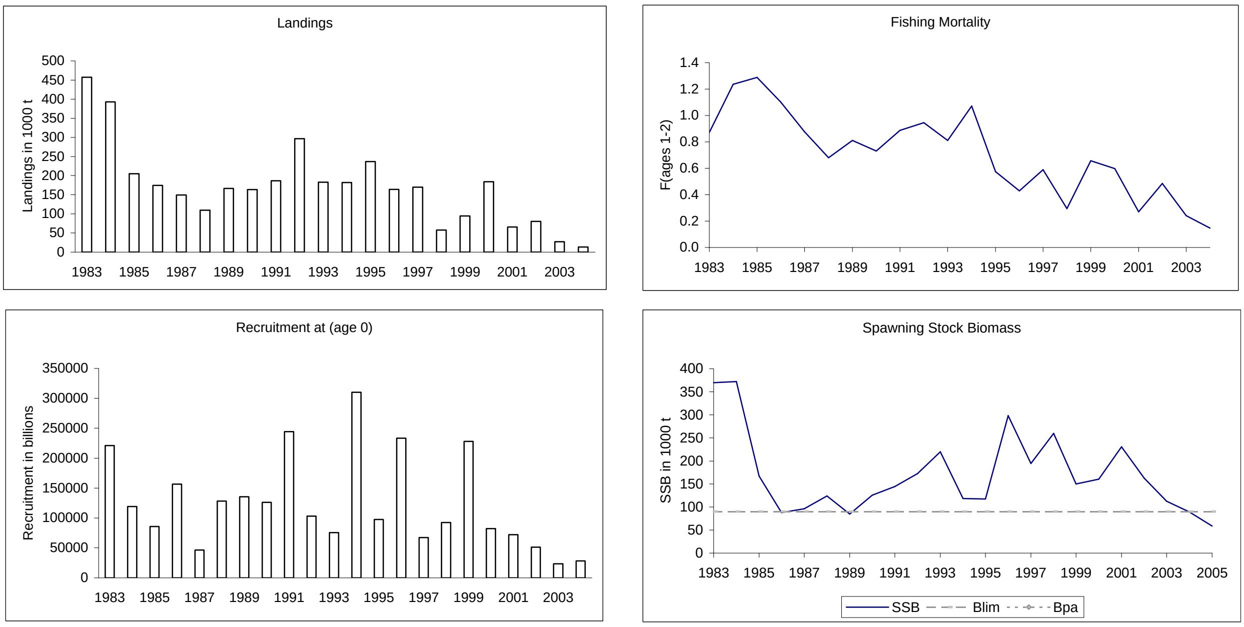


Figure 12.3.3 Trends in yield, SSB and TSB for Norway pout in the North Sea and Skagerrak during the period 1983-2004.

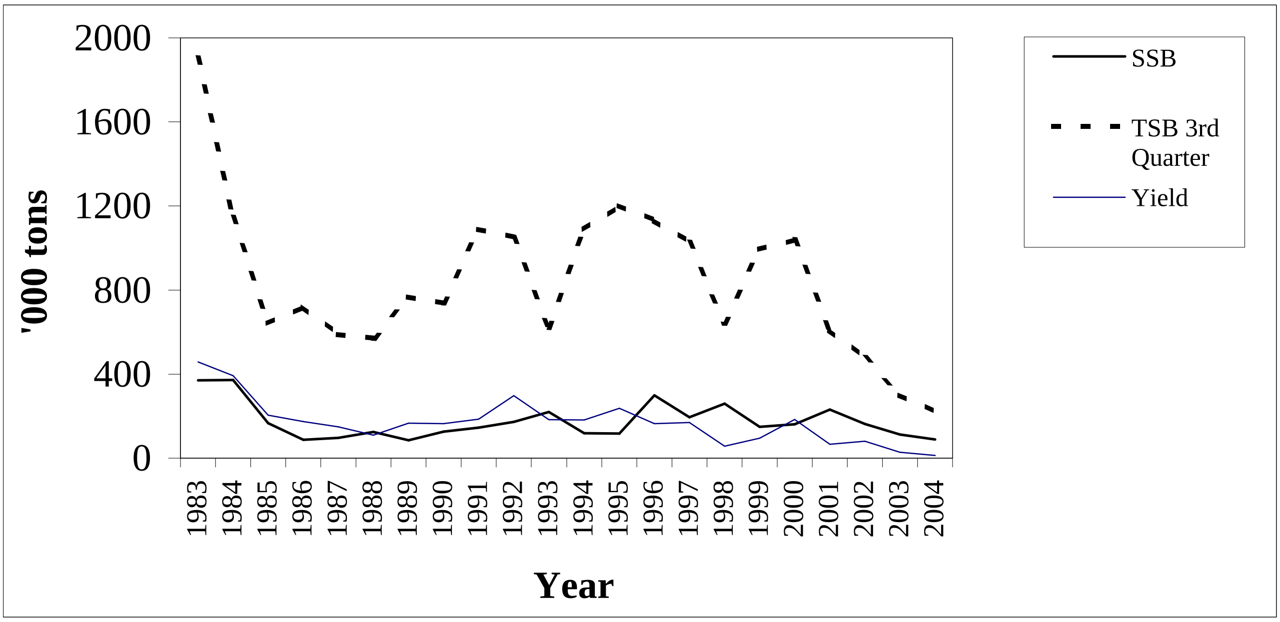
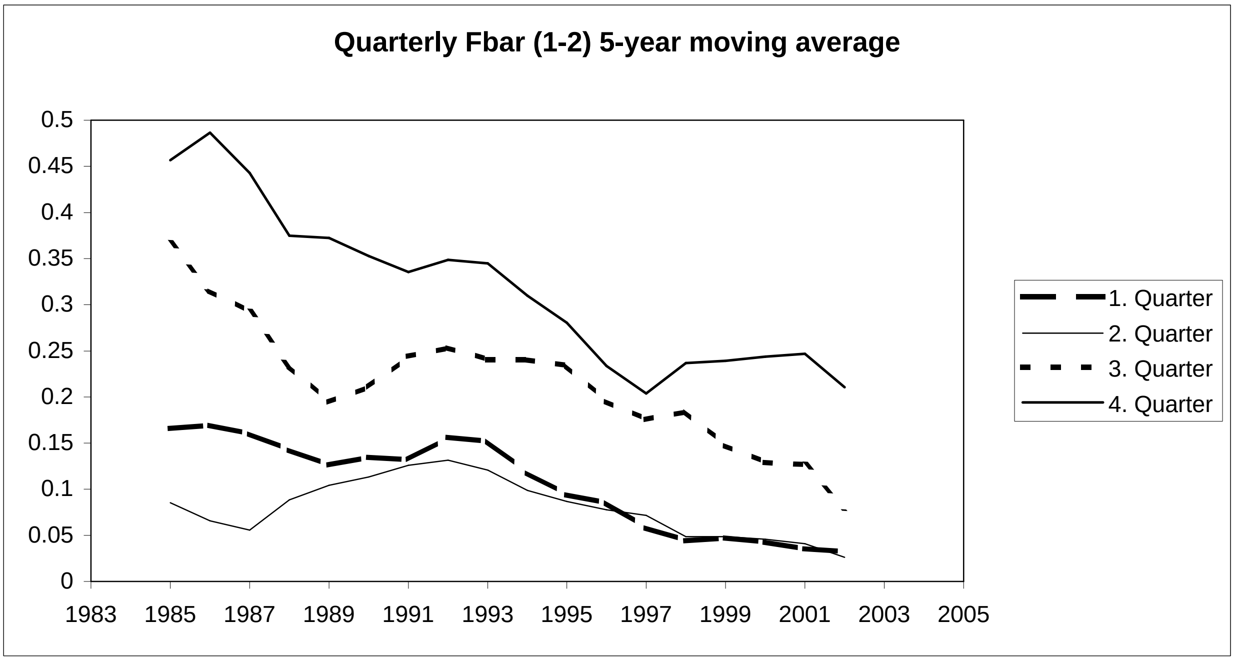


Fig. 12.3.4. **Norway pout IIIA and IV. Quarterly F(1-2) Upper: 5 years moving average, lower: F(1-2) by quarter and year**



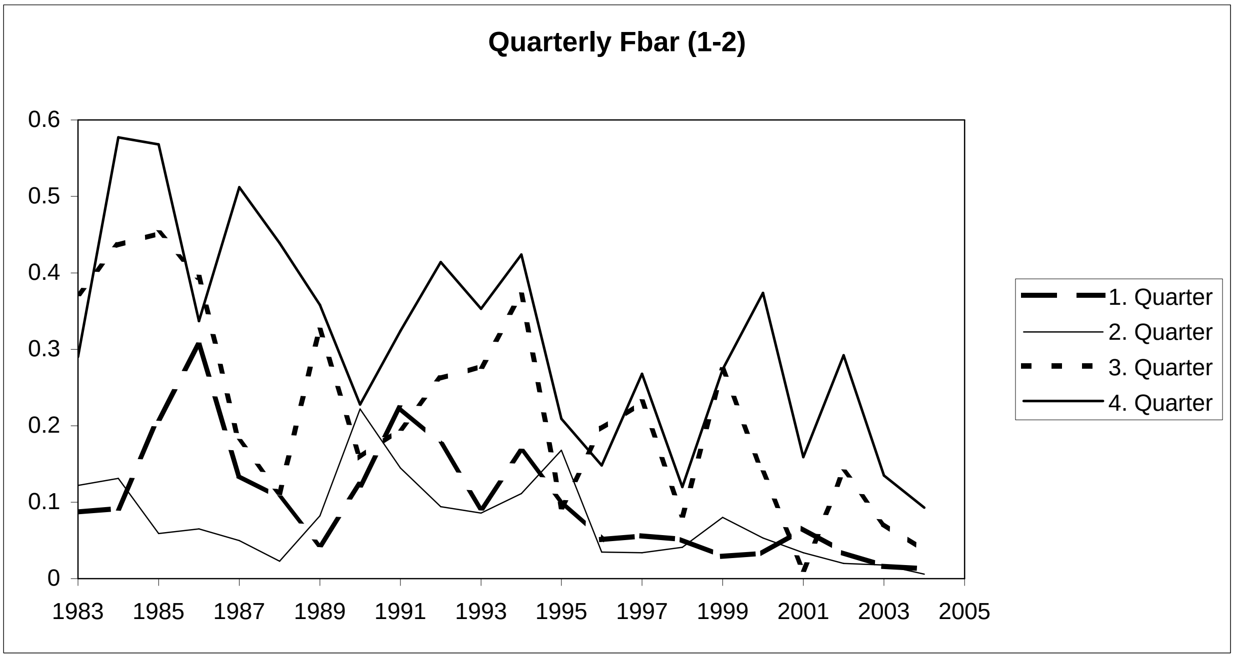


Figure 12.3.5 **Retrospective analyses of SSB and Recruitment and $F_{ann(1\text{-}2)}$. No shrinkage used.**

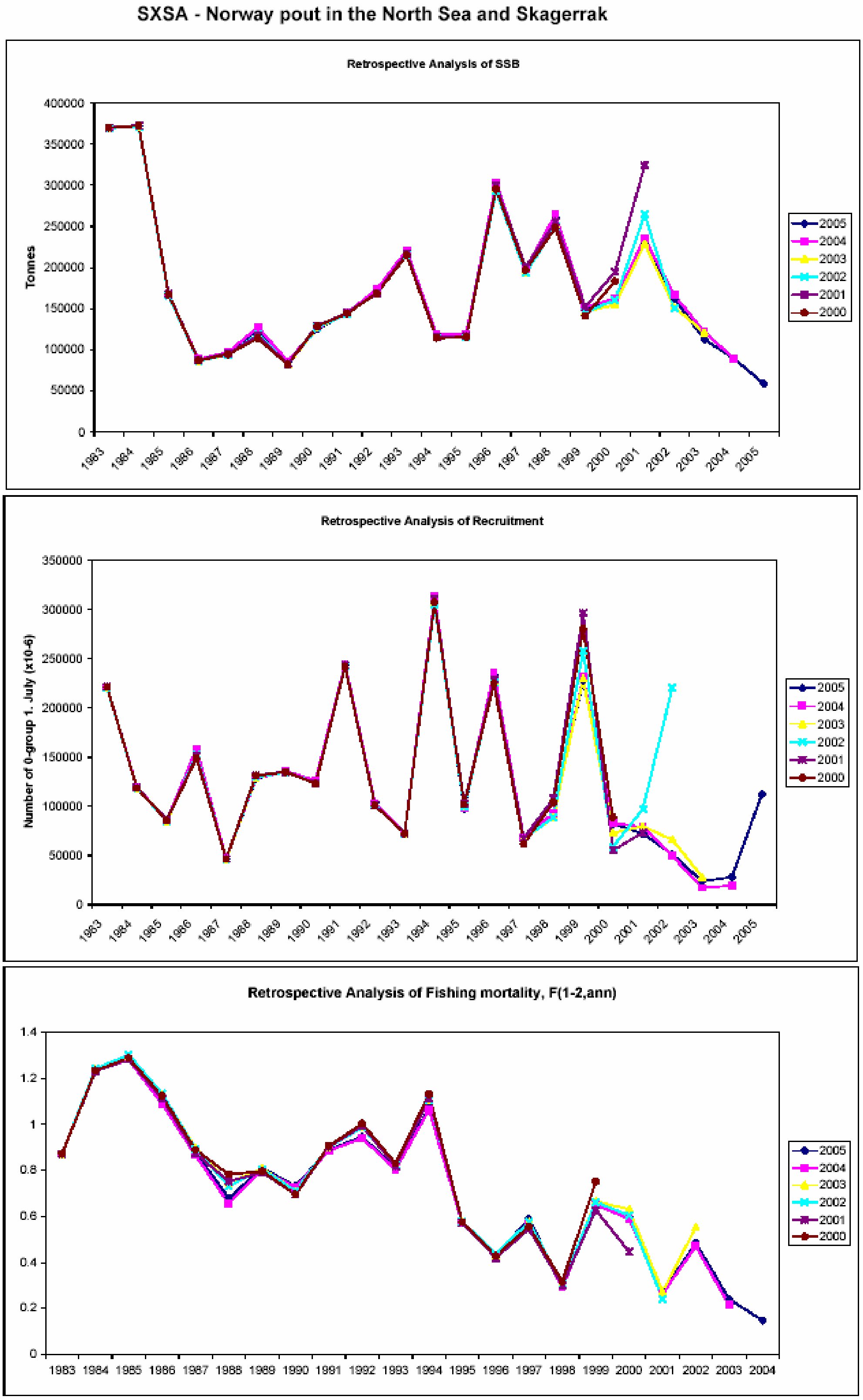
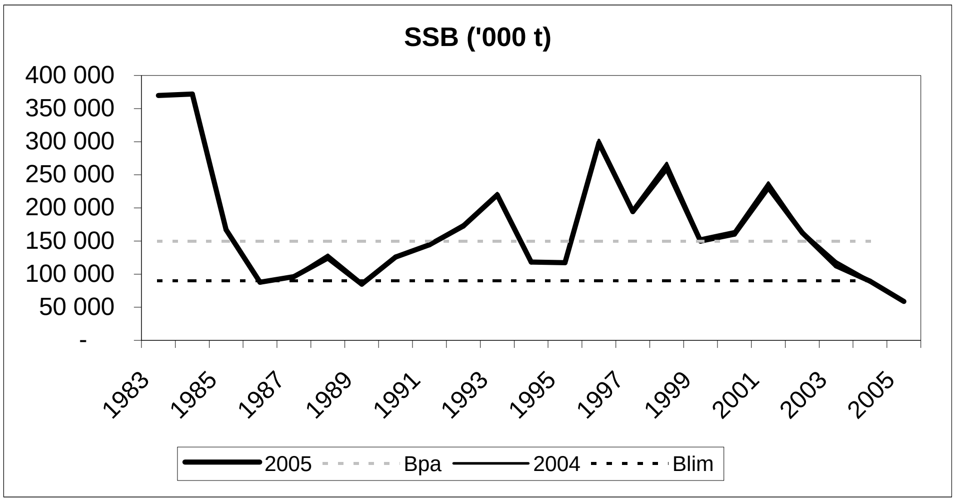
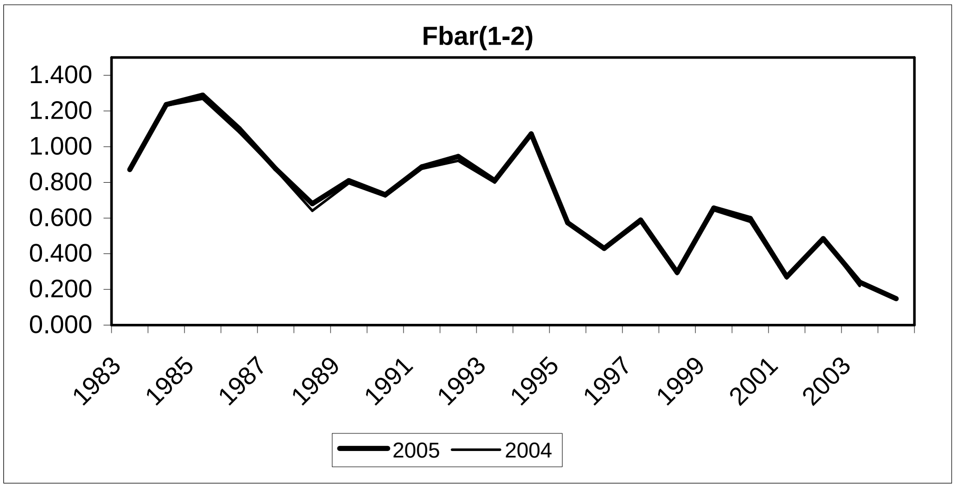


Figure 12.3.6 Norway pout IIIa and IV. Comparison of 2005 SXSA baseline assessment with 2004 benchmark assessment.





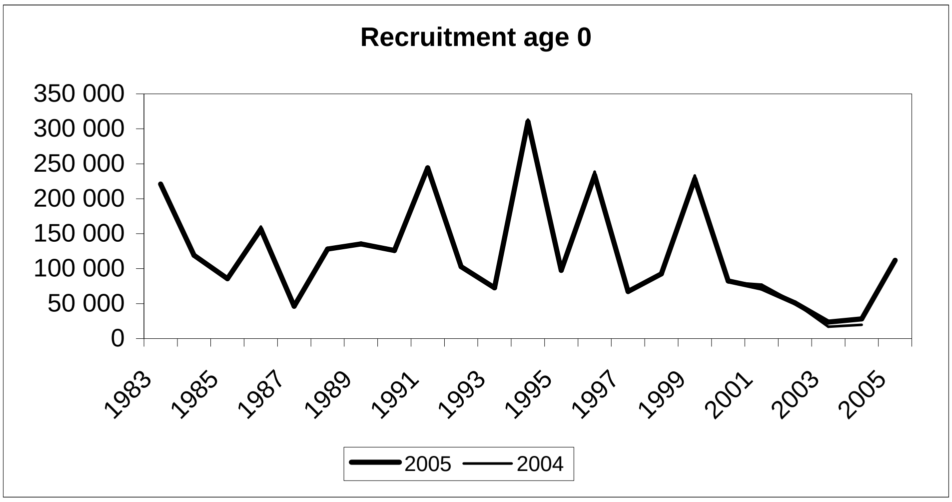
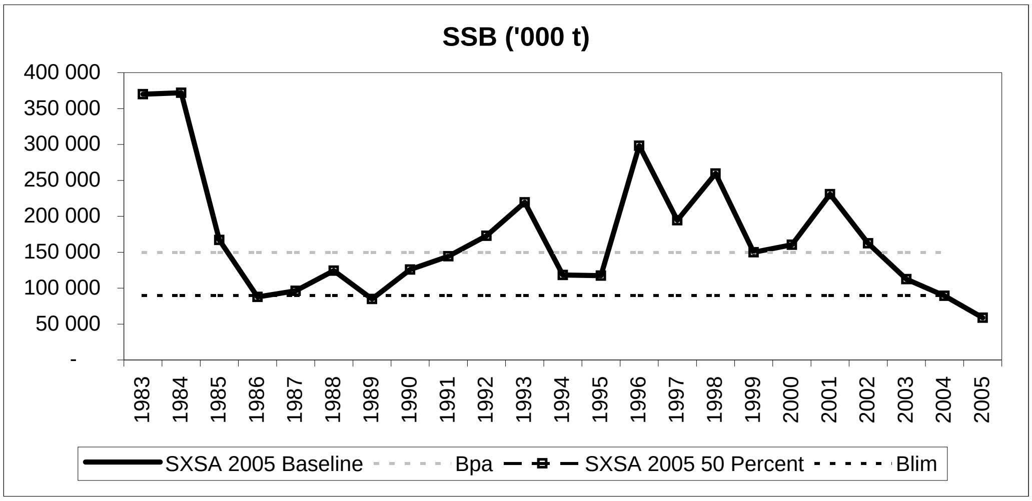
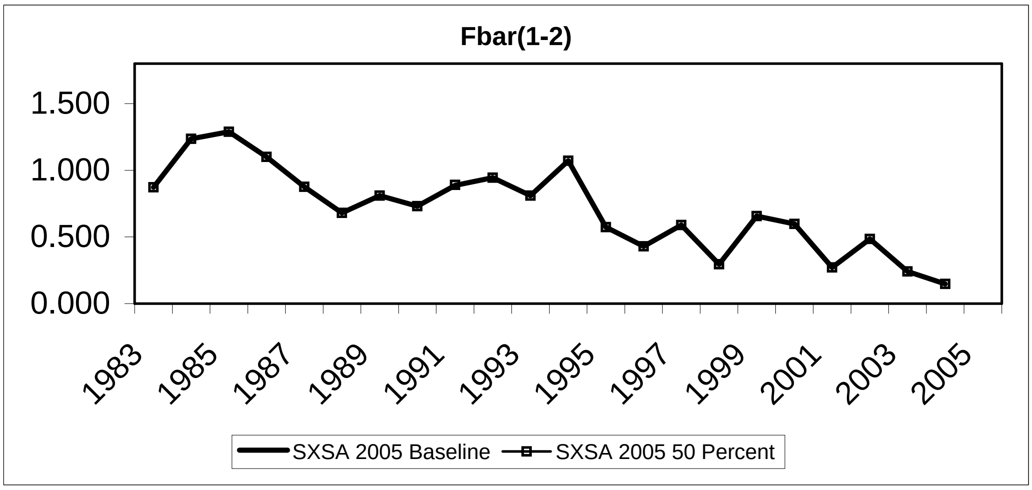


Figure 12.3.7 Norway pout IIIa and IV. Comparison of 2005 SXSA baseline assessment with the same assessment using 50 % catches in q1 and q2 2005 of the q1 and q2 catches in 2004.





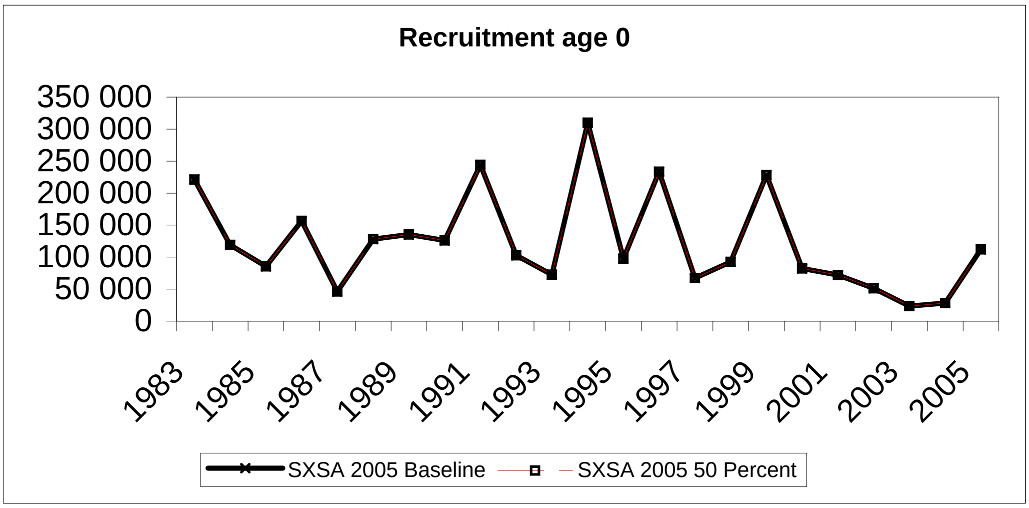


Figure 12.3.8.1 Norway pout. SMS Exploratory Run. Spawning stock biomass (SSB), fishing mortality (F1-2) and Recruitment (age0, quarter 1)

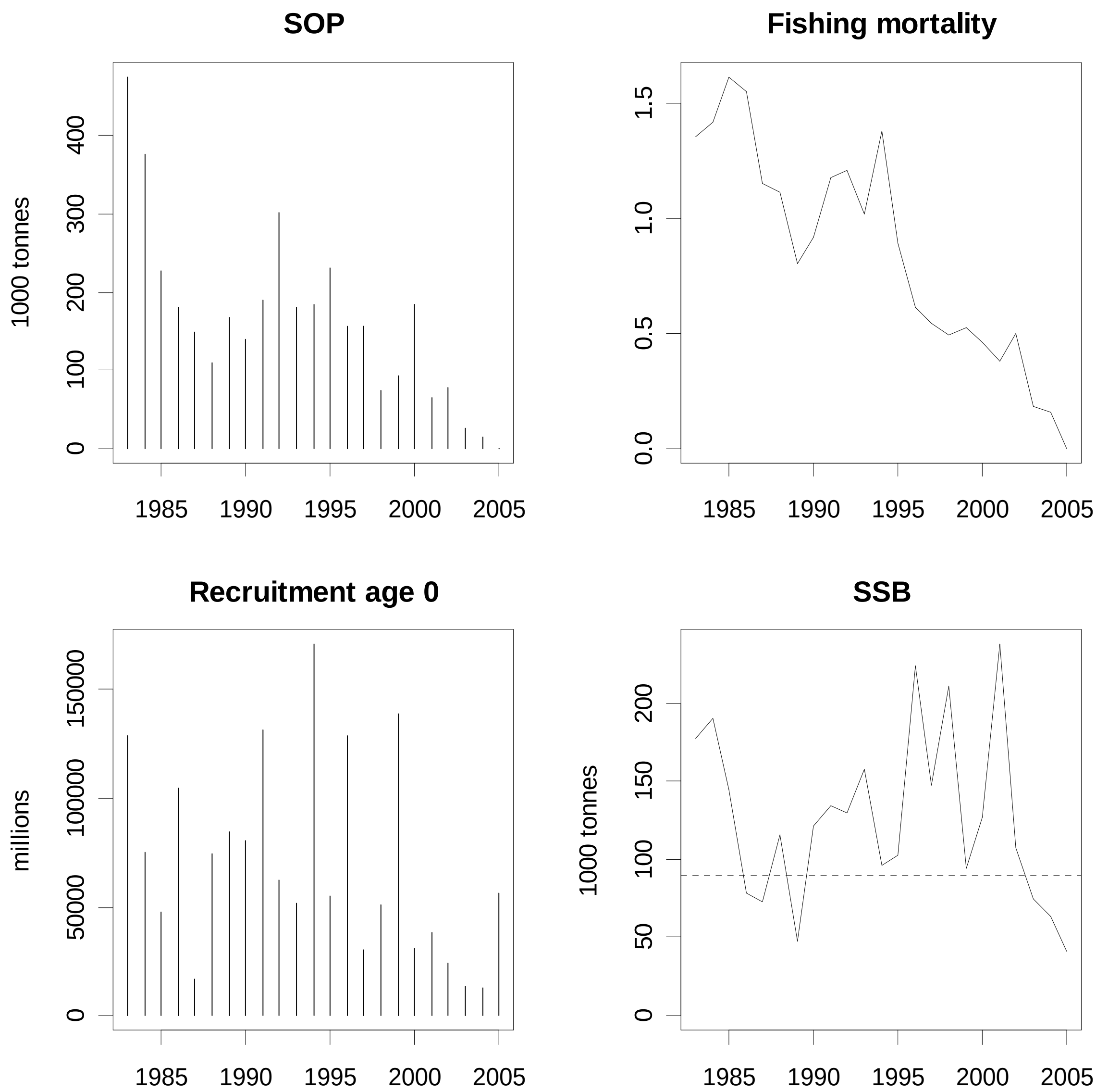


Figure 12. 3.8.2 **Norway pout. SMS Exploratory Run. Catch and survey residuals Panels are individually scaled (see bubbles with numbers)**

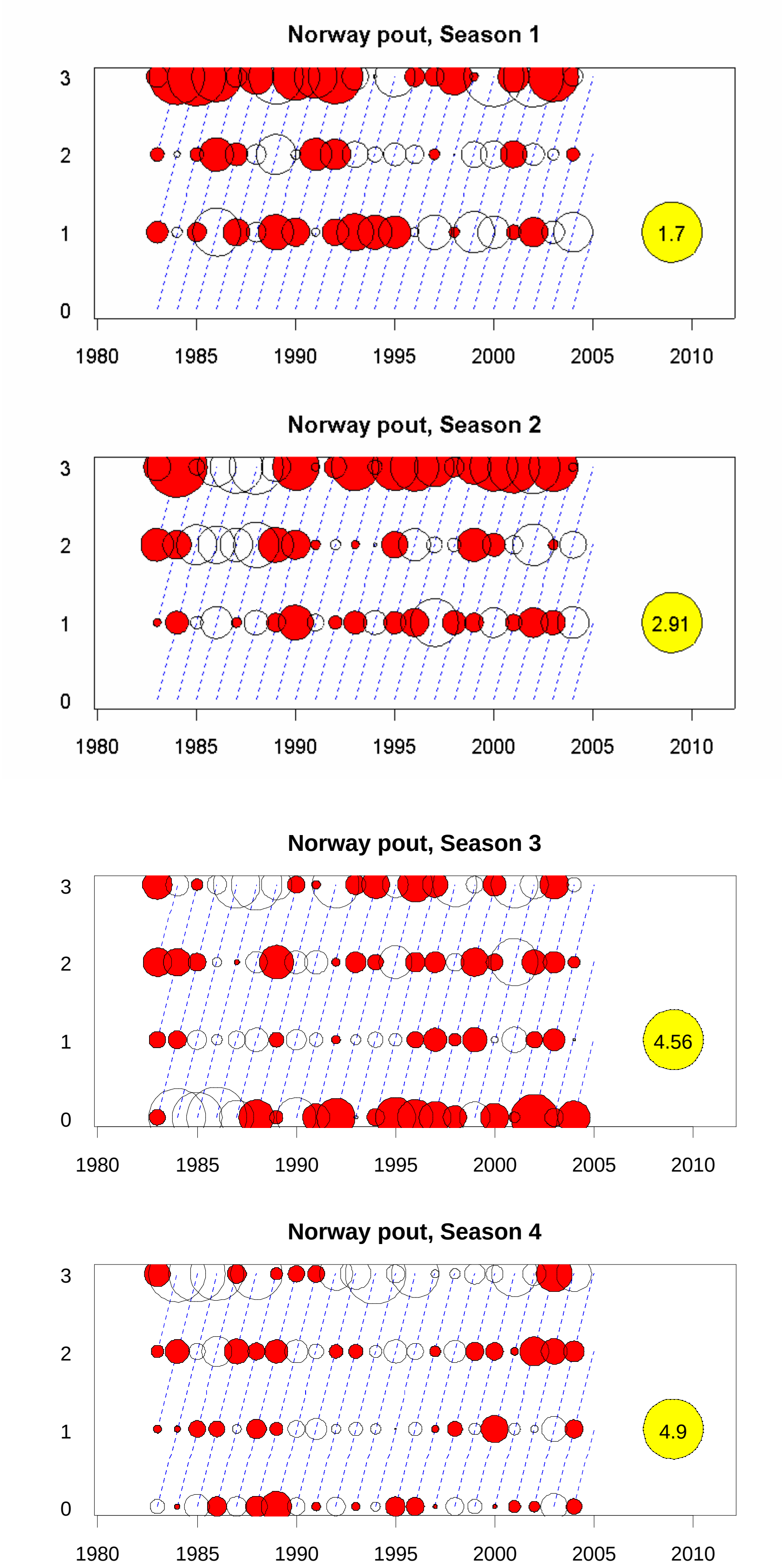


Figure 12.3.8.2 (Cont.'d)

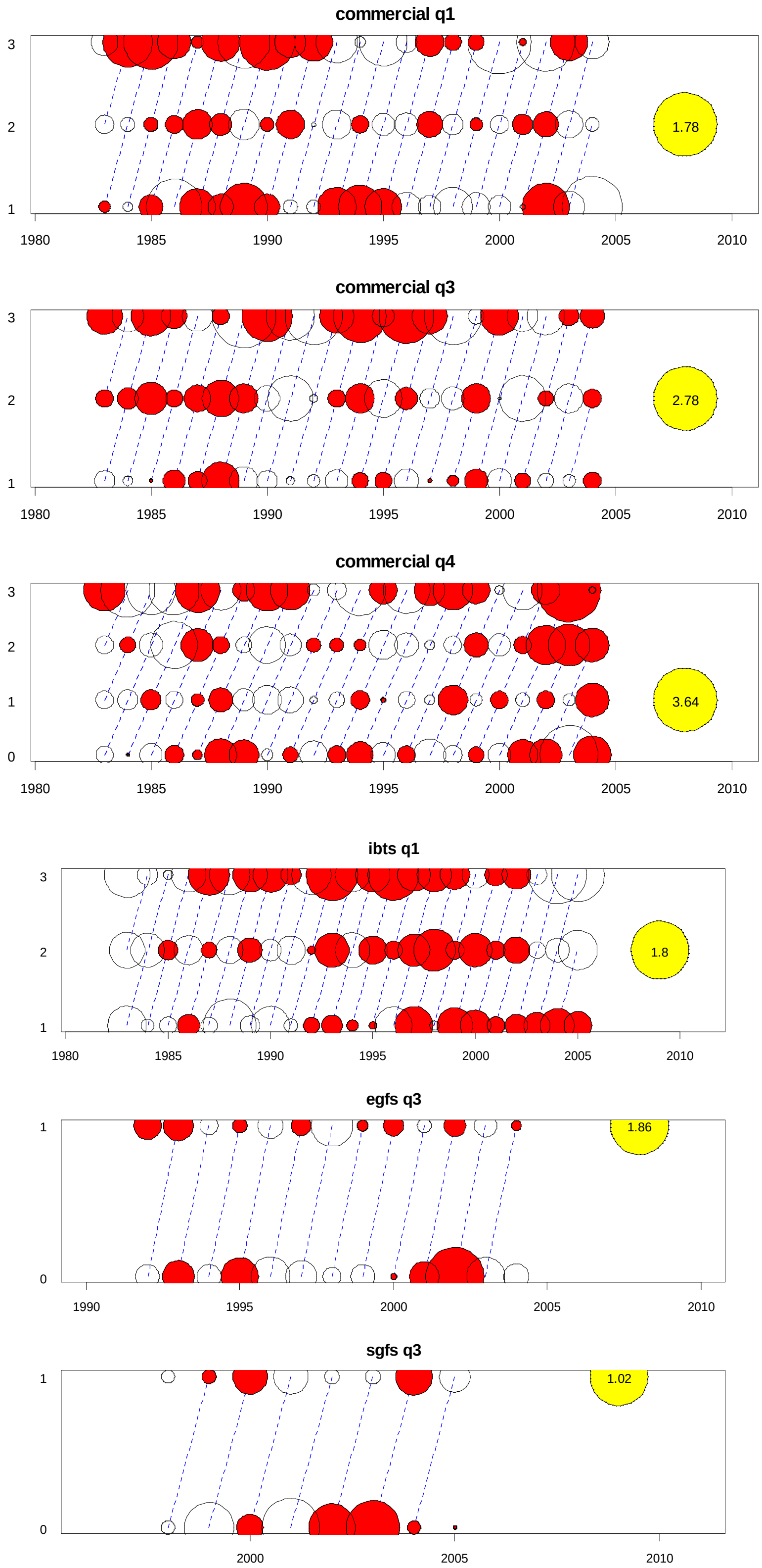


Figure 12.3.8.2 (Cont.'d)

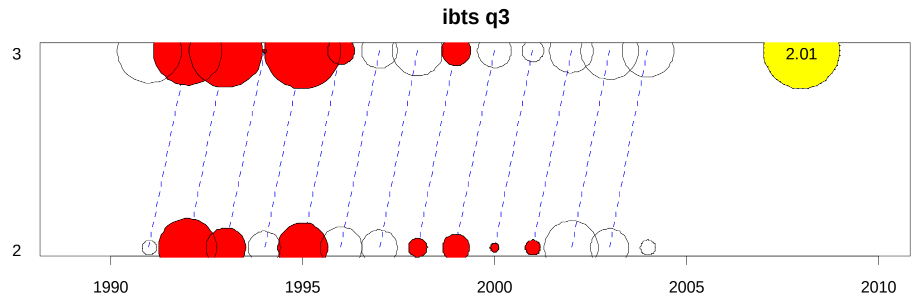


Figure 12. 3.8.3 Norway pout. SMS Exploratory Run. Retrospective runs.

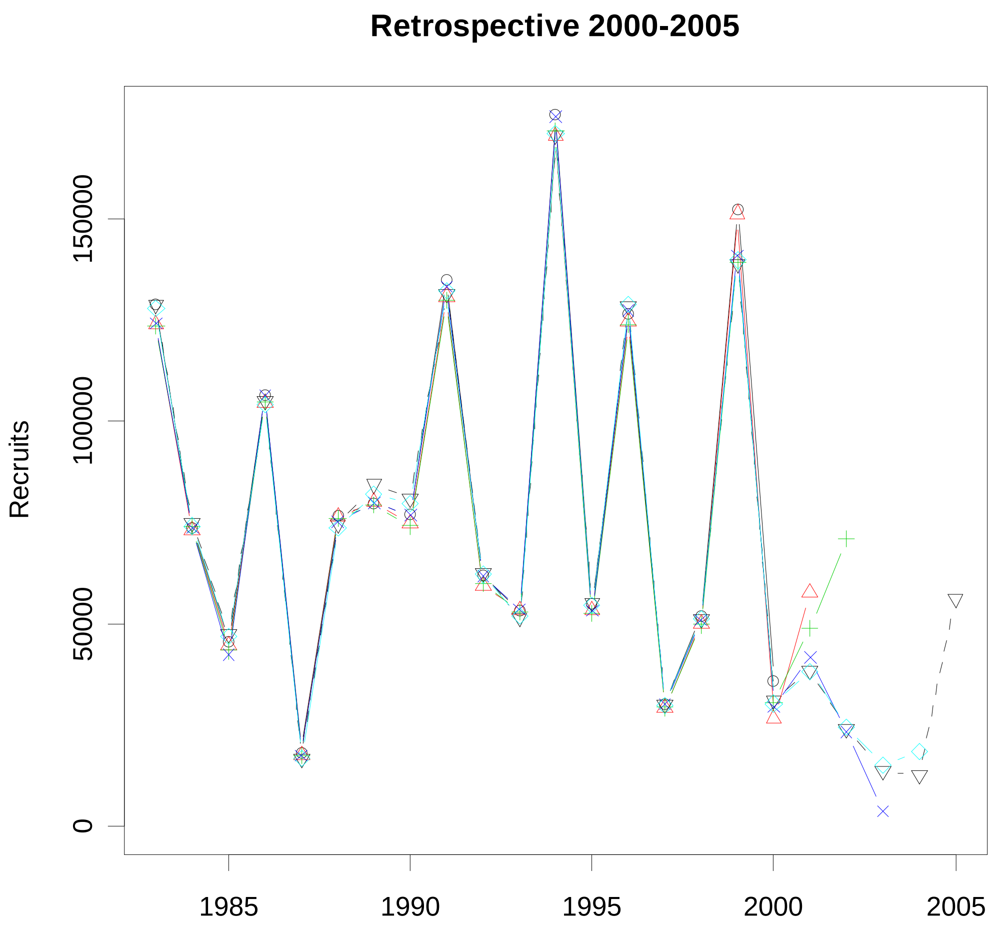
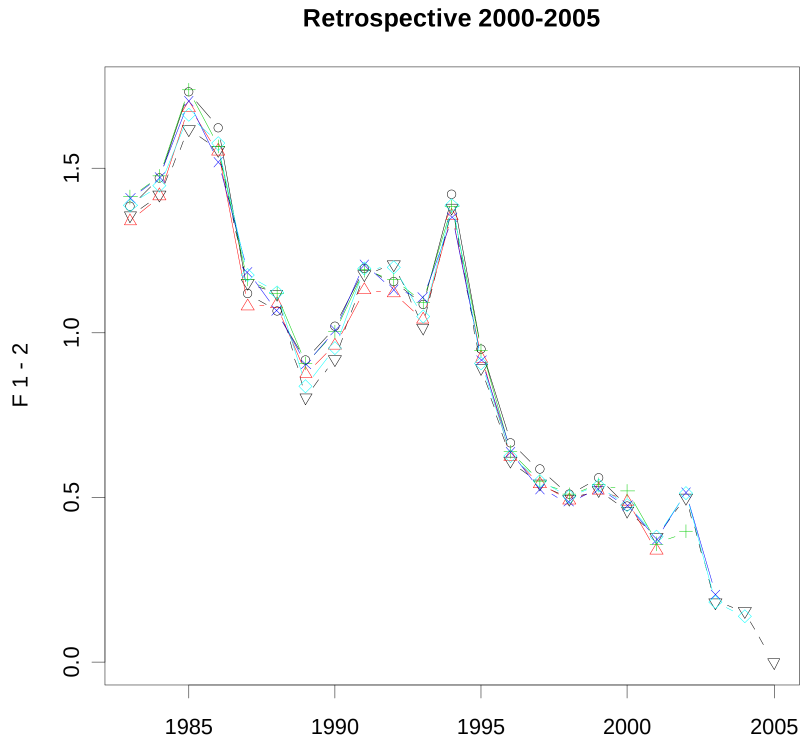


Figure 12.3.8.3 (Cont.'d)



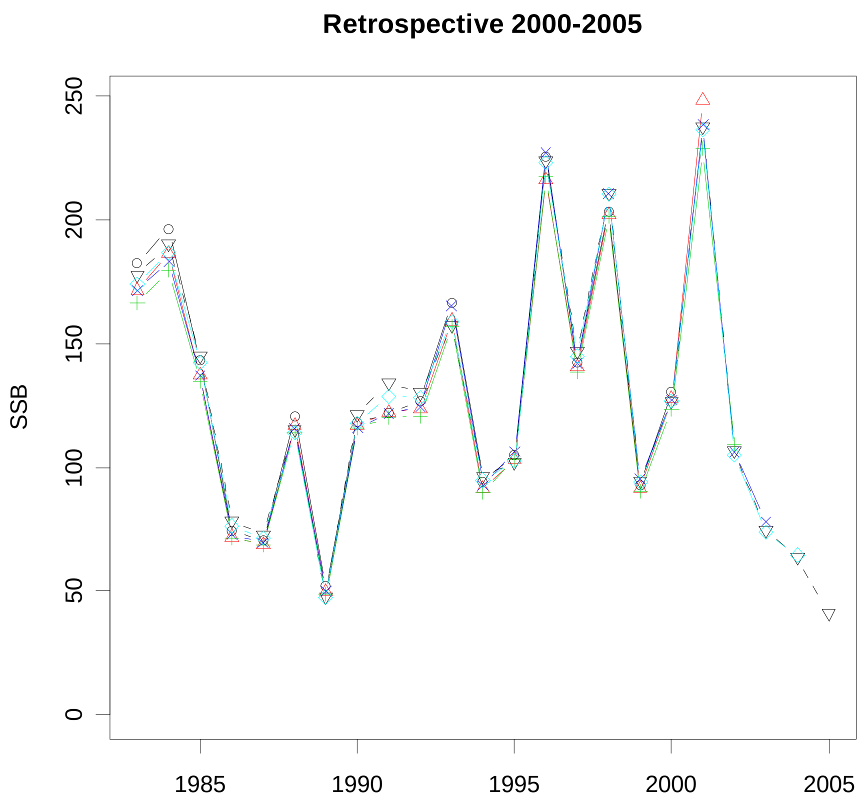
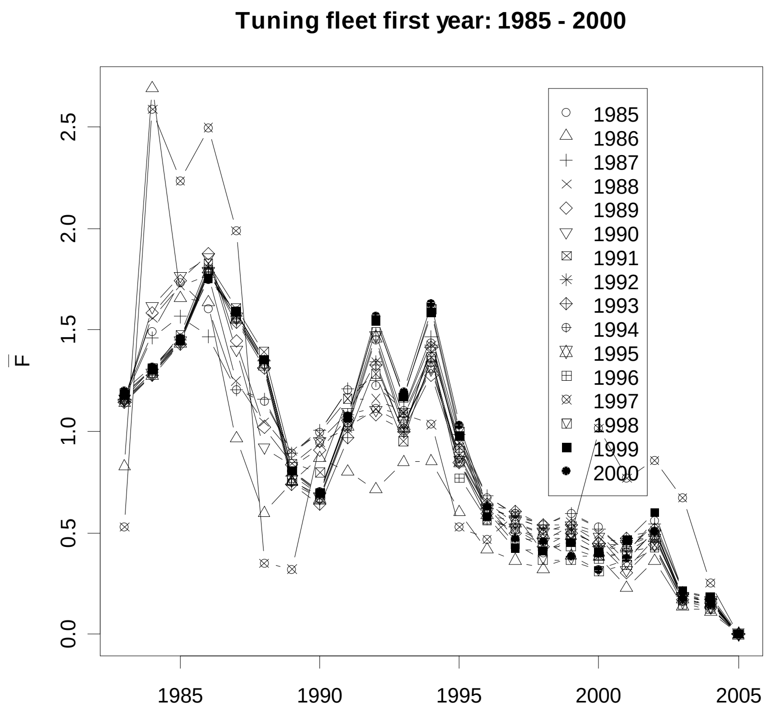


Figure 12.3.8.4 Norway pout. SMS Exploratory Run. Tuning fleet window, all fleets data applied.



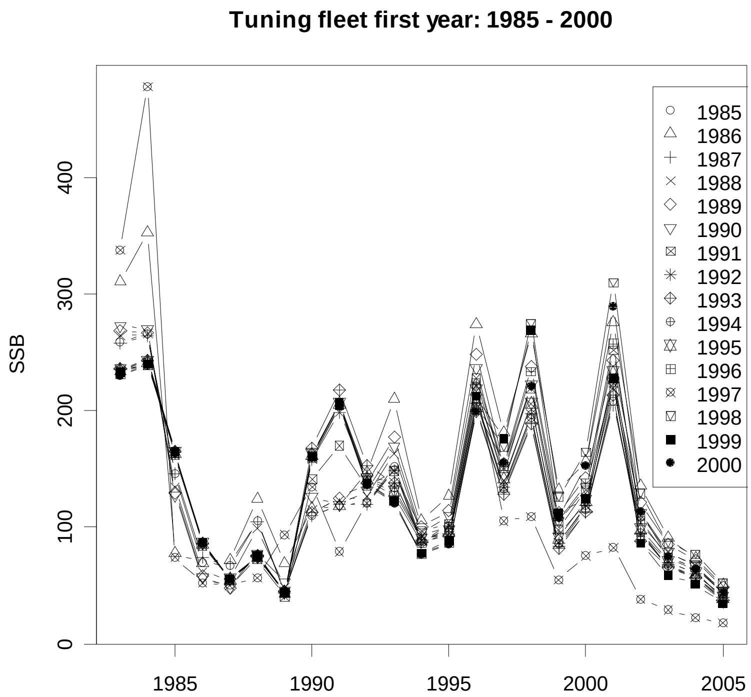


Figure 12.3.8.4 (Cont.'d)

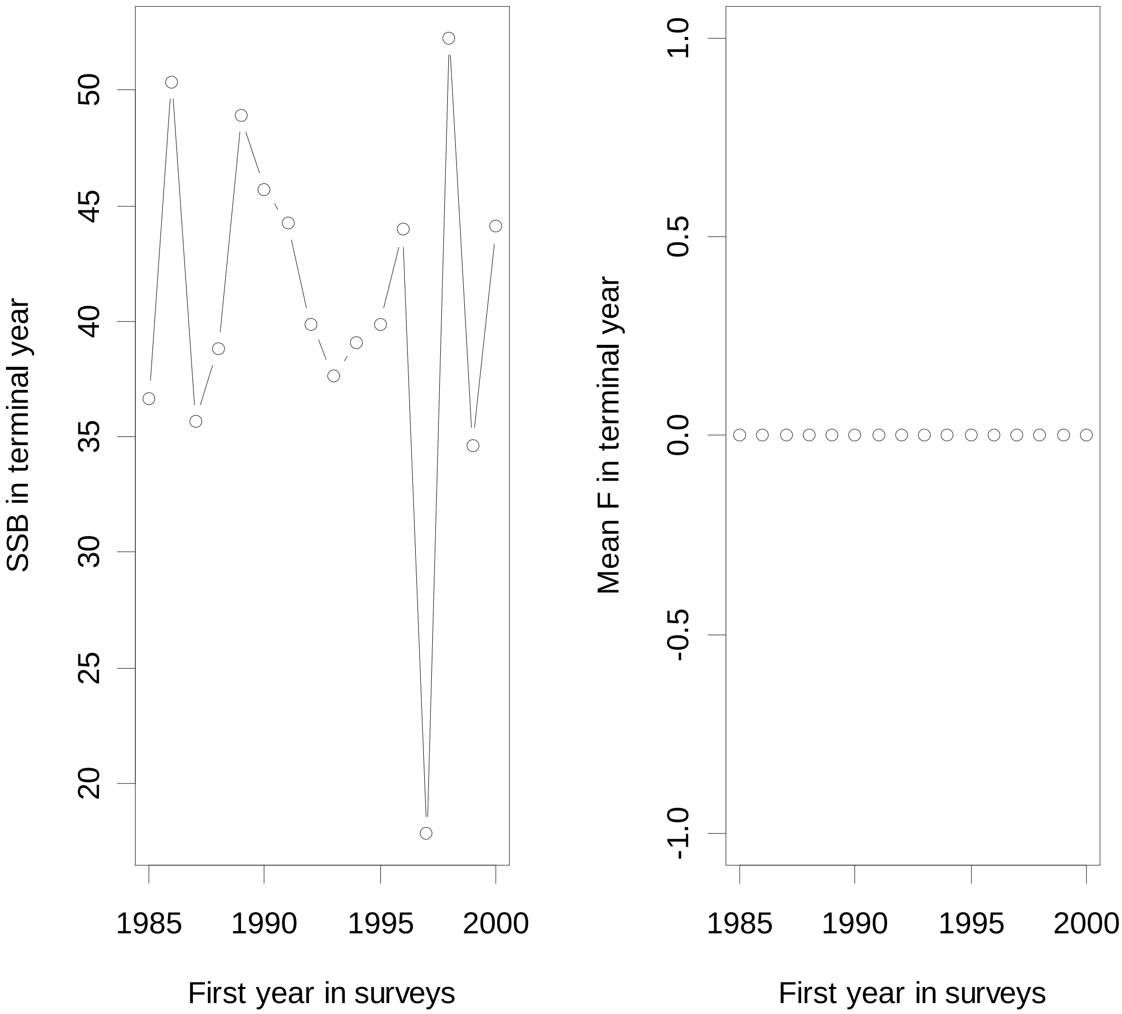


Figure 12.3.9 Norway pout IIIa and IV. Comparison of 2005 SXSA baseline assessment with SMS 2005 assessment.

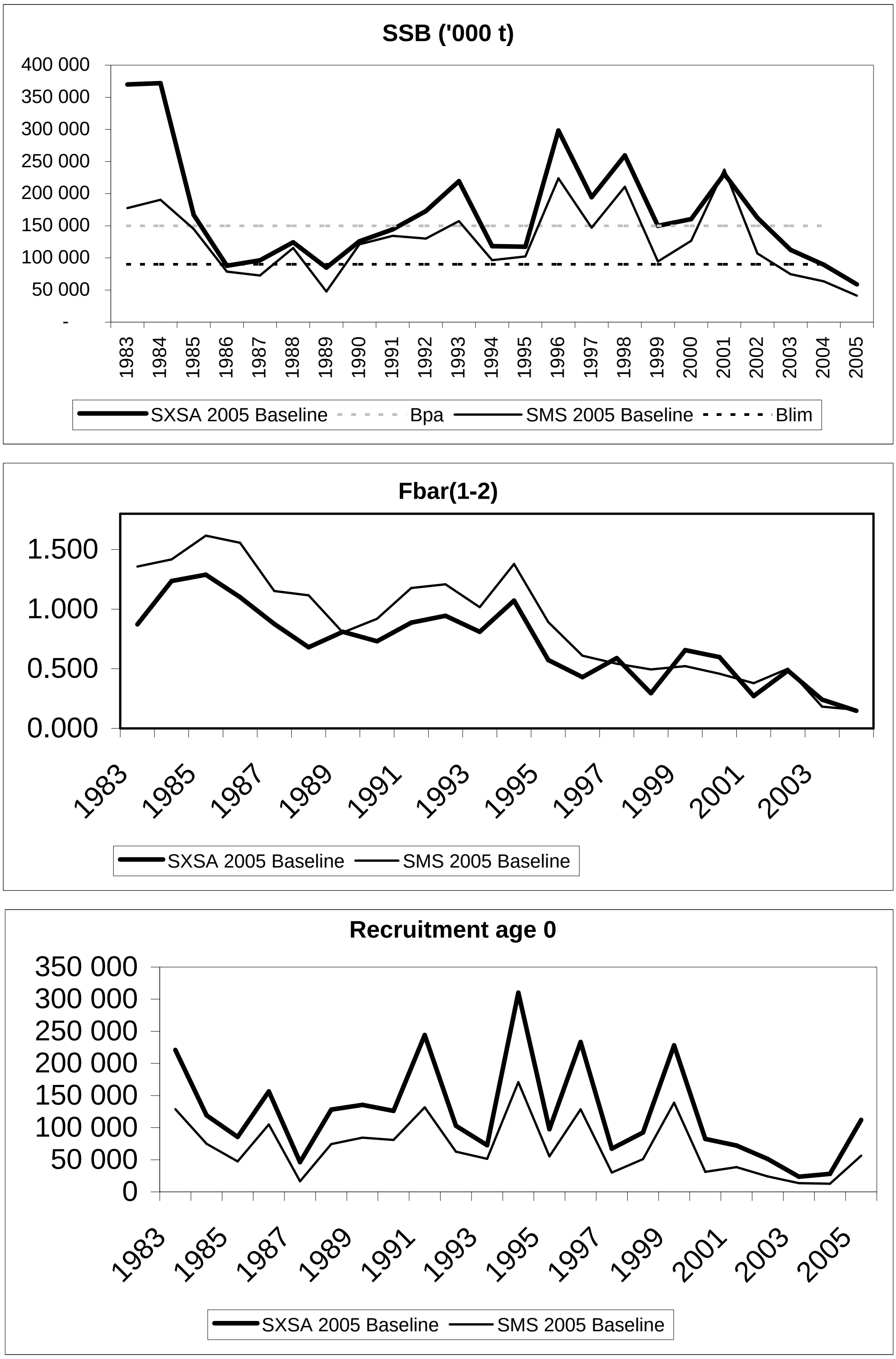


Figure 12. 3.10.1 Norway pout. SURBA Exploratory Run. Spawning stock biomass (SSB), total mortality (Z) and Recruitment (R)

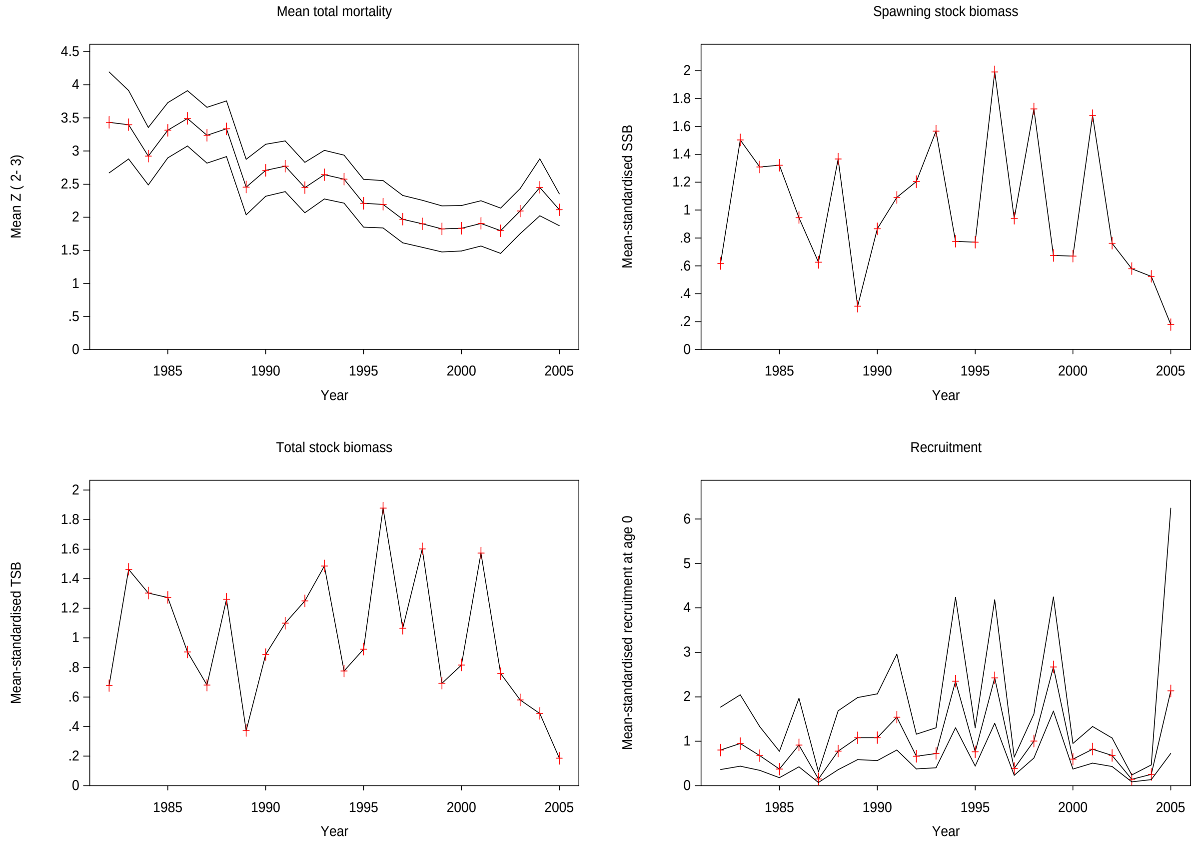


Figure 12.3.10.2 Norway pout. SURBA Exploratory Run. Survey residuals.

SURBA Residuals

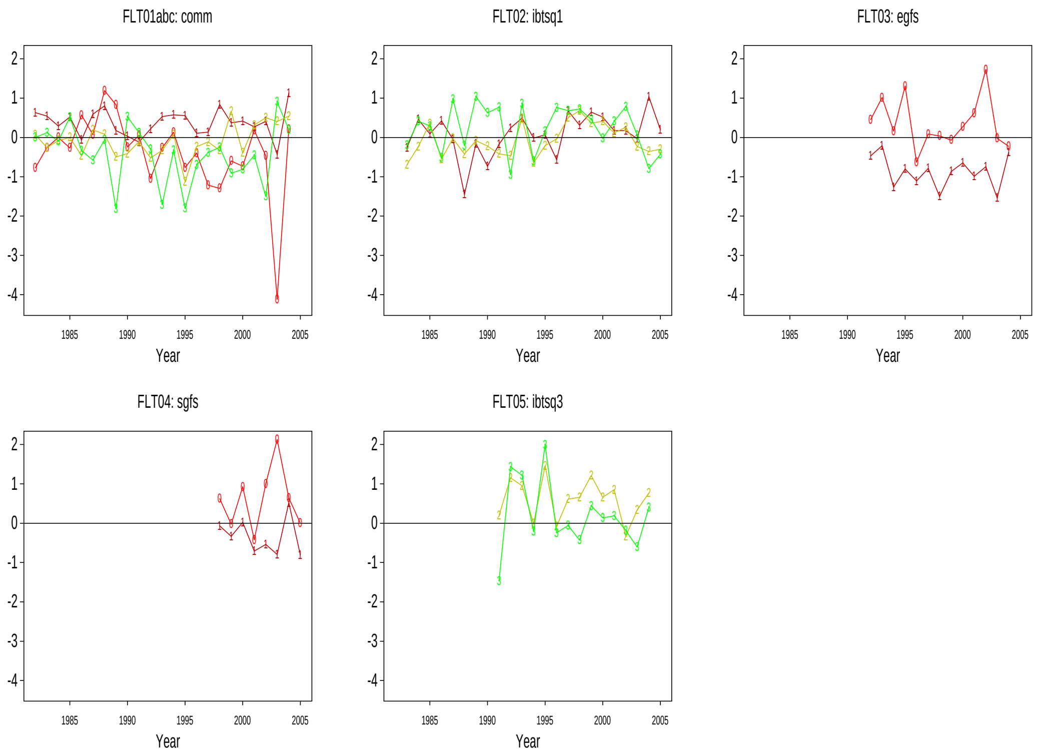


Figure 12.3.10.3 Norway pout. SURBA Exploratory Run. Retrospective runs.

SURBA Retrospective

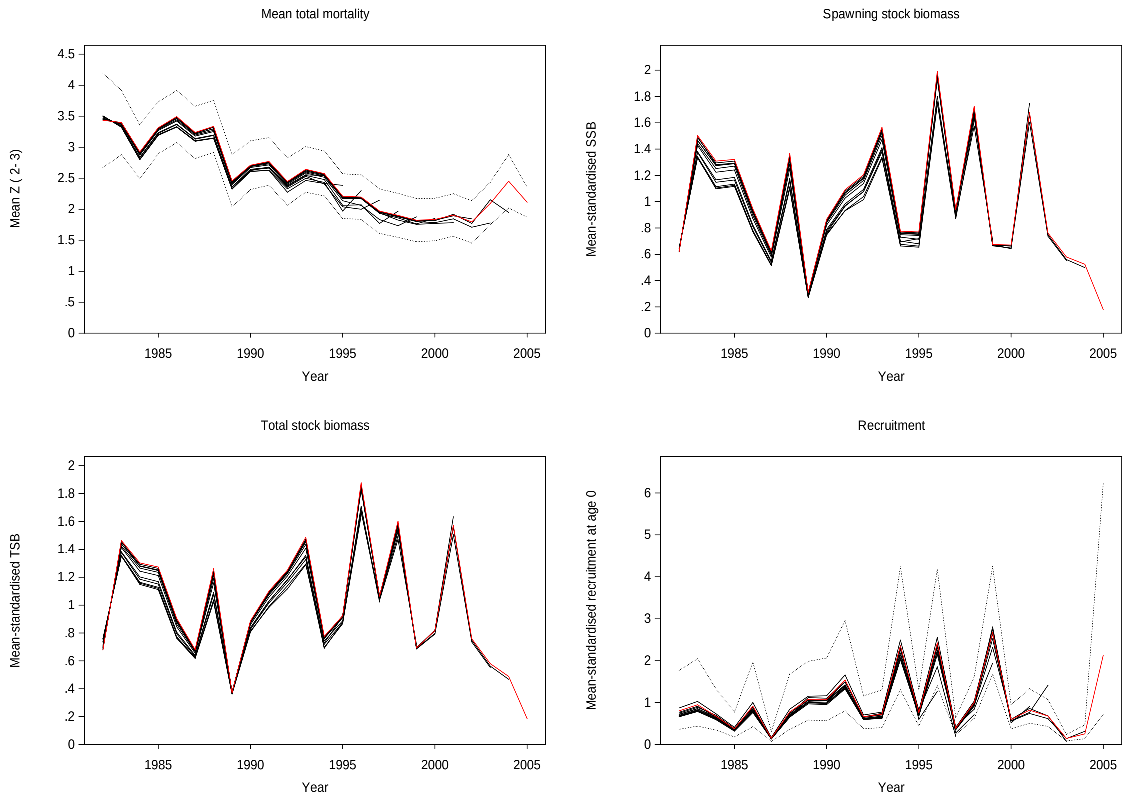
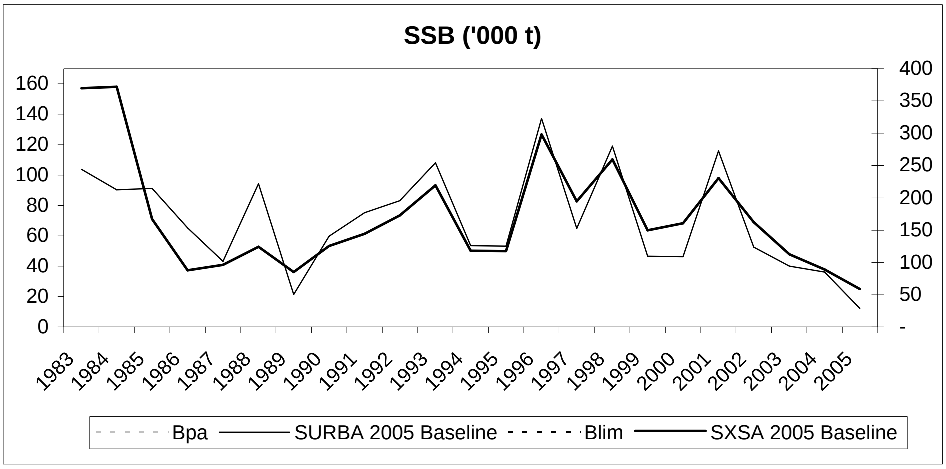
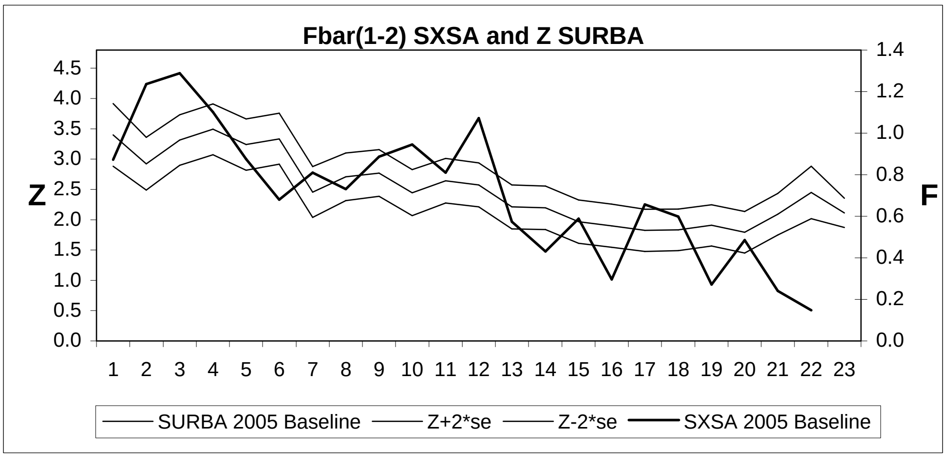


Figure 12.3.11 **Norway pout IIIa and IV. Comparison of 2005 SXSA baseline assessment (right axix) with SURBA 2005 assessment (left axis).**





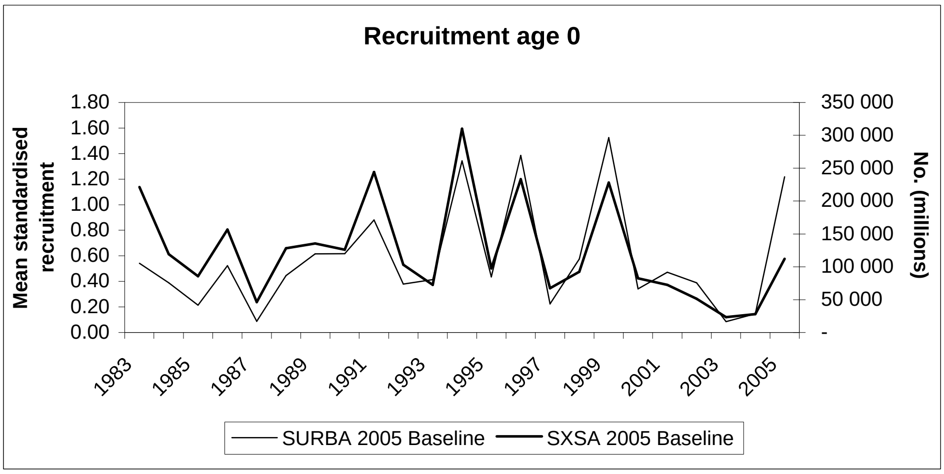


Figure 12.3.12 Norway pout IIIa and IV. Stock summary using the new proprosed natural mortalities compared to accepted assessment.

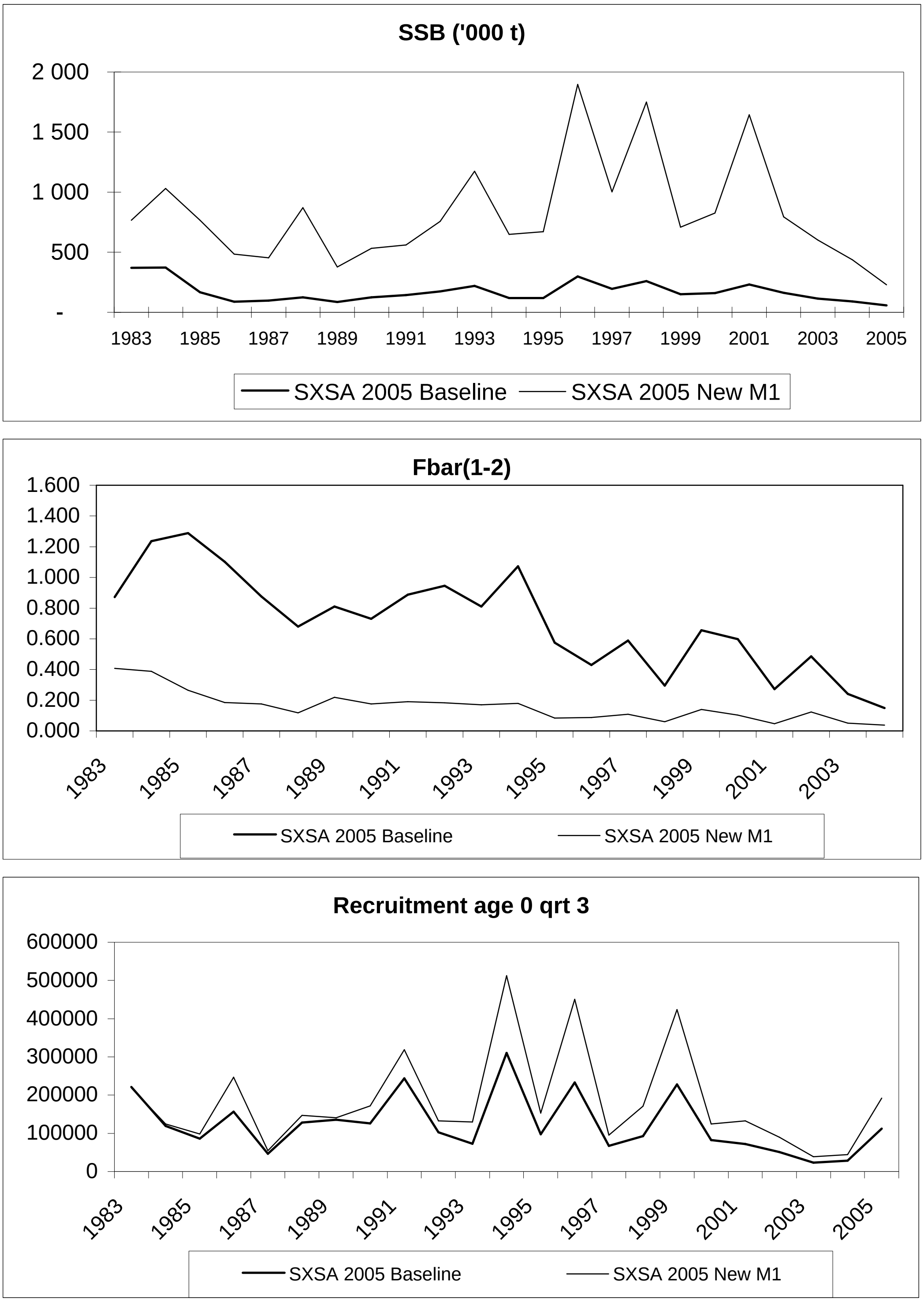


Figure 12.9.1. Norway pout. Historical performance of the assessment. Circles indicate forecasts.

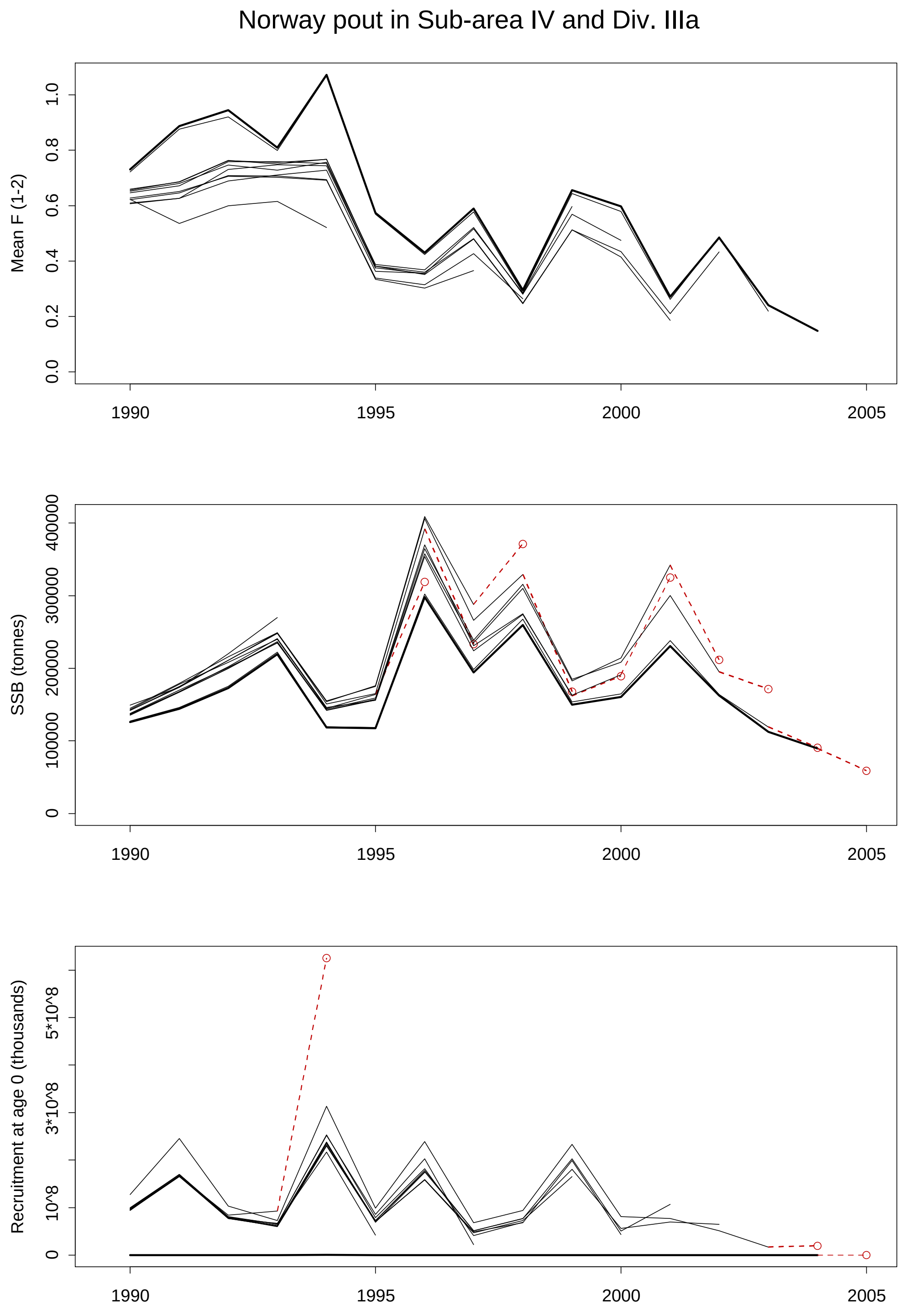
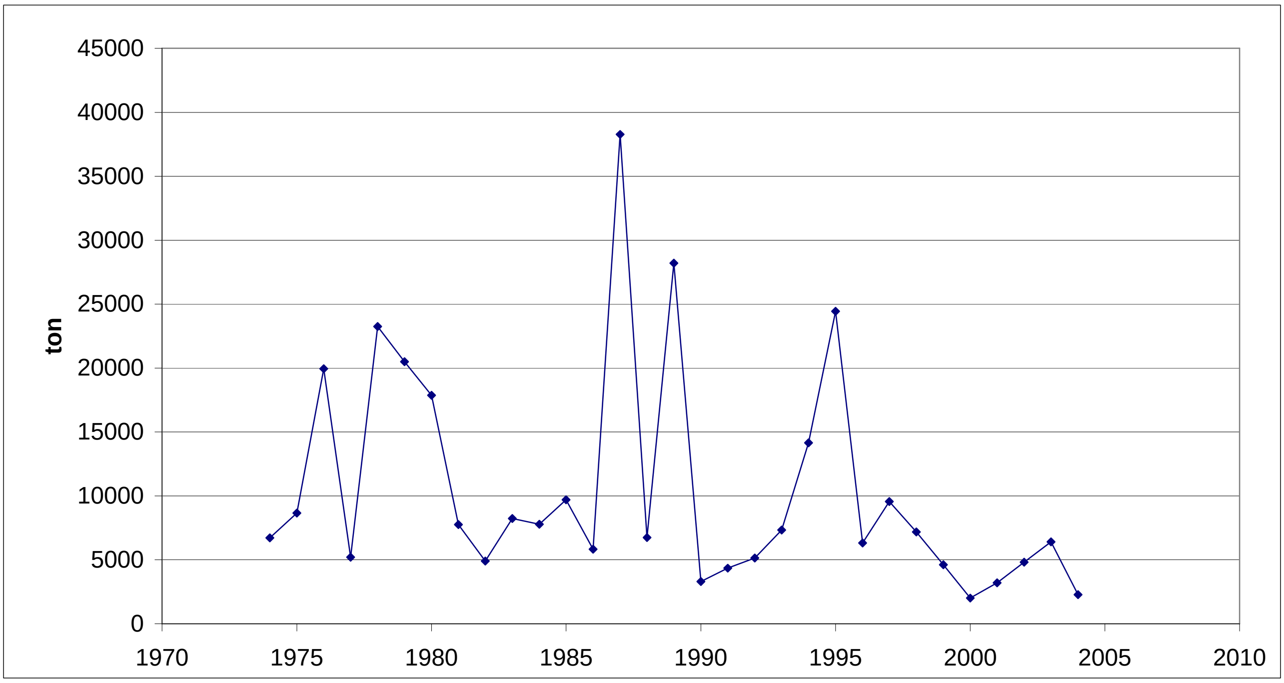


Figure 12.12.1 **Norway pout in Division VIa**
Catch trends



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 excl 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

Due to the decline in the stock abundance of sandeels in IV that have occurred in recent years, there is a need to carry out a more thorough analysis of the stock dynamics. The assessment is therefore classified as a benchmark assessment.

13.1.1 General

13.1.1.1 Ecosystem aspects

Due to the stationary habit of post-settled sandeels, a patchy distribution of the sandeel habitat, and a limited interchange of the planktonic stages between the spawning areas the sandeel stock in IV consist of a number of sub-populations. Due to a to coarse spatial aggregation level of the fisheries data that is used in the sandeel assessment it is presently not possible to make an assessment that cake account of the sub-population structure of sandeels.

The catches of sandeels in area IV consist mainly of the lesser sandeel *Ammodytes marinus*. However, other species of sandeels is also caught. At some of the grounds In the Dogger Bank area the smooth sandeel *Gymnammodytes semisquamatus* can be important, and in the catches from more coastal grounds the other Ammodytes species *Ammodytes tobianus* can be important. The greater sandeel *Hyperoplus lanceolatus* appears in the catches from all grounds, but usually in insignificant numbers compared to *A. marinus*.

The stock dynamics of sandeels is driven by a highly variable recruitment and a high natural mortality in addition to fishing. The recruitment seems more linked to environmental factors than to the size of the spawning stock biomass. As this may indicate an impact of environmental variables on sandeel stock dynamics there is presently not data to quantify a link between changes in the environment and sandeel population dynamics.

Sandeels are important prey species for many marine predators, but the effects of variation in the size of this stock on predators are poorly known. Although the direct effects of sandeel fishing that have been identified on other species fished for human consumption, e.g. haddock and whiting are relatively small in comparison to the effects of directed fisheries for human consumption species there is still relatively scant information on the indirect effects of the sandeel fishery.

Other ecosystem effects of the sandeel fishery are discussed in the ICES Report of the Advisory Committee on Ecosystems, June 2003, Section 11.

13.1.1.2 Fisheries

General information about the sandeel fishery can be found in the stock quality handbook (no. Q13).

Changes in the fleet composition

The size distribution of the Danish fleet has changed through time (Figure 13.1.1.2, and section 13.1.3,), with a clear tendency towards fewer and larger vessels. This change is especially apparent in 2005, when only 96 Danish vessels participated in the fishery, compared to 200 vessels in 2004 (Table 13.1.1.1). The same tendency is seen for the Norwegian vessels fishing sandeels (Table 13.1.3.1).

Trends in effort

Figure 13.1.1.3 shows the trends in effort over years. Total international standardized effort peaked in 1989, and was at a relative stable level from 1989 to 2001. There was a decrease in effort from 2001 to 2002 and a steep decrease in effort from 2004 to 2005. A combination of low abundance of sandeels and high fuel prices was clamed by the fishing industry to be the explanation to this large decrease in effort from 2004 to 2005.

Trends in CPUE

Figure 13.1.1.3 shows the trends in CPUE over years. CPUE fluctuated without a clear trend throughout the period 1983 to 2001. A large increase in CPUE was observed from 2001 to 2002, followed by a large decrease from 2002 to 2003. CPUE in 2004 and 2005 was on a similar low level as in 2003.

Landing and trends in landings

Landings statistics of sandeel by country and area of the North Sea are presented in Table 13.1.1.2 to 13.1.1.6. For 2004 official landings were only available as total landings for Area IV. Figure 13.1.1.1 shows the areas for which catches are tabulated in Tables 13.1.1.4 and 13.1.1.5.

The catch history is shown in Figure 13.1.1.3. The sandeel fishery developed during the 1970's, and landings peaked in 1998 at more than 1 million tons. Since then there have been an rapid decrease in landings, and the total landings were at a historic low level in 2003. Danish landings declined 60% from 2002 to 2003 and Norwegian landings declined by more than 80%. The landings in 2004 were at a similar low level as in 2003.

The reduction in landings has been particularly large in the Norwegian EEZ, with close to 90 % reduction in 2003 and 2004 compared to landings in 1994-2002. In 2005 landings decreased further to about half the landings in 2003 and 2004.

Danish and Norwegian total landings in first half year of 2005 were 158,389 t. Total landings of Danish vessels in 2005, including landings up to the end of August, were just above 189,000 t. Landings in 2005 will thus be at a lover level than those in 2003 and 2004.

The distribution of landings

The spatial distribution of sandeel landings is considered as a good representation of stock distribution, except for areas where severe restrictions on fishing effort is applied (i.e. the Firth of Forth and Shetland areas). Figure 13.1.1.4 shows the distribution of catches for 2004 and first half year of 2005 by quarter and ICES statistical rectangle. Yearly landings for the period 1995-2005 distributed by ICES rectangle are shown in Figure 13.1.1.5.

Because sandeels, *Ammodytes marinus*, in the North Sea possibly consist of a number of sub-populations (see section 13.1.1.1 and the stock quality handbook) the industrial fishery targets different parts of the sandeel populations during the year and between years. This between-year variation in the fishing pattern appears from Figure 13.1.1.5, although the general high importance of the Dogger Bank and the southern part of the Norwegian zone is confirmed. For example, the fishery at the Viking Bank in the Norwegian EEZ (see Figure 13.1.1.1, was large in 1995, and decreased to a low level in 1996 and almost vanished from 1997 and onwards. Further, fishery at the grounds between the Dogger Bank area and the southern part of the Norwegian zone (e.g. Elbov Spit and Tail End) was much larger in 2001 and 2002 than in the other years shown on the graph. This variation is supposed to be due to variation in local abundance of sandeels, due to differences in mortality and recruitment taken place at a small spatial scale. The sub-population structure of *A. marinus* and the highly variable fishing pattern has large implications to the biological data that is used in the sandeel assessment (see section 13.1.2 and the stock quality handbook).

The distribution of landings in 2003 seemed more extensive than the typical long-term pattern with generally low landings at the grounds most frequently exploited (Figure 13.1.1.4, Figure 13.1.1.5, Table 13.1.1.4 and 13.1.1.5). Landings were particularly low in the north-eastern grounds, which reflect the large decrease in Norwegian landings. A relative increase in the importance of grounds close to the coast was observed.

The tendency towards an increase in landings from grounds closer to the coast was even more pronounced in 2004 and 2005 than in 2003. Further, in 2005 much of the fishery in the traditionally more important areas, as the Dogger Bank area, occurred at grounds that have not been fished for a number of years. These changes in fishing pattern are 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, and it is in accordance with information from the fishermen themselves.

A change in the fishing pattern occurred from 2002 to 2003, over the same period when a dramatic decrease was observed in landings and CPUE. Due to the population structure of sandeels (see section 13.1.1.1) this change in fishing pattern probably lead to an in crease in the importance of sandeel populations that usually contributed less to the fishery. This is confirmed by an increase of *A. tobianus* in the samples from the landings in recent years (DIFRES unpublished information).

The sandeel fishery in the EU zone was closed 2nd July, under the application of the real time monitoring system (see section 13.1.1.4 and section 13.1.13).

13.1.1.3 ICES advice

Based on the 2004 assessment ICES concluded that the state of the North Sea sandeel stock was uncertain (ICES 2005a). SSB in 2004 was estimated to be at a historic low value (325,000 t). SSB in 2003 was above Blim, but decreased in 2004 to below Blim due to the historic low recruitment in 2002. On the basis of this information ICES classified the stock in 2004 as having reduced reproductive capacity, and advised that the management of the sandeel fishery in 2005 should attempt to rebuild SSB to Bpa by 2006.

ICES (2005a) advised, that the fishery in 2005 should be managed through effort control, and that a real-time monitoring of the sandeel stock in the beginning of the fishing season of 2005 was required to determine a sustainable effort level for the main fishing season. Further, in the absence of a real-time monitoring system the effort in 2005 should be less than 40% of the effort in 2004. The 40% level was based on the short-term forecast with a conservative recruitment value.

ICES (ICES 2005a) also advised that there is a need to develop management objectives to ensure that the stock remains high enough to provide food for a variety of predator species. Further, local depletion of sandeel aggregations should be prevented, particularly in areas where predators congregate.

In the light of studies linking low sandeel availability to poor breeding success of kittiwake, ICES advised in 2000 for a closure of the sandeel fisheries in the Firth of Forth area east of Scotland (see Figure 13.1.1.1).

13.1.1.4 Management

TAC

The TAC was set to 826,200 tonnes in 2004 and to 660,960 tonnes in 2005. In the Norwegian zone a TAC on 10,000 tonnes was set to EU countries in 2005.

Closed periods

In 2005 Danish vessels were not allowed to fish sandeels before 31st of March. The sandeel fishery in the Norwegian EEZ is closed from 25 June to 31 March to avoid fishery on 0-group sandeels.

Closed areas

All commercial fishing in the Firth of Forth area has been prohibited since 2000, except for a maximum of 10 boat days in each of May and June for stock monitoring purposes. The closure was maintained for three years (see e.g. Wright et al. 2002) and has been extended until 2006, with an increase in the effort of the monitoring fishery to 40 boat days, after which the effect of the closure will be evaluated.

Recent investigations (Simon et *al.* in prep) indicate that the biomass of sandeels increased sharply in the first year of the closure and remained at a relative high level in the years following the closure. The closure appears to have coincided with a period of raised recruit production, which could coincide with the closure of the fishery.

Real time management of the fishery in 2005

The Council of the EU agreed in December 2004 that the Commission should implement a fishing effort regulation in 2005 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 2004 year-class. The Commission based this regulation on advice from STECF.

From the estimate of the 2004 year-class, STECF recommended that the agreed HCR for sandeel given in Annex V of Council Regulation (EC) 27/2005 should be implemented with immediate effect, which meant a closure of the fishery for North Sea sandeel from mid may and for the remainder of 2005 (STECF 2005b). Further, STECF stressed the importance of rapid action to close the fishery as the HCR depends on swift action to function correctly. However, the sandeel fishery in the EU zone was first closed 2nd July, when the main sandeel fishing season was over.

13.1.2 Natural Mortality, Maturity, Age Composition and mean Weight at Age

Maturity and natural mortality

Maturity and natural mortality are assumed at fixed values and are described in the stock annex. This year an exploratory assessment was carried out, using the smoothed natural mortality for sandeels estimated by ICES (2005b) and presented in Figure (13.1.2.1). The time series of natural mortality estimated by ICES (2005b) only include up to 2003, so 2003 estimates were copied to 2004 and 2005.

In contras to the fixed values of natural mortality used in previous sandeel assessments (see the stock annex), the natural mortalities estimated by ICES (2005b) show large variability over years (Figure 13.1.2.1). The most significant differences between the natural mortalities of sandeels used in previous sandeel assessments and those estimated by ICES (2005b) are those for age-0 sandeels. The natural mortalities of age-0 sandeels estimated by ICES (2005b) are about twice as high than those used in previous sandeel assessments.

Age composition and mean weight at age

The compilation of age-length-weight keys was carried out using the method described in the stock annex. The mean weights-at-age in the catch for the southern and northern North Sea in the time period 2001 to 2005 are given in Tables 13.1.2.3 and 13.1.2.4. The mean weight at age in the catch used in the assessment is the mean weights at age in the catch for the Southern and Northern North Sea weighted by catch numbers. Mean weight in the catch from 1983 to 2005 is given in Tables 13.1.2.5 by half year and in Table 13.1.2.6 by year.

The mean weight at age in the stock is mean weight in the catch first half-year, and an arbitrary chosen weight at 1 gram was used for the 0-group. Mean weight in the stock from 1983 to 2004 is given in Tables 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 13.1.2.2 and 13.1.2.3.

Mean weight at age show large fluctuations over time. Most remarkable is a decrease in mean weight at age for age 2 and 3 sandeels in the first half year, the period where most of the catch is taken. This large variability is due to temporal and spatial variability in the growth of sandeels, and because the industrial fishery target different part of the sandeel populations during the year and between years. Additional information about the variation in catch weight at age can be found in the stock quality handbook (Q13). No major or unusual change in mean weight in the stock and in the catch was recorded in 2004 and 2005 compared to previous years.

Catch at age

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

The tuning series used in the assessment

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 has since 2003 been included in tuning series. The effect of this on the assessment was analysed in last year’s assessment (see ICES 2005a). Effort data for Norwegian vessels were not available for the southern area in 2005 due to low fishing. 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.

Standardisation of effort data

Due to the change in size distribution of the vessels fishing sandeels in the North Sea (see section 13.1.1.2) and the relationship between vessel size and fishing power effort standardisation is required when establishing the commercial tuning series used in the sandeel assessment. The assumption underlying the standardisation procedure and the procedure itself was described in last years report (ICES 2005a) and can be found in the stock quality handbook (Q13). The results of the standardisation procedure, the analyses of the relationship between CPUE and vessel size, are given in Table 13.1.3.2. The combined Norwegian and Danish effort is shown in Tables 13.1.3.3 and 13.1.3.4. The tuning fleets used in the assessments area given in Table 13.1.3.5. The CPUE for these fleets are summarised in Figures 13.1.3.1 and 13.1.3.2.

Trends in CPUE

All fleets show a large decrease in CPUE from 2002 to 2003 and a continued low level of CPUE in 2004 and 2005. However, there is a small increase in CPUE from 2004 to 2005, although both the fleet and the total international effort was more than halved from 2004 to 2005.

Fisheries independent tuning

There is no survey time-series available for this stock. However, several of the European as well as the Norwegian research institutes are presently developing survey techniques that hopefully will be suitable for measuring sandeel abundances. The state of development of the surveys and preliminary indices are given in section 13.1.12.

13.1.4 Data analysis

Seasonal XSA (SXSA) was used as the assessment model as in last years benchmark assessment.

13.1.4.1 Exploratory data analyses

Exploratory data analyses were carried out using the Seasonal XSA (SXSA) and the SMS model.

13.1.4.1.1 Seasonal XSA

The SXSA model and the settings of the model

The Seasonal XSA developed by Skagen (1993) was used to estimate fishing mortalities and stock numbers at age by half year, using data from 1983 to 2004 and first half year of 2005. The default settings that have been used for this model in precious assessments are listed in Table 13.1.4.1.

This year 3 runs were made with the SXSA model. The first run (SXSA run 01) used the default settings (Table 13.1.4.1). In the second run (SXSA run 02) the effect of changing the tuning series was explored. In the last run (SXSA run 03) the effect of changing the fixed values of natural mortalities was explored.

SXSA run 01 – default settings

The residuals of log stock number for SXSA run 01 (default settings) are given in Figure 13.1.4.1. There are large trends in the residuals from SXSA run 01, which indicate changes in catchability over the year range of data used in the assessment. Of special concern is the trends in the residuals for the tuning fleet in the first half year in the southern North Sea, where the SXSA model seem to overestimate stock number of age-1 sandeels from 1999 and onwards. As the landings of 1-group sandeels in the southern North Sea in the first half year make up far the largest fraction of the total landings, especially in recent years where the fishery in the Northern part of the North Sea has been almost non existent (see section 13.1.1.2), this may seriously bias the results of the SXSA analysis. The retrospective analysis for SXSA run 01 (Figure 13.1.4.2) confirm this concern, because of a tendency in recent years to underestimate F and overestimate SSB.

SXSA run 02 – changing the tuning series

Because of the trends in the residuals for 1-group sandeels in the first half year, seen in SXSA run 01, another SXSA run was carried where the two tuning fleets in the first half year were split into two time periods, i.e. before and after 1999. In SXSA run 02 the following tuning series were used (Table 13.1.3.6):

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

Fleet 2: Northern North Sea 1999-2005 first half year

Fleet 3: Southern North Sea 1983-1998 first half year

Fleet 4: Southern North Sea 1999-2005 first half year

Fleet 5: Northern North Sea 1983-2004 second half year

Fleet 6: Southern North Sea 1983-2004 second half year

The residuals of log stock number for SXSA run 02 are given in Figure 13.1.4.3 and the results of the retrospective analysis in Figure 13.1.4.4. The change in the tuning series removed the trends in the residuals of log stock numbers, and the tendency to underestimate F and overestimate SSB was also reduced markedly.

The estimates of catchabilities for the tuning fleets are given in Table 13.1.4.2. (SXSA run 01) and Table 13.1.4.3 (SXSA run 02). The largest effect of changing the tuning series is a large increase of the catchability of 1-group sandeels in the southern North Sea for the period 1999-2005.

SXSA run 03 – changing natural mortalities

A third SXSA analysis was carried out, to explore the effect of the assessment result of using the estimates of natural mortality estimated by ICES (2005b, Figure 13.1.2.1). The residual of log stock numbers for this SXSA analysis is given in Figure 13.1.4.5.

13.1.4.1.2 SMS

A series explorative runs were made using the SMS model:

- Run01, investigates the possibilities of extending the assessment time series back to 1975.
- Run02, investigates the use of SPALY SXSA settings for the revised extended time series
- Run03, investigate the effects of splitting the catch and CPUE into two separable periods

SMS (Stochastic Multi Species model) (Lewy and Vinther, 2004) is an age structured assessment model to handle biological interaction, however, it can be reduced to operate with one species only. In "single species mode" an objective functions for catch at age numbers, survey indices at age are minimized assuming a log-normal error distribution for the two data sources. SMS uses maximum likelihood to weight the various data sources. For more details about SMS see section 1.3.4.

Since the last WG meeting, SMS has been modified slightly. Now, it is possible to estimate the variance of catch at age observations for each season separately. Previously it was assumed that the variance was the same for all seasons. This modification is a prerequisite for the assessment of sandeel, which has very distinct fishery seasons and variance level of catch observations.

The SMS model does not require “tuning data” for the whole assessment period, in contrast to SXSA. The times series of catch observations could therefore be extended back to 1975 with data previously used in the assessment. CPUE data for the period before 1983, are also available as presented below:

1. Northern North Sea, first half year, 1976-2005
2. Northern North Sea, second half year, 1976-2004
3. Southern North Sea, first half year, 1982-2005
4. Southern North Sea, second half year, 1982-2004

Explorative SMS run01

The results from this run showed a very clear year effect of the residuals for fleet 1 for the period before 1980, and it was decided to remove this period from the CPUE time series. Fleet 4 had a very high CV for all age groups and this fleet was discarded. The stock dynamic for the for the period before 1983 is described under *run03*

Explorative SMS run02

The catch residuals (Figure 13.1.4.6) for a SMS run with the adjusted fleet data show a distinct cluster of positive residuals for age 1 in the first season (first half-year) for the period 1998-2005. The same can be seen in the residual plot for CPUE observations (Figure 13.1.4.7) As the main part of the catch weight comes from that season and age group this bias cannot be ignored.

The retrospective analysis (Figure 13.1.4.8) shows a rather stable estimate of SSB irrespective of terminal year. Fishing mortality shows however a clear increase in the period 1998-2003, when data for 2004 or 2005 are used as terminal year. The same can be seen when the retrospective analysis are done by individual fleets (Figure 13.1.4.9) Fleet 1, "North 1 half year" shows a quite similar retrospective pattern, as the run with all fleets included. The retrospective analysis for the southern fleet for first half year, show a more gradually upward revision of F in 2003 when 2004 and 2005 are used as terminal year. The second half-year fleet show a highly variable retrospective estimate of F.

To improve the residual and retrospective plots, SMS runs were tried with a shorter time series of CPUE data. The CPUE time series were truncated such that the first year in the time series was from 1985, 1986 .. up to 2000. The final year was kept constant at 2005. The results are shown in Figure 13.1.4.10. The estimate of SSB and F are rather insensitive to the CPUE time series length used in the assessment for the historical part, however with quite variable estimates for the most recent period. Figure 13.1.4.11 gives a more detailed look at the relation between CPUE time series length and estimated SSB and F for 2005. There is no trend in the estimates of SSB when the CPUE time series begin before 1993. However, after that year, there is a close relation between estimated SSB and the first year in the CPUE data series.

Explorative SMS run03

It is not possible from Figure 13.1.4.11 to judge what causes the downward revision of SSB in the terminal year. The cluster of positive age-1 residuals for the period 1999-2005 might indicate a shift in the exploitation pattern from 1999 onwards. It was therefore decided to assume one exploitation pattern before 1998 and one for the period since 1999 in the F model for catch at age observations. The CPUE data are a subset of the total international catch so the change in exploitation pattern is assumed for both catch and CPUE data. To implement the change in exploitation pattern, CPUE data are simply divided into two series; one for the period up to 1998 and one for the period after 1999 as shown below.

Survey –CPUE data	Year range	Catchability at age	Variance at age of survey observation
Northern North Sea, 1 half-year	1980-1998 1999-2005	By age-group: age 1-2 Combined: age 3-4	By age-group: age 1-4
Northern North Sea, 2 half-year	1976-1998 1999-2004	By age-group: age 0-2 Combined: age 3-4	By age-group: age 0-4
Southern North Sea, 1 half-year	1982-1998 1999-2005	By age-group: age 1-2 Combined: age 3-4	By age-group: age 1-4

The catch residual plots from run03 show that the cluster of positive residuals for age 1 in the most recent years has disappeared from both the catch residuals (Figure 13.1.4.12) and the CPUE residuals (Figure 13.1.4.13). Some progress is also obtained for the retrospective pattern (Figure 13.1.4.14), even though F for 2002 and 2003 still increase when data for 2004 or 2005 are used. The increase is however smaller than for the SMS run where the exploitation pattern was assumed constant for the whole period.

A comparison of the run02 and run03 is presented in Figure 13.1.4.17 and Table 13.1.4.4. The result of splitting the time series into two parts is a slightly lower SSB and higher F for the most recent years. By splitting the time series, the number of SMS parameters increases and a better fit is expected. This is also the case; the CVs (Table 13.1.4.4) are slightly reduced for in run03 compared to run02. For catch observations the biggest reduction in CV is obtained for age 1, in the first half-year. The effect of splitting the CPUE fleets into two parts is in general a lower CV for the sub-fleets, with the highest reduction in CV for the shorter and most recent CPUE time series. The biggest reduction in CV is for the “Southern fleet, 1 half-year”, where age 1 and 2 in the most recent time series obtain CVs at 30%, which has been defined as a lower threshold. The effect of splitting in sub-fleet seems therefore to be a higher weight on the CPUE from the southern North Sea, which is reasonable, as most of the catch have been taken there in the most recent years.

The SMS diagnostics (Table 13.1.4.5) show that the log-likelihood contributions are highest from catch data. For the CPUE data the likelihood contributions are highest from the Southern North Sea in the most recent period. Coefficient of variation (CV) of catch observation is clearly smallest for the first half-year. CV of CPUE data are in general rather high, and with the lowest CV for age 1 and 2 in the first half-year.

The seasonal component of the separable F-model (label “F, season effect”) shows a clear shift between the two separable periods. In the most recent period, the proportion of annual F taken in the first half-year has increased. The age component (label “F, age effect”) show a relative higher exploitation of the 0 and 1 group compared to the older age-groups for the most recent period. The product of the individual components is shown in the exploitation pattern table for the two periods. It can clearly be seen, that the most recent period has a more uniform exploitation of age 1-4 and that the second half year fishery has become less important.

Survey (CPUE) catchabilities are estimated in the same order of magnitude for age 2 and for the age 3-4 group indicating that SMS could have been configured with age independent catchability from age 2.

The uncertainty of estimated stock numbers SSB and F are presented in Figure 13.1.4.15. CVs of SSB and mean F are increasing for the most recent years, due to the fewer data point available for the estimation. A step increase in CV is observed for 2005, probably due to the fact that data includes only the first half-year. CV is around 25% for the stock number estimate the 1 Jan 2005 and 30% for the 1 Jul. 2005

The uncertainties presented above have been calculated from the Hessian matrix. Assessment uncertainties estimated by Markov Chain Monte Carlo (MCMC) simulations, with 200 000 chains thinned by a factor 500 is presented on Figure 13.1.4.16. It is clear that the uncertainty of the estimate of F has been high in the full assessment period.

13.1.4.1.3 Comparison of the exploratory runs

SXSA runs

Of the 3 SXSA analyses run 02 was chosen as the final. Run 01 was discarded because of the cluster of positive residuals for age-1 CPUE from the most dominant fleet, and a clear bias in the retrospective F pattern. SXSA run 03 is configured as run 02 but uses natural mortalities estimated by MSVPA. Run 03 showed similar trends in SSB as SXSA run 02, whereas the estimates of recruitment and F, were generally higher in SXSA run 3. This difference was mainly due to the larger natural mortality for the 0-group sandeels used in SXSA run 03. There is no difference in the performance of run 02 and run 03 and as such, no basis for an objective choice between configurations. It was however, decided to select run 02 as the best configuration as theSGMSNS group express some reservation about the quality of the estimate of natural mortality for the most recent years.

SMS runs

The SMS showed it was possible to extend the time back in time from 1983 (as used by SXSA) to 1975. The split of the CPUE time series and use of two periods for the separable F-model had the same positive effects on residuals and retrospective F pattern as for the SXSA model. SMS use a separable model for F, which is estimated from a year, season and age effect. Such model cannot capture sudden changes in exploitations pattern in a particular year, e.g the large 0-group fishery in 2001. This might be the reason for the drop in F(1-2) in 2003 only seen in SMS runs

Model comparison

SXSA and SMS runs show the same effect of splitting the CPUE time series into two sub-fleets:

a) the cluster of positive residuals for age 1, 1999-2005 disappears;

b) a less biased retrospective pattern in F and

c) a higher F and lower SSB in the most recent years.

A comparison of the explorative SXSA and SMS assessments, and previous year’s assessments is shown in Figure 13.1.4.18. Figure 13.1.4.20 is a comparison between the SXSA run and SMS run 03. The SXSA and SMS explorative runs gave quite similar results for the time trend of SSB, but the absolute levels differ between model configurations. All the runs show that SSB is at a historical low level, even though SSB in 2005 is estimated slightly higher than for 2004. The main difference in the explorative runs is in the estimate of fishing mortality. Fs for the most recent years are estimated higher and more variable by the SMS model. All SXSA runs show a decrease in F since 2001, while SMS estimate a step decrease in F in 2003 followed by a seep increase in 2003 and subsequently decreases in 2004 and 2005.

13.1.4.2 Final Assessment

SMS uses maximum likelihood to weight data sources, while SXSA uses a fixed input weight on the individual tuning fleets. When the CPUE are split into two SMS gives a relative higher weight to the southern Fleet, where SXSA keeps the same weight on the northern and southern fleet. This different weighting may have caused the different F pattern for the two models. Compared with the total international effort (Figure 13.1.1.3) none of the two models estimate F, which closely follow the effort. SXSA gives a gradually decline in F since 2001, whereas effort was increasing between 2002 and 2004. SMS estimated a relative high F for the period 2001-2004, but F in 2002 seems estimated too low.

Both SXSA and SMS assume constant catchability in the CPUE time series. In addition, SMS assumes constant catchability (or more correctly, constant exploitation pattern) for the F-model and catch data. CPUE time series are however, subset of the total international catch data and changes in the exploitation pattern will violate the assumption of constant catchability for the CPUE time series. Said in another way; if exploitation pattern changes, the assumptions for both models are violated. The split of the CPUE time series into shorter time series and the assumption of two separable periods for SMS, as done by the assessments, is one way of making the exploitation pattern more uniform, but abrupt annual changes cannot be handle by either of the models.

It is difficult to judge whether the SXSA assumption that catch data are exact, or the SMS assumption that exploitation pattern are constant, violates the assumptions most. A look at the F values from SXSA (Table 13.1.4.7) shows a very variable exploitation pattern from year to year, and extreme F values for age 4. This indicates that there might be a considerable sampling uncertainty in the international catch at age data, which SMS might be better to handle.

SXSA was chosen for the final assessment, because the model is the default model for this stock and SXSA does not rely on the assumption of constant exploitation pattern in catch at age data.

The stock summary plot for SXSA run 02 is shown in Figure 13.1.4.19 and the assessment summary in Table 13.1.4.9. Partial fishing mortalities by each of the commercial tuning fleets are shown in Table 13.1.4.6 and annual fishing mortalities in Table 13.1.4.7. The stock number at age is given in Table 13.1.4.8.

13.1.5 Recruitment estimates

Recruitment indices used in previous sandeel assessments

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.

Provisional information about the 2005 year class

After the closure of the sandeel fishery in the EU zone 19th of July (see section 13.1.1.4 and 13.1.13) a monitoring fishery was allowed in order to collect information about the 2005 year class and to monitor any changes in the stock situation. In this fishery a limited effort was allowed for a small number of vessels (see section 13.1.13). However, both effort and landings in this monitoring fishery were on a low level. This may indicate that the 2005 year class is not a large year class.

The Danish Institute for Fisheries Research (DIFRES) will carry out a survey in December 2005, that may provide information about the size of the 2005 year class (see the text below).

Recruitment estimates used for short term forecasting

For the short term forecast (section 13.1.7) the 25th percentile, on 327 10^9 age-0 sandeels, of the long-term average recruitment was used as the recruitment in 2005 and 2006. This was used because recruitment has been low for the last 3 years.

Fisheries independent information on sandeel abundance

There is no fishery independent time series of sandeel abundance in the North Sea because the ICES co-ordinated surveys are not suited to measure densities of this species and because there are no other annual dedicated research sampling programmes for this species.

A range of surveys have been carried out by Danish, English, German, Norwegian and Scottish research institutes, but these field investigations have been targeted to answer specific questions about the biology in smaller localised areas, more than to investigate overall changes in sandeel abundance.

In recent years research has also been focused towards investigations of survey designs that may provide abundance indices of sandeels for the use of stock assessment if implemented in future large scale sampling programmes. Different sampling devises and approaches have been used, e.g. i) sampling of juvenile and adult sandeels from the water column using demersal and pelagic trawls and acoustic measuring techniques, ii) sampling of the pelagic life stages by use of different types of larval sampling devises, iii) sampling of post-settled fish from the seabed using different types of seabed sampling devises, demersal trawls and dredges. However, there has not been any systematic comparison of the different sampling approaches that can be used to evaluate the usability of the different approaches as a method for providing fisheries independent indices of sandeels for the use in stock assessment.

Three European fishery research institutes (FRS, DIFRES and CEFAS) have employed a modified scallop dredge to obtain estimates of relative density of sandeels in the sand for some specific areas and times. This sampling approach is useful because sandeels tend to lie dormant in the sediment during the night time and late autumn and winter. DIFRES has collected information about relative abundance and age/length distribution of post-settled sandeels on surveys since 1996 using this modified scallop dredge. Sampling has since 2003 been standardised according to sampling time and locations, in order to establish a time series of data that can be used as relative abundance estimates of post-settled sandeels. Sampling is carried out in the end of the year, when sandeels have commenced their winter dormancy period, and the catchability of the gear is supposed to be largest. Sampling is carried out at 28 fixed positions at known sandeel habitat situated at the most important fishing banks in the North Sea from the Little Fisher Bank in the North Eastern North Sea, to the Dogger Bank area in the south western North Sea. This survey has the potential to provide quantitative information about sandeel abundance and distribution.

Institute of Marine research (IMR) plan to conduct two surveys in 2006 to further develop methodology and to measure the abundance 1-group and older sandeels in April/May and the abundance of 0-group sandeels in August/September. During these surveys a multi-frequency echo-sounder (18, 38, 200 and 400kHz) and a commercial sandeel trawl is used to measure the abundance of sandeels in the free water-masses during daytime, and a Van Veen grab and two different dredgers are used to sample sandeels in the seabed during night. This survey approach was tested during a preliminary survey in April/May 2005.

13.1.6 Historic stock trends

The final assessment estimate SSB in 2004 to be historic low and under B_{lim}. 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 2000 and for the rest of the time series. Also in

1986 and from 1989 to 1991 SSB was on a low level, but SSB has previous to 2000 not been below B_{pa} for two succeeding years. The downward trends in SSB in recent years have occurred in spite of that the effort of the fleet has decreased during the same time period (see section 13.1.1.2 and 13.1.3).

The large 2001 year class did not lead to an increase in SSB in 2003. This year class was exposed to a high fishing mortality as 0-group in 2001 and as 1-group in 2002 (Table 13.1.4.6 and 13.1.4.7).

13.1.7 Short term prognosis

The high natural mortality of sandeel and the few year classes in the fishery make the stock size and catch opportunities largely dependent on the size of the incoming year classes.

Although recruits (age 0) usually have appeared in the second half years fishery at the time of the WG, the biological samples from this fishery are normally not available. Further, the 2005 fishing season was special because there was no fishery after 2nd July (see section 13.1.1.2 and 13.1.1.4). There is therefore no information in the 2005 catch data that can be used for the estimation of the 2005 year-class (see also section 13.1.13).

0-group CPUE is a poor predictor of recruitment (ICES C.M. 2003) why traditional deterministic forecasts are not considered appropriate. Therefore the working group has previously not provided short term forecasts.

Because of the critical state of the sandeel stock the working group did provide an indicative short term prognosis during the working group meeting in 2004, using a range of scenarios for the recruitment and exploitation pattern in 2004.

Prognosis for 2006 and 2007

This year a new short term prognosis was made. The prediction was made using half year time steps.

In the absence of information about the recruitment a low recruitment was assumed for 2005 and 2006. This was chosen because the last 3 years recruitments have been low. Recruitment in 2005 and 2006 was assumed to be 327 10^9, which is the 25th percentile of the long-term average recruitment. Stock and catch weights for the second half year of 2005 and for 2006 were taken as averages of half year values of 2003-2004. Stock numbers at 1^{st} of January 2005 were taken from the final SXSA assessment. Fs-at-age for the forecasts were taken as the average exploitation pattern for 2003-2004, scaled to F_{1-2} in 2004. 2004 first half year Fsq=0.454 and 2004 second half year Fsq=0.148.

Low recruitment (25th percentile of time-series recruitment) was used for 2005 and 2006

Basis: F(2006) =F(2004) scaled over 2003 and 2004; SSB(2006) = 446,000 t; landings (2005) = 167,000 t

Rationale	Relative effort F(2006)/F(2004)	Basis	F(2006)	Landings(2006) `000 t	SSB(2007) `000 t
Zero catch	0	F=0	0.000	0	718
Status quo	0.1	Fsq*0.1	0.060	56	673
	0.2	Fsq*0.2	0.120	109	632
	0.3	Fsq*0.3	0.180	160	593
	0.4	Fsq*0.4	0.241	207	557
	0.5	Fsq*0.5	0.301	252	523
	0.6	Fsq*0.6	0.361	294	492
	0.7	Fsq*0.7	0.421	334	462
	0.8	Fsq*0.8	0.481	372	434
	0.9	Fsq*0.9	0.541	408	408
	1.0	Fsq*1	0.602	442	384
	1.1	Fsq*1.1	0.662	475	361
	1.2	Fsq*1.2	0.722	506	339

Shaded scenarios are not considered consistent with the precautionary approach.

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

13.1.8 Medium term prognoses

Medium term prognoses can not be made for sandeels.

13.1.9 Biological reference points

B_{lim} be set at 430,000 t, the lowest observed SSB. The B_{pa} is estimated to 600,000 t. Further information about biological reference points for sandeels in IV can be found in the stock quality handbook (Q13).

13.1.10 Quality of the assessment

Implications for the assessment of recent changes in the fishery and stock situation

A change in the fishing pattern has implications for the sandeel assessment. In recent years, when the sandeel stock has been low, the fishery has fished as historically less important fishing grounds. The fishery data from the last year’s fishery may therefore represent other stock component of sandeels than the data from the years when the stock was on a higher level. The information in the tuning data, as well as in the biological data, from recent years might not be comparable to that from previous years. This is also indicated in the results of the exploratory assessments carried out by the WG this year.

The most appropriate solution to this problem would be to assess the different stock component separately. However, the demands to the data, regarding spatial and temporal resolution, for such analysis are presently not satisfied by the data available for stock assessment for sandeels in IV. The sampling level might also be to low to allow for an assessment based on the up to data knowledge about sandeel population structure, as information about age, length, weight and maturity would be required for each of the stocks that will have to be assessed.

Assumption in the assessment about constant catchability

The assessment of sandeels in IV is carried out without fisheries independent indices of sandeel abundance. The tuning fleets used in the assessment represent almost all landings of sandeels in the North Sea.

So far the only adjustment in fleet efficiency is linked to vessel horse power. Other factors such as better methods for detecting sandeel schools using multi-frequency echo-sounders and sonars, development in fishing gear to trawl on rougher bottom substrate, larger trawls and high precision positions systems for mapping bottom topography and to identify new trawling positions have not been adjusted for. If such improvements have resulted in substantial increased efficiency, the sandeel stock may have been decreasing over the years, whereas landings and CPUE have remained relatively high due to increased efficiency and exploitation of new areas.

Both SXSA and SMS assume constant catchability in the CPUE time series. A changes in efficiency will violate the assumption of constant catchability for the CPUE time series, and this is probably the reason for the tendency of underestimating fishing mortality and overestimating sandeel abundance in recent year. The split of the CPUE time series into shorter time series is a first step to take increase in efficiency into account.

It is difficult to judge whether the SXSA assumption that catch data are exact, or the SMS assumption that the exploitation pattern is constant, violates the assumptions most. A look at the F values from SXSA shows a very variable exploitation pattern from year to year, and extreme F values for age 4. This indicates that there might be a considerable sampling uncertainty in the international catch at age data, which SMS might be better to handle. High level exploitation pattern estimated by the SXSA indicate that various stock components dominate from year to year.

13.1.11 State of the stock

SSB in 2004 is estimated to be historic low and under B_{lim} and below B_{pa} from 2000 and for the rest of the time series. Previous to 2000 SSB has not been below B_{pa} for two succeeding years.

SSB in 2007 is entirely dependent on the size of the 2005 year class. SSB is in the short term prognosis estimated to 446,000 t, just above B_{lim}, in 2006.

13.1.12 Management considerations

No fishing mortality (F) reference points are given for sandeels in the North Sea because there is only a weak correlation between the size of the spawning stock biomass and the recruitment. The recruitment of sandeels seems more linked to environmental factors than to the size of the spawning stock biomass (Arnott and Ruxton 2002).

Schooling fish like sandeels are particularly vulnerable to overexploitation because they may be caught efficiently at low stock densities (e.g. Ulltang 1980). For the same reason, commercial tuning data is likely to overestimate the stock size at low densities (e.g. Pope 1980).

Implications of the stock situation for management of the 2006 sandeel fishery

A drastic change in the stock situation of sandeels in IV seemed to have occurred from 2003, and onwards. The change in 2003 came from a historic low recruitment in 2002. Further, there is no information to suggest an improvement in the stock situation.

Presently there is no information about the size of the 2005 year class. However, a survey will be carried out in at the end of 2005 that will provide more information about the size of this year class. If the 2005 year class is determined to be low, then a very limited fishery could be allowed in 2006. The short term prognosis, based on the assumption of a low recruitment in 2005, showed that a limited fishing effort (20% of 2004) could be allowed in 2006 which would result in SSB in 2007 being above Bpa. If the survey indicates that the 2005 year class is at least about average then real time monitoring of a fishery in 2006 could be implemented. The monitoring would serve to provide a more accurate estimate of the size of the 2005 year class and enable more effective management of the fishery. It is, however, paramount that the harvest control rules are enforced expediently. In 2005 the fishery was closed when the main sandeel season was over, despite the recommendation from STECF to close the fishery in the middle of May.

Risk of local depletion

The low stock size increases the risk of local depletion. There is therefore a need to monitor the stock situation and hence the fishery on a finer spatial scale. Access to VMS data is a prerequisite for this.

Changes in the fleet composition

There has been a 50% decline in the number of vessels fishing sandeels from 2004 to 2005. This decline in the fleet is expected to continue in the future.

The Danish fishing industry has proposed effort limitations and closed seasons for the 2006 sandeel fishery.

13.1.13 Real time management of sandeels in the North Sea in 2005

Real time management (see ICES 2005a, STECF 2005b) was carried out in 2005, in order to estimate the size of the 2004 year class, as the regulation of the fishery in 2005 was based on the size of this year-class.

In 2005 the STECF Sandeel Fisheries *ad hoc* working group improved the method used to estimate the size of the 2004 year class, in order to identify small year-classes.

The 2005 fishery was very unusual because a very low effort and CPUE was observed in the start of the fishing season (Figures 13.1.13.1 and 13.1.13.2). Total sandeel landings in April 2005 were 4500t, which is 5% of the average April landing for the period 1996-2004 or 10% of the landings in April 2003 and 2004. However from week 17 to 18 a sharp increase in CPUE and from 18 to 19 a sharp increase in effort is observed in the Danish sandeel fishery (Figure 13.1.13.1), indicating that the start of the fishing season in 2005 was delayed for about 3 weeks, compared to previous years.

The STECF *ad hoc* working group produced an abundance estimates based on cumulated data using the agreed methodology. Using data up to week 17, the abundance of the 2004 year-class was estimated to be at 150,000 million individuals at age 0 (Figure 13.1.13.3). Weekly estimates of the 2004 year class were afterwards estimated on a weekly basis, using data up to week 21 (figure 13.1.13.3). The weekly estimate of the 0-group numbers increased since week 16. Using data including week 21 gave an estimate of the 2004 year class at 304,000 million (Figure 13.1.13.3). This estimate is close to that of the final assessment, presented this year, on 324,031 million.

The change in fishing pattern observed in 2005 makes the estimate of the 2004 year class very uncertain. Total effort in April 2005 was much lower than that observed for the historical year range the method is based on. In addition, the temporal distribution of effort in April has not been seen in the previous years. Therefore, there is both a high sampling variance and a potential model error on the estimate of the 2004 year-class using the method described by STECF (2005a). It was therefore not possible to classify the 2004 year-class as being below or above the 300 000 million threshold using real time monitoring in 2005.

A short term deterministic age-structured projection model was constructed by the STECF Sandeel Fisheries *ad hoc* working group, in order to evaluate the EU harvest control rules (EU HCR) used in the real time monitoring of sandeels (STECF 2005a). In addition to the EU HCR an alternative model was also considered which took account of biological reference points and TAC constraints. The results of this analysis showed that the EU HCR was largely incompatible with achieving Bpa in 2006 particularly at low to mid range recruitment.

A more detailed description of the real time monitoring in 2005 in given in the document:

Real time management in 2005 - annex to section 13 of WGNSSK 2005 report.doc
This document can be found at the ICES network in the folder where text of the sandeel section of the 2005 WGNSSK 2005 report is stored.

Table 13.1.1.1 Sandeel in IV. Effort of Danish vessels (kilo watt days * 10^3) and number of Danish and Norwegian vessels participating I the sandeel fishery in the North Sea by year.

	Denmark		Norway
Year	**Kilo watt days (thousands)**	**Number of vessels**	**Number of vessels**
2002	7.867	207	53
2003	7.306	166	35
2004	7.334	200	40
27. June 2005	2.838	96	22

Table 13.1.1.2. Sandeel in IV. Official landings reported to ICES

SANDEELS IVa

Country	1997	1998	1999	2000	2001	2002	2003	2004
Denmark	26.498	23.138	3.388	4.742	1.058	111	399	N/A
Faroe Islands	11.221	11.000	6.582					N/A
Norway	98.386	172.887	44.620	11.522*	4.121*	185*	280*	N/A
Sweden	-	55	495	55	-	-	73	N/A
UK (E/W/NI)	-	-	-	-	-	-	-	N/A
UK (Scotland)	3.463	5.742	4.195	4.781	970	543	186	N/A
Total	139.568	212.822	59.280	21.100	6.149	839	938	

*Preliminary.

SANDEELS IVb

Country	1997	1998	1999	2000	2001	2002	2003	2004
Denmark	731.184	603.491	503.572	533.905	638.657	627.097	245.096	N/A
Faroe Islands	-	-	-					N/A
Germany	-	-	-	-	-	-	534	N/A
Ireland	-	-	389	-	-	-		N/A
Norway	252.177	170.737	142.969	107.493*	183.329*	175.799*	29.336*	N/A
Sweden	-	8.465	21.920	27.867	47.080	36.842	21.444	N/A
UK (E/W/NI)	2.575	-	-	-	-	-	-	N/A
UK (Scotland)	20.554	18.008	7.280	5.978	-	2.442	115	N/A
Total	1.006.490	800.701	676.130	675243	869066	842180	296525	

*Preliminary.

SANDEELS IVc

Country	1997	1998	1999	2000	2001	2002	2003	2004
Denmark	3.163	9.674	10.356	11.993	7.177	4.996	28.646	N/A
France	-	-	-	1	-	-	-*	N/A
Netherlands	-	+	+	-	-	+	-*	N/A
Sweden	-	-	-	-	-	-	160	N/A
UK (E/W/NI)	-	-	-	+	-	-	+	N/A
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	2004
Total IV tonnes	1.149.221	1.023.197	745.766	708.337	882.392	848.015	326.269	372.343
TAC		1.000.000	1.000.000	1.020.000	1.020.000	1.020.000	918.000	826.200

By-catch and other landings

	1997	1998	1999	2000	2001	2002	2003	2004
Area IV tonnes: official-WG	11.439	18.797	10.628	9.188	20.781	37.315	00.849	N/A

Summary table - landing data provided by Working Group members

	1997	1998	1999	2000	2001	2002	2003	2004
Total IV - tonnes	1.137.782	1.004.400	735.138	699.149	861.611	810.700	325.420	361.600

Table 13.1.1.3 Sandeel in IV. Landings ('000 t), 1952-2004 (Data provided by Working Group members).

Year	Denmark	Germany	Faroes	Ireland	Netherlands	Norway	Sweden	UK	Total
1952	1,6	-	-	-	-	-	-	-	1,6
1953	4,5	+	-	-	-	-	-	-	4,5
1954	10,8	+	-	-	-	-	-	-	10,8
1955	37,6	+	-	-	-	-	-	-	37,6
1956	81,9	5,3	-	-	+	1,5	-	-	88,7
1957	73,3	25,5	-	-	3,7	3,2	-	-	105,7
1958	74,4	20,2	-	-	1,5	4,8	-	-	100,9
1959	77,1	17,4	-	-	5,1	8,0	-	-	107,6
1960	100,8	7,7	-	-	+	12,1	-	-	120,6
1961	73,6	4,5	-	-	+	5,1	-	-	83,2
1962	97,4	1,4	-	-	-	10,5	-	-	109,3
1963	134,4	16,4	-	-	-	11,5	-	-	162,3
1964	104,7	12,9	-	-	-	10,4	-	-	128,0
1965	123,6	2,1	-	-	-	4,9	-	-	130,6
1966	138,5	4,4	-	-	-	0,2	-	-	143,1
1967	187,4	0,3	-	-	-	1,0	-	-	188,7
1968	193,6	+	-	-	-	0,1	-	-	193,7
1969	112,8	+	-	-	-	-	-	0,5	113,3
1970	187,8	+	-	-	-	+	-	3,6	191,4
1971	371,6	0,1	-	-	-	2,1	-	8,3	382,1
1972	329,0	+	-	-	-	18,6	8,8	2,1	358,5
1973	273,0	-	1,4	-	-	17,2	1,1	4,2	296,9
1974	424,1	-	6,4	-	-	78,6	0,2	15,5	524,8
1975	355,6	-	4,9	-	-	54,0	0,1	13,6	428,2
1976	424,7	-	-	-	-	44,2	-	18,7	487,6
1977	664,3	-	11,4	-	-	78,7	5,7	25,5	785,6
1978	647,5	-	12,1	-	-	93,5	1,2	32,5	786,8
1979	449,8	-	13,2	-	-	101,4	-	13,4	577,8
1980	542,2	-	7,2	-	-	144,8	-	34,3	728,5
1981	464,4	-	4,9	-	-	52,6	-	46,7	568,6
1982	506,9	-	4,9	-	-	46,5	0,4	52,2	610,9
1983	485,1	-	2,0	-	-	12,2	0,2	37,0	536,5
1984	596,3	-	11,3	-	-	28,3	-	32,6	668,5
1985	587,6	-	3,9	-	-	13,1	-	17,2	621,8
1986	752,5	-	1,2	-	-	82,1	-	12,0	847,8
1987	605,4	-	18,6	-	-	193,4	-	7,2	824,6
1988	686,4	-	15,5	-	-	185,1	-	5,8	892,8
1989	824,4	-	16,6	-	-	186,8	-	11,5	1039,1
1990	496,0	-	2,2	-	0,3	88,9	-	3,9	591,3
1991	701,4	-	11,2	-	-	128,8	-	1,2	842,6
1992	751,1	-	9,1	-	-	89,3	0,5	4,9	854,9
1993	482,2	-	-	-	-	95,5	-	1,5	579,2
1994	603,5	-	10,3	-	-	165,8	-	5,9	785,5
1995	647,8	-	-	-	-	263,4	-	6,7	917,9
1996	601,6	-	5,0	-	-	160,7	-	9,7	776,9
1997	751,9	-	11,2	-	-	350,1	-	24,6	1137,8
1998	617,8	-	11,0	-	+	343,3	8,5	23,8	1004,4
1999	500,1	-	13,2	0,4	+	187,6	22,4	11,5	735,1
2000	541,0	-	-	-	+	119,0	28,4	10,8	699,1
2001	630,8	-	-	-	-	183,0	46,5	1,3	861,6
2002	629,7	-	-	-	-	176,0	0,1	4,9	810,7
2003	274,0	-	-	-	-	29,6	21,5	0,5	325,6
2004	277,1	2,7	-	-	-	48,5	33,2	+	361,5

+ = less than half unit.

- = no information or no catch.

Table 13.1.1.4. 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
2004												
Feb	0	0	0	0	0	0	0	0	0	7		7
Mar	326	0	0	1001		0	37		260	2		1626
Apr	15893	627	0	15824	4847	0	10732	471	322	834		49550
May	46631	1044	0	21607	5495	0	22629	20484	233	8578		126701
Jun	21841	146	0	5077	1800	0	13821	13680	4789	35909		97063
Jul	1146	116		813	2272		6019	7430	1184	12923		31903
Aug	325			3963	5449		2589			3357		15683
Sept					3006		116			2		3124
Oct												
Total	86162	1933	0	48285	22869	0	55943	42065	6788	61612	0	325657
%	26%	1%	0%	15%	7%	0%	17%	13%	2%	19%	0%	100%
Average 1994-2004												
	37%	2%	0%	21%	18%	0%	10%	4%	1%	7%	0%	100%
2005*												
Apr	4017			71	1476		462	144		57		6227
May	34506	57		9536	7512		6507	13333	30	1549		73030
Jun	19216	21		8952	2545		8107	8224	17956	14111		79132
Total	57739	78	0	18559	11533	0	15076	21701	17986	15717	0	158389
%	36%	0%	0%	12%	7%	0%	10%	14%	11%	10%	0%	100%

*) Only landings by Denmark and Norway

Table 13.1.1.5. Sandeel in IV. Annual landings ('000 t) by area of the North Sea.
Data provided by Working Group members (Denmark, Norway and Scotland).

	Area										Sampling area		
Year	1A	1B	1C	2A	2B	2C	3	4	5	6	Shetland	Northern	Southern
1972	98,8	28,1	3,9	24,5	85,1	0,0	13,5	58,3	6,7	28,0	0	130,6	216,3
1973	59,3	37,1	1,2	16,4	60,6	0,0	8,7	37,4	9,6	59,7	0	107,6	182,4
1974	50,4	178,0	1,7	2,2	177,9	0,0	29,0	27,4	11,7	25,4	7,4	386,6	117,1
1975	70,0	38,2	17,8	12,2	154,7	4,8	38,2	42,8	12,3	19,2	12,9	253,7	156,5
1976	154,0	3,5	39,7	71,8	38,5	3,1	50,2	59,2	8,9	36,7	20,2	135,0	330,6
1977	171,9	34,0	62,0	154,1	179,7	1,3	71,4	28,0	13,0	25,3	21,5	348,4	392,3
1978	159,7	--50.2--		346,5	--70.3--		42,5	37,4	6,4	27,2	28,1	163,0	577,2
1979	194,5	0,9	61,0	32,3	27,0	72,3	34,1	79,4	5,4	44,3	13,4	195,3	355,9
1980	215,1	3,3	119,3	89,5	52,4	27,0	90,0	30,8	8,7	57,1	25,4	292	401,2
1981	105,2	0,1	42,8	151,9	11,7	23,9	59,6	63,4	13,3	45,1	46,7	138,1	378,9
1982	189,8	5,4	4,4	132,1	24,9	2,3	37,4	75,7	6,9	74,7	52,0	74,4	479,2
1983	197,4	-	2,8	59,4	17,7	-	57,7	87,6	8,0	66,0	37,0	78,2	419,0
1984	337,8	4,1	5,9	74,9	30,4	0,1	51,3	56,0	3,9	60,2	32,6	91,8	532,8
1985	281,4	46,9	2,8	82,3	7,1	0,1	29,9	46,6	18,7	84,5	17,2	79,7	513,5
1986	295,2	35,7	8,5	55,3	244,1	2,0	84,8	22,5	4,0	80,3	14,0	375,1	457,4
1987	275,1	63,6	1,1	53,5	325,2	0,4	5,6	21,4	7,7	45,1	7,2	395,9	402,8
1988	291,1	58,4	2,0	47,0	256,5	0,3	37,6	35,3	12,0	102,2	4,7	384,8	487,6
1989	228,3	31,0	0,5	167,9	334,1	1,5	125,3	30,5	4,5	95,1	3,5	492,4	526,3
1990	141,4	1,4	0,1	80,4	156,4	0,6	61,0	45,5	13,8	85,5	2,3	219,5	366,7
1991	228,2	7,1	0,7	114,0	252,8	1,8	110,5	22,6	1,0	93,1	+	372,9	458,9
1992	422,4	3,9	4,2	168,9	67,1	0,3	101,2	20,1	2,8	54,4	0	176,7	668,6
1993	196,5	21,9	0,1	26,2	164,9	0,3	88,0	26,6	3,9	48,7	0	276,0	301,9
1994	157,0	108,6	-	61,7	203,4	2,7	175,0	16,0	2,8	42,0	0	489,7	279,5
1995	322,4	43,9	147,4	86,7	169,5	1,0	59,4	26,6	5,3	55,8	1,3	421,2	496,8
1996	310,5	18,6	31,2	40,8	153,0	4,5	134,1	12,7	3,0	52,5	1	341,2	419,5
1997	352,0	53,3	8,9	92,8	390,5	1,2	112,9	18,1	4,7	88,6	2,4	566,8	535,8
1998	282,2	58,3	2,0	90,3	395,3	1,0	40,6	34,5	4,2	63,4	5,2	497,2	480,7
1999	266,7	32,6	0,1	132,8	167,9	0,0	48,0	16,9	2,7	27,2	4,2	248,7	446,4
2000	226,1	29,2	0,0	87,2	139,9	0,3	111,7	20,4	8,3	43,3	4,3	281,0	385,4
2001	239,9	13,0	1,6	263,0	177,9	0,1	49,6	12,4	7,3	49,0	1,3	242,2	571,6
2002	403,6	5,2	0,0	177,0	110,9	0,0	64,9	13,6	3,0	31,3	0,5	181,0	628,4
2003	106,9	7,2	0,1	43,6	24,5	0,0	30,0	35,0	16,2	40,0	0,5	61,8	241,7
2004	86,2	1,9		48,3	22,9		55,9	42,1	6,8	61,6		80,7	245,0

Sampling areas: Northern - Areas 1B, 1C, 2B, 2C, 3.
Southern - Areas 1A, 2A, 4, 5, 6.

Table 13.1.1.6. Sandeel in IV. Monthly landings (t) by Denmark, Norway and Scotland (Data provided by Working Group members).

Year	Month	Denmark	Norway	Scotland	Total
1999	Mar	6.851	8.496	479	15.826
	Apr	115.596	24.149	1.854	141.599
	May	202.813	56.961	6.578	266.352
	Jun	97.284	14.478	434	112.197
	Jul	49.333	13.245	0	62.578
	Aug	19.044	27.823	2.043	48.910
	Sept	6.217	26.366	88	32.672
	Oct	2.567	15.738	0	18.305
	Nov	405	332		737
	Total	500.110	187.589	11.476	699.175
2000	Mar	7.524	3.325	687	11.536
	Apr	126.644	44.879	1.436	172.959
	May	195.866	48.292	6.400	250.558
	Jun	150.394	20.089	1.677	172.160
	Jul	60.126	1.923		62.049
	Aug	247	113	560	921
	Sept	184	393		577
	Oct	3			3
	Total	540.988	119.015	10.759	670.763
2001	Mar	10.684	1.481	144	12.310
	Apr	95.723	14.922	295	110.940
	May	183.757	31.231	589	215.577
	Jun	127.292	10.124	0	137.416
	Jul	106.654	18.403	0	125.057
	Aug	65.021	60.192	236	125.449
	Sep	33.741	32.583	0	66.324
	Oct	7.910	14.054	0	21.963
	Nov	30	0	0	30
	Total	630.811	182.991	1.264	815.066
2002	Mar	10.236	717	0	10.953
	Apr	177.597	63.083	109	240.789
	May	247.494	86.942	2.898	337.334
	Jun	174.467	24.568	1.448	200.483
	Jul	14.228	48	0	14.276
	Aug	5.652	261	422	6.335
	Sep	0	364	0	364
	Oct	3	0	0	3
	Dec	2	0	0	2
	Total	629.679	175.983	4.877	810.539
2003	Mar	2.802	231		3.033
	Apr	42.885	8.003	366	51.254
	May	96.105	10.401		106.506
	Jun	80.271	1.817		82.088
	Jul	27.784	1.186		28.970
	Aug	15.782	6.422	121	22.325
	Sep	4.407	1.555		5.962
	Oct	1.831	0		1.831
	Nov	2.070	0		2.070
	Dec	45	0		45
	Total	273.982	29.615	487	304.084
2004	Feb	7	0		7
	Mar	1.444	183		1.627
	Apr	42.664	6.886		49.550
	May	100.715	25.986	29	126.730
	Jun	89.369	7.695		97.064
	Aug	30.485	1.419		31.904
	Sep	12.191	3.492		15.683
	Oct	254	2.869		3.123
	Total	277.129	48.530	29	325.688
2005	Apr	4.350	1.876	*	6.226
	May	60.473	12.556	*	73.029
	Jun	76.234	2.900	*	79.134
	Total	141.057	17.332	0	158.389

* 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		2005
Season	1	2	1	2	1	2	1	2	1
AGE									
0	*	46385.	*	0.	*	7510.	*	2961.	*
1	6434.	771.	21719.	157.	2315.	118.	6819.	656.	2459.
2	2408.	73.	2649.	6.	1305.	164.	542.	9.	397.
3	472.	134.	402.	0.	456.	0.	375.	11.	94.
4+	1035.	0.	219.	0.	635.	0.	213.	0.	48.
SOP	88280.	153698.	*********	1263.	51447.	29772.	59588.	19555.	26638.

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		2005
Season	1	2	1	2	1	2	1	2	1
AGE									
0	*	73443.	*	0.	*	5320.	*	2383.	*
1	64084.	819.	84858.	1370.	4982.	922.	33909.	1637.	14444.
2	13531.	15.	8667.	472.	15588.	452.	1113.	473.	4745.
3	1158.	0.	1060.	0.	3593.	163.	4302.	405.	284.
4+	2389.	0.	250.	0.	1204.	28.	270.	68.	400.
SOP	432330.	184311.	608649.	17428.	197210.	31295.	249398.	30821.	131442.

Table 13.1.2.2 Sandeel in IV. Catch numbers at age (numbers · 10^{-6}) by year.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
age 0	0	12289	7217	753	13196	3381	12704	25731	6931	27798	457
age 1	84839	12483	79990	39450	13487	106762	36388	74190	74159	21390	58109
age 2	4116	46061	10699	40488	36570	7183	21396	11938	14462	18359	11353
age 3	14044	5815	2045	1704	21436	4377	3167	2347	1645	5030	9202
age 4+	490	1054	48	371	2880	3491	956	775	960	1767	3032
Total	103490	77702	99999	82766	87569	125194	74611	114981	98157	74344	82153

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
age 0	4046	33906	2629	36362	34975	6659	119828	0	12829	5344
age 1	82363	25454	145980	26956	34965	62568	72108	108104	8337	43022
age 2	13094	27252	8457	77278	10598	15363	16026	11794	17509	2136
age 3	2979	7836	8090	5515	19685	3608	1764	1461	4212	5094
age 4+	1530	2548	2027	2736	2136	5373	3424	469	1867	551
Total	104012	96995	167183	148847	102359	93571	213151	121829	44754	56147

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
2001	0	1,89	2,48	1,62	3,28	1,68	3,10
	1	5,48	9,73	7,21	9,07	6,29	9,61
	2	10,10	17,00	15,63	17,61	11,78	17,50
	3	11,55	-	19,81	9,07	15,82	9,07
	4	13,09	-	25,45	-	-	-
	5	16,93	-	-	-	-	-
	5+			8,03			
	6	21,04	-	-	-	-	-
	4++	15,20	-	9,18	-	11,58	-
2002	0	-	-	1,77	-	1,77	-
	1	4,89	7,33	7,65	-	6,17	7,33
	2	9,05	17,52	12,17	-	11,77	17,52
	3	23,36	-	18,27	-	18,40	-
	4	25,29	-	-	-	-	-
	5	-	-		-	-	-
	5+						
	6	26,42	-	-	-		
	4++	26,08	-	32,12	-	31,98	-
2003	0	2,26	3,56		2,82	2,26	3,37
	1	5,34	15,74	5,23	12,13	5,30	13,00
	2	13,03	17,90	15,72		14,70	17,90
	3	11,86		20,57		17,81	
	4	14,47				14,47	
	5	17,24				17,24	
	5+						
	6						
	4++	14,82		29,93		18,69	
2004	0		3,76	1,73	3,46	1,73	3,56
	1	6,07	13,13	7,36		6,27	13,13
	2	11,10		10,07	21,42	10,64	21,42
	3	11,23	18,50	15,78		13,40	18,50
	4	25,01				25,01	
	5	33,17				33,17	
	5+						
	6						
	4++	30,69		27,53		28,39	
2005	0	1,00				1,00	
	1	7,36		7,56		7,43	
	2	15,44		14,28		14,42	
	3	17,16		15,99		16,06	
	4	22,56				22,56	
	5	33,00				33,00	
	5+						
	6						
	4++	23,41		23,94		23,90	

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
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	2,65
	1	5,25	7,47
	2	7,86	15,72
	3	9,33	17,30
	4	11,65	13,80
	5	15,27	-
	6	24,43	-
	7	15,05	-
	8+	15,90	-
	4++	12,47	13,80
2004	0		2,60
	1	5,49	7,35
	2	10,49	13,31
	3	11,34	13,37
	4	10,27	12,97
	5		
	6		
	7		
	8+		
	4++	10,27	12,97
2005	0	2,46	-
	1	5,54	-
	2	9,19	-
	3	10,73	-
	4	11,93	-
	5	13,63	-
	6	14,35	-
	7	12,67	-
	8+		-
	4++	12,18	-

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	5,30	14,70	17,81	18,69
2004	6,27	10,64	13,40	28,39
2005	7,43	14,42	16,06	23,90

Northern North Sea, second half-year

year	age-0	age-1	age-2	age-3	age-4+
1983	3,03	13,23	27,84	36,20	
1984	3,03	13,23	27,84	36,20	
1985	3,03	13,23	27,84	36,20	51,91
1986	3,03	13,23	27,84	36,20	
1987	3,03	13,23	27,84	36,20	
1988	3,03	13,23	27,84	36,20	44,00
1989	5,00	8,90	16,00		
1990	3,03	13,23	27,84	36,20	44,00
1991	3,42	9,57	14,99	16,20	44,00
1992	5,48	18,03	25,40	21,56	
1993	2,71	10,37	19,22	20,28	21,37
1994	6,58	22,75	30,20	58,07	72,15
1995	5,08	13,46	14,20	21,00	19,00
1996	2,94	10,85	14,92	15,59	23,58
1997	1,71	8,11	10,15	23,96	17,19
1998	2,48	3,91	11,13	20,15	13,39
1999	3,07	7,78	10,43	24,15	
2000		14,92	17,95	19,18	22,67
2001	3,10	9,61	17,50	9,07	
2002		7,33	17,52		
2003	3,37	13,00	17,90		
2004	3,56	13,13	21,42	18,5	

Southern North Sea, first half-year

year	age-1	age-2	age-3	age-4+
1983	5,51	9,96	13,74	16,90
1984	5,51	9,96	13,74	16,95
1985	5,51	9,96	13,74	16,51
1986	5,51	9,96	13,74	16,30
1987	5,80	11,00	15,60	18,04
1988	4,00	12,50	15,50	18,73
1989	4,00	12,50	15,50	18,01
1990	4,00	12,50	15,50	19,28
1991	8,20	16,40	16,90	17,20
1992	7,43	13,83	17,51	22,60
1993	6,08	11,54	15,09	20,31
1994	6,07	11,01	13,46	16,94
1995	7,30	13,20	16,60	20,48
1996	5,57	8,31	13,16	16,89
1997	6,52	10,92	11,81	16,27
1998	5,54	8,38	10,64	13,21
1999	5,52	9,27	13,50	18,33
2000	6,16	9,56	14,42	15,93
2001	4,22	7,93	12,57	16,76
2002	6,14	8,10	12,49	16,73
2003	5,25	7,86	9,33	12,47
2004	5,49	10,49	11,34	10,27
2005	5,54	9,17	10,73	12,18

Southern North Sea, second half-year

year	age-0	age-1	age-2	age-3	age-4+
1983	2,42	7,50	10,75	14,12	17,71
1984	2,42	7,50	10,75	14,12	17,71
1985	2,42	7,50	10,75	14,12	18,66
1986	2,42	7,50	10,75	14,12	18,76
1987	1,30	8,90	10,80	21,40	19,85
1988	1,00	10,50	14,00	17,00	19,11
1989	1,00	10,50	14,00	17,00	19,01
1990	1,00	10,50	14,00	17,00	20,05
1991	2,60	7,50	13,60	12,00	
1992	3,40	9,43	16,61	20,04	22,58
1993	3,08	10,13	15,66	17,04	21,96
1994		8,56	17,16	19,50	23,74
1995		6,60	13,60	17,70	21,22
1996	2,34	9,90	16,66	21,77	33,39
1997	4,72	7,99	13,54	14,73	18,88
1998	2,79	3,01	12,65	11,57	17,14
1999	5,42	10,02	11,05	16,85	15,68
2000	1,66	6,61	13,68	15,74	18,34
2001	2,40	9,51	17,00		
2002		8,40	12,53		
2003	2,65	7,47	15,72	17,30	13,80
2004	2,6	7,35	13,31	13,37	12,97

Table 13.1.2.6 Sandeel in IV. Mean weight (g) in the catch by year.

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Age-0	0,0027	0,0000	0,0024	0,0030	0,0024	0,0030	0,0050	0,0029	0,0030	0,0054	0,0027
age-1	0,0059	0,0059	0,0059	0,0064	0,0070	0,0061	0,0055	0,0053	0,0077	0,0073	0,0064
age-2	0,0103	0,0117	0,0103	0,0115	0,0116	0,0130	0,0131	0,0129	0,0159	0,0131	0,0131
age-3	0,0149	0,0140	0,0166	0,0151	0,0187	0,0165	0,0161	0,0180	0,0188	0,0180	0,0172
age-4+	0,0177	0,0173	0,0297	0,0172	0,0291	0,0191	0,0181	0,0243	0,0229	0,0249	0,0211

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Age-0	0,0066	0,0051	0,0029	0,0019	0,0025	0,0032	0,0017	0,0027	0,0000	0,0031	0,0031
age-1	0,0067	0,0074	0,0073	0,0061	0,0045	0,0057	0,0065	0,0045	0,0062	0,0056	0,0058
age-2	0,0149	0,0150	0,0113	0,0098	0,0087	0,0090	0,0088	0,0086	0,0091	0,0087	0,0112
age-3	0,0166	0,0198	0,0150	0,0120	0,0121	0,0137	0,0136	0,0132	0,0141	0,0106	0,0117
age-4+	0,0194	0,0210	0,0261	0,0214	0,0164	0,0216	0,0172	0,0152	0,0239	0,0146	0,0176

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	8,39	10,29	14,62
2004	5,62	10,54	11,51	18,25
2005	5,82	9,57	12,06	13,43

Second half-year

Year	age-0	age-1	age-2	age-3	age-4+
1983	1,11	11,83	14,73	19,14	24,35
1984	1,19	10,58	16,58	19,54	21,90
1985	1,19	10,69	14,65	22,49	24,95
1986	1,72	10,64	14,75	17,96	30,44
1987	1,43	11,18	14,29	17,26	20,91
1988	1,44	10,81	18,07	17,19	20,61
1989	1,28	10,76	15,80	17,05	19,39
1990	1,36	10,72	15,51	19,37	19,95
1991	1,10	10,67	15,49	18,02	19,39
1992	1,54	10,57	14,85	18,67	20,44
1993	1,44	10,91	14,25	17,61	20,49
1994	6,58	10,95	27,46	45,24	31,15
1995	5,08	10,14	13,66	17,96	21,19
1996	2,90	10,33	16,13	20,52	32,88
1997	1,94	8,04	11,70	15,27	18,86
1998	2,49	3,84	12,03	13,92	17,11
1999	3,15	8,29	10,49	17,14	15,68
2000	1,66	7,56	14,29	15,96	18,87
2001	2,67	9,56	17,42	9,07	
2002		8,29	12,60		
2003	3,07	8,10	16,30	17,30	13,80
2004	3,13	9	13,46	13,51	12,97

Table 13.1.2.8 Sandeel in IV. Mean weight (kg) in the stock by year

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
age-0	0,0010	0,0010	0,0010	0,0010	0,0010	0,0010	0,0010	0,0010	0,0010	0,0010	0,0010
age-1	0,0050	0,0041	0,0042	0,0042	0,0047	0,0044	0,0044	0,0043	0,0043	0,0041	0,0045
age-2	0,0129	0,0138	0,0128	0,0131	0,0128	0,0148	0,0135	0,0133	0,0132	0,0131	0,0127
age-3	0,0169	0,0163	0,0188	0,0163	0,0160	0,0158	0,0196	0,0176	0,0170	0,0172	0,0164
age-4+	0,0248	0,0210	0,0221	0,0278	0,0212	0,0192	0,0183	0,0193	0,0207	0,0212	0,0213

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
age-0	0,0010	0,0010	0,0010	0,0010	0,0010	0,0010	0,0010	0,0010	0,0010	0,0010	0,0010
age-1	0,0063	0,0071	0,0068	0,0056	0,0050	0,0056	0,0064	0,0044	0,0061	0,0053	0,0056
age-2	0,0130	0,0154	0,0100	0,0094	0,0085	0,0089	0,0086	0,0085	0,0090	0,0084	0,0105
age-3	0,0146	0,0200	0,0145	0,0118	0,0120	0,0134	0,0133	0,0135	0,0141	0,0103	0,0115
age-4+	0,0187	0,0209	0,0211	0,0216	0,0163	0,0222	0,0170	0,0152	0,0239	0,0146	0,0183

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	250	322	291
2004	493	300	390	381
2005	361		394	

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	
2005	n/a (very low)		n/a (very low)	

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	28613	48	736771	15770	<0.0001	0,32
North	2	12761	48	280072	7149	<0.0001	0,27
South	1	59406	48	2069181	46530	<0.0001	0,34
South	2	18722	48	459717	12625	<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	31,17
1985	-0,17	0,72	39,12
1986	1,46	0,43	42,92
1987	1,34	0,49	51,71
1988	1,02	0,50	38,92
1989	0,97	0,49	35,07
1990	1,76	0,27	24,67
1991	1,03	0,50	38,91
1992	1,19	0,44	33,55
1993	1,00	0,47	33,55
1994	1,23	0,53	56,30
1995	1,21	0,49	44,68
1996	1,03	0,45	30,74
1997	1,50	0,46	50,90
1998	0,79	0,53	36,86
1999	0,95	0,48	32,94
2000	0,80	0,55	40,62
2001	1,22	0,44	34,30
2002	1,04	0,52	44,84
2003	-0,46	0,61	15,96
2004	0,51	0,51	24,52
2005	1,29	0,39	28,15

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	48,57
1987	1,50	0,32	24,68
1988	1,51	0,35	29,39
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	28,37
1994	1,80	0,37	43,56
1995	1,96	0,35	44,85
1996	1,61	0,37	36,45
1997	1,30	0,38	27,36
1998	1,09	0,40	24,58
1999	1,16	0,42	29,26
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
2004	0,47	0,46	18,06

South Jan-Jun

Year	d^y	f^y	CPUE
1982	1,19	0,49	43,25
1983	0,63	0,58	41,03
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	0,60	0,58	38,52
1994	1,18	0,53	53,19
1995	0,89	0,59	56,74
1996	0,47	0,62	41,65
1997	1,15	0,57	64,14
1998	0,73	0,59	46,64
1999	1,26	0,46	40,64
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
2005	0,41	0,55	27,99

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	2,17	0,32	48,90
1995	2,06	0,36	51,97
1996	0,98	0,55	50,14
1997	1,35	0,45	41,10
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
2004	0,73	0,46	24,00

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)

	Norwegian			Danish			Total	Derived
Year	Standardized Fishing days	Catch sampled for fishing effort ('000t)	CPUE (t/day)	Catch sampled for fishing effort ('000 t)	CPUE (t/day)	Mean CPUE (t/day)	internat. catch ('000t)	internat. effort ('000 days)
First half-year								
1976	593	11,1	18,7	-	-	18,7	110,3	5,90
1977	2061	50,4	24,4	-	-	24,5	276,0	11,27
1978	1761	44,9	25,5	-	-	25,5	109,7	4,30
1979	1451	29,6	20,4	-	-	20,4	47,7	2,34
1980	2733	112,8	41,3	-	-	41,3	220,9	5,35
1981	1804	42,8	23,7	-	-	23,7	93,3	3,94
1982	1231	26,9	21,9	13,5	34,9	26,2	62,3	2,38
1983	338	8,7	25,7	17,4	28,9	27,8	54,5	1,96
1984	139	3,5	25,2	54,1	41,2	40,2	74,1	1,84
1985	382	8,7	22,8	47,4	46,7	43,0	69,9	1,63
1986	1565	60,4	38,6	154,1	54,7	50,2	221,3	4,41
1987	2219	122,9	55,4	214,4	51,8	53,1	360,9	6,80
1988	3600	143,8	39,9	158,6	39,0	39,5	332,0	8,41
1989	4211	146,9	34,9	247,0	35,1	35,0	435,2	12,43
1990	2299	58,6	25,5	89,7	24,7	25,0	148,7	5,94
1991	1748	67,7	38,7	198,4	39,0	39,0	282,2	7,24
1992	1214	53,7	44,2	106,7	33,6	37,1	151,2	4,07
1993	1565	70,7	45,2	138,2	33,6	37,5	189,0	5,04
1994	2707	130,1	48,1	289,0	56,4	53,8	413,4	7,68
1995	3429	208,6	60,8	146,4	44,7	54,2	348,5	6,43
1996	2036	100,9	49,6	101,8	30,8	40,1	203,1	5,06
1997	3489	254,9	73,1	190,0	50,9	63,6	456,5	7,18
1998	2622	220,8	84,2	125,8	37,1	67,1	364,8	5,44
1999	2217	77,4	34,9	47,5	32,9	34,2	137,2	4,02
2000	2328	104,5	44,9	154,7	40,6	42,3	271,1	6,40
2001	672	44,6	66,4	45,9	34,3	50,1	88,5	1,77
2002	1003	119,5	119,2	58,5	44,8	94,8	179,7	1,90
2003	914	17,1	18,7	15,3	16,0	17,41	53,8	3,09
2004	692	19,3	27,9	41,6	24,5	25,59	61,2	2,39
2005	469	13,8	29,4	13,7	28,2	28,78	26,7	0,93
Second half-year								
1976	108	2,0	18,5	-	-	18,5	44,9	2,43
1977	445	11,8	26,5	-	-	26,5	110,0	4,15
1978	811	22,5	27,6	-	-	27,8	53,3	1,92
1979	1688	52,2	30,9	-	-	30,9	147,7	4,78
1980	1117	33,1	29,6	-	-	29,5	71,1	2,41
1981	398	7,9	19,6	-	-	19,9	44,9	2,26
1982	-	-	-	1,8	32,3	33,0	12,0	0,36
1983	65	2,4	36,9	12,3	36,6	37,3	23,7	0,64
1984	-	-	-	10,7	29,6	30,2	17,7	0,59
1985	-	-	-	16,4	38,0	38,8	16,8	0,43
1986	555	21,8	39,3	96,1	60,2	57,4	153,8	2,68
1987	1586	68,1	42,9	3,1	24,7	42,1	76,9	1,83
1988	922	26,9	29,2	64,3	29,4	29,3	71,4	2,43
1989	590	11,5	19,5	44,9	25,6	24,4	57,2	2,35
1990	721	22,8	31,6	61,0	31,1	31,3	70,8	2,26
1991	943	30,3	32,1	72,0	38,7	36,8	90,7	2,47
1992	24	1,5	63,8	43,0	34,8	35,8	25,5	0,71
1993	972	30,7	31,6	59,1	28,4	29,5	87,0	2,95
1994	777	35,7	45,9	82,8	43,6	44,3	76,4	1,73
1995	1009	53,3	52,8	59,4	44,8	48,6	72,6	1,49
1996	749	42,9	57,3	93,9	36,5	43,0	140,7	3,27
1997	1542	95,7	62,1	22,9	27,5	55,4	121,5	2,19
1998	2257	114,4	50,7	35,5	24,6	44,5	148,5	3,34
1999	1665	77,8	46,7	37,8	29,3	41,0	125,2	3,05
2000	0	0,0	0,0	7,6	33,3	33,3	10,0	0,30
2001	1508	122,2	81,0	28,0	36,9	72,8	153,8	2,11
2002	0	0,7	0,0	0,5	10,6	4,5	1,3	0,29
2003	295	7,5	25,4	19,5	21,0	22,23	29,8	1,34
2004	404	7,8	19,3	6,3	18,1	18,76	19,6	1,04

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.

Year	First half year CPUE (t/day)	Total Int'l catch ('000 t)	Total int'l effort ('000 days)	Second half year CPUE (t/day)	Total Int'l catch ('000 t)	Total int'l effort ('000 days)
1982	48,2	427	8,85	35,7	53	1,47
1983	42,8	360	8,41	33,9	59	1,75
1984	50,5	461	9,13	32,9	71	2,16
1985	41,9	417	9,95	33,6	111	3,29
1986	53,7	386	7,20	44,1	76	1,71
1987	57,4	298	5,19	37,1	105	2,83
1988	46,7	462	9,89	30,2	33	1,11
1989	43,8	506	11,54	29,5	19	0,63
1990	31,0	342	11,03	35,6	24	0,67
1991	47,0	327	6,95	46,6	132	2,84
1992	54,9	621	11,31	36,2	73	2,02
1993	38,6	268	6,94	32,0	34	1,07
1994	53,4	226	4,24	48,9	48	0,97
1995	56,8	429	7,56	52,0	68	1,30
1996	41,6	294	7,05	50,1	139	2,77
1997	64,2	421	6,55	41,1	138	3,36
1998	46,6	448	9,61	26,2	43	1,64
1999	40,9	432	10,56	31,9	36	1,13
2000	43,1	360	8,36	33,4	53	1,59
2001	38,7	433	11,20	46,4	185	3,98
2002	62,2	609	9,79	22,4	19	0,86
2003	22,6	211	9,33	20,5	31	1,53
2004	25,2	250	9,91	24,0	31	1,30
2005	28,0	132	4,70			

Table 13.1.3.5 Sandeel in IV. Tuning fleets used in SXSA run 01. Total international standardised effort and catch at age in numbers (millions).

Year	Season	Area	Effort	a-0	a-1	a-2	a-3	a-4
1976	1	1	5,90	237	5697	1130	445	155
1976	2	1	2,40	6126	648	84	368	37
1977	1	1	11,30	3686	24307	2351	516	144
1977	2	1	4,20	3067	2856	913	142	141
1978	1	1	4,30	0	6127	2338	573	144
1978	2	1	1,90	7820	1001	307	39	2
1979	1	1	2,30	0	2335	1328	242	12
1979	2	1	4,80	44203	1310	433	66	10
1980	1	1	5,40	17	13394	8865	1050	827
1980	2	1	2,40	8349	1173	214	19	8
1981	1	1	3,90	17	5505	4109	904	174
1981	2	1	2,30	9128	346	94	14	6
1982	1	1	2,40	2	3518	2132	556	85
1982	2	1	0,40	6530	65	0	0	0
1983	1	1	2,00	0	5684	1215	89	12
1983	2	1	0,60	7911	303	316	19	0
1984	1	1	1,80	0	11692	1647	153	5
1984	2	1	0,60	0	1207	121	43	0
1985	1	1	1,60	1	2688	3292	1002	480
1985	2	1	0,40	349	109	239	89	11
1986	1	1	4,40	7	23934	2600	200	0
1986	2	1	2,70	7105	7077	473	0	0
1987	1	1	6,80	0	26236	10855	350	155
1987	2	1	1,83	455	5768	198	0	0
1988	1	1	8,41	2453	9855	25922	1319	26
1988	2	1	2,43	13196	1283	340	119	17
1989	1	1	12,43	6124	56661	2219	3385	0
1989	2	1	2,35	3380	4038	274	0	0
1990	1	1	5,94	0	13101	3907	578	175
1990	2	1	2,26	12107	1670	342	51	15
1991	1	1	7,24	0	41855	2342	908	318
1991	2	1	2,47	13616	866	28	8	3
1992	1	1	4,07	137	9871	4056	486	305
1992	2	1	0,71	6797	48	3	0	0
1993	1	1	5,04	1112	15768	2635	1023	646
1993	2	1	2,95	26960	1004	112	34	22
1994	1	1	7,68	398	28490	7225	5954	2156
1994	2	1	1,73	457	829	1211	396	25
1995	1	1	6,43	0	36140	3360	1091	145
1995	2	1	1,49	4046	3374	338	26	2
1996	1	1	5,06	0	11524	5385	761	301
1996	2	1	3,27	31817	1706	1772	136	55
1997	1	1	7,18	2434	67038	3640	5254	1206
1997	2	1	2,19	2431	11346	633	25	2
1998	1	1	5,44	2278	6667	33216	2039	410
1998	2	1	3,34	35220	10005	1837	79	1
1999	1	1	4,02	265	2118	3491	5086	1023
1999	2	1	3,05	33653	694	551	58	0
2000	1	1	6,40	0	22887	8810	1420	1470
2000	2	1	0,30	0	467	84	24	46
2001	1	1	1,77	87	6434	2408	472	1035
2001	2	1	2,11	46385	771	73	134	0
2002	1	1	1,90	12	21719	2649	402	219
2002	2	1	0,29	0	157	6	0	0
2003	1	1	3,09	599	2315	1305	456	635
2003	2	1	1,34	7510	118	164	0	0
2004	1	1	2,39	179	6819	542	375	213
2004	2	1	1,04	2961	656	9	11	0
2005	1	1	0,93	5	2459	397	94	48

Table 13.1.3.5 Continued

Year	Season	Area	Effort	a-0	a-1	a-2	a-3	a-4
1982	1	2	8,90	242	56545	6224	3277	1939
1982	2	2	1,50	5039	4718	490	344	40
1983	1	2	8,40	955	2232	35029	934	387
1983	2	2	1,80	9298	240	2806	513	2
1984	1	2	9,10	20	62517	2257	13272	442
1984	2	2	2,20	0	9423	92	577	44
1985	1	2	10,00	6573	7790	39301	2490	265
1985	2	2	3,30	11940	1896	3229	2234	298
1986	1	2	7,20	0	43629	7333	1604	30
1986	2	2	1,70	112	5350	293	241	18
1987	1	2	5,19	0	4351	22771	1158	165
1987	2	2	2,83	298	3095	6664	196	51
1988	1	2	9,89	1420	2349	10074	17914	2769
1988	2	2	1,11	0	0	234	2084	68
1989	1	2	11,54	29	44444	4525	957	3368
1989	2	2	0,63	1	1619	165	35	123
1990	1	2	11,03	0	20179	16670	2467	745
1990	2	2	0,67	597	1438	477	71	21
1991	1	2	6,95	0	20058	9224	1320	454
1991	2	2	2,84	12115	11411	344	111	0
1992	1	2	11,31	2	60337	10021	1002	621
1992	2	2	2,02	134	3903	382	157	34
1993	1	2	6,94	0	3581	14659	3707	1012
1993	2	2	1,07	838	1037	953	266	87
1994	1	2	4,24	0	24697	2594	2654	715
1994	2	2	0,97	0	4093	322	198	137
1995	1	2	7,56	0	39060	6503	1531	1226
1995	2	2	1,30	0	3166	2789	307	157
1996	1	2	7,05	0	10194	16015	6403	1169
1996	2	2	2,77	2088	2031	4080	536	1023
1997	1	2	6,55	0	52359	3648	2405	683
1997	2	2	3,36	198	15238	536	406	136
1998	1	2	9,61	57	9546	39553	3188	2260
1998	2	2	1,64	1142	738	2673	209	65
1999	1	2	10,56	0	31951	6499	13150	947
1999	2	2	1,13	1322	203	58	1392	166
2000	1	2	8,36	1126	35613	5973	1825	3528
2000	2	2	1,59	6659	3601	496	339	330
2001	1	2	11,20	579	64084	13531	1158	2389
2001	2	2	3,98	73443	819	15	0	0
2002	1	2	9,79	420	84858	8667	1060	250
2002	2	2	0,86	0	1370	472	0	0
2003	1	2	9,33	6148	4982	15588	3593	1204
2003	2	2	1,53	5320	922	452	163	28
2004	1	2	9,91	0	33909	1113	4302	270
2004	2	2	1,30	2383	1637	473	405	68
2005	1	2	4,70	67	14444	4745	284	400

Table 13.1.3.6 Sandeel in IV. Tuning fleets used in SXSA run 02. Total international standardised effort and catch at age in numbers (millions).

Year	Season	Area	Effort	a-0	a-1	a-2	a-3	a-4
1976	1	1	5,90	237	5697	1130	445	155
1977	1	1	11,30	3686	24307	2351	516	144
1978	1	1	4,30	0	6127	2338	573	144
1979	1	1	2,30	0	2335	1328	242	12
1980	1	1	5,40	17	13394	8865	1050	827
1981	1	1	3,90	17	5505	4109	904	174
1982	1	1	2,40	2	3518	2132	556	85
1983	1	1	2,00	0	5684	1215	89	12
1984	1	1	1,80	0	11692	1647	153	5
1985	1	1	1,60	1	2688	3292	1002	480
1986	1	1	4,40	7	23934	2600	200	0
1987	1	1	6,80	0	26236	10855	350	155
1988	1	1	8,41	2453	9855	25922	1319	26
1989	1	1	12,43	6124	56661	2219	3385	0
1990	1	1	5,94	0	13101	3907	578	175
1991	1	1	7,24	0	41855	2342	908	318
1992	1	1	4,07	137	9871	4056	486	305
1993	1	1	5,04	1112	15768	2635	1023	646
1994	1	1	7,68	398	28490	7225	5954	2156
1995	1	1	6,43	0	36140	3360	1091	145
1996	1	1	5,06	0	11524	5385	761	301
1997	1	1	7,18	2434	67038	3640	5254	1206
1998	1	1	5,44	2278	6667	33216	2039	410
1999	1	2	4,02	265	2118	3491	5086	1023
2000	1	2	6,40	0	22887	8810	1420	1470
2001	1	2	1,77	87	6434	2408	472	1035
2002	1	2	1,90	12	21719	2649	402	219
2003	1	2	3,09	599	2315	1305	456	635
2004	1	2	2,39	179	6819	542	375	213
2005	1	2	0,93	5	2459	397	94	48
1982	1	3	8,90	242	56545	6224	3277	1939
1983	1	3	8,40	955	2232	35029	934	387
1984	1	3	9,10	20	62517	2257	13272	442
1985	1	3	10,00	6573	7790	39301	2490	265
1986	1	3	7,20	0	43629	7333	1604	30
1987	1	3	5,19	0	4351	22771	1158	165
1988	1	3	9,89	1420	2349	10074	17914	2769
1989	1	3	11,54	29	44444	4525	957	3368
1990	1	3	11,03	0	20179	16670	2467	745
1991	1	3	6,95	0	20058	9224	1320	454
1992	1	3	11,31	2	60337	10021	1002	621
1993	1	3	6,94	0	3581	14659	3707	1012
1994	1	3	4,24	0	24697	2594	2654	715
1995	1	3	7,56	0	39060	6503	1531	1226
1996	1	3	7,05	0	10194	16015	6403	1169
1997	1	3	6,55	0	52359	3648	2405	683
1998	1	3	9,61	57	9546	39553	3188	2260
1999	1	4	10,56	0	31951	6499	13150	947
2000	1	4	8,36	1126	35613	5973	1825	3528
2001	1	4	11,20	579	64084	13531	1158	2389
2002	1	4	9,79	420	84858	8667	1060	250
2003	1	4	9,33	6148	4982	15588	3593	1204
2004	1	4	9,91	0	33909	1113	4302	270
2005	1	4	4,70	67	14444	4745	284	400

Table 13.1.3.6 Continue

Year	Season	Area	Effort	a-0	a-1	a-2	a-3	a-4
1976	2	5	2,40	6126	648	84	368	37
1977	2	5	4,20	3067	2856	913	142	141
1978	2	5	1,90	7820	1001	307	39	2
1979	2	5	4,80	44203	1310	433	66	10
1980	2	5	2,40	8349	1173	214	19	8
1981	2	5	2,30	9128	346	94	14	6
1982	2	5	0,40	6530	65	0	0	0
1983	2	5	0,60	7911	303	316	19	0
1984	2	5	0,60	0	1207	121	43	0
1985	2	5	0,40	349	109	239	89	11
1986	2	5	2,70	7105	7077	473	0	0
1987	2	5	1,83	455	5768	198	0	0
1988	2	5	2,43	13196	1283	340	119	17
1989	2	5	2,35	3380	4038	274	0	0
1990	2	5	2,26	12107	1670	342	51	15
1991	2	5	2,47	13616	866	28	8	3
1992	2	5	0,71	6797	48	3	0	0
1993	2	5	2,95	26960	1004	112	34	22
1994	2	5	1,73	457	829	1211	396	25
1995	2	5	1,49	4046	3374	338	26	2
1996	2	5	3,27	31817	1706	1772	136	55
1997	2	5	2,19	2431	11346	633	25	2
1998	2	5	3,34	35220	10005	1837	79	1
1999	2	5	3,05	33653	694	551	58	0
2000	2	5	0,30	0	467	84	24	46
2001	2	5	2,11	46385	771	73	134	0
2002	2	5	0,29	0	157	6	0	0
2003	2	5	1,34	7510	118	164	0	0
2004	2	5	1,04	2961	656	9	11	0
1982	2	6	1,50	5039	4718	490	344	40
1983	2	6	1,80	9298	240	2806	513	2
1984	2	6	2,20	0	9423	92	577	44
1985	2	6	3,30	11940	1896	3229	2234	298
1986	2	6	1,70	112	5350	293	241	18
1987	2	6	2,83	298	3095	6664	196	51
1988	2	6	1,11	0	0	234	2084	68
1989	2	6	0,63	1	1619	165	35	123
1990	2	6	0,67	597	1438	477	71	21
1991	2	6	2,84	12115	11411	344	111	0
1992	2	6	2,02	134	3903	382	157	34
1993	2	6	1,07	838	1037	953	266	87
1994	2	6	0,97	0	4093	322	198	137
1995	2	6	1,30	0	3166	2789	307	157
1996	2	6	2,77	2088	2031	4080	536	1023
1997	2	6	3,36	198	15238	536	406	136
1998	2	6	1,64	1142	738	2673	209	65
1999	2	6	1,13	1322	203	58	1392	166
2000	2	6	1,59	6659	3601	496	339	330
2001	2	6	3,98	73443	819	15	0	0
2002	2	6	0,86	0	1370	472	0	0
2003	2	6	1,53	5320	922	452	163	28
2004	2	6	1,30	2383	1637	473	405	68

Table 13.1.4.1 Sandeel in IV. Options for Seasonal survivor analysis (SXSA run 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                   2005
 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 1983-2004                              Year 2005
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 13.1.4.2 Sandeel in IV. SXSA (Run 01), catchability

Fleet 1: Northern North Sea

	q	
Season	1	2
Age		
0	*	0,0095
1	0,0257	0,0150
2	0,0317	0,0091
3	0,0317	0,0091

Fleet 2: Southern North Sea

	q	
Season	1	2
Age		
0	*	0,0008
1	0,0192	0,0284
2	0,0415	0,0341
3	0,0415	0,0341

Table 13.1.4.3 Sandeel in IV. SXSA (Run 02), catchability

Fleet 1: Northern North Sea 83-98

	q	
Season	1	2
Age		
0	*	*
1	0,0251	*
2	0,0275	*
3	0,0275	*

Fleet 2: Northern North Sea 99-05

	q	
Season	1	2
Age		
0	*	*
1	0,0300	*
2	0,0498	*
3	0,0498	*

Fleet 3: Southern North Sea 83-98

	q	
Season	1	2
Age		
0	*	*
1	0,0146	*
2	0,0414	*
3	0,0414	*

Fleet 4: Southern North Sea 99-05

	q	
Season	1	2
Age		
0	*	*
1	0,0410	*
2	0,0464	*
3	0,0464	*

Fleet 5: Northern North Sea 83-04

	q	
Season	1	2
Age		
0	*	0,0098
1	*	0,0154
2	*	0,0093
3	*	0,0093

Fleet 6: Southern North Sea 83-04

	q	
Season	1	2
Age		
0	*	0,0008
1	*	0,0278
2	*	0,0323
3	*	0,0323

Table 13.1.4.4 Sandeel in IV. Comparison of SMS runs using one or two separable periods respectively.

one period (run02)

Exploitation pattern (scaled to mean F=1)

		0	1	2	3	4
1975-2005	season 1:	0.00	0.57	1.13	1.31	1.31
	season 2:	0.05	0.13	0.17	0.20	0.20

two periods (run03)

Exploitation pattern (scaled to mean F=1)

		0	1	2	3	4
1975-1998	season 1:	0.00	0.52	1.14	1.35	1.35
	season 2:	0.05	0.14	0.20	0.24	0.24
1999-2005	season 1:	0.00	0.78	1.04	1.05	1.05
	season 2:	0.06	0.09	0.09	0.09	0.09

one period (run02) / two periods (run03)

sqrt(catch variance) ~ CV: / sqrt(catch variance) ~ CV:

	one period (run02): season		two periods (run03): season	
age	1	2	1	2
0		1.257		1.232
1	0.535	0.647	0.469	0.629
2	0.300	0.804	0.300	0.763
3	0.384	1.157	0.382	1.135
4	0.384	1.157	0.382	1.135

one period (run02)

sqrt(CPUE variance) ~ CV:

North 1 half year 1980 2005		0.51	0.69	0.66	1.32
North 2 half year 1980 2004	2.48	0.87	1.41	2.07	1.65
South 1 half year 1982 2005		0.73	0.47	0.67	0.65

two periods (run03)

sqrt(CPUE variance) ~ CV:

North 1 half year 1980 1998		0.41	0.69	0.65	1.27
North 1 half year 1999 2005		0.67	0.65	0.45	0.81
North 2 half year 1976 1998	2.02	0.95	1.51	2.09	1.60
North 2 half year 1999 2004	2.52	0.53	0.97	1.36	1.14
South 1 half year 1982 1998		0.69	0.54	0.74	0.68
South 1 half year 1999 2005		0.30	0.30	0.42	0.58

Table 13.1.4.5 Sandeel in IV. SMS diagnostics

```
objective function:  134.312
objective function weight:
     1     1  0.05     1

unweighted oobjective function contributions (total):
              Catch   CPUE     S/R    Stom.   Penalty
                3.5   130.8    -1.0     0.0 0.00e+000


unweighted objective function contributions (per observation):
              Catch    CPUE     S/R   Stomachs
               0.01    0.38   -0.03    0.00


contribution by fleets:
-----------------------
North 1 half year 1980 1998  total:9.656     mean:0.130
North 1 half year 1999 2005  total:2.186     mean:0.078
North 2 half year 1980 1998  total:109.873   mean:0.955
North 2 half year 1999 2004  total:19.242    mean:0.641
South 1 half year 1982 1998  total:5.637     mean:0.083
South 1 half year 1999 2004  total:-15.764   mean:-0.563


F, Year effect:
---------------
          sp.1
1975:    1.000
1976:    1.205
1977:    1.632
1978:    1.627
1979:    2.015
1980:    2.092
1981:    1.882
1982:    2.780
1983:    1.723
1984:    2.230
1985:    4.172
1986:    1.507
1987:    1.105
1988:    2.626
1989:    2.153
1990:    2.192
1991:    2.077
1992:    1.332
1993:    1.373
1994:    1.761
1995:    1.294
1996:    1.684
1997:    1.385
1998:    1.843
1999:    1.000
2000:    1.116
2001:    1.438
2002:    0.836
2003:    1.385
2004:    1.077
2005:    0.501

F, season effect:
-----------------
age: 0
```

```
    1975-1998:   0.000 0.500
    1999-2005:   0.000 0.500
age: 1
    1975-1998:   1.872 0.500
    1999-2005:   4.278 0.500
age: 2 - 4
    1975-1998:   2.805 0.500
    1999-2005:   5.734 0.500


F, age effect:
--------------
                 0     1     2     3     4
1975-1998:   0.034 0.094 0.137 0.163 0.163
1999-2005:   0.086 0.128 0.128 0.130 0.130
```

Table 13.1.4.5 Continued.

Exploitation pattern (scaled to mean F=1)

		0	1	2	3	4
1975-1998	season 1:	0.00	0.52	1.14	1.35	1.35
	season 2:	0.05	0.14	0.20	0.24	0.24
1999-2005	season 1:	0.00	0.78	1.04	1.05	1.05
	season 2:	0.06	0.09	0.09	0.09	0.09

sqrt(catch variance) ~ CV:

	season	
age	1	2
0		1.232
1	0.469	0.629
2	0.300	0.763
3	0.382	1.135
4	0.382	1.135

Survey catchability:

North 1 half year 1980 1998		4.07e-005	5.43e-005	4.58e-005	4.58e-005
North 1 half year 1999 2005		5.85e-005	8.12e-005	1.00e-004	1.00e-004
North 2 half year 1976 1998	6.23e-006	1.34e-005	9.18e-006	4.23e-006	4.23e-006
North 2 half year 1999 2004	4.47e-006	1.60e-005	1.04e-005	1.11e-005	1.11e-005
South 1 half year 1982 1998		2.67e-005	7.50e-005	1.05e-004	1.05e-004
South 1 half year 1999 2004		7.89e-005	8.08e-005	8.51e-005	8.51e-005

sqrt(CPUE variance) ~ CV:

North 1 half year 1980 1998		0.41	0.69	0.65	1.27
North 1 half year 1999 2005		0.67	0.65	0.45	0.81
North 2 half year 1976 1998	2.02	0.95	1.51	2.09	1.60
North 2 half year 1999 2004	2.52	0.53	0.97	1.36	1.14
South 1 half year 1982 1998		0.69	0.54	0.74	0.68
South 1 half year 1999 2004		0.30	0.30	0.42	0.58

Recruit-SSB	alfa	beta	beta intern	recruit s2	recruit s
Species 1: Geometric mean:	1.983e+001			0.345	0.587

Table 13.1.4.6 Sandeel in IV. SXSA (run 02) fishing mortality at age.

Partial fishing mortality
Northern North

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	0.090	0.010	0.055	0.015	0.045	0.004	0.077	0.053	0.162	0.082	0.191	0.057
2	0.021	0.012	0.079	0.009	0.087	0.027	0.173	0.071	0.135	0.005	0.788	0.037
3	0.034	0.015	0.012	0.012	0.119	0.024	0.046	0.000	0.088	0.000	0.066	0.020
4+	0.051	0.000	0.009	0.000	0.228	0.010	0.000	0.000	0.054	0.000	0.015	0.160
F (1- 2)	0.055	0.011	0.067	0.012	0.066	0.016	0.125	0.062	0.149	0.043	0.490	0.047

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.015	*	0.028	*	0.025	*	0.031	*	0.065	*	0.001
1	0.357	0.087	0.168	0.059	0.278	0.016	0.052	0.001	0.197	0.029	0.198	0.015
2	0.169	0.041	0.170	0.042	0.161	0.005	0.145	0.000	0.057	0.004	0.352	0.117
3	0.718	0.000	0.168	0.041	0.191	0.003	0.139	0.000	0.119	0.008	0.389	0.053
4+	0.000	*	0.212	0.069	0.475	0.017	0.197	0.000	0.563	0.187	1.190	0.284
F (1- 2)	0.263	0.064	0.169	0.051	0.219	0.011	0.099	0.000	0.127	0.017	0.275	0.066

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.017	*	0.024	*	0.011	*	0.136	*	0.101	*	0.000
1	0.166	0.039	0.126	0.044	0.135	0.054	0.076	0.282	0.025	0.022	0.218	0.014
2	0.097	0.017	0.105	0.067	0.150	0.044	0.297	0.036	0.198	0.064	0.521	0.014
3	0.184	0.008	0.073	0.030	0.378	0.004	0.259	0.022	0.184	0.005	0.300	0.012
4+	0.031	0.001	0.084	0.036	0.410	0.001	0.087	0.000	0.305	0.000	0.199	0.014
F (1- 2)	0.131	0.028	0.115	0.055	0.142	0.049	0.187	0.159	0.111	0.043	0.369	0.014

Year	2001		2002		2003		2004		2005
Season	1	2	1	2	1	2	1	2	1
AGE									
0	*	0.085	*	0.000	*	0.032	*	0.013	*
1	0.057	0.022	0.141	0.004	0.117	0.016	0.089	0.026	0.030
2	0.149	0.014	0.133	0.001	0.053	0.015	0.123	0.004	0.025
3	0.130	0.069	0.122	0.000	0.085	0.000	0.065	0.005	0.067
4+	0.506	0.000	0.174	0.000	0.586	0.000	0.155	0.000	0.027
F (1- 2)	0.103	0.018	0.137	0.002	0.085	0.015	0.106	0.015	0.027

Partial fishing mortality
Southern North Sea

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.016	*	0.000	*	0.014	*	0.000	*	0.002	*	0.000
1	0.035	0.008	0.293	0.115	0.129	0.070	0.141	0.040	0.027	0.044	0.046	0.000
2	0.602	0.105	0.109	0.007	1.043	0.369	0.489	0.044	0.284	0.158	0.306	0.025
3	0.357	0.408	1.061	0.167	0.295	0.605	0.369	0.103	0.292	0.089	0.897	0.358
4+	1.654	0.471	0.839	0.236	0.126	0.270	0.012	0.010	0.057	0.026	1.586	0.640
F (1- 2)	0.319	0.057	0.201	0.061	0.586	0.219	0.315	0.042	0.155	0.101	0.176	0.013

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.000	*	0.001	*	0.022	*	0.001	*	0.002	*	0.000
1	0.280	0.035	0.259	0.051	0.133	0.217	0.317	0.052	0.045	0.030	0.172	0.074
2	0.345	0.025	0.725	0.058	0.635	0.059	0.359	0.026	0.319	0.036	0.127	0.031
3	0.203	0.021	0.717	0.057	0.278	0.044	0.286	0.083	0.430	0.062	0.174	0.026
4+	1.692	*	0.903	0.097	0.678	0.000	0.401	0.045	0.882	0.739	0.395	1.573
F (1- 2)	0.313	0.030	0.492	0.055	0.384	0.138	0.338	0.039	0.182	0.033	0.149	0.052

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.000	*	0.002	*	0.001	*	0.004	*	0.004	*	0.019
1	0.183	0.037	0.111	0.052	0.105	0.073	0.109	0.021	0.381	0.006	0.338	0.107

2	0.190	0.139	0.311	0.155	0.150	0.037	0.354	0.053	0.368	0.007	0.353	0.081
3	0.262	0.098	0.610	0.119	0.173	0.059	0.405	0.059	0.476	0.114	0.386	0.171
4+	0.260	0.055	0.326	0.668	0.232	0.102	0.480	0.028	0.283	0.105	0.477	0.102
F (1- 2)	0.186	0.088	0.211	0.103	0.128	0.055	0.232	0.037	0.374	0.007	0.346	0.094

Year	2001		2002		2003		2004		2005
Season	1	2	1	2	1	2	1	2	1
AGE									
0	*	0.134	*	0.000	*	0.023	*	0.011	*
1	0.569	0.024	0.551	0.031	0.251	0.123	0.443	0.065	0.174
2	0.837	0.003	0.434	0.048	0.635	0.041	0.252	0.201	0.303
3	0.320	0.000	0.321	0.000	0.673	0.074	0.747	0.190	0.204
4+	1.168	0.000	0.198	0.000	1.111	0.794	0.197	0.087	0.224
F (1- 2)	0.703	0.013	0.492	0.039	0.443	0.082	0.347	0.133	0.238

Table 13.1.4.7 Sandeel in IV. SXSA (run 02) annual fishing mortality at age.

Year	age-0	age-1	age-2	age-3	age-4-	F1-2
1983	0,029	0,146	0,790	0,778	4,171	0,468
1984	0,000	0,456	0,220	1,368	1,193	0,338
1985	0,015	0,232	1,608	0,974	0,623	0,920
1986	0,017	0,291	0,833	0,543	0,021	0,562
1987	0,005	0,278	0,596	0,492	0,143	0,437
1988	0,027	0,292	1,301	1,397	3,349	0,796
1989	0,015	0,776	0,624	1,059	0,000	0,700
1990	0,029	0,534	1,092	1,079	1,537	0,813
1991	0,047	0,586	0,947	0,558	1,476	0,767
1992	0,032	0,435	0,580	0,536	0,714	0,508
1993	0,067	0,298	0,448	0,667	2,939	0,373
1994	0,001	0,456	0,651	0,690	6,121	0,554
1995	0,017	0,426	0,442	0,580	0,367	0,434
1996	0,025	0,315	0,640	0,885	1,056	0,478
1997	0,011	0,336	0,397	0,663	0,816	0,366
1998	0,141	0,376	0,799	0,807	0,664	0,588
1999	0,106	0,461	0,686	0,833	0,752	0,574
2000	0,019	0,684	1,063	0,915	0,870	0,873
2001	0,220	0,718	1,133	0,555	3,031	0,926
2002	0,000	0,786	0,669	0,489	0,413	0,727
2003	0,055	0,483	0,815	0,910	3,914	0,649
2004	0,024	0,638	0,580	1,072	0,460	0,609

Table 13.1.4.8 Sandeel in IV. SXSA (Run 02) 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	*	879980.	*	226732.	*	1204901.	*	623273.	*	199460.	*	718210.
1	105257.	33920.	383865.	96206.	101877.	31123.	533159.	155159.	275217.	82695.	89118.	25383.
2	90515.	31000.	27280.	15090.	69149.	11479.	23667.	7732.	115789.	50085.	59685.	10537.
3	3734.	1666.	22555.	4128.	12163.	5294.	6261.	2720.	5638.	2544.	34797.	7579.
4+	498.	6.	885.	228.	2966.	1378.	3081.	2041.	3663.	2193.	3655.	162.
SSN	94747.		50721.		84277.		33009.		125090.		98138.	
SSB	1242258.		762545.		1177952.		497838.		1652384.		1505944.	
TSN	200004.	946571.	434586.	342384.	186154.	1254176.	566168.	790925.	400307.	336978.	187256.	761870.
TSB	1771700.	1866703.	2336391.	1623525.	1604817.	2088161.	2726443.	2947939.	2945903.	2015250.	1898065.	1632629.

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	325139.	*	635693.	*	805045.	*	318713.	*	621985.	*	870725.
1	313867.	54142.	143828.	32726.	277120.	64395.	344482.	84145.	138561.	39238.	260842.	63699.
2	19621.	7631.	39209.	9436.	23982.	6606.	41613.	16369.	65317.	29624.	30279.	12257.
3	8108.	1880.	5850.	1428.	6984.	2857.	5072.	2182.	13053.	4877.	23290.	8565.
4+	4267.	103.	1507.	257.	1237.	197.	2390.	844.	2304.	187.	3776.	181.
SSN	31995.		46566.		32203.		49075.		80674.		57345.	
SSB	501428.		653807.		460963.		681575.		1092510.		803545.	
TSN	345862.	388894.	190395.	679541.	309323.	879100.	393558.	422252.	219235.	695911.	318187.	955426.
TSB	1882443.	1153351.	1266515.	1394512.	1649807.	1730279.	2087062.	1681287.	1716034.	1835611.	2436418.	7156538.

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	358049.	*	1964368.	*	334086.	*	396891.	*	503692.	*	504485.
1	390936.	97828.	158170.	45015.	859920.	243929.	148352.	44742.	153960.	35975.	202879.	39153.
2	47699.	23813.	74177.	32202.	33475.	16472.	175658.	58169.	26911.	9860.	28643.	7097.
3	8648.	3630.	16667.	5307.	21070.	7853.	12428.	4052.	43545.	14259.	7522.	2385.
4+	6476.	3219.	5162.	2257.	4609.	1543.	7178.	2625.	5146.	1837.	11715.	3761.
SSN	62823.		96007.		59153.		195264.		75602.		47881.	
SSB	1043716.		1091963.		663586.		1766917.		936514.		545027.	
TSN	453759.	486540.	254176.	2049149.	919073.	603883.	343617.	506479.	229562.	565624.	250760.	556882.
TSB	3831088.	3269562.	2159608.	6864193.	5504935.	2951046.	2510163.	1961155.	1797153.	2261498.	1843453.	1343902.

Year	2001		2002		2003		2004		2005
Season	1	2	1	2	1	2	1	2	1
AGE									
0	*	868658.	*	80066.	*	345286.	*	324031.	*
1	222216.	38978.	309990.	49397.	35976.	8809.	146547.	29209.	142015.
2	28375.	5971.	30473.	11162.	39061.	12352.	6271.	2850.	21839.
3	5286.	2209.	4809.	2027.	8706.	2521.	9556.	2576.	1897.
4+	4364.	122.	1787.	814.	2326.	53.	1934.	901.	2408.
SSN	38025.		37069.		50092.		17762.		26144.
SSB	379176.		383513.		451305.		211395.		264223.
TSN	260241.	915938.	347059.	143466.	86068.	369022.	164309.	359567.	168159.
TSB	1359149.	2815991.	2286852.	550143.	640539.	1377070.	1034992.	1361941.	1090748.

Table 13.1.4.9 Sandeel in IV. SXSA (run 02) assessment summary

Year	Recruits Age 0	Totalbio	SSB	Landings	Yield/SSB	Mean F Ages 1-2
1983	879980	1771700	1242258	530.641	0,4272	0,4678
1984	226732	2336391	762545	750.040	0,9836	0,3377
1985	1204901	1604817	1177952	707.105	0,6003	0,9200
1986	623273	2726443	497838	685.949	1,3779	0,5617
1987	199460	2945903	1652384	791.050	0,4787	0,4372
1988	718210	1898065	1505944	1.007.303	0,6689	0,7962
1989	325139	1882443	501428	826.836	1,6490	0,6997
1990	635693	1266515	653807	584.912	0,8946	0,8128
1991	805045	1649807	460963	898.959	1,9502	0,7666
1992	318713	2087062	681575	820.140	1,2033	0,5077
1993	621985	1716034	1092510	576.932	0,5281	0,3729
1994	870725	2436418	803545	770.746	0,9592	0,5536
1995	358049	3831088	1043716	915.042	0,8767	0,4342
1996	1964368	2159608	1091963	776.126	0,7108	0,4776
1997	334086	5504935	663586	1.114.044	1,6788	0,3664
1998	396891	2510163	1766917	1.000.376	0,5662	0,5875
1999	503692	1797153	936514	718.667	0,7674	0,5736
2000	504485	1843453	545027	692.499	1,2706	0,8731
2001	868658	1359149	379176	858.619	2,2644	0,9256
2002	80066	2286852	383513	806.921	2,1040	0,7275
2003	345286	640539	451305	309.724	0,6863	0,6492
2004	324031	1034992	211395	359.362	1,7000	0,6090
2005		1090748	264223			
Average	595885	2103490	816091	750091	1,1066	0,6117
Units	(Millions)	(Tonnes)	(Tonnes)	(Tonnes)		

Figure 13.1.1.1 Sandeel in IV. Danish sandeel sampling areas.

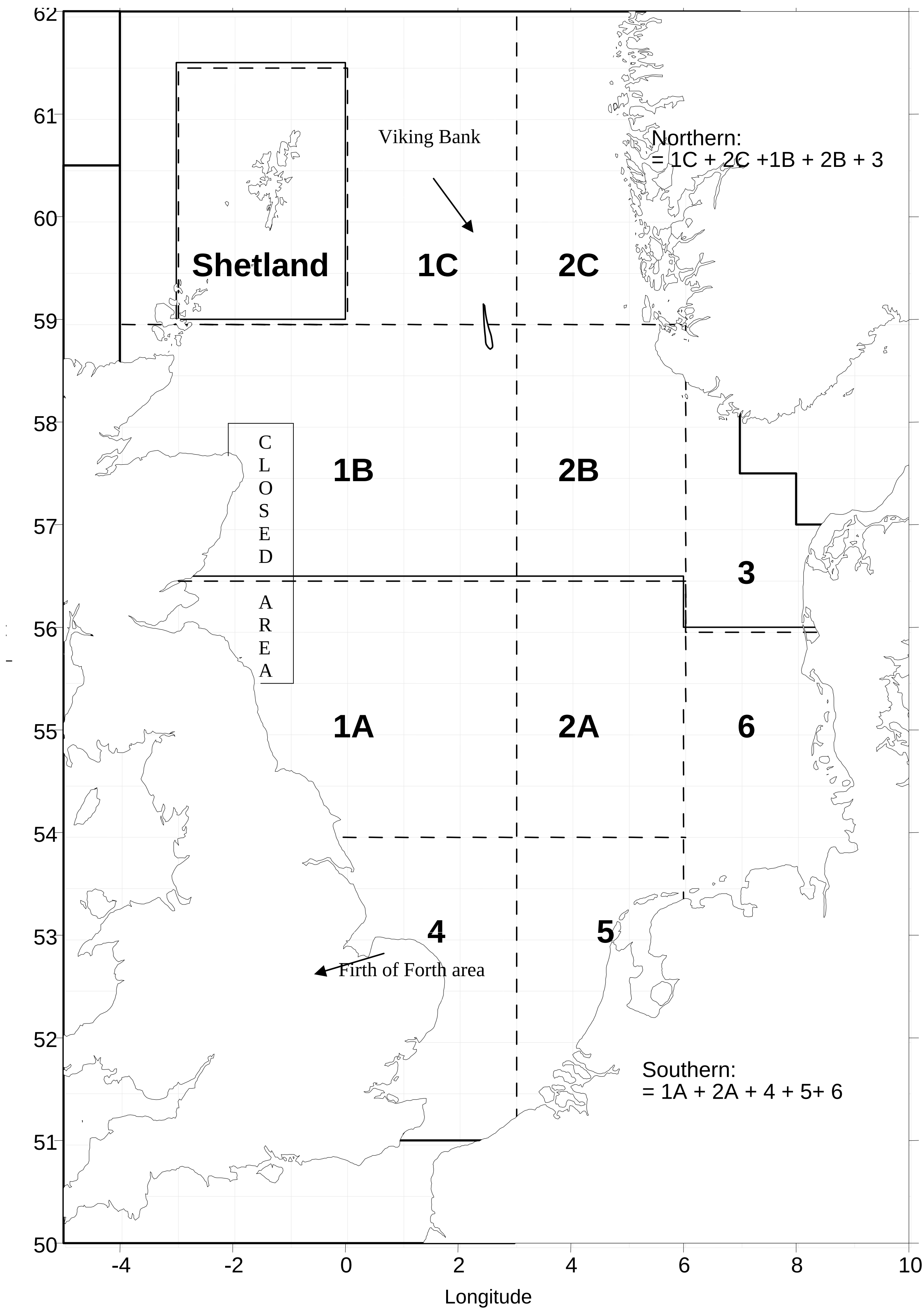


Figure 13.1.1.2 Sandeel in IV. Total effort for the Danish fleet by GT class for the years 1987 to 2003.

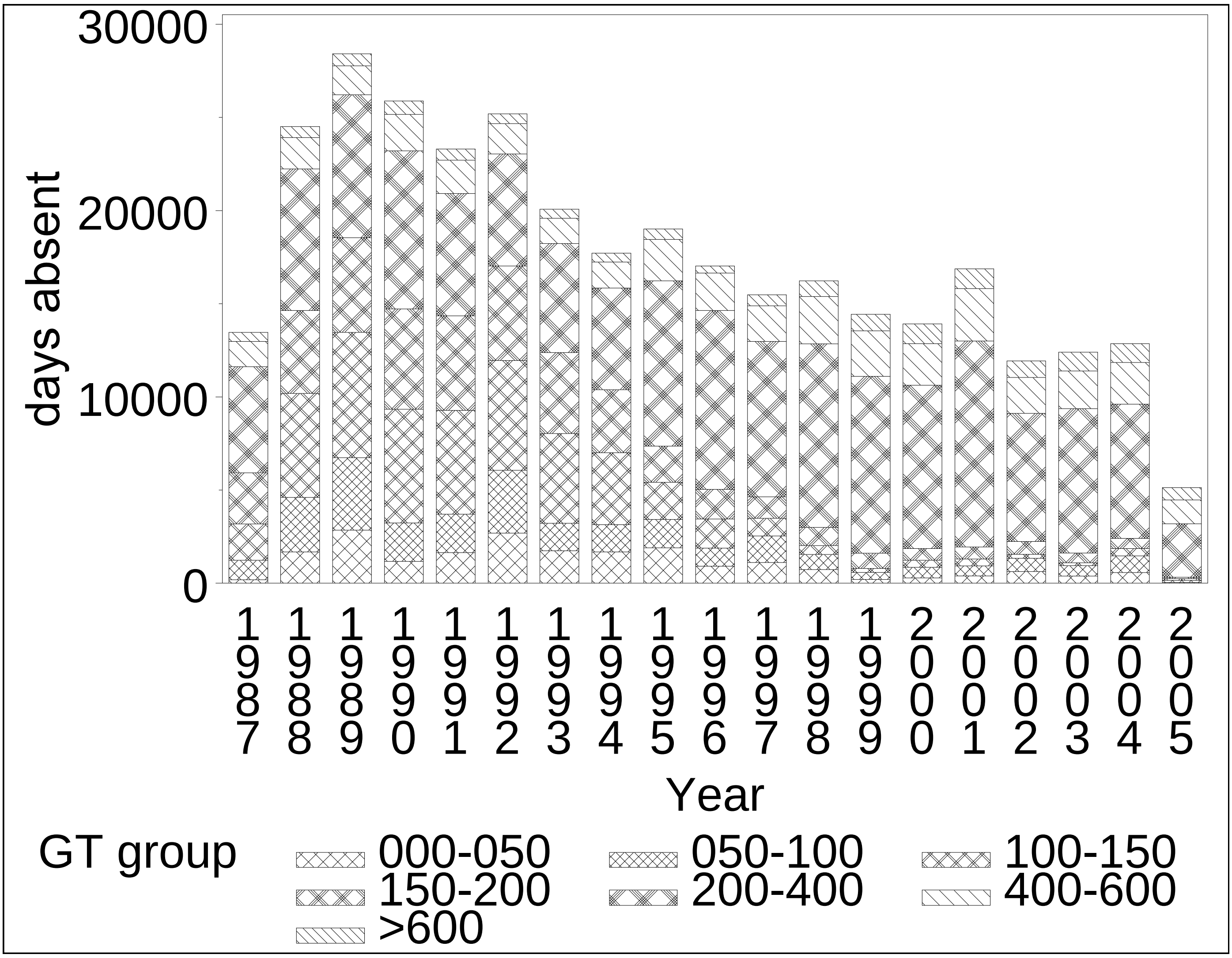
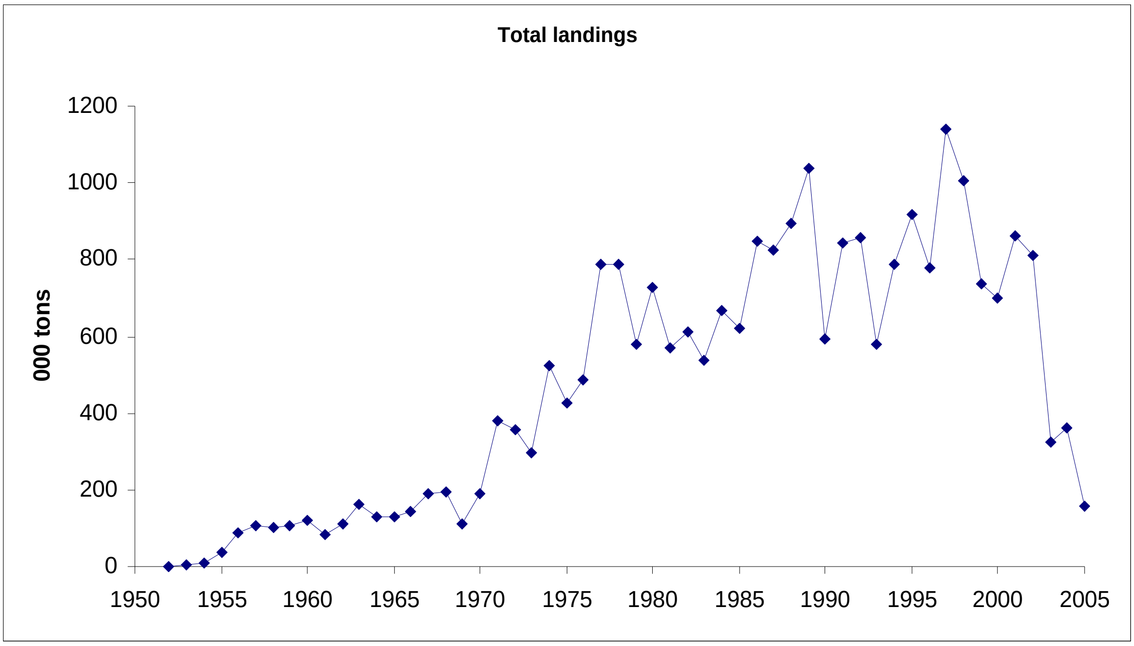


Figure 13.1.1.3 Sandeel in IV. Total international landings, effort and CPU. 2005 only represent first half year.



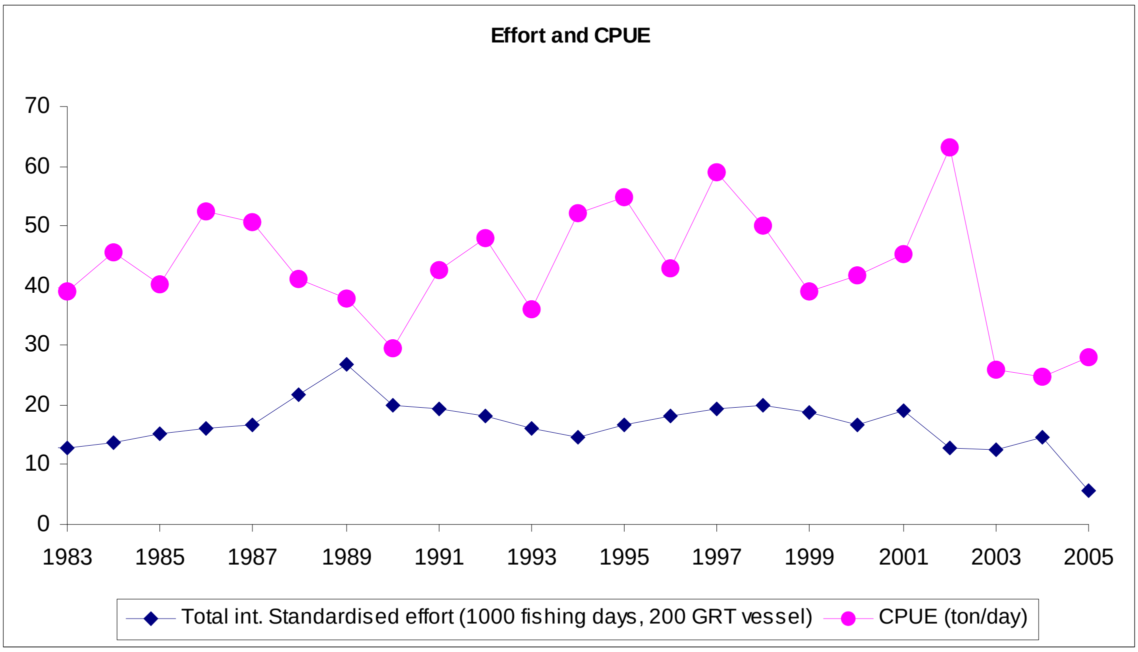
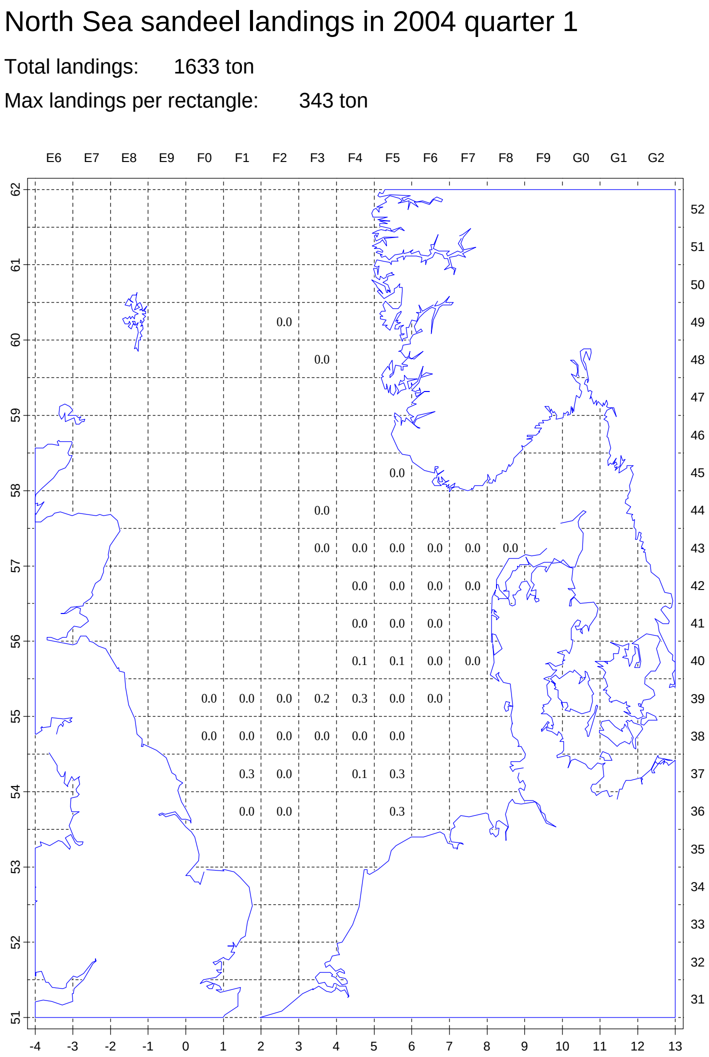


Figure 13.1.1.4 Sandeel in IV. Quarterly catches of sandeels by Denmark, Norway and Scotland in 2004 and by Denmark and Norway in 2005 by ICES rectangle (**'**000 tonnes).



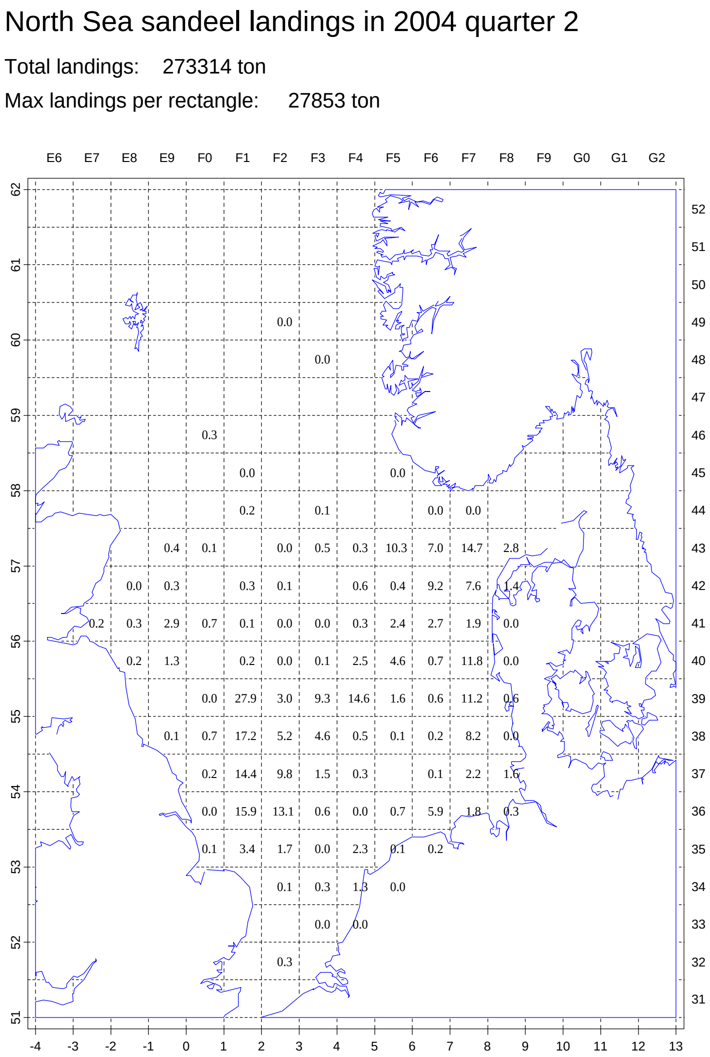
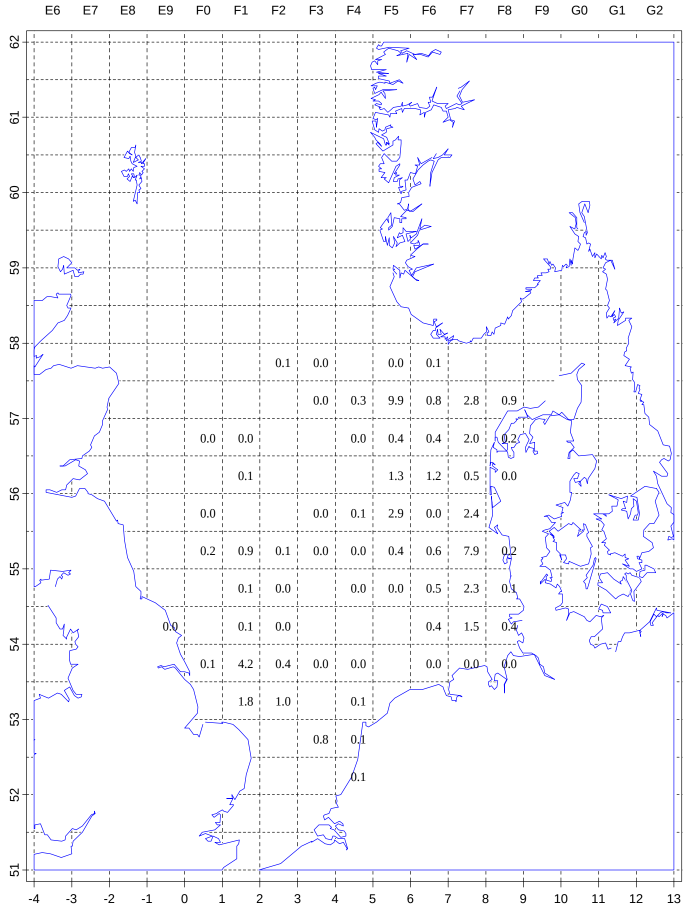


Figure 13.1.1.4.(continued) Quarterly catches of Sandeel by ICES rectangle (‘000 tonnes).

North Sea sandeel landings in 2004 quarter 3

Total landings: 50711 ton

Max landings per rectangle: 9926 ton



North Sea sandeel landings in 2004 quarter 4

Total landings: 0 ton

Max landings per rectangle: 0 ton

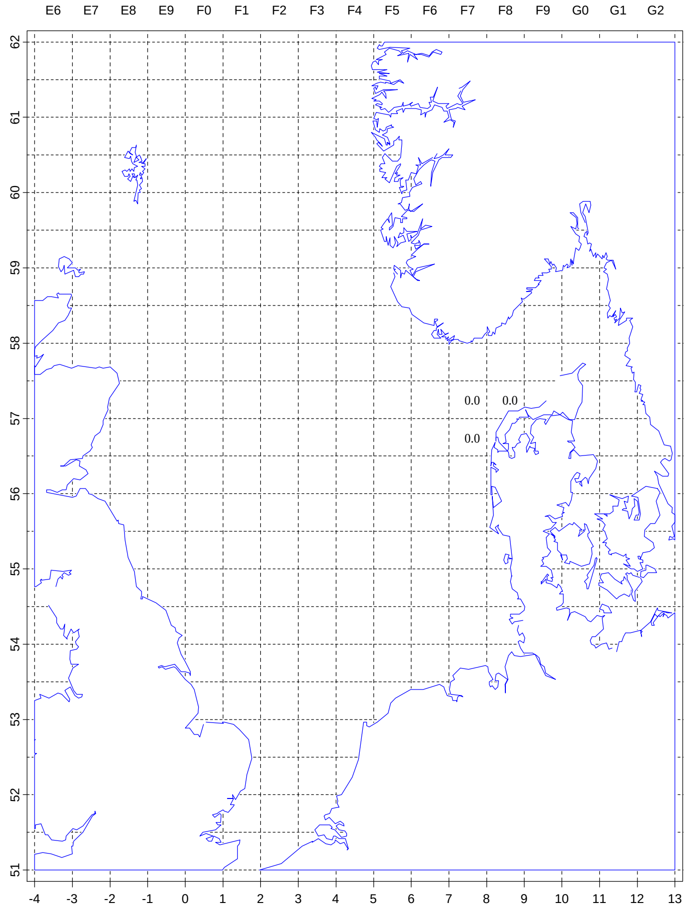


Figure 13.1.1.4. (continued) Quarterly catches of Sandeel by ICES rectangle ('000 tonnes).

North Sea sandeel landings in 2005 quarter 2

Total landings: 158389 ton

Max landings per rectangle: 20928 ton

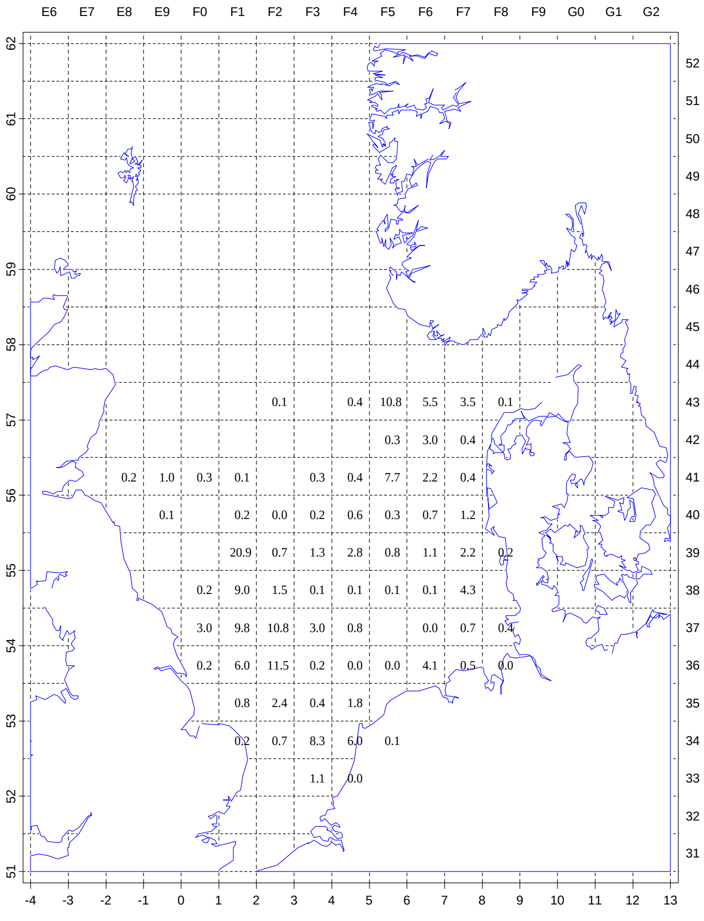


Figure 13.1.1.5 Sandeel in IV. Landings of Sandeel by year and ICES rectangles for the period 1995-2005. Landings include Danish and Norwegian landing for the whole period. Scottish landings are included from 1997 and onwards; Swedish landings are included from 1998. Landing from other countries are negligible. The area of the circles corresponds to landings by rectangle. All rectangle landings are scaled to the largest rectangle landings shown at the 1995 map. The area that was closed to sandeel fishery in 2000 and the boundary between the EU and the Norwegian EEZ are shown on the map

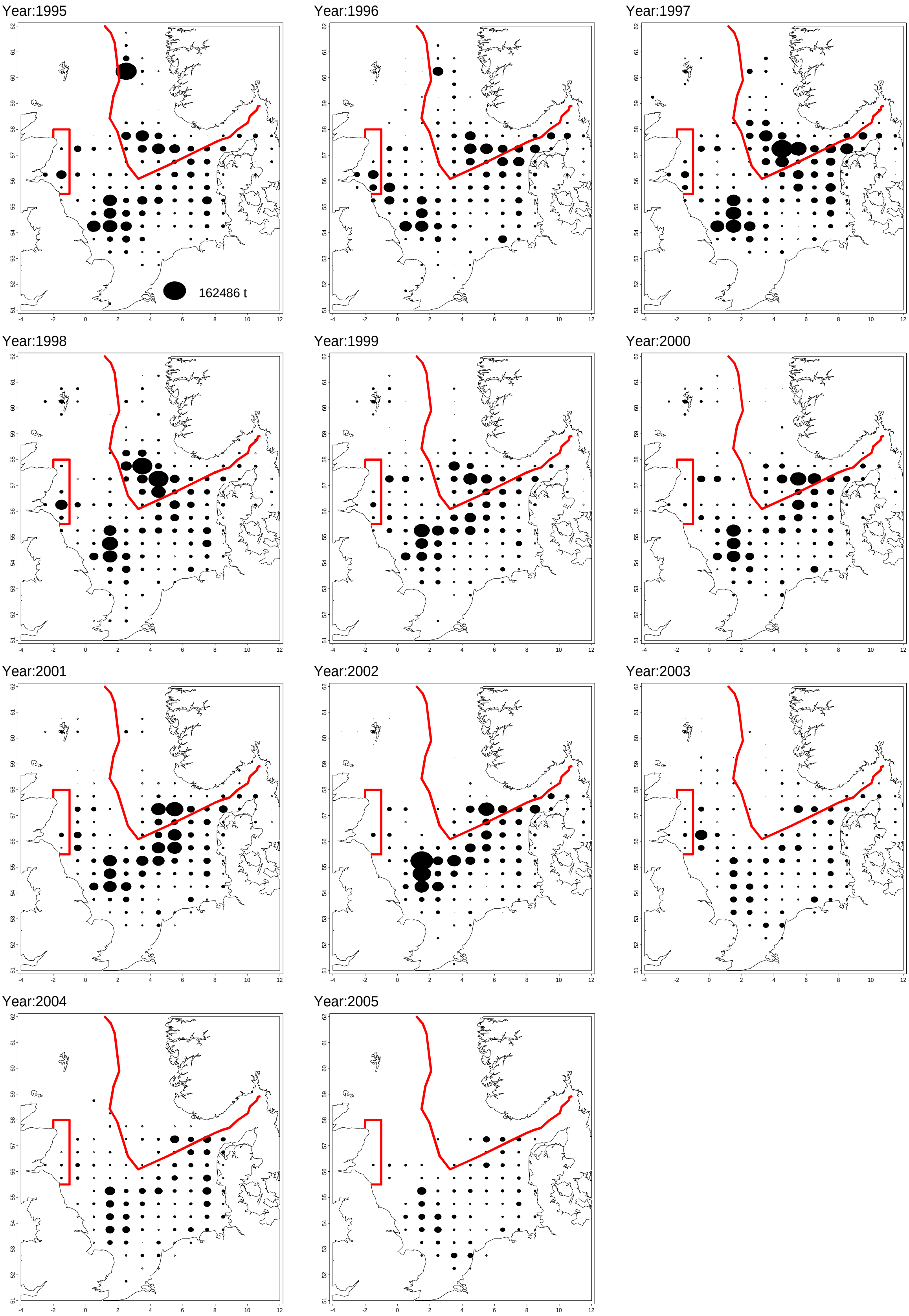


Figure 13.1.2.1 Sandeel in IV. Natural mortalities (M_1+M_2) of sandeels by age and year, estimated by ICES (2005b), used in exploratory assessments).

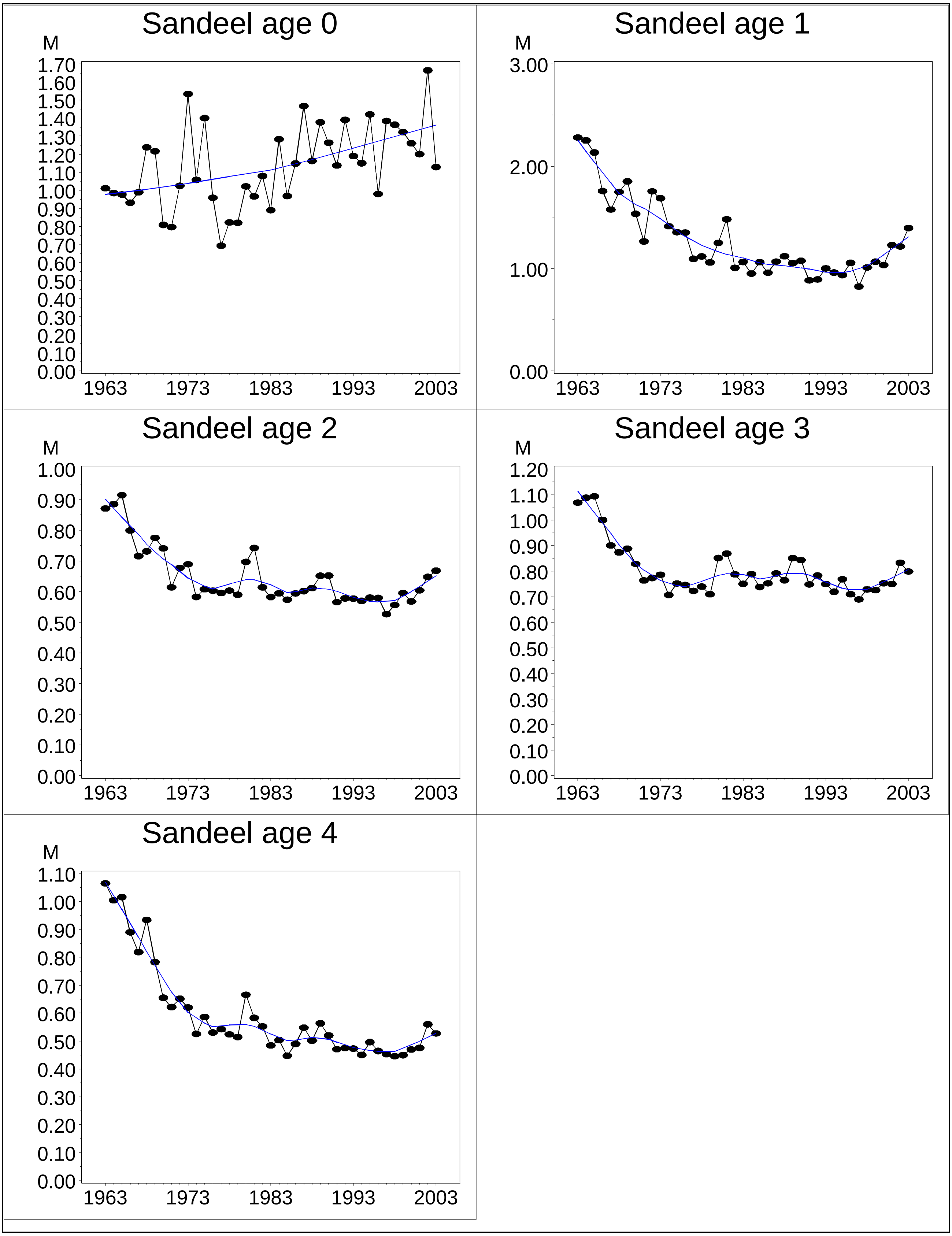
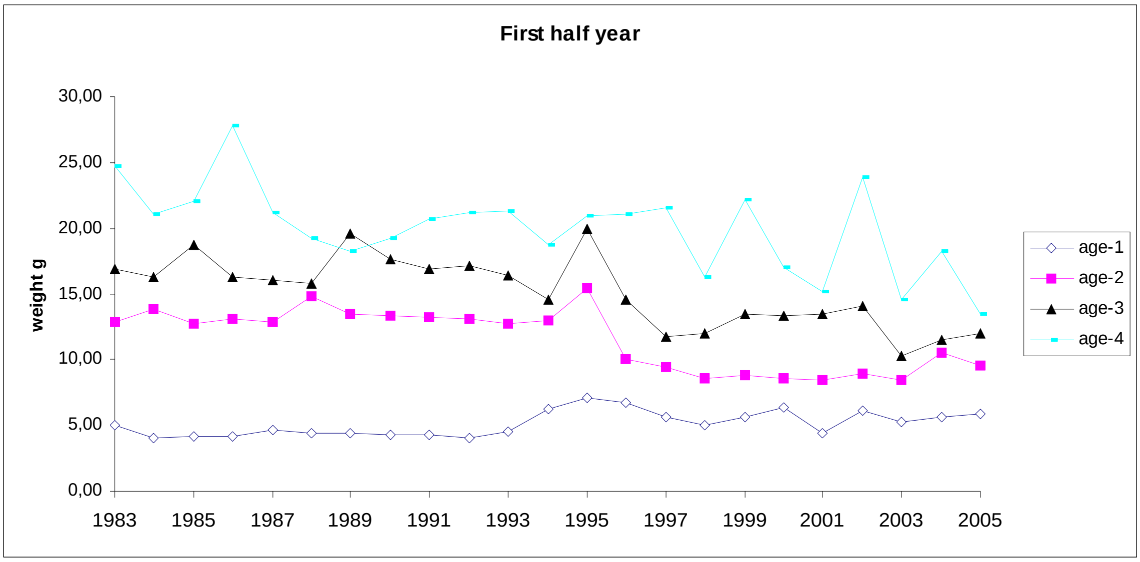


Figure 13.1.2.2 Sandeel in IV. Mean weight at age in the stock, by half year.



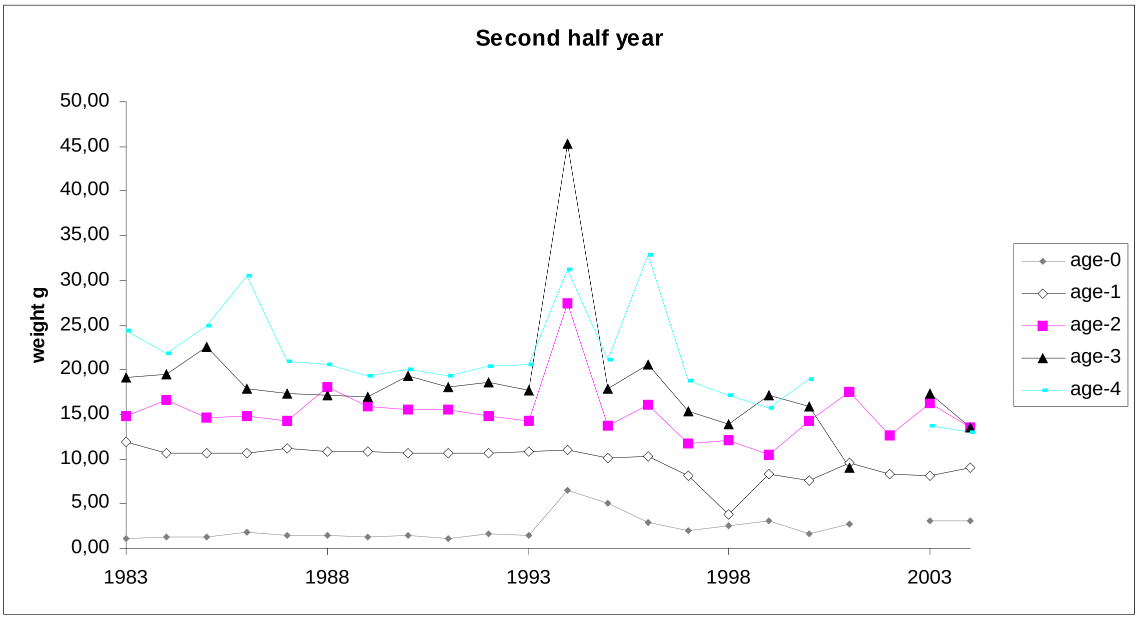


Figure 13.1.2.3 Sandeel in IV. Mean weight at age in the catch by fleet and half year.

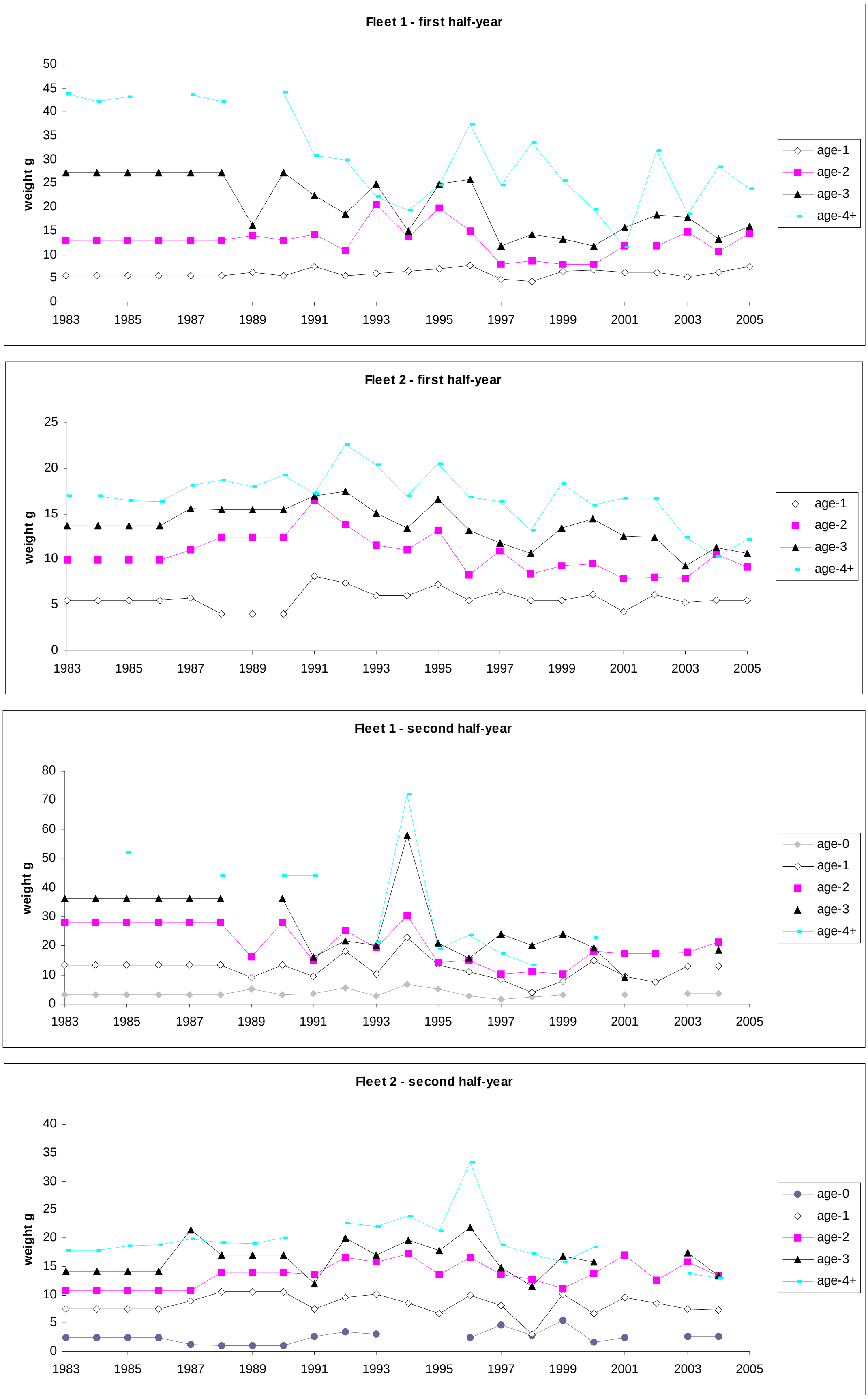


Figure 13.1.3.1 Sandeel in IV. CPUE (ton/day) by fleet.

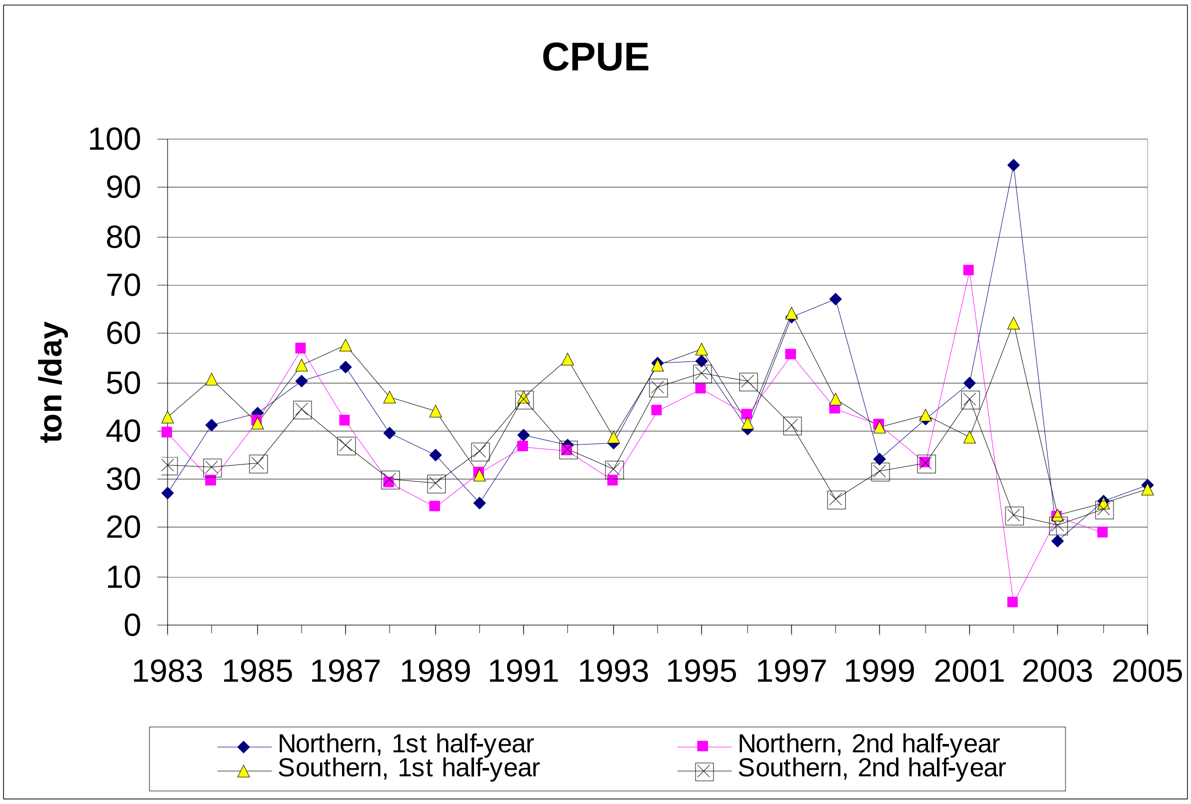


Figure 13.1.3.2 Sandeel in IV. Normalized CPUE by fleet age group and year.

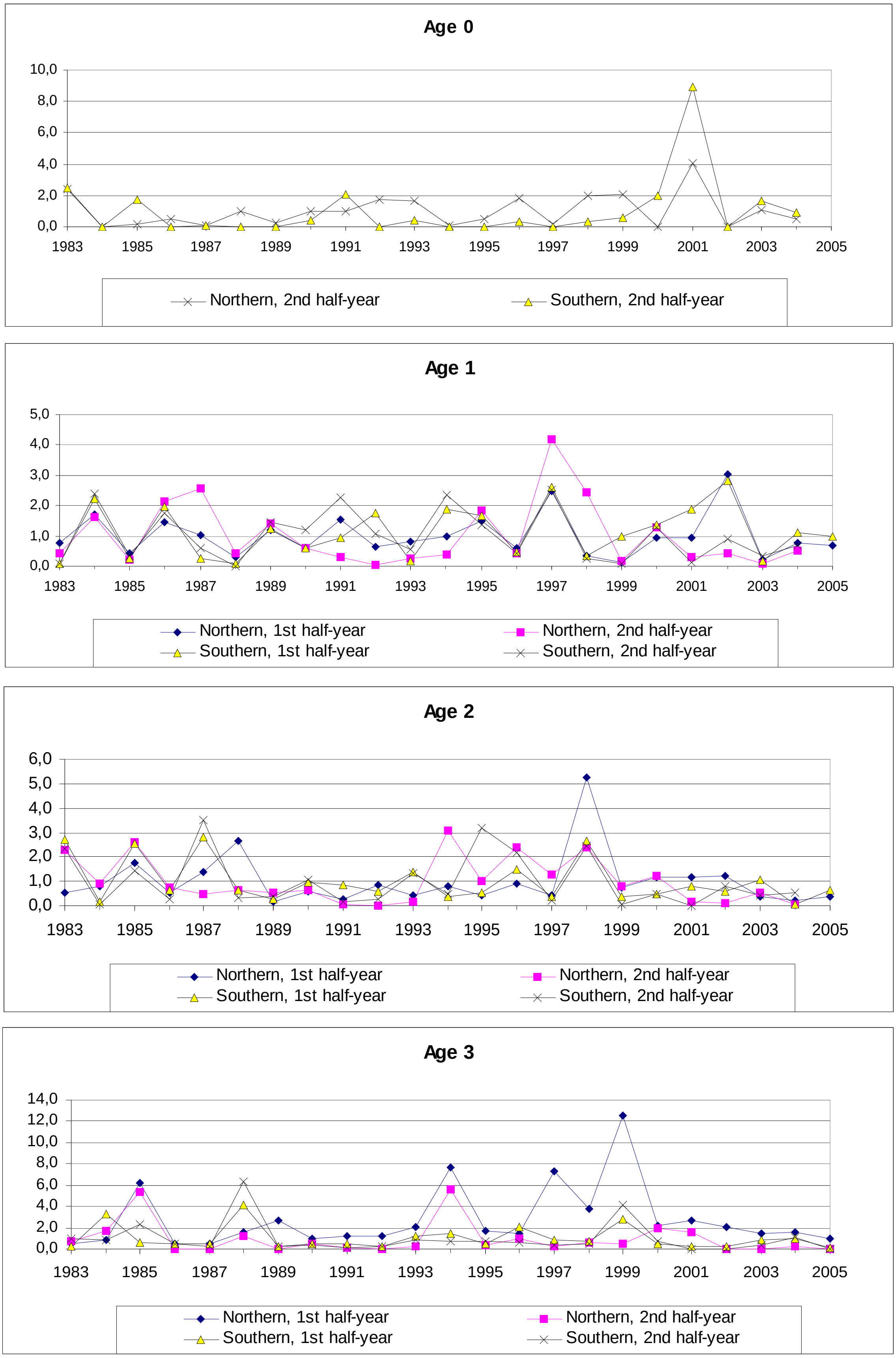
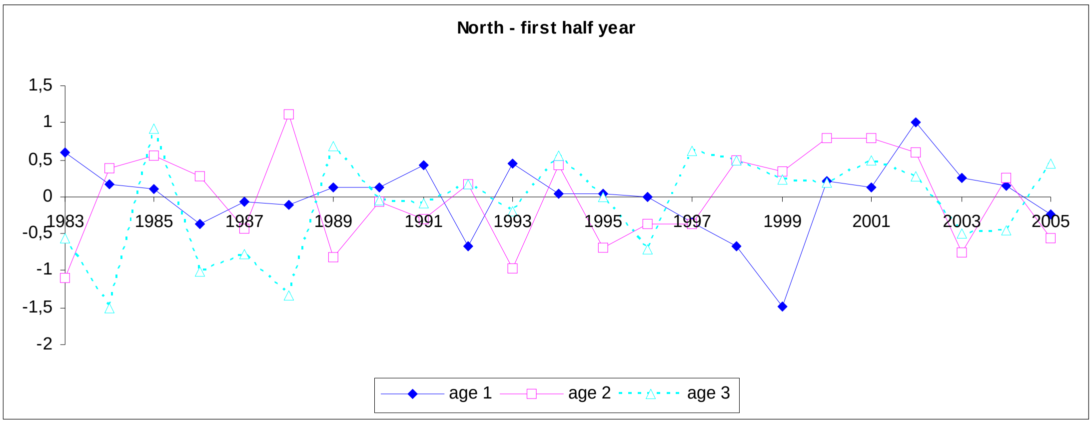
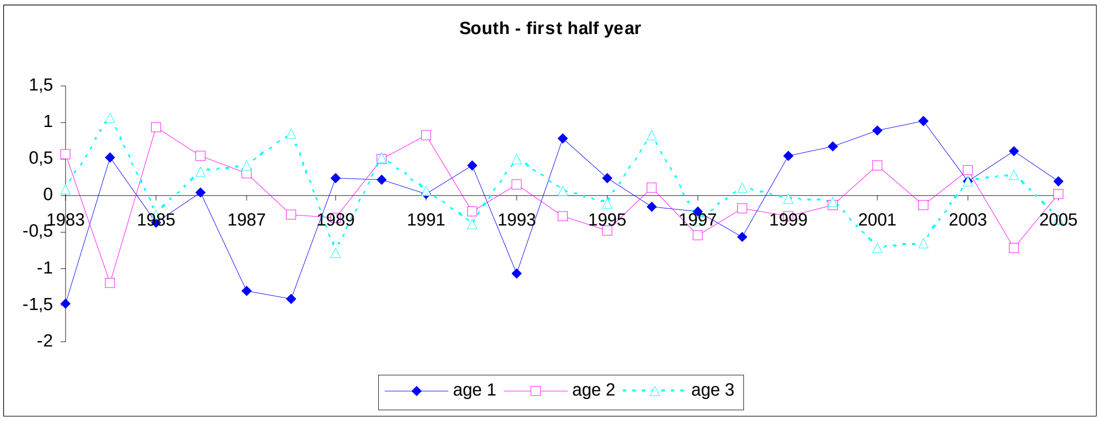
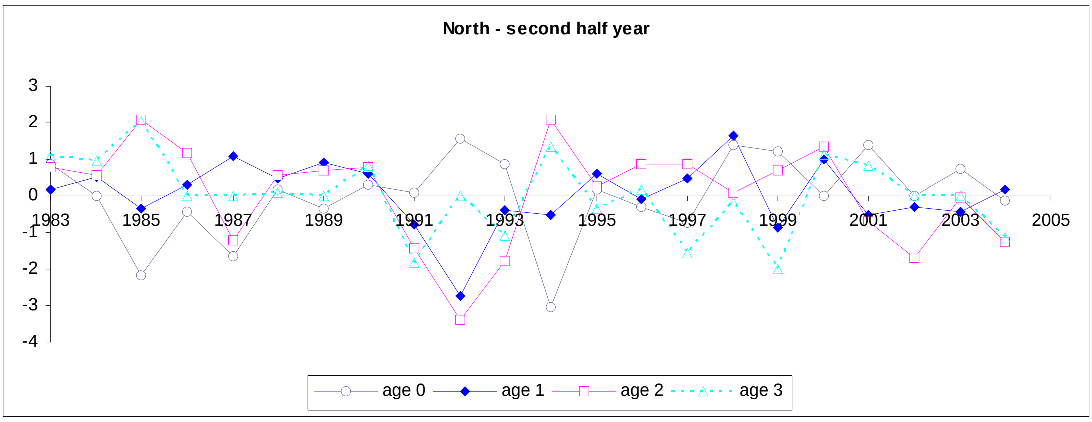


Figure 13.1.4.1 Sandeel in IV. Log residual stocknr. (nhat/n) by fleet. SXSA Run 01.







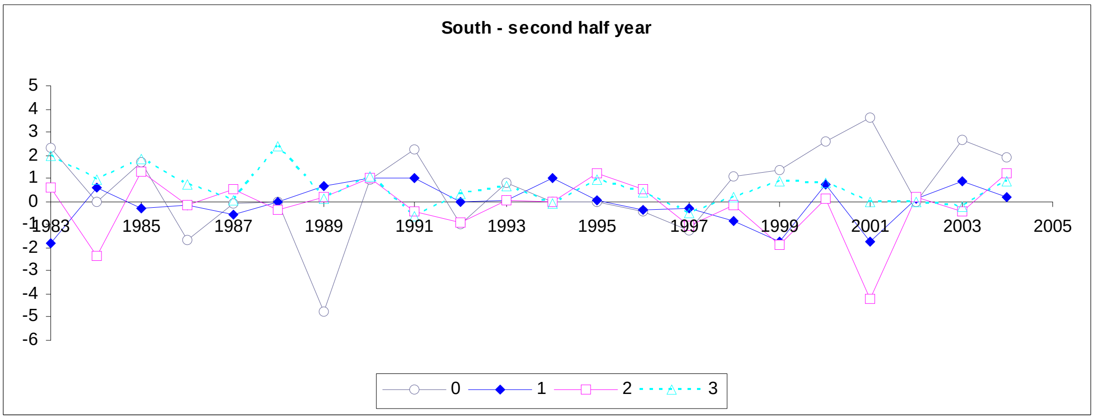
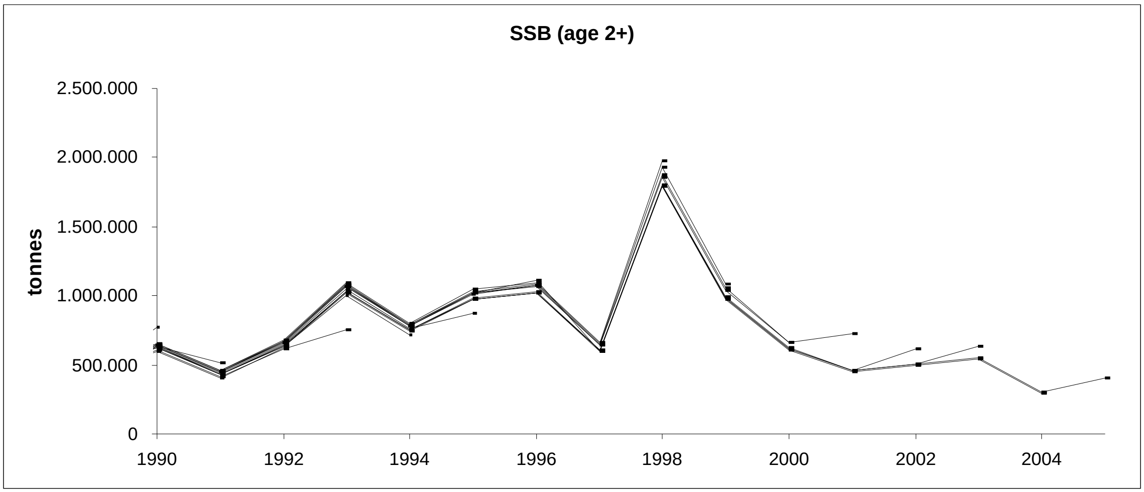
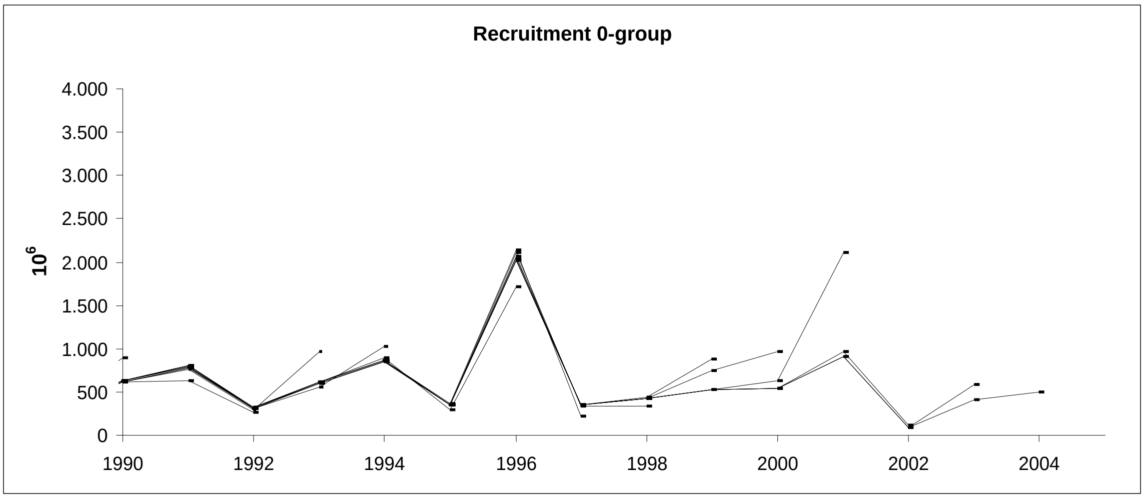


Figure 13.1.4.2 Sandeel IV. Retrospective analysis of SSB, recruitment, and Fbar 1990-2004 for SXSA run 01.





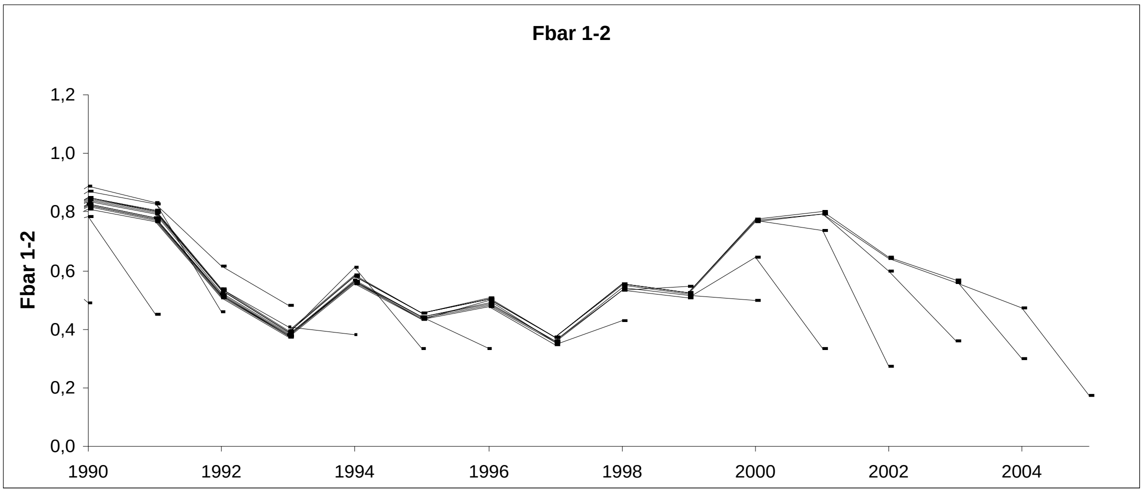


Figure 13.1.4.3 Sandeel in IV. Log residual stocknr. (nhat/n) by fleet. SXSA Run 02.

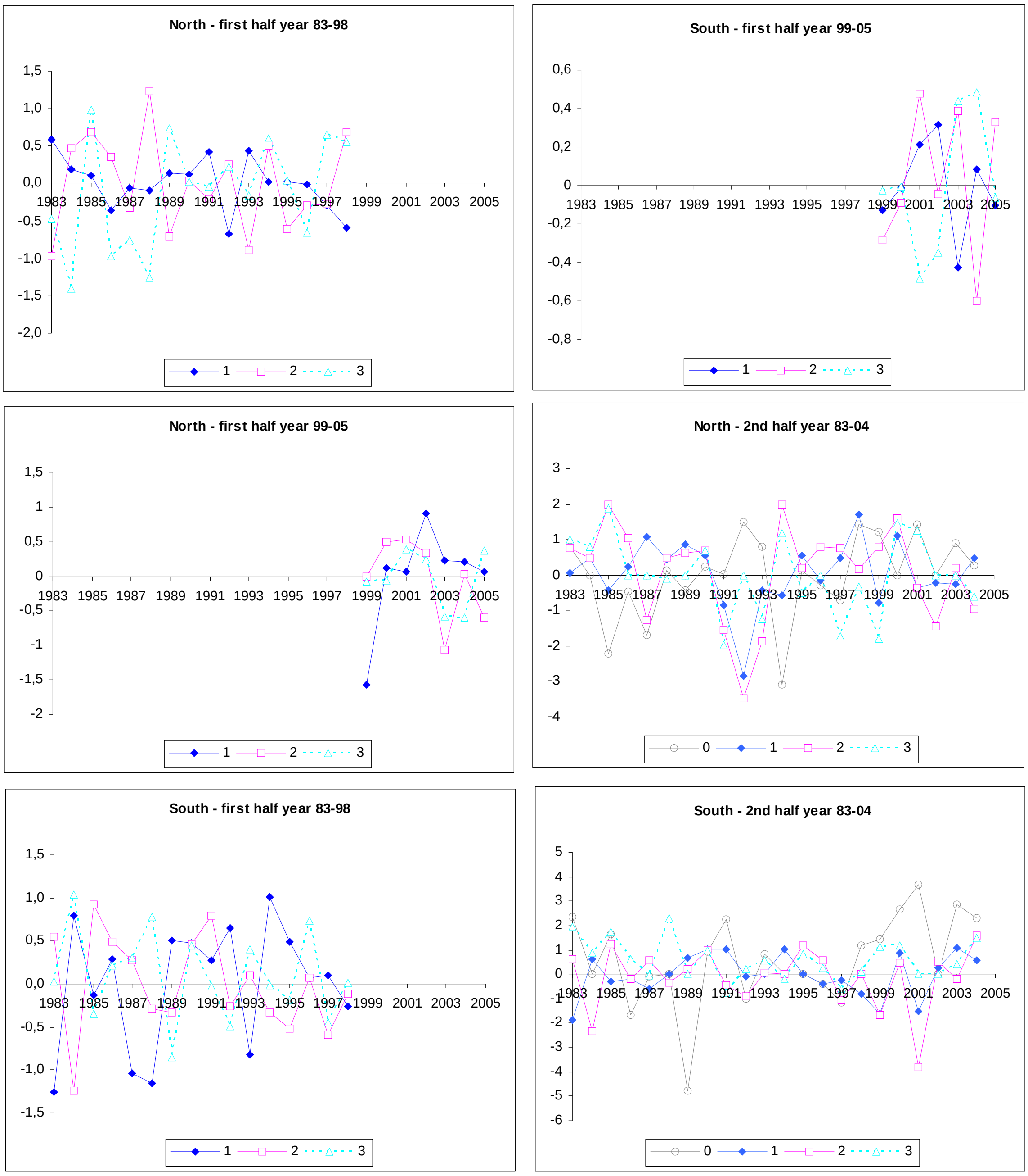


Figure 13.1.4.4 Sandeel IV. Retrospective analysis of SSB, recruitment, and Fbar 1990-2004 for SXSA run 02.

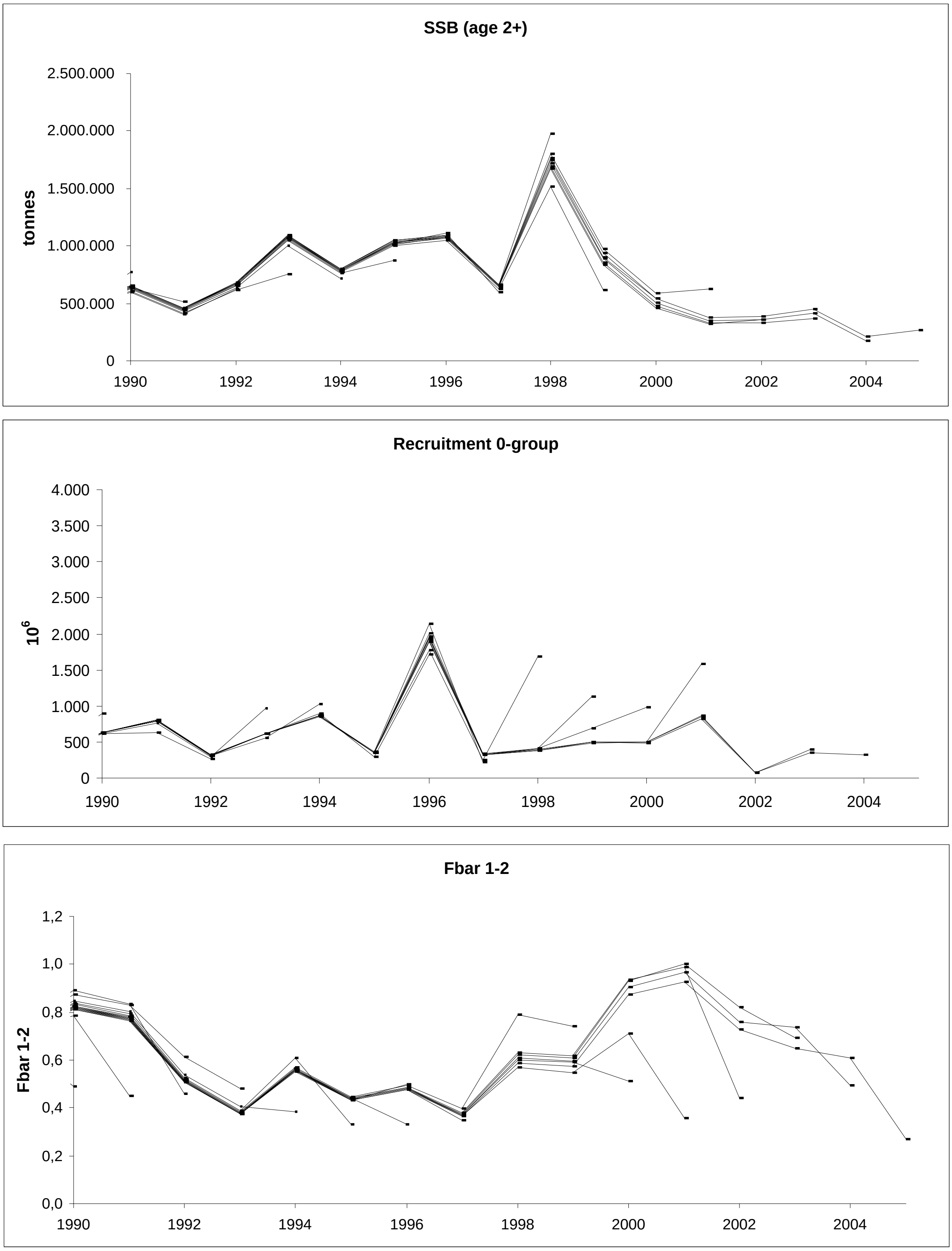


Figure 13.1.4.5 Sandeel in IV. Log residual stocknr. (nhat/n) by fleet. SXSA Run 03

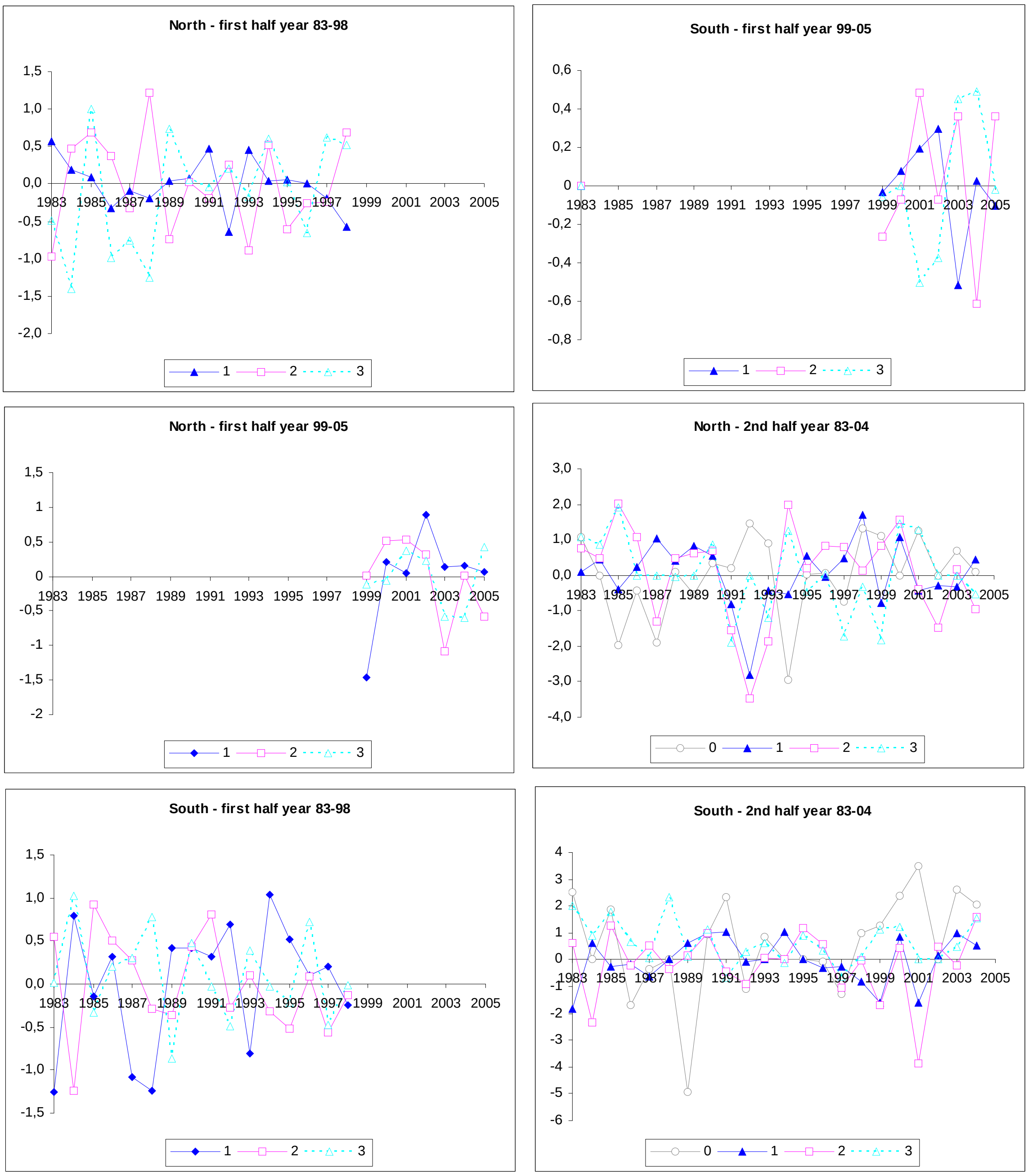
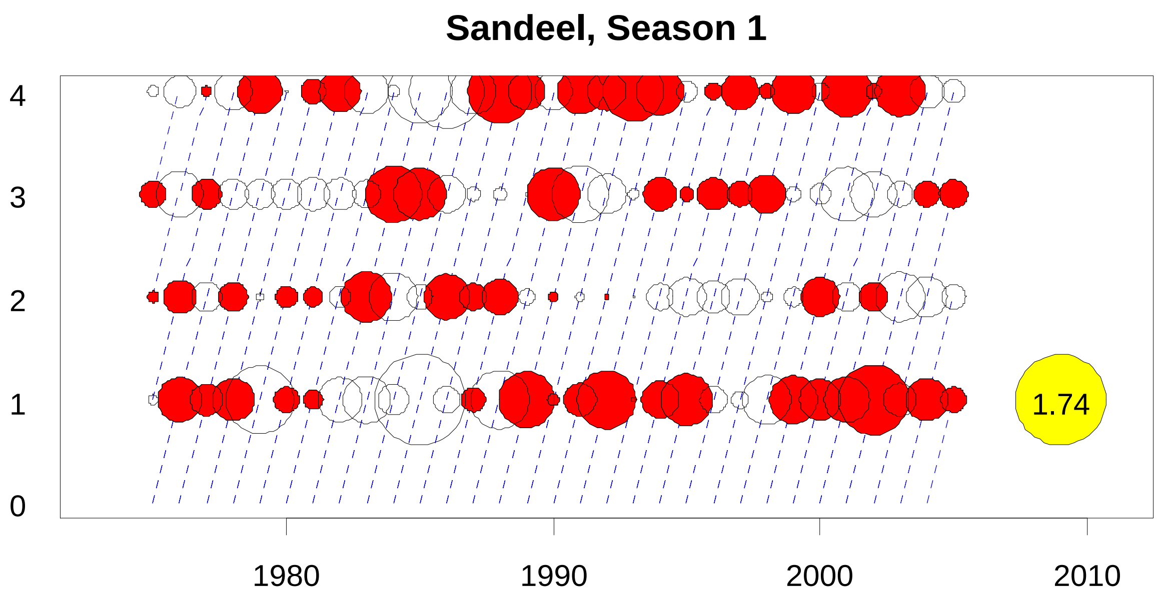


Figure 13.1.4.6 Sandeel in IV. Catch residuals from SMS explorative run 2. (red means more fish observed than expected). Scaling dependent on fleet.



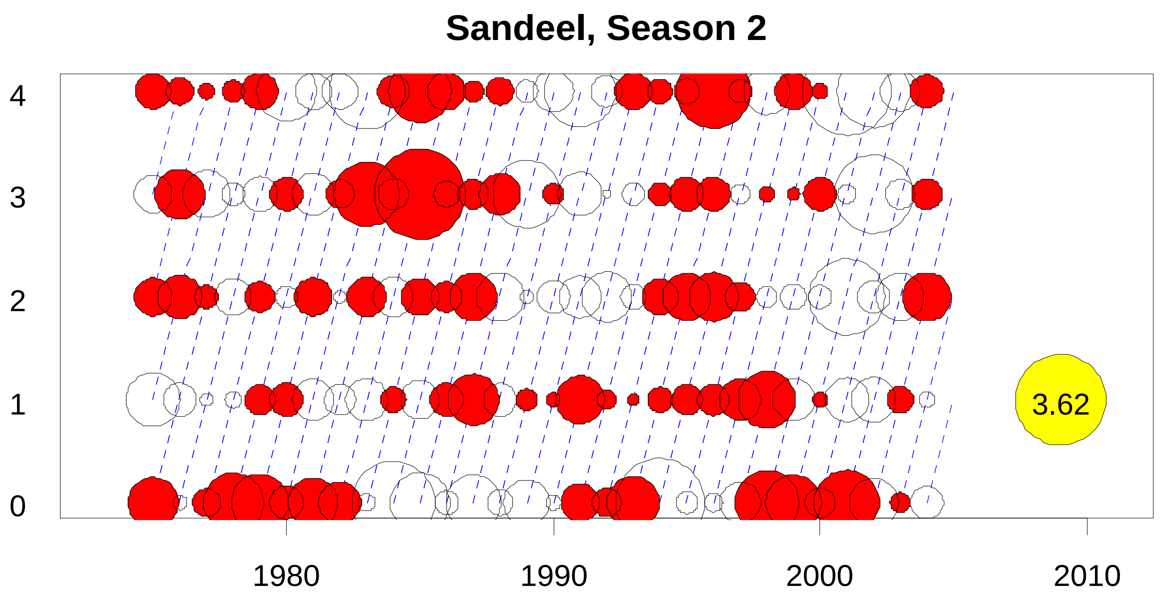


Figure 13.1.4.7 Sandeel in IV. Survey residuals from SMS explorative run 2. (red means more fish observed than expected). Scaling dependent on fleet.

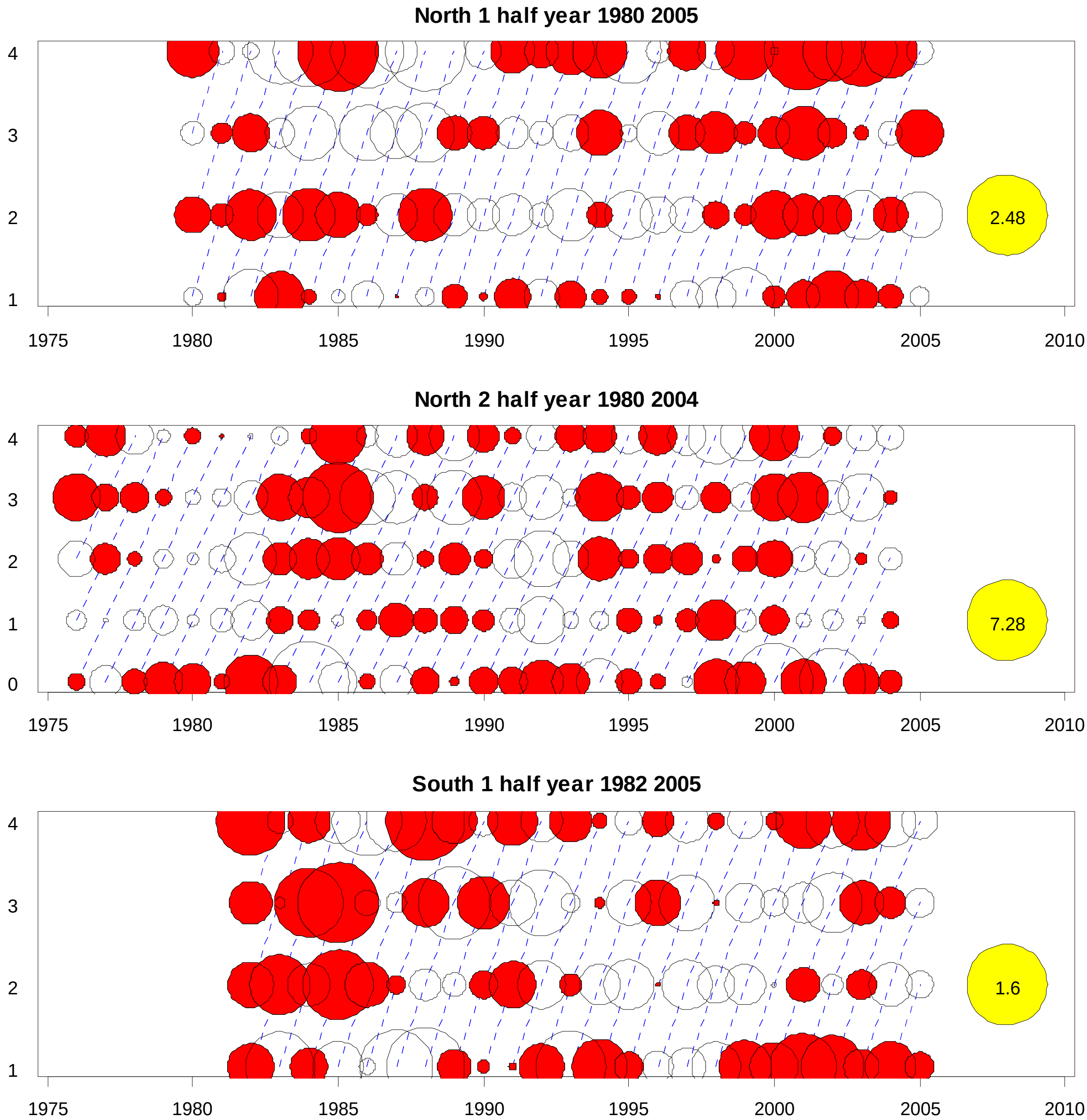
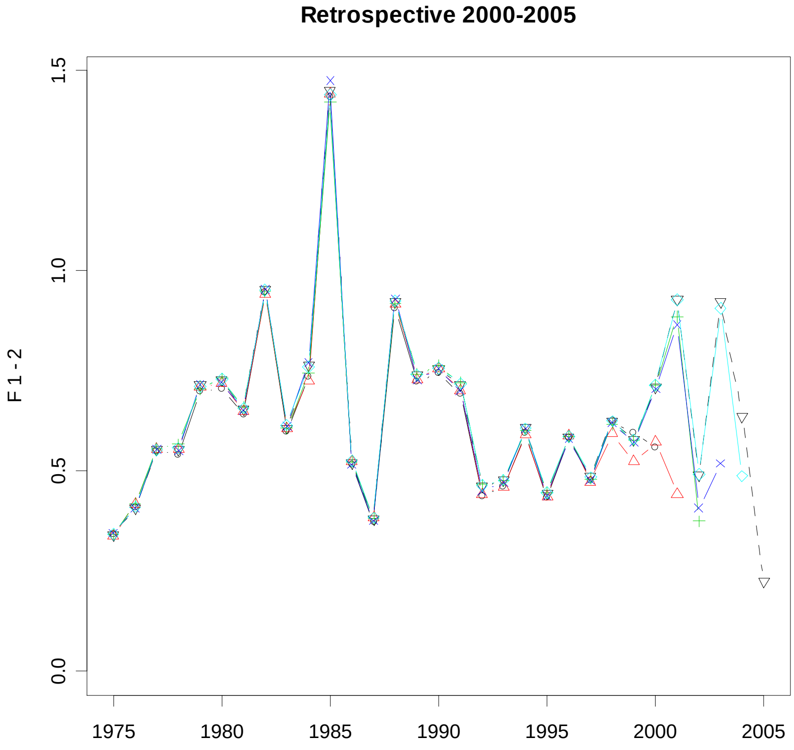


Figure 13.1.4.8 Sandeel in IV. SMS explorative run 2, Retrospective analysis all fleets



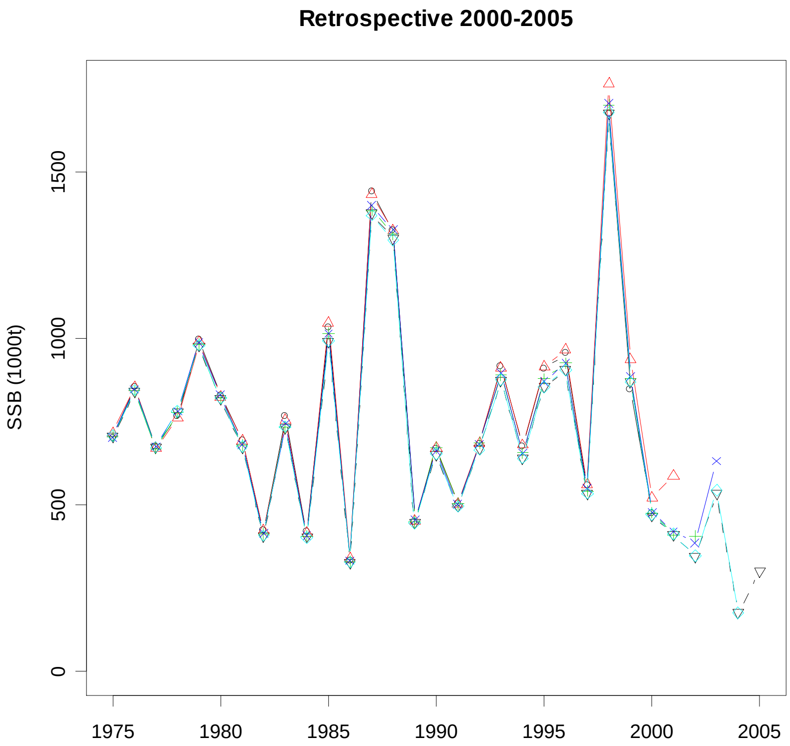
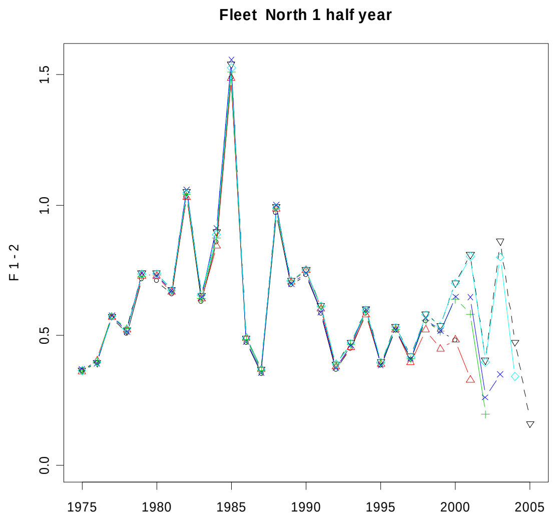
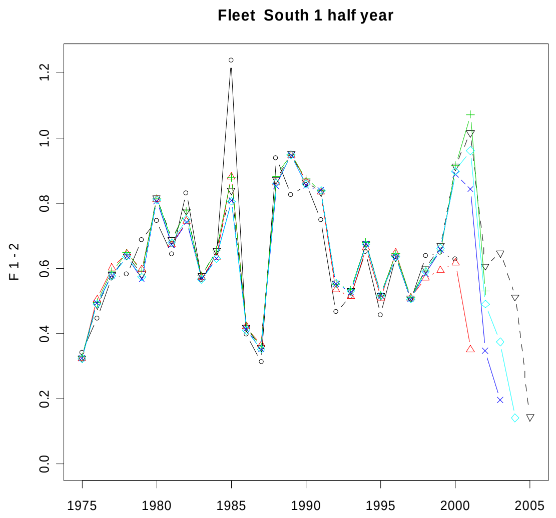


Figure 13.1.4.9 Sandeel in IV. SMS explorative run 2, Retrospective analysis by individual fleets.





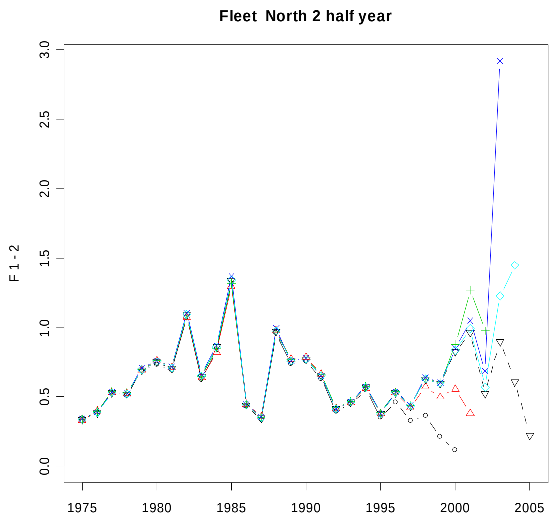
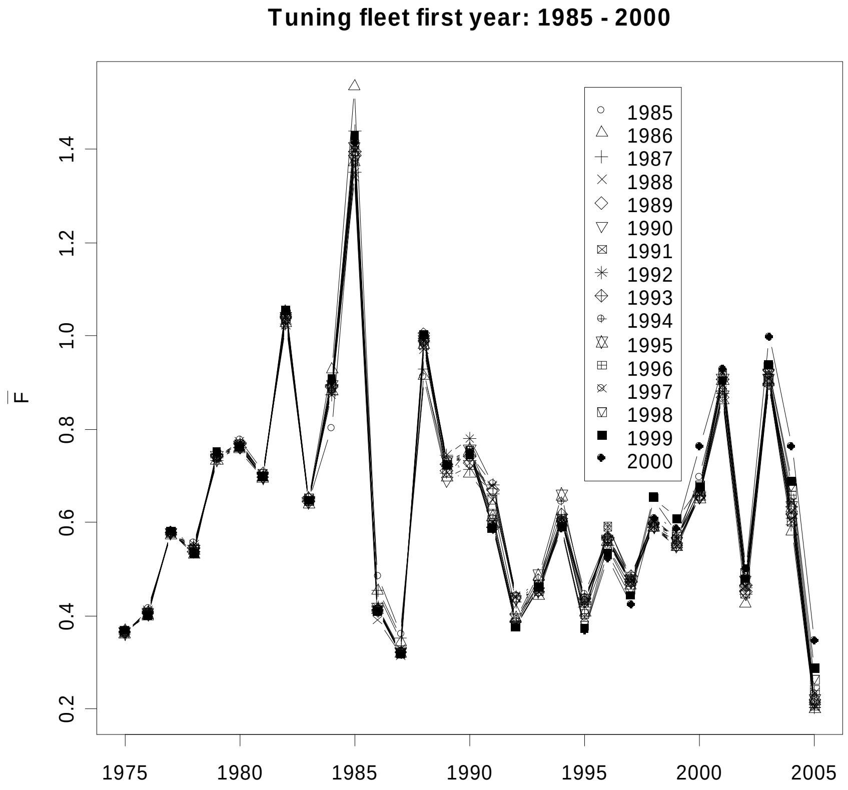


Figure 13.1.4.10 Sandeel in IV. SMS explorative run 2. Estimated SSB and F from various CPUE time series window, all fleets



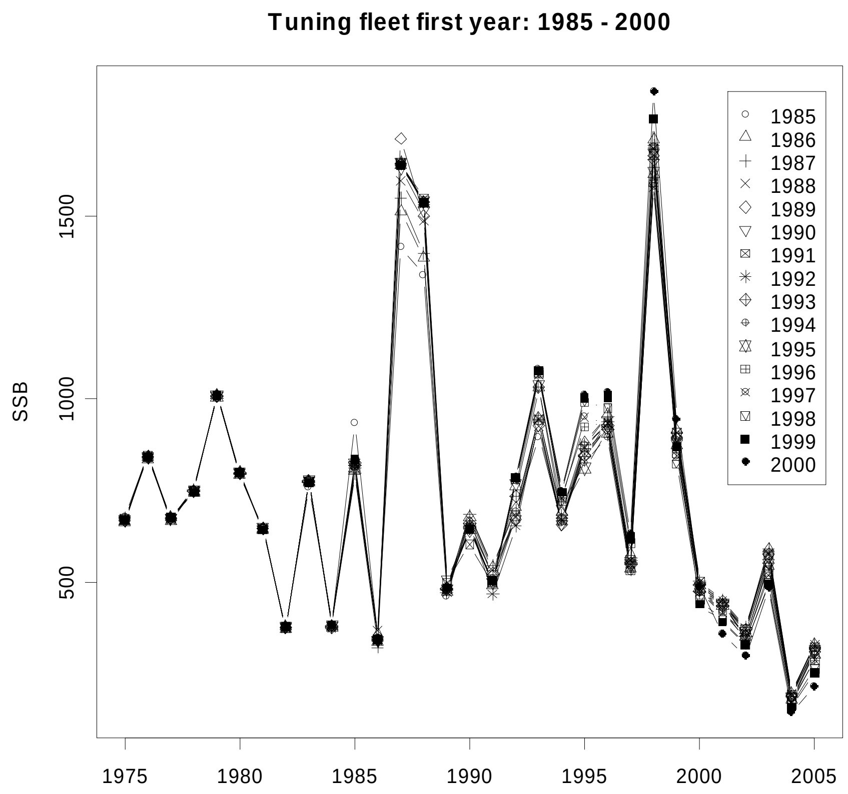


Figure 13.1.4.11 Sandeel in IV. SMS explorative run 2 Effect on estimated SSB and F in 20 of CPUE time series window, all fleets.

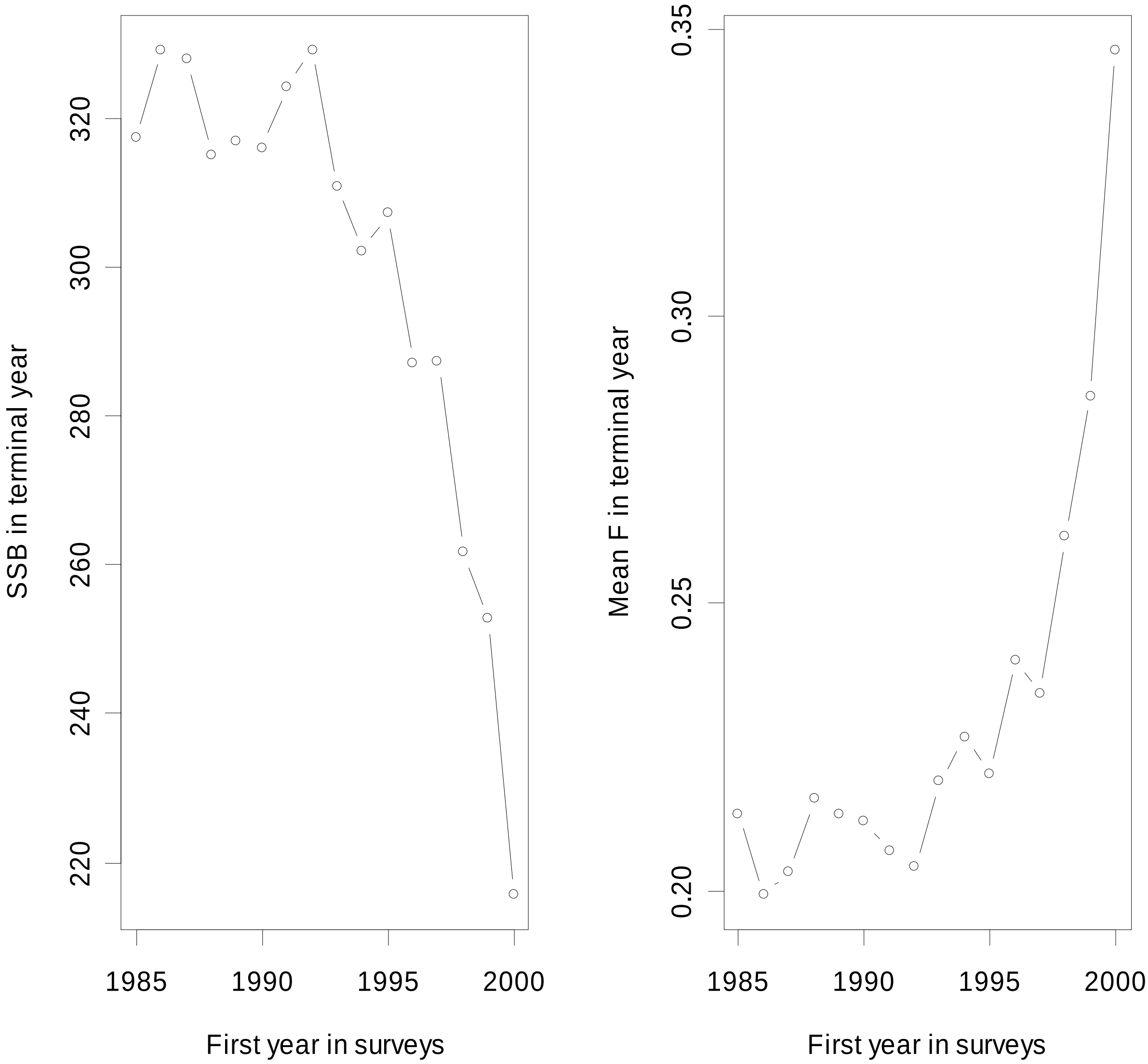
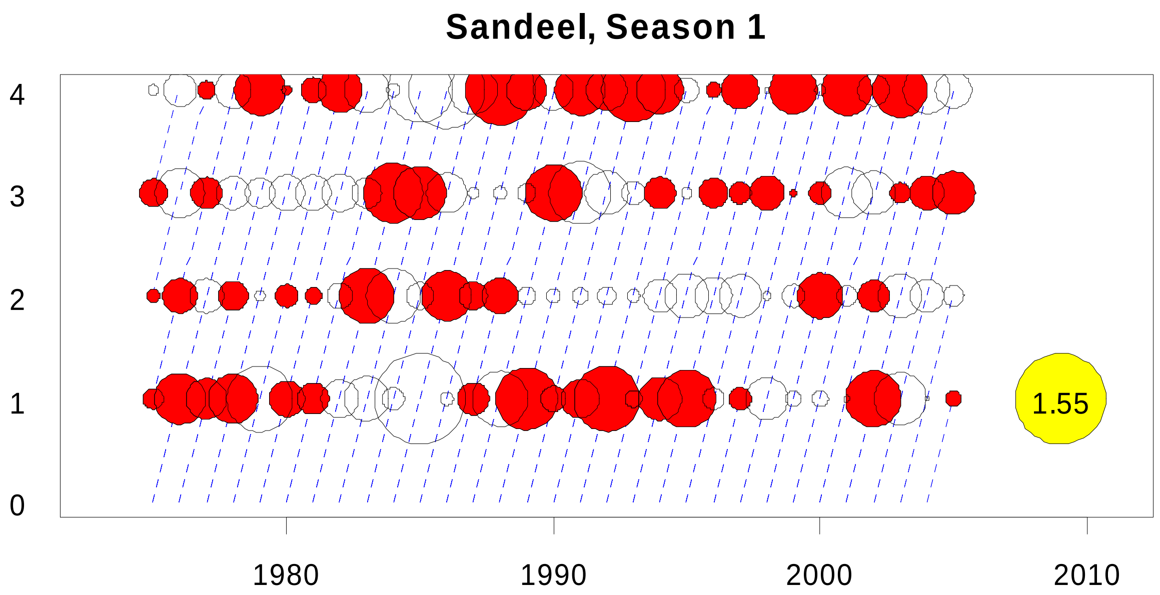


Figure 13.1.4.12 Sandeel in IV. SMS explorative run 3, Catch residuals. Scaling dependent on survey.



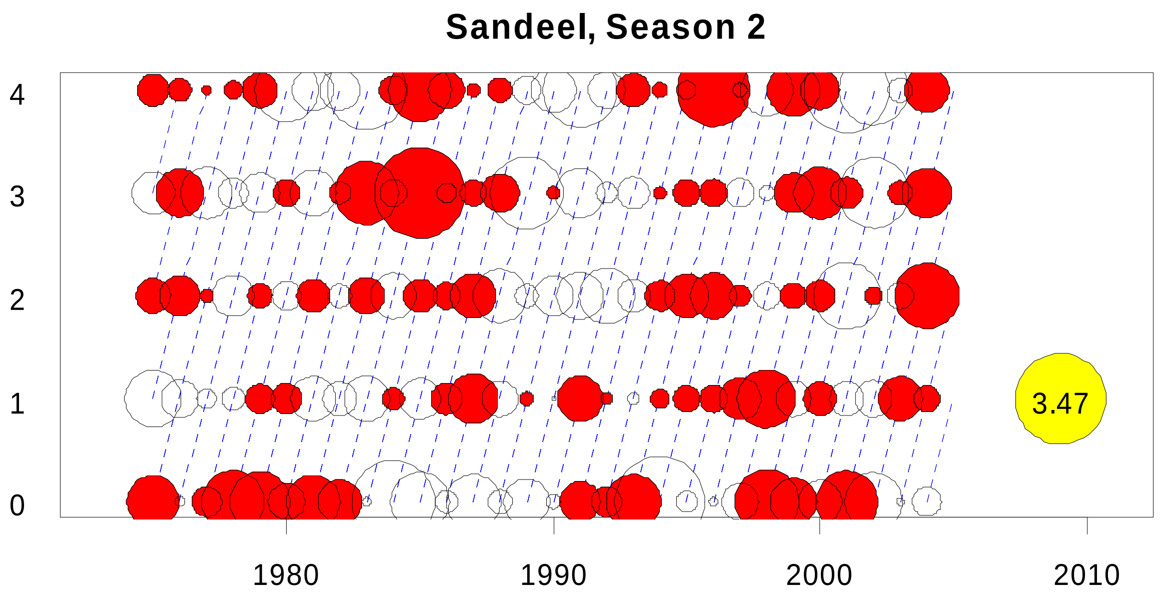


Figure 13.1.4.13 Sandeel in IV. SMS explorative run 3, CPUE residuals. Scaling dependent on survey.

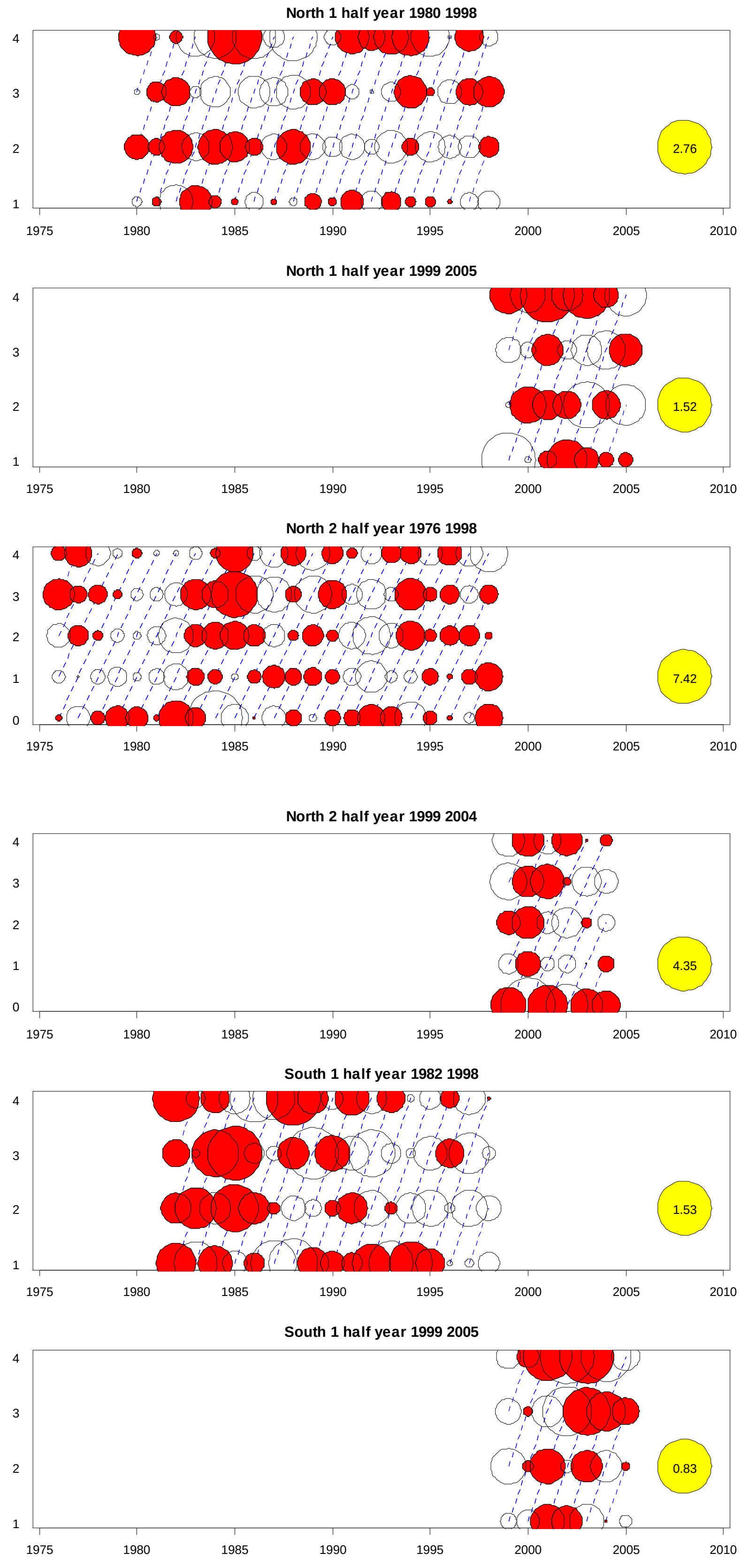


Figure 13.1.4.14 Sandeel in IV. SMS explorative run 3, Retrospective analysis, all fleets.

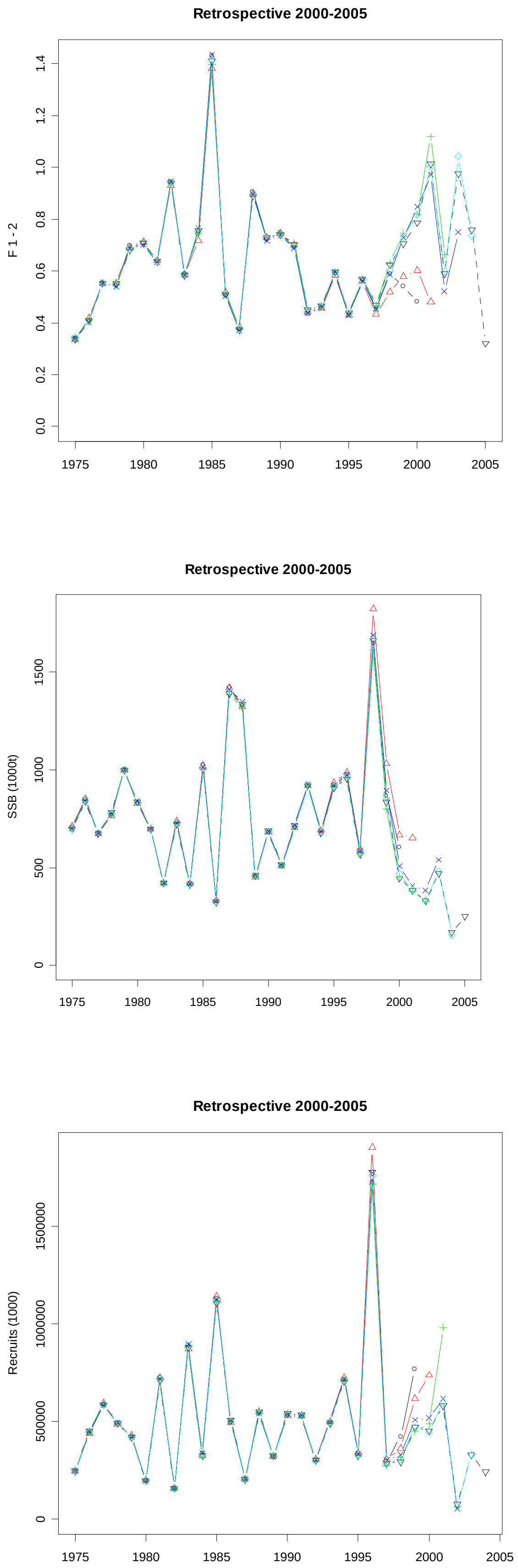
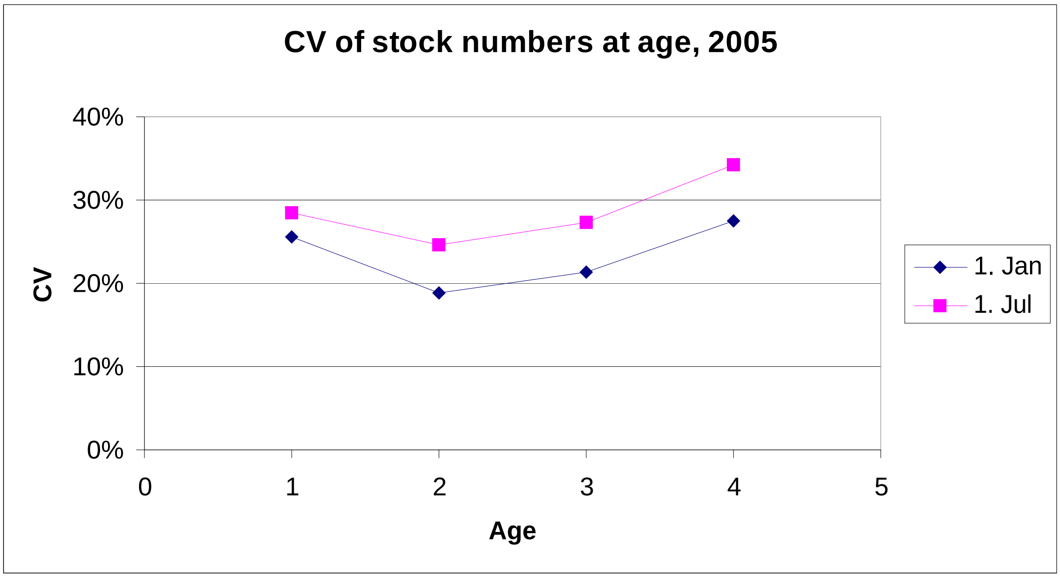


Figure 13.1.4.15 Sandeel in IV. SMS explorative run 03, Estimated CV at stock numbers, mean F and SSB



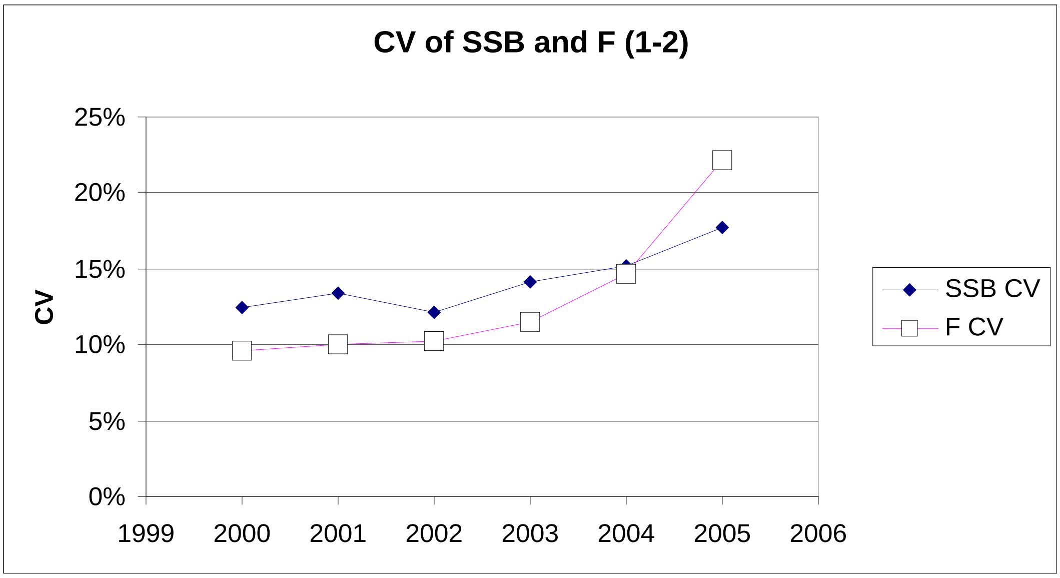
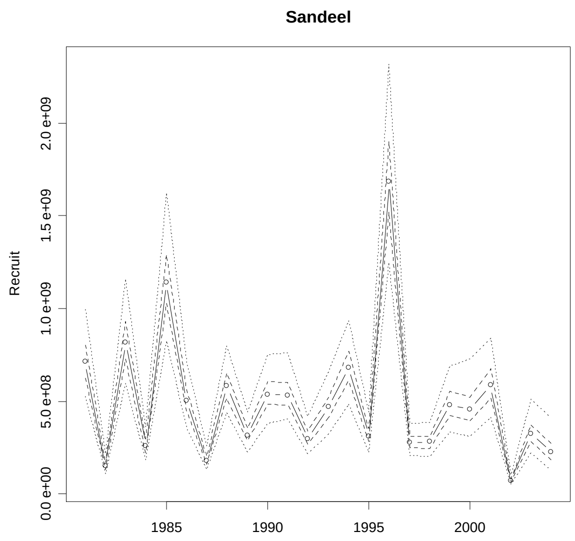
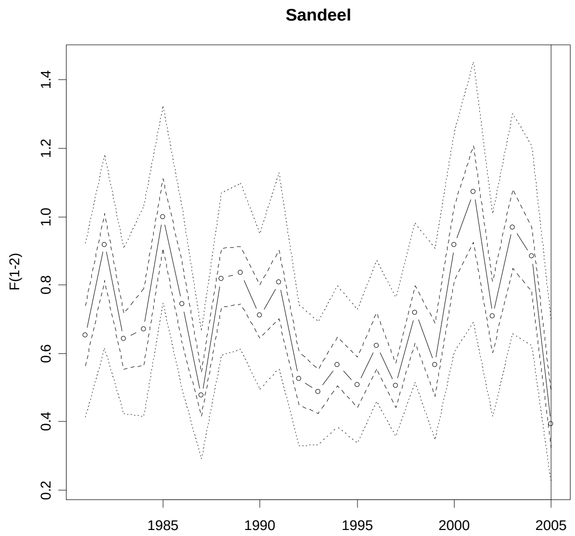


Figure 13.1.4.16 Sandeel in IV. SMS explorative run 03. Posterior density (2.5, 25, 50, 75 and 97.5 percentiles) of recruitment, average F and SSB estimated from 200000 Markov Chain Monte Carlo simulations.





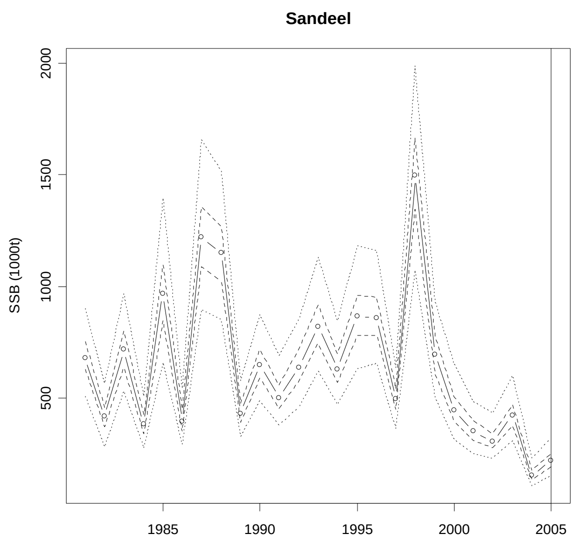
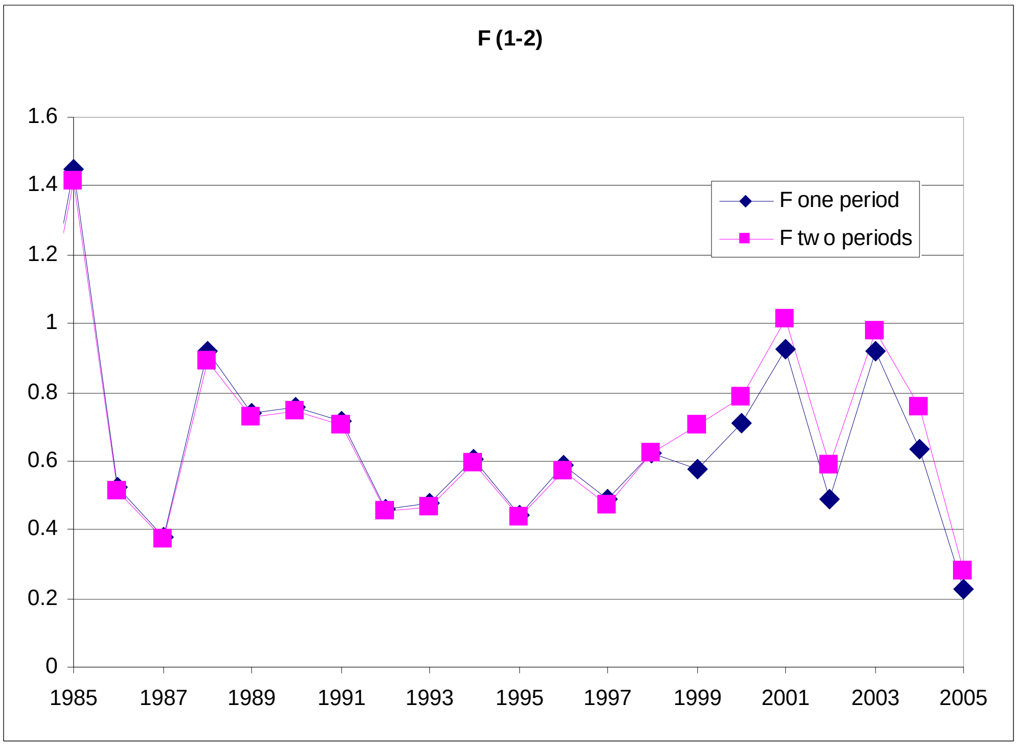


Figure 13.1.4.17 Sandeel in IV. Comparison of SMS explorative runs, with one or two separable periods.



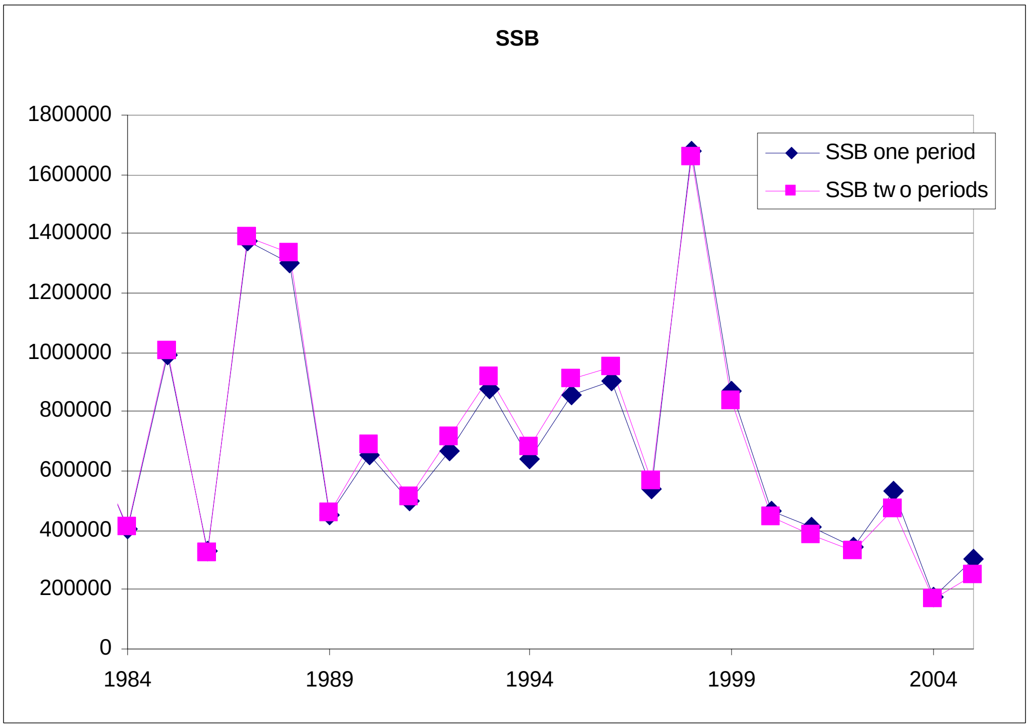


Figure 13.1.4.18 Sandeel in IV. Comparison of historical performances of assessments in 2005 using the SXSA and the SMS model.

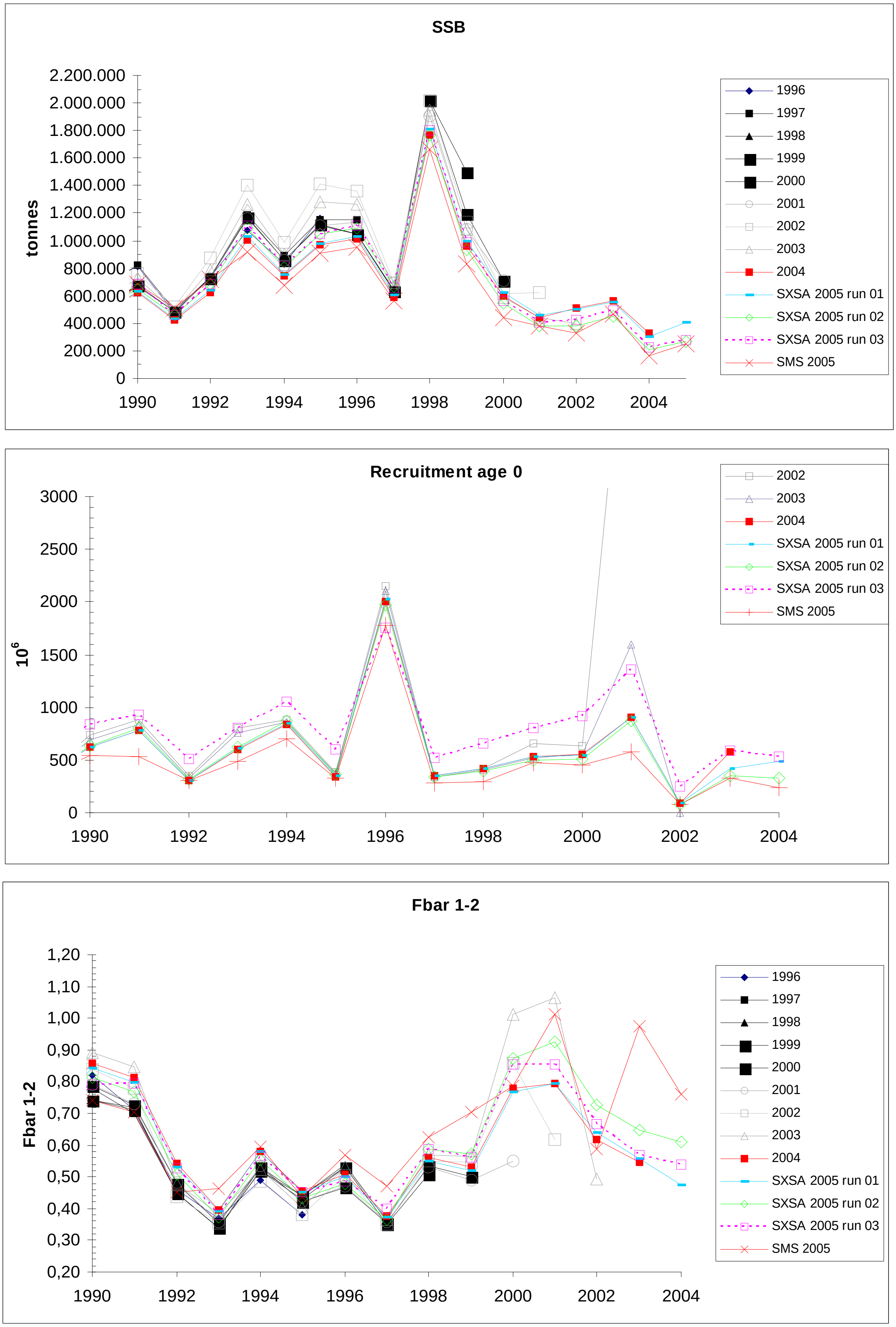


Figure 13.1.4.19 Sandeel in IV. Stock summary for SXSA run 02

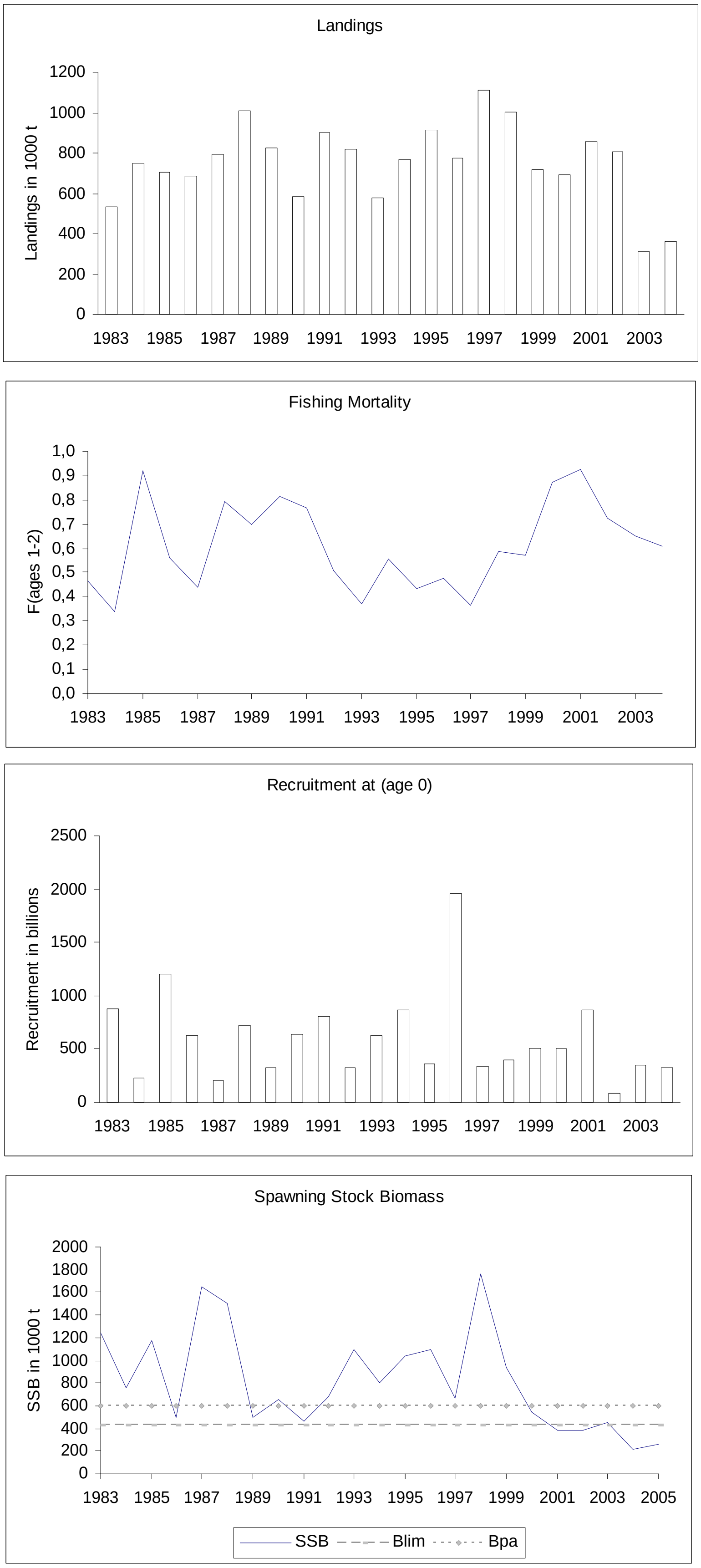
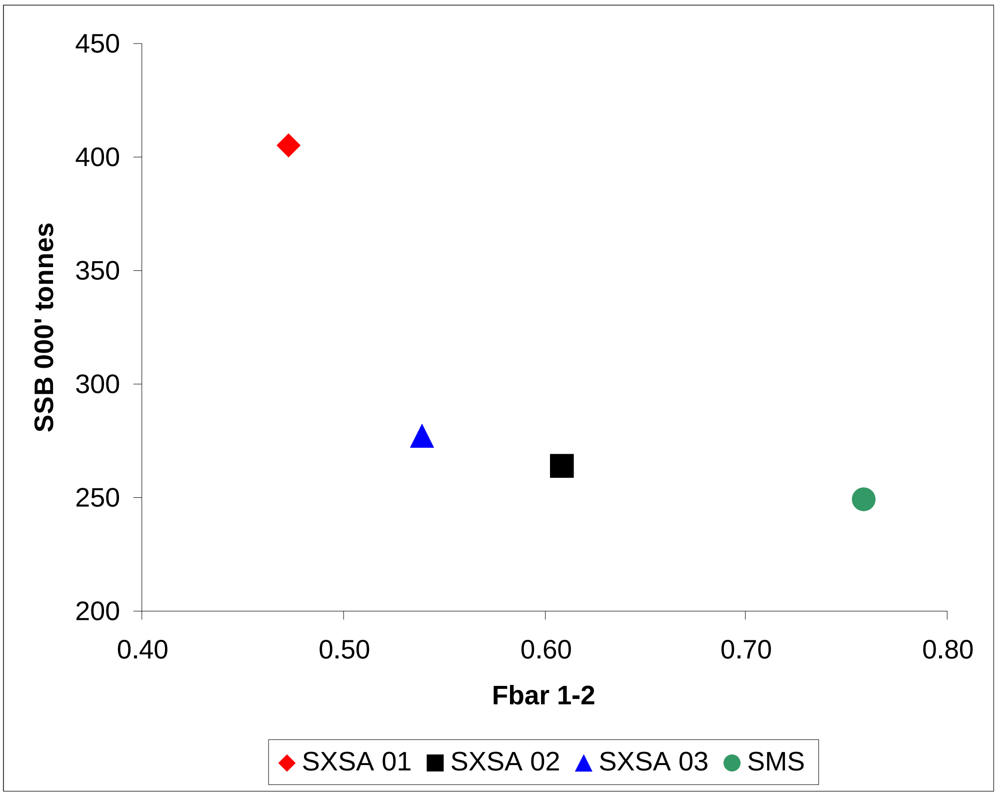


Figure 13.1.4.20 Sandeel in IV. Overview of exploratory runs.



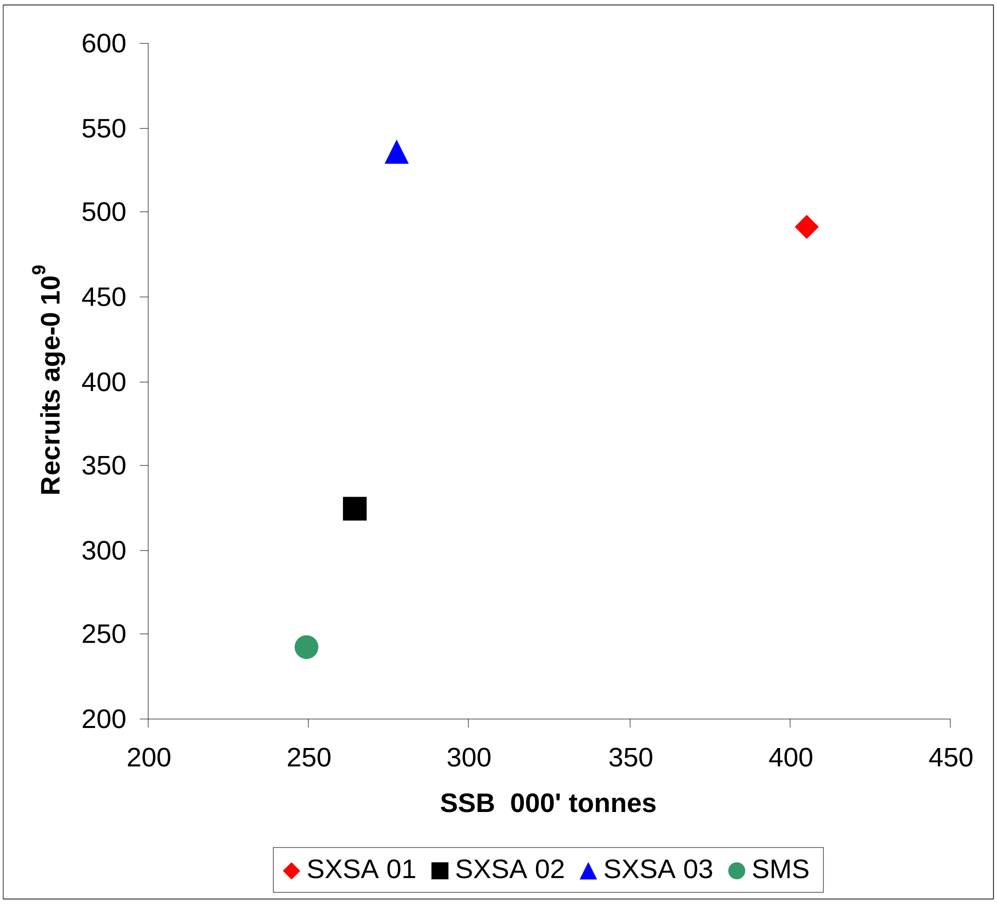
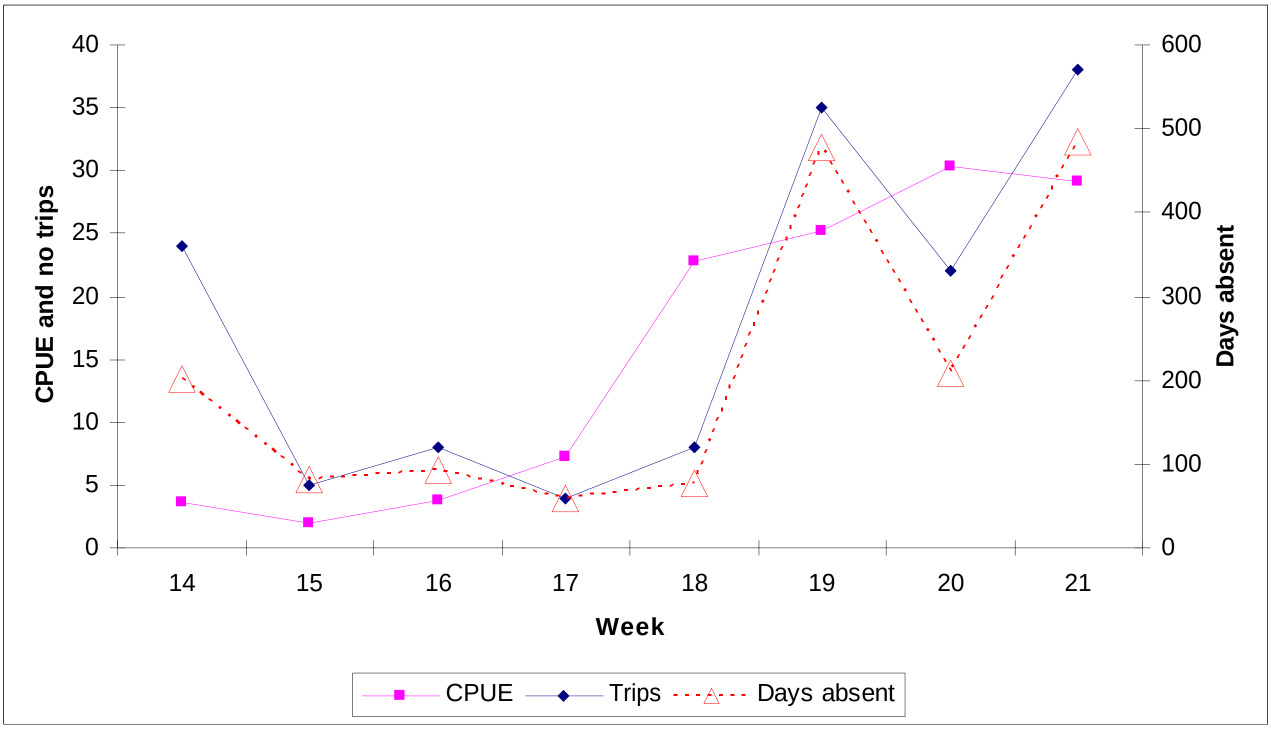


Figure 13.1.13.1. Fishing effort and CPUE of the Danish North Sea sandeel fishery in 2005. Effort is given as number of fishing trips and as days absent from harbour standardised to a 200 GT vessel. CPUE is calculated as catch weight per standardised days absent. The week number (given below) is calculated such that week 1 includes the first 7 days of 2005.



Week definition: ***13***: 8. Apr.-14 ***14***: 9-15 ***15***: 16-22 ***16***: 23-.29 ***17***: 30-6. May ***18***: 7-13 ***19***: 14-20 ***20***: 21-27 ***21***: 28-3 Jun. ***22***: 4-10 ***23***: 11-17

Figure 13.1.13.2. Sandeel in IV. Cumulated total effort (KW days * 10^3) of Danish vessels fishing sandeels in 2003 and 2004 by week.

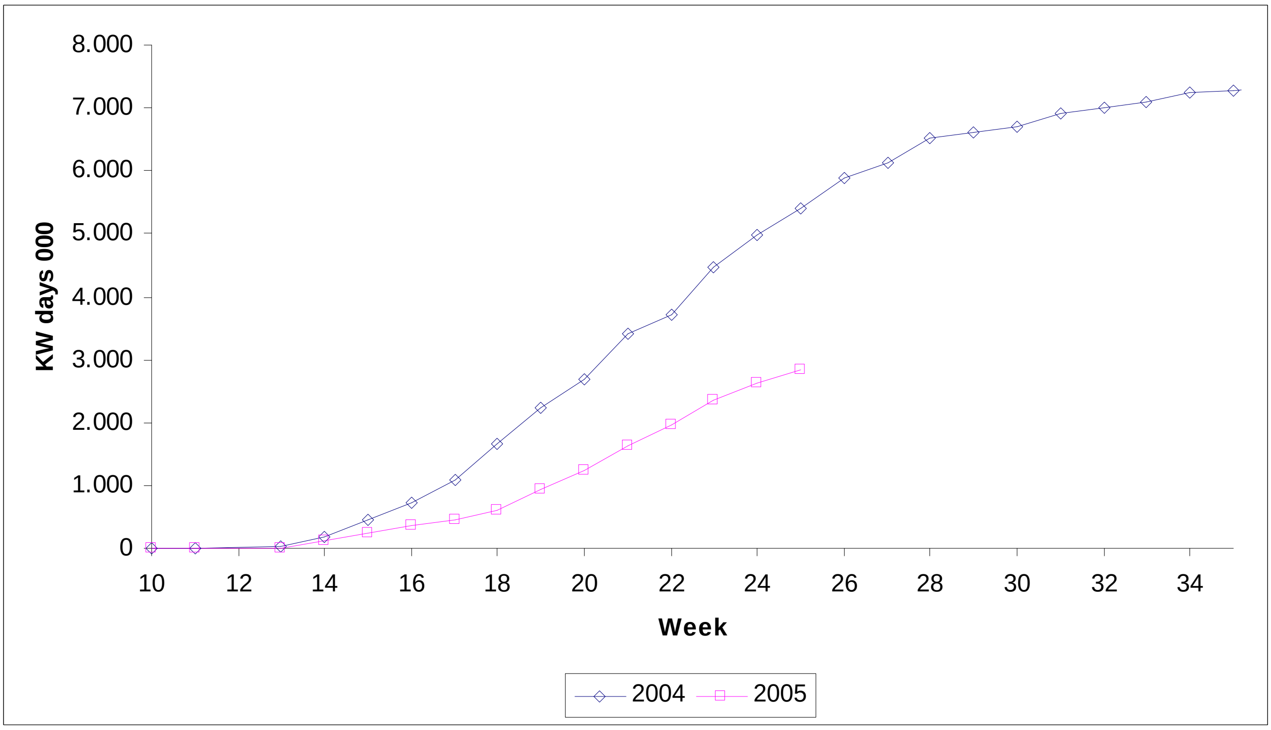
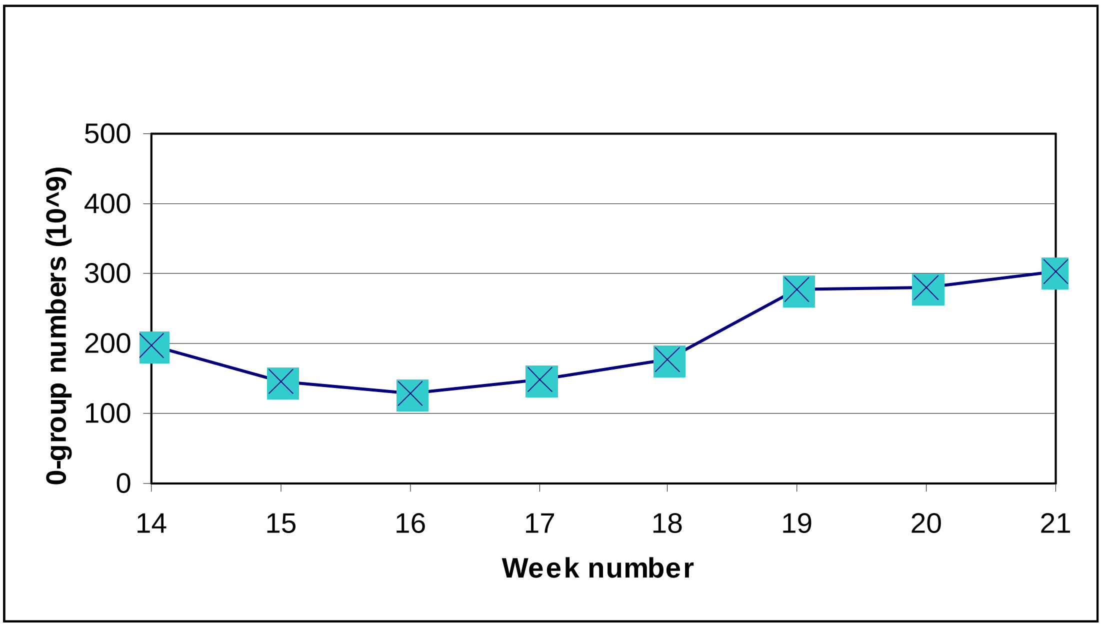


Figure 13.1.13.3. Sandeel in IV Abundance estimates of the 2004 year-class at age 0 sandeel by week.



14 NEPHROPS (Norway lobster) IN DIVISION IIIa and DIVISION IV

Nephrops stocks have previously been identified by WGNEPH on the basis of population distribution, and defined as separate Functional Units. The Functional Units (FU) are defined by the groupings of ICES statistical rectangles given inTable 14.1and illustrated in Figure 14.1. Functional Units are aggregated into Management Areas (MA) (**Table 14.1**), the level at which WGNEPH and ACFM have previously recommended management should take place.

Nephrops management is provided at the Division level, with Division IIIa discussed in Section 14.1 and Division IV in Section 14.3. Within Division, examination and analysis of the data available is provided on a Management Area and stock by stock basis, with Management Area E (FU3&4) in Section 14.1.1, Management Area F (FU9&10) in Section 14.3.1, Management Area G (FU7) in Section 14.3.2, Management Area S (FU32) in Section 14.3.3, Management Area I (FU6&8) in Section 14.3.4 and Management Area H (FU5&33) in Section 14.3.5. Management considerations for Division IIIa and Division IV are discussed as a whole in Sections 14.2 and 14.4 respectively.

Landings are reported by Management area in Table 14.2.

The trends observed in the North Sea Commission Fisheries Partnership stock survey for *Nephrops* are shown in Figure 14.40. These are discussed in each Management Area section.

General comments relating to all Nephrops stocks

Hitherto, ICES has assessed the *Nephrops* stocks on a bi-annual circle. The last regular assessment was conducted in 2003, providing advice for 2004 and 2005. Because of the nature of *Nephrops* assessments, it has not been possible to provide catch predictions in previous advice. TAC advice has therefore generally been based on average historical landings.

Previously WGNEPH has conducted a variety of analyses on the *Nephrops* data, including XSA, examination of trends in underwater TV surveys and a review of a number of stock indicators, and these have been repeated here.

Other assessment approaches are also being considered by WKNEPH (Workshop on *Nephrops* stocks), including length based SURBA and VPA methods, and CSA.

Nephrops cannot be aged directly, and so for age based cohort analysis approaches have been investigated to generate pseudo-ages from slicing length frequency distributions, on the basis of growth parameters. Concerns have been raised at both WGNEPH and WGNSDS about the implications of the use of the knife edge slicing technique for catch at age analysis of the resulting year classes. The increase in variability in length at age for older individuals may lead to a number of “real” ages being included within a sliced age, leading to an overestimation of F.

Although examined as exploratory runs, XSA assessments were not included in the report owing to concerns over the appropriateness of this approach. Therefore yield and biomass per recruit on the basis of XSA results have not been included.

Medium-term projections have not been conducted. WGNEPH has previously expressed concerns over the appropriateness of such approaches for *Nephrops*, where stock recruit relationships are poorly understood, and WGNSDS had further concerns over the required age structured assessment.

Differences in burrow emergence patterns in relation to reproductive behaviour mean that mature female *Nephrops* spend much of the period while ovigerous (typically September to

April) within their burrows, and are therefore less available to trawl fisheries at this time. This results in lower exploitation of the female component of the stock.

No reference points have been determined for *Nephrops* stocks.

Ecosystem aspects

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

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

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

Recent reports from industry and gear technologists suggest a more widespread use of “flip-up” gear in twin rig *Nephrops* trawls (see Graham WD). This development will allow fleets to expand onto rougher ground, potentially exploiting new *Nephrops* areas.

14.1 NEPHROPS IN Division IIIa

Division IIIa contains MA E, which includes FU 3 and 4. These two FU’s are assessed together.

Management

The 2004 and 2005 TAC for *Nephrops* in ICES area IIIa was 4 600 tonnes.

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

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

EU catch restrictions apply to *Nephrops* trawlers.

Official catch statistics for Division IIIa are presented in Table 14.3. Some minor revisions have been made to 2002 catch data.

14.1.1 Nephrops in Management Area E

Advice

In 2003 ICES concluded that

the stocks in this Management Area appear to be exploited at sustainable levels

and advised that

“there is no basis to change the previous advice for Division IIIa, given in 2001, and a total catch of less than 4 700 t for both 2004 and 2005 can be taken”.

Landings from MA E by FU and other rectangles outside FU are shown in Table 14.4. Landings from other rectangles are low. Landings by country are shown in Table 14.5.

14.1.1.1 Skagerrak and Kattegat (FU 3 & FU 4)

The Danish, Swedish and Norwegian *Nephrops* fisheries in the area are described in the 1999 WGNEPH report (ICES, 1999a). Some changes have taken place in these fisheries in recent years. For the Swedish fishery a trend in the twin trawl fishery can be seen towards a more mixed fishery for fish and *Nephrops*, while single trawlers continue to target mainly *Nephrops*. Around 50 % of the Swedish annual *Nephrops* landings normally originate from coastal waters. The restrictions in the fisheries for cod in particular seem to have resulted in some significant changes in the Danish fisheries for *Nephrops*. Traditionally, *Nephrops* have mainly been caught in trawls using 70-89 mm mesh sizes. In the last five years an increasing proportion of total landings of *Nephrops* have been caught by vessels using gears with mesh sizes >89mm (which historically have been used in the fishery for cod, plaice and other demersal fish species). In Skagerrak and Kattegat mesh sizes between 70-89 mm have been prohibited since 2005 unless the codend and the extension piece is constructed of square meshed netting with a sorting grid (Council Regulation 27/2005). Those changes in fishing patterns may be seen in the light of the declines in most important demersal fish stocks in the North Sea, Skagerrak and Kattegat. Economically, *Nephrops* has in recent years been one of the most important human consumption species in the Danish fishery in IIIa.

14.1.1.1.1 The fishery in 2004

Skagerrak

Denmark, Sweden and Norway exploit this stock. Denmark and Sweden dominate in this fishery, with 69 % and 27 % by weight of the landings in 2004 (Table 14.6). Landings by the Swedish creel fishery represent 13-18 % of the total Swedish *Nephrops* landings from the Skagerrak in the period 1991 to 2002 and has increased in recent years to 28% in 2004.

In the early 1980s, total *Nephrops* landings from the Skagerrak increased from around 1,000t to just over 2,670t, upon which they remained fluctuating at a level between 2,000 and 3,000t. After a drop in 1992-94, the landings increased again to an all time high of about 3,250t in 1998 followed by a slight decreasing trend.

Kattegat

Both Denmark and Sweden have *Nephrops* directed fisheries in the Kattegat. In 2004, Denmark accounted for about 83 % of total landings, while Sweden took remaining 17 %.

After the low that was observed in 1994, total *Nephrops* landings from the Kattegat increased again until 1998. Since then, they seem to have stabilised around 1800 t but show a decrease in 2002 and an increase again in recent two years (Figure 14.4). Trends are similar for Denmark and Sweden.

14.1.1.1.2 Catch, effort and research vessel data

Skagerrak

Effort data for the Swedish fleet are available from logbooks for 1978-2004 (Figure 14.2) with the last 14 years being separated into single and twin trawl (also see Figure 14.3). The log book trawl category for *Nephrops* single trawlers can be distinguished targeting *Nephrops* during the whole period while the twin trawler show a shift to targeting both fish and *Nephrops* in recent years. Total Swedish trawling effort sharply decreased between 1992 and

1996, and has shown a decreasing trend since then. Effort in recent year is about 25% of the peak in the beginning of 1990s.

Over the same period of time, the LPUEs first increased to peak in 1998, then decreased slightly again in 2000 and 2001. Since 2002 LPUE of the *Nephrops* directed single trawlers increased again and shows the highest overall LPUE for the whole period in 2004.

Figure 14.3 show the landings, effort and LPUEs by quarter and sex from Swedish single and twin trawlers. After a decline in LPUE for males in 2000 and 2001 an increase is shown for 2002 to 2004. The females show an opposite trend during the last four years meaning that the overall increase in LPUE in recent years is due to an increase in LPUE of males.

Danish effort figures for the Skagerrak (**Table 14.8** and Figure 14.2) were estimated from logbook data. For the whole period, it is assumed that effort is exerted mainly by vessels using twin trawls. The overall trend in effort for the Danish fleet is similar to that in the Swedish fishery. After having been at a relatively low level in 1994-97, effort increased again in the next five years followed by a decrease in the two most recent years. The trend in LPUE is similar to that in the Swedish fishery, with a declining trend since 1998 and an increase in 2002 but has been stable in the two most recent years while the Swedish LPUE increases (Figure 1.2).

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

Kattegat

Swedish standardised total effort has been relatively stable over the period 1978-90. An increase is noted in 1993 and 1994, followed by a decrease until 1996, and a stabilisation at intermediate levels in the past years (Figure 14.4). Figures for total Danish effort are based on logbook records since 1987. Danish effort increased during 1995 to 2001, but since then it has been showing a decreasing trend until 2004 (Figure 14.4).

The Swedish and Danish annual LPUEs show similar trends. The LPUEs were at their lowest in 1989-94, then increased again up to 1997 followed by a decrease. In the past two years, the LPUEs have increased for both countries (Table 14.11 and Table 14.12; Figure 14.4).

Skagerrak and Kattegat

The trends in effort and LPUE are very similar for the Skagerrak and the Kattegat (FUs 3 and 4) for both the Swedish and the Danish fleet (Figure 14.7). Overall effort (all areas and all fleets combined) decreased from 1991 to 1996, but from 1996-2000 a slight increase was seen followed by a constant level in 2001 and 2002 and a decrease in recent two years to the lowest effort levels in the period.

For both areas the discard samples and the corresponding samples of landed catch are raised to totals by raising the average weight ratios landed catch/discards obtained from the at-sea-sampling. This is done on a quarterly basis. The Danish and Swedish discard sampling programme are the basis for estimation of total catch of *Nephrops*. Although catch estimations are available for 1991 to 2004, LPUE are considered more reliable and are therefore used in the indicator assessments for this MA.

14.1.1.1.3 Catch structure

Skagerrak

For the Skagerrak, size distributions of both the landings and discards are available from both Denmark and Sweden for 1991-2004. Of these, the Swedish data series can be considered as being the most complete, since sampling took place regularly throughout the time period and usually covered the whole year. The Swedish discard samples are obtained by agreement with selected fishermen, and this might tempt fishermen to bias the samples. However, the reliability of the catch samplings is cross-checked by special discard sampling projects in both the Skagerrak and the Kattegat. In recent years the Swedish *Nephrops* sampling is highly dependent on onboard observers discard sampling for both Skagerrak and Kattegat. Geographically, the samples from the Swedish fishery mainly cover the north-eastern part of the Skagerrak.

In 1991, a biological sampling programme of the Danish *Nephrops* fishery was started on board the fishing vessels, in order to also cover the discards in this fishery. Due to its high cost and the lack of manpower, Danish sampling intensity in the early years was in general not satisfactory, and seasonal variations were not often adequately covered. However, in recent years the Danish at-sea-sampling has improved considerably. The Norwegian *Nephrops* fishery is small and has not been sampled. Trends in mean size in catch and landings are shown in Figure 14.2 and **Table 14.9**.

Figure 14.5 gives an idea of the high amounts of discards in the *Nephrops* fisheries in the Skagerrak, and of the differences in numbers between the Danish and Swedish fisheries. It appears that the proportion of discards are higher in the Danish catches than in the Swedish. These are probably due both to geographical differences in stock composition on the main fishing grounds visited by the three fleets, and to differences in the fishing gear used.

Kattegat

For the Kattegat, size distributions of both the landings and discards are available from Sweden for 1990-1992 and 2004, and from Denmark for 1992-2004. The at-sea-sampling intensity has increased in recent years. The results of the Danish sampling programme indicate very variable levels of discards in the Kattegat trawl fishery for *Nephrops* in the beginning of the period of data. Discarding levels are compared in Figure 14.6 Trends in mean size are shown in Figure 14.4 and Table 14.13.

14.1.1.1.4 Natural mortality, maturity at age and other biological parameters

No data considered at the WG, as catch at age analysis not considered viable.

14.1.1.1.5 Final assessment

No analytical assessment is presented for this stock

Long- term trends in biomass, effort and recruitment

The assessment of the state of the *Nephrops* stocks in the Skagerrak and Kattegat area is based on the patterns in fluctuations of total combined LPUE by Denmark and Sweden during the period 1990-2004 and the patterns in fluctuations of discards in the fisheries as estimated from the catch samples for the same period.

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

Since the abundance of *Nephrops* discards (mainly small specimens below minimum landing size) may also be regarded as an index of recruitment, they can be used to further explain the current developments in the stocks. The large amounts of discards in the periods 1993-95 and 1999-2000 reflect strong recruitment during these years (Figure 14.6). The high levels of recruitment in 1993-95 are believed to have significantly contributed to the high LPUE in 1998-99. Following this line of argument, the relatively low amounts of discards seen in both areas in 1996-98 could explain the decline in LPUEs in 2000-2001. Further extrapolations along this line imply that the high amount of discards (strong recruitment) in 1999-2000 now appears as the increase in LPUE in 2003 and 2004 (Figure 14.7).

NSCFP stock survey trends are shown in Figure 14.40. These suggest that *Nephrops* shows a slight increase since 2002 in FU 3, and a more marked increase in FU 4 since 2003, agreeing with the trends observed in LPUE.

Quality of assessment

Fishery data

Perceptions of the stock are based on Swedish and Danish LPUE data. The TAC is not thought to be restrictive for the fleets exploiting this stock, but no information is available on technological creep in the fishery.

14.2 Division IIIa Nephrops Management Considerations

The *Nephrops* TAC for IIIa has not been restrictive, and logbook data are considered reliable. The high recruitment (shown as high discard levels) observed in 1999 and 2000 has resulted in high LPUE in 2004. The LPUE series (Figure 14.7) all show a peak around 1998 and an increasing trend in recent years, which is believed to reflect the high recruitment observed around 1993 and 1999. Following this line of reasoning one could expect a slight decrease in LPUE in coming years.

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

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

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

Mixed fishery aspects

In view of the severe situation for the cod stocks in the North Sea and Kattegat it should also be noted that if *Nephrops* fishing effort is allowed to increase, this may have implications for these stocks in mixed fisheries where *Nephrops* is targeted, unless species and size selectivity of the gears is improved.

Recent developments in the gear used in the Swedish coastal fishery are described in Annex 1 of the *Nephrops* section.

14.3 NEPHROPS IN Division IV

Division IV contains MA F, G, H, I and S, which include FU 5, 6, 7, 8, 9, 10, 32, and 33. Although Management Advice is provided at the MA level, management is applied at the scale of the Division through TAC.

Management

The 2004 and 2005 TAC for *Nephrops* in ICES area IV was 21 350 tonnes.

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

Days at sea limits restrict *Nephrops* trawlers to 25 days per month when using mesh sizes 70-99mm.

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

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

EU catch restrictions apply to *Nephrops* trawlers.

The TAC for Division IV *Nephrops* has increased from 15 200 to 21 350 tonnes since 1999, with advice for most of the North Sea being provided on the basis of historical landings owing to the inability to conduct appropriate catch predictions. Advice for the Fladen Ground has recently been based on a harvest ratio of TV survey abundance estimates. Despite this increase, anecdotal evidence suggests that the allocation of opportunity through North Sea wide TAC does not necessarily match catch potential and TACs have been restrictive in some stocks, and may have been exceeded.

Official catch statistics for Division IV are presented in Table 14.14.

14.3.1 Nephrops in Management Area F

Advice

In 2003 ICES concluded that

"all stocks in this Management Area appear to be exploited at sustainable levels. ."

and advised that

"there is no basis to change the previous advice. The single stock boundary for the Management Area should be 2,000 t for both 2004 and 2005."

Official catch statistics for Division IV are presented in Table 14.14. Landings from MA F by FU and other rectangles outside FU are shown in Table 14.15. Landings from other rectangles are low. Some minor revisions have been made to 2002 catch data.

14.3.1.1 Moray Firth (FU 9)

General information on the fishery can be found in the Stock Annex.

14.3.1.1.1 The fishery in 2004

Landings from this fishery are predominantly reported from Scotland, with very small contributions from England in the mid 1990's, but not recently, and are presented in Table 14.16, together with a breakdown by gear type. Total international reported landings in 2004 were 1,335 tonnes, all by Scotland. This estimate for total landings has increased from about 1,100 tonnes in the most recent years, but is lower than the 1,500 tonnes landed in 2000. Reported effort by Scottish *Nephrops* trawlers has fluctuated around a relatively stable level since the early 1990's, but is at the lower end of the range in 2004 (Table 14.17 and Figure 14.8). Scottish *Nephrops* trawler LPUE fluctuated around a stable level through the 1990's but has increased in the most recent years.

14.3.1.1.2 Catch, effort and research vessel data

Males generally make the largest contribution to the landings and the LPUEs (Figure 14.9), although the sex ratio does vary, and females were more important in landings in the early 1990's, exceeding males in 1994. Effort is generally highest in the 3rd quarter of the year in this fishery, but the pattern varies between years, and the seasonal pattern does not appear as strong in recent years. LPUE of both sexes remained relatively constant up to 2002, but has shown a slight increase since then. LPUE appears higher for males in the 1st and 4th quarters, and for females in the 3rd quarter.

Discarding of undersize and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 1990. Discarding rates averaged over the period 2002 to 2004 for this stock were 30% by number, or 14% by weight. This represents a small increase in discarding rate compared to the 2002 to 2004 period. An indication of the size distribution of discards compared to landings is provided in Figure 14.10. CPUE data for each sex, for *Nephrops* above and below 35 mm CL, are shown in Figure 14.11. This size was chosen for all the Scottish stocks examined as the general size limit for discarded animals. The data show a slight peak in CPUE for smaller individuals (both sexes) in 1995, with a slight decline after this, stable values between 1997 and 2002, and a slight increase for males in 2003 and 2004. The LPUE for larger individuals shows relatively stable levels during the late 1990's, and slightly higher levels in the most recent years.

The available commercial CPUE and research-vessel survey data are described in the Stock Annex (Sections B.3 and B.4), and are tabulated in Table 14.19 and Table 14.20.

Underwater TV surveys are available for this stock since 1993 (missing survey in 1995). Figure 14.12 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density. Figure 14.13 shows the time series estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates.

14.3.1.1.3 Catch structure

Examination of the CPUE data leads to the suggestion that the stock showed an increase in 1995, then declined to a stable level, and shows a slight increase in the most recent years. The mean size of the larger category has shown a slight increase since 1996, but overall has remained relatively stable, while the smaller category shows two distinct dips in mean size (1995 & 2002; Figure 14.8) which are generally interpreted as increases in recruitment, particularly when associated with increases in CPUE of the smaller size category.

Quarterly landings and discard at length data were available from Scotland. These were raised to annual values of removals and sliced using the WGNEPH program L2AGE into age classes. The sampling levels are shown in Section 2.2.4.

The sampling, raising and collation procedures for length-compositions and mean weights-at-age are described in the Stock Annex. Landings and discard data are combined to removals at length before slicing. Removals at age are presented in the commercial fleet tuning files (Table 14.19). Mean weights-at-age have remained very stable over time, which may be an artefact of the slicing procedure. Data are provided in the Stock Files.

14.3.1.1.4 Natural mortality, maturity at age and other biological parameters

Natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females. All males of age 1 or older, and all females of age 2 or older are assumed to be mature.

The derivation of these values is discussed in the Stock Annex. Proportion *F* and *M* before spawning were both set to 0.0, in order to generate abundance (and hence SSB) estimates dated to January 1st.

Growth parameters for age slicing are as follows:

Males; L_∞ = 62mm, k = 0.165

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

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

14.3.1.1.5 Assessment data

Commercial catch data

Levels of market and discard sampling are good, and the length structure of removals in the fishery is considered to be well represented.

Survey data

General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in Annex 2 of the *Nephrops* section. The numbers of valid stations used in the final analysis in each year are shown in Table 14.20. On average, 36.2 stations have been considered valid each year, and are raised to a stock area of 2195 km^2.

Exploratory assessment runs

XSA

The XSA method was applied separately to both sexes for this stock, following the approach suggested by Darby and Flatman (1994). The commercial CPUE series was used to tune the VPA.

Both assessments have considerable retrospective bias, and given the concerns of the WG on the appropriateness of the commercial CPUE tuning fleet, the Official landings and effort data, the implications of the slicing procedure and the validity of a dynamic pool model for *Nephrops*, it was decided not to present an XSA assessment. XSA diagnostics from the runs are provided in Stock file.

14.3.1.1.6 Final assessment

Underwater TV Survey

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

Comparison with last years assessment

The new TV survey data presented at the meeting extends the time series by 2 years. The abundance estimate increased between 2002 and 2003, and declined slightly in 2004, but remained higher than the 2002 value (Figure 14.13).

Long- term trends in biomass, effort and recruitment

The TV survey estimate of abundance for *Nephrops* in the Moray Firth suggests that the population increased between 1992 and 1994 and then declined to a stable level between 1997 and 2001 (no survey was conducted in 1995). Following this the population increased again in 2002, and has remained relatively stable at this higher level since then. Abundance is estimated to be over 40% higher in recent years (2002-2004) compared to the previous period (1999 – 2001). The trends in abundance observed in the TV survey data have to some extent been reflected in CPUE and mean size data, in that they suggest an increase in recruitment in 1995 and 2002.

NSCFP stock survey trends are shown in Figure 14.40. This shows a continuous increase in *Nephrops* in MA F since 2001. This supports the suggestion of an increase in abundance since 2001, with generally moderate or high numbers of recruits.

Quality of assessment

Fishery data

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

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

Surveys

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

14.3.1.2 Noup (FU 10)

General information on the fishery can be found in the Stock Annex.

14.3.1.2.1 The fishery in 2004

Landings from this fishery are solely reported from Scotland, and are presented in Table 14.22, together with a breakdown by gear type. Total international reported landings in 2004 was 228 tonnes, which represents a decline from the recent high value of 401 tonnes in 2002. Reported effort by Scottish *Nephrops* trawlers increased rapidly in the late 1980's and early 1990's, to a peak in 1994, and has shown a general decline since this date (Table 14.23 and Figure 14.14). Scottish *Nephrops* trawler LPUE has shown an increasing trend since the mid 1980's.

14.3.1.2.2 Catch, effort and research vessel data

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

The available research-vessel survey data are described in the Stock Annex and tabulated in Table 14.24.

Underwater TV surveys are available for this stock in 1994 and 1999. Figure 14.15 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density.

14.3.1.2.3 Age composition and mean weights-at-age

No data available

14.3.1.2.4 Natural mortality, maturity at age and other biological parameters

No data available

14.3.1.2.5 Assessment data

Commercial catch data

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

Survey data

General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in Annex 2 of the *Nephrops* section. The numbers of valid stations used in the final analysis in each year are shown in Table 14.24, and are raised to a stock area of 339 km^2. Survey data are not available for recent years.

14.3.1.2.6 Final assessment

No assessment is presented for this stock

Comparison with last years assessment

No new survey data are available.

Long-term trends in biomass, effort and recruitment

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

NSCFP stock survey trends are shown in Figure 14.40. This supports the suggestion of an increase in abundance since 2001 for the northeast of Scotland area.

Quality of assessment

Fishery data

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

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

Surveys

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

14.3.1.3 Management Area F Management considerations

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

Little information is available for the Noup stock, but LPUE appears to have been increasing recently.

It is proposed that the harvest ratio approach based on TV survey abundance is adopted for the Moray Firth, with an additional allowance for the Noup stock, where recent TV data is not available.

Landings potentials given a range of harvest ratios are presented in Table 14.21. Typical harvest ratios based on a variety of approaches and considered to be sustainable for other species range from 20 – 30% (see Annex 2 of the *Nephrops* section). Recent landings from the Noup stock and other rectangles within the MA have been about 400t.

14.3.2 Nephrops in Management Area G

Advice

TAC advice has recently been provided on the basis of a harvest ratio based on underwater TV burrow surveys. In 2003 ICES concluded that

"the state of exploitation of the stock shows considerable spatial variation, with the most heavily fished parts considered to be exploited at sustainable levels."

and advised that

"landings of less than 12,800 t for Management Area G for 2004 and 2005 would be appropriate boundaries, based on an increase in abundance measured by TV surveys, and assuming a harvest rate of 7.5%, known to be sustainable in other areas."

Official catch statistics for Division IV are presented in Table 14.14. Landings from MA G by FU and other rectangles outside FU are shown in Table 14.25. Landings from other rectangles are low.

14.3.2.1 Fladen Ground (FU 7)

General information on the fishery can be found in the Stock Annex.

14.3.2.1.1 The fishery in 2004

Landings from this fishery are predominantly reported from Scotland, with small contributions from Denmark and others, and are presented in Table 14.26, together with a breakdown by gear type. Total international reported landings in 2004 was 8,728 tonnes, consisting of 8,592 tonnes landed by Scotland and 136 tonnes landed by other countries. These estimates for total landings have increased from a previous high level of 7,247 tonnes in 2002. Reported effort by Scottish *Nephrops* trawlers shows an increasing trend up to 2002, but shows a sharp drop in 2003 (Table 14.27 and Figure 14.17). Scottish *Nephrops* trawler LPUE fluctuates around a high level, with a considerable increase in 2003 and 2004. Danish LPUE data also show a recent increase (Table 14.28).

14.3.2.1.2 Catch, effort and research vessel data

Males consistently make the largest contribution to the landings and the LPUEs (Figure 14.17). Effort is generally higher in the 2nd and 3rd quarters of the year in this fishery, but the pattern varies between years. LPUE of both sexes remained relatively constant up to 2000, but has shown a considerable increase in more recent years. LPUE appears higher in the second half of the year.

Discarding of undersize and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 2000. Discarding rates averaged over the period 2002 to 2004 for this stock were 13% by number, or 7% by weight. This represents a small decrease in discarding rate compared to the 2000 to 2002 period. An indication of the size distribution of discards compared to landings is provided in Figure 14.18. LPUE data for each sex, for *Nephrops* above and below 35 mm CL, are shown in Figure 14.19. This size was chosen for all the Scottish stocks examined as the general size limit for discarded animals. The data show a slight peak in LPUE for smaller individuals in 1994, with a slight decline after this, and increasing values in 2003 and 2004. The LPUE for larger males showed higher levels between 1996 and 2000, a declined in 2001 and 2002, and then increasing values in the most recent years. LPUE for the larger females shows slight increases in 1994, 1999 and then in the most recent years.

The available commercial CPUE and research-vessel survey data are described in the Stock Annex (Sections B.3 and B.4), and are tabulated in

Table 14.30 and Table 14.31. Underwater TV surveys are available for this stock since 1992 (missing survey in 1996). Figure 14.20 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density. Figure 14.21 shows the time series estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates.

14.3.2.1.3 Catch structure

Examination of the LPUE data leads to the suggestion that the stock has remained relatively stable over much of the time series, but shows an increase in the most recent years. However, the mean size of the two size categories (Figure 14.16) has remained stable throughout the period, and does not show evidence of an increase in recruitment (a drop in mean size of the smaller size category is generally observed during periods of good recruitment).

Quarterly landings and discard at length data were available from Scotland. These were raised to annual values of removals and sliced using the WGNEPH program L2AGE into age classes. The sampling levels are shown in 2.2.4.

The sampling, raising and collation procedures for length-compositions and mean weights-at-age are described in the Stock Annex. Landings and discard data are combined to removals at length before slicing. Removals at age are presented in the commercial fleet tuning files (Table 14.30). Mean weights-at-age have remained very stable over time, which may be an artefact of the slicing procedure. Data are provided in the Stock Files.

14.3.2.1.4 Natural mortality, maturity at age and other biological parameters

Natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females. All males of age 1 or older, and all females of age 2 or older are assumed to be mature.

The derivation of these values is discussed in the Stock Annex. Proportion *F* and *M* before spawning were both set to 0.0, in order to generate abundance (and hence SSB) estimates dated to January 1st.

Growth parameters for age slicing are as follows:

Males; L_∞ = 66mm, k = 0.16

Immature Females; L_∞ = 66mm, k = 0.16

Mature Females; L_∞ = 56mm, k = 0.10, Size at maturity = 25mm

14.3.2.1.5 Assessment data

Commercial catch data

Levels of market sampling are reasonable and are good for discards (although the time series is short), and the length structure of removals in the fishery is considered to be well represented.

The short time series of discard data, and concerns over the uncertainty in landings and effort records, and the age slicing procedure mean that the data are not considered suitable to conduct catch at age analysis for this stock.

Survey data

General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in Annex 2 of the *Nephrops* section. The numbers of valid stations used in the final analysis in each year are shown in Table 14.31. On average, 60 stations have been considered valid each year, and are raised to a stock area of 28153 km^2.

14.3.2.1.6 Final assessment

Underwater TV Survey

The underwater TV survey is presented as the best available information on the Fladen *Nephrops* stock. This survey provides a fishery independent estimate of *Nephrops* abundance.

At present it is not possible to extract any length or age structure information from the survey, and it therefore only provides information on absolute abundance over the area of the survey.

Comparison with last years assessment

The new TV survey data presented at the meeting extends the time series by 2 years. The abundance estimate declined between 2002 and 2003, remaining at this level in 2004 (Figure 14.21).

Long- term trends in biomass, effort and recruitment

The TV survey estimate of abundance for *Nephrops* in the Fladen suggests that the population increased between 1992 and 1994 and then declined to a stable level between 1997 and 2000 (no survey was conducted in 1996). Following this the population increased again to 2002, and then declined to the pre 2002 stable level in the most recent years. The trends in abundance observed in the TV survey data have not been reflected in LPUE data or mean size data. This may be owing to the short time series of discard data, or spatial changes in the fishery.

NSCFP stock survey trends are shown in Figure 14.40. This shows an increase in *Nephrops* between 2001 and 2002, a slight decrease to 2003, and marked increase since this date. This supports the suggestion of an increase in abundance for this area, but does not indicate any change in the levels of discards or recruits.

Quality of assessment

Fishery data

The length and sex composition of the landings data is considered to be well sampled. Discard sampling has been conducted on a quarterly basis for Scottish *Nephrops* trawlers in this fishery since 2000, and is considered to represent the fishery adequately.

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

Surveys

Underwater TV surveys have been conducted for this stock since 1992, with a continual annual series available since 1997. The number of valid stations in the survey have remained relatively stable throughout the time period, although have been below average in more recent years. Confidence intervals around the abundance estimates are greater during the most recent years, when abundance estimates have been slightly higher, and station numbers lower.

14.3.2.2 Management Area G Management considerations

Underwater TV surveys of the Fladen indicate that stock abundance has been relatively stable over the longer term, although has declined in recent years from the peak in 2002. It is proposed that the application of the harvest ratio approach based on TV survey abundance is continued for the Fladen Ground, with an additional allowance for landings outside FUs. This approach has been applied to the Fladen Ground since 1999, using a harvest ratio of 7.5%. This ratio has previously been considered appropriate for this stock, given the generally low density of *Nephrops* at the Fladen Ground, and the less well understood stock dynamics and consistency of recruitment compared to more intensively studies inshore stocks.

Landings potentials of the Fladen Ground (FU 7) given a range of harvest ratios are presented in Table 14.32. Landings from other rectangles inside the MA are about 100t.

14.3.3 Nephrops in Management Area S

Advice

In 2003 ICES concluded that

landings have shown an increasing trend in recent years. Danish LPUE has decreased over the last three years. However, this might be caused by changes in trawl mesh size and fishing pattern .

and advised that

“the current TAC advice of 1,200 t should be maintained until further expansion of the fishery can be shown to be sustainable”.

Official catch statistics for Division IV are presented in Table 14.14.

14.3.3.1 Norwegian Deep (FU 32)

A description of the Danish *Nephrops* fisheries in Subareas IIIa and IV (including the one in the Norwegian Deep) is given in the 1999 WGNEPH report (ICES, 1999a). Due to changes in the management regime (mesh size regulations in the Norwegian zone of the northern North Sea in 2002, there was a switch to increasing Danish effort targeting *Nephrops* in the Norwegian Deep. However the distribution of the fishing effort between *Nephrops* and roundfish has not yet been fully analysed.

Traditionally the Norwegian effort for *Nephrops* has been low, and the majority of the Norwegian *Nephrops* landings from FU 32 has largely been as by-catch from the *Pandalus* fishery. Because of the landings restrictions for *Pandalus*, shrimp trawlers have started fishing more specifically for *Nephrops* in the most recent years. Also, there are an increasing number of boats that target *Nephrops* year-round, making one-week trips and landing their catches in Denmark.

From 1999 to 2004, 159 to 185 vessels landed *Nephrops* from the Norwegian Deep. The average length of the vessels was around 17 m.

There has been a change in the most commonly used mesh size. In 1999, 90 % of vessels used 70-80 mm trawls according to the reported logbooks. In 2000, small-meshed trawls taking 18 % of *Nephrops* landings performed 29 % of the trawling hours. This is also reflected in the by-catch of landed fish species. Until 1999, reported fish weight was less than 30 % of the landings. From 2000 onwards it has been more than 70 %. Fishing for *Nephrops* using trawls with mesh size 70-120 mm should have square meshes in the cod-end, or have a 80 mm square mesh panel and a top-panel of at least 140 mm diamond meshes. By-catch of cod and haddock should not exceed 10% in weight of total catch.

Sediment maps for this MA indicate that the area of suitable sediment for *Nephrops* is larger than the current extent of the fishery, and there are possibilities of expansion into new grounds which are not currently fished for *Nephrops*.

14.3.3.1.1 The fishery in 2004

International landings from the Norwegian Deep increased from less than 20 t in the mid-1980s to 1,216 t in 2002, the highest figure so far. In 2003 and 2004 Danish landings declined slightly and total landings in 2004 amounted to 934 tons. Danish vessels take 80-90 % of total landings (Table 14.33).

14.3.3.1.2 Catch, effort and research vessel data

Effort and LPUE figures for the period 1989-2004 are available from Danish logbooks (Figure 14.22). The available logbook data from Norwegian *Nephrops* trawlers cover only a small proportion of the landings (27 % in the year 2000). The few vessels having reported *Nephrops* landings in the earlier years, and the change in fleet structure make the Norwegian logbook data unsuitable for any LPUE analysis. Since 1993 vessel size has increased in the Danish fleet targeting *Nephrops* and caused a considerable increase in the Danish LPUEs from 1993 onwards (Figure 14.22). A similar development is occurring in the Norwegian fleet. In recent years the Danish LPUEs have fluctuated somewhat, around 200 $kg.day^{-1}$. Some of the fluctuations may be caused by fishing vessels locally switching between roundfish and *Nephrops* due to changes in management regulations in the Norwegian zone. It appears that, compared to 2002 and 2003, the Danish effort declined in 2004. It is known that the efficiency of the gear is improving all the time. However, further quantification of the 'technological creeping' in the gear is not possible at present.

14.3.3.1.3 Catch structure

The average size of *Nephrops* as recorded from Danish catches in the period 2000-2004 (using a 100 mm *Nephrops* trawl) is shown in Figure 14.22. These averages (both in catches and landings) show a slightly decreasing trend both for males and females. Figure 14.23 compares the size distribution (2004) in the Danish catches (100 mm mesh size) and the Norwegian surveys (using a 70mm mesh size trawl). Note that the 100 mm mesh trawls are mainly catching *Nephrops* greater than the local 40 mm legal minimum size.

14.3.3.1.4 Natural mortality, maturity at age and other biological parameters

No data available

14.3.3.1.5 Assessment data

Commercial catch data

No data available

14.3.3.1.6 Final assessment

No assessment is presented for this stock

Long- term trends in biomass, effort and recruitment

The slight decrease in mean size in the catches and landings (Figure 14.22) could indicate a high exploitation pressure in recent years. The decline in landings in 2003 and 2004 may be explained partly by a lower market price in that period. However, the (Danish) LPUE's in 2004 are higher than in the previous years and there are no signs of overexploitation of the stock at present.

NSCFP stock survey trends are shown in Figure 14.40. This shows an increase in *Nephrops* between 2001 and 2002, a slight decrease to 2003, and marked increase since this date.

Quality of assessment

Fishery data

Perceptions of the stock are based on Danish LPUE data. The TAC is not thought to be restrictive for the fleet exploiting this stock, but no information is available on technological creep in the fishery.

14.3.3.2 Management Area S Management considerations

Recent trends in overall size distribution in the catches indicate that the *Nephrops* stock in the Norwegian Deep is fully exploited. The trend in Danish LPUE figures do not indicate any decline in stock abundance. Given the lack of catch forecasts for FU 32, the WG concludes that the level of exploitation on this stock should not be increased. Recent average landings have been approximately 1,100t (average landings 2002-2004).

The WG recommends that the stock be monitored more closely. The Norwegian logbook system should be improved. Sampling of Norwegian commercial catches from this area should be intensified and analysed. Also the sampling of the Danish vessels should be intensified to cover all seasons of the year.

14.3.4 Nephrops in Management Area I

Advice

In 2003 ICES concluded that

"all stocks in this Management Area appear to be exploited at sustainable levels ."

and advised that

"there is no basis to change the previous advice. The single stock boundary for the Management Area should be 4,170 t for both 2004 and 2005."

Official catch statistics for Division IV are presented in Table 14.14. Landings from MA I by FU and other rectangles outside FU are shown in Table 14.34. Landings from other rectangles are lower than from FUs, but have increased since 2000. This increase is largely thought to be related to increased landings from the Devil's Hole area.

14.3.4.1 Farn Deeps (FU 6)

General information on the fishery can be found in the Stock Annex.

14.3.4.1.1 The fishery in 2004

Since the beginning of the time-series, the UK fleet has accounted for virtually all landings from the Farn Deeps (Table 14.35). Total landings were about 2,200 t in 2004. Landings have been stable at around these levels since 1995, following a peak of almost 3,700 t in 1994. Fishing effort recorded for UK trawlers has followed a similar trend to landings since the mid-1980s (Figure 14.24). Peak effort of 143,103 hours trawling corresponded to the peak in the landings in 1994. Effort had reduced by 45 % to 78,103 hours in 1998, but increased to 104,103 hours in 2001. Effort has fallen since, down to 60,796 hours in 2004, the lowest level since 1984. This may have been due to changes in the fleet such as the decommissioning of larger vessels, the impacts of technical regulations and days at sea legislation (Stock Annex).

14.3.4.1.2 Catch, effort and research vessel data

Males predominate over females in the landings, averaging about 69 % of the annual totals since 1985 (Figure 14.31). Effort is generally highest in the 1st and 4th quarter of the year in this fishery (Figure 14.25).

CPUE data (available from 1985) are calculated mainly from discard sampling during the winter fishing season (October to March). Figures from 1994 onwards are calculated using catch sampling data. Estimated discarding during this period has fluctuated around 40 % by weight of the catch, similar to levels recorded since the beginning of the data series in 1985. Length distributions of landed and estimated discarded portions of the catch are shown in Figure 14.26. CPUE had remained relatively high since 1995, fluctuating without obvious trend between 38 and 49 kg/hour trawling (Figure 14.24) until 2004. CPUE in 2004 was the highest recorded since 1985 at 58 kg/hour trawling.

LPUE had remained stable since 1993, at a relatively high level around 26 kg.hour^{-1} trawling (Figure 14.24) until 2000. Since 2000 annual LPUE has steadily increased to its highest value in the series of 33 kg.hour^{-1} trawling in 2004. The increase from the low value of 18 kg.hour^{-1} in 1991 could have been due to a reduction in discarding, although this is not apparent as a decrease in the mean size of the *Nephrops* landed.

The differences between LPUE figures for individual vessels suggest that earlier years could have included less truly directed effort. Restrictions on finfish fishing over the last five years will have restricted total effort in FU6 thereby reducing the more casual effort on *Nephrops*. Further research is needed to better define directed fishing effort and thereby improve on this series.

Quarterly LPUE values were more variable than the annual trends, but overall the same pattern is apparent. LPUEs of both sexes are typically highest in the 1st and 4th quarters, although in 2002 in females the LPUE showed less seasonal variation. In females, higher LPUEs in winter presumably reflect a concentration of *Nephrops* directed effort, rather than increased availability. In 2004 LPUE was 4 times higher in males than in females, prior to that it had been consistently 1.5-3 times higher. Male LPUE in quarters 1 and 4 of 2004 was higher than the average for a period of stability since 1993. Female LPUE in 2004 was slightly decreased in quarters 1 compared with the previous 4 years. This contributes to the slight downward trend in the annual female LPUE. LPUEs for *Nephrops* above and below 35 mm CL also show the same patterns (Figure 14.27). Large males were fished at a higher LPUE than small males and since 2000 the increase in overall LPUE has been driven by the increase in LPUE for the larger males. By contrast, LPUE was slightly higher in small than large females, presumably reflecting the greater proportion of immature individuals < 35 mm CL.

Underwater TV surveys of the Farn Deeps grounds have been conducted at least once in each year from 1996 onwards. Figure 14.28 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density. Figure 14.29 shows the time series estimated abundance for the TV surveys, with 95% confidence intervals.

14.3.4.1.3 Catch structure

Declines in mean size of the smaller size category are generally interpreted as increases in recruitment, particularly when associated with increases in CPUE of the smaller size category.

Mean sizes in the landings have generally increased since the early 1990s, although a slight dip was observed in 2002 (Table 14.37). Mean landed sizes in the above and below 35 mm CL groups have remained stable or only slightly increasing since 1993 (Figure 14.24), suggesting that the increasing trend in overall mean size was due to a shift in favour of large *Nephrops* as a proportion of the total landings. This may have been due to the change in mesh size (see

Stock Annex) or a change in discarding practices, but it may also be a result of potential sampling biases, with the smallest *Nephrops* not being available for measuring.

The trend in mean sizes in the catches had been the inverse of that in the landings until 2000 when the trend appears to have been reversed (Table 14.37). Mean size in 2004 for males is the highest in the series, 7% above the long-term average. Mean size in the < 35 mm CL group has been more variable in the catch than in the landings. There has been an increase in mean size for both sexes since 2001. There is only a slight incline in the trend for females with the mean size in 2004 being at the long term average of 27.1 mm CL. Although the male mean size is the highest since 1992 at 28.5 mm CL it is still within the range for the whole series.

A discard sampling programme ceased in 1999 owing to uncertainties about the assumptions underlying identification of the discarded portion of total catches. Instead, discards have been estimated from comparison of total unsorted catch samples with landings samples.

These were raised to annual values of removals and sliced using the WGNEPH program L2AGE into age classes. The sampling levels are shown in 2.2.4.

14.3.4.1.4 Natural mortality, maturity at age and other biological parameters

Natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females. All males of age 1 or older, and all females of age 2 or older are assumed to be mature.

The derivation of these values is discussed in the Stock Annex. Proportion *F* and *M* before spawning were both set to 0.0, in order to generate abundance (and hence SSB) estimates dated to January 1st.

Growth parameters for age slicing are as follows:

Males; L_∞ = 66mm, k = 0.160

Immature Females; L_∞ = 66mm, k = 0.160

Mature Females; L_∞ = 58mm, k = 0.060, Size at maturity = 24mm

14.3.4.1.5 Assessment data

Commercial catch data

Levels of market and catch sampling are good, and the length structure of removals in the fishery is considered to be well represented.

Survey data

General analysis methods for underwater TV survey data are similar to the Scottish surveys, and are described in Annex 2 of the *Nephrops* section.

The values of burrow density, stock abundance and biomass given in Table 14.38. These are unstratified survey estimates. Sediment types within the Farn Deeps are relatively homogeneous, and there is no statistical evidence of differences in trends between different parts of the ground (ICES, 2000b). Spring burrow densities remained constant between 1996 and 1997, declined by more than half in 1998, before increasing again between 1999 and 2002, returning to 78 % of the 1996 value. The spring 1998 count is probably a large under-estimate because of very poor visibility during this survey.

The surveys in autumn are conducted at the start of the winter fishery to provide an index of the abundance before exploitation. The station locations are shown in Figure 14.28, with a time series shown in Figure 14.29. Subsequent autumn surveys show a gradual increase in abundance to a level in 2004 16% above the autumn average.

Burrow densities in autumn were higher than those in the spring that followed, presumably a result of depletion by the winter fishery. The most recent autumn survey, in 2001, shows the highest burrow density of the series. Comparison of burrow densities between autumn 1998 and spring 1999 indicates over-winter survival of about 77 %. After accounting for natural mortality and the fact that 80% of the annual removals were taken over that period, this represents an annualised fishing mortality of about 0.15. Over-winter survival for 2001-02 was also 77 % but over a reduced period, which represents an annualised fishing mortality of about 0.25. These estimates are lower than estimated for males at previous WGs but not unreasonable, given that this represents exploitation of both males and females. The difference between these estimates of F is consistent with higher effort recorded for the 2001-02 season. No such estimate is possible for the winter of 1997-98, owing to the very poor estimate for spring 1998. The lower than expected survey estimate for autumn 2002 may be because of the reduced number of stations sampled.

Exploratory assessment runs

XSA

The XSA method was applied separately to both sexes for this stock, following the approach suggested by Darby and Flatman (1994). The commercial CPUE series was used to tune the VPA.

The XSA for the males appeared to perform reasonably well but the female assessment had considerable retrospective bias. Given the concerns of the WG on the appropriateness of the commercial CPUE tuning fleet, the official landings and effort data, the implications of the slicing procedure and the validity of a dynamic pool model for *Nephrops*, it was decided not to present an XSA assessment. XSA diagnostics from the runs are provided in the Stock file.

14.3.4.1.6 Final assessment

Underwater TV Survey

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

Comparison with last years assessment

The 2002 burrow density estimates were revised after revalidation and the new TV survey data presented at the meeting extends the time series by a further 2 years. The abundance estimate increased between the last two years and the 2004 estimate remains within the range of all the autumn estimates.

Long- term trends in biomass, effort and recruitment

The increase in the estimate of autumn abundance from the TV surveys in the last few years corresponds to an increase in LPUE. Mean size of the smaller length groups for males and females has increased in recent years but the LPUE for these length groups has remained fairly static. Effort has been declining yet the LPUE on the larger males has increased. The increase in mean size could be due to changes in mesh size, gear restrictions; and landing practices

(Stock Annex) and the potential sampling biases suggested earlier rather than an indication about recruitment.

NSCFP stock survey trends are shown in Figure 14.40. For FU 6 the survey shows an increase between 2001 and 2002, a relatively stable period to 2004 and an increase in 2005. Although the sample size in the NSCFP stock survey is relatively small for area 4 (n=15) the abundance trend appears to agree with the recent increase in abundance from the TV estimates for FU6. The recruitment estimates and changes in size ranges agree with the signals from the trends in LPUE on the lower length groups and differences in the catch distributions. The comments on discarding suggest an increase in LPUE on larger males – targeting areas with larger males - rather than a change in discarding practice.

Quality of assessment

Fishery data

The length and sex composition of the catch data are considered to be well sampled. Anecdotal evidence and the uptake would suggest that current annual TACs are not limiting, however it is apparent that nationally and regionally they may be restrictive enough to encourage some under-reporting (ICES 2003).

Surveys

The TV data series for this functional area is relatively short and with missing years if spring and autumn surveys are considered separately. However over the series consistency has been maintained between most surveys. A standard survey of 81 core stations was not completed in 2001 and 2002 but the respective autumn and spring surveys are comparable. The confidence intervals around the abundance estimates appear smaller than those for other stocks mainly because of the greater number of stations sampled relative to the survey area. The larger confidence intervals in this series are apparent on those surveys where the abundance estimates are higher, the range of burrow densities is greater or where fewer stations are sampled (Table 14.38). *Nephrops* are caught outside the survey area although the quantities caught and the size of the areas fished are unclear. Using BGS sediment maps the areas where potentially *Nephrops* could be outside the survey area are limited and if included would have little affect on the abundance estimates.

The harvest ratio approach uses landings and discard length distribution data. Catch samples are considered well sampled but landing samples could be biased through an underestimate of the small component. The landed portion of the discard estimate therefore may effectively contain landed *Nephrops*. Correcting the landing length distribution will affect the discard estimates but not the shape of the catch length distribution. Because discard mortality is set at 100% the estimated Fs are not affected, however an overestimate of the discards will underestimate the landings potential.

14.3.4.2 Firth of Forth (FU 8)

General information on the fishery can be found in the Stock Annex.

14.3.4.2.1 The fishery in 2004

Landings from this fishery are predominantly reported from Scotland, with very small contributions from England, and are presented in Table 14.40, together with a breakdown by gear type. Total international reported landings in 2004 was 1,658 tonnes. This estimate for total landings has increased by over 500 tonnes from 2003, but is lower than previous high of over 2,200 tonnes landed in 1999. Reported effort by Scottish *Nephrops* trawlers dipped in

2003, but has remained relatively stable since 1995 (Table 14.41 and Figure 14.30). Scottish *Nephrops* trawler LPUE was relatively stable in the late 1980's and early 1990's, increased for a three year period (1997-1999) before falling back to the previous stable level, and has increased again in 2004.

14.3.4.2.2 Catch, effort and research vessel data

Males generally make the largest contribution to the landings and the LPUEs (Figure 14.31), although the sex ratio does vary, and the proportions were almost equal in 1997. Effort is generally highest in the 3rd quarter of the year in this fishery, but the pattern varies between years with the 4th quarter also being important in some years, and the seasonal pattern does not appear as strong recently. LPUE of both sexes show similar trends over time, with higher levels observed in the late 1990's and in the most recent year. LPUE appears higher for males in the 1st and 4th quarters, and for females in the 2nd and 3rd quarter.

Discarding of undersize and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 1990. Discarding rates averaged over the period 2002 to 2004 for this stock were 45% by number, or 25% by weight. This represents a small decrease in discarding rate compared to the 2002 to 2004 period. An indication of the size distribution of discards compared to landings is provided in Figure 14.32. CPUE data for each sex, for *Nephrops* above and below 35 mm CL, are shown in Figure 14.33. This size was chosen for all the Scottish stocks examined as the general size limit for discarded animals. The data show slightly higher levels in CPUE for smaller individuals (both sexes) in the late 1990's, with a decline after this, and a small increase in 2003 for males and 2004 for females. The LPUE for larger individuals shows a similar increase in the late 1990's, and a more pronounced increase than the smaller size category in the most recent years.

The available commercial CPUE and research-vessel survey data are described in the Stock Annex, and are tabulated in Table 14.43 and Table 14.44.

Underwater TV surveys are available for this stock since 1993 (missing surveys in 1995 and 1997). Figure 14.34 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density. Figure 14.35 shows the time series estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates. Visibility was very poor in 1998, and this may have contributed to the low estimate of burrow abundance in this year.

14.3.4.2.3 Catch structure

Examination of the CPUE data leads to the suggestion that the stock showed an increase in the late 1990's, and in the most recent years. The mean size of the larger category shows a very slight decline over time, while the smaller category shows two distinct dips in mean size (1994 & 2003; Figure 14.30), and a less marked decline in mean size in 1998. Declines in mean size of the smaller size category are generally interpreted as increases in recruitment, particularly when associated with increases in CPUE of the smaller size category.

Quarterly landings and discard at length data were available from Scotland. These were raised to annual values of removals and sliced using the WGNEPH program L2AGE into age classes. The sampling levels are shown in 2.2.4.

The sampling, raising and collation procedures for length-compositions and mean weights-at-age are described in the Stock Annex. Landings and discard data are combined to removals at length before slicing. Removals at age are presented in the commercial fleet file (Table 14.43). Mean weights-at-age have remained very stable over time, which may be an artefact of the slicing procedure. Data are provided in the Stock Files.

14.3.4.2.4 Natural mortality, maturity at age and other biological parameters

Natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females. All males of age 1 or older, and all females of age 2 or older are assumed to be mature.

The derivation of these values is discussed in the Stock Annex. Proportion *F* and *M* before spawning were both set to 0.0, in order to generate abundance (and hence SSB) estimates dated to January 1st.

Growth parameters for age slicing are as follows:

Males; L_∞ = 66mm, k = 0.163

Immature Females; L_∞ = 66mm, k = 0.163

Mature Females; L_∞ = 58mm, k = 0.065, Size at maturity = 26mm

14.3.4.2.5 Assessment data

Commercial catch data

Levels of market and discard sampling are good, and the length structure of removals in the fishery is considered to be well represented.

Survey data

General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in Annex 2 in *Nephrops* section. The numbers of valid stations used in the final analysis in each year are shown in Table 14.44. On average, 38.8 stations have been considered valid each year, and are raised to a stock area of 915 km^2.

Exploratory assessment runs

XSA

The XSA method was applied separately to both sexes for this stock, following the approach suggested by Darby and Flatman (1994). The commercial CPUE series was used to tune the VPA.

Both assessments have considerable retrospective bias, and given the concerns of the WG on the appropriateness of the commercial CPUE tuning fleet, the Official landings and effort data, the implications of the slicing procedure and the validity of a dynamic pool model for *Nephrops*, it was decided not to present an XSA assessment. XSA diagnostics from the runs are provided in Stock file.

14.3.4.2.6 Final assessment

Underwater TV Survey

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

Comparison with last years assessment

The new TV survey data presented at the meeting extends the time series by 2 years. The abundance estimate increased between 2002 and 2003, and then declined in 2004, to approximately the 2002 value (Figure 14.35).

Long- term trends in biomass, effort and recruitment

The TV survey estimate of abundance for *Nephrops* in the Firth of Forth suggests that the population declined between 1993 and 1998 (although no surveys were conducted in 1995 or 1997), increased to a stable level between 1999 and 2001, and then increased to 2003, declining slightly in the most recent year. The recent average abundance (2002-2004) is 23% higher than the previous period (1999-2001). The increases in abundance in the late 1990's and most recent years have been reflected in CPUE and mean size data, in that they suggest an increase in recruitment in 1998 and 2003.

NSCFP stock survey trends are shown in Figure 14.40. For FU 8 the survey shows a continuous increase in *Nephrops* since 2001. This supports the suggestion of an increase in abundance since 2001, with generally moderate or high numbers of recruits.

Quality of assessment

Fishery data

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

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

Surveys

Underwater TV surveys have been conducted for this stock since 1993, with a continual annual series available since 1998. The number of valid stations in the survey was particularly high between 1999 and 2001, and slightly below average in the most recent years. Confidence intervals around the abundance estimates are greater during the most recent years, when abundance estimates have been slightly higher.

14.3.4.3 Management Area I Management considerations

It is proposed that the harvest ratio approach based on TV survey abundance is adopted for the Farn Deeps and Firth of Forth, with an additional allowance for landings outside FUs.

For the Farn Deeps (FU 6) previous working groups have expressed concerns about the higher exploitation on males and about the sustainability of the high levels of directed effort in this fishery. Effort currently appears to be at its lowest level since 1984 and LPUE appears to be at its highest in the series. The TV surveys appear to confirm this recent increase in abundance. CPUE trends suggest that recruitment has not been strong over the last few years but the increase in the mesh size could have masked any recruitment signals. All signs suggest the stock is healthy although the males in this stock do suffer greater fishing pressure.

Landing potentials were calculated for a range of harvest ratios on the average of the last two TV survey abundance estimates, 2003 and 2004 (Table 14.39). Only the last two years were used because the autumn 2002 abundance estimate was considered an underestimate. The 95% confidence limits around the abundance estimate are translated to the landings potentials. Typical harvest ratios based on a variety of approaches and considered to be sustainable for other species range from 20 – 30% (see Annex 2 of the *Nephrops* section).

The distinct seasonality in this fishery leads to much higher exploitation in males than females. Bearing this in mind, a harvest ratio considered appropriate for stocks with more balanced exploitation may be too high for the Farn Deeps.

Use of harvest ratios and the implications if the exploitation ratio of males to females is not 50:50 has been considered for some of the Scottish stocks (ICES 2004) and will be further investigated by WKNEPH in 2006.

Underwater TV survey data suggest that the Firth of Firth stock has increased in abundance by 23% in comparison with the period between 1999 and 2001. Indications from the fishery support this, suggesting increased catch rates and recent good recruitment.

Landings potentials of the Firth of Forth (FU 8) given a range of harvest ratios are presented in Table 14.45. Typical harvest ratios based on a variety of approaches and considered to be sustainable for other species range from 20 – 30% (see Annex 2 of the *Nephrops* section).

Recent landings from other rectangles within the MA have been about 500t. These are mostly from the Devil's Hole area. Occasional Scottish TV surveys have been conducted in this area, but a series is not yet available. Data will be presented to the WG in 2006.

14.3.5 Nephrops in Management Area H

Advice

In 2003 ICES concluded that

"the Botney Gut - Silver Pit stock appears to be exploited at sustainable levels, and the Off Horn Reef stock is not fully exploited"

and advised that

"for the overall Management Area, the fishery should be bounded by a TAC of 2,380 t for both 2004 and 2005, since the stocks in FU 5 and FU 33 appear to be able to sustain catches of the order of recent years.

Official catch statistics for Division IV are presented in Table 14.14.

14.3.5.1 Botney Gut / Silver Pit (FU 5)

An extensive description of the *Nephrops* directed fisheries in the Botney Gut - Silver Pit area is given in the 2003 Report of WGNEPH (ICES, 2003).

14.3.5.1.1 The fishery in 2004

2003 and 2004 saw a further decline of the Belgian *Nephrops* fishery in the area. Up to 1995, the Belgian fleet used to take over 75% of the international landings from this stock, but since then, its share has dropped to less than 25%. The Netherlands are now the most important player in FU 5, with over 60% of the total international landings being made by Dutch trawlers, for first sale in the Netherlands or in Belgium.

Total international *Nephrops* landings from FU 5 in 2004 were 1,054t, representing a continued decrease on the peak observed in 2001 of 1,329t.

14.3.5.1.2 Catch, effort and research vessel data

Long-term effort, LPUE and mean size data (for males and females >35 mm CL separately) are available for the Belgian fleet only (Figure 14.36). LPUE data for the Danish fishery are presented in Table 14.49.

Long-term effort of the Belgian *Nephrops* fleet has shown an almost continuous decrease since the all-times high in the early 1990s. In 2004, effort was at the slowest level in the time series, with only 8.7 10^3 hours fishing for all *Nephrops* directed voyages combined, and 5.7 10^3 hours fishing for the *Nephrops* specialist trawlers, i.e. vessels fishing for *Nephrops* during most of the year, as opposed to the occasional *Nephrops* trawlers, who only fish for *Nephrops* during the peak season (typically between May and October).

Annualised LPUEs of the Belgian *Nephrops* specialist trawlers (Table 14.48) have fluctuated without obvious trend until the early 2000s, but most recently seem to have jumped to an all-times high (around 19.0 $kg.hour^{-1}$). However, the LPUE values for 2003 and 2004 should be treated with utmost caution since (a) they are based on a very small number of vessels only, (b) the *Nephrops* specialist trawlers remaining are the ones operating twin-rigs (which do have higher catch rates than the single rigs that were in use in the 1980s and 1990s), and (c) there is a tendency - also amongst the specialist trawlers - to concentrate fishing effort in the season with the highest catch rates. The Danish LPUE have been far more stable in recent years, remaining more or less the same level since 2000 (Table 14.49).

Mean sizes of male and female *Nephrops* in the landings (calculated across the range of size classes >35mm CL to reduce the effect of variations in recruitment and discarding) are shown in Figure 14.36 and Table 14.50. Mean sizes of males show evidence of an overall downward trend, while mean sizes of females seem to have stabilised, albeit at a level that is considerably lower than in the early 1990s.

14.3.5.1.3 Catch structure

A comparison was made between the size compositions of the Belgian *Nephrops* landings (males and females separately) in the years 1999-2004 (Figure 14.37). The data suggest a shift in the size distribution of the landings, particularly in 2001 and 2002 (and for females also in 2003), with proportionally fewer large and more small *Nephrops* being landed than in 1999 and 2000. The data for 2004 show evidence of a return to the pre-2001 situation. Although the observed shift apparently was of a temporary nature, it stresses the need to closely monitor this stock. As a matter of fact, shifts of this type may be indicative of increased fishing pressure on the oldest age classes in the population and/or of a change in discarding practices, towards retaining more of the smaller *Nephrops*.

14.3.5.1.4 Natural mortality, maturity at age and other biological parameters

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

Growth parameters for age slicing were as follows:

Males: L_∞ = 62mm CL, k = 0.165.

Immature females: L_∞ = 62mm CL, k = 0.165.

Mature females: L_∞ = 60mm CL, k = 0.080, Size at 50% maturity = 27mm CL.

Growth parameters were assumed to be similar to those of Scottish *Nephrops* stocks with similar overall size distributions of the landings (see e.g. WGNEPH, 2003). Female size at 50% maturity was taken from Redant (1994).

14.3.5.1.5 Assessment data

Commercial catch data

Port sampling programs of the commercial *Nephrops* landings are in operation in Belgium (since 1986) and the Netherlands (since 2002). Sampling frequency and sample sizes in the Belgian and Dutch port sampling programs are assumed to be sufficient to produce reliable estimates of the numbers-at-length in the landings. A recent study on the precision levels of raised size distributions (Luyssaert & Redant, unpublished) showed that it would be unwise to reduce the sampling levels in the Belgian *Nephrops* port sampling program (which are now at 200-300 animals per market category), since this would more or less double the risk of obtaining estimated weights of the landings that depart more than 10% (plus or minus) from the actual weights (even for pooled quarterly size distributions).

Discard data are available for the Belgian *Nephrops* fleet only (since 2002). Samples of the unsorted discards are collected monthly by contracted fishermen and analysed by the staff of the Sea Fisheries Department. Measurements taken include length sampling of *Nephrops* and of all fish species in Appendix XII of EU-Regulation 1639/2001. Concurrently with the discard samplings, length frequency data are also being collected for the most important commercial fish species in the by-landings (viz. cod, haddock, whiting, gurnards, striped red mullet, plaice, dab, lemon sole and sole).

Exploratory assessment runs

XSA

In previous assessments of this stock (see e.g. WGNEPH, 2001, 2003), XSAs were run for males and females separately, with input numbers-at-age matrices that were obtained by slicing the length frequency distributions of the removals (= landings + dead discards) by the international fleet, using the L2AGE slicing procedure. In the absence of port sampling programs for this stock in Denmark, the Netherlands and the UK, the Belgian length frequency data of the landings and discards were used to calculate the size distributions of the total international removals (see e.g. WGNEPH, 2001, 2003). This approach was defendable as long as the Belgian catches represented a major part of the international catches. With the recent decline of the Belgian *Nephrops* directed fishery in the area, this is no longer the case. Dutch length frequency data on the landings are available since 2002, and their inclusion in the calculations of the numbers-at-age matrices would at least partly have resolved the problem. At the time of the meeting however, only the Dutch data for 2004 were available to the stock co-ordinator (in addition to the full Belgian data series), and this was considered insufficient to repeat the XSA. Hence, it was decided not to perform an analytical assessment on this stock, and to base the perception of the stock and the associated advice on the trends in LPUEs, mean sizes, etc.

14.3.5.1.6 Final assessment

No analytical assessment presented.

Long- term trends in biomass, effort and recruitment

Previous assessments have considered this stock to be fully exploited. LPUE trends are relatively stable up to the most recent years. Interpretation of recent changes are complicated by changes in the fleet providing the data. Changes in size distribution data may suggest increases in recruitment in 2001 and 2002.

NSCFP stock survey trends are shown in Figure 14.40. For FU 5 the survey shows an increase in *Nephrops* between 2001 and 2002, but a stable or declining trend after this.

Quality of assessment

Fishery data

The problems associated with under-reporting of the landings are believed to be adequately resolved, at least as far as the Belgian fleet is concerned. Each year, the Belgian *Nephrops* landing figures are adjusted by means of correction factors (one per market category) based on the ratio between the actual landings, as recorded by the scientific observers responsible for the port sampling programs, and the officially reported landings, as derived from the sale slips. For the other fleets, no such corrections could be made, since there is no verifiable information on the importance of their non-reported landings.

14.3.5.2 Off Horn Reef (FU 33)

A description of the Danish *Nephrops* fisheries in Sub-areas IIIa and IV (including the one in the Off Horn Reef area) is given in the 1999 Report of WGNEPH (ICES, 1999). Initially, this *Nephrops* fishery was carried out by Danish vessels only, but in the more recent years, other countries have also contributed. However, it appears that Denmark still accounts for >90% of the total international landings (see Table 14.51). According to logbook information, most of the Danish *Nephrops* directed fishery in FU 33 takes place in the 3rd quarter.

14.3.5.2.1 The fishery in 2004

Denmark accounts for most of the *Nephrops* landings from FU 33. The *Nephrops* landings from the Horns Reef area by the Danish fishery have continued to increase in recent years and amounted to almost 1,100 t in 2004 (Figure 14.38). One likely reason for this increase is constraints upon the cod fisheries in the North Sea. The other countries reporting landings from the area are Belgium, and the UK.

Danish landings from FU 33 were marginal for many years. Since the mid-1990s however, there has been a steady increase in the landings. From 1997 to 2004, Danish landings increased considerable, from 274 to 1,097 t. This increase in landings seems to correspond to a more than 4-fold increase in fishing effort during the same period. It appears from Table 14.52 that LPUEs have been rather stable since 1998, fluctuating around 200 kg.day^{-1}.

14.3.5.2.2 Catch, effort and research vessel data

The recent start in the sampling for this fishery means it is not realistic to draw conclusions from changes in size composition or sex ratio. Size distributions recorded from Danish catch sampling are shown in Figure 14.39. There is currently no evidence of a shift in the size composition of catches.

14.3.5.2.3 Catch structure

No data available

14.3.5.2.4 Natural mortality, maturity at age and other biological parameters

No data available

14.3.5.2.5 Assessment data

Commercial catch data

Given the short series of catch sampling, the data are not considered suitable to conduct catch at age analysis for this stock.

14.3.5.2.6 Final assessment

No analytical assessment is presented for this stock

Long- term trends in biomass, effort and recruitment

Trends in LPUE data suggest that stock levels are remaining relatively stable.

NSCFP stock survey trends are shown in Figure 14.40. For FU 33 the survey shows an increase between 2001 and 2002, a stable period to 2004, and an increase in 2005. There were no strong indications of changes in recruitment or discarding levels.

Quality of assessment

Fishery data

Perceptions of the stock are based on Danish LPUE data. The TAC is not thought to be restrictive for the fleet exploiting this stock, but no information is available on technological creep in the fishery.

14.3.5.3 Management Area H Management considerations

In its 2003 assessment of the *Nephrops* stock in the Botney Gut - Silver Pit area (FU 5), WGNEPH concluded that the stock was fully exploited and recommended that the TAC for FU 5 be maintained at the previously recommended level of 1,100 t (ICES, 2003). The evidence of a (temporary) shift in the length composition of the landings stresses the need to closely monitor this stock, but is not of such a nature that further restrictions of the fishery need to be envisaged. Current levels of exploitation appear to be sustainable.

In the future, the inclusion of Dutch length frequency data on the landings and of Belgian length frequency data on the discards should enable WGNSSK to run exploratory analytical assessments on this stock again, which should give more ground to the management advice.

For the Off Horn Reef stock (FU 33), the very high and stable LPUE values (despite a large increase in fishing effort over the past 10 years) indicate that the current exploitation level on this stock is giving no reason for special concern. Although exploitation has increased considerably over the last decade, current levels certainly appear sustainable. Given the developing nature of the fishery, maintaining exploitation at recent average levels might limit opportunity unnecessarily, in relation to single species considerations.

14.4 Division IV Nephrops Management Considerations

Advice is provided on a Management Area basis, while management through the TAC is applied over the whole North Sea, and includes a number of other FUs exhibiting various states of exploitation. On numerous occasions (see e.g. ICES, 1997a and 1999a), the WGNEPH has pointed out the difficulties of managing *Nephrops* stocks in this way, and suggested that some subdivision of the TAC area would be desirable. While maintaining the view that *Nephrops* stocks are most appropriately managed at a smaller scale, the WG recognises that this may not be possible or practical for other reasons. The WG feels however, that ways should be found of ensuring that effort and landings are allocated appropriately at a more local level than is possible under the current overall TAC approach. Under the present management and TAC allocation system, changes in the North Sea TAC implied by the advice for one particular stock (as has been the case in the past with the Fladen Ground) would be divided between all nations with North Sea *Nephrops* quota, and would to lead changes in opportunity for all North Sea *Nephrops* fleets, which may lead to the risk of unacceptably high effort levels on more vulnerable grounds (where increases in activity are not advised). The risk of rapid uptake of quota in expanding fisheries (such as the Fladen Ground or Off Horn Reef), and the associated reduction of opportunity in smaller stocks remains while TACs are allocated to large areas.

Mixed fishery aspects

Analysis of catch rates from half hour tows on a recent trawl survey of the Farn deeps involving four commercial *Nephrops* trawlers (Bell, M. et al, 2004, Fisheries Science Partnership2004/5 Programme 6: NE *Nephrops*) showed that there was a tendency for catch rates of cod, plaice, haddock and lemon sole to be low when catch rates of *Nephrops* were high and vice versa. This relationship was particular apparent for cod and plaice. The possible reasons are discussed but generally the analysis suggests that specific targeting of *Nephrops* can reduce bycatch.

Table 14.1 *Nephrops* Functional Units and descriptions by statistical rectangle.

Functional Unit	Stock	ICES Rectangles	Management Area	Division
3	Skagerrak	47G0-G1; 46F9-G1; 45F8-G1; 44F7-G0; 43F8-F9	E	IIIa
4	Kattegat	44G1-G2; 42-43G0-G2; 41G1-G2	E	IIIa
5	Botney Gut	36-37 F1-F4; 35F2-F3	H	IV
6	Farn Deep	38-40 E8-E9; 37E9	I	IV
7	Fladen	44-49 E9-F1; 45-46E8	G	IV
8	Firth of Forth	40-41E7; 41E6	I	IV
9	Moray Firth	44-45 E6-E7; 44E8	F	IV
10	Noup	47E6	F	IV
32	Norwegian Deep	44-52 F2-F6; 43F5-F7	S	IV
33	Off Horn Reef	39-41E4; 39-41E5	H	IV

Table 14.2 Summary of Nephrops landings from the ICES area, by Management Area, 1991-2004

ICES sub-area	**IIIa**	**IV**					**Area IV Total**	**Overall total**
MA	E	F	G	S	I	H		All MAs
1991	4238	1780	4273	178	3823	1023	11077	15315
1992	2912	1822	3402	160	3491	736	9611	12523
1993	3209	2253	3532	338	5661	945	12729	15938
1994	2874	2171	4686	759	5953	682	14251	17125
1995	3427	1654	6624	494	4704	1234	14710	18137
1996	3979	1896	5368	960	4557	921	13702	17681
1997	4206	1856	6266	760	4722	1554	15159	19365
1998	5044	1360	5230	838	4599	1640	13667	18711
1999	4943	1361	6696	1129	5006	2204	16396	21339
2000	4703	1880	5650	1051	4353	1978	14912	19615
2001	4055	1696	5644	1191	4735	2429	15695	19750
2002	4441	1588	7410	1216	3917	2418	16549	20990
2003	3754	1534	6402	1110	4024	2457	15527	19281
2004*	3953	1665	8807	934	4399	2621	18426	22379

* provisional   na = not available

Table 14.3 Nominal landings (tonnes) of Nephrops in Division IIIa, 1986 – 2004, as officially reported to ICES.

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Denmark	2647	2840	2869	3022	3094	2790	2046	2251	2049	2419	2843	2959	3538	3487	3329	2868	3277	2752	2955
Germany	0	0	0	0	0	0	0	0	0	1	1	5	12	6	7	1	7	12	12.3
Germany, Fed. Rep. of	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Norway	64	80	88	54	140	185	104	103	62	90	102	117	184	214	181	138	116	99	95
Sweden	1237	1240	1062	829	1098	1249	772	863	763	913	1105	1129	1314	1259	1195	1040	1033	896	903
Total	3958	4160	4019	3905	4332	4224	2922	3217	2874	3423	4051	4210	5048	4966	4712	4047	4433	3759	3966.3

Table 14.4 Management Area E (IIIa): Total Nephrops landings (tonnes) by Functional Unit plus Other rectangles, 1991-2004.

Year	FU 3	FU 4	Other	Total
1991	2934	1304	0	4238
1992	1900	1012	0	2912
1993	2285	924	0	3209
1994	1981	893	0	2874
1995	2429	998	0	3427
1996	2694	1285	0	3979
1997	2612	1594	0	4206
1998	3248	1796	0	5044
1999	3194	1749	0	4943
2000	2894	1809	0	4703
2001	2282	1773	0	4055
2002	2977	1464	0	4441
2003	2126	1628	0	3754
2004	2312	1641	0	3953

Table 14.5 Management Area E (IIIa): Total Nephrops landings (tonnes) by country, 1991-2004.

Year	Denmark	Norway	Sweden	Total
1991	2824	195	1219	4238
1992	2052	111	749	2912
1993	2250	100	859	3209
1994	2049	62	763	2874
1995	2419	90	918	3427
1996	2844	101	1034	3979
1997	2959	117	1130	4206
1998	3541	184	1319	5044
1999	3486	214	1243	4943
2000	3325	181	1197	4703
2001	2880	138	1037	4055
2002	3293	116	1032	4441
2003	2757	99	898	3754
2004	2955	95	903	3953

Table 14.6 Nephrops Skagerrak (FU 3): Landings (tonnes) by country, 1991-2004.

Year	Denmark	Norway	Sweden			Total
			Trawl	Creel	Sub-total	
1991	1639	195	949	151	1100	2934
1992	1151	111	524	114	638	1900
1993	1485	100	577	123	700	2285
1994	1298	62	531	90	621	1981
1995	1569	90	659	111	770	2429
1996	1772	101	708	113	821	2694
1997	1687	117	690	118	808	2612
1998	2055	184	864	145	1009	3248
1999	2070	214	793	117	910	3194
2000	1877	181	689	147	836	2894
2001	1416	138	594	134	728	2282
2002	2053	116	658	150	808	2977
2003	1421	99	471	135	606	2126
2004	1595	95	449	173	622	2312

Table 14.7 Nephrops Skagerrak (FU 3): Catches and landings (tonnes), effort (‘000 hours trawling), CPUE and LPUE (kg/hour trawling) of Swedish Nephrops trawlers, 1991-2004 (data presented for single and twin trawls separately).

Single trawl						Twin trawl				
Year	Catches	Landings	Effort	CPUE	LPUE	Catches	Landings	Effort	CPUE	LPUE
1991	676	401	71.4	9.5	5.6	740	439	39.5	18.7	11.1
1992	360	231	73.7	4.9	3.1	370	238	34.1	10.9	7.0
1993	614	279	72.6	8.4	3.8	568	258	35.9	15.8	7.2
1994	441	246	60.1	7.3	4.1	444	248	34.1	13.1	7.3
1995	501	336	60.8	7.8	5.2	403	270	32.9	12.2	8.2
1996	754	488	51.1	14.8	9.6	187	121	13.0	14.4	9.3
1997	643	437	44.4	14.4	9.8	219	149	17.5	12.5	8.5
1998	794	557	49.7	16.0	11.2	254	178	16.7	15.2	10.6
1999	605	386	34.5	17.5	9.3	382	244	27.6	13.8	8.8
2000	486	329	32.7	14.9	10.9	349	237	31.3	11.1	10.1
2001	446	236	26.2	17.0	10.4	470	249	33.7	14.0	7.4
2002	503	301	29.4	17.1	8.8	392	244	33.3	11.8	7.1
2003	310	254	21.5	13.9	11.4	168	138	22.5	7.5	6.1
2004	474	257	20.1	23.6	12.8	217	118	21.7	10.0	5.4

Table 14.8 *Nephrops* Skagerrak (FU 3): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching *Nephrops* with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1991-2004.

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

Table 14.9 *Nephrops* Skagerrak (FU 3): Mean sizes (mm CL) of male and female *Nephrops* in catches of Danish, Swedish and Norwegian trawlers combined, 1991-2004.

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

Table 14.10 *Nephrops* Kattegat (FU 4): Landings (tonnes) by country, 1991-2004.

Year	Denmark	Sweden			Total
		Trawl	Creel	Sub-total	
1991	1185	119	0	119	1304
1992	901	111	0	111	1012
1993	765	159	0	159	924
1994	751	142	0	142	893
1995	850	148	0	148	998
1996	1072	213	0	213	1285
1997	1272	319	3	322	1594
1998	1486	306	4	310	1796
1999	1416	329	4	333	1749
2000	1448	357	4	361	1809
2001	1464	304	6	309	1773
2002	1240	219	5	224	1464
2003	1336	287	5	292	1628
2004	1360	270	11	281	1641

Table 14.11 Nephrops Kattegat (FU 4): Catches and landings (tonnes), effort (‘000 hours trawling), CPUE and LPUE (kg/hour trawling) of Swedish *Nephrops* trawlers, 1991-2004 (data presented for single and twin trawls separately).

	Single trawl					Twin trawl				
Year	Catches	Landings	Effort	CPUE	LPUE	Catches	Landings	Effort	CPUE	LPUE
1991	66	39	10.3	6.4	3.7	93	55	8.8	10.6	6.2
1992	44	28	11.6	3.8	2.4	101	65	14.2	7.1	4.6
1993	128	58	14.9	8.6	3.9	187	85	17.8	10.6	4.8
1994	95	53	16.2	5.7	3.2	138	77	14.2	9.7	5.4
1995	79	53	9.6	7.8	5.5	125	84	11.0	12.2	7.7
1996	207	134	13.7	15.1	9.8	97	63	7.5	13.0	8.4
1997	269	183	18.0	15.0	10.2	183	124	12.7	14.3	9.7
1998	181	127	13.1	13.8	9.7	215	151	15.0	14.4	10.1
1999	146	93	8.1	17.9	11.4	306	195	20.1	15.2	9.7
2000	114	77	8.5	13.4	9.1	330	224	24.5	13.5	9.1
2001	117	62	7.6	15.4	8.2	353	187	25.1	14.1	7.4
2002	42	25	3.7	11.2	6.7	256	153	23.2	11.0	6.6
2003	49	40	4.6	10.7	8.7	222	181	24.8	9	7.3
2004	70	44	4.3	16.2	10.1	253	158	16.5	15.4	9.6

Table 14.12 *Nephrops* Kattegat (FU 4): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching Nephrops with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1991-2004.

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

Table 14.13 Nephrops Kattegat (FU 4): Mean sizes (mm CL) of male and female Nephrops in discards, landings and catches of Danish trawlers, 1991-2004

Year	Discards					
	Discards		Landings		Catch	
	Males	Females	Males	Females	Males	Females
1991	30.7	31.1	42.4	42.5	32.5	32.9
1992	33.0	30.3	44.4	43.2	36.7	34.9
1993	30.5	29.3	42.3	43.1	31.3	30.1
1994	29.7	28.3	40.8	40.2	31.2	28.9
1995	30.8	30.5	42.4	42.0	33.7	33.2
1996	32.7	31.3	42.0	44.0	36.7	37.3
1997	33.6	33.2	45.0	44.5	37.1	35.0
1998	34.2	33.2	45.6	44.1	41.3	36.8
1999	32.9	33.8	45.3	40.9	37.8	34.9
2000	35.1	35.2	45.7	42.1	40.4	36.9
2001	32.2	33.0	44.1	41.9	35.9	36.5
2002	34.4	33.3	44.4	43.8	37.2	36.2
2003	33.0	33.2	43.5	42.2	37.1	36.0
2004	34.7	34.2	45.1	43.2	39.9	37.5

Table 14.14 Nominal landings (tonnes) of Nephrops in Division IV, 1986 – 2004, as officially reported to ICES.

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Belgium	344	437	500	574	610	427	384	418	304	410	185	311	238	350	252	283	284	229	213.2
Denmark	323	479	409	508	743	880	581	691	1128	1182	1315	1309	1440	1963	1747	1935	2154	2128	2232
Faeroe Islands	0	0	0	0	0	0	0	1	3	12	0	1	1	1	0	0	0	0	0
France	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germany	0	0	0	0	0	2	2	16	24	16	69	64	58	104	79	140	125	50	49.9
Germany, Fed. Rep. of	5	1	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Netherlands	0	0	0	0	9	3	134	131	159	254	423	627	695	662	572	851	966	940	918
Norway	1	2	17	17	46	117	125	107	171	74	83	64	93	144	147	115	130	100	93
Sweden	0	0	0	0	0	4	0	1	1	1	0	1	3	4	37	26	14	1	0.8
UK - Eng+Wales+N.Irl.	0	0	0	2938	2332	1955	1451	2983	3613	2530	2462	2206	2094	2431	2210	2691	1964	2295	2232.7
UK - England & Wales	2002	2173	2397	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UK – Scotland	6190	5304	6527	7065	6871	7501	6898	8250	8850	10018	8981	10466	8980	10715	9834	9681	11045	10094	12916
Total	8865	8403	9852	11103	10613	10889	9575	12598	14253	14497	13518	15049	13602	16374	14878	15722	16682	15838	18655.6

Table 14.15 Nephrops, Management Area F: Total Nephrops landings (tonnes) by Functional Unit plus Other rectangles, 1981-2004.

Year	FU 9	FU 10	Other	Total
1981	1416	36	0	1452
1982	1120	19	1	1140
1983	940	15	1	956
1984	1170	111	3	1284
1985	2081	22	15	2118
1986	2143	68	44	2255
1987	1991	44	34	2069
1988	1959	76	45	2080
1989	2576	84	44	2704
1990	2038	217	68	2323
1991	1519	196	65	1780
1992	1591	188	43	1822
1993	1808	376	69	2253
1994	1538	495	138	2171
1995	1297	280	77	1654
1996	1451	344	101	1896
1997	1446	316	94	1856
1998	1032	254	74	1360
1999	1008	279	74	1361
2000	1541	275	64	1880
2001	1403	177	116	1696
2002	1118	401	69	1588
2003	1079	337	118	1534
2004	1335	228	102	1665

Table 14.16 Nephrops, Moray Firth (FU 9), Nominal Landings of Nephrops, 1981-2004, as officially reported.

Year	UK Scotland				UK England	Total **
	Nephrops trawl	Other trawl	Creel	Sub-total		
1981	1298	118	0	1416	0	1416
1982	1034	86	0	1120	0	1120
1983	850	90	0	940	0	940
1984	960	209	0	1170	0	1170
1985	1908	173	0	2081	0	2081
1986	1933	210	0	2143	0	2143
1987	1723	268	0	1991	0	1991
1988	1638	321	0	1959	0	1959
1989	2102	474	0	2576	0	2576
1990	1700	338	0	2038	0	2038
1991	1284	233	0	1519	0	1519
1992	1282	305	0	1591	0	1591
1993	1505	303	0	1808	0	1808
1994	1178	360	0	1538	0	1538
1995	967	330	0	1297	0	1297
1996	1084	364	1	1449	2	1451
1997	1102	343	0	1445	1	1446
1998	739	289	4	1032	0	1032
1999	813	194	1	1008	0	1008
2000	1343	195	3	1541	0	1541
2001	1188	213	2	1403	0	1403
2002	883	248	2	1118	0	1118
2003	872	197	10	1079	0	1079
2004*	1223	103	9	1335	0	1335

* provisional na = not available
** There are no landings by other countries from this FU

Table 14.17 Nephrops, Moray Firth (FU 9): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish Nephrops trawlers, 1981-2004 (data for all Nephrops gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	1298	36.7	35.4	1298	36.7	35.4	na	na	na
1982	1034	28.2	36.7	1034	28.2	36.7	na	na	na
1983	850	21.4	39.7	850	21.4	39.7	na	na	na
1984	960	23.2	41.4	960	23.2	41.4	na	na	na
1985	1908	49.2	38.8	1908	49.2	38.8	na	na	na
1986	1933	51.6	37.5	1933	51.6	37.5	na	na	na
1987	1723	70.6	24.4	1723	70.6	24.4	na	na	na
1988	1638	60.9	26.9	1638	60.9	26.9	na	na	na
1989	2102	69.6	30.2	2102	69.6	30.2	na	na	na
1990	1700	58.4	29.1	1700	58.4	29.1	na	na	na
1991	1284	47.1	27.3	571	25.1	22.7	713	22.0	32.4
1992	1282	40.9	31.3	624	24.8	25.2	658	16.1	40.9
1993	1505	48.6	31.0	783	28.1	27.9	722	20.6	35.0
1994	1178	47.5	24.8	1023	42.0	24.4	155	5.5	28.2
1995	967	30.6	31.6	857	27.0	31.7	110	3.6	30.6
1996	1084	38.2	28.4	1057	37.4	28.3	27	0.8	33.8
1997	1102	47.7	23.1	960	42.5	22.6	142	5.1	27.8
1998	739	34.4	21.5	576	28.1	20.5	163	6.3	25.9
1999	813	35.5	22.9	699	31.5	22.2	114	4.0	28.5
2000	1343	49.5	27.1	1068	39.8	26.8	275	9.7	28.4
2001	1188	47.6	25.0	913	37.0	24.7	275	10.6	25.9
2002	883	35.5	24.9	649	27.2	23.9	234	7.9	29.6
2003	872	28.9	30.2	737	25.3	29.1	135	3.6	37.5
2004*	1223	31.7	38.6	1100	29.2	37.7	123	2.5	49.2

Table 14.18 Nephrops, Moray Firth (FU 9): Mean sizes (CL mm) above and below 35 mm of male and female Nephrops in Scottish catches and landings, 1991-2004.

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

Table 14.19 Nephrops, Moray Firth (FU 9) Commercial fleet tuning series for Scottish Nephrops trawlers, for males and females. Effort (first column) is reported as hours (000's) fished, numbers removed are in thousands. Raising procedures documented in the Stock Annex (section B4).

mal	TUNE	DATA	EFFOR100HRS						
101									
FLEET	1								
1981	2004								
1	1	0	1						
1	9								
40	23.5	1620	13630	15985	7456	2912	1337	477.1	246.5
30.6	22.4	1855	6926	7986	4841	2558	1198	496.5	431.7
23.7	33.3	1926	7384	7606	3820	1750	807.4	384.1	743.1
28.3	50.5	3167	13362	13294	6509	2739	1168	437.1	351.8
53.6	74.7	7696	25943	19775	9636	3317	1183	383.9	221.6
57.3	65	7688	32495	19865	6586	2755	1116	371.6	155.6
81.6	84.5	7349	24238	19237	8943	2895	1301	838.2	655.9
72.8	73.6	7741	24434	21502	7275	3141	929.3	262.2	259.5
85	84.5	6088	28546	29411	11235	5742	2794	1282	1078
70	127.9	5175	16953	18661	8777	2471	706.7	238.6	195.4
55.6	27.5	5339	20893	16955	6867	1865	627.3	129.5	73.1
51.4	4.5	2322	16526	18284	11064	3203	1051	252.7	103.2
58.3	0.2	1286	9342	12658	9666	3296	1131	381	189.3
61.9	49.9	1522	6146	6645	4594	2142	901.1	376.5	237.9
38.3	491.9	17266	15688	10714	4059	1488	646.1	231.5	166.2
47.6	4	2110	16675	16793	6741	1749	601.1	237.8	249.2
61.1	1.5	3803	15141	12222	7033	2970	877.6	236	192.4
45.5	27.8	2380	7791	8504	4027	1388	532.9	174.8	159.6
43.3	11.6	1327	7543	9562	5076	1833	651.2	247.9	171.3
55.6	0.8	936	10119	12955	9007	3517	1319	548.3	521.3
54.5	22.8	1085	9842	14312	7050	3447	1441	577.5	414.1
41.8	238.8	4288	5734	6820	3974	2177	1430	768.1	811.6
34	15.2	1658	8313	9404	4698	1782	849.4	484.4	505.6
33.4	11.8	2289	8626	11704	8538	3555	1064	329.2	353

fem	TUNE	DATA	EFFOR100HRS											
101														
FLEET	1													
1981	2004													
1	1	0	1											
1	14													
40	36.5	4667	7353	6281	5102	3726	2325	1601	1192	663.1	420.5	322.5	183.4	359.4
30.6	32.3	3692	4419	4603	4452	3877	3271	2142	1655	1074	646.1	473.1	261.1	671.8
23.7	47.5	3218	3125	2771	2805	2644	2315	1861	1453	874.3	682.7	605.3	326.2	797.8
28.3	56	2847	3207	3057	2901	2434	1732	1425	1116	670.1	517	455.1	239.6	538.8
53.6	99.7	7542	9066	8638	7867	6350	4514	3327	2587	1604	1174	1000	486	959.7
57.3	102	10415	14971	11788	9384	6794	4023	2654	2129	1532	1200	1065	627.8	1643
81.6	100.2	8106	8866	7461	6237	4885	3815	2710	2107	1332	908.4	737.3	394.9	1407
72.8	75.6	7251	7151	6880	6484	5440	4127	3114	2482	1643	1150	950.7	588.5	1646
85	103.8	5785	8063	8602	7406	5409	3460	2087	1546	922.4	834.2	798.5	630.8	2267
70	157.1	6027	9910	9936	8747	6952	5294	3437	2750	1980	1603	1450	837.8	2591
55.6	90.2	7429	10567	9236	8105	6118	3319	2165	1579	842.9	517.1	385.4	228	641
51.4	17.8	2626	5530	4717	4335	4024	3788	2801	2232	1491	864	611	337	1004
58.3	2.8	1434	4021	5498	6575	6921	6753	5278	4142	2567	1912	1647	736.7	1438
61.9	105.8	2364	4130	4490	5705	6820	7777	6946	5607	3582	2161	1587	689.1	1489
38.3	569.4	21735	6402	4470	3891	3063	2376	2445	2257	1937	1455	1261	623.9	1396
47.6	5.9	2380	6953	8319	7270	5351	3468	2248	1803	1309	953.8	810.5	456.8	1024
61.1	8.6	4464	6759	6910	6094	4592	3067	1861	1482	1089	869.7	781	452.9	1045
45.5	65	3287	3618	3352	3538	3318	2694	1698	1339	941	624.5	496.6	254.9	821.2
43.3	27.4	1752	2786	2988	2921	2572	2129	1788	1503	1102	521.6	287.1	207.1	521.8
55.6	6.5	2094	4033	4818	4823	4453	4120	3145	2573	1824	1335	1137	631.5	1714
54.5	7.7	1452	2933	3253	3700	3813	3585	1997	1651	1387	787.6	545.5	273.7	825.9
41.8	297.6	5777	2659	2892	2839	2642	2508	2170	1866	1434	1020	852.8	534.1	1814
34	30.4	1738	1881	2173	2595	2713	2620	1906	1591	1213	766	585.7	384.1	906.8
33.4	85.4	2346	2890	2601	2665	2571	2277	1837	1585	1257	1221	1207	957.7	2984

Table 14.20 Nephrops, Moray Firth (FU 9): Results of the 1993-2004 TV surveys.

Year	Stations	Mean density	Abundance	95% confidence interval	Biomass
		burrows/m²	millions	millions	'000 tonnes
1993	31	0.19	418	94	6.7-10.5
1994	29	0.39	850	213	15.1-25.1
1995			no survey		
1996	27	0.26	563	109	8.7-12.8
1997	34	0.14	317	66	4.8-7.3
1998	31	0.18	391	115	5.3-7.5
1999	52	0.22	484	105	7.2-11.3
2000	44	0.21	467	118	6.6-11.2
2001	45	0.19	417	135	5.4-10.5
2002	31	0.29	630	146	9.2-14.8
2003	32	0.32	706	306	7.6-19.3
2004	42	0.31	686	200	9.3-16.9

Table 14.21 Nephrops, Moray Firth (FU 9): Predicted landings potential based on abundance estimates using TV surveys, current landings and discard length distributions for the Moray Firth, and a range of harvest ratios, with an indication of the 95% confidence interval.

HR%	Landings	95%
10	1405	453
15	2108	679
20	2811	906
25	3513	1132
30	4216	1359

Table 14.22 *Nephrops*, Noup (FU 10), Nominal Landings of Nephrops, 1981-2004, as officially reported.

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

* provisional   na = not available

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

Table 14.23 Nephrops, Noup (FU 10): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish Nephrops trawlers, 1981-2004 (data for all Nephrops gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	13	0.4	34.3	13	0.4	34.3	na	na	na
1982	12	0.5	24.7	12	0.5	24.7	na	na	na
1983	9	0.3	30.7	9	0.3	30.7	na	na	na
1984	75	2.0	36.9	75	2.0	36.9	na	na	na
1985	2	0.1	25.0	2	0.1	25.0	na	na	na
1986	46	0.7	62.6	46	0.7	62.6	na	na	na
1987	12	0.7	18.1	12	0.7	18.1	na	na	na
1988	23	1.0	34.3	23	1.0	34.3	na	na	na
1989	24	0.9	25.8	24	0.9	25.8	na	na	na
1990	101	2.9	34.6	101	2.9	34.6	na	na	na
1991	110	4.8	22.9	23	0.9	25.6	87	3.9	22.3
1992	56	1.8	31.1	33	1.4	23.6	23	0.4	57.5
1993	200	4.8	41.7	152	3.6	42.0	48	1.2	39.0
1994	308	8.4	36.7	273	7.6	36.0	35	0.8	42.1
1995	162	3.9	41.5	139	3.5	39.9	23	0.4	63.2
1996	180	4.4	40.9	174	4.2	41.4	6	0.2	30.0
1997	185	5.3	34.9	172	4.9	35.1	13	0.4	32.5
1998	183	3.2	57.2	171	3.0	57.0	12	0.2	60.0
1999	211	4.1	51.8	196	3.8	53.0	15	0.3	54.9
2000	196	2.0	98.0	161	1.8	89.4	35	0.2	175.0
2001	89	1.7	52.4	82	1.4	58.6	7	0.3	23.3
2002	244	3.3	73.9	185	2.1	88.1	59	1.2	49.2
2003	258	2.7	95.6	217	2.3	94.3	41	0.4	102.5
2004	175	2.2	79.5	144	2.2	65.5	31	0.0	

Table 14.24 Nephrops, Noup (FU 10): Results of the 1994-1999 TV surveys. No TV surveys were possible for this stock between 2000-2004.

Year	Stations	Mean density	Abundance	95% confidence interval	Biomass
		burrows/m²	millions	millions	'000 tonnes
1994	10	0.63	250	90	4.0-8.0
1995			no survey		
1996			no survey		
1997			no survey		
1998			no survey		
1999	10	0.30	120	42	1.9-3.8

Table 14.25 Nephrops, Management Area G: Total Nephrops landings (tonnes) by Functional Unit plus Other rectangles, 1981-2004.

Year	FU 7	Other	Total
1981	373	2	375
1982	422	0	422
1983	693	0	693
1984	646	7	653
1985	1148	18	1166
1986	1543	17	1560
1987	1696	14	1710
1988	1573	11	1584
1989	2299	31	2330
1990	2540	20	2560
1991	4221	52	4273
1992	3363	39	3402
1993	3493	39	3532
1994	4569	117	4686
1995	6440	184	6624
1996	5218	150	5368
1997	6171	95	6266
1998	5136	94	5230
1999	6521	175	6696
2000	5570	81	5650
2001	5541	103	5644
2002	7247	163	7410
2003	6294	108	6402
2004	8728	79	8807

Table 14.26 Nephrops, Fladen (FU 7), Nominal Landings of Nephrops, 1981-2004, as officially reported.

Year	Denmark	UK Scotland			Other countries **	Total
		Nephrops trawl	Other trawl	Sub-total		
1981	0	304	69	373	0	373
1982	0	382	40	422	0	422
1983	0	548	145	693	0	693
1984	0	549	97	646	0	646
1985	7	1016	125	1141	0	1148
1986	50	1398	95	1493	0	1543
1987	323	1024	349	1373	0	1696
1988	81	1306	186	1492	0	1573
1989	165	1719	415	2134	0	2299
1990	236	1703	598	2301	3	2540
1991	424	3024	769	3793	4	4221
1992	359	1794	1179	2973	31	3363
1993	224	2033	1233	3266	3	3493
1994	390	1817	2356	4173	6	4569
1995	439	3569	2428	5997	4	6440
1996	286	2338	2592	4930	2	5218
1997	235	2713	3221	5934	2	6171
1998	173	2291	2672	4963	0	5136
1999	96	2860	3549	6409	16	6521
2000	103	2915	2546	5461	6	5570
2001	64	3539	1936	5475	2	5541
2002	173	4513	2546	7059	15	7247
2003	82	4175	2033	6208	4	6294
2004*	136	7274	1318	8592	0	8728

* provisional   na = not available

** Other countries includes Belgium, Norway and UK England

Table 14.27 Nephrops, Fladen (FU 7): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish Nephrops trawlers, 1981-2004 (data for all Nephrops gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	304	8.6	35.3	304	8.6	35.3	na	na	na
1982	382	12.2	31.3	382	12.2	31.3	na	na	na
1983	548	15.4	35.6	548	15.4	35.6	na	na	na
1984	549	11.4	48.2	549	11.4	48.2	na	na	na
1985	1016	26.6	38.2	1016	26.6	38.2	na	na	na
1986	1398	37.8	37.0	1398	37.8	37.0	na	na	na
1987	1024	41.6	24.6	1024	41.6	24.6	na	na	na
1988	1306	41.7	31.3	1306	41.7	31.3	na	na	na
1989	1719	47.2	36.4	1719	47.2	36.4	na	na	na
1990	1703	43.4	39.2	1703	43.4	39.2	na	na	na
1991	3024	78.5	38.5	410	11.4	36.0	2614	67.1	39.0
1992	1794	38.8	46.2	340	9.4	36.2	1454	29.4	49.5
1993	2033	49.9	40.7	388	9.6	40.4	1645	40.3	40.8
1994	1817	48.8	37.2	301	8.4	35.8	1516	40.4	37.5
1995	3569	75.3	47.4	2457	52.3	47.0	1022	23.0	44.4
1996	2338	57.2	40.9	2089	51.4	40.6	249	5.8	42.9
1997	2713	76.5	35.5	2013	54.7	36.8	700	21.8	32.1
1998	2291	60.0	38.2	1594	39.6	40.3	697	20.5	34.0
1999	2860	76.8	37.2	1980	50.3	39.4	880	26.5	33.2
2000	2915	92.1	31.7	2002	62.9	31.8	913	29.2	31.3
2001	3539	108.2	32.7	2162	65.8	32.9	1377	42.4	32.5
2002	4513	109.6	41.2	2833	58.9	48.1	1680	50.7	33.1
2003	4175	53.7	77.7	3388	42.8	79.2	787	10.9	72.2
2004*	7274	56.1	129.7	6177	47.5	130.0	1097	8.6	127.6

Table 14.28 Nephrops, Fladen (FU 7): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching Nephrops with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1991-2004.

Year	Logbook data	
	Effort	LPUE
1991	3115	116
1992	2447	127
1993	857	130
1994	1289	239
1995	846	341
1996	595	243
1997	400	346
1998	284	160
1999	197	251
2000	292	170
2001	213	181
2002	335	369
2003	194	307
2004	290	461

Table 14.29 Nephrops, Fladen (FU 7): Mean sizes (CL mm) above and below 35 mm of male and female Nephrops in Scottish catches and landings, 1991-2004.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1993	na	na	30.4	29.6	38.7	38.2
1994	na	na	30.0	28.9	39.2	37.8
1995	na	na	30.6	29.8	39.9	38.1
1996	na	na	30.4	29.1	40.6	38.8
1997	na	na	30.2	29.1	40.9	38.8
1998	na	na	30.8	29.4	40.7	38.4
1999	na	na	30.9	29.6	40.5	38.5
2000	30.8	30.1	31.2	30.5	41.3	38.7
2001	30.1	29.4	30.7	29.7	39.6	38.0
2002	30.6	30.1	31.3	30.7	39.5	38.3
2003	30.9	29.8	31.3	30.1	40.0	38.1
2004	30.8	29.9	31.1	30.3	40.1	38.7

Table 14.30 Nephrops, Fladen (FU 7) Commercial fleet tuning series for Scottish Nephrops trawlers, for males and females. Effort (first column) is reported as hours (000's) fished, numbers removed are in thousands. Raising procedures documented in the Stock Annex (section B4).

mal	TUNE	DATA EFFORT 100HRS							
101									
FLEET	1								
1990	2004								
1	1	0	1						
1	9								
58.2	0	1048	13834	19688	10956	5238	2047	1175	1146
98.4	7.4	3985	30548	42095	20573	7204	2268	636.3	297.8
73.1	0.1	2330	26736	31134	17283	7351	2961	929.1	713.2
79.3	0.1	5403	29350	36871	17844	5275	1863	433.5	76.6
111.8	52.9	8097	38286	40338	19852	7093	2536	525	160.6
119.8	3.5	4704	45147	49413	26831	15391	4108	1138	485.4
112.4	0.2	4581	41693	40358	23308	11234	5117	2677	2020
160.3	0.2	6100	37786	38638	31282	18973	7961	2949	2282
121.8	0.3	3524	31616	40117	23220	12836	6467	2724	2038
162	0.2	4048	32081	40689	31786	14804	6937	2825	2236
161.9	0.4	1600	21859	33560	27649	14229	7788	4051	3929
158	0.2	6386	40443	49345	20914	6316	2617	1210	1888
151.3	7.4	3899	45796	65257	31927	11809	4081	1459	1402
75.9	0	3274	31483	54282	32236	14822	5334	1881	2008
64.8	134.9	4569	45292	71958	46769	21497	9564	3234	1950

fem	TUNE	DATA EFFORT 100HRS											
101													
FLEET	1												
1990	2004												
1	1	0	1										
1	13												
58.2	0.5	1469	4707	7784	6627	4523	3463	2754	1319	821.9	538.9	279.5	651.7
98.4	16.2	3988	11617	18098	14973	8653	4768	2674	1324	804.3	507.3	233.2	620.4
73.1	0.9	2922	7967	9785	6206	3200	1947	1313	965.4	465.5	268.6	182.1	527.4
79.3	0.8	5402	9797	12542	10591	7642	4022	2813	1148	619.8	366.6	184.9	323.6
111.8	51	13298	18531	18165	16052	11987	6587	3627	1859	817.9	392.9	183.1	264.8
119.8	21.8	4835	18499	19905	14855	13119	9445	6668	3104	1428	780.7	516.5	620.5
112.4	1.1	4048	13218	16127	8259	4413	2536	1910	947.4	590.8	390.8	210.5	412.6
160.3	1.4	6479	15853	18906	10955	6700	4220	2720	1558	946.8	616.5	332.1	725.3
121.8	1.4	4526	11909	16022	10571	5580	3221	1572	644.8	465.8	330.3	169.7	417.5
162	1.5	8269	17230	23516	16305	13406	8099	5507	2588	1866	1293	594.9	724.5
161.9	6.3	2223	7908	11739	11394	9108	5636	3702	1707	1177	805.2	389.5	970.9
158	6.4	9306	21803	27996	21963	15647	10028	5441	2242	1381	879.5	407.1	682.9
151.3	6	4562	16379	28197	27397	17172	8861	4446	2503	1341	836.8	544.1	949.3
75.9	72.4	5721	12076	18196	18118	12425	7912	4478	2509	1386	801.8	325.8	539.5
64.8	20.1	4355	17884	25574	22315	16309	10921	7365	3974	2574	1728	898.1	1810

Table 14.31 Nephrops, Fladen (FU 7): Results of the 1992-2004 TV surveys.

Year	Stations	Mean density	Abundance	95% confidence interval	Biomass
		burrows/m²	millions	millions	'000 tonnes
1992	69	0.17	4942	508	110-135
1993	74	0.21	6007	768	132-171
1994	59	0.30	8329	1099	176-230
1995	61	0.24	6733	1209	130-186
1996			No survey		
1997	56	0.13	3736	689	71-104
1998	60	0.18	5181	968	99-144
1999	62	0.20	5597	876	111-152
2000	68	0.17	4898	663	99-130
2001	50	0.23	6725	1310	127-188
2002	54	0.29	8217	1022	168-217
2003	55	0.21	5890	1129	112-165
2004	52	0.21	5976	1112	114-166

Table 14.32 Nephrops, Fladen (FU 7): Predicted landings potential based on abundance estimates using TV surveys, current landings and discard length distributions for the Fladen, and a range of harvest ratios, with an indication of the 95% confidence interval.

HR%	Landings	95%
5	8627	1402
7.5	12940	2103
10	17254	2804
15	25880	4206
20	34507	5608

Table 14.33 Nephrops Norwegian Deep (FU 32): Landings (tonnes) by country, 1993-2004.

Year	Denmark	Norway	UK	Total
1993	220	102	16	338
1994	584	165	10	759
1995	418	74	2	494
1996	868	82	10	960
1997	689	64	7	760
1998	743	91	4	838
1999	972	144	13	1129
2000	871	147	33	1051
2001	1026	112	53	1191
2002	1043	121	52	1216
2003	996	100	14	1110
2004*	835	93	6	934

* provisional na = not available

Table 14.34 Nephrops, Management Area I: Total Nephrops landings (tonnes) by Functional Unit plus Other rectangles, 1981-2004.

Year	FU 6	FU 8	Other	Total
1981	1073	1006	74	2153
1982	2524	1195	156	3875
1983	2078	1724	100	3902
1984	1479	2134	78	3691
1985	2027	1969	106	4103
1986	2015	2263	143	4421
1987	2191	1674	147	4012
1988	2505	2528	308	5341
1989	3098	1886	158	5142
1990	2498	1930	133	4561
1991	2064	1404	355	3823
1992	1463	1757	270	3491
1993	3030	2369	261	5661
1994	3684	1850	407	5940
1995	2568	1763	373	4704
1996	2482	1688	387	4557
1997	2189	2194	339	4722
1998	2176	2145	278	4599
1999	2401	2205	401	5006
2000	2178	1785	391	4353
2001	2574	1528	633	4735
2002	1953	1340	637	3917
2003	2245	1126	653	4024
2004*	2153	1658	588	4399

Table 14.35 Nephrops Farn Deeps (FU 6): Landings (tonnes) by country, 1981-2004.

Year	UK England	UK Scotland	Sub total	Other countries**	Total
1981	1006	67	1073	0	1073
1982	2443	81	2524	0	2524
1983	2073	5	2078	0	2078
1984	1471	8	1479	0	1479
1985	2009	18	2027	0	2027
1986	1987	28	2015	0	2015
1987	2158	33	2191	0	2191
1988	2390	105	2495	0	2495
1989	2930	168	3098	0	3098
1990	2306	192	2498	0	2498
1991	1884	179	2063	0	2063
1992	1403	60	1463	10	1473
1993	2941	89	3030	0	3030
1994	3530	153	3683	0	3683
1995	2478	90	2568	1	2569
1996	2386	96	2482	1	2482
1997	2109	80	2189	0	2189
1998	2029	147	2176	1	2177
1999	2197	194	2391	0	2391
2000	1947	231	2178	0	2178
2001	2319	255	2574	0	2574
2002	1739	215	1953	0	1953
2003	2031	214	2245	0	2245
2004	1952	201	2153	0	2153

* provisional   na = not available

** Other countries includes Be and Dk

Table 14.36 Farn Deeps (FU 6): Catches and landings (tonnes), effort (‘000 hours trawling), CPUE and LPUE (kg/hour trawling) of UK Nephrops trawlers, 1985-2004.

Year	Catches	Landings	Effort	CPUE	LPUE
1985	4224	2012	88.7	47.6	22.7
1986	2800	1995	90.1	31.1	22.1
1987	4435	2177	98.3	45.1	22.2
1988	5530	2472	118.1	46.8	20.9
1989	4639	3076	133.5	34.7	23.0
1990	4096	2471	116.2	35.3	21.3
1991	3075	2020	114.7	26.8	17.6
1992	2287	1437	69.5	32.9	20.7
1993	3567	3011	111.8	31.9	26.9
1994	5190	3684	143.4	36.2	25.7
1995	3152	2539	97.0	32.5	26.2
1996	3681	2475	90.5	40.7	27.4
1997	2501	2155	85.3	29.3	25.3
1998	2134	2128	78.2	27.3	27.2
1999	3748	2369	86.7	43.2	27.3
2000	3526	2073	88.7	39.8	23.4
2001	5069	2412	103.6	48.9	23.3
2002	3080	1898	75.2	40.9	25.2
2003	3891	2165	77.9	49.9	27.8
2004*	3549	1997	60.8	58.4	32.9

* provisional   na = not available

Table 14.37 Nephrops Farn Deeps (FU 6): Mean sizes (CL mm) of male and female Nephrops in English catches and landings, 1985-2004.

Year	Catches		Landings	
	Males	Females	Males	Females
1985	30.1	28.5	35.4	33.8
1986	31.7	30.2	35.3	33.7
1987	28.6	27.0	35.3	33.3
1988	28.7	27.3	35.0	33.9
1989	29.0	28.2	32.4	31.9
1990	27.1	27.4	31.8	31.3
1991	28.9	27.1	33.5	33.1
1992	30.8	29.0	33.0	31.9
1993	32.1	28.7	33.4	30.1
1994	30.5	27.7	33.8	30.5
1995	28.4	27.4	33.8	31.6
1996	29.8	28.2	34.5	32.1
1997	29.9	29.6	33.5	32.1
1998	30.0	28.9	34.9	33.7
1999	29.6	27.5	35.1	33.6
2000	28.7	27.9	34.1	33.6
2001	28.3	27.5	36.2	35.0
2002	29.9	28.0	34.7	32.9
2003	30.3	28.1	36.0	35.4
2004*	31.1	28.2	36.9	33.9

* provisional   na = not available

Table 14.38 Nephrops Farn Deeps (FU 6): Results from TV surveys carried out in 1996-2004, giving estimates of stock abundance and biomass.

Year	Stations	Season	Mean density	Abundance	95% confidence interval	Biomass
			burrows/m²	millions	millions	'000 tonnes
1996	71	Spring	0.58	1789	154	26.0-31.1
	-	Autumn	No survey			
1997	105	Spring	0.59	1821	185	26.0-32.1
	87	Autumn	0.61	1892	214	26.7-33.7
1998	78	Spring	0.25	759	84	10.7-13.5
	91	Autumn	0.44	1372	132	19.7-24.1
1999	95	Spring	0.34	1051	125	14.7-18.8
	-	Autumn	No survey			
2000	98	Spring	0.40	1242	116	17.8-21.6
	-	Autumn	No survey			
2001	-	Spring	No survey			
	180	Autumn	0.67	2057	125	30.7-35.0
2002	180	Spring	0.52	1591	100	23.7-27.1
	37	Autumn	0.41	1268	220	16.7-23.8
2003	-	Spring	No survey			
	92	Autumn	0.45	1400	170	19.6-25.1
2004*	-	Spring	No survey			
	81	Autumn*	0.62	1922	245	26.7-34.7

* provisional

Table 14.39 Nephrops, Farn Deeps (FU 6): Predicted landings potential based on abundance estimates using TV surveys, current landings and discard length distributions for the Farn Deeps, and a range of harvest ratios, with an indication of the 95% confidence interval.

HR%	Landings potential (tonnes)		
10	1983	+/-	248
15	2975	+/-	372
20	3966	+/-	496
25	4958	+/-	620
30	5950	+/-	744

Table 14.40 Nephrops, Firth of Forth (FU 8), Nominal Landings of Nephrops, 1981-2004, as officially reported.

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

* provisional   na = not available

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

Table 14.41 Nephrops, Firth of Forth (FU 8): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish Nephrops trawlers, 1981-2004 (data for all Nephrops gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	945	42.6	22.2	945	42.6	22.2	na	na	na
1982	1138	51.7	22.0	1138	51.7	22.0	na	na	na
1983	1681	60.7	27.7	1681	60.7	27.7	na	na	na
1984	2078	84.7	24.5	2078	84.7	24.5	na	na	na
1985	1908	73.9	25.8	1908	73.9	25.8	na	na	na
1986	2204	74.7	29.5	2204	74.7	29.5	na	na	na
1987	1582	62.1	25.5	1582	62.1	25.5	na	na	na
1988	2455	94.8	25.9	2455	94.8	25.9	na	na	na
1989	1833	78.7	23.3	1833	78.7	23.3	na	na	na
1990	1901	81.8	23.2	1901	81.8	23.2	na	na	na
1991	1359	69.4	19.6	1231	63.9	19.3	128	5.5	23.3
1992	1714	73.1	23.4	1480	63.3	23.4	198	8.5	23.3
1993	2349	100.3	23.4	2340	100.1	23.4	9	0.2	45.0
1994	1827	87.6	20.9	1827	87.6	20.9	0	0.0	0.0
1995	1708	78.9	21.6	1708	78.9	21.6	0	0.0	0.0
1996	1621	69.7	23.3	1621	69.7	23.3	0	0.0	0.0
1997	2137	71.6	29.8	2137	71.6	29.8	0	0.0	0.0
1998	2105	70.7	29.8	2105	70.7	29.8	0	0.0	0.0
1999	2192	67.7	32.4	2192	67.7	32.4	0	0.0	0.0
2000	1775	75.3	23.6	1761	75.0	23.5	14	0.3	46.7
2001	1484	68.8	21.6	1464	68.3	21.4	20	0.5	40.0
2002	1302	63.6	20.5	1286	63.3	20.3	16	0.3	53.3
2003	1115	53	21.0	1082	52.4	20.6	33	0.6	55.0
2004*	1651	63.3	26.1	1633	62.9	26.0	18	0.4	45.0

Table 14.42 Nephrops, Firth of Forth (FU 8): Mean sizes (CL mm) above and below 35 mm of male and female Nephrops in Scottish catches and landings, 1991-2004.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1981	na	na	31.5	31.0	39.7	38.7
1982	na	na	30.4	30.1	40.0	39.1
1983	na	na	31.1	30.8	40.2	38.7
1984	na	na	30.3	29.7	39.4	38.4
1985	na	na	30.6	29.9	39.5	38.2
1986	na	na	29.7	29.2	39.1	38.5
1987	na	na	29.9	29.6	39.1	38.2
1988	na	na	28.5	28.5	39.2	39.0
1989	na	na	29.2	28.9	38.7	38.9
1990	28.5	27.5	29.8	28.6	38.3	38.8
1991	28.7	27.5	29.8	28.7	38.3	38.7
1992	29.5	28.0	30.2	28.7	38.1	38.7
1993	28.7	28.0	30.3	29.5	39.0	38.6
1994	25.7	25.1	29.1	28.5	38.8	37.8
1995	27.9	27.1	29.4	28.9	38.7	37.9
1996	28.0	27.4	29.8	28.8	38.6	38.6
1997	27.3	27.0	29.2	28.7	38.8	38.2
1998	27.7	26.4	29.0	27.9	38.6	38.4
1999	27.2	26.5	29.6	28.8	38.0	37.9
2000	28.5	27.2	30.7	29.8	38.2	38.3
2001	28.1	26.7	30.6	29.2	38.0	37.9
2002	27.1	26.3	29.8	29.3	38.3	37.9
2003	27.2	25.5	30.2	29.1	38.1	38.0
2004*	28.6	27.8	30.7	30.0	38.4	37.6

Table 14.43 Nephrops, Firth of Forth (FU 8) Commercial fleet tuning series for Scottish Nephrops trawlers, for males and females. Effort (first column) is reported as hours (000's) fished, numbers removed are in thousands. Raising procedures documented in the Stock Annex (section B4).

mal	TUNE	DATA	EFFORT100HRS						
101									
FLEET	1								
1981	2004								
1	1	0	1						
1	9								
45.2	19.8	3751.8	8975.1	9194.4	4801.5	1831.6	679.4	242.8	173.8
54.3	91.7	6003.6	12650	10960	5307.2	2701	1001.4	356.5	256.6
62.3	36.1	6767.8	17456	16187	6853.2	3153.7	1296.6	645.6	500.4
87	106.4	11840	24426	21242	11144	4204.7	1336.5	420.6	211.5
76.2	57.9	8639	23301	18535	7678.3	3136.4	986.5	322.6	167.7
76.8	66.7	12002	35587	17897	6243.8	2169.3	592	205.3	116.1
65.6	38.1	9829.1	26814	15266	5377.8	1776.8	537.9	217.4	106.8
97.6	98.2	22396	38661	18816	8091.9	2645	889.9	305	147.4
80.9	59.7	13545	30921	15374	4448.1	1334.3	395.2	132.2	93.8
83	62.6	11912	36132	18911	4753.1	1054	351.5	90.6	31.5
71.6	7.3	7802.1	25501	14465	3576.6	921	198.4	60.8	25.6
74.9	20.1	5949.3	33008	22200	6558.4	1226.2	256.5	57.9	15.2
100.9	21.3	8807.8	36871	22991	10103	3859.2	1127.7	246	67.4
88.3	2443.3	50575	44525	14637	4631.2	1597	451.7	138.2	42.9
80.4	220.1	14354	38643	14940	4111.9	1422	314.1	84.5	36.1
72.2	162.3	13959	37595	15519	4398.7	1200.9	337	118	82.4
73.2	821	20044	37042	16031	4295.2	1357.3	392.9	128.8	75.1
71.5	156	23322	42600	19764	4849	1363.1	402.6	135.1	75.9
67.8	60.8	30660	40615	22455	6461.6	1137.5	311.7	73.5	20.3
75.5	262	12584	43147	23220	5282	1324	340.3	103.2	41.9
69.3	338.9	11224	24215	17062	4428.6	891.2	260.1	65.8	19.2
64.3	865.9	15973	24056	12382	2641.9	698	189.8	62.3	25.2
53.1	517.8	14798	24740	13688	4578.9	863.2	187.9	60.5	17.8
63.2	164.9	9658.7	24450	18628	5258.1	1381.1	322.1	94.3	33.5

fem	TUNE	DATA	EFFORT100HRS										
101													
FLEET	1												
1981	2004												
1	1	0	1										
1	13												
45.2	8.1	3559.9	2693.6	1954.7	1899.8	1836.2	1606.2	1371.5	1113.8	848	537.8	448.2	844.9
54.3	12.3	4749.4	3378.9	1986.1	1521.3	1616.5	1297.9	1027.6	866.1	727	571	490.4	874.6
62.3	11.4	6264.8	4969.3	3609.9	3449.2	3153.6	2687.6	1489.1	1128.9	951.3	567.9	473.9	862.3
87	21	9472.3	7630	5487.9	4651.4	3727.8	2499.5	1655.8	1190.7	804.5	417.8	350.9	828.2
76.2	22.3	7844.4	6489.6	5032.7	4181.8	3232.4	2179.1	1223.6	837.2	573.1	304	242.8	446.5
76.8	22.2	12432	14194	11768	9272.3	6283.7	4025.2	2335.1	1676.5	1240	611.6	496.1	1099.4
65.6	8.8	8003.9	8101.9	6323.7	5326.2	4128	2902.3	1704.3	1224.4	898.8	380.4	301.1	637.3
97.6	94.7	19096	13780	9618.5	6999.4	5726.1	4660.7	3028.6	2303.4	1771.9	1338	1127.7	2036.1
80.9	34.3	12586	10874	7829.4	5792.8	4253.8	3704.7	2577.8	2155.1	1884.5	1089.2	911.2	1909.7
83	26.9	12059	12309	8219	5541.2	3904.6	2830.1	1996.3	1588	1269.8	624.4	520.7	1353.5
71.6	1.3	9489.2	8381	5869.4	4256.3	3225.3	1984.3	1261.1	884	579.4	317.9	267.9	730.1
74.9	35.8	6587.4	8237.8	6796.9	4968.9	2909.8	1520.7	890.4	612.4	409.7	230	190.8	481.6
100.9	28.7	8910.6	10787	8601	6714.8	5109.9	2509.5	1857.8	1501.2	1206.1	445.9	352	1166.6
88.3	2338	52707	19636	10857	6873.4	4322	2641.3	1962.9	1358.5	763.5	365.5	293.8	539.8
80.4	306.1	16827	12823	9093.5	6989.7	4905.5	2624.4	1670.5	1089	583.7	288.3	234.2	458.6
72.2	181.6	14939	15099	11795	7643.1	4187.8	2363.7	1704.8	1293.1	931.7	498.1	413.1	911.2
73.2	612.3	22660	18682	13596	10065	6134.1	3500.6	2410.1	1703	1073.1	616.1	505.7	862.8
71.5	324.9	26588	16679	9315.4	6056	3935.5	2243.9	1381	937.5	582.2	321	260.4	547.1
67.8	241.6	29917	17711	12074	8393.1	5547.6	3076.1	2379	1781.3	1198.8	512.2	390.6	647
75.5	271.3	15532	21210	13151	6771.8	4475.9	2186.9	1324.2	930.2	636.1	355.4	297.1	550.5
69.3	406.1	14182	10240	7529.2	5887.7	3825	2464.2	1713	1149.8	622	279.8	218.3	476.3
64.3	624.2	19105	8937.8	6658.3	5264.1	3959.3	2522.9	1382.5	884.1	523	245.9	191.6	316.8
53.1	631.3	15857	9040.1	3995.8	2004.8	1378.2	1461.4	1165.2	884.4	603.9	248.8	192.3	367.9
63.2	164.5	10520	9084.2	7585.3	6024.4	4701.7	3799.4	2493.4	1724.1	1065.4	443.9	328.5	449.8

Table 14.44 Nephrops, Firth of Forth (FU 8): Results of the 1993-2004 TV surveys.

Year	Stations	Mean density	Abundance	95% confidence interval	Biomass
		burrows/m²	millions	millions	'000 tonnes
1993	37	0.72	655	167	9.9-16.7
1994	30	0.58	529	92	7.6-10.8
1995			no survey		
1996	27	0.48	443	104	5.8-9.3
1997			no survey		
1998	32	0.38	345	95	4.2-7.5
1999	49	0.60	546	92	7.7-10.8
2000	53	0.57	523	83	7.5-10.3
2001	46	0.54	494	93	6.8-10.0
2002	41	0.66	600	140	7.8-12.6
2003	36	0.80	735	150	9.9-15.0
2004	37	0.65	594	126	7.9-12.2

Table 14.45 Nephrops, Firth of Forth (FU 8): Predicted landings potential based on abundance estimates using TV surveys, current landings and discard length distributions for the Firth of Forth, and a range of harvest ratios, with an indication of the 95% confidence interval.

HR%	Landings	95%
10	868	187
15	1302	281
20	1736	375
25	2170	468
30	2604	562

Table 14.46 Nephrops Management Area H (North Sea South East): Total Nephrops landings (tonnes) by Functional Unit plus Other rectangles, 1991-2004.

Year	FU 5	FU 33	Other	Total
1991	862	74	88	1023
1992	611	76	48	736
1993	721	160	64	945
1994	503	137	41	682
1995	869	165	200	1234
1996	679	77	165	921
1997	1150	277	128	1554
1998	1071	350	219	1640
1999	1185	725	294	2204
2000	1070	600	308	1978
2001	1329	759	340	2429
2002	1142	839	437	2418
2003	1120	911	426	2457
2004 *	1054	1227	340	2621
* provisional na = not available				

Table 14.47 Nephrops Botney Gut - Silver Pit (FU 5): Landings (tonnes) by country, 1991-2004.

Year	Belgium	Denmark	Netherl.	UK	Total **
1991	682	176	na	4	862
1992	571	22	na	19	611
1993	694	20	na	7	721
1994	494	0	na	9	503
1995	641	77	148	3	869
1996	266	41	317	55	679
1997	486	67	540	56	1150
1998	372	88	584	28	1071
1999	436	53	538	158	1185
2000	366	83	402	218	1070
2001	353	145	553	278	1329
2002	281	94	617	151	1142
2003	265	36	661	158	1120
2004 *	171	39	646	198	1054

* provisional na = not available
** Totals for 1991-94 exclusive of landings by the Netherlands

Table 14.48 Nephrops Botney Gut - Silver Pit (FU 5): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Belgian Nephrops trawlers, 1991-2004.

Year	Landings	Effort	LPUE
1991	566	74.0	7.7
1992	525	74.5	7.0
1993	672	58.3	11.5
1994	453	35.5	12.7
1995	559	32.5	17.2
1996	245	30.1	8.1
1997	399	31.8	12.5
1998	309	28.6	10.8
1999	322	31.8	10.1
2000	174	21.8	8.0
2001	195	21.5	9.1
2002	144	15.8	9.1
2003	118	6.2	19.3
2004 *	106	5.7	18.8

* provisional na = not available

Table 14.49 Nephrops Botney Gut. Danish effort data from logbook records and estimated total effort. Based on Nephrops trawl and demersal trawl (mesh size >70 mm).

year	effort	LPUE	est. Total effort
1993	108	206	97
1994	0	0	0
1995	111	611	126
1996	132	261	157
1997	59	412	163
1998	174	447	197
1999	107	408	130
2000	253	299	278
2001	271	278	522
2002	193	239	392
2003	132	247	146
2004	149	242	161

Table 14.50 Nephrops Botney Gut - Silver Pit (FU 5): Mean sizes of Nephrops > 35 mm CL landed by Belgian Nephrops trawlers, 1991-2004.

Year	Landings	
	Males	Females
1991	40.8	41.3
1992	40.9	40.9
1993	41.0	40.9
1994	40.3	40.6
1995	40.7	39.8
1996	41.3	39.4
1997	41.2	39.0
1998	41.0	39.2
1999	40.9	39.5
2000	40.8	39.9
2001	40.3	39.7
2002	39.7	39.3
2003	40.5	39.3
2004 *	40.1	39.9
* provisional na = not available		

Table 14.51 Nephrops Off Horn Reef (FU 33): Landings (tonnes) by country, 1993-2004.

Year	Belgium	Denmark	Netherl.	UK	Total **
1993	0	159	na	1	160
1994	0	137	na	0	137
1995	3	158	0	1	164
1996	1	74	0	0	77
1997	0	274	0	0	276
1998	4	333	0	1	350
1999	22	683	0	6	724
2000	13	537	0	9	598
2001	52	667	0	+	719
2002	21	772	0	4	797
2003	15	842	0	1	858
2004*	37	1097	0	1	1135
* provisional na = not available, ** Totals for 1993-94 exclusive of landings by the N					

Table 14.52 Nephrops Off Horns Reef (FU 33): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching Nephrops with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1993-2004.

Year	Logbook data		Estimated total effort
	Effort	LPUE	
1993	975	170	971
1994	739	165	830
1995	724	194	816
1996	370	157	471
1997	925	161	1702
1998	1442	208	1601
1999	2323	252	2710
2000	2286	209	2569
2001	2818	191	3489
2002	3214	207	3734
2003	3640	212	3973
2004*	4306	234	4694

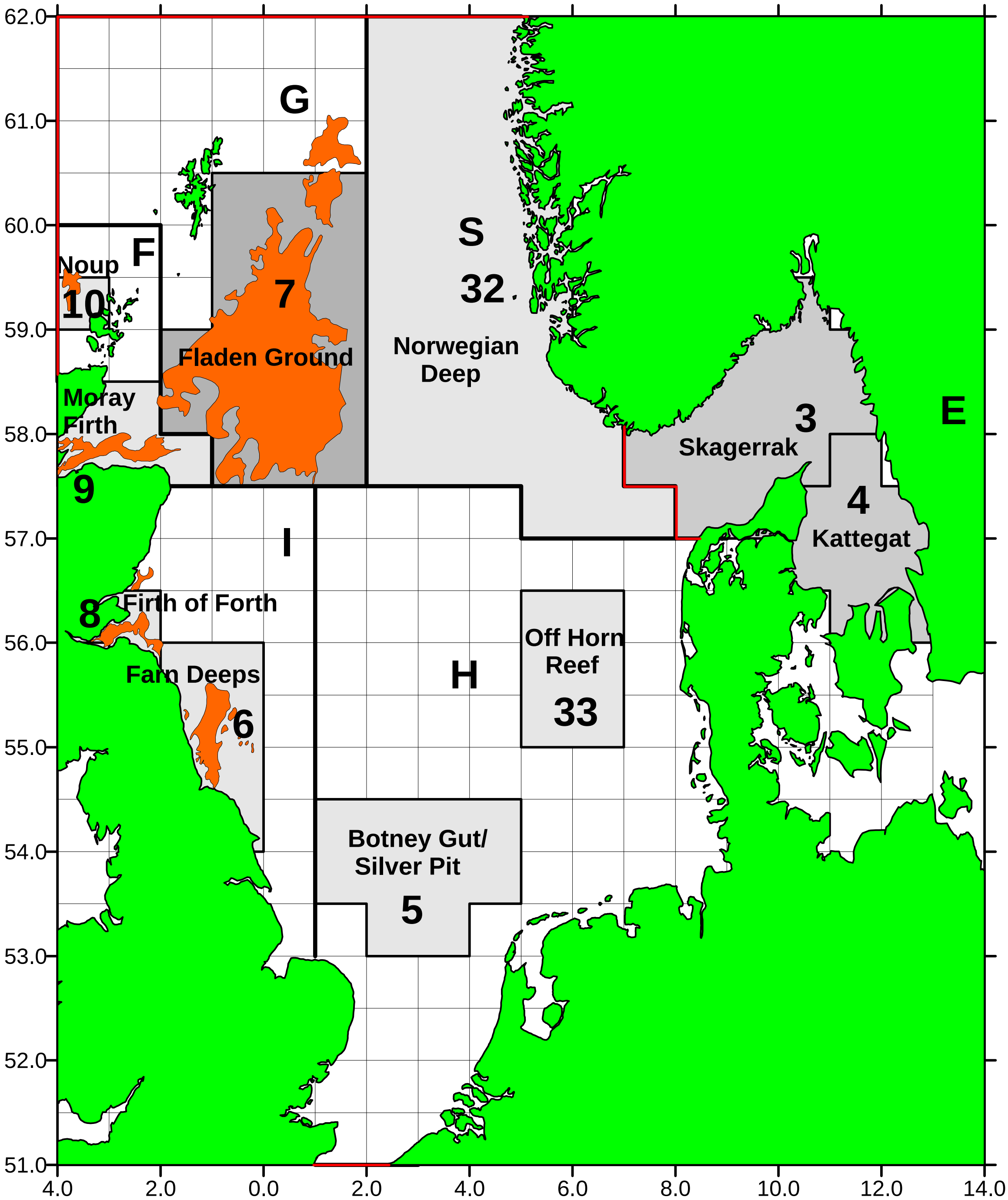


Figure 14.1 Nephrops Functional Units and Management Areas in the North Sea and Skagerrak/Kattegat region.

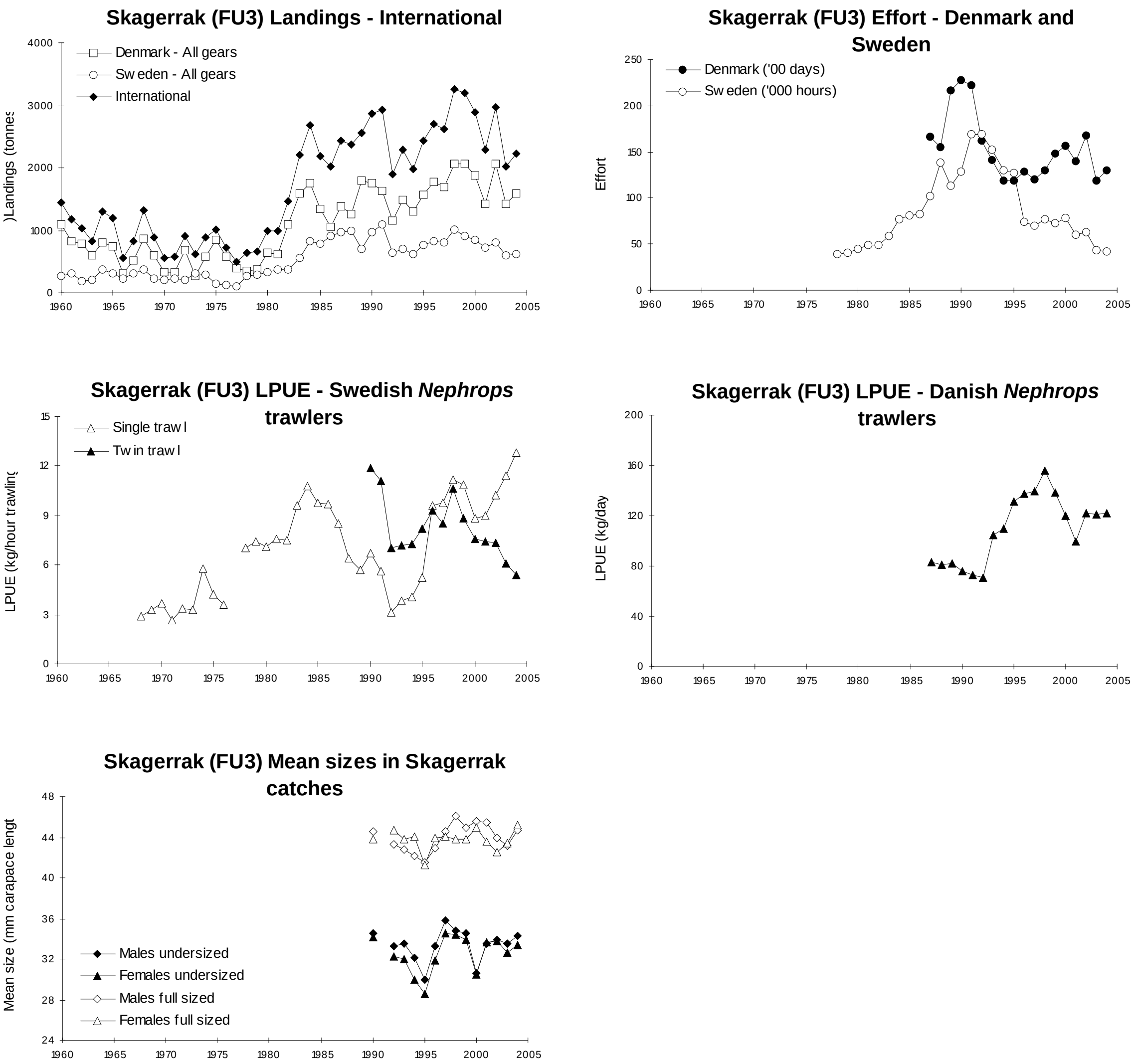


Figure 14.2 Nephrops Skagerrak (FU 3): Long-term trends in landings, effort, LPUEs, and mean sizes of Nephrops.

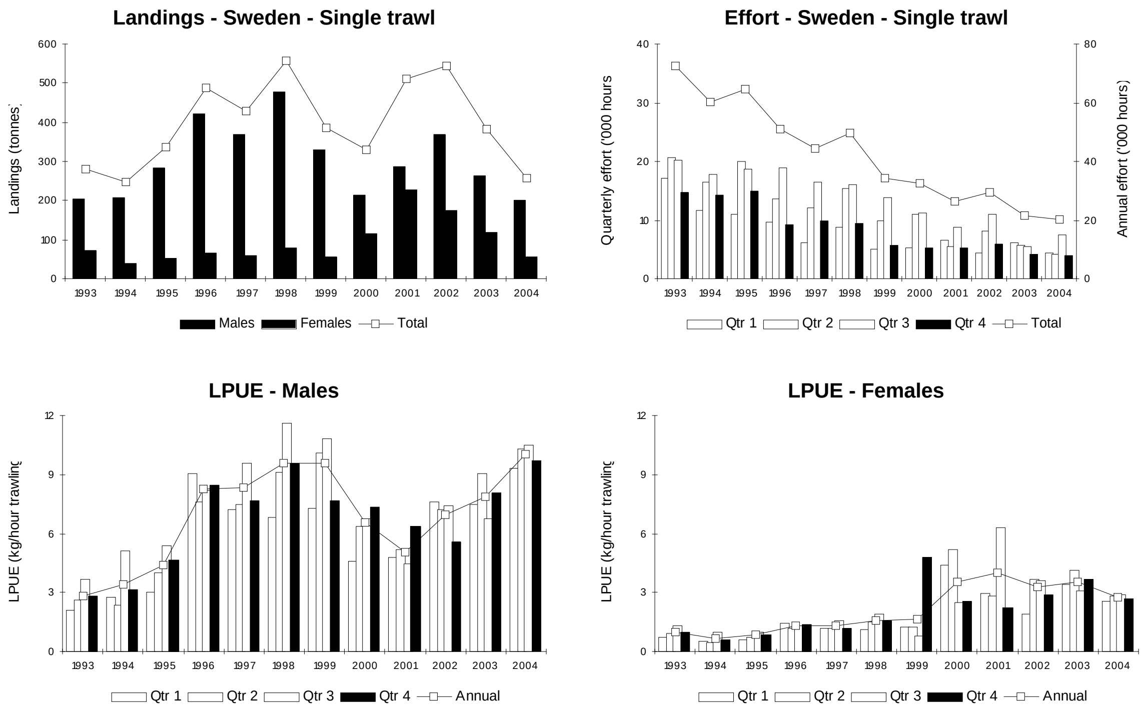


Figure 14.3 Nephrops Skagerrak (FU 3): Landings, effort and LPUEs by quarter and sex from Swedish Nephrops trawlers - Single trawl.

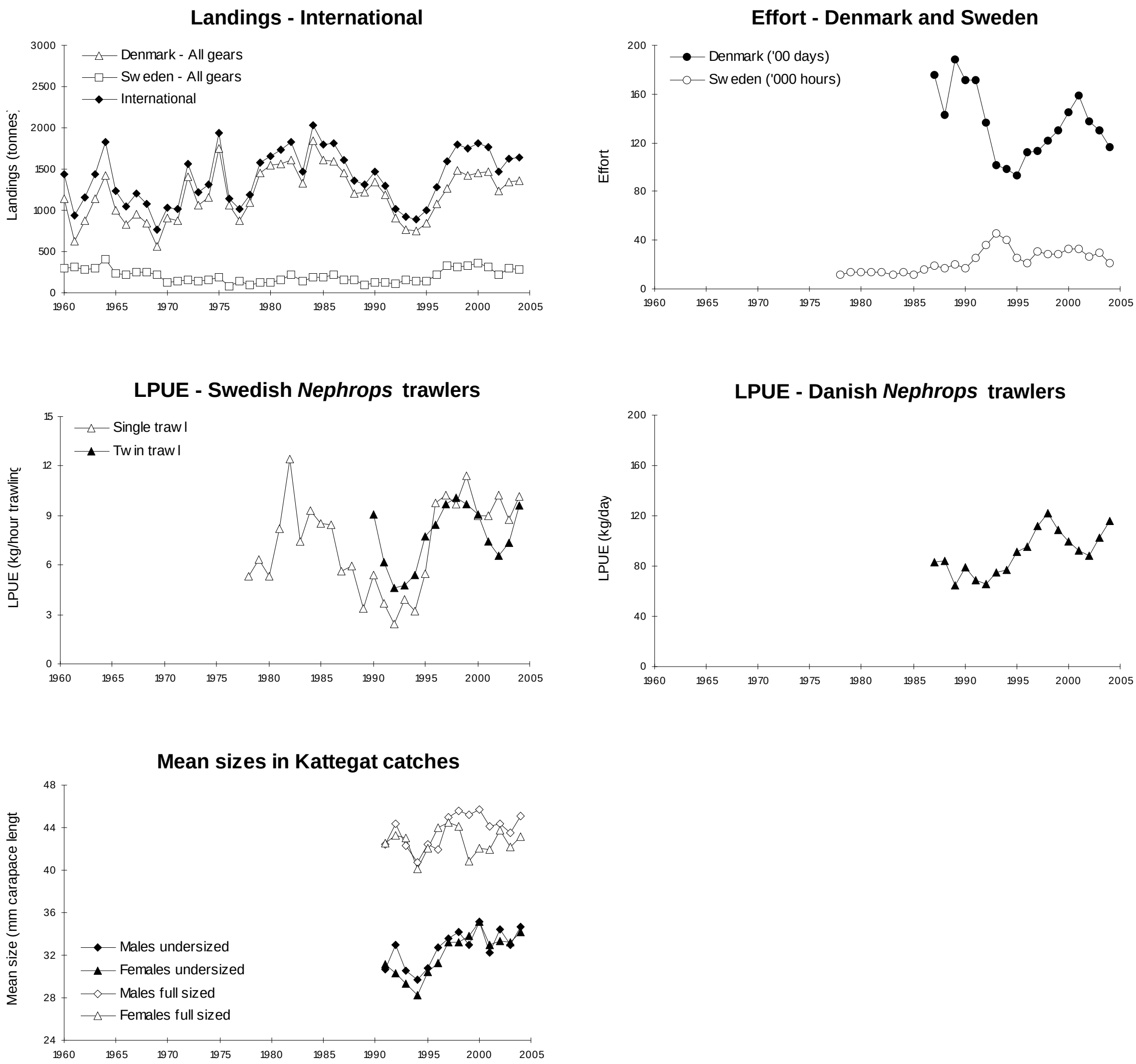


Figure 14.4 Nephrops Kattegat (FU 4): Long-term trends in landings, effort, LPUEs, and mean sizes of Nephrops.

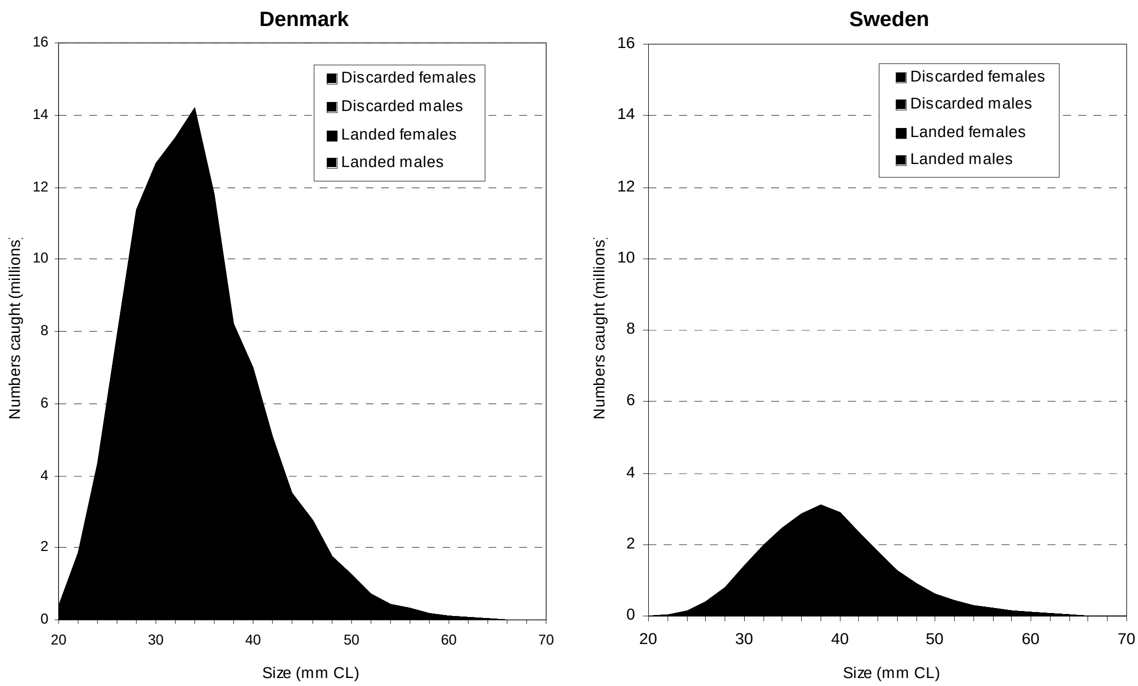
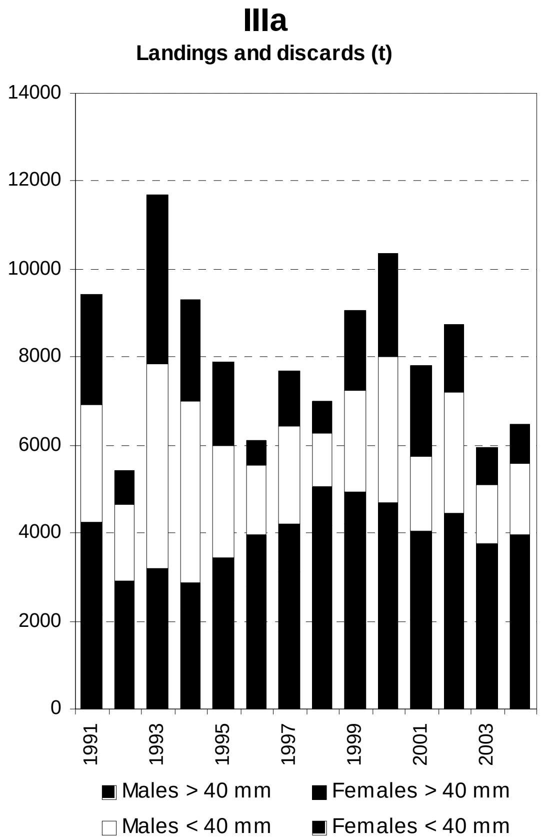


Figure 14.5 Nephrops Skagerrak (FU 3): Length frequency distributions of Nephrops catches, split by catch fraction (landings and discards) and sex. Data for Denmark, Sweden and Norway shown separately. Average for 1991-2004 (Denmark and Sweden) and 1991-2002 (Norway).



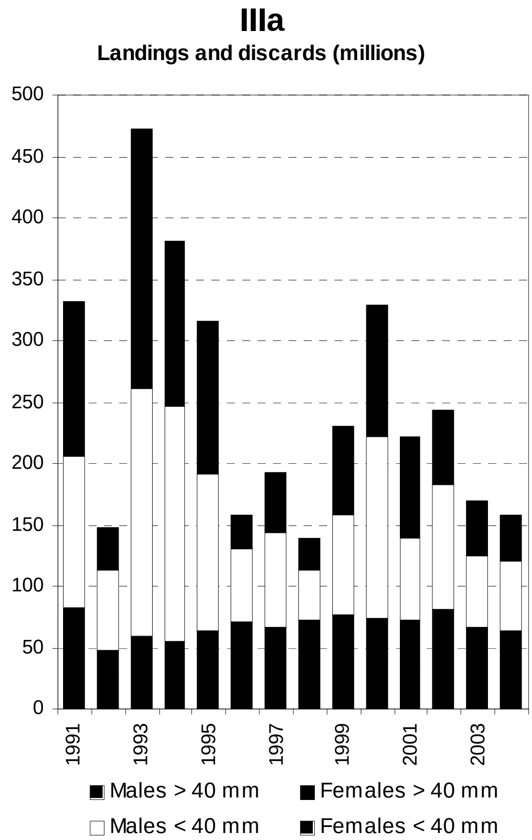


Figure 14.6 Nephrops Skagerrak (FU 3) and Kattegat (FU 4): Composition of Nephrops catches, split by catch fraction (landings and discards) and by sex, 1990-2004 (Skagerrak) and 1991-2004 (Kattegat).

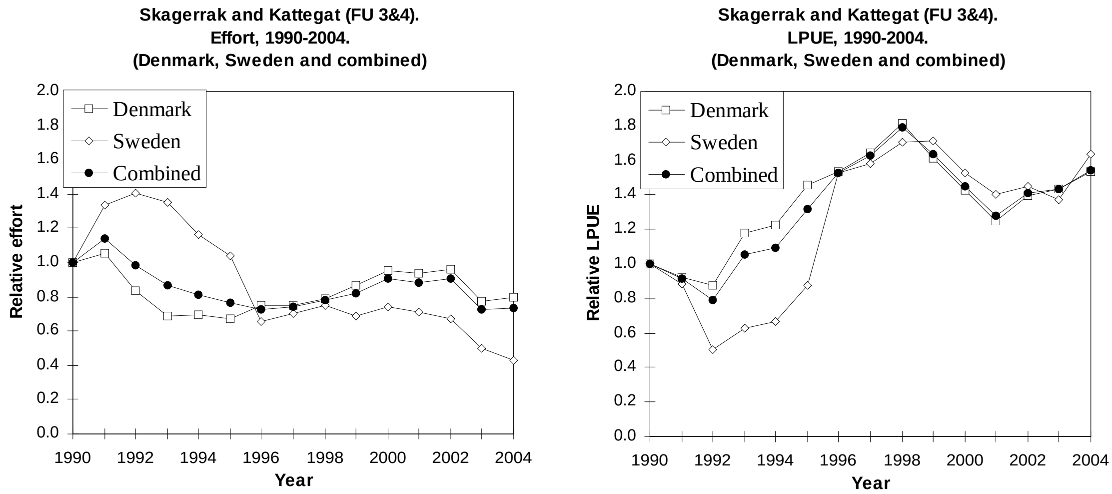


Figure 14.7 Nephrops Skagerrak (FU 3) and Kattegat (FU 4): Relative changes in effort and LPUE)

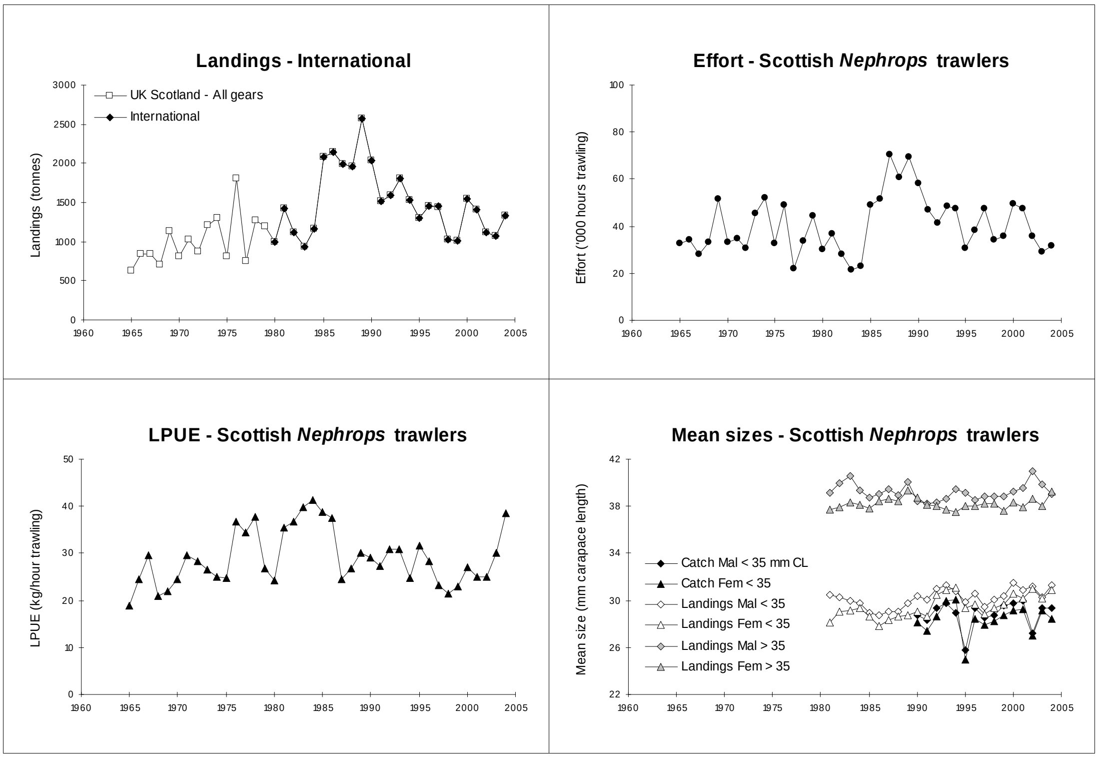


Figure 14.8 Nephrops, Moray Firth (FU 9), Long term landings, effort, LPUE and mean sizes.

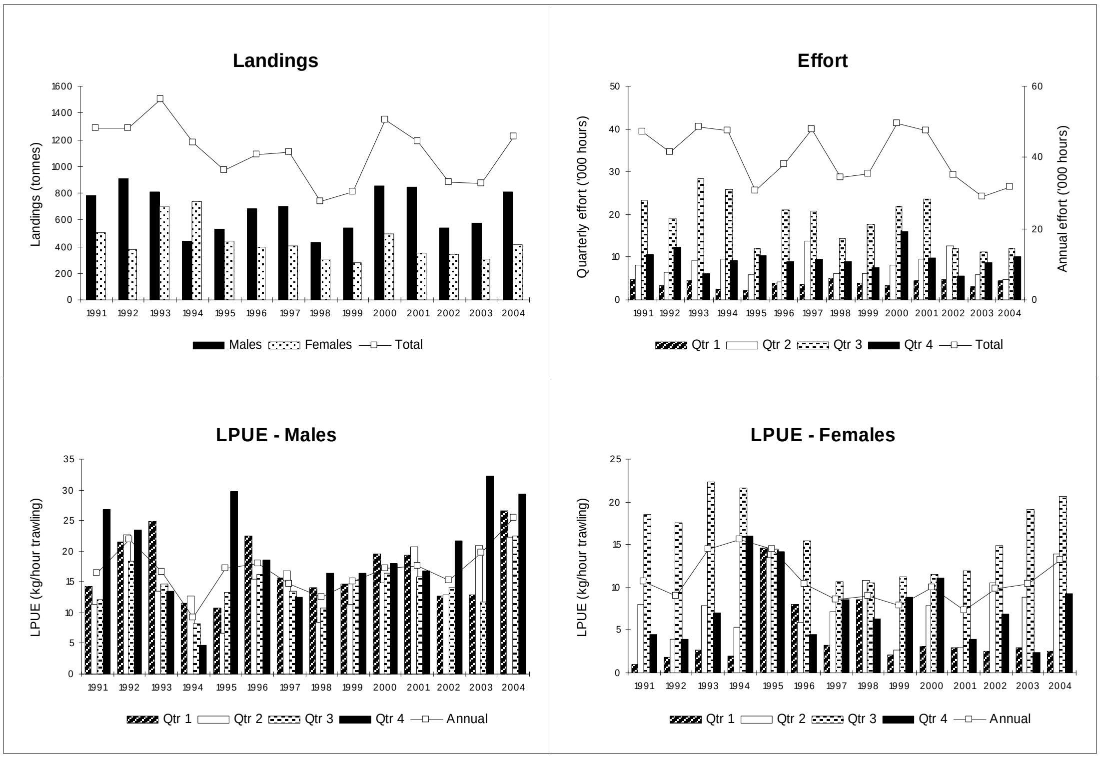


Figure 14.9 Nephrops, Moray Firth (FU 9), Landings, effort and LPUEs by quarter and sex from Scottish Nephrops trawlers.

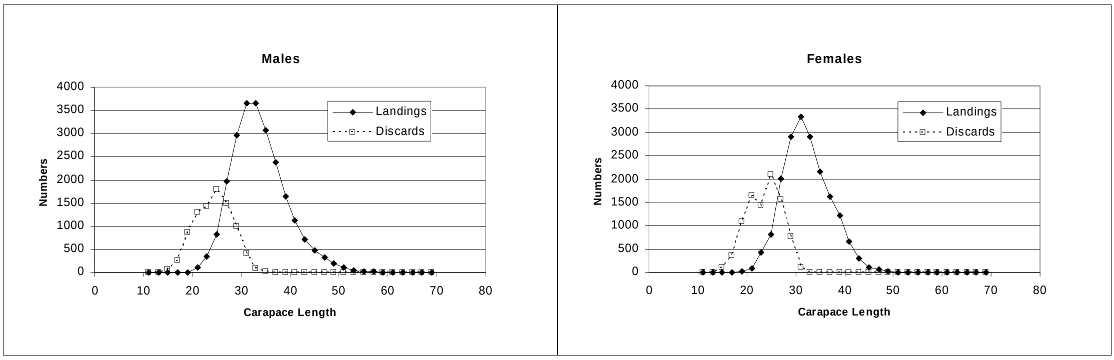


Figure 14.10 Nephrops, Moray Firth (FU 9), Length frequency distributions of male and female landings and discards, averaged over 2002 – 2004.

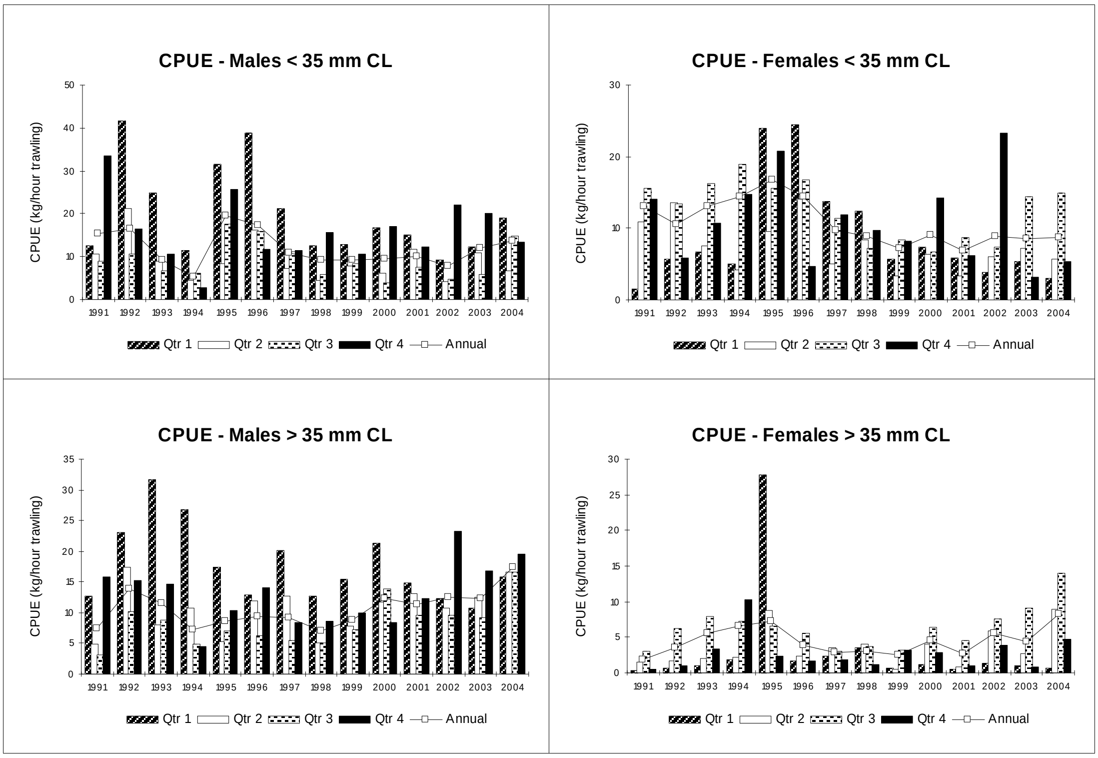


Figure 14.11 Nephrops, Moray Firth (FU 9), CPUEs by sex and quarter for selected size groups, Scottish Nephrops trawlers.

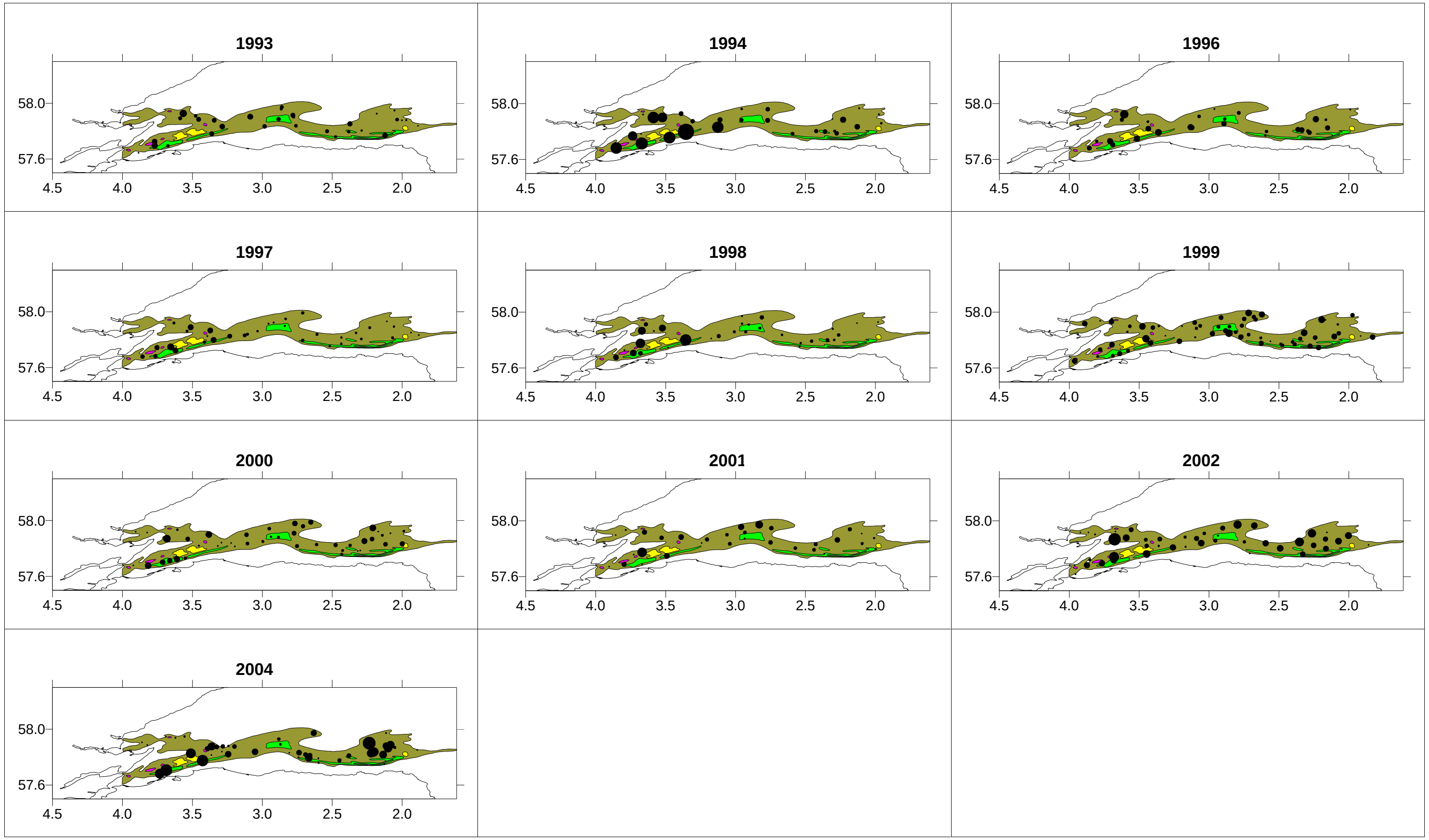


Figure 14.12 Nephrops, Moray Firth (FU 9), TV survey station distribution and relative density, 1993 – 2004. Green and brown areas represent areas of suitable sediment for Nephrops.

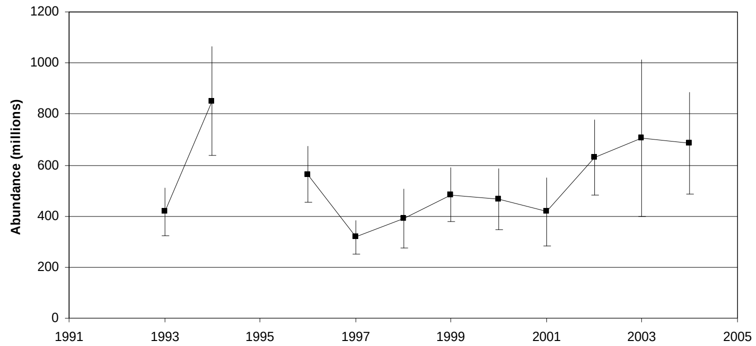


Figure 14.13 Nephrops, Moray Firth (FU 9), Time series of TV survey abundance estimates, with 95% confidence intervals, 1993 – 2004.

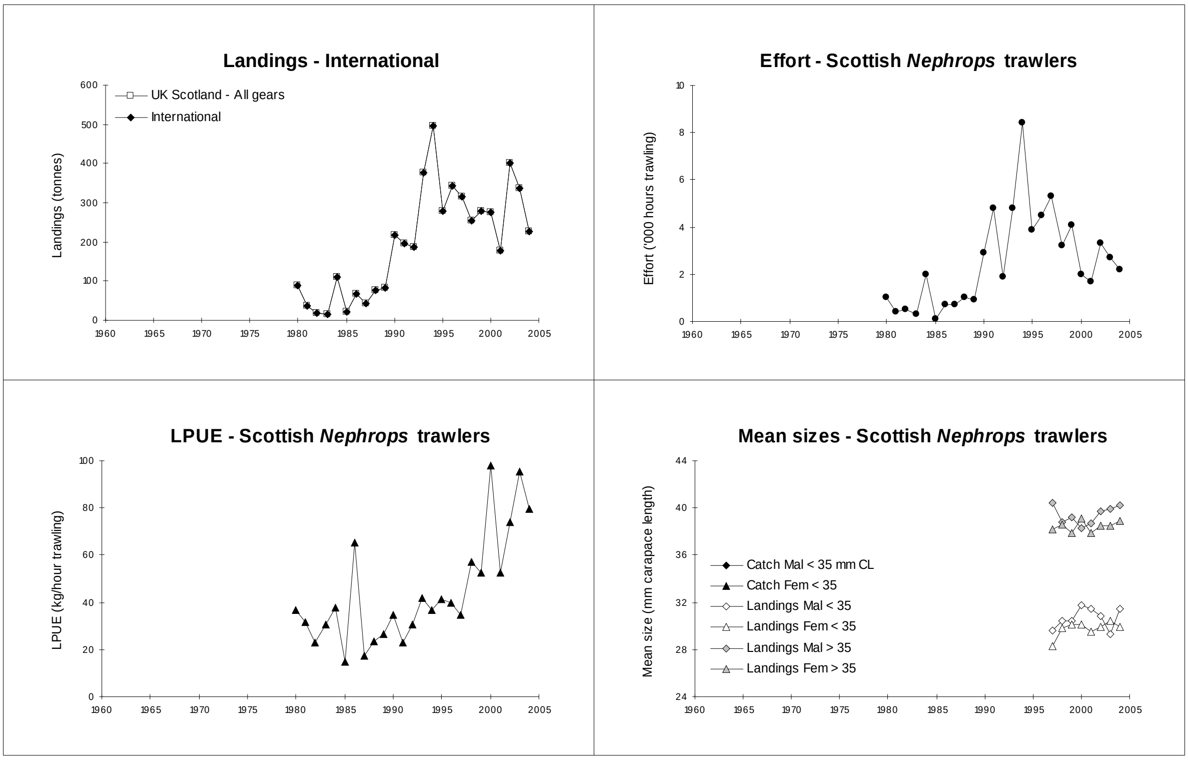


Figure 14.14 Nephrops, Noup (FU 10), Long term landings, effort, LPUE and mean sizes.

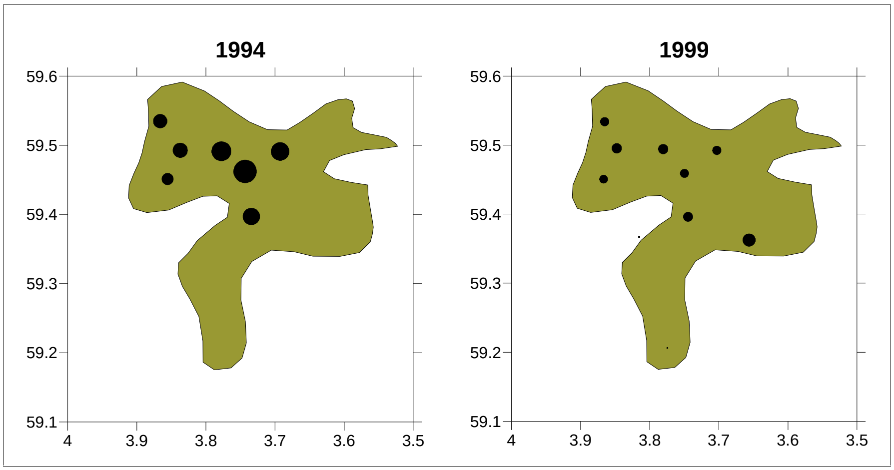


Figure 14.15 Nephrops, Noup (FU 10), TV survey station distribution and relative density, 1994 and 1999. Green and brown areas represent areas of suitable sediment for Nephrops.

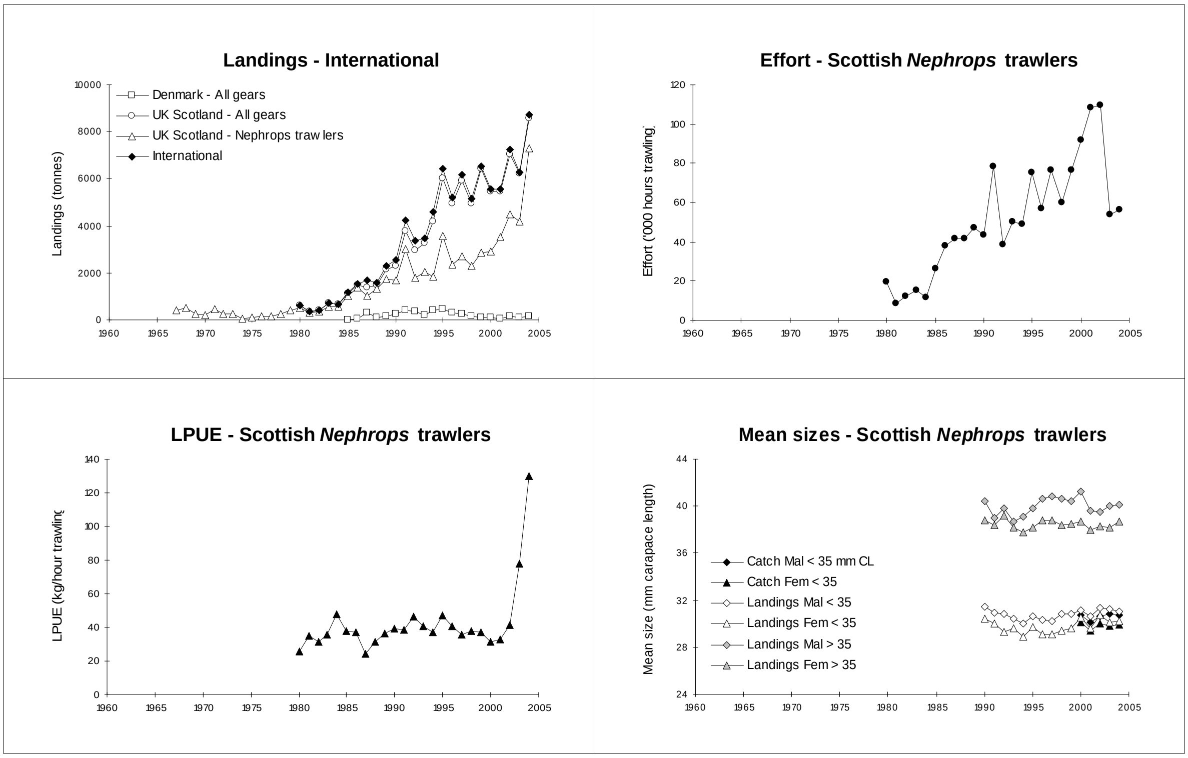


Figure 14.16 Nephrops, Fladen (FU 7), Long term landings, effort, LPUE and mean sizes.

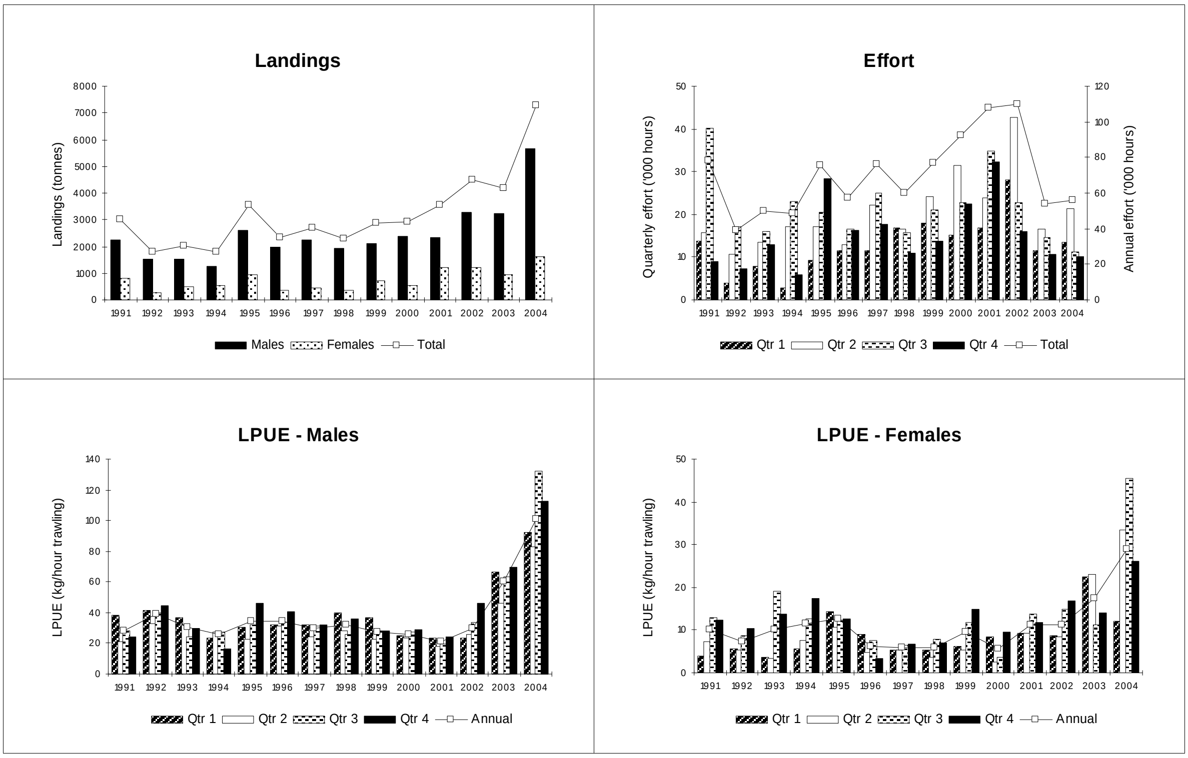


Figure 14.17 Nephrops, Fladen (FU 7), Landings, effort and LPUEs by quarter and sex from Scottish Nephrops trawlers.

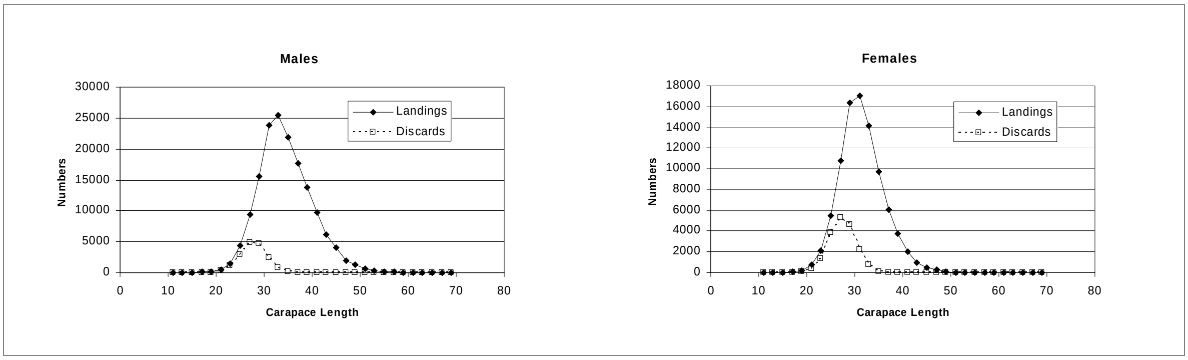


Figure 14.18 Nephrops, Fladen (FU 7), Length frequency distributions of male and female landings and discards, averaged over 2002 – 2004.

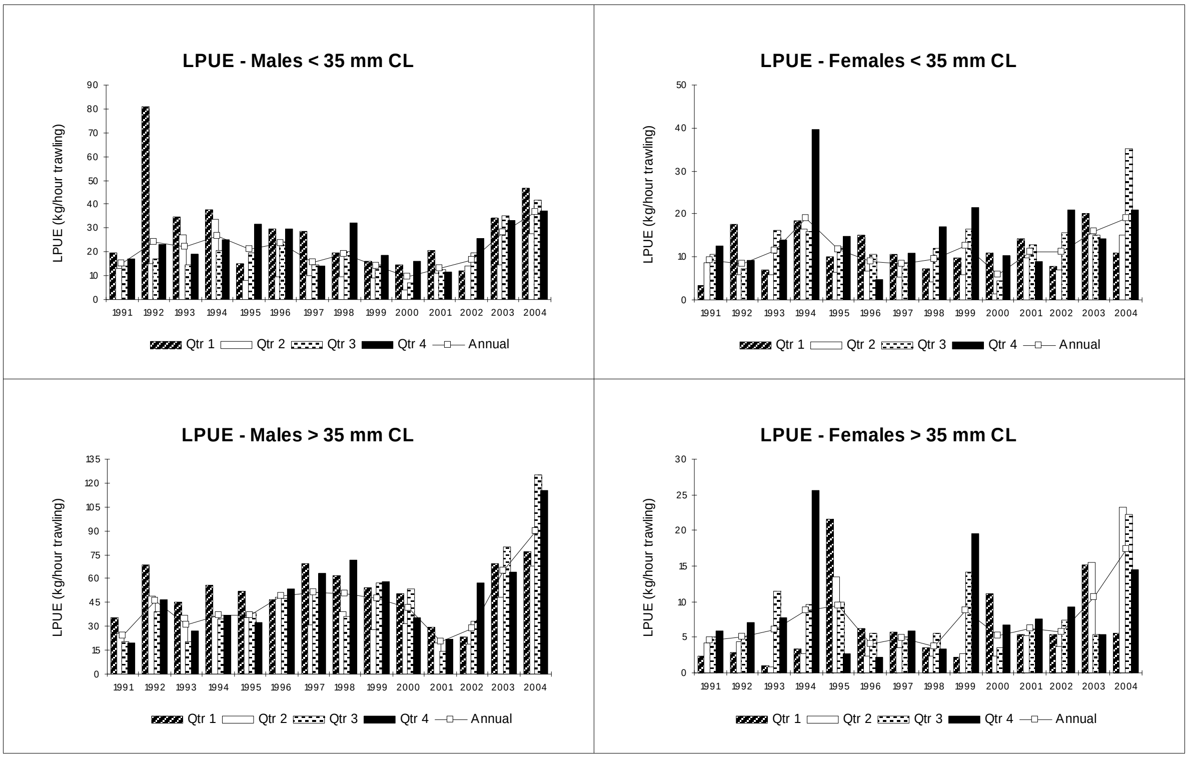


Figure 14.19 Nephrops, Fladen (FU 7), LPUEs by sex and quarter for selected size groups, Scottish Nephrops trawlers.

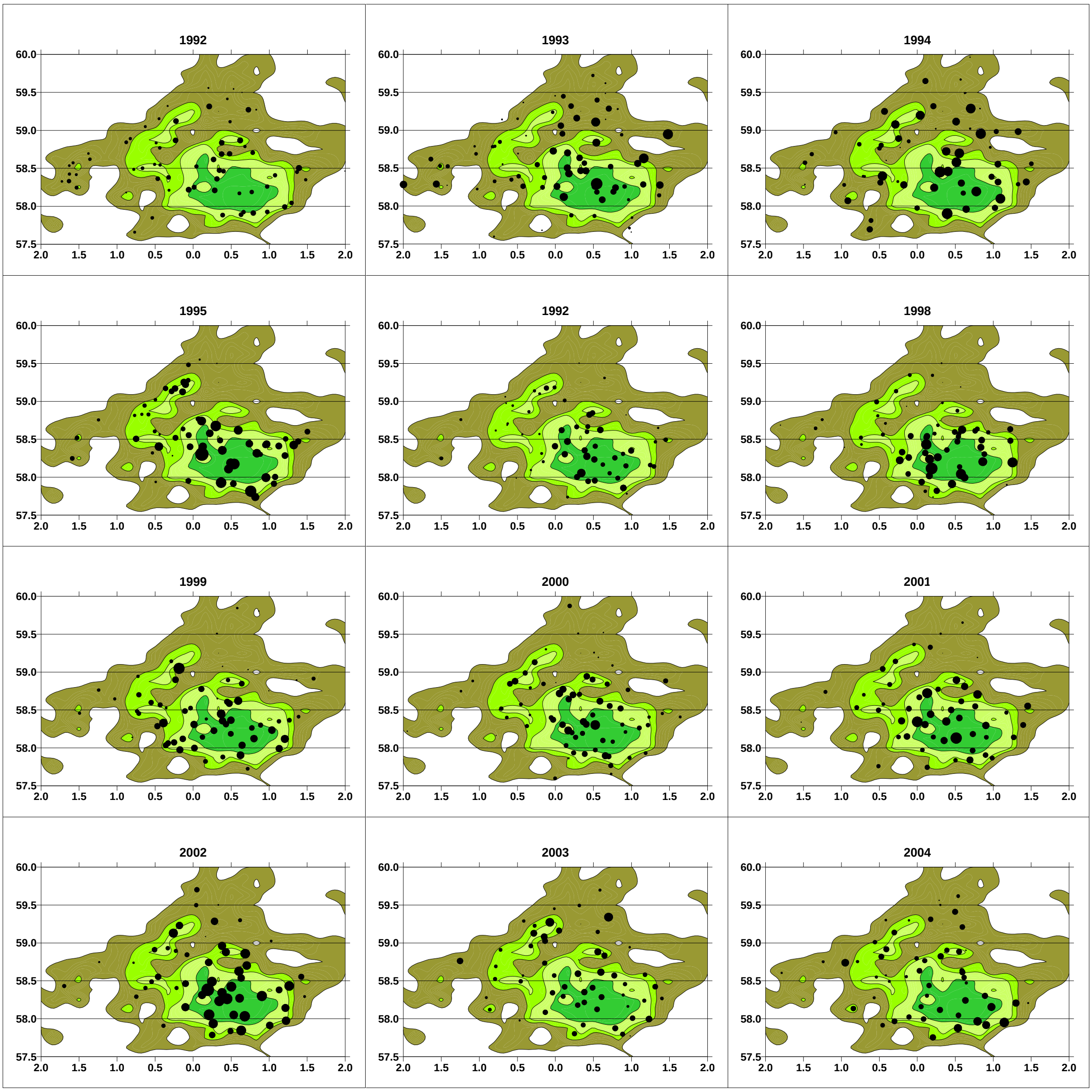


Figure 14.20 Nephrops, Fladen (FU 7), TV survey station distribution and relative density, 1992 – 2004. Green and brown areas represent areas of suitable sediment for Nephrops.

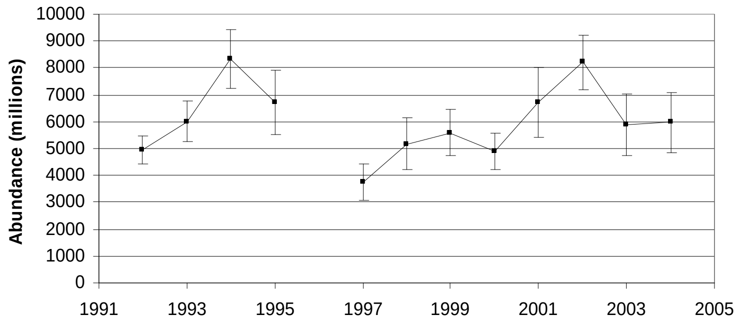


Figure 14.21 Nephrops, Fladen (FU 7), Time series of TV survey abundance estimates, with 95% confidence intervals, 1992 – 2004.

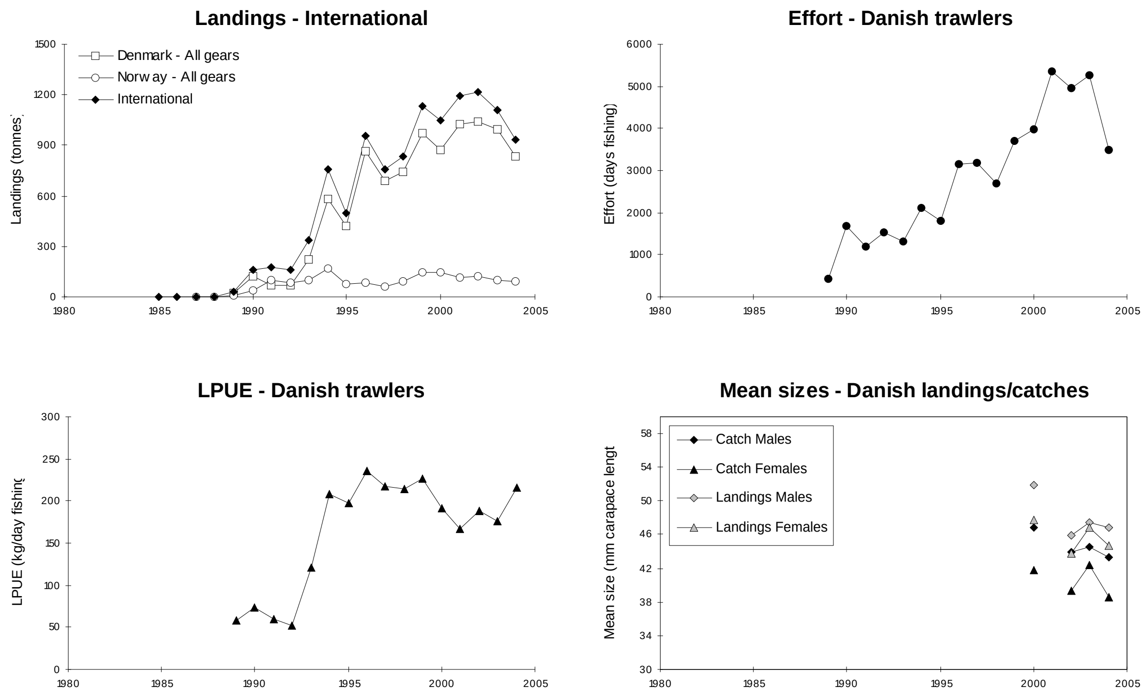


Figure 14.22 Nephrops Norwegian Deep (FU 32): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of Nephrops.

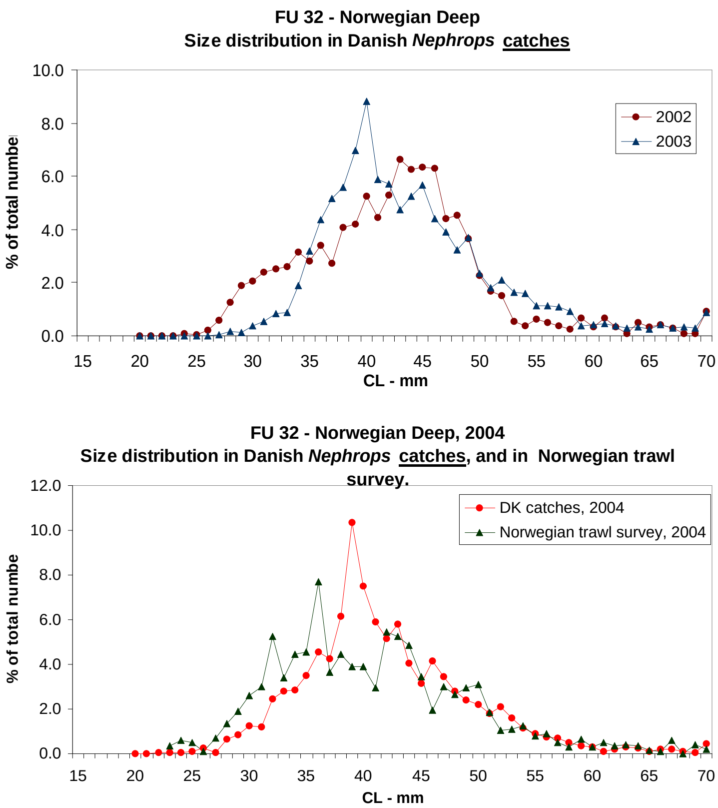


Figure 14.23 Nephrops Norwegian Deep (FU 32): LFDs from Norwegian survey cruises in the Skagerrak (FU 4) and the Norwegian Deep (FU 32) (using a 70 mm Nephrops trawl), and from Danish Nephrops/finfish trawlers in FU 32 (using 100 mm mesh trawls).

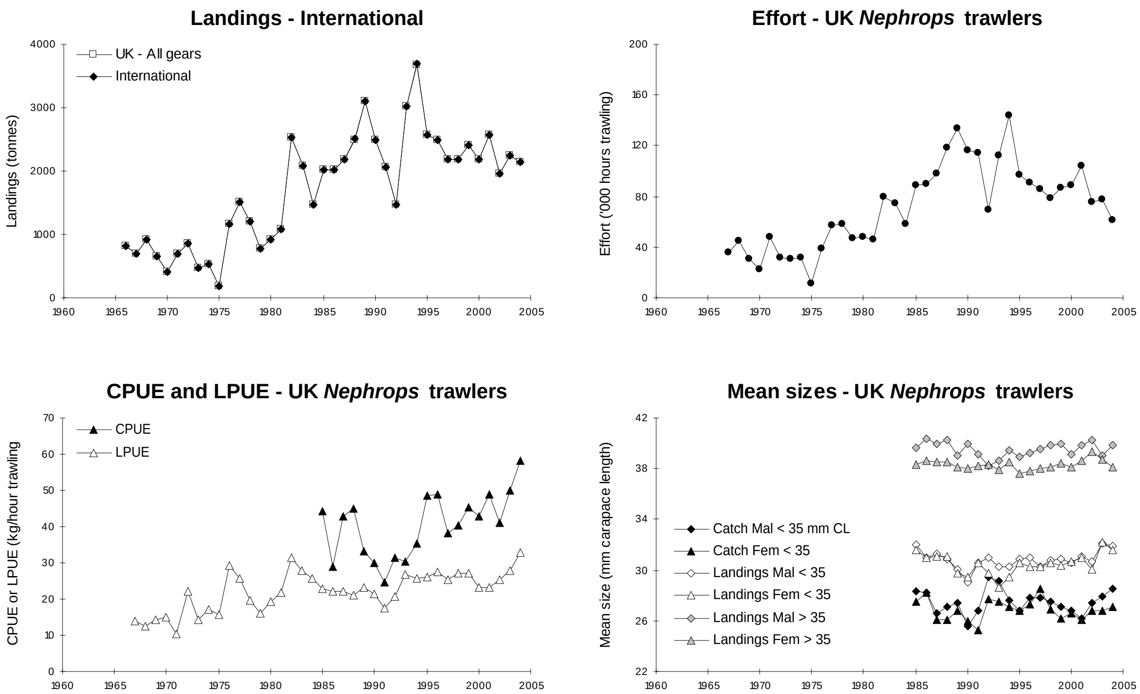


Figure 14.24 Nephrops Farn Deeps (FU 6): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of Nephrops

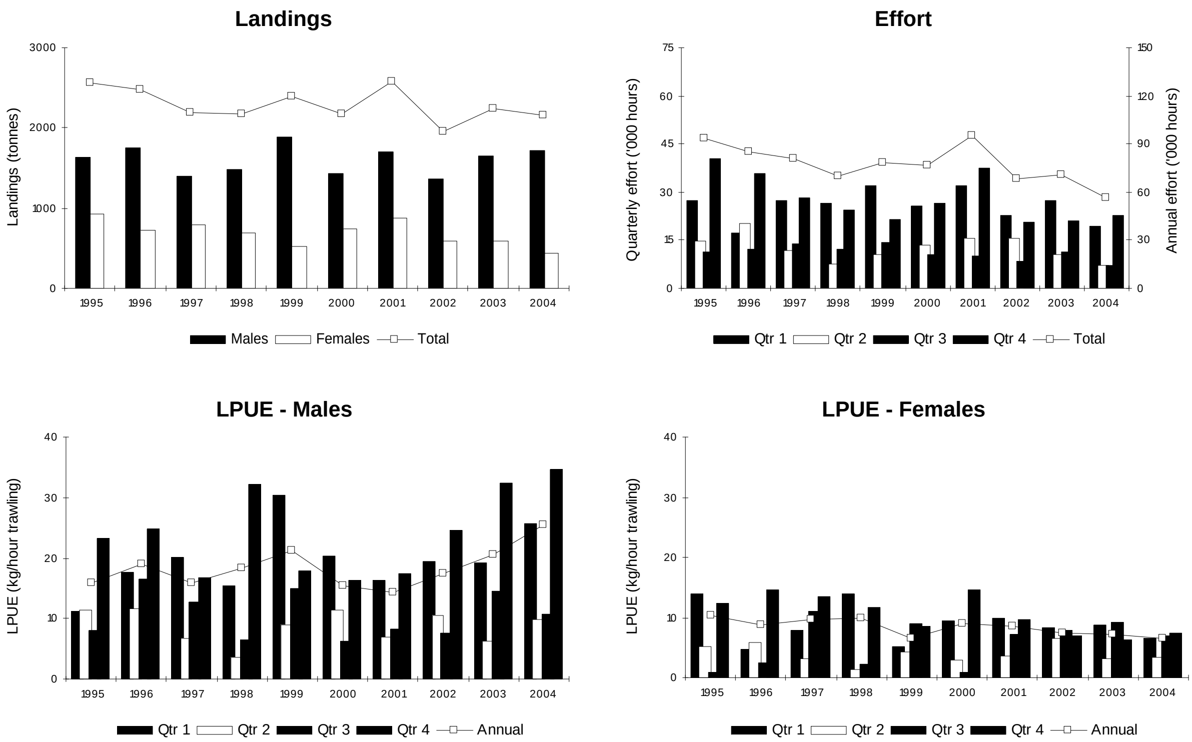


Figure 14.25 Nephrops Farn Deeps (FU 6): Landings, effort and LPUEs by quarter and sex from English Nephrops trawlers.

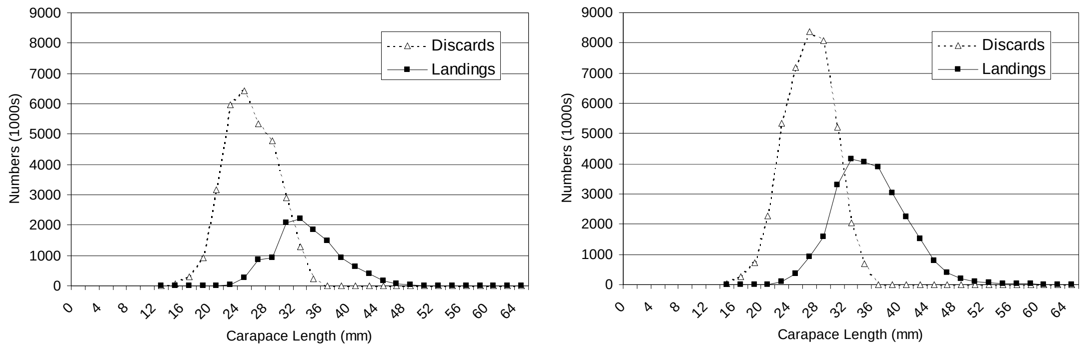


Figure 14.26 Nephrops Farn Deeps (FU 6): Length frequency distributions of male and female landings and discards, averaged over 2002 – 2004.

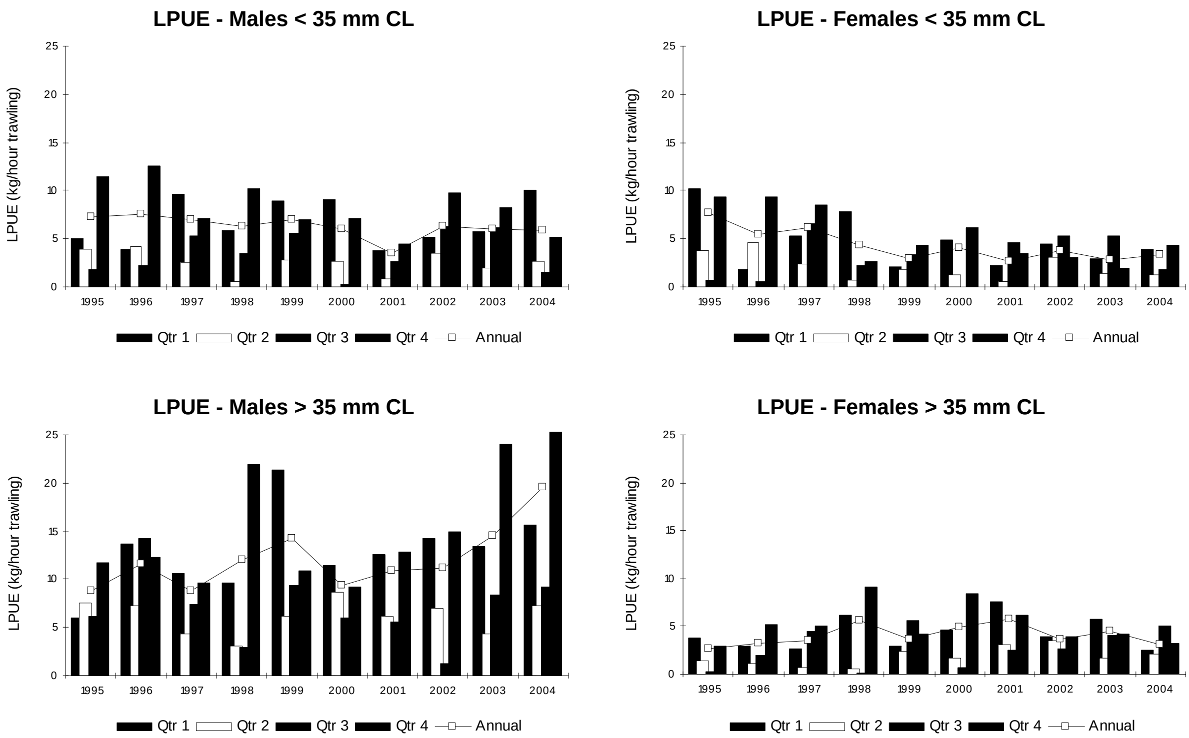


Figure 14.27 Nephrops Farn Deeps (FU 6): LPUEs by sex and quarter for selected size groups, English Nephrops trawlers.

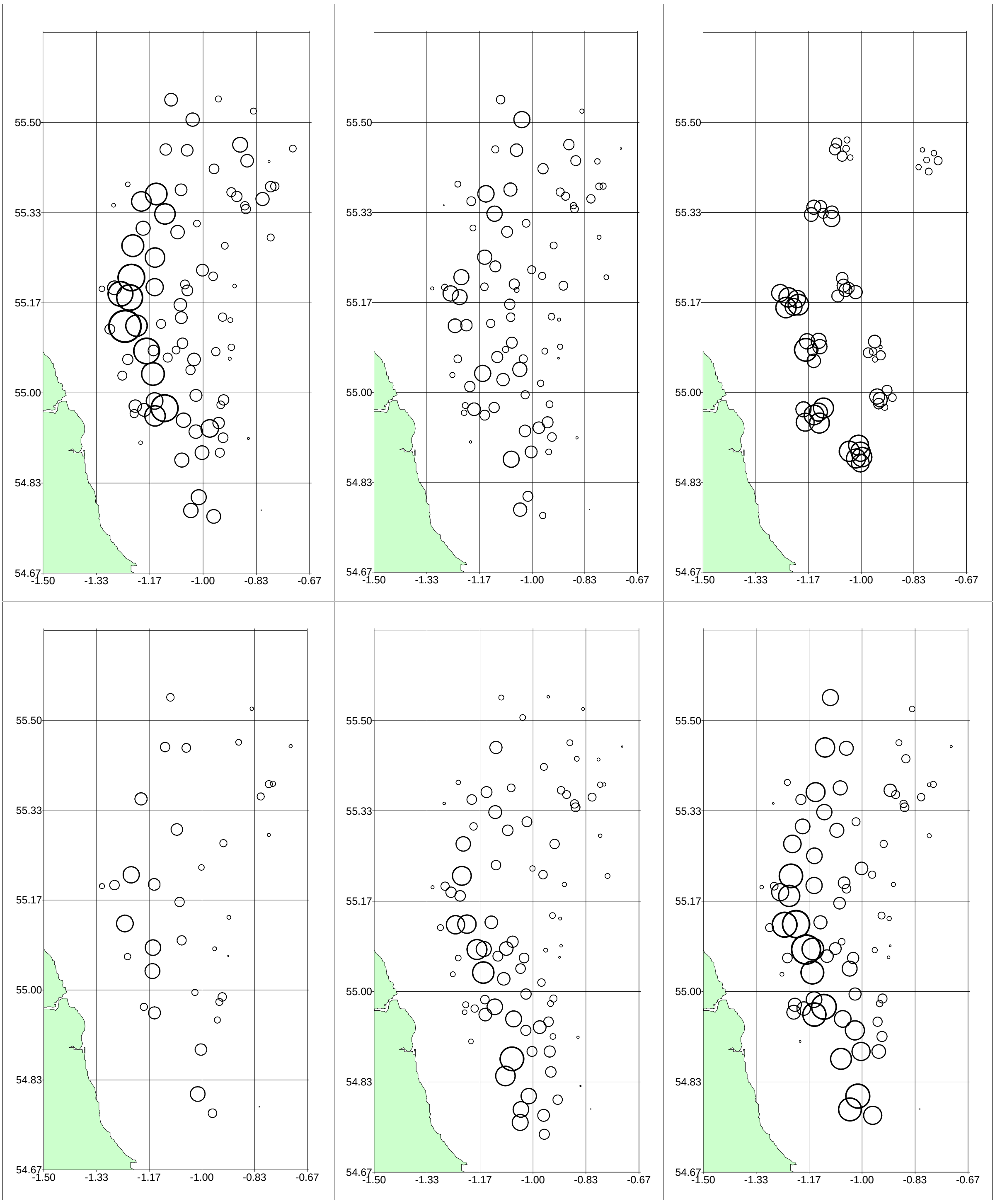


Figure 14.28 Nephrops Farn Deeps (FU6) - Station distribution and relative burrow density, from Autumn surveys 1997 – 2004. Top row 1997,1998 & 1999 (left to right), bottom row 2002,2003 & 2004 (left to right).

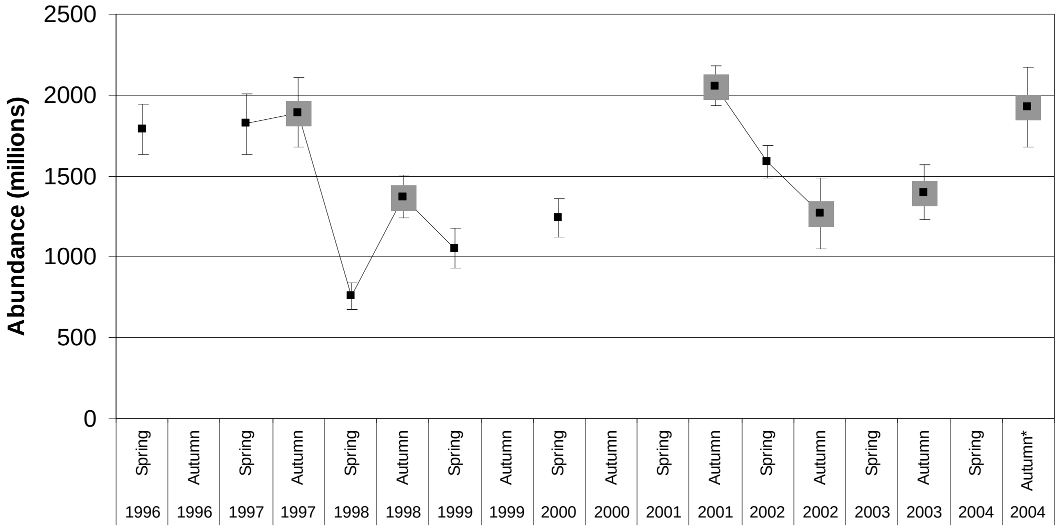


Figure 14.29 Nephrops, Farn Deeps (FU 6), Time series of TV survey abundance estimates, with 95% confidence intervals, 1996 – 2004.

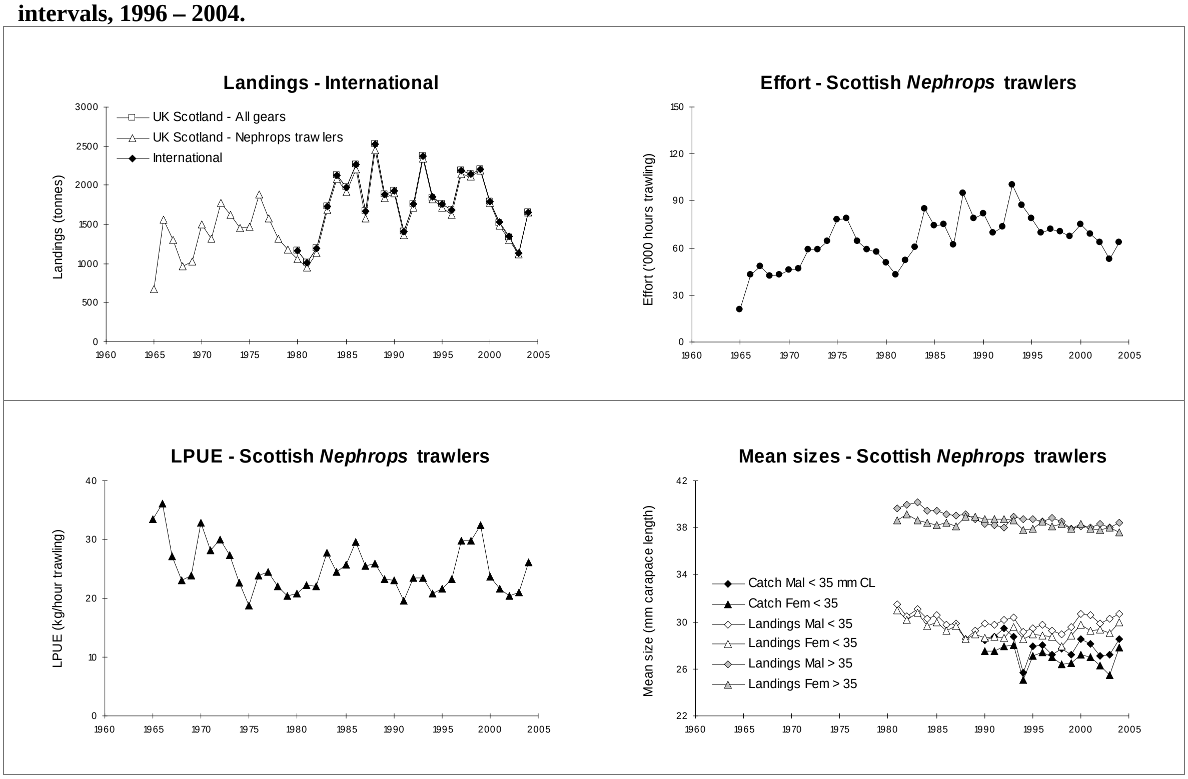


Figure 14.30 Nephrops, Firth of Forth (FU 8), Long term landings, effort, LPUE and mean sizes.

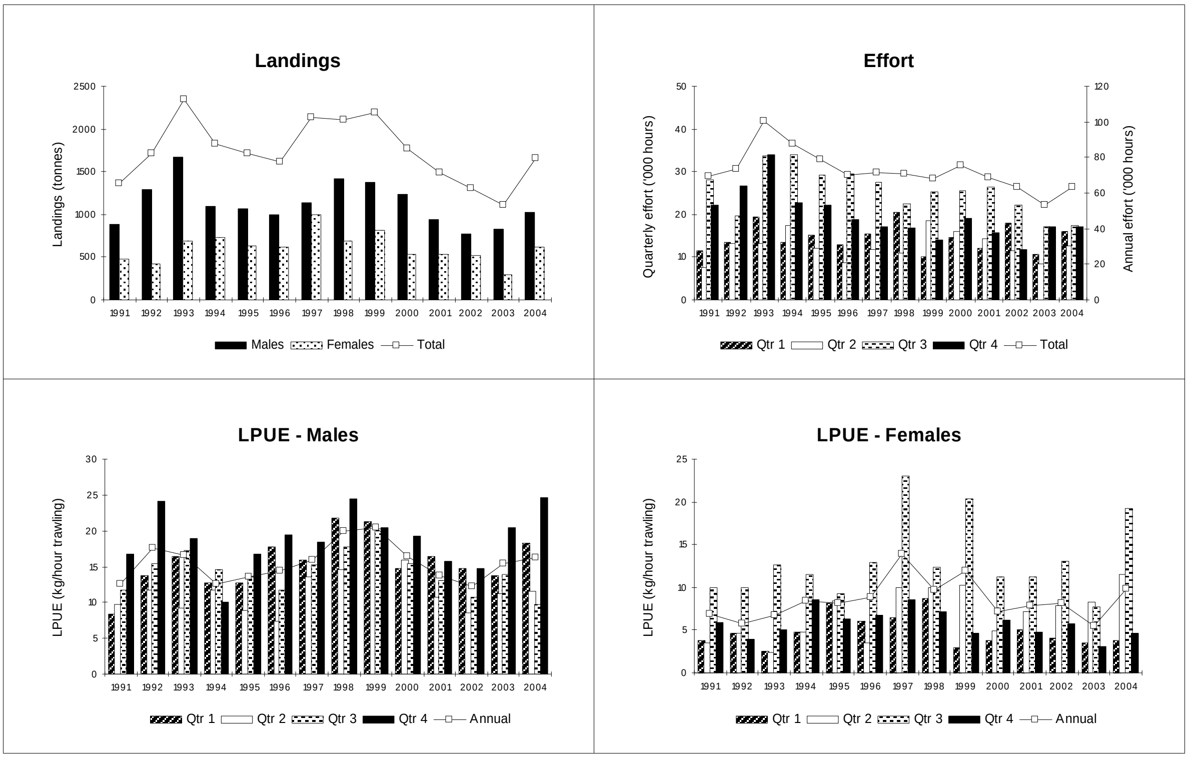


Figure 14.31 Nephrops, Firth of Forth (FU 8), Landings, effort and LPUEs by quarter and sex from Scottish Nephrops trawlers.

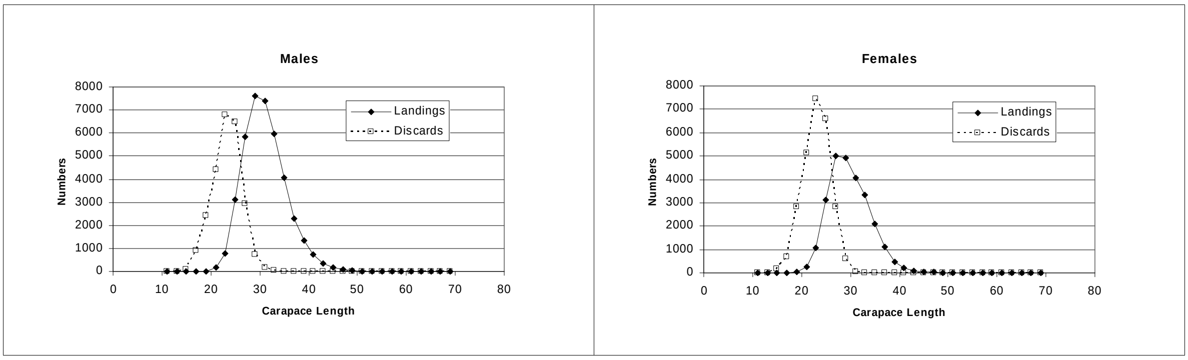


Figure 14.32 Nephrops, Firth of Forth (FU 8), Length frequency distributions of male and female landings and discards, averaged over 2002 – 2004.

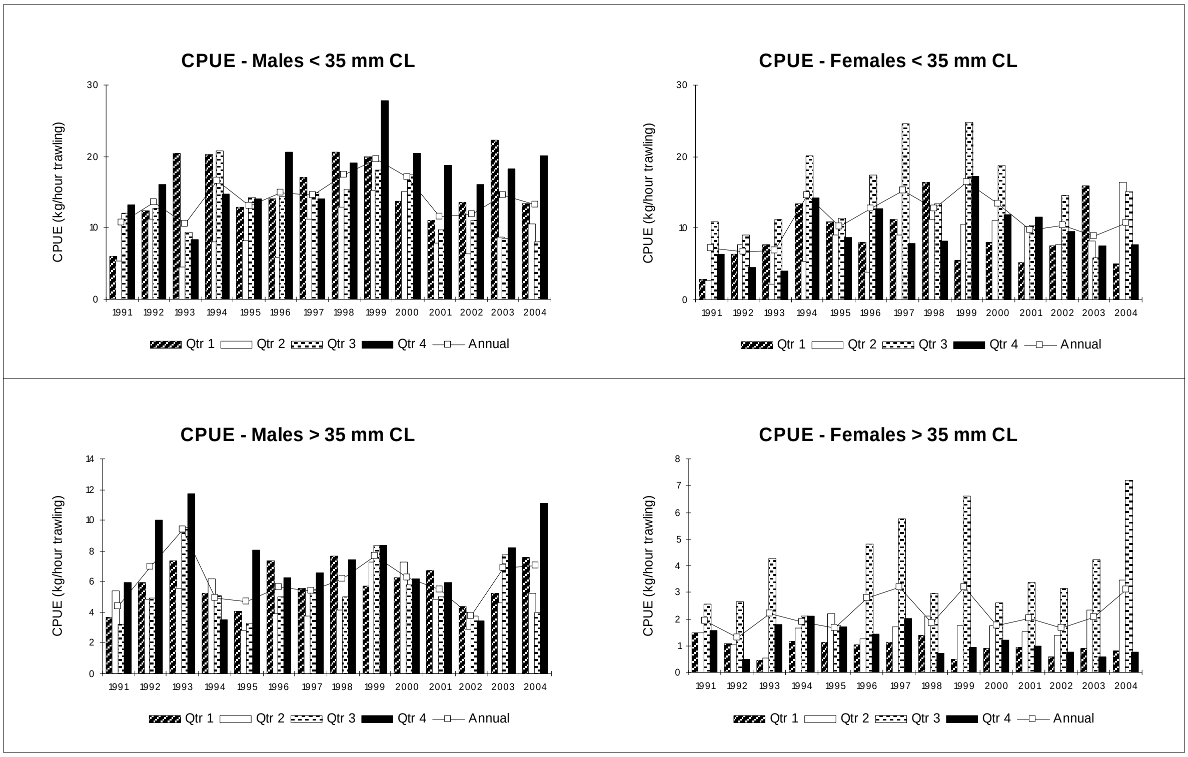


Figure 14.33 Nephrops, Firth of Forth (FU 8), CPUEs by sex and quarter for selected size groups, Scottish Nephrops trawlers.

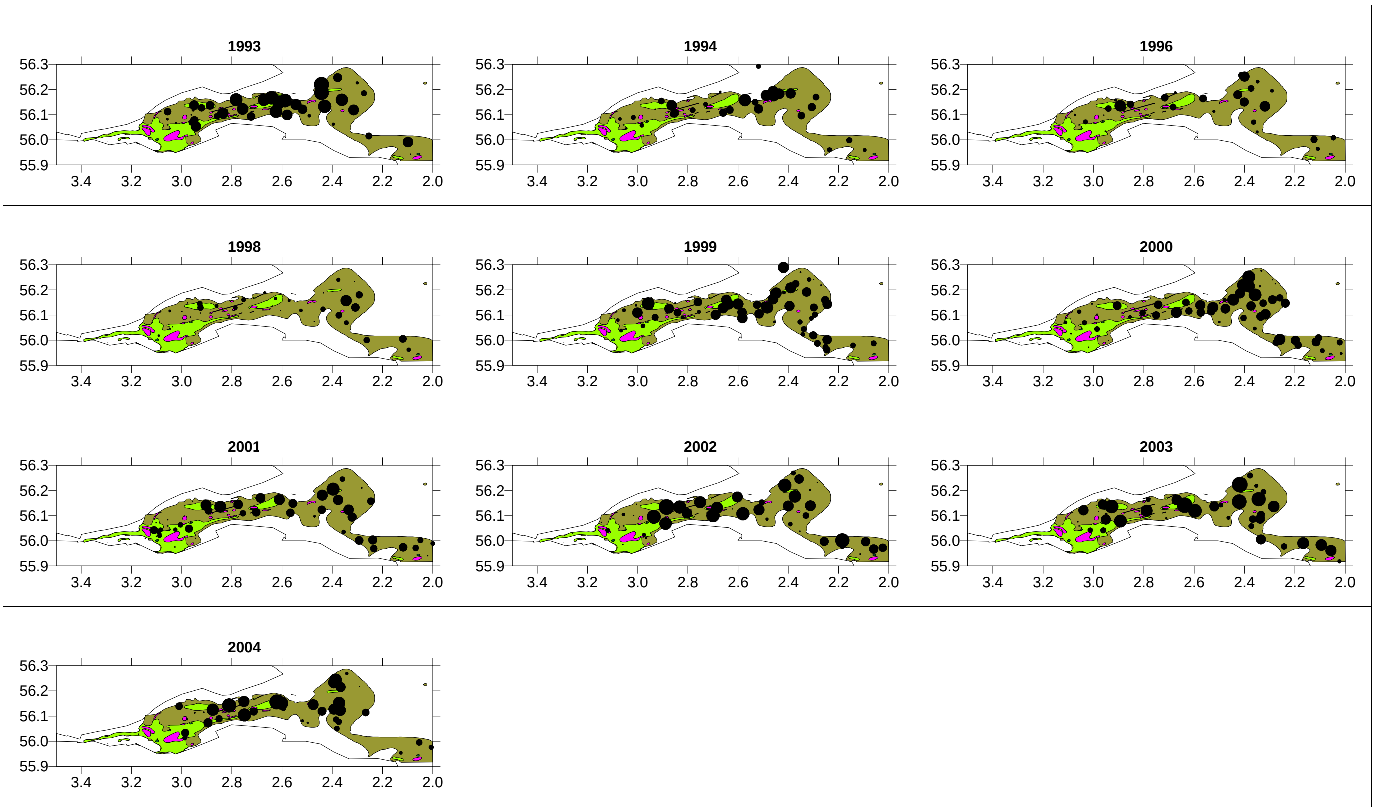


Figure 14.34 Nephrops, Firth of Forth (FU 8), TV survey station distribution and relative density, 1993 – 2004. Green and brown areas represent areas of suitable sediment for Nephrops.

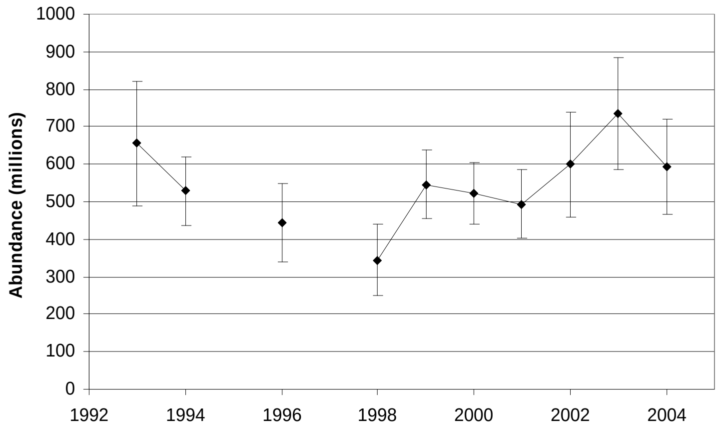


Figure 14.35 Nephrops, Firth of Forth (FU 8), Time series of TV survey abundance estimates, with 95% confidence intervals, 1993 – 2004.

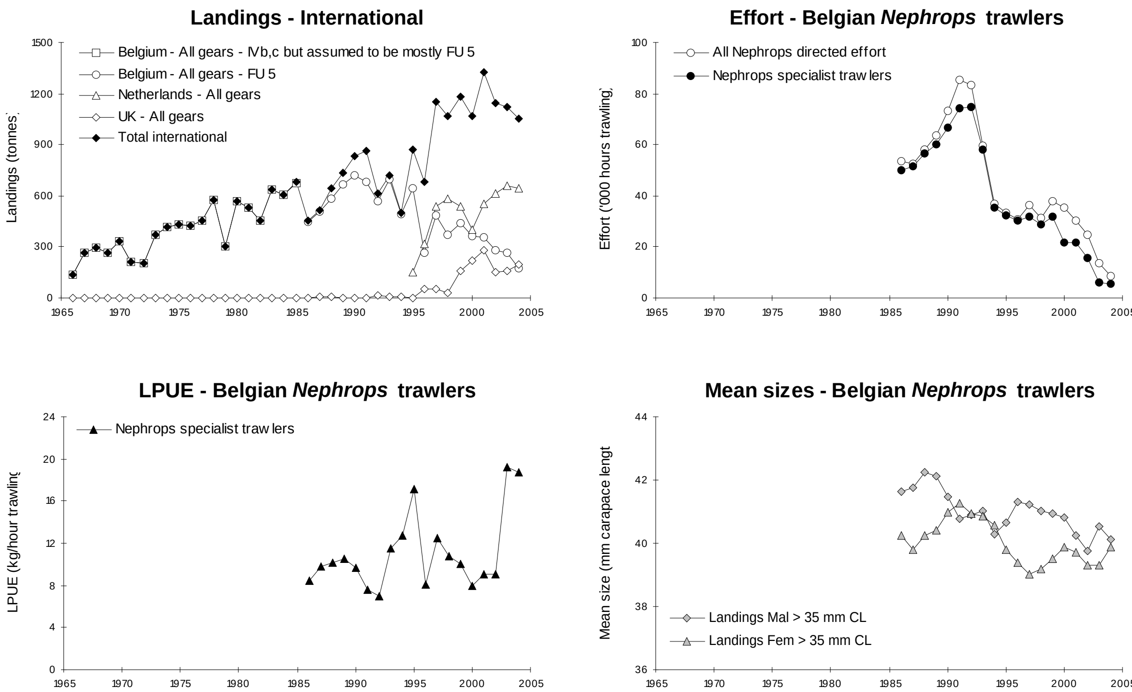


Figure 14.36 Botney Gut - Silver Pit (FU 5): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of Nephrops.

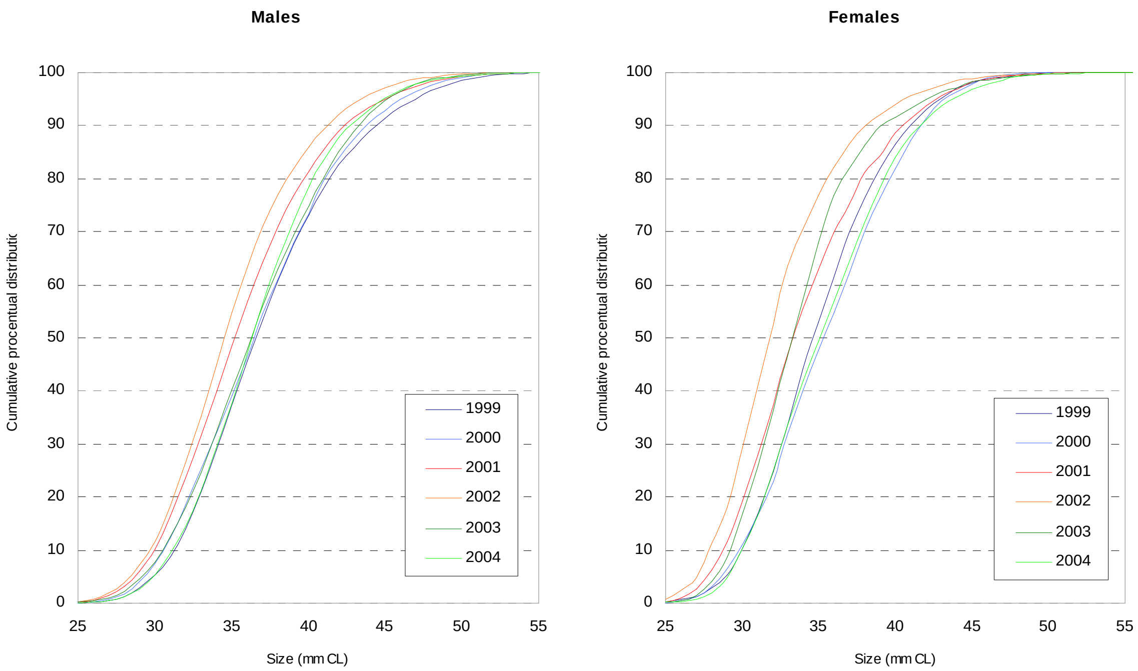


Figure 14.37 Botney Gut - Silver Pit (FU 5): Cumulative procentual distributions of Belgian Nephrops landings (1999-2004).

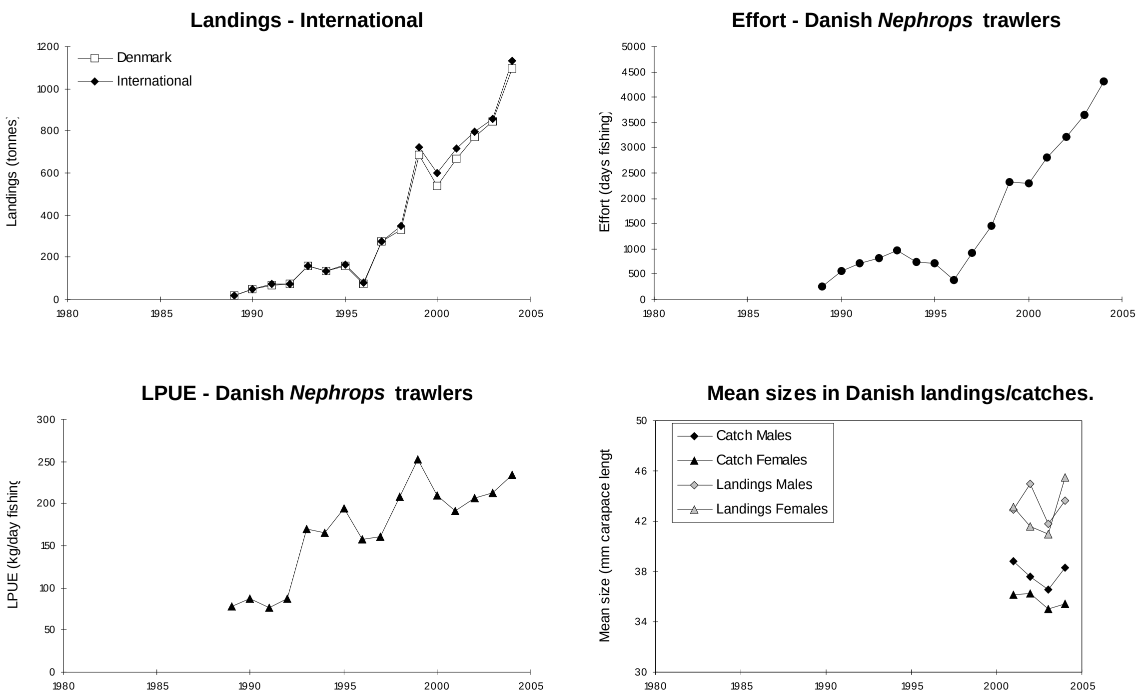


Figure 14.38 Nephrops Off Horn Reef (FU 33): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of Nephrops.

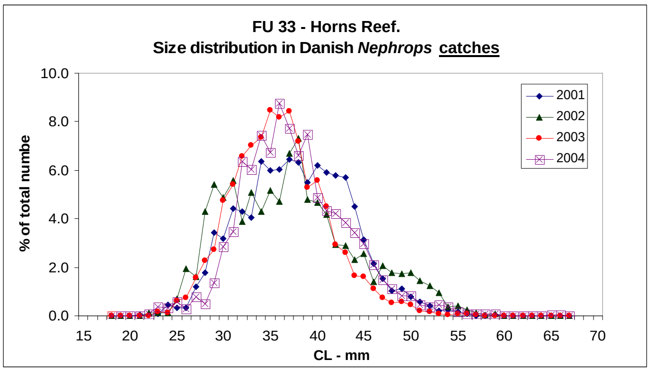


Figure 14.39 Nephrops Off Horn Reef Size distributions of Danish catches, 2001-2004

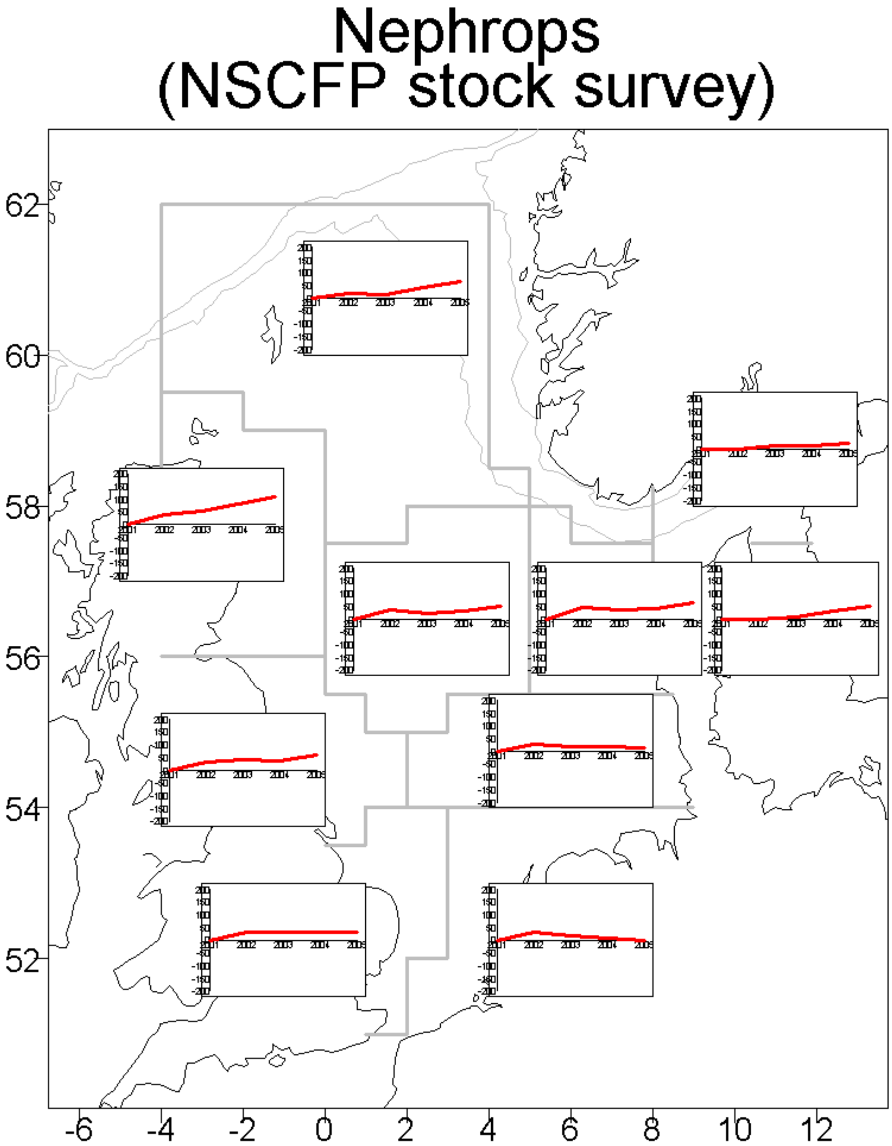


Figure 14.40 North Sea Commission Fisheries Partnership stock survey for Nephrops

ANNEX 1 NEW SPECIES SELECTIVE NEPHROPS TRAWL IN SWEDISH NATIONAL WATERS.

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In a Swedish national demersal fish recovery plan one action was to move the trawling boarder off shore from 3 to 4 nautical miles outside the baseline. A problem with this was that approximately 50% of the Swedish *Nephrops* landings normally originate from the coastal zone that now was to be closed to trawling. Species selectivity trials were therefore carried out with *Nephrops* trawls equipped with a species sorting grid of 35 mm bar space and 70 mm square mesh all around in the cod end and extension piece in order to target *Nephrops* and exclude fish from the catch.

Selectivity trials.

About 50 trawl hauls with grid and square meshes were carried out on four commercial *Nephrops* trawlers during autumn 2002. The results show that a grid with 35 mm bar space, in combination with 70 mm square mesh, using a cod-end and extension piece of 8 m total length (see fig 1), significantly reduce the by-catch of fish (see fig. 2). There was no significant reduction of marketable sized *Nephrops*. The catch of marketable sized fish decreased by 90-100% and under-sized fish and *Nephrops* by 66% compared to the catch in conventional *Nephrops* trawl.

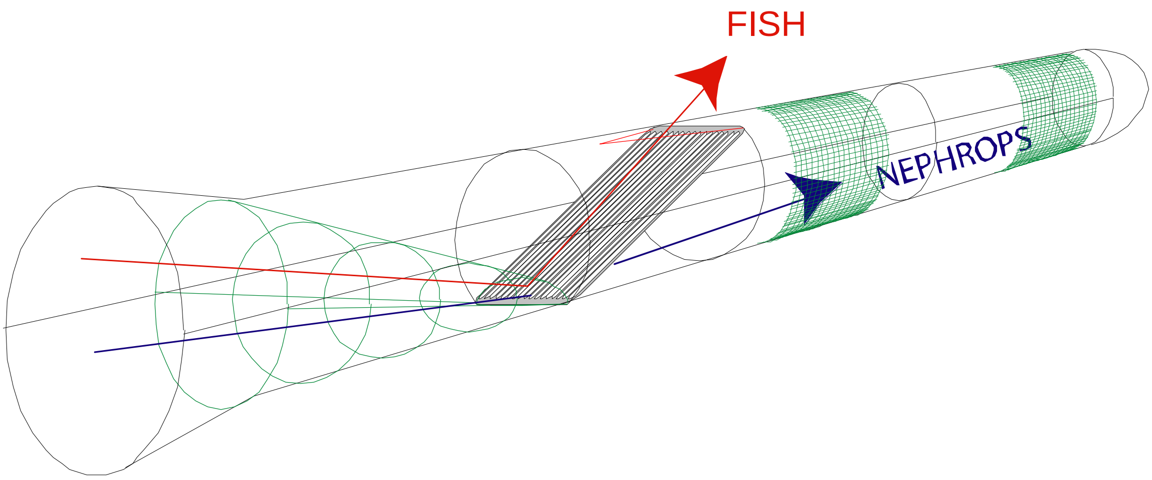

Figure 1. Schematic sketch of a species-sorting grid in *Nephrops* trawl. Catch is guided along a funnel to the lower base of the grid, where larger fish is sorted out from the trawl along the grid and through the outlet, while smaller fish and *Nephrops* go through the grid and into the size sorting square mesh extension piece and cod-end.

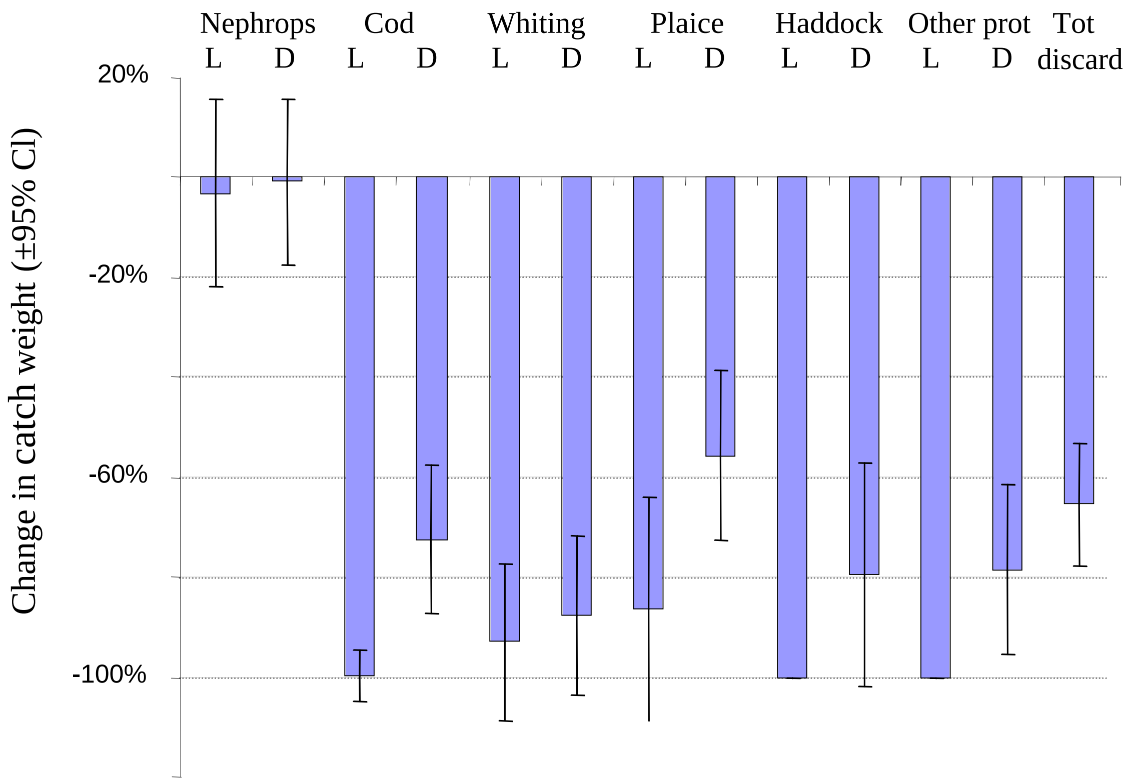

Figure 2. Estimated percentage change in landings (L) and discards (D) weight between a *Nephrops* trawl without grid (=0%) and introduction of a 35 mm grid in it. Other protected species include all other regulated species.

The conclusion from the study was that the introduction of a 35 mm grid and 70 mm square mesh cod-end in the *Nephrops* trawl fishery in Skagerrak and Kattegat would significantly reduce the mortality of by-catch of both marketable sized and under-sized fish in a *Nephrops* trawl without affecting the catch of marketable sized *Nephrops*. According to published results, this level of selection is unlikely to be achieved using techniques that depend solely on mesh selection.

In February 2004 the new technical regulations, including *Nephrops* trawl equipped with grid and square meshes, became mandatory on Swedish national waters in Skagerrak and Kattegat. The main objectives of these new regulations were to significantly reduce fishing mortality on local populations of demersal fish species like cod, pollack and haddock (i.e. both juveniles and adults.

Follow-up in log book.
The implication of introducing the grid trawl in the commercial fishery is also shown in the Swedish log book data where this new trawl category can be distinguished from other trawls. According to the log book data *Nephrops* trawl landings is to about 80% caught by *Nephrops* single trawls and twin trawls. Yearly landings from these trawls during 1989 until August 2005 are shown in figure 3. *Nephrops* trawls were made of 70 mm diamond meshes until 2002 when EU legislation (Council Regulation 2056/2001) prohibited use of mesh sizes between 70-89 mm unless it was made of square meshes. Hereafter most *Nephrops* trawls are made of 90 mm diamond or 70 mm square meshes.

During 2004 about 11 000 trawling hours were carried out with the new grid and square mesh trawl corresponding to 24 % of the *Nephrops* trawl landings. During 2005 (until August), 13 000 trawling hours were used to catch 43 % of *Nephrops* trawl landings in Division IIIa.

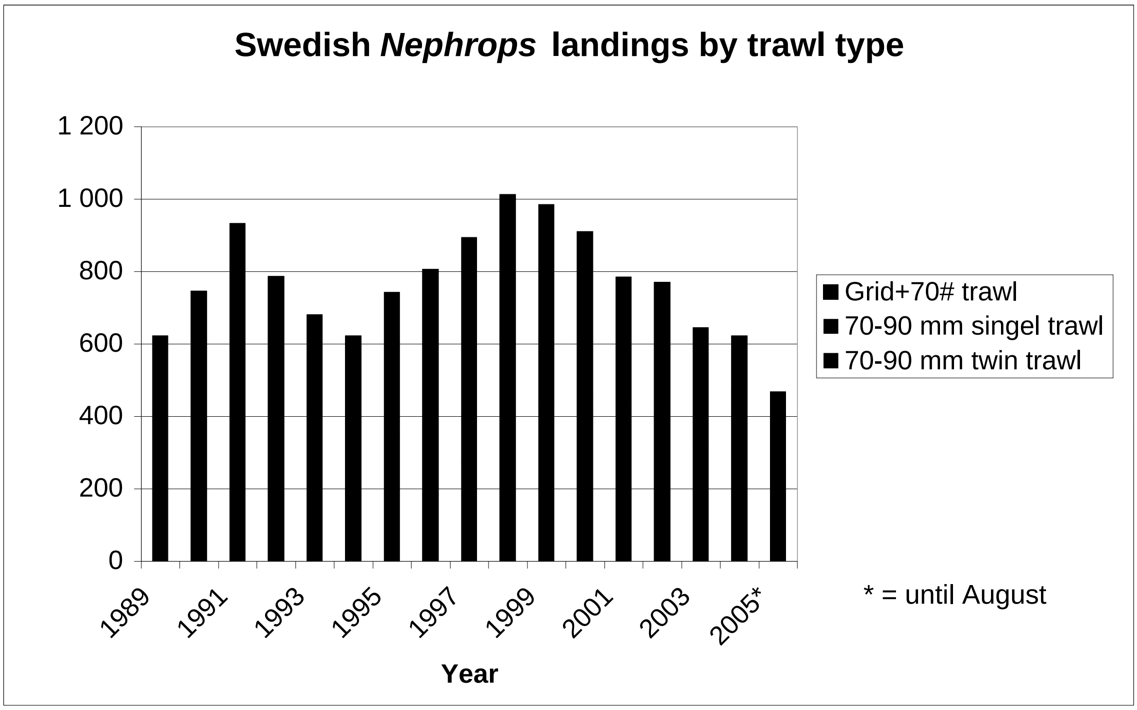

Figure 3. Annual Swedish *Nephrops* landings from IIIa by trawl category.

When twin trawls were introduced in Sweden in 1990 they were mainly used to target *Nephrops* but in recent years there has been a shift to increasingly target fish with twin trawls. Species compositions in landings from twin-, single and grid trawl is shown for 2004 and until May 2005 in figure 4. Twin trawl landings consist of less than 20 % *Nephrops* and the remaining 80% of fish species. The *Nephrops* directed single trawl fishery with 90 mm diamond mesh show about 50% *Nephrops* in the landings.

When comparing landing composition in the grid trawl to the composition in the traditional gears a very clear difference is seen. The proportion of *Nephrops* is much higher in the landings with the new grid trawl. Total landing for this gear was 155.599 tonnes in 2004. Of this 147.249 tonnes was *Nephrops* (95%), 783 kg (0.5%) cod , 4.5 tonnes (2.9%) plaice and 27 kg of sole (fig. 4). During 2005 (until August) the proportion *Nephrops* was 96%. This must be interpreted as very encouraging figures given that the aim was to significantly reduce fishing mortality on all sizes of demersal fish (only 5 % bycatch fish species in landings).

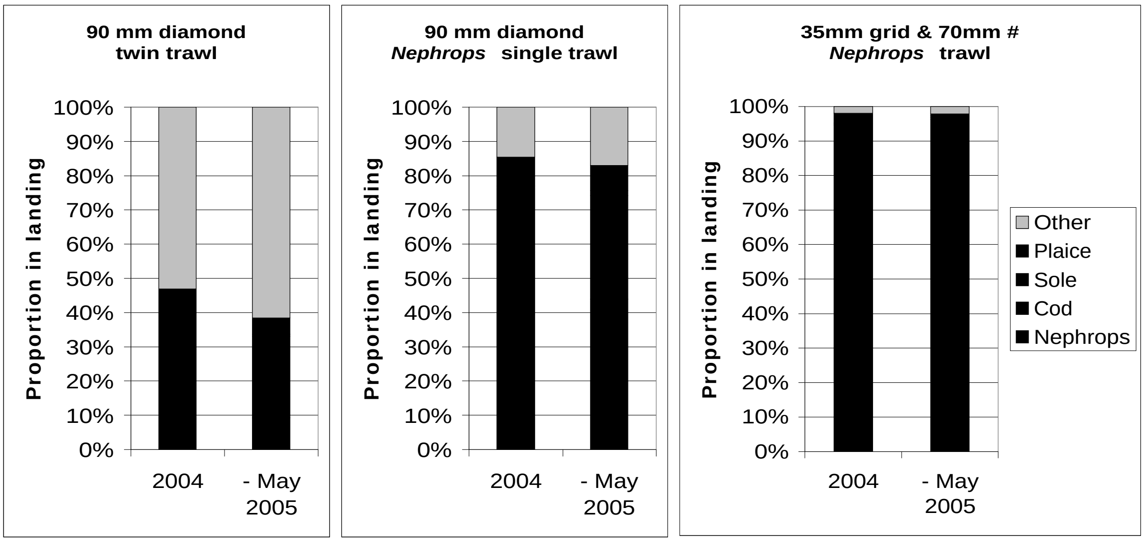

Figure 4. Species composition in landings from twin trawl, *Nephrops* single trawl and grid&square mesh *Nephrops* trawl during 2004 and beginning of 2005.

ANNEX 2 - UNDERWATER TV SURVEYS FOR *NEPHROPS*

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

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

Scottish Underwater Survey methodology

An underwater colour TV camera (Kongsberg-Simrad OE1364) is mounted on an aluminium sledge (Shand and Priestly, 1999), towed slowly (< 1kt) astern of the survey vessel. The camera is arranged on the sledge to view obliquely forwards between the runners of the sledge, with a width of view of approximately 1m. Lighting for the camera is provided by underwater lights mounted on the sledge, and powered from the vessel through the umbilical. A micro-range finder is mounted vertically on the sledge to provide information on the height of the camera above the seabed, and the degree of sinking of the sledge runners into the mud sediment. These data, together with camera lens angle specifications, are used to calculate the dimensions of the camera field of view. An odometer wheel is used to measure the distance traveled along the seabed during a TV run, typically lasting for 10 minutes. Data on the vessel location, elapsed time, sledge depth, range finder and odometer readings are recorded during a TV run with ‘in-house’ data logging software.

Recordings are made of each TV run, and burrow counts made both at the time of recording, and subsequently by at least two experienced observers under controlled conditions. Discrepancies between counts are investigated. The counts are converted into densities using information on the width of view of the camera and length of the tow. Burrow occupancy is assumed to be 100% in estimating total stock abundance. Field studies using SCUBA have shown that *Nephrops* regularly maintain and repair their burrows, and that trawling fills in burrow openings. Multiple occupancy of burrows has also been observed. Overall animal abundance is estimated by raising the mean densities to the appropriate strata area. Total survey abundance variance and confidence limits are calculated from strata abundance variances. The abundance and uncertainty estimation procedure is described by Bailey et al. (1993).

UWTV surveys use a random stratified design, with stratification based on sediment distribution and geographic area.

Surveys have been conducted in June or July in most years, but occasionally have been delayed until September owing to other vessel commitments. However, since the survey counts burrows rather than animals, there are no behavioural implications of small changes in survey timing.

English Underwater Survey methodology

This survey was set up after initial consultation with the Scotland, and the methodology adopted and the technology used differs only slightly from that used for the Scottish stocks. The English sledge used is narrower and the camera situated further back, which requires the angle of the camera to the sea bed to be set steeper giving a narrower field of view.

A mesh screen is temporarily fixed to the sledge runners and viewed underwater to measure the field of view. The distance travelled is calculated by using a HIPAP beacon fixed to the sledge which allows the position of the sledge to be recorded at regular intervals using data logging software. An odometer wheel is also used for calibration and as back up. In all, ships position, sledge position, elapsed time, sledge depth, odometer readings, and cable length are recorded along with video for the length of the tow, which is typically 10 mins. Initial counts are made live at sea and subsequently from recordings by two experienced counters under controlled conditions. Discrepancies are investigated.

Estimates of abundance are calculated as described in the Scottish section. Despite the survey station positions being originally randomly stratified by grid and sediment distribution, statistical analysis showed that for this fishery, there was no significant difference between abundance estimates raised unstratified or by stratification. Burrow densities are raised to and confidence intervals calculated for the unstratified survey area.

Surveys were originally conducted in the spring. Autumn surveys were conducted to provide an estimate of abundance before the fishery started and thereby an estimate of depletion at the end of the subsequent spring survey. Because of the availability the research vessel these surveys now take place in the Autumn before the season starts and provides an estimate before exploitation.

Advice from TV data

At the 1999 meeting of WGNEPH, concern was expressed that the TAC set at the time was unrealistically low for the Fladen Ground stock, given its large size and the expanding fishery (ICES, 1999). It was feared that this would encourage mis-reporting and lead to deterioration of the information for the stock, and ultimately the chance of not detecting future problems that might arise. As a consequence, the advice moved away from the previous reliance on the historical landings data as a basis for providing a TAC recommendation. Instead, the independent estimates of stock abundance provided by the TV survey were used to estimate a likely landings level. This estimate was based on a 'harvest ratio' (defined here as catch in numbers/stock abundance) from the lower end of the harvest ratios observed across a range of other *Nephrops* stocks, as calculated during the 1998 *Nephrops* Study Group (ICES, 1998). This preliminary approach was continued at the 2001 and 2003 meetings of the WGNEPH. Given the generally low density of *Nephrops* at the Fladen Ground, and the less well understood stock dynamics and consistency of recruitment compared to more intensively studied inshore stocks, an arbitrary conservative harvest ratio of 7.5% of the mean abundance (over preceding three surveys) was considered appropriate by WGNEPH, and accepted by ACFM. Observed harvest ratio's for other *Nephrops* stocks are generally higher ranging from 9.7 – 33% of the biomass and in many cases these rates have been sustained for many years. The observed rates are based on calculations using reported landings and stock sizes from analytical assessments (ICES, 1998). Given concerns over the accuracy of landings and the use of age structured, dynamic pool based analytical approaches for *Nephrops*, the true harvest ratios probably differ from the calculations. Nevertheless, it seems likely that harvest rates in the major, long established *Nephrops* fisheries are well above 7.5% (a harvest ratio of this size implies a very low F value of 0.078). It also seems likely that just as reliance on historic landings was rejected as a basis for TAC advice at the Fladen Ground, the same may well be advisable for other *Nephrops* stocks.

As outlined above the first stage of the process involves estimation of numbers in the population. Previously, the mean abundance over recent years has then been used as the basis for applying the harvest ratio. This figure is multiplied by an appropriate harvest ratio to estimate a suitable limit on the number of animals removed (harvest abundance). To provides an indication of the length structure of the animals of each sex removed from the population, average length frequency distributions (ideally calculated over the three most recent years) for the two sexes from monthly market samples are raised to annual removals (landings + dead discards) using discard estimates from observer trips (with 25% discard survival) and/or catch sampling, and reported landings figures. The length structure of removals is then raised to the harvest abundance, and the weight of the landed component estimated to provide TAC advice.

Uncertainties in the approach include the extent to which the area of coverage of the survey reflects the distribution of the stock and fishery, and the sensitivity of the outcome to potential differences in the selectivity of the fisheries and the survey. Some areas where fisheries exist have not been surveyed and are therefore not included in the raised survey estimates, and this provides a further precautionary buffer. An assumption is made that the population exploited by the fishery is representative of the population generating the burrows observed. For trawl fisheries this is thought to be the case, as *Nephrops* first appear in catches when they become more active foragers on the seabed surface, having left the "juvenile stage" and created their own burrows. Behavioural and selectivity factors mean this is not the case for creel fisheries, where the mean size of catches is far larger than in the population, and creel fishery data is not included in the harvest ratio approach.

The implications of this approach for fisheries with very different exploitation patters for the two sexes has been briefly examined by WGNEPH 2004, but requires further investigation, and will be considered in 2006 by WKNEPH and a TV survey workshop.

Reference F and harvest ratios

In order to better implement the harvest ratio approach, more robust ratios are required, based around established sustainable rates observed for other exploited species (preferably with similar biological characteristics) or around some reference F value, to determine the appropriate percentage of the population to be exploited.

Typical harvest ratio's that are used for other stocks range from 25-33% of the biomass for cockles in the Burry Inlet. A harvest control rule of 25% of the average fishable biomass has been adopted for Icelandic cod since 1995 (ICES, 2004), following research suggesting this would lead to a low probability of stock collapse. The EU Norway agreement on North Sea herring sets TAC advice equivalent to an F value of 0.25 on adult fish, while for area VIa, a harvest control rule with F between 0.2 and 0.25 has been shown to be sustainable while delivering a reasonably high yield.

Yield per recruit reference points calculated using Length Cohort Analysis (LCA) have been considered for west of Scotland *Nephrops* stocks. These are calculated from the shape of the exploitation pattern and should be relatively independent of the uncertain landings. These reference point estimates are quite consistent between years, and also between areas (for information, values estimated using MFYPR based on XSA outputs are also quite similar). The overall averages of the annual values are F_{max} 0.39, $F_{0.1}$ 0.24 and F30% SPR 0.34. These roughly equate to harvest ratios of 32%, 21% and 29%, respectively. Although $F_{0.1}$ is essentially an arbitrary choice of fishing mortality rate, it has been shown to not unduly reduce spawning abundance for a broad range of models of stock dynamics, and appears robust to alternative stock recruitment relationships (Deriso, 1987). $F_{0.1}$ has been used successfully as a management reference point for Icelandic *Nephrops* stocks for a number of years, and is used as a reference fishing mortality in New Zealand for both cockles (Morrison & Cryer, 1999) and scallops (Cryer, 1998). For North east Atlantic mackerel, medium and long-term predictions have indicated that a long-term harvesting strategy with a fixed F near $F_{0.1}$ would be optimal with respect to long-term yield and low risk (ICES, 2005).

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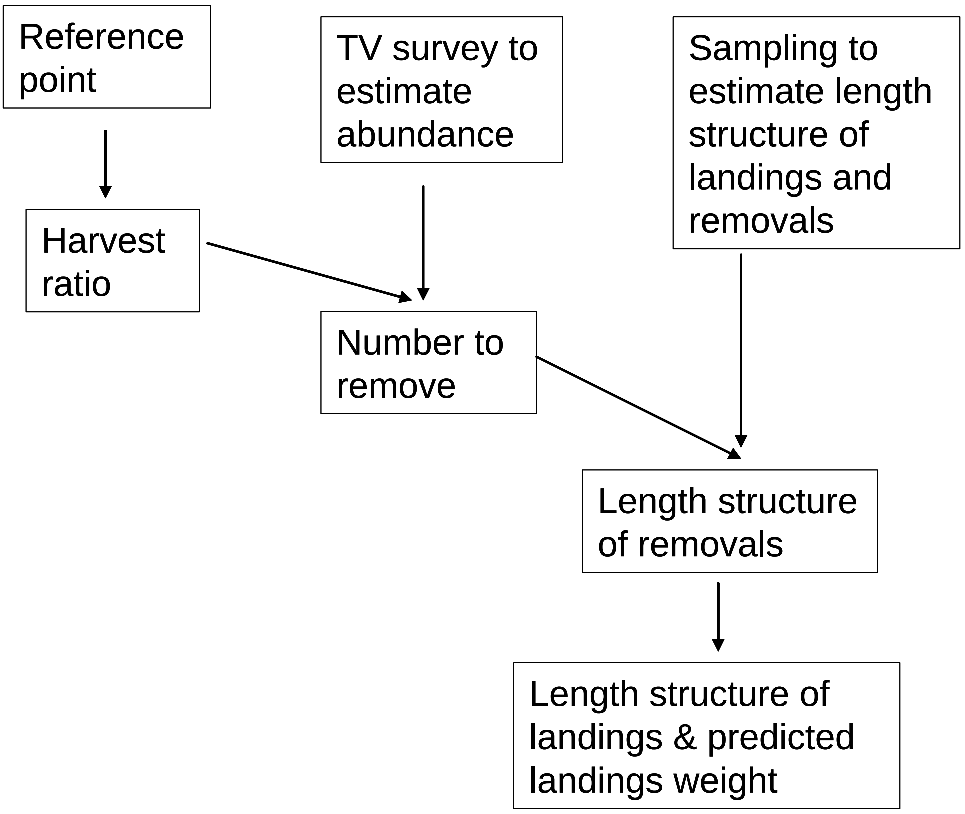
Flow diagram of harvest ratio procedure.



15 Mixed Fisheries Data

15.1 Introduction

Effort regulations (e.g. limits on days at sea for certain fleet segments) have been in force since 2003 in an attempt to enhance the correlation between TACs and the fleet's capacity. The effectiveness of such regulations is somewhat undermined by a lack of understanding regarding the technical interactions of fleets, gears and fishing strategies including discard activity. There have been initiatives by both ICES (SGDFF) and the EU Commission (STECF sub-groups) striving to collate data regarding the landings, discards and effort of national fleets and fisheries.

WGNSSK 2004 made an initial attempt to collate catch at age data by fishery for the stocks assessed within the group. This exercise met with limited success as member nations strived to get their data preparation in order. This year the exercise has been repeated with a greater degree of success although there remains a substantial lack of information in some areas. The data sets compiled by the group are designed to assist not only the comments on mixed fishery interactions within this report, but are to be made available to other bodies such as STECF who in tandem with ICES are pushing for these data to be made available. One such group is the STECF subgroup on cod recovery plans which meets the week following this WG. The STECF subgroup called for national quantitative information regarding recent catch composition of the regulated gears by age including discards from onboard observations for 2003 and 2004 and nominal effort data (Kw*days at sea) by fleets. The data was to be provided in the data-exchange formats defined by SGDFF in 2004 (Report of the Study Group on the Development of Fishery-Based Forecasts, ICES CM 2004/ACFM:11). The data compilation exercise undertaken in this WG was designed to simultaneously fulfil the needs of WGNSSK and the STECF subgroup.

15.2 Fleet specific catches and discards data, also by age

The catch data in the format defined by the ICES SGDFF (2004) allows stratification into fleets based on area, year, quarter, gear, mesh size groups and national fisheries (metiers). The fleet specific landings and discard data are species specific, raised to the official national landings and also provide information about age compositions and mean weight and length at age. Such data is used to form the basis for estimation of total fleet specific catch compositions of species and age groups including discards.

15.2.1 Availability of data

Table 15.2.1.1 lists an overview on data submissions covering the various management areas North Sea and Skagerrak, Eastern Channel, Kattegat, Eastern and Western Baltic, West of Scotland and Southwest of Scotland, Irish and Celtic Seas by country to date.

Tables 15.2.1.2 and 15.2.1.3 lists the numbers of fleets and number of stations (hauls) by regulated gears other than pelagic in 2003 and 2004 with quantitative discards estimates, respectively. Such estimates must be considered as minimum estimates, as data reports were not consistent for these parameters. However, it can be seen that among the 6 regulated gears the demersal trawls 70-99 mm and ≥100 mm and beam trawls≥80 mm are reasonably covered by samples, while demersal trawls 16-31 mm and static gears appear underrepresented. Even the group of others, gears without effort regulations excluding pelagic gears or with missing mesh size information are represented by a number of stations.

15.2.2 Estimation of fleet specific international landings and discards

The estimation of fleet specific international landings and discards is based on linking the information about fleet specific discards and catch and discards at age among countries and replacing poor or lacking values with aggregated information from other countries.

Reported data by country are aggregated by fleet properties and raised to the officially reported landings or discards in the SGDFF 2004 format. Fleet definitions are based on area, year, quarter, gear and mesh size groups and national fisheries (metiers) definitions.

The data management and estimation procedures follow the simple rising strategies outlined below:

- Data management:
  The fleets are classified to their management areas, years, quarters and effort regulated gear groups disregarding the countries and fisheries (metiers).

- Estimation of discard rates by fleet (DR):

  Let the following notation be : D=discards, L= landings, *snf* = sampled national fleet, *unf* = unsampled or poorly sampled national fleet.

  A poorly sampled fleet is defined as such when $SOP_{snf} < 0.75$ or $SOP_{snf} > 1.25$

  The available landings and discards are aggregated (summed) by fleets and mean discard rates are calculated:

  $$DR = \frac{\sum_{snf} D_{snf}}{\sum_{snf} (L_{snf} + D_{snf})} \qquad \text{with} \quad D_{snf} \geq 0 \text{ and} \quad \text{with} \quad L_{snf} + D_{snf} > 0$$

  otherwise 0 (means no catch)

  Fleet specific discard amounts are calculated when no discard information is available by

  $$D_{unf} = \frac{L_{unf}.DR}{(1 - DR)} \qquad \text{when } D_{unf} \text{ is null (empty)}$$

  Fleets without any discards information remain as such.

  An example of this raising procedure is given in Table 15.2.2.1, the values between parenthesis are the estimated values.

- Estimation of landings in numbers and mean weight at age for non or poor sampled national fleets

  Let *i* be the age reference
  Landings in numbers ($N_{snf,i}$) and mean weight at age ($W_{snf,i}$) are aggregated by sampled fleets when $SOP_{snf} \geq 0.75$ and $SOP_{snf} \leq 1.25$.

  Raising of numbers and mean weights at ages 0-11 to non or poor sampled fleets by

  $$N_{unf,i} = \frac{\sum_{snf} (N_{snf,i}).L_{unf}}{\sum_{snf} L_{snf}}$$

  $$W_{unf,i} = mean(W_{snf,i})$$

The mean weights are unweighted and an appropriate weighing procedure, i.e. number of fish measured, should be explored.

Fleets without any landings at age information remain as such.

An example of this raising procedure is given in Table 15.2.2.2 under the header "Landings", the values between parenthesis are the estimated values.

- Estimation of discards in numbers and mean weight at age for non or poor sampled fleets

  Discards in numbers ($N_{snf,i}$) and mean weight at age ($W_{snf,i}$) are aggregated by sampled fleets when $SOP_{snf} \geq 0.75$ and $SOP_{snf} \leq 1.25$ along the same procedure as for the landings.

  Raising of numbers and mean weights at ages 0-11 to non or poorly sampled fleets by

$$N_{unf,i} = \frac{\sum_{snf} (N_{snf,i}).D_{unf}}{\sum_{snf} D_{snf}}$$

$$W_{unf,i} = mean(W_{snf,i})$$

  The mean weights are unweighted and an appropriate weighing procedure, i.e. number of fish measured, should be explored.

  Fleets without any landings at age information remain as such.

  An example of this raising procedure is given in Table 15.2.2.2 under the header "Discards", the values between parenthesis are the estimated values.

- Catch at age estimation including discards

  Catches by fleets are estimated as the sum of landings and discards. Missing discards are ignored.

  Catches at ages 0-11 in numbers are estimated as the sum of landings at age in numbers and discards at age in numbers. Missing discards are ignored.

  Mean weights at ages 0-11 are estimated at weighted means (according to ratios of landings at age and discards at age to catches at age).

  Finally, all fleets' catches and catches at ages in numbers and mean weights are aggregated finally over management areas, years and effort regulated gear groups.

  Fleets without any information on discards or landings at age and discards at age remain unchanged and need to be raised separately on an agreed basis in case that they constitute significant landings.

15.2.3 Catch composition by regulated gears in the North Sea and Skagerrak

Despite the low sampling efforts, catch compositions of the gears including discards appear fairly consistent over the years 2003 and 2004 (Tables 15.2.3.1 and Fig. 15.2.3.1). Discard estimates of the main target species in the demersal fisheries are significant, and any assessments, predictions, advice and finally TAC and/or effort regulations must take them into account.

15.2.3.1 Gear category beam ≥80 mm:

This fleet segment is mainly targeting flatfish with sole and plaice as the most important species, but is known to catch also cod and whiting and dab. The fleet is operating in known nursery grounds for cod, whiting, plaice and sole and creates ecologically problematic high by-catches and discards of non-target species, especially invertebrates. Since 1989, the fleet operates under an area management, so so-called plaice-box, which is accessible only for beamers with ≤221 Kw. According to recent information, this regulation appears poorly respected. Furthermore, large by-catches of undersized plaice are caught in the 80 mm beam-trawl fisheries (Fig. 15.2.3.5), and the effort deployed is substantially higher than that needed to take the highest sustainable yield. Scientific advice has pointed to a need to reduce effort directed at plaice. Any increase in mesh size would have a significant negative short term-effect on catches of sole.

According to the sampling data, the catch composition is mainly composed of plaice, whiting, sole and cod (Tab. 15.2.3.1 and Fig. 15.2.3.1). Discard rates in weight are highest for whiting (97%), but also significant for cod (47%) and plaice (40-60%). The estimate of annual whiting discards exceed 30,000 tons in 2004, but must be considered uncertain in this order of magnitude. Also the discarded cod ranges around 3,000 tons in 2004. Age compositions for discards are not sufficient for rising. The discard rates of plaice even indicate discards in the order of the TAC of about 50,000 tons, and the discards are mainly fish at ages 3 and younger (about 90% in numbers are discarded, Fig. 15.2.3.5). Discards of sole are estimated in the order of 10 % of the catch weight and are mainly fish at ages 2 and 3 (Fig. 15.2.3.6). Catches of haddock, saithe and *Nephrops* appear low.

15.2.3.2 Gear category demersal trawl ≥100mm

This gear segment covers a wide range of fisheries targeting roundfish and flatfish and it is within this segment we find the vessels that have the highest catch rate of cod. The other demersal stocks exploited by this fleet segment are all, with the exception of saithe and possibly haddock, fully utilised or overfished. Derogations based on track records are effective for vessels with less than 5% of each of cod, sole and plaice in their landings in 2002. This derogation seems in practice only to affect vessels having targeted saithe. The derogation adopted in December 2004, giving more days to vessels fishing with mesh sizes above 120 mm, has most likely not had a positive effect on the cod stock.

Depending on the various fishing strategies, the catch composition is found more diverse than in the beam≥80 mm and is mainly composed of round fish species haddock, saithe, cod and whiting. Plaice, whiting and *Nephrops* constitute minor parts (Tab. 15.2.3.1 and Fig. 15.2.3.1). Discard rates in weight are highest for whiting (around 40%), haddock (around 20-30%) and plaice (10-40%). Cod (10%) and saithe (10%) discard rates are low, but indicate total annual discards of around 1,000-2,000 and 6,000-8,000 t respectively. The estimate of annual whiting discards vary among 3,500 tons annually. The majority of discarded fish are haddock of about 15,000 t with a decreasing tendency as the clearly identifiable strong year class 1999 becomes older (Fig. 15.2.3.3).

15.2.3.3 Gear category demersal trawl 16-31

In 2003 and 2004, Denmark deployed 90 % of the international effort but no data on catch composition, which is dominated by Norway pout, are reported. The target species of the gear group demersal trawl16-31 are Norway pout, blue whiting and sprat, while sandeel fisheries often use even mesh <16mm with catch retained on board consisting of no more than 10 % of other species. The Norway pout and sandeel fisheries are closed in 2005.

The information of the catch composition including discards of this gear group is sparse.

15.2.3.4 Gear category demersal trawl 70-99 mm

The main target species for this fleet segment is *Nephrops*. The "*Nephrops*" fishery can operate with only 30% *Nephrops* on board, up to 20% of cod, and the remaining catch made up of whiting, anglerfish, sole etc. As such it is effectively a mixed *Nephrops*/fish fishery, though individual fishing operations can target particular species quite effectively. The *Nephrops* trawl has to be equipped with certain escapement devices (square mesh panel). In addition to the *Nephrops* vessels the segment also includes vessels fishing with a mesh size of 80 mm or more for plaice and/or roundfish like cod, haddock, whiting and red mullet in the southern part of the North Sea, often using multi-net rigs. Saithe is a minor by-catch. The target species (almost all species except cod, saithe and haddock) must account for at least 70% of the landings. The 20% cod limit also applies to these vessels. The latest scientific advice on the *Nephrops* stocks concerned is from 2003. The general conclusion in 2003 was that the stocks were exploited at sustainable levels. Unofficial information indicates substantial landings in excess of those officially reported in recent years. As mentioned above, only the haddock stock does provide potential increases in catches.

As described above, the sampling programmes of commercial catches reveal that these small meshed trawl fisheries have the most diverse catch composition with almost equal shares of *Nephrops*, haddock, whiting and plaice. Substantial discard rates in weight (Table 15.2.3.1) are indicated for whiting (75%), plaice (50-70%), haddock (40-55%), cod (30-40%). It should be noted that *Nephrops* discards have not been reported to the data base. The strong haddock year class 1999 can be identified clearly (Fig.15.2.3.3). As has been observed for the beam≥80 mm, the great majority of the fish discarded are juveniles in an enormous amount (Fig.15.2.3.2-5). Discarded cod at ages 1 and 2 in numbers are lower but in the order of magnitude of discards estimated for the white fish trawl≥100mm (Fig.15.2.3.2). The gears does not select saithe and sole, for which both landings and discards are low.

15.2.3.5 Gear category demersal longline

This gear could target almost all species in a highly selective pattern, but is used mainly to catch round fish. Professional fishermen deploy this gear with a very low effort, but in local recreational fisheries the catches could raise to significant levels.

The data base on catches including discards indicates this gear category as targeting the round fish species with insignificant landings and no effort information available.

15.2.3.6 Gear category static including gill nets, trammel nets and tangle nets

This group covers a diversity of fisheries, including cod-directed gill net fisheries, large-mesh static nets directed at turbot or anglerfish, and smaller-meshed trammel nets directed at sole. A derogation is available permitting vessels in the eastern channel to fish with trammel nets of mesh size equal to or less than 110mm and absent from port for no more than 24h to be absent from port for 19 days. In the North Sea, gear of this type is used by Denmark to target sole, by Denmark and UK to catch both sole and cod, and also by France to target cod. Data are not available concerning the catch composition in these fisheries in the eastern channel.

The compilation of national landings and discard data reveals that static gears catch cod, sole, plaice and monk with very low discard rates (Table 15.2.3.1 and Fig.15.2.3.1). Also saithe appears a significant part of the landings.

15.2.3.7 Gear category other

This gear category of others are not effort regulated and or probably not provided in a consistent way to be linked to the regulated gear types (mesh size information missing). It covers a variety of gears, mainly demersal trawls including small meshed beam trawls. Pelagic trawls are not considered at all.All the main demersal target species cod, haddock, whiting, saithe, plaice, sole and Nephrops constitute significant portions in the landings or discards. However, overall the landings and discards appear relatively low.

Table 15.2.1.1 Data basis on fleets' specific landings and discard data, also at age by nation, 2003-2004 for the various management areas North Sea and Skagerrak, Eastern Channel, Kattegat, Eastern and Western Baltic, West of Scotland and Southwest of Scotland, Irish and Celtic Seas.

Country	Year restrictions	Area restrictions	Fleet restrictions	Species restrictions	Landings	Discards	Landings at age	Discards at age
Belgium	Data provided	Data provided	No mesh size for otter trawls	Main species	Data provided	No data	No data	No data
Denmark	Data provided	Data provided	Data provided	Data provided	Data provided	No data	All available	No data
Estonia	No data	No data	No data	No data	No data	No data	No data	No data
Finland	Data provided	Eastern Baltic only	Inconsistent fleets, no mesh	Main species	Main species	Main species	No data	No data
France	Data provided	Data provided	Data provided	Main species, no Nephrops	Data provided	No data	Only 2003	No data
Germany	Data provided	Data provided	Data provided	Data provided	Data provided	Data provided	All available	All available, only cod in the Baltic
Ireland	2004 only	Data provided	No mesh size	Main species	Data provided	Not by quarter	All available	Not by quarter
Netherlands	Data provided	Data provided	Beam trawls	Plaice, sole, cod, whiting	Plaice, sole and cod, whiting	Only plaice and sole	Plaice, sole and cod	Only plaice and sole
Latvia	Data provided	Data provided	Data provided	Data provided	Data provided	Data provided	All available	Only cod
Lithuania	No data	No data	No data	No data	No data	No data	No data	No data
Poland	Data provided	Data provided	Data provided	Only cod	Only cod	No data	Only cod	No data
Sweden	2004 only	Baltic only	Data provided, double reports for each fleet?	Only cod	Data provided	Data provided	Only cod	Only cod
UK England	Data provided	Data provided	Data provided	Main species	Data provided	Only 2004	All available	All available in 2004, no weights at age
UK Scotland	Data provided	2003 North Sea 2004 North Sea and west of Scotland	Few otter, gill and small beamer without mesh	Only main species,	Data provided	Data provided	All available	All available
Norway	Data provided	Data provided	Data provided	Main species	Data provided	Data provided	No data	No data

In joint data base: not Sweden yet, waiting for 2003. Discard data were made available by different aggregation level for assessment purposes to WGNSSK

Tabel 15.2.1.2 Overview on number of fleets using regulated gears (no pelagic trawls) with quantitative discard information in the North Sea and Skagerrak in 2003 and 2004. Note that the discard information for *Nephrops* is sparse.

REG_GEAR	YEAR	COD	HAD	NEP	PLE	POK	SOL	WHG
Beam>=80	2003	4	4	3	10	22	10	3
Beam>=80	2004	13	2	3	15	31	18	11
DemTrawl>=100	2003	70	74	8	14	116	4	74
DemTrawl>=100	2004	67	65		28	129	14	66
DemTrawl16-31	2003	1	2			4		1
DemTrawl16-31	2004	1	1			5		1
DemTrawl70-99	2003	28	30	8	12	46	2	21
DemTrawl70-99	2004	30	29	8	14	52	6	28
Longline	2003	8	7		2	14		2
Longline	2004	8	7		4	15		1
Other	2003	24	26	16	8	54	2	18
Other	2004	25	21	16	9	41	2	17
Static	2003	8	8	6	8	51	5	8
Static	2004	9	8		10	68	8	8

Table 15.2.1.3 Number of sampled stations (length and/or age for landings and/or discards) by management area, regulated gears and species in 2003 and 2004. Note that there is no discard information for *Nephrops* by age. The data should be considered minimum estimates as reporting of number of sampled stations and fish measured or aged is inconsistent.

REG_GEAR	YEAR	COD	HAD	PLE	POK	SOL	WHG
Beam>=80	2003			20		6	6
Beam>=80	2004	18		29		11	
DemTrawl>=100	2003	19		10	46		10
DemTrawl>=100	2004	57	57	9	57		32
DemTrawl16-31	2003						
DemTrawl16-31	2004						
DemTrawl70-99	2003			35			
DemTrawl70-99	2004	24	24	17			7
Other	2003						
Other	2004						
Static	2004			14		14	

Table 15.2.2.1 Example of raising procedure for discards volume. Presented figures are virtual and estimated numbers are between parenthesis.

Country	Species	Year	Quarter	Gear + Mesh range	Area	Total landings (t.)	Discard	
							Total (t)	Rates
A	COD	2003	1	DT >=100	4	2000	100	(0.0551)
B	COD	2003	1	DT >=100	4	5000	(292)	
C	COD	2003	1	DT >=100	4	500	(29)	
D	COD	2003	1	DT >=100	4	1000	75	
A	COD	2003	1	BEAM>=80	4	85	-	-
B	COD	2003	1	BEAM>=80	4	127	-	
C	COD	2003	1	BEAM>=80	4	32	-	
D	COD	2003	1	BEAM>=80	4	54	-	

Tabel 15.2.2.2 Example of estimates of landings and discards numbers and mean weight at age. Presented figures are virtual and estimated numbers are between parentheses.

Country	Species	Year	Quarter	Gear + Mesh range	Area	Landings				Discards			
						Total (t.)	Nb at age *i*	Mean weight *i*	SOP (sum *i*)	Total (t.)	Nb at age *i*	Mean weight *i*	SOP (sum *i*)
A	COD	2003	1	DT >=100	4	2000	135.2	0.874	1.05	100	20.5	0.670	1.1
B	COD	2003	1	DT >=100	4	5000	(246.5)	(0.767)	-	(292)	(36.2)	(0.623)	-
C	COD	2003	1	DT >=100	4	500	(24.7)	(0.767)	1.3	(29)	(3.6)	(0.623)	-
D	COD	2003	1	DT >=100	4	1000	12.7	0.66	1.1	75	1.2	0.576	0.8
A	COD	2003	1	BEAM>=80	4	85	-	-	-	85	-	-	-
B	COD	2003	1	BEAM>=80	4	127	-	-	-	127	-	-	-
C	COD	2003	1	BEAM>=80	4	32	-	-	-	32	-	-	-
D	COD	2003	1	BEAM>=80	4	54	-	-	-	54	-	-	-

Table 15.2.3.1 Landings and discards (t) and discard rates in 2003 and 2004 in the North Sea and Skagerrak by species and gears (no pelagic trawls).

SPECIES	YEAR	REG_GEAR	LANDINGS	DISCARDS	CATCH	DISC RATE BY GEAR	DISC RATE BY TOTAL INT. CATCH
COD	2003	Beam>=80	5370.051		5370.051		
COD	2003	DemTrawl>=100	12735.847	1127.008	13862.855	0.08	0.03
COD	2003	DemTrawl16-31	5.564	0.004	5.568	0	0
COD	2003	DemTrawl70-99	3182.893	2372.779	5555.672	0.43	0.07
COD	2003	Longline	1636.931		1636.931		
COD	2003	Other	820.767	0.454	821.221	0	0
COD	2003	Static	5403.632		5403.632		
SUM			29155.685	3500.245	32655.930	0.11	0.11
COD	2004	Beam>=80	3754.336	3308.889	7063.224	0.47	0.1
COD	2004	DemTrawl>=100	12264.071	2024.446	14288.513	0.14	0.06
COD	2004	DemTrawl16-31	2.212	0.109	2.321	0.05	0
COD	2004	DemTrawl70-99	2912.765	1128.432	4041.195	0.28	0.03
COD	2004	Longline	739.782		739.782		0
COD	2004	Other	753.437	3.587	757.024	0	0
COD	2004	Static	5861.845	0.001	5861.846	0	0
SUM			26288.448	6465.464	32753.905	0.2	0.2

SPECIES	YEAR	REG_GEAR	LANDINGS	DISCARDS	CATCH	DISC RATE BY GEAR	DISC RATE BY TOTAL INT. CATCH
HAD	2003	Beam>=80	554.761		554.761		
HAD	2003	DemTrawl>=100	34708.494	16881.720	51590.214	0.33	0.25
HAD	2003	DemTrawl16-31	33.357	1.983	35.340	0.06	0
HAD	2003	DemTrawl70-99	5361.703	6949.518	12311.221	0.56	0.1
HAD	2003	Longline	495.829		495.829		
HAD	2003	Other	613.752	136.816	750.568	0.18	0
HAD	2003	Static	595.533		595.533		
SUM			42363.429	23970.037	66333.466	0.36	0.36
HAD	2004	Beam>=80	502.190	14.000	516.190	0.03	0
HAD	2004	DemTrawl>=100	44242.720	13380.215	57622.929	0.23	0.2
HAD	2004	DemTrawl16-31	5.768	0.854	6.622	0.13	0
HAD	2004	DemTrawl70-99	5163.126	3423.214	8586.337	0.4	0.05
HAD	2004	Longline	422.483		422.483		
HAD	2004	Other	256.015	26.853	282.868	0.09	0
HAD	2004	Static	437.493	0.000	437.493		
SUM			51029.795	16845.136	67874.922	0.25	0.25

SPECIES	YEAR	REG_GEAR	LANDINGS	DISCARDS	CATCH	DISC RATE BY GEAR	DISC RATE BY TOTAL INT. CATCH
NEP	2003	Beam>=80	39.516		39.516		
NEP	2003	DemTrawl>=100	1513.126		1513.126		
NEP	2003	DemTrawl16-31	1.108		1.108		
NEP	2003	DemTrawl70-99	11630.779		11630.779		
NEP	2003	Other	346.313		346.313		
NEP	2003	Static	2.608		2.608		
SUM			13533.450		13533.450		
NEP	2004	Beam>=80	44.265		44.265		
NEP	2004	DemTrawl>=100	1772.003		1772.003		
NEP	2004	DemTrawl70-99	23765.026		23765.026		
NEP	2004	Longline	1.153		1.153		
NEP	2004	Other	332.166		332.166		
NEP	2004	Static	0.008		0.008		
SUM			25914.621		25914.621		

SPECIES	YEAR	REG_GEAR	LANDINGS	DISCARDS	CATCH	DISC RATE BY GEAR	DISC RATE BY TOTAL INT. CATCH
PLE	2003	Beam>=80	49480.644	52702.000	102182.644	0.52	0.38
PLE	2003	DemTrawl>=100	8393.144	797.000	9190.144	0.09	0.01
PLE	2003	DemTrawl16-31	2.795		2.795		
PLE	2003	DemTrawl70-99	6842.141	14352.000	21194.141	0.68	0.1
PLE	2003	Longline	0.432		0.432		
PLE	2003	Other	693.111		693.111		
PLE	2003	Static	5157.653		5157.653		
SUM			70569.920	67851.000	138420.920	0.49	0.49
PLE	2004	Beam>=80	46118.042	47393.464	93511.506	0.51	0.38
PLE	2004	DemTrawl>=100	9962.644	6534.039	16496.683	0.4	0.05
PLE	2004	DemTrawl16-31	1.120		1.120		
PLE	2004	DemTrawl70-99	6112.294	6045.381	12157.675	0.5	0.05
PLE	2004	Longline	4.444		4.444		
PLE	2004	Other	327.339		327.339		

Table 15.2.3.1 continued. Landings and discards (t) and discard rates in 2003 and 2004 in the North Sea and Skagerrak by species and gears (no pelagic trawls.

SPECIES	YEAR	REG_GEAR	LANDINGS	DISCARDS	CATCH	DISC RATE BY GEAR	DISC RATE BY TOTAL INT. CATCH
POK	2003	Beam>=80	38.990		38.990		
POK	2003	DemTrawl>=100	85202.515	6104.525	91307.040	0.07	0.06
POK	2003	DemTrawl16-31	52.984		52.984		
POK	2003	DemTrawl70-99	2969.059	464.333	3433.392	0.14	0
POK	2003	Longline	588.854		588.854		
POK	2003	Other	863.156	5.959	869.115	0.01	0
POK	2003	Static	7298.291		7298.291		
SUM			97013.849	6574.817	103588.666	0.06	0.06
POK	2004	Beam>=80	39.642		39.642		
POK	2004	DemTrawl>=100	84930.727	8227.138	93157.865	0.09	0.08
POK	2004	DemTrawl16-31	27.507	0.075	27.582	0	0
POK	2004	DemTrawl70-99	3154.002	762.952	3916.954	0.19	0.01
POK	2004	Longline	430.076		430.076		
POK	2004	Other	972.414	11.186	983.600	0.01	0
POK	2004	Static	4521.913		4521.913		0
SUM			94076.281	9001.351	103077.632	0.09	0.09

SPECIES	YEAR	REG_GEAR	LANDINGS	DISCARDS	CATCH	DISC RATE BY GEAR	DISC RATE BY TOTAL INT. CATCH
SOL	2003	Beam>=80	16242.899	1752.000	17994.899	0.1	0.09
SOL	2003	DemTrawl>=100	150.769		150.769		
SOL	2003	DemTrawl16-31	0.568		0.568		
SOL	2003	DemTrawl70-99	151.415		151.415		
SOL	2003	Longline	1.881		1.881		
SOL	2003	Other	177.402		177.402		
SOL	2003	Static	1436.767		1436.767		
SUM			18161.701	1752.000	19913.701	0.09	0.09
SOL	2004	Beam>=80	16881.012	2524.468	19405.478	0.13	0.12
SOL	2004	DemTrawl>=100	192.857	14.509	207.363	0.07	0
SOL	2004	DemTrawl70-99	139.264	138.913	278.176	0.5	0.01
SOL	2004	Longline	0.267		0.267		
SOL	2004	Other	107.686		107.686		
SOL	2004	Static	1166.573	5.436	1172.009		
SUM			18487.659	2683.326	21170.979	0.13	0.13

SPECIES	YEAR	REG_GEAR	LANDINGS	DISCARDS	CATCH	DISC RATE BY GEAR	DISC RATE BY TOTAL INT. CATCH
WHG	2003	Beam>=80	520.616	17271.000	17791.616	0.97	0.39
WHG	2003	DemTrawl>=100	5020.679	3476.246	8496.925	0.41	0.08
WHG	2003	DemTrawl16-31	0.408	0.210	0.618	0.34	0
WHG	2003	DemTrawl70-99	4116.141	13776.202	17892.343	0.77	0.31
WHG	2003	Longline	3.026		3.026		
WHG	2003	Other	178.865	38.002	216.867	0.18	0
WHG	2003	Static	30.076		30.076		
SUM			9869.811	34561.660	44431.471	0.78	0.78
WHG	2004	Beam>=80	1189.939	32779.633	33969.572	0.96	0.59
WHG	2004	DemTrawl>=100	4967.165	3979.392	8946.553	0.44	0.07
WHG	2004	DemTrawl16-31	2.288	1.799	4.087	0.44	0
WHG	2004	DemTrawl70-99	3606.896	8468.410	12075.303	0.7	0.15
WHG	2004	Longline	3.812		3.812		
WHG	2004	Other	63.216	9.721	72.937	0.13	0
WHG	2004	Static	40.024		40.024		
SUM			9873.340	45238.955	55112.288	0.82	0.82

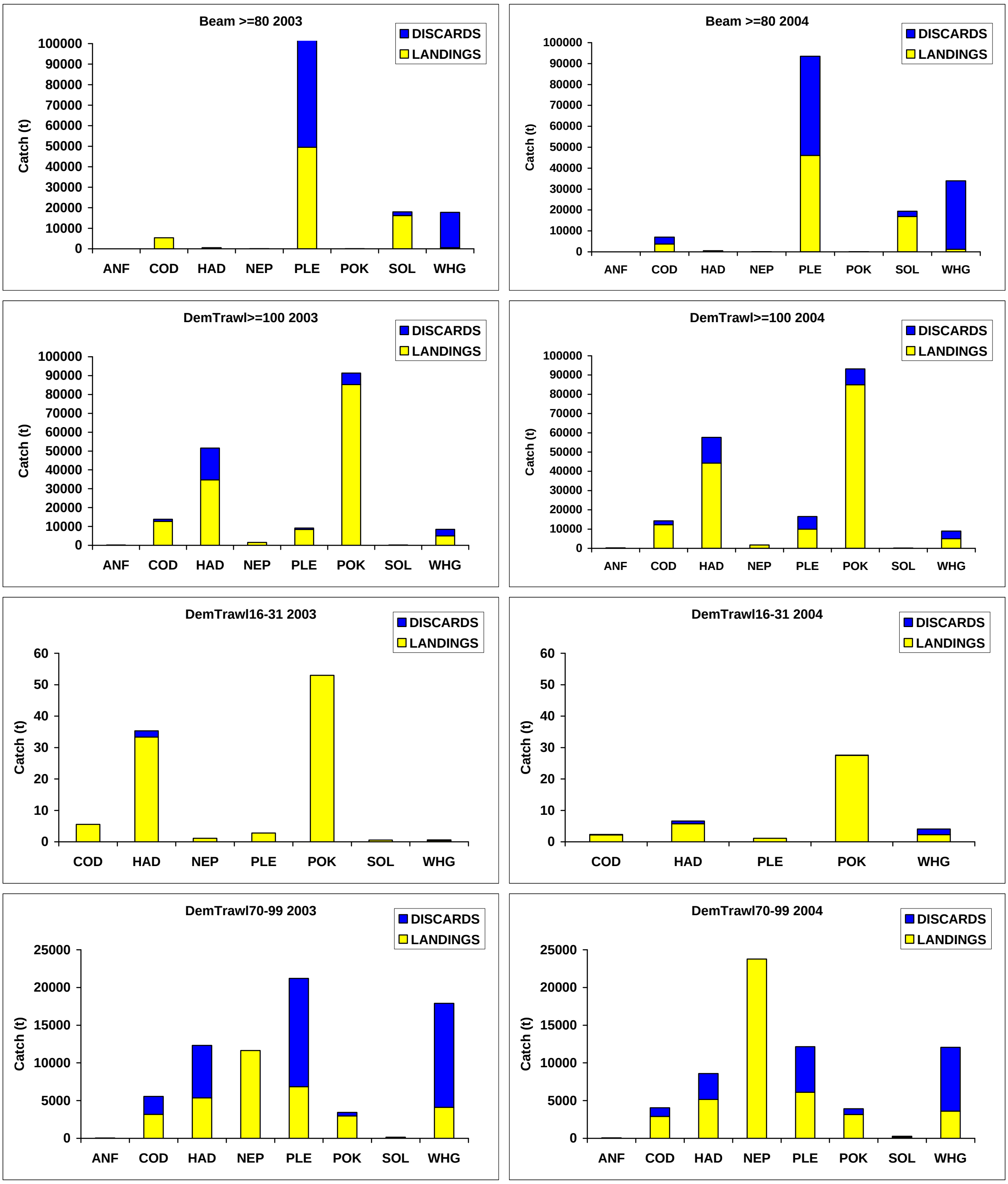


Fig. 15.2.3.1 Landings and discards by regulated gears and by species in 2003 and 2004, representing Scottish and German official landings and raised discards only.

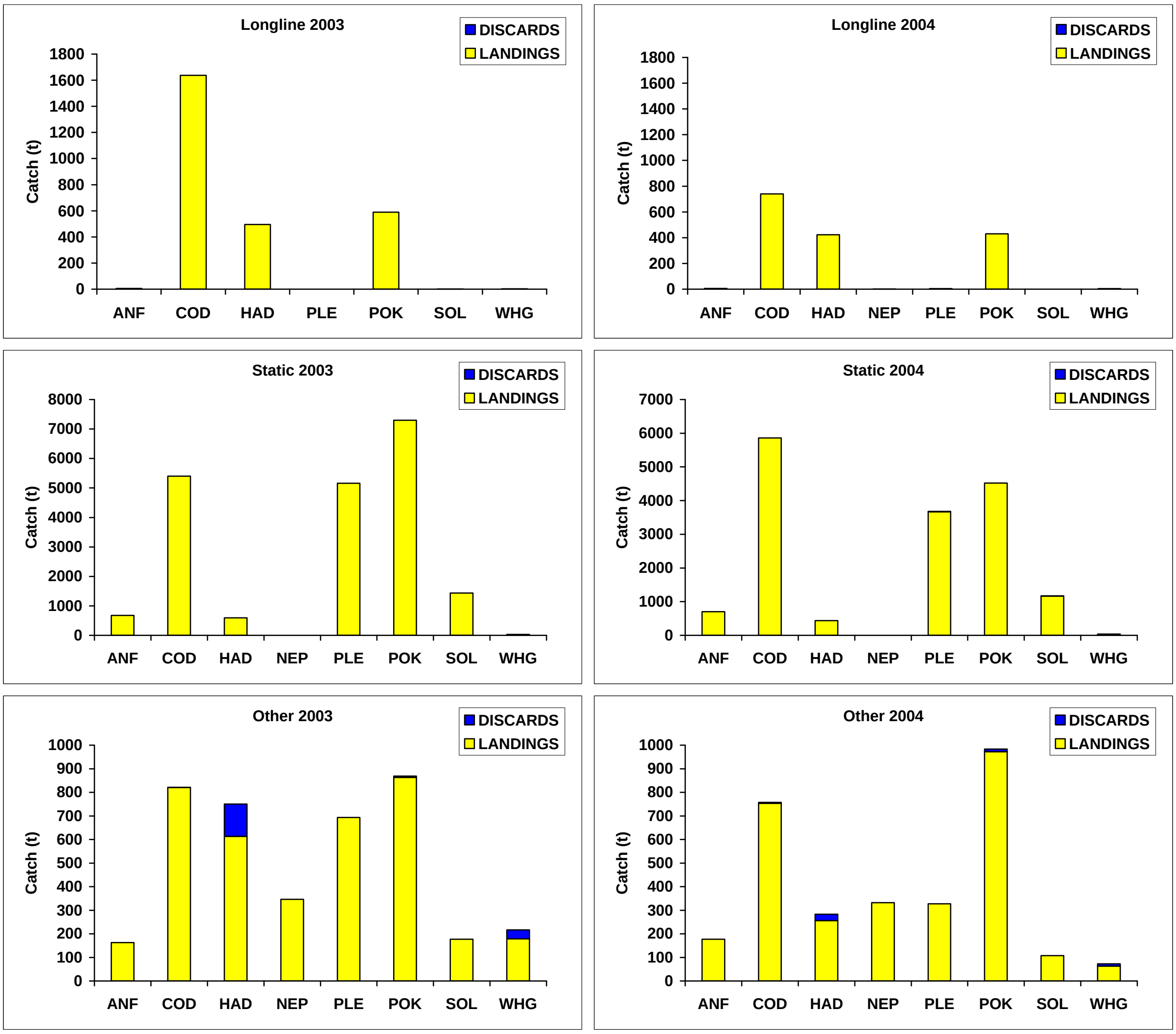


Fig. 15.2.3.1 continued. Landings and discards by regulated gears and by species in 2003 and 2004, representing Scottish and German official landings and raised discards only.

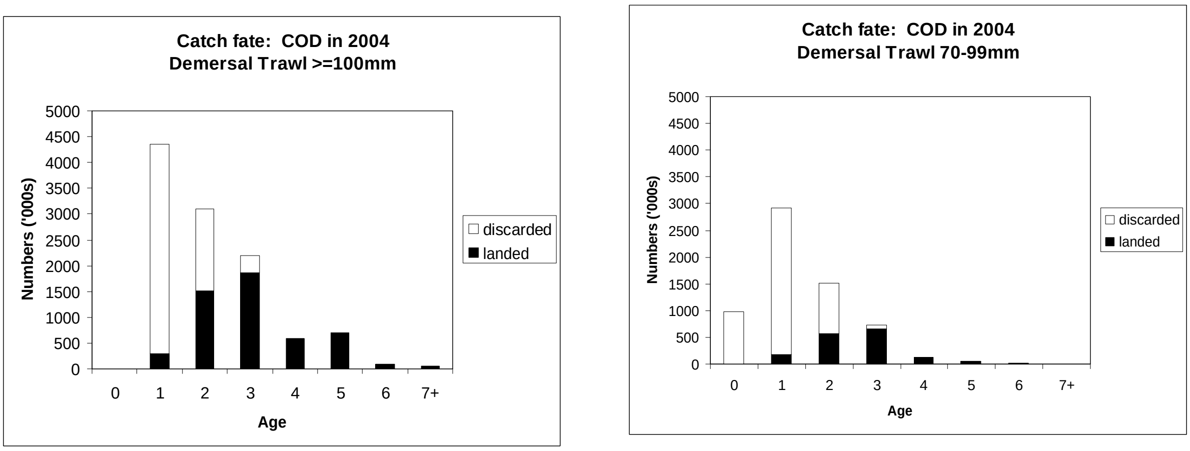


Fig. 15.2.3.2 North Sea, Skagerrak in 2004. Landings and discards (D) at age for cod by the regulated gears demersal trawl≥100mm and 70-99mm.

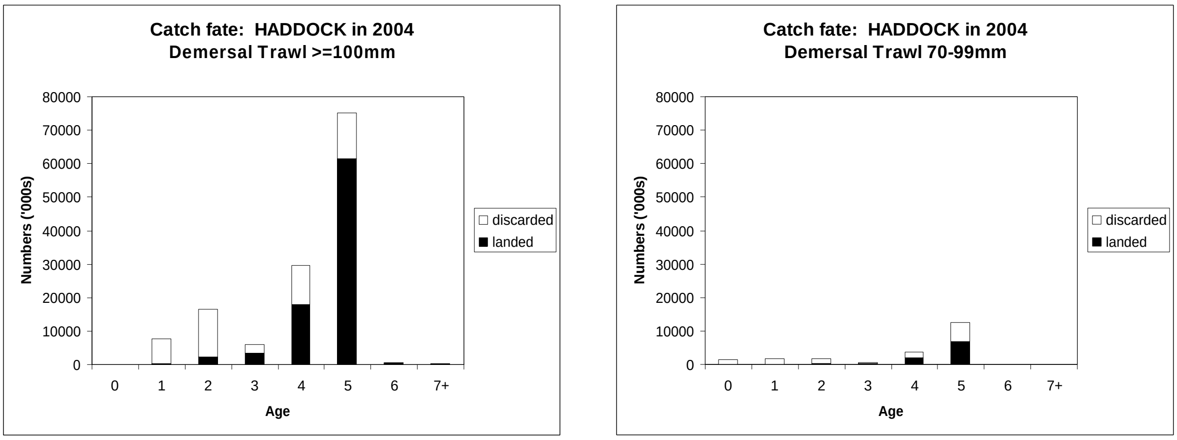


Fig. 15.2.3.3 North Sea, Skagerrak in 2004. Landings and discards (D) at age for haddock by the regulated gears demersal trawl≥100mm and 70-99mm.

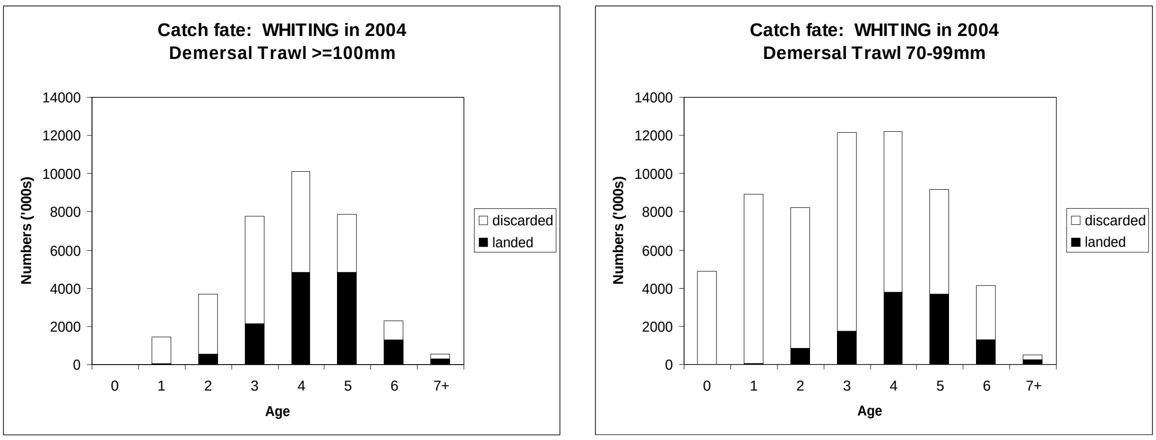


Fig. 15.2.3.4 North Sea, Skagerrak in 2004. Landings and discards (D) at age for whiting by the regulated gears demersal trawl≥100mm and 70-99mm.

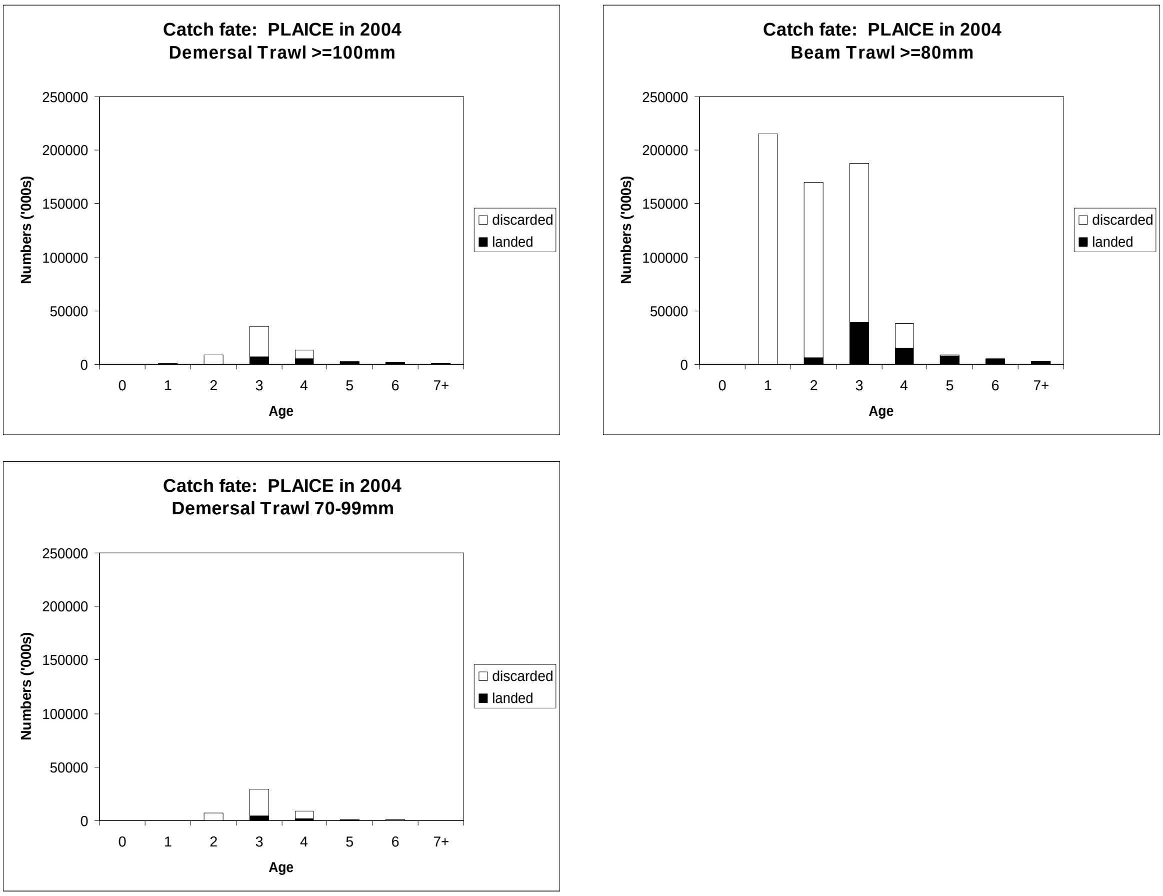


Fig. 15.2.3.5 North Sea, Skagerrak in 2004. Landings and discards (D) at age for plaice by the regulated gears demersal trawl≥100mm, 70-99mm and beam≥80mm.

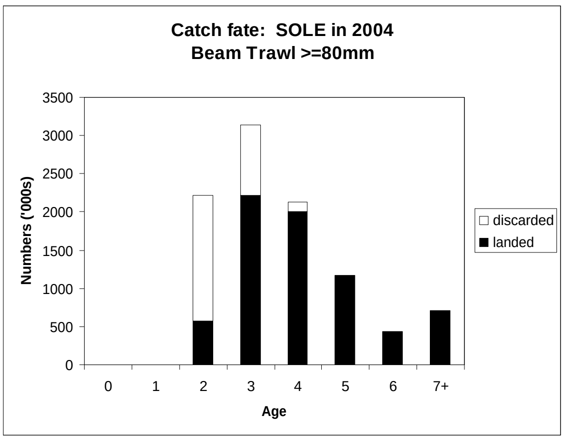


Fig. 15.2.3.6 North Sea, Skagerrak in 2004. Landings and discards (D) at age for sole by the regulated gear beam≥80mm.

15.3 Nominal effort data (Kw*days at sea) based on national logbooks

15.3.1 Availability of data

The effort data called in the format defined by the ICES SGDFF (2004) allow stratification by fleets based on area, year, quarter, gear and mesh size groups and national fisheries (metiers). The data cover the period 2000-2004, for some countries back to 1997 and were made available to the WGNSSK. The data availability is listed in Table 15.3.1.

15.3.2 Estimation of fleet specific trends in nominal effort

The nominal effort data (Kw*day at sea) are aggregated by year, the management areas of the North Sea and Skagerrak, Western and Eastern Baltic, Kattegat, West of Scotland, Irish and Celtic Seas as well as by the regulated gear types. The aggregation is by summing the national fleet nominal efforts.

15.3.3 Trends in fleet specific nominal effort in the North Sea and Skagerrak

Overall, the nominal effort of demersal gear types decreased steadily since 2000. Compared with 2000 and 2002, the relative decreases in 2004 amounted to -21% and -15% (Tab. 15.3.3.1 and Fig. 15.3.3.1), respectively. Main fishing gears in terms of nominal effort are beam≥80, and the demersal trawls≥100 and 70-99 mm, contributing about 80% to the total effort deployed. Other gears, comprising also regulated gears but without mesh size information, contributed less than 20% to the total effort. Given the inconsistencies due to missing data reports, the data may represent about 90 % of the overall effort. National trends in nominal effort by regulated gears are given in Table 15.3.3.2 and illustrated in Fig. 15.3.3.2

Until 2004, the regulated gear beam ≥80mm reveals a decrease in nominal effort by -24% and -14% when compared with the years 2000 and 2002, respectively. Since 2000, most of the decrease was met by the Dutch fleets, while the French and UK-England fleets show the highest relative decline since 2000 of about 50%, (Tab. 15.3.2.2 and Fig. 15.3.2.2).

During the period 2000-2004, the nominal effort of demersal trawls ≥100mm, the gear type distinguished by the highest cod catches, decreased significantly by -43%. Since 2002, the decrease amounts to -35%. While Scotland contributed most to this decrease in absolute terms and all countries reported consistently on significant declines in this sector, only Norway, France, and Germany increased their relatively low effort obviously under the derogation for saithe directed fishing (Fig. 15.3.2.2).

The target species of the gear group of demersal trawl 16-31mm are Norway pout, blue whiting and sprat while sandeel fisheries often use even mesh <16mm with catch retained on board consisting of no more than 10 % of any mixture of other species. The Danish and Swedish efforts decreased significantly in 2002 leading to an overall reduction by about 60% since 2000.

The effort of the great variety of fleets aggregated under the category of demersal trawl 70-99mm increased by 51% from 2000 until 2004. The increase since 2002 is estimated to amount to 11%. While all countries increased their efforts in this fleet sector significantly, main contributors are Scotland and Denmark in absolute terms (Fig. 15.3.2.2).

Scotland is the only country reporting significant nominal efforts using demersal longlines. During 2002 to 2004, the effort decreased significantly by 64 %, and by about 69% since 2000.

Static gear fisheries are dominated by Danish vessels showing a decline by 23% during 2002 to 2004. Scotland, the Netherlands and Sweden are distinguished by significant increases of their low efforts since 2000.

Significant efforts are reported for other demersal gears without mesh size information and the fleets of demersal otter trawl<16 or otter trawls with 32-54 mm, mainly directed at sandeel, herring, and horse mackerel. There are also other nations reporting such mesh sizes fishing for squid or a variety of targets without any discard information. Also included in other gears are significant amounts efforts of small and large beamers using mesh sizes of 16-31 mm, fishing for brown shrimp (Crangon). Such high nominal efforts of Denmark, Germany and Sweden appear unchanged since 2000. Pelagic trawls are not considered at all.

Table 15.3.1 Data basis on fleets' specific nominal effort data (Kw*days at sea), 2000-2004, for the various management areas North Sea and Skagerrak, Eastern Channel, Kattegat, Eastern and Western Baltic, West of Scotland, Irish and Celtic Seas.

COUNTRY	YEAR RESTRICTIONS	AREA RESTRICTIONS	FLEET RESTRICTIONS
Belgium	2003-2004	Data provided	Otter trawlers without mesh
Denmark	2000-2004	Data provided	Data provided
Estonia	No data	No data	No data
Finland	2002-2004	Data provided (22-24, 25-32)	Data provided
France	2000 2004	Data provided	Data provided
Germany	2000-2004	Data provided	Data provided
Ireland	2000-2004	Data provided	No mesh sizes
Netherlands	1997-2004	Data provided	Not all beam efforts classified to engine power
Latvia	2000-2004	Data provided	Data provided
Lithuania	No data	No data	No data
Poland	No data	No data	No data
Sweden	1997-2005	Data provided	Data provided
UK England	1997-2004	Data provided	Data provided
UK Scotland	1997-2004	Data provided	Data provided
Norway[1]	2004-2004	Data provided	Data provided

[1]) Kw*fishing days

Table 15.3.3.1 Trends in nominal effort (Kw*days at sea) by effort regulated gear types in the North Sea and Skagerrak, 2000-2004, Belgium not included.

GearReg	2000	2001	2002	2003	2004
Beam>=80	66232289	64007488	58301694	51538730	50423235
DemTrawl>=100	58033709	53642767	50835419	38229639	32848854
DemTrawl16-31	254099	278355	148093	169729	101175
DemTrawl70-99	17368331	18555840	23567088	26969679	26155495
Longline	203275	146005	173568	137190	62635
Other	27310812	28307716	25968538	26588877	25395950
Static	5127360	4756987	4335929	3237775	3342538
SUM	174529875	169695158	163330329	146871619	138329882
change relative to 2000		-0.03	-0.06	-0.16	-0.21
change relative to 2002				-0.1	-0.15

Tab. 15.3.3.2 Trend in nominal effort (KW*days at sea) by country for the effort regulated and other unregulated gears (including reports without mesh size information) except pelagics in the North Sea and Skagerrak, 2000-2004, Belgium not included.

GearReg	COUNTRY	2000	2001	2002	2003	2004
Beam>=80	BEL					
Beam>=80	DEN	1074157	1230444	1393934	1349965	1290806
Beam>=80	ENG	8316622	8283711	6072252	4809522	4723454
Beam>=80	FRA	111520	75680	112752	57246	54338
Beam>=80	GER	2850547	2357885	2155098	1891552	2377306
Beam>=80	NED	47289070	45040459	41491705	37816572	35220714
Beam>=80	NOR	1251569	1126981	1600285	997447	1421391
Beam>=80	SCO	5338804	5892328	5475668	4616426	5335226
sum		66232289	64007488	58301694	51538730	50423235
change relative to 2000			-0.03	-0.12	-0.22	-0.24
change relative to 2002					-0.12	-0.14
DemTrawl>=100	DEN	9402721	10069985	9971411	7094101	6111104
DemTrawl>=100	ENG	4424917	4204662	3163570	1958711	1295282
DemTrawl>=100	FRA	1967547	1855316	2610036	2548157	2782250
DemTrawl>=100	GER	2472476	2082833	2833663	2763762	3478294
DemTrawl>=100	NED	1449902	966601	1048343	468983	408732
DemTrawl>=100	NOR	2554237	2733642	5429344	6313703	5043732
DemTrawl>=100	SCO	34885864	30847606	24870201	16786930	13559088
DemTrawl>=100	SWE	876045	882122	908851	295292	170372
sum		58033709	53642767	50835419	38229639	32848854
change relative to 2000			-0.08	-0.12	-0.34	-0.43
change relative to 2002					-0.25	-0.35
DemTrawl16-31	DEN	223951	225245	133891	145366	84048
DemTrawl16-31	ENG	4486		231	2189	4369
DemTrawl16-31	FRA	6804	3240	6156		365
DemTrawl16-31	GER	1967	4940	570	1088	
DemTrawl16-31	NED	1372	4248	5283	10439	3544
DemTrawl16-31	SCO		4470		10647	4853
DemTrawl16-31	SWE	15519	36212	1962		3996
sum		254099	278355	148093	169729	101175
change relative to 2000			0.1	-0.42	-0.33	-0.6
change relative to 2002					0.15	-0.32
DemTrawl70-99	DEN	4714929	4290768	5822251	7016629	7386546
DemTrawl70-99	ENG	1148516	1179118	981560	2030896	1832405
DemTrawl70-99	FRA	989056	1849271	1473167	1207857	1510815
DemTrawl70-99	GER	280033	283911	323114	969416	829333
DemTrawl70-99	NED	412305	574437	779432	1411082	1064050
DemTrawl70-99	SCO	6232892	6718610	10399358	10864642	10437309
DemTrawl70-99	SWE	3590600	3659725	3788206	3469157	3095037
sum		17368331	18555840	23567088	26969679	26155495
change relative to 2000			0.07	0.36	0.55	0.51
change relative to 2002					0.14	0.11

Tab. 15.3.3.2 continued. Trend in nominal effort (KW*days at sea) by country for the effort regulated and other unregulated gears (including reports without mesh size information) except pelagics in the North Sea and Skagerrak, 2000-2004, Belgium not included.

GearReg	COUNTRY	2000	2001	2002	2003	2004
Longline	FRA			2080		327
Longline	NED		-9	964	2399	356
Longline	SCO	203275	146014	170524	134791	61952
sum		203275	146005	173568	137190	62635
change relative to 2000			-0.28	-0.15	-0.33	-0.69
change relative to 2002					-0.21	-0.64
Other	BEL					
Other	DEN	14336912	15868920	13499550	13470263	12538888
Other	ENG	590730	657674	683573	632029	424925
Other	FRA	12022	23014	6688	19023	18111
Other	GER	7390406	7097012	7130754	7897258	7424426
Other	IRL	158235	194575	222269	155107	195394
Other	NED	805644	578810	624301	533987	660959
Other	SCO	555815	366784	388080	669273	832415
Other	SWE	3461048	3520927	3413323	3211937	3300832
sum		27310812	28307716	25968538	26588877	25395950
change relative to 2000			0.04	-0.05	-0.03	-0.07
change relative to 2002					0.02	-0.02
Static	DEN	3456283	3368330	2943832	2065065	2171621
Static	ENG	472282	465253	268365	176315	216605
Static	FRA	641426	550256	662478	405704	403617
Static	GER	341031	117740	164420	184958	116779
Static	NED	62868	88161	99713	98260	115027
Static	SCO	70429	77229	95591	195184	171723
Static	SWE	83041	90018	101530	112289	147166
sum		5127360	4756987	4335929	3237775	3342538
change relative to 2000			-0.07	-0.15	-0.37	-0.35
change relative to 2002					-0.25	-0.23

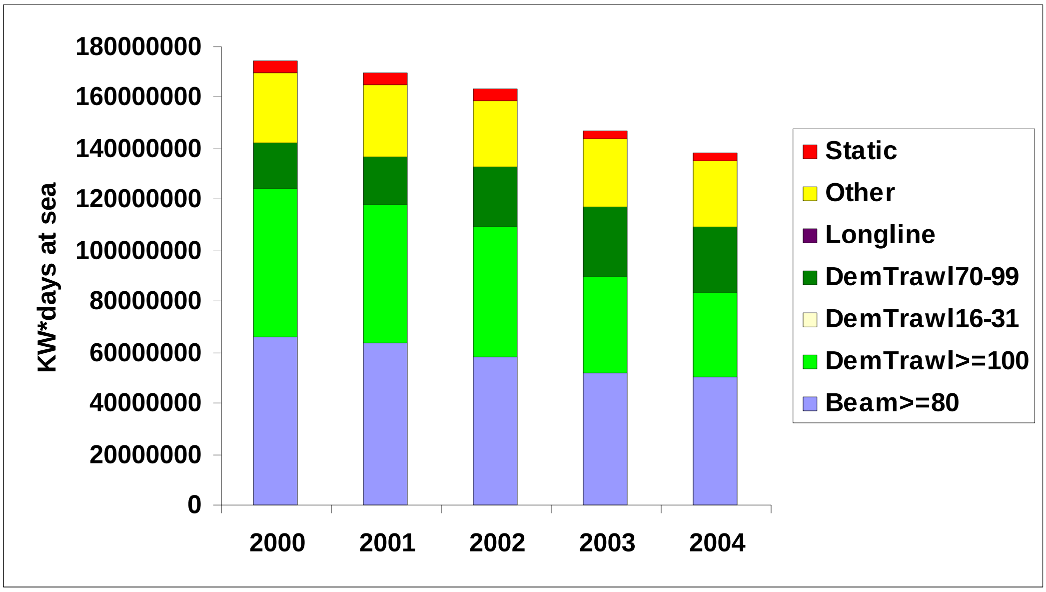


Fig. 15.3.3.1 Trend in nominal effort (KW*days at sea) for the effort regulated and other unregulated gears (including reports without mesh size information) except pelagics in the North Sea and Skagerrak, 2000-2004, Belgium not included.

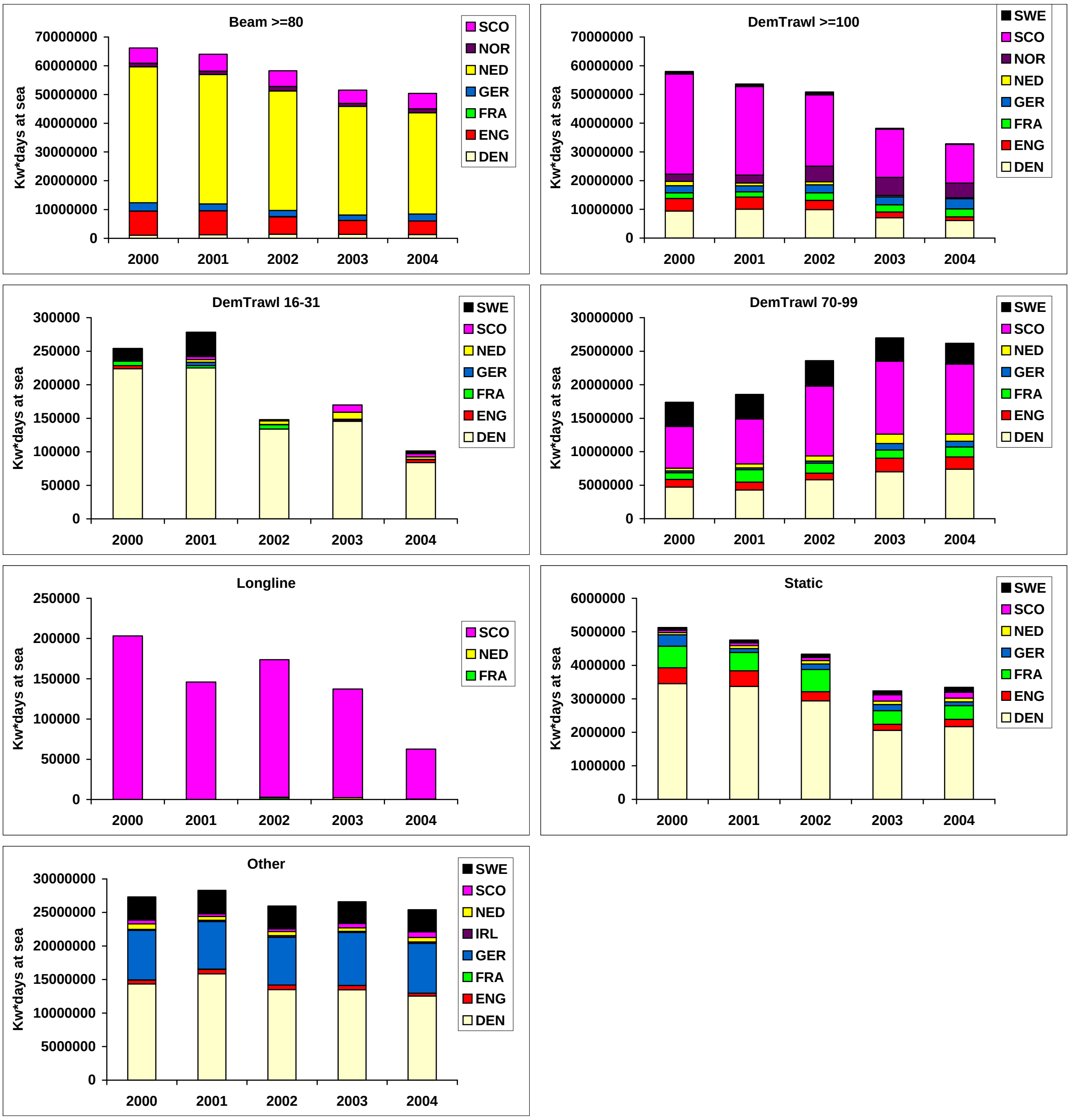


Fig. 15.3.3.2 Trend in nominal effort (KW*days at sea) by country for the effort regulated and other unregulated gears (including reports without mesh size information) except pelagics in the North Sea and Skagerrak, 2000-2004, Belgium not included.

15.4 Conclusions

Despite the relatively low sampling efforts, catch compositions of the gears including discards appear fairly consistent over the years 2003 and 2004.

The landings and discard data compiled and estimated in the mixed fisheries data base are consistent with the assessment inputs with the exception of whiting, where high discards in the beam trawl fleets resulted in different estimates. Overall, the data base appears suitable to quantify the gear specific effects on the demersal fish stocks in the North Sea and Skagerrak.

Beam trawls≥80 mm and demersal trawls 70-99 mm contribute most to the estimated discards in weight.

Estimated discard amounts are highest for whiting, plaice while haddock discards appear recently decreased.

Until 2004, overall nominal effort has decreased since 2000 and 2002 by 21% and15 %, respectively. The roundfish trawl≥100 mm has shown the steepest decline by 43% since 2000 and by 35% since 2002, while the demersal trawls 70-99 mm shows a significant increase by 51% and 11%, respectively. During the periods 2000 to 2004 and 2000 to 2002, beam trawls≥80 mm show a modest decline by 24% and 14%.

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Annex B

1 Quality handbook: Cod in Sub-Area IV and Divisions IIIa and VIId

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

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2 Quality handbook: Haddock in Sub-Area IV and Division IIIa

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2.1 GENERAL

2.1.1 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

2.1.2 Fishery

In the North Sea, haddock is taken as part of a mixed demersal fishery along with cod and whiting. Saithe, ling and blue ling are also caught in this fishery. Other demersal species caught as a by-catch in this fishery include plaice, lemon sole, dogfish, skate sp., witch, megrim, redfish, dab, hake, and turbot with lesser quantities of catfish, forkbeard, grenadier sp., tusk, halibut, turbot, Greenland halibut, brill and pollack.

The large majority of the haddock catch is taken by Scottish light trawlers, seiners and pair trawlers. Until 2001, these gears had a minimum legal mesh size of 100 mm, and smaller quantities were taken by other Scottish vessels, including Nephrops trawlers which used mesh sizes between 70 and 100mm mesh and hence may have had higher discard rates. New gear regulations were brought in for 2002 as a part of the North Sea cod recovery plan (Commission Regulation (EC) No 2056/2001). Vessels from other countries including England, Denmark and Norway also participate in the fishery, and haddock are also taken as a 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.

2.1.3 Ecosystem aspects

The haddock larvae feed on immature copepods, while euphausiids, appendicularians, decapod larvae, copepods and fish are food items for 0 age haddock (3-14cm). When the juvenile haddock become demersal they still feed on pelagic organisms but more importantly prey on slow moving 15cm benthic invertebrates such as worms, small molluscs, sea urchins and brittle stars. The prey of a larger haddock include sandeel, norway pout, long rough dab, gobies, sprat and herring. The haddock are predicted to feed in shoals as the majority of the stomach contents at different sampling stations contained similar prey. Haddock also feed heavily on the demersal egg deposits of herring.

2.2 DATA

2.2.1 Commercial catch

Quarterly age composition data for the North Sea (Sub-area IV) human consumption landings are supplied by Denmark, Norway, England and Wales, France and Scotland. These nations accounted for 90% of the total human consumption landings. Sampling levels are given in 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 ogive from the Scottish sampling programme to the level of the national fleet landings. The Scottish discard programme follows a stratified random design, with fishing trips stratified by area, gear and quarter, and total Scottish discards are estimated by a stratified ratio estimator (Thompson, 1992). Given the cost of discard sampling, many strata are not sampled and currently ad-hoc fillin rules are applied to those strata, (e.g. empty inshore Nephrops trawl strata will be filled in with available inshore Nephrops trawl data from the same quarter). Given the ad-hoc nature of this approach and the large number of strata this traditional estimator can be both biased and imprecise. Stratoudakis et al (1999) developed an alternative collapsed-ratio estimator that collapses the strata with similar discard ratios, and uses a more robust auxiliary variable than species landings. Total discards are then estimated by summing across collapsed strata. Collapsing strata has the effect of increasing the sample size in each stratum, and results in a collapsed ratio estimator that has reduced bias and increased precision as compared to a fully stratified ratio estimator. Work is still required to formalise the method, but in general historic estimates are revised downwards while more recent estimates are largely unchanged.

Landings and discard information are provided, variously, as quarterly age compositions, quarterly landings, and annual landings. Discard information is not always supplied, but is sometimes supplied disaggregated to fleet while corresponding landings are given as a national totals, in this case discard age compositions and weights at age are combined to match the landings. Discard age compositions are used where possible and the resulting average discard ogive is applied to fleets where information only on landings is supplied, or where discard information is unusable. Where nations supply only values of total landings, age compositions are implied by the weighted average of the available information, as supplied by other nations.

2.2.2 Biological

Natural mortality

Maturity

Weight at age

Proportion mortality before spawning

Natural mortality

The values of natural mortality and proportion mature at age used in the assessment are unchanged from last year's meeting. The estimates of natural mortality originate from MSVPA (ICES 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.

2.2.3 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.

2.2.4 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).

2.2.5 Other relevant data

None.

2.3 Historical Stock Development

2.3.1 Deterministic modelling

Model used: XSA

Software used: Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability dependent on stock size for ages < 1

Regression type = C

Minimum of 5 points used for regression

Survivor estimates shrunk to the population mean for ages < 1

Catchability independent of age for ages >= 3

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

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

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

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR
Caton	Catch in tonnes	1963 – last data year	0-7+	Yes
Canum	Catch at age in	1963 – last data	0-7+	Yes

	numbers	year		
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.

2.3.2 Uncertainty analysis

Scenario analysis using Fishlab Excel spreadsheet where alternative structural model assumptions can be explored.

2.3.3 Retrospective analysis

Retrospective analysis using Fishlab Excel spreadsheet with diminishing tuning series (cut off final years), or retrospective XSA runs within the Lowestoft software suite.

2.4 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 1999 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 Fsq 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%.

2.5 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.

2.6 Long-term projections, yield per recruit

To be specified.

2.7 Biological reference points

2.8 Other issues

None.

2.9 References

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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.

CEFAS web pages on haddock :

http://www.cefas.co.uk/fishinfo/melanogrammus.htm

http://www.cefas.co.uk/fsmi/roundfish-haddock.htm

FRS Marine Laboratory web page on haddock :

http://www.frs-scotland.gov.uk/FRS.Web/Delivery/display_standalone.aspx?contentid=708

3 Quality Handbook: Whiting in Sub-Area IV and Division VIId

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

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3.1 General

3.1.1 Stock definition

Whiting is known to occur exclusively in some localised areas, but for the most part it is caught as part of a mixed fishery operating throughout the entire year. Adult whiting are widespread in the North Sea, while high numbers of immature fish occur off the Scottish coast, in the German Bight and along the coast of the Netherlands.

Tagging experiments, and the use of a number of fish parasites as markers, have shown that the whiting found to the north and south of the Dogger Bank form two virtually separate populations (Hislop & MacKenzie, 1976). It is also possible that the whiting in the northern North Sea may contain 'inshore' and 'offshore' populations.

3.2 Fishery

3.2.1 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.

3.3 Data

3.3.1 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.

3.3.2 Biological

Natural mortality

Natural mortality values are rounded averages of estimates produced by previous key runs of the North Sea MSVPA (see Section 1.3.1.3 of the 1999 WG report: ICES CM 2000/ACFM:7). The values used in both the assessment and the forecast are :

Age	1	2	3	4	5	6	7	8+
Natural Mortality	0.95	0.45	0.35	0.30	0.25	0.25	0.20	0.20

Maturity

The maturity ogive is based on North Sea IBTS quarter 1 data, averaged over the period 1981-1985. The maturity ogive used in both the assessment and forecast is:

Age	1	2	3	4	5	6	7	8+
Maturity Ogive	0.11	0.92	1.00	1.00	1.00	1.00	1.00	1.00

Weight at age

Weight at age in the stock is assumed to be the same as weight at age in the catch.

Proportion mortality before spawning

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to zero.

3.3.3 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.

3.3.4 Other relevant data

None

3.4 Historical Stock Development

N/A for the time being

3.5 Short-term Projection

N/A for the time being

3.6 Medium-Term Projections

N/A for the time being

3.7 Yield and Biomass per Recruit / Long-Term Projections

N/A for the time being

3.8 Biological Reference Points

The precautionary fishing mortality and biomass reference points agreed by the EU and Norway, (unchanged since 1999), are as follows:

Blim = 225,000 t; Bpa = 315,000 t; Flim = 0.90; Fpa = 0.65.

3.9 Other Issues

3.10 References

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4 Quality handbook: Saithe in Sub-Areas IV and VI and Division IIIa

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4.1 General

4.1.1 Stock definition

The geographical distribution of juveniles (< age 3) and adults differs. Typical for all saithe stocks are the inshore nursery grounds. Juveniles are therefore mainly distributed along the west and south coast of Norway, the coast of Shetland and the coast of Scotland. Around age 3 the individuals gradually migrate from the costal areas to the northern part of the North Sea (57□N - 62□N), where the feeding grounds of the adult part of the stock are situated. The age at maturity is between 4 and 6 years, and spawning takes place in January-March at about 200 m depth along the Northern Shelf edge and the western edge of the Norwegian deeps. Larvae and post-larvae are widely distributed in Atlantic water masses across the northern part of the North Sea, and around May the 0-group suddenly appear along the coast (of Norway, Shetland and Scotland). The west coast of Norway is probably the most important nursery ground for saithe in the North Sea.

When saithe exceed 60-70 cm in length the diet changes from plankton (krill, copepods) to fish (mainly Norway pout, blue whiting, haddock and herring). Large saithe (>70 cm) has a highly migratory behaviour and the feeding migrations extend from far into the Norwegian Sea to across the Norwegian deeps to the coast. Because of its life-history, saithe in the North Sea is partly “geographically” protected from heavy exploitation as juveniles and as large adults.

Before 1999 saithe in Sub-area IV and Division IIIa and saithe in Sub-area VI was treated as a separate stock units. These stock boundaries were more for management purposes than a biological basis for stock separation. Present biological knowledge shows no evidence that saithe in Division IVa and Via belong to separate stock units. There seems to be a similar recruitment pattern and the spawning areas in these divisions are not separated (ICES 1995).

Tagging experiments by various countries have shown that exchange between all saithe stock components in the north-east Atlantic takes place to a variable extent (ICES 1995). For example, a substantial migration of immature saithe from the Norwegian coast between 62□N and 66□N to the North Sea has been shown to occur (Jakobsen 1981). 0-group saithe, on the other hand, drifts from the northern North Sea to the coast of Norway north of 62□N.

4.1.2 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.

4.1.3 Ecosystem Aspects

4.2 Data

4.2.1 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.

4.2.2 Biological

Weights

Average weights at age in the stock are assumed to be equal to average weights at age in the catches. Average weights at age by fleet are supplied by Denmark, Germany, France, Norway, UK (England), and UK (Scotland) for Area IV and only UK(Scotland) for Area VI.

Aberdeen (FRS) is responsible for the database with weights at age in the catches from the different countries.

Natural mortality

A natural mortality rate of 0.2 is used for all ages in all years. A constant maturity ogive based on historic biological sampling is used for all years:

Age	1	2	3	4	5	6	7+
Proportion mature	0.0	0.0	0.0	0.15	0.7	0.9	1.0

4.2.3 Surveys

A Norwegian acoustic survey is conducted in conjunction with the Norwegian part of the IBTS quarter 3 survey, covering the area north of 56o30 N up to 62o N. The time series from this survey extends back to 1995.

Time series from the English and Scottish Groundfish surveys are also available for tuning but saithe is considered to be poorly represented in these.

Abundance indices of saithe in the North Sea are also available from the IBTS quarter 1 and IBTS quarter 3 surveys. It should be noted that data from the Norwegian acoustic survey and the English and Scottish Groundfish surveys are used in the calculation of the IBTS quarter 3 indices.

4.2.4 Commercial CPUE

Three time series of CPUE are used in the tuning: Norwegian bottom trawl, German bottom trawl and French fresh fish trawlers. All fleets are targeting saithe along the Northern Shelf edge and along the western edge of the Norwegian deep, primarily at depths between 150 - 250 m. A more detailed description of the CPUE time series follows.

Norwegian bottom trawl: This time series extends back to 1980. The resolution of the logbook data is day-by-day (i.e. a record comprises total daily catch and total hours trawled for each vessel). Only records where the weight proportion of saithe exceeds 50 % and records from vessels larger than 30 m are used to calculate CPUE (kg/h). Samples of age compositions in commercial trawl catches are used to age disaggregated the CPUE time series.

German bottom trawl: This age disaggregated CPUE time series extends back to 1995, and it is described in (Rätz et al. 2005)

French fresh fish trawlers: This time series extends back to 1978, however, only data from 1990 onwards is considered as usable used for tuning purposes. The French saithe fishery has developed in the seventies, during the gadoid outburst. At the beginning of the nineties, the saithe stock reached its lowest historical level. Part of the French vessels reacted by fishing in different areas and in deeper waters. The remaining vessels have been harvesting saithe, almost exclusively in the North Sea, and with by-catches of deep-water species (blue ling) west of Scotland. The French fleet targeting saithe is now made up of large trawlers and freezer trawlers over 50 m. The vessels are registered in Boulogne and Lorient.

Series of CPUE (kg/h) at age were not supplied for the French freezers after 2002, as the landings from this fleet were neither length- nor age-sampled. The French tuning fleet is therefore made up of the non-freezer trawlers. Data are restricted to the fishing trips with more than 10% of saithe landings.

Scottish lighttrawl: This time series extends back to 1989. Due to historic problems with effort recording, this fleet is rejected from other assessments. This fleet also primarily target other species than saithe.

4.2.5 Other Relevant Data

4.3 Historical Stock Development

4.3.1 Deterministic Modelling

Model used: XSA (Darby and Flatman 1994)

Software used: Lowstoft VPA suite.

The settings of the final runs in 2004 and 2005 are given in the following table:

Year of assessment:	2004	2005
Assessment model:	XSA	XSA
Fleets:	FRAtrb (age range: 3-9, 1990 onwards)	FRAtrb (age range: 3-9, 1990 onwards)
	GERotb (age range: 3-9, 1995 onwards)	GERotb (age range: 3-9, 1995 onwards)
	NORtrl (age range: 3-9, 1980 onwards)	NORtrl (age range: 3-9, 1980 onwards)
	NORacu (age range: 3-7, 1995 onwards)	NORacu (age range: 3-6, 1995 onwards)
		IBTSq3 (age range: 3-6,

		1991 onwards)
Age range:	1-10+	3-10+
Catch data:	1967-2994	1967-2994
Fbar:	3-6	3-6
Time series weights:	Tricubic over 20 years	Tricubic over 20 years
Power model for ages:	No	No
Catchability plateau:	Age 7	Age 7
Survivor est. shrunk towards the mean F:	5 years / 3 ages	5 years / 3 ages
S.e. of mean (F-shrinkage):	1.0	1.0
Min. s.e. of population estimates:	0.3	0.3
Prior weighting:	no	no
Number of iterations before convergence:	37	39

4.3.2 Uncertainty Analysis

Nothing here yet.

4.3.3 Retrospective Analysis

4.4 Short-Term Projection

Model used:

WGFRANSW (Reeves and Cook 1994)

Recruitment at age 3 in the terminal year is estimated as the geometric mean of the estimated number of age 3 from the period from1988 to terminal year-3. Stock numbers of the older age groups (> age 3) are estimated XSA survivors.

Mortality:

Natural mortality is 0.2 for all ages. Fishing mortalities at age is the mean of the XSA fishing mortalities at age for the 3 last years (the fishing pattern is not scaled to F3-6 for the last years.

Maturity:

The constant maturity ogive used (see section 2.2).

Mean weights at age in the stock and catch:

The average of mean weights at age for the last three years.

4.5 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).

4.6 Long-Term Projections, Yield-per-recruit

Nothing here yet.

4.7 Biological reference points

F0.1	0.10	Flim	0.60
Fmax	0.22	Fpa	0.40
Fmed	0.35	Blim	106 000 t
Fhigh	>0.54	Bpa	200 000 t

4.8 Other Issues

None

4.9 References

Darby, C.D. and Flatman, S. 1994. Virtual Population Analysis: version 3.1 (Windows/DOS) user guide. Info. Tech. Ser., MAFF Direct. Fish. Res., Lowestoft, (1): 85pp.

ICES 1995. Report of the saithe study group. ICES CM 1995/G:2.

ICES 2003. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, June 2002. ICES CM 2003/ACFM:02.

Jakobsen, T. 1981. preliminary results of saithe tagging experiments on the Norwegian coast. ICES CM 1981/G:35.

Reeves, S. and Cook, R. 1994. Demersal assessment programs, September 1994. WD in WGNSSK 1994.

Rätz, H.J., Panten, K. and Ulleweit, J. 2002 German Otter Trawl Board Fleet as Tuning Series for the Assessment of Saithe in IV, VI and IIIa, 1995-2001. WD:1 in ICES CM 2003/ACFM:02.

5 Quality handbook: Sole in Sub-Area IV

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 14/09/2004: Sieto Verver (sieto.verver@wur.nl).

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5.1 General

5.1.1 Stock definition

The sole in the North Sea (area IV) are considered to be a separate stock from the smaller stock in the Eastern Channel (area VIId). There is some movement of juvenile sole from the North Sea into the Eastern Channel (ICES CM 1989/G:21) and from the Eastern Channel into the North Sea. Adult sole appear to largely isolated from other regions, except during the winter when sole from the southern North Sea may enter the Channel temporarily.

5.1.2 Fishery

Sole is mainly taken by beam trawlers in a mixed fishery with plaice in the southern part of the North Sea.

The Netherlands: A high proportion of the fishing effort in the southern part of the North Sea is by Dutch beam trawlers fishing for plaice and sole, using 80 mm mesh size. A small proportion of the Dutch beam trawl fleet is fishing for only plaice, using larger mesh size.

UK: The English fleet consists of a large number of small otter trawlers fishing in the southern North Sea for sole mainly in the 2nd and 3rd quarter of the year. Prior to 2002, sole was also taken as by-catch in the English beam trawl fishery fishing for plaice with 120mm mesh, but these vessels do not participate in the fishery any more.

Belgium: The majority of the Belgian fleet use beam trawls exclusively and fish for sole and plaice, mostly in the central and southern North Sea.

Denmark: The main Danish fishery is a directed one for sole using fixed nets although there is also a little effort using beam trawling, and some by-catch in otter trawlers.

Germany: The German sole fishery can be divided into three segments: large beam-trawl vessels (7 vessels), 20-30 Euro-cutters and a varying number of small shrimp beam-trawl vessels catching sole during the 2nd and 3rd quarter.

5.1.3 Management reference points

The management reference points for this stock are presented in the text table below:

Flim	Fpa	Blim	Bpa
undefined	0.40	25 000t	35 000t

5.2 Data

The text table below show the countries and the kind of data they provide to the Working Group.

Country	**Catch weights**	**Catch numbers at age**	**Weight in catch**	**Length composition**

The Netherlands	X	X (by sex)	X (by sex)	X (by sex)
Scotland	X			
UK (England,Wales)	X	X	X	X
UK (Northern Ireland)	X			
Germany	X	X	X	
Belgium	X	X	X	X
France	X	X	X	
Denmark	X	X	X	
Norway	X			

The catch weights are based on official logbook data corrected with unallocated landings, which represent the difference between official landings and the figures supplied by the WG members. Catch numbers at age are derived from market sampling programmes. The age compositions were combined on a quarterly basis and then raised to the annual international total.

Data are supplied as FISHBASE files containing quarterly numbers at age, weight at age, length at age and total landings. The files are aggregated by the stock coordinator to derive the input VPA files in the Lowestoft format. No SOP corrections are applied to the data, because individual country SOPs are usually better than 95%. The quarterly data files by country as well as the input files can be found with the stock co-ordinator (Sieto Verver, RIVO, The Netherlands, sieto.verver@wur.nl).

Despite the data regulation that came into action in 2002, no structural sampling takes place to collect samples from national vessels, which land abroad and this constitutes for a substantial part of the total landings by some countries. Some samples are taken but there is no international exchange system for this information available.

5.3 Historical Stock Development

Model used: XSA

Software used: Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability dependent on stock size for ages < 2

Regression type = C

Minimum of 5 points used for regression

Survivor estimates shrunk to the population mean for ages < 2

Catchability independent of age for ages >= 7

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

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

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

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1957 – 2004	1-10+	Yes
Canum	Catch at age in numbers	1957 – 2004	1-10+	Yes
Weca	Weight at age in the commercial catch	1957 – 2004	1-10+	Yes
West	Weight at age of the spawning stock at spawning time.	1957 – 2004	1-10+	Yes
Mprop	Proportion of natural mortality before spawning	1957 - 2004	1-10+	No
Fprop	Proportion of fishing mortality before spawning	1957 – 2004	1-10+	No
Matprop	Proportion mature at age	1957 – 2004	1-10+	No
Natmor	Natural mortality	1957 – 2004	1-10+	No

Tuning data:

Type	Name	Year range	Age range
Survey fleet	NL-BTS ISIS	1985-2004	1 - 9
Tuning fleet 2	NL-SNS	1970 – 2004	
(no 2003 survey)	0 - 4		
Tuning fleet 3	NL Comm BT	1990 - 2004	2 - 9

5.4 Short-Term Projection

Model used: RCT3

Regression type = C

Tapered time weighting not applied

Survey weighting not applied

Final estimates shrunk towards mean

Minimum S.E. for any survey taken as .20

Minimum of 3 points used for regression

Fishing mortality at age were the average over the last 3 years, scaled to the reference F(2-6). Weight at age in the catch and in the stock are averages for the last 3 years. The maturity ogive and natural mortality were the same as XSA.

Model used: Age structured.

Software used: WGFRANSW.

Initial stock size: Taken from XSA for age 3 and older. The number at age 1 in the last data year is estimated using the geometric mean over a long period (1957 –last data year), while for age 2 recruitment estimates were used, derived with RCT3.

Maturity: Set to 1 for age 3 and older in all years, same as in XSA.

F and M before spawning: Set to 0 for al ages in all years.

Weight at age in the stock: Average weight over the last 3 years.

Weight at age in the catch: Average weight over the last 3 years.

Stock recruitment model used: Long term geometric mean for age 1 is used

Procedures used for splitting projected catches: none.

5.5 Medium-term projections

5.6 Long-term projections, yield per recruit

5.7 Biological reference points

5.8 Other issues

5.9 References

ICES. 1989. Report of ad hoc study group on juvenile sole tagging, Ostende, 10-12 March 1989. ICES CM 1989/G:21.

6 Quality handbook: Sole in Division VIId

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

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11/12/2005: Coby Needle (needlec@marlab.ac.uk)

6.1 GENERAL

6.1.1 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).

6.1.2 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.

6.1.3 Ecosystem Aspects

No information is available.

6.2 Data

6.2.1 Commercial Catch

The landings are taken by three countries France (50%), Belgium (30%) and England (20%). Age sampling for the period before 1980 was poor, but between 1981 and 1984 quarterly samples were provided by both Belgium and England. Since 1985, quarterly catch and weight-at-age compositions were available from Belgium, France, and England.

Belgium

France

England

English commercial landings in tonnes by quarter, area and gear are derived from the sales notes statistics for vessels under 12m who do not complete logbooks. For those over 12m (or >10m fishing away for more than 24h), data is taken from the EC logbooks. Effort and gear information for the vessels <10m is not routinely collected and is obtained by interview and by census. .No information is collected on discarding from vessels <10m but it is known to be low. Discarding from vessels >10m has been obtained since 2002 under the EU Data Collection Regulation and is also relatively low.

Length samples are combined and raised to monthly totals by port and gear group for each stock. Months and ports are then combined to give quarterly total length compositions by gear group; unsampled port landings are added in at this stage. Quarterly length compositions are added to give annual totals by gear. These are for reference only, as ALK conversion takes place at the quarterly level. Age structure from otolith samples are combined to the quarterly level, and generally include all ports, gears and months. For sole the sex ratio from the randomally collected otolih samples are used to spli the unsexed length composition into sex-separate length compositions. The quarterly ses separate age-length-keys are used to transform quarterly length compositions by gear group to quarterly age compositions. At this stage the age compositions by gear group are combined to give total quarterly age compositions.

A minimum of 24 length samples are collected per gear category per quarter. Age samples are collected by sexes separately and the target is 300 otoliths per sex per quarter. If this is not reached, the 1st and 2nd or 3rd and 4th quarters are combined.

Weight at age is derived from the length samples using [to be completed].

The text table below shows which country supply which kind of data:

Kind of data supplied quarterly					
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Belgium	x	x	x		x
England	x	x	x		x
France	x	x	x		x

Data are supplied as FISHBASE files containing quarterly numbers at age, weight at age, length at age and total landings. The files are aggregated by the stock coordinator to derive the input VPA files in the Lowestoft format. No SOP corrections are applied to the data because individual country SOPs are usually better than 95%. The quarterly data files by country can be found with the stock co-ordinator

The resulting files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under w:\acfm\nsskwg\2002\data\sol_eche or w:\ifapdata\eximport\nsskwg\sol_eche.

6.2.2 Biological

Natural mortality

Natural mortality was assumed constant over ages and years at 0.1.

Maturity

The maturity ogive used was knife-edged with sole regarded as fully mature at age 3 and older as in the North Sea.

Weight at age

Prior to 2001 WG, stock weights were calculated from a smoothed curve of the catch weights interpolated to the 1st January. Since the 2002 WG, second quarter catch weights were used as stock weights in order to be consistent with North Sea sole.

Proportion mortality before spawning

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

6.2.3 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%.

6.2.4 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.

6.2.5 Other Relevant Data

None.

6.3 Historical Stock Development

6.3.1 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

6.3.2 Uncertainty Analysis

6.3.3 Retrospective Analysis

6.4 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

6.5 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

6.6 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

6.7 Biological Reference Points

Biological reference points

Bpa	Fpa	Flim
8000 t	0.4	0.55

6.8 Other Issues

None.

6.9 References

CEFAS 1999. PA software users guide. The Centre for Environment, Fisheries and Aquaculture Science, CEFAS, Lowestoft, United Kingdom, 22 April 1999.

7 Quality handbook: Plaice in Sub-Area IV

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

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11/12/2005: Coby Needle (needlec@marlab.ac.uk)

7.1 General

7.2 Data

The text table below show the countries and the kind of data they provide to the Working Group.

Country	Catch weights	Catch numbers at age	Weight in catch	Length composition
The Netherlands	X	X (by sex)	X (by sex)	X (by sex)
Scotland	X			
UK (E & W)	X	X	X	X
UK (NI)	X			
Germany	X	X	X	
Belgium	X	X	X	X
France	X	X	X	

Denmark	X	X	X	
Norway	X			
Sweden	X			

The catch weights are based on official logbook data corrected with unallocated landings, which represent the difference between official landings and the figures supplied by the WG members. Catch numbers at age are derived from market sampling programmes. The age compositions were combined on a quarterly basis and then raised to the annual international total.

Data are supplied as FISHBASE files containing quarterly numbers at age, weight at age, length at age and total landings. The files are aggregated by the stock coordinator to derive the input VPA files in the Lowestoft format. No SOP corrections are applied to the data, because individual country SOPs are usually better than 95%. The quarterly data files by country as well as the input files can be found with the stock co-ordinator (Sieto Verver, RIVO, The Netherlands, sieto.verver@wur.nl).

From 2002 onwards, following EU regulation (1639/2001), each country is obliged to sample landings from foreign vessels that land in their country. These samples from flag vessels are now included in the Dutch age composition

7.3 Historical Stock Development

Model used: XSA

Software used: Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability independent on stock size for all ages

Regression type = C

Minimum of 5 points used for regression

Catchability independent of age for ages >= 6

Survivor estimates shrunk towards the mean F of the final 5 years or the 2 oldest ages.

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

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

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1957 – 2004	1-10+	Yes

Canum	Catch at age in numbers	1957 – 2004	1-10+	Yes
Weca	Weight at age in the commercial catch	1957 – 2004	1-10+	Yes
West	Weight at age of the spawning stock at spawning time.	1957 – 2004	1-10+	Yes
Mprop	Proportion of natural mortality before spawning	1957 - 2004	1-10+	No
Fprop	Proportion of fishing mortality before spawning	1957 – 2004	1-10+	No
Matprop	Proportion mature at age	1957 – 2004	1-10+	No
Natmor	Natural mortality	1957 – 2004	1-10+	No

Tuning data:

Type	Name	Year range	Age range
Survey fleet 1	NL-BTS ISIS	1985-2004	1 - 9
Survey fleet 2	NL-SNS	1970 – 2004 (no 2003 survey)	0–4
Survey fleet 3	NL-BTS TRIDENS	1996 – 2004	2-9

7.4 Short-Term Projection

Model used: age structured

Software used: WGFRANSW

Model options chosen:

Fishing mortality at age were the average over the last 3 years, scaled to the reference F(2-6). Weight at age in the catch and in the stock are averages for the last 3 years.

Initial stock size is taken from the XSA for age 3 and older and from RCT3 for age 2. The long-term geometric mean recruitment is used for age 1 in all projection years.

Natural mortality: Set to 0.1 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Average weight over the last 3 years

Weight at age in the catch: Average weight over the last 3 years

Stock recruitment model used: Long term geometric mean for age 1 is used

Procedures used for splitting projected catches: None

7.5 Medium-Term Projection

7.6 Long-term projections, yield per recruit

To be specified.

7.7 Biological reference points

The biological reference points and the basis for the management reference point are:

Blim = 160 000 tonnes

Bpa = 230 000 tonnes

Flim = 0.74, which is the sum of the appropriate FHC and Fdiscards.

7.8 Other issues

None.

7.9 References

8 Quality handbook: Plaice in Division IIIa

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 15/09/2003: Clara-Ulrich Rescan (clu@dfu.min.dk)

11/12/2005: Coby Needle (needlec@marlab.ac.uk)

8.1 General

8.1.1 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).

8.1.2 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.

8.1.3 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).

8.2 Data

8.2.1 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.

8.2.2 Biological

Natural mortality

A fixed natural mortality of 0.1 per year was assumed for all years and ages.

Maturity

A knife-edge maturity distribution was employed: age group 2 was assumed to be immature, whereas age 3 and older plaice were assumed mature.

Weight at age

Weights-at-age in the stock were assumed equal to those of 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.

8.2.3 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.

8.2.4 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.

8.2.5 Other Relevant Data

None.

8.3 Historical Stock Development

8.3.1 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

8.3.2 Uncertainty analysis

8.3.3 Retrospective analysis

8.4 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

8.5 Medium-term projections

8.6 Long-term projections, yield per recruit

8.7 Biological reference points

8.8 Other issues

8.9 References

9 Quality handbook: Plaice in Division VIId

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

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9.1 GENERAL

9.1.1 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.

9.1.2 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).

9.1.3 Ecosystem Aspects

No information is available.

9.2 Data

9.2.1 Commercial Catch

The landings are taken by three countries France (55% of combined TAC), England (29%) and Belgium (16%). Quarterly catch numbers and weights were available for a range of years depending on country; the availability is presented in the text table below. Levels of sampling prior to 1985 were poor and these data are considered to be less reliable. In 2001 international landings covered by market sampling schemes represented the majority of the total landings.

Belgium

Belgian commercial landings and effort information by quarter, area and gear are derived from log-books (CHECK).

Sampling for age and length occurs for the beam trawl fleet (main fleet operating in Belgium).

Quarterly sampling of landings takes place at the auctions of Zeebrugge and Oostende (main fishing ports in Belgium). Length is measured to the cm below. Samples are raised per market category to the catches of both harbours.

Quarterly otolith samples are taken throughout the length range of the landings (sexes separated). These are aged and combined to the quarterly level. The ALK is used to obtain the quarterly age distribution from the length distribution.

In 2003 a pilot study started on on-board sampling with respect to discarded and retained catch.

France

French commercial landings in tonnes by quarter, area and gear are derived from log-books for boats over 10m and from sales declaration forms for vessels under 10m. These self declared production are then linked to the auction sales in order to have a complete and precise trip description.

The collection of discard data has begun in 2003 within the EU Regulation 1639/2001. This first year of collection will be incomplete in term of time coverage, therefore the use of these data should be investigated only from 2005.

The length measurements are done by market commercial categories and by quarter into the principal auctions of Grandcamp, Port-en-Bessin, Dieppe and Boulogne. Samplings from Grandcamp and Port-en-Bessin are used for raising catches from Cherbourg to Fecamp and samplings from Dieppe and Boulogne are used to raise the catches from Dieppe to Dunkerque

Otoliths samples are taken by quarter throughout the length range of the landed catch for quarters 1 to 3 and from the october GFS survey in quarter 4. These are aged and combined to the quarterly level and the age-length key thus obtained is used to transform the quarterly length compositions. The length not sampled during one quarter are derived from the same year close quarter.

Weight, sex and maturity at length and at age are obtained from the fish sampled for the age-length keys.

England

English commercial landings in tonnes by quarter, area and gear are derived from the sales notes statistics for vessels under 12m who do not complete logbooks. For those over 12m (or

>10m fishing away for more than 24h), data is taken from the EC logbooks. Effort and gear information for the vessels <10m is not routinely collected and is obtained by interview and by census. . No information is collected on discarding from vessels <10m. Discarding from vessels >10m has been obtained since 2002 under the EU Data Collection Regulation.

The gear group used for length measurements are beam trawl, otter trawl and net.

Separate-sex length measurements are taken from each of the gear groupings by trip. Trip length samples are combined and raised to monthly totals by port and gear group. Months and ports are then combined to give quarterly total length compositions by gear group; unsampled port landings are added in at this stage. Quarterly length compositions are added to give annual totals by gear. These are for reference only, as ALK conversion takes place at the quarterly level. Otoliths samples are taken by 2cm length groups separately for each sex throughout the length range of the landed catch. These are aged and combined to the quarterly level, and include all ports, gears and months. The quarterly sex-separate age-length-keys are used to transform quarterly length compositions by gear group to quarterly age compositions.

A minimum of 24 length samples are collected per gear category per quarter. Age samples are collected by sexes separately and the target is 300 otoliths per sex per quarter. If this is not reached, the 1st and 2nd or 3rd and 4th quarters are combined.

The text table below shows which country supplies which kind of data:

Country	Numbers	Weights-at-age
Belgium	1981-present	1986-present
France	1989- present	1989- present
UK	1980- present	1989- present

Data are supplied as FISHBASE files containing quarterly numbers at age, weight at age, length at age and total landings. The files are aggregated by the stock co-ordinator to derive the input VPA files in the Lowestoft format. No SOP corrections are applied to the data because individual country SOPs are usually better than 95%. The quarterly data files by country can be found with the stock co-ordinator

The resulting files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under w:\acfm\nsskwg\2002\data\ple_eche or w:\ifapdata\eximport\nsskwg\ple_eche.

9.2.2 Biological

Natural mortality

Natural mortality was assumed constant over ages and years at 0.1 as in the North Sea.

Maturity

The maturity ogive used assumes that 15% of age 2, 53% of age 3 and 96% of age 4 are mature and 100% for ages 5 and older.

Weight at age

Prior to 2001, stock weights were calculated from a smoothed curve of the catch weights interpolated to the 1st January. From 2001, second quarter catch weights were used as stock weights in order to be consistent with North Sea sole. The database was revised back to 1990.

Proportion mortality before spawning

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

9.2.3 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.

9.2.4 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.

9.2.5 Other Relevant Data

None.

9.3 Historical Stock Development

9.3.1 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 spawn-ing	1980 – last data year	2– 10+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawn-ing	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	2– 10+	No – set to 0.2 for all

		year		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

9.3.2 Uncertainty Analysis

9.3.3 Retrospective Analysis

9.4 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

9.5 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.

9.6 Long-term projections, yield per recruit

9.7 Biological Reference Points

Blim = 5400 t.

Bpa = 8000 t.

Flim = 0.54

Fpa = 0.45

9.8 Other Issues

None.

9.9 References

Beek, F.A. van, Leeuwen, P.I. van and Rijnsdorp, A.D. 1989. On the survivalof plaice and sole discards in the otter trawl and beam trawl fisheries in the North Sea. ICES C.M. 1989/G:46, 17pp

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10 Quality handbook: Norway pout in Sub-Area IV

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

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10.1 GENERAL

10.1.1 Stock definition

Norway pout is a small, short-lived gadoid species, which rarely gets older than 5 years (Sparholt, Larsen and Nielsen 2002a). The species is mainly distributed from the west of Ireland to Kattegat, and from the North Sea to the Barents Sea.

The distribution for this stock is in the northern North Sea (>57□N) and in Skagerrak at depths between 50 and 250 m (Raitt 1968; Sparholt, Larsen and Nielsen 2002b).In the North Sea shelf area, it is mainly distributed in the northern part (largely to the north of 57□N) and in Skagerrak at depths between 50 and 250 m (Raitt 1968, Sparholt et al. 2002a). Figures 1 and 2 show geographical distribution of the stock obtained from the ICES IBTS surveys. The IBTS Surveys only cover areas within the 200 m depth zone. However, very few Norway pout are caught at depths greater than 200 m in the North Sea and Skagerrak on shrimp trawl survey (Sparholt et al. 2002b). For the Norwegian Trench, Albert (1994) found Norway pout at depths greater than 200 m, but very few deeper than 300 m.

At present, there is no evidence for separating the North Sea component into smaller stock units. Norway pout in the eastern Skagerrak is only to a very small degree a self-contained stock. The main bulk drifts as larvae from more western areas to which they return mainly during the latter part of their second year of life before becoming mature (Poulsen 1968). ICES ACFM (October 2001) asked the ICES WGNSSK to verify the justification of treating ICES Division VIa as a management area for Norway pout (and sandeel) separately from ICES areas IV and IIIa. Preliminary results from an analysis of regionalized survey data on Norway pout maturity, presented in a Working Document to the 2000 meeting of the ICES WGNSSK Working Group (Larsen, Lassen, Nielsen and Sparholt,2001 in ICES C.M.2001/ACFM:07), gave no evidence for a stock separation in the whole northern area.

Spawning distribution: Spawning in the North Sea takes place mainly in the northern part in the area between Shetland and Norway in coastal waters.

Larvae and juvenile distribution: The species is not generally considered to have specific nursery grounds, but pelagic 0-group fish remain widely dispersed in the northern North Sea close to spawning grounds. The main bulk drifts as larvae from more western areas to which they return mainly during the latter part of their second year of life before becoming mature (Poulsen 1968). The IBTS CPUE map (Figure 2) shows, how¬ever, a relative high CPUE in the Skagerrak area in the third quarter, where the 0-group dominates the catches.

Adult migration: There is an adult spawning migration out of Skagerrak and Kattegat as no spawning occurs in this area. Otherwise there is no indication of adult migration. Based on IBTS data, the main aggregations of settled fish are distributed around the 150 m contour, with a slight preference for deeper water for the older fish.

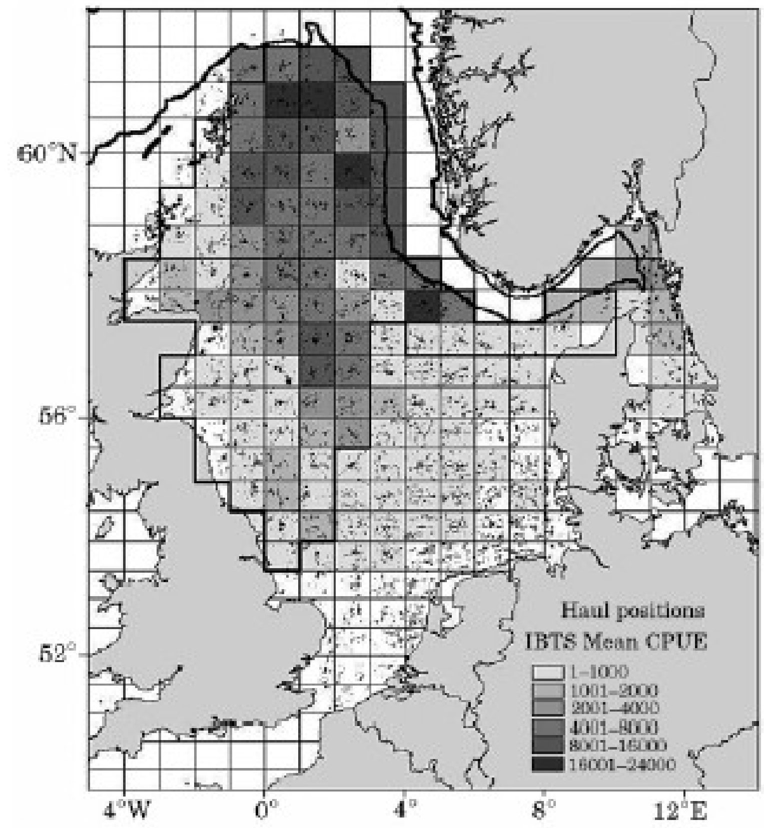

Figure 1 Positions fished at the International Bottom Trawl Survey (IBTS) first quarter and mean CPUE (numbers) of Norway pout by rectangle, 1981–1999. The standard area used to calculate abundance indices and the 200 m depth contour is also shown [from Sparholt et al., 2002b].

10.1.2 Fishery

The fishery is mainly carried out by Danish and Norwegian (large) vessels using small-mesh trawls in the north-western North Sea especially at the Fladen Ground and along the edge of the Norwegian Trench in the north-eastern part of the North Sea. Main fishing seasons are 3rd and 4th quarters of the year with also high catches in 1st quarter of the year especially previous to 1999. Norway pout is caught in small meshed trawls (16-31 mm) in a mixed fishery with blue whiting, i.e. in addition to the directed Norway pout fishery, the species is also taken as by-catch in the blue whiting fishery. The fishery is mainly carried out by Denmark (~70-80%) and Norway (~20-30%) at fishing grounds in the northern North Sea especially at Fladen Ground and along the edge of the Norwegian Trench. Norway pout is landed for reduction purposes (fish meal and fish oil).

With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery. The Norway pout fishery is regulated by technical measures such as mini¬¬mum mesh size in the trawls, fishing area closure in the Norway pout box in the North-Western part of the North Sea, and by-catch regulations to protect other species. An overview of relevant technical regulations for the Norway pout fishery and stock is given below in section f.

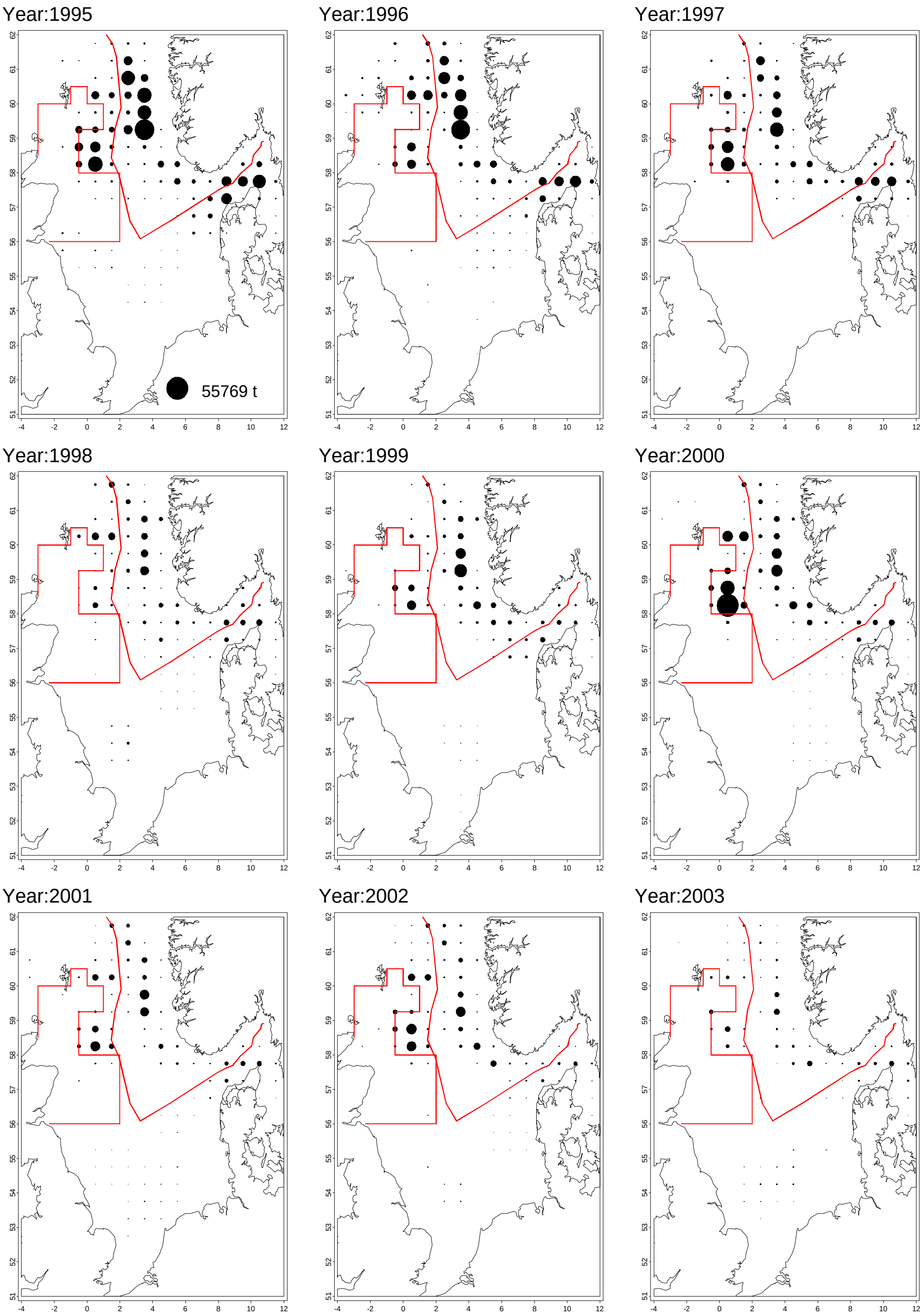

Figure 2 Landings of Norway pout by year and ICES rectangles for the period 1995-2003. Landings include Danish and Norwegian landing for the whole period. The area of the circles represents landings by rectangle. All rectangle landings are scaled to the largest rectangle landings shown at the 1995 map. The "Norway pout box" and the boundary between the EU and the Norwegian EEZ are shown on the map.

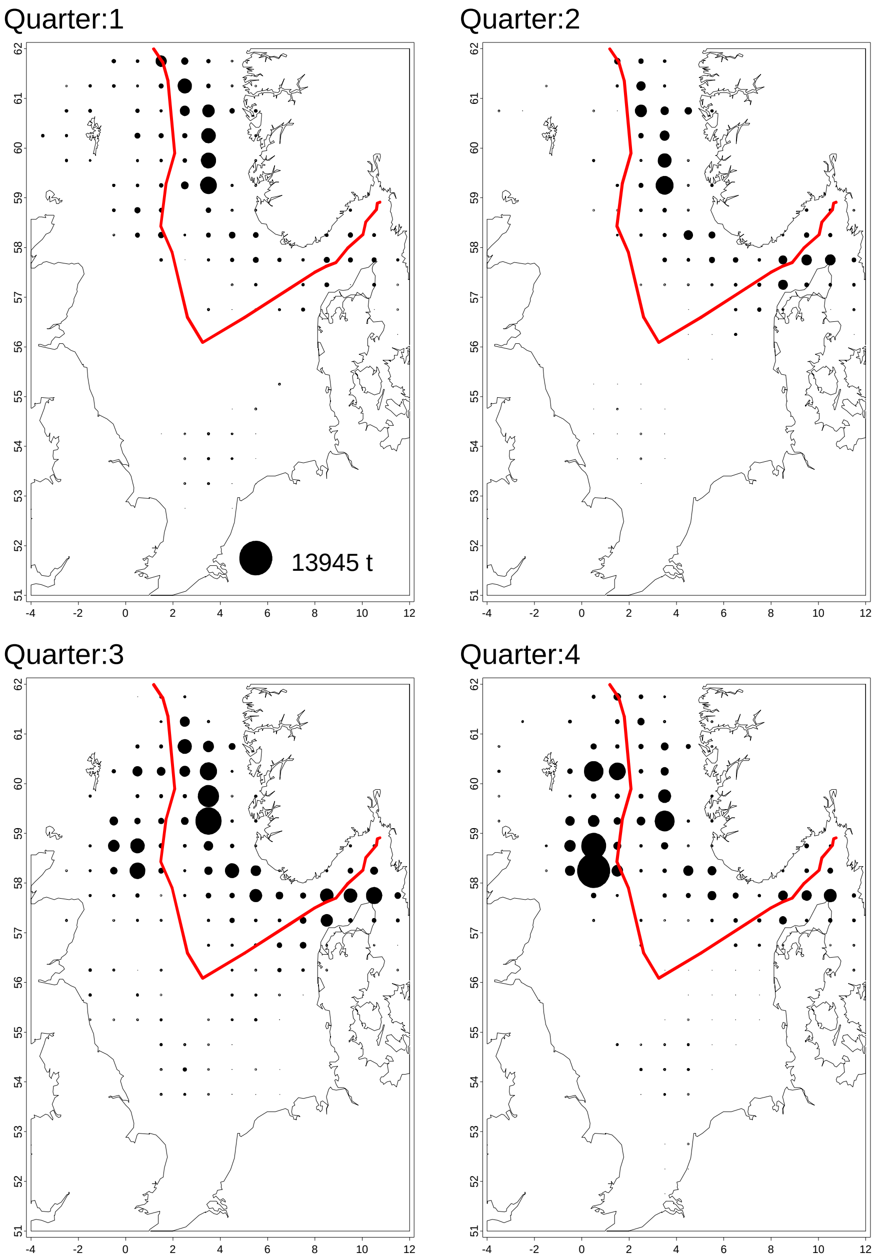

Figure 3 Average Danish and Norwegian landings of Norway pout by quarter of the year and ICES rectangles for the period 1994-2003. The area of the circles represents landings by rectangle. All rectangle landings are scaled to the largest rectangle landings shown at the quarter 1 map

10.1.3 Ecosystem aspects

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. By-catches of other species should also be taken into account in management of the fishery. Existing technical measures such as the closed Norway pout box, mini¬¬mum mesh size in the fishery, and by-catch regulations to protect other species have been maintained.

The population dynamics for Norway pout in the North Sea and Skagerrak are very dependent on changes caused by recruitment variation and variation in predation mortality (or other natural mortality causes) and less by the fishery (Sparholt et al. 2002a,b). Recruitment in Norway pout is highly variable and influences spawning stock biomass and total stock biomass rapidly due to the short life span of the species. The fishing mortality is generally lower than the natural mortality, and this stock is important as food source for other species.

10.2 Data

10.2.1 Commercial catch and effort data

The assessment uses the combined catch and effort data from the commercial Danish and Norwegian small meshed trawler fleets fishing mainly in the northern North Sea.

For the Danish and Norwegian commercial landings sampling procedures of the commercial landings, which vary between the countries, were described in detail in the report of the WGNSSK meeting in 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

Results and parameter estimates by period from the yearly regression analysis on CPUE versus GRT for the different Danish vessel size categories are used in the effort standardization of both the Norwegian and Danish commercial fishery vessels included in the assessment tuning fleet.

Background descriptions of the commercial fishery tuning series used and methods of effort standardization of the commercial fishery between different vessel size categories and national commercial fleets are given in the 2004 working group report (ICES 2005) and the 1996 working group report (ICES CM 1997/Assess:6). Previous to the 2001 assessment the effort has been standardized by vessel category (to a standard 175 GRT vessel) only using the catch rate proportions between vessel size categories within the actual year. In 2002 the assessment was run both with and without the new standardization method (regression). The differences in results of output SSB, TSB and F between the two assessment runs were small.

With respect to further exploration of the effect of using effort standardization and using a combined Danish and Norwegian commercial fishery tuning fleet in the Norway pout assessment different analyses have been made in relation to the benchmark assessment in 2004. This was done to investigate alternative standardization methods and alternative division of the commercial fishery assessment tuning fleet used in the assessment. The results of these analyses were presented to and discussed by the working group in 2004 and presented in the 2004 report of this working group in section 12.

In the 2004 (as well as in the 2001-2003) assessments the output of the regression analyses using time series from 1987-2004 has been applied to the Danish and Norwegian commercial fishery as well. Effort standardization of both the Danish and the Norwegian part of the commercial fishery tuning series is performed by applying standardization factors to reported catch and effort data for the different vessel size categories. The standardization factors are obtained from regression of CPUE indices by vessel size category over years of the Danish commercial fishery tuning fleet. The number of small vessels in the Danish Norway pout fishing fleet has decreased significantly and the relative number of large vessels has increased in the latest years. Furthermore, there was found no trends in CPUE between vessel categories over time. For these reasons the CPUE indices used in the regression has been obtained from pooled catch and effort data over the years 1994-present assessment year by vessel category in order to obtain and include estimates for all vessel categories also for the latest years where no observations exists for the smallest vessels groups.

The conclusion of the discussion in the working group of these analysis results was that further analysis and exploration of data is necessary before suggesting an alternative standardization method and alternative division of commercial fishery tuning fleets to be used in the assessment. This should be done in a future benchmark assessment of the stock.

Parameter estimates from regressions of ln(CPUE) versus ln(average GRT) by period together with estimates of standardized CPUE to the group of Danish 175 GRT industrial fishery trawlers is shown for the period 1994-2004 in this quality control handbook below.

The regression model used in effort standardisation is the following:

Regression models: CPUE=b*GRTa => ln(CPUE)=ln(b)+a*ln((GRT-50))

Parameter estimates from regressions of ln(CPUE) versus ln(average GRT) by period together with estimates of standardized CPUE to the group of Danish 175 GRT industrial fishery trawlers is used to standardize effort in the commercial fishery tuning fleet used in the Norway pout assessment. Parameter estimates for the period 1994-2004 is the following:

Year	Slope	Intercept	R-Square	CPUE(175 tonnes)
1994-2004	0.18	18.88	0.77	32.86

Norwegian effort data

In 1997, Norwegian effort data were revised as described in sections 13.1.3.1 and 1.3.2 of the 1997 working group report (ICES CM 1998/Assess:7). Furthermore, in the 2000 assessment Nor¬¬we¬¬gi¬an 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 si¬ze category and year for the Danish commercial fishery in area IVa is given. This is based on fishing trips where total catch included at least 70 % Norway pout and blue whiting per trip, and where Norway pout was reported as main species in catch in the logbook per fishing day and fishing trip. There has been a relative reduction in the number and effort of small vessels and an increase for the larger vessels in the fleet in the latest years. Furthermore, it appears clearly that there is big difference in CPUE (as an indicator of fishing power) between different vessel size categories (BRT). Accordingly, standardization of effort is necessary when using a combined commercial fishery tuning fleet in the assessment including several vessel categories. Minor revisions (up-dating) of the Danish effort and catch data used in the effort standardization and as input to the tuning fleets have been made for the 2001 assessment.

Exploration of methods for effort standardization

With respect to further exploration of the effect of using effort standardization and using a combined Danish and Norwegian commercial fishery tuning fleet in the Norway pout assessment different analyses have been made in relation to the benchmark assessment in 2004. This was done to investigate alternative standardization methods and alternative division of the commercial fishery assessment tuning fleet used in the assessment. The results of these analyses were presented to the working group and were discussed here in 2004.

Analysis of variance (GLM-analyses) of catch, effort and log transformed CPUE data on trip basis for the Danish commercial fishery for Norway pout during the period 1986 to 2004 showed statistical significant differences in catch rates between different GT-groups, years, quarters of years (seasons), and fishing areas, as well as statistical significant first order interaction effects between all of these variables. The detailed patterns in this variation are not clear and straight forward to conclude on.

It has not yet been possible to obtain disaggregated effort and catch data by area and vessel size (GT-group) from the Norwegian Norway pout fishery to perform similar analyses for the Norwegian fishery.

Also it is not possible to regenerate the historical time series (before 1996) of catch numbers at age in the commercial fishery tuning fleet by nation which is only available for the combined Danish and Norwegian commercial tuning fleet. The reason for this is partly that there is no documentation of historical allocation of biological samples (mean weight at age data) to catch data (catch in weight) in the tuning fleet in order to calculate catch number at age for the period previous to 1996 for both nations, and partly because it seems impossible to obtain historical biological data for Norway pout (previous to 1996) from Norway. Alternative division of the commercial fishery tuning fleet would, thus, need new allocation of biological data to catch data for both the Danish and Norwegian fleet, and result in a significantly shorter Norwegian commercial fishery tuning fleet time series, and a historically revised Danish commercial fishery tuning fleet with new allocation of biological data to catch data. Revision of the tuning fleet would, furthermore, need analyses of possible variation in biological mean weight at age data to be applied to different fleets, as well as of the background for and effect of this possible variation.

Standardized effort data

The resulting combined and standardized Danish and Norwegian effort for the commercial fishery used in the assessment is presented in the input data to the yearly performed assessment, as well as the combined CPUE indices by age and quarter for the commercial fishery tuning fleet.

The seasonal variation in effort data is one reason for performing a seasonal VPA.

10.2.2 Biological data

Age reading

There are no reports of age reading problems of Norway pout otoliths, no indications of low quality of the age length keys used in the assessment of this stock.

Weight at age

Mean weight at age in the catch is estimated as a weighted average of Danish and Norwegian data. Historical levels and variation in mean weight at age in catch by quarter of year is shown in Figure 12.2.1 in the 2004 benchmark assessment in the 2004 ICES WGNSSK Report (ICES 2005). In general, the mean weights at age in the catches are variable between seasons of year. The same mean weight at age in the stock is used for all years. Mean weight in catch is not used as estimator of weight in the stock partly because the smallest 0-group fish are not fully recruited to the fishery in 3rd quarter of the year.

Maturity and natural mortality

Spawning in the North Sea takes place mainly in the northern part in the area between Shetland and Norway. Around 10 % of the Norway pout reach maturity already at age 1, however, most individuals reach maturity at age 2.

The same proportion mature and natural mortality are used for all years in the assessment. The natural mortality is set to 0.4 for all age groups in all seasons that result in an annual natural mortality of 1.6 for all age groups. The proportion mature used is 0% for the 0-group, 10% of the 1-group and 100% of the 2+-group independent of sex.

In the 2001 and 2002 assessment exploratory runs were made with revised input data for natural mortality based on the results from two papers presented to the working group in 2001, (both papers published in ICES J. Mar. Sci. in 2002, Sparholt, Larsen and Nielsen 2002a,b). This was not explored further in the 2003 up-date assessment but this year benchmark assessment of the stock includes an exploratory run with revised natural mortalities. These revised natural mortalities are given in Table 12.2.3 in the 2004 ICES WGNSSK Report (ICES 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 ma¬tu¬rity 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).

10.2.3 Assessment tuning fleet data and indices (general)

Revision of assessment tuning fleets (survey CPUE data and commercial fishery CPUE data) in the 2004 benchmark assessment:

Revision of the Norway pout assessment tuning fleets was performed during the 2004 benchmark assessment. The background for this, the results and the conclusions from the analyses in relation to this are described here in the stock quality handbook as well as in the benchmark assessment in the working group report from 2004.

Revision of the Norway pout assessment tuning fleets during benchmark assessment have been based partly on cohort analyses and analyses of correlations within and between the different tuning fleet indices by age group, as well as on the results from a row of exploratory assessment runs described under section 12.3 of the 2004 benchmark assessment (ICES 2005) which analyses the performance of the different tuning fleets in the assessment. The exploratory assessment runs also give indications of possible catchability patterns and trends in the fishery over time within the assessment period. The analyses of the tuning fleet indices are presented in the benchmark assessment 2004 (ICES 2005) Figures 12.2.3-12.2.8 and Tables 12.2.9-12.2.12.

An overview over the resulting tuning data and fleets used in the assessment during different time periods are shown in the table over tuning data in section C below.

10.2.4 Survey data

Survey index series of abundance of Norway pout by age and quarter are for the assessment period available from the IBTS (Q1 and Q3) and the EGFS (Q3) and the SGFS (Q3). The SGFS data from 1998 onwards should be used with caution due to new survey design (new vessel from 1998 and new gear and extended survey area from 1999). The 0-group indices from this survey have accordingly not been used in the assessment tuning fleet for this survey previous to the 2004 benchmark assessment. The index for the 0-group from SGFS changed with an order of magnitude in the years after the change in survey design compared to previous years (Table 12.2.8, ICES 2005). The EGFS data from previous to 1992 should be used with caution as the survey design shifted in 1992. This change in survey design has until 2004 been accounted for by simply multiplying all indices with a factor 3.5 for all age groups in the years previous to 1992 in order to standardize it to the later indices. The EGFS survey indices for Norway pout has been revised in the 2004 assessment compared to the previous years assessment for the 1996, 2001, 2002, and 2003 indices. In previous years assessments (before 2004) the full EGFS survey time series for all age groups have been included as an assessment tuning fleet. Time series for IBTS Q3 are only available from 1991 and onwards. The 3rd quarter IBTS and the EFGS and SGFS are not independent of each other as the two latter is a part of the first. Accordingly, the following changes have been made for the survey tuning index series in the 2004 benchmark assessment (also shown in the tuning series overview table in section C):

1. The IBTS Q3 for the period 1991-2003 has been included in the assessment. This survey has a broader coverage of the Norway pout distribution area compared to the EGFS and SGFS isolated. However, as this survey index is not available for the most recent year to be used in the seasonal assessment it has been chosen to exclude the 0- and 1-group indices from the IBTS Q3 in order to allow inclusion of the 0- and 1-group indices from the SGFS and EGFS which are available for the most recent year in the assessment. Accordingly, the IBTS Q3 tuning fleet for age 2 and age 3 has been included in the assessment as a new tuning fleet. The SXSA demands at least two age groups in order to run which is the reason for in-

cluding 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.

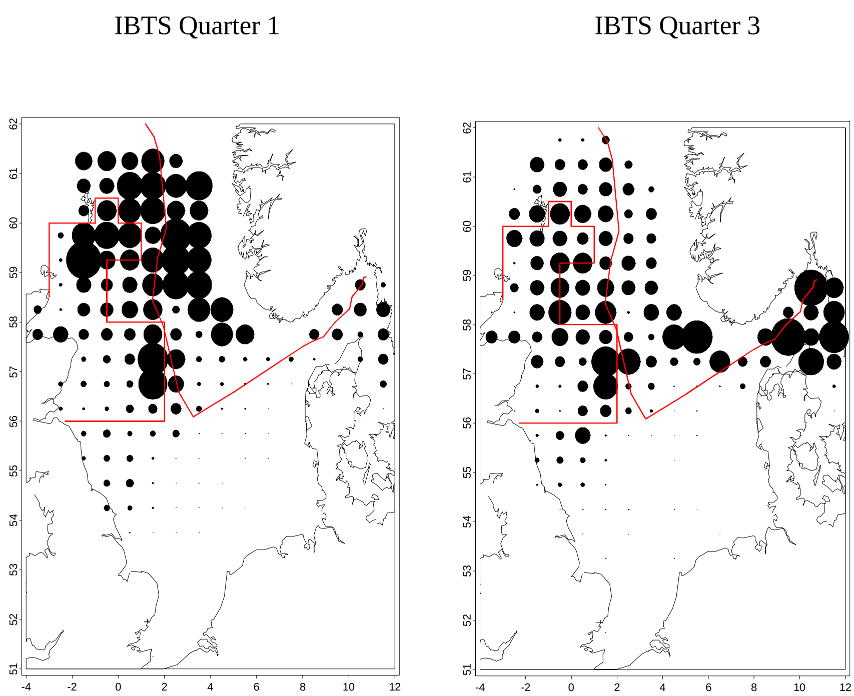

Figure 4 IBTS mean CPUE (numbers per hour) by quarter during the period 1991-2004. The area of the circles is proportional to CPUE. The IBTS surveys do only cover areas within the 200 m depth zone. The "Norway pout box" and the boundary between the EU and the Norwegian EEZ are shown on the map. The maps are scaled individually.

10.2.5 Commercial CPUE data

Combined CPUE indices by age and quarter for the Danish and Norwegian commercial fishery tuning fleet is calculated from effort data obtained from the method of effort standardization of the commercial fishery tuning fleet described under section B.1 and vessel category specific catches by area. CPUE is estimated on a quarterly basis for the Danish and Norwegian commercial fleets.

The resulting combined, commercial fishery CPUE data by age and quarter used in tuning of the assessment based on the combined and standardized Danish and Norwegian effort data and on catch data for the commercial fishery is presented in the input data to the yearly performed assessment.

Commercial fishery tuning fleets:

In addition to the analyses of the commercial fishery assessment tuning fleet as described above (effort standardization) the quarterly CPUE indices of the commercial fishery tuning fleet were analyzed during the 2004 benchmark assessment:

1. The indices for the 0-group in 3rd quarter of the year have been excluded from the commercial fishe¬ry tuning fleet. The main argumentation for doing that is that this age group indicate clear pat¬terns in trends in catchability over the assessment period as shown in the single fleet/quarter assess¬ment runs in section 12.3 (Figure 12.3.7), ICES (2005). Secondly, there is no correlation between the commercial fishery quarter 3 0-group index and the commercial fishery quarter 4 0-group index, and no correlation between the quarter 3 commercial fishery 0-group index in a given year with the 1-group index of the 3rd quarter commercial fishery 1-group index the following year.
2. The 2nd quarter indices for all age groups of the 2nd quarter have been excluded from the commercial fishery tuning fleet. This is mainly because of indications of strong trends in catchability over time in the assessment period for this part of the tuning fleet for all age groups as indicated by single fleet tuning runs in the section 12.3 (Figure 12.3.7), ICES (2005).. Also, the within quarter and between quarter correlation indices are in general relatively poor. The cohorte analyses of the 2nd quarter commercial fishery indices indicate as well relative changes over time.

10.3 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 1983-2005 where the estimated catchability, rhat, is a geometric mean over years by age, quarter and tuning fleet. In the 2004 benchmark assessment exploration of trends in tuning fleet catchabilities was investigated by single fleet runs with the SXSA. The accepted assessment with revised tuning fleets in the 2004 benchmark assessment assume constant catchability.

Tuning is performed over the period 1983 to present producing log residual (log(Nhat/N)) stock numbers and survivor estimates by year, quarter, age and tuning fleet. The contributions from the various age groups to the survivor estimates by year and quarter and fleet are in the SXSA combined to an overall survivors estimate, shat, estimated as the geometric mean over years of log(shat) weighted by the exponential of the inverse cumulated fishing mortality as described in Skagen (1993).

Comparison of 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.

Summary of conclusions from the exploratory catch at age analyses in the 2004 benchmark assessments:

A number of exploratory runs were carried out as part of the benchmark assessment in 2004 in order to evaluate performance of stock indices as tuning fleets and also to compare performance of the seasonal XSA (SXSA) to the ‘conventional’ XSA. The exploratory runs are described in the 2004 working group report. The conclusions of the explorative runs in the 2004 benchmark assessment were the following:

1. Catch and CPUE data for the assessment of Norway pout are very noisy, but internally consistent. The assessment, using SMS, gave very similar results irrespective of the CPUE time series used. Four of the seven CPUE series are data from the commercial fishery and these data are already included in the catch data. Therefore, these commercial fleets will not give a signal very different from the catch data. None of the scientific surveys had a clear signal different form the signal in the catch data.
2. A comparison of the revised 2004 assessment with new tuning fleets compared to the previous 2003 assessment showed that the estimates of the SSB, recruitment and the average fishing mortality of the 1- and 2-group for the revised, accepted assessment were in general consistent with the estimates of previous years assessment. Only historical F seemed to slightly deviate from the previous years assessment.
3. The overall performance and output for the XSA model was similar to the SXSA model, so the working group in 2004 decided to continue using SXSA. Both methods did overall not show insensible to the tuning fleet indices used in the assessment.

In the up-date assessment in 2005 output of the SXSA model was compared to output from the SMS and SURBA model to evaluate the use of the SXSA model in a situation with having zero catches in the termi¬nal year of the assessment. The results showed similar output of the different models and the same percep¬tion of the stock. The results are in detail presented in the 2005 ICES WGNSSK Report (ICES 2006).

Software used:

SXSA program available from ICES.

(XSA program available from ICES; Exploratory run, 2004)

(SMS program available from Morten Vinther, DIFRES, Copenhagen; Exploratory run, 2004 and 2005).

(SURBA program available from Coby Needle, MARLAB, Aberdeen; Exploratory run, 2005)

The SXSA does not rely on the assumption of constant exploitation pattern in catch at age data as for example the SMS does. The SURBA can not perform quarterly based assessment.

Model Options chosen:

The parameter settings and options of the SXSA has been the same in all recent years assessments, except that recruitment season to the fishery has been backshifted from 3rd quarter of the year to 2nd quarter of the year 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

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:	commercial q134	(Q1: Age 1-3; Q2: None; Q3: Age 1-3)
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

		2003 ASSESSMENT	2004 & 2005 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

10.4 Short-Term Projection

A deterministic short-term forecast is given for the stock. This was done for the Norway pout stock for the first time in 2004. The forecast is calculated as a stock projection up to 1st of January the following year. The projection up to 1st of January is based on the assessment estimate of recruitment in the assessment year. Mean catch weight at age are averaged over the last three years. Different F-scenarios are evaluated. A sensitivity analysis around the recruitment estimated was made in the 2005 forecast corresponding to a range of 75-125% of estimated recruitment in 2005. This was because the recruitment estimate in 2005 was only based on one index.

Catch predictions for 0- and 1-groups are important as the fishery traditionally target the 0-group already in 3rd and (especially in) 4th quarter of the year as well as the 1-group in the 1st quarter of the following year. In the 2004 benchmark assessment it was shown that Survey indices in the 3rd quarter seems to predict strong 0-group year classes relatively well when comparing with 0-group indices from commercial fishery (4th quarter) and to 1-group survey indices the following spring.

The deterministic forecast is off course affected by that: (a) the potential catches are largely dependent on the size of a few year classes, (b) the large dependence on the strength of the recruiting 0-group year classes, and (c) added uncertainty (in assessment and potential forecast) arising from variations in natural mortality. However, the forecast is not dependent on any assumption about the strength of the new year class.

10.5 Medium-term projections

10.6 Long-term projections, yield per recruit

10.7 Biological Reference Points

Blim = 90 000 t

Bpa = 150 000 t

Flow =0.23

Fmed =0.67

Fhigh =1.21

Blim is 90.000 t, the lowest observed biomass

Bpa be established at 150,000 t. This affords a high probability of maintaining SSB above Blim, taking into account the uncertainty of assessments. Below this value the probability of below average recruitment increases.

Flim None advised.

Fpa None advised.

There is no specific management objective set for this stock.

The population dynamics of Norway pout in the North Sea and Skagerrak are very dependent on changes caused by recruitment variation and variation in predation mortality (or other natural mortality causes). Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species. With present fishing mortality levels in recent years the status of the stock is more determined by natural processes and less by the fishery.

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species.

In managing this fishery, by-catches of other species should be taken into account.

Existing measures to protect other species should be maintained.

10.8 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 spe¬¬cies have been taken into account. Technical measures such as the closed Norway pout box, mini¬¬mum mesh size in the fishery, and by-catch regulations to protect other species have been used in managing this stock and the fishery.

10.9 References

10.10 Overview of some recent management measures and regulations relevant for the Norway pout fishery and stock (from STCEF, 2005)

10.10.1 Technical measures by EU

Mesh Size Regulations In The North Sea And Adjacent Areas

Use of towed nets of any size mesh is permitted, however according to the mesh size in use there is an obligation to retain only particular species of fish. These tables are a simplified synopsis of measures in Council Regulation 850/98 and Commission Regulation 2056/2001.

Conditions for use of towed gear (North Sea and West Scotland)		
Mesh size	Main target species in North Sea	Synopsis of required catch percentages
b.) 16 to 31mm	Norway pout, sprat	Minimum 60% of one species of Norway pout, sardine, sandeel, anchovy, eels, smelt and some non-human consumption species (with no more than 5% of cod, haddock or saithe, and some upper limits on the percentages of other species such as mackerel, squids, flatfish, gurnards, Nephrops), or at least 90% of any two or more of those species.

Areas Closed To Some Fishing Activities

During the 1960s a significant small meshed fishery developed for Norway pout in the northern North Sea. This fishery was characterized by relatively large by-catches, especially of haddock and whiting. In order to reduce by-catches of juvenile roundfish, the “Norway pout box” was introduced where fisherries with small meshed trawls were banned. The “Norway pout box” has been closed for industrial fishery for Norway pout since 1977 onwards (EC Regulation No 3094/86). The box includes roughly the area north of 56° N and west of 1° W (see Figure 6.2).

(It is not possible to fully quantify the effect of the closure of the fishery inside the Norway pout box. Before closure, the Danish and Faeroes fisheries mainly took place in the northwestern North Sea and the Norwegian fishery in the Norwegian Trench (ICES 1977). Based on IBTS samples for the period 1991-2004 (Figure 6.2), 30.0% and 27.5% of Norway pout numbers were estimated to be inside the Norway pout box for the first and third quarter, respectively. It should be noted that the IBTS survey does not cover depths >200 m along the Norwegian Trench, and that no fishery inside the Norway pout box may contribute to overestimation of the abundance relative to area outside).

Area	Characteristics, Location and Seasonality	Purpose	Defined in Regulation (EC):
North-	Annual, closed to all fishing except static	Reduction of	Annex III

West of Scotland	gear and pelagic fishing	fishing mortality on VIa cod	27/2004 (annual measure in place since 2004).
Norway pout box	Prohibited to retain more than 5% of the catch as Norway pout if they are caught within an area bounded by 56°N and the UK coast: 58°N 2°E, 58°N 0°30' W, 59°15' N 0°30'W, 59°15' N 1° E, 60° N 1° E, 60°N 0°, 60°30'N 0°, 60°30'N and the coast of the Shetland Islands, 60°N and the coast of the Shetland Islands, 60°N 3°W, 58°30'N 3°W 58°30'N and the coast of the mainland UK.	Protection of juvenile gadoids (cod, haddock) caught in mixtures with Norway pout)	Article 26 of Regulation 850/98

Minimum Landing Sizes

These sizes are defined in Annex XII to Regulation 850/1998, though some changes are in effect for 2005 by means of the TAC and quota regulation (Regulation 27/2005). Here sizes for some of the main commercial species only are stated.

Species	Minimum Landing Size in 2005, as North Sea/IIIa	Regulation
Norway pout	None	850/1998

Quotas Relevant To The European Community

Quotas have been established by the Community as follows for the relevant species. These figures refer to Total Allowable Catches in Community waters and to quotas for the Community in Norwegian waters.

Year	Sandeel, IIa+IIIa+IV EC zone	Sandeel, IVa, Norway zone	Norway Pout IIa+IIIa+IV, EC zone	Norway pout, Norway zone	Anglerfish, IIa+IVa, EC zone	Anglerfish, IVa Norway Zone
2000	1020000	150000	220000	500001	17660	in 'others'
2001	1020000	150000	211200	500001	14130	in 'others'
2002	918000	150000	198000	500001	10500	in 'others'
2003	918000	131000	198000	500001	7000	in 'others'
2004	826200	131000	198000	500001	7000	in 'others'
2005	660960	10000	0	50002	10314	1800

1 Including mixed horse mackerel.

2 Including mixed horse mackerel, and only as by-catches.

Year	Anglerfish Vb, VI, XII, XIV (EC)	Horse mackerel, IIa (EC), IV(EC)	Horse mackerel, Vb (EC waters), VI, VII, VIIIa,b,d,e, XII, XIV	Industrial fish, IV (Norwegian waters)	Other species, IIa, IV, VIa N of 56°30, allocation to NO, FAR, no restriction for EC.	Other species, Norwegian waters of IV
2000	8000	51000	240000	8001	5400	11000
2001	6400	51000	240000	8001	5400	11000
2002	4770	58000	150000	8001	5400	11000
2003	3180	50267	130000	8001	5400	11000
2004	3180	50267	137000	8001	5400	11000
2005	4686	42727	137000	8001	5120	7000

1 Of which maximum 400 tonnes of horse mackerel.

Effort Limits

Days-at-Sea

Since 2003, the Community has limited the number of days that a fishing vessel can be out of port and fishing in the North Sea and adjacent areas. This is implemented through annexes to the TAC and Quota Regulations (2341/2002, 2287/2003, 27/2005). Days at sea may be transferred between vessels with an adjustment for differences in engine power between the vessels. Additional days have been allocated to some member states in respect of decommissioning taking place since 2001.

The baseline days-at-sea allocations (i.e. before additions to take account of decommissioning) were as follows:

Gear type	Otter trawl, 100mm (90mm in IIIa) or over	Beam trawls, 80mm or over	Static demersal nets	Demersal longlines	Otter trawls 70-99mm (70-89mm in Skagerrak)	Trawl fishery 16-31mm
Typical target species	Cod, haddock, whiting	Plaice and sole	Cod, turbot	Cod	Nephrops	Norway pout, sandeel
2003	9	15	16	19	25	23

2004	10	14	14	17	22	20
2005	10 *	13	13	16	21	19

(*) - including one additional day allowable where administrative sanctions are in place.

10.10.2 Technical measures by Norway

TACs And Effort Limits

Norway has no national quotas on anglerfish, sandeel, Norway pout or horse mackerel, for Norwegian vessels in the Norwegian economic zone. These fisheries are regulated by technical measures and effort regulations.

Technical Measures

The Norwegian technical regulations are generally designed to avoid catches of non-targeted species and/or fish below the minimum size. The discard ban on commercially important species is considered a cornerstone of this policy. Other important elements are the surveillance, monitoring and inspections at sea by the Coastguard, the obligation to change fishing grounds, prohibition against fishing for particular species during specific periods or in specific areas, and the development of, and the requirement to use selective fishing gear. The philosophy behind the Norwegian technical regulations is to enable the fishermen to meet their obligation to avoid illegal catches.

The technical regulations are summarised in “Regulations relating to sea-water fisheries” of 22 December 2004.This stipulates the discard ban, the percentage composition of the catch that may be legally caught according to area and type of fishing gear being used, the characteristics of fishing gear that may be used in the fishery on certain species or in different areas, the minimum catching sizes and specific measures to limit catches of fish under the minimum catching size, regulations of mesh design, mesh sizes, selectivity devices etc.

When fishing demersal species for human consumption in the North Sea with trawl or Danish seine, it is prohibited to use gear where the mesh size of any part of the gear is less than 120 mm. In the Norwegian saithe fishery in the EU zone 110 mm may be used in accordance to the EU regulation in the EU zone.

In the North Sea gill net fisheries for cod, haddock, saithe, plaice, ling, pollack and hake it is prohibited to use gill nets where the full mesh size is less than 148 mm. In the fishery for anglerfish the minimum mesh size is 360 mm and in the halibut fishery the minimum mesh size is 470 mm.

Only the most relevant regulations with regard to anglerfish, sandeel, Norway pout and horse mackerel will be highlighted below.

Sandeel And Norway Pout

Summary of the Norwegian regulations for sandeel and Norway pout:

- The sandeel fishery is closed from 25 June to 31 March.
- Norway pout may only be fished as bycatch in the mixed industrial fishery in all areas under Norwegian fisheries jurisdiction.
- Two areas (the Patch bank and the Egersund bank) in the Norwegian economic zone are closed to fishing for Norway pout, sandeel, and blue whiting.

- Licensing scheme for vessels fishing with small mesh trawl.
- Reduction capacity scheme for vessels fishing with small mesh trawl.

ACFM recommended that effort in 2005 should not exceed 40 % of the effort in 2004. Based upon this advice, the sandeel season in the Norwegian economic zone was further shortened in 2005. The sandeel season, defined as the period when smaller mesh size than 16 mm can be used, was 8 months (March – October) in 2003 and earlier. This season was reduced to April – September in 2003 and to the period 1 April to 23 June in 2005.

Furthermore, as a consequence of the advice on effort reduction Norway and the EU agreed to reduce the exchange of sandeel quotas dramatically compared with previous years. Due to the same reason, Norway did not allocate a traditional quota of sandeel to the Faeroes in 2005.

As a result of the recommendation from ACFM, Norway and the EU have agreed that Norway pout only may be fished as bycatch in 2005. Consequently, Norway pout was excluded from the exchange of quotas between Norway and the Faroes in 2005.

Areas closed to fishing for Norway pout, sandeel and blue whiting

Two areas in the Norwegian economic zone have been closed for fishing on Norway pout, sandeel and blue whiting. The approach has been to close areas were the probability of illegal by-catches of juveniles and not-targeted species, such as cod, saithe, haddock, are considered unacceptable high. This measure could therefore also be mentioned as a measure to protect juveniles of other species than Norway pout and sandeel. As of 1 January 2002 the Patch bank was permanently closed. Before the closure of the Patch bank an annual average of approximately 2.000 tonnes of Norway pout were fished in this area by Norwegian vessels. As from 1 May 2005 a seasonal closure of the Egersund bank in the period 1 December to 31 May was determined (map below). Other areas are under evaluation for permanent or seasonal closure.

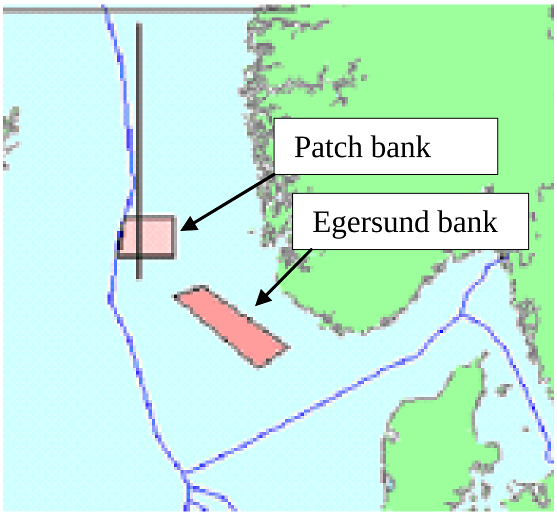

Figure 5 Seasonal closure of the Egersund bank.

Capacity reduction scheme for vessels fishing for sandeel and Norway pout

A small mesh trawl license is required to use a smaller mesh size than 16 mm in the directed fishery for sandeel in the season 15 April – 23 June. The same licence is required in order to participate in the mixed industrial fishery for blue whiting and Norway pout.

The number of vessels holding such a license has been reduced substantially the latter years as a result of the capacity reduction scheme put in place in 2002. The potential number of participating vessel was about 75 vessels in 2001. By May 2005 the number of potential participants has been reduced to about 50. In 2004 38 vessels participated in the sandeel fishery. The number of participating vessels so far in 2005 was 22 as of 24 May 2005.

Additional Danish regulations of the industrial fisheries (see section 5, sandeel, STCEF 2005)..

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11 Quality handbook: Sandeel in Sub-Area IV

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

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11.1 GENERAL

11.1.1 Stock definition

For assessment purposes, the European continental shelf was divided into four regions for sandeel assessment purposes up to 1995: Division IIIa (Skagerrak), northern North Sea, southern North Sea, and Shetland Islands and Division VIa. These divisions were based on regional differences in growth rate and evidence for a limited movement of adults between divisions (e.g. ICES CM 1977/F:7, ICES CM 1991/Assess:14.). The two North Sea divisions were revised in 1995, and it was decided to amalgamate the two stocks into a single stock unit with two fleets, one fleet in the northern North Sea and one in the southern North Sea. The Shetland sandeel stock is assessed separately. ICES assessments have used these stock definitions since 1995.

Sandeels are largely stationary after settlement and the North Sea sandeel fishery must be considered as exploiting a complex of local populations. Recruitment to local areas may not only be related to the local stock, as interchange between areas seems to take place during the early phases of life before settlement.

Based on the distribution and simulated dispersal of larval stages, Wright et al. (1998) suggest that the North Sea stock could be split into six areas, including the Shetland as a separate population. Assessments have tentatively been made for some of these areas (Pedersen et al. 1999) and there was high correlation between the results from the study and the assessment made by the WG for the whole North Sea. Presently there are insufficient information about sandeel biology, especially about the intermixing of the early life stages between spawning aggregations, to allow for and alternative separation of the North Sea into separate population units to be assessed.

11.1.2 Fishery

Sandeel is taken by trawlers using small meshed trawls with mesh sizes < 16 mm. The fishery is seasonal. The geographical distribution of the sandeel fishery varies seasonally and annually, taking place mostly in the spring and summer. In the third quarter of the year the distribution of catches generally changes from a dominance of the west Dogger Bank area back to the more easterly fishing grounds.

Most of the sandeel catch consists of the lesser sandeel Ammodytes marinus, although small quantities of other Ammodytoidei spp. are caught as well. There is little by-catch of protected species (ICES 2004).

In most years and particularly prior to 1998, most landings of sandeels in March were taken from the eastern North Sea banks whilst sandeel landings in April-June were mainly from the west Dogger Bank. As there can be regional differences in the age composition this seasonal expansion of the fishery can result in a change in the age composition in the fishery. In some years a relatively large part of the sandeel landings are taken from the central and eastern North Sea along the Danish west coast. From 1991, grounds off the Scottish east coast have been targeted particularly in June. However, since 2000 the banks in the Firth of Forth area have been closed to fishing.

Technical measures for the sandeel fishery include a minimum percentage of the target species at 95% for meshes < 16 mm, or a minimum of 90% target species and maximum 5% of the mixture of cod, haddock, and saithe for 16 to 31 mm meshes.

11.1.3 Ecosystem aspects

ACFM consider that there is a need to ensure that the sandeel stock remains high enough to provide food for a variety of predator species.

In 1999 the U.K called for a moratorium on sandeel fishing adjacent to seabird colonies along the U.K. coast and in response the EU requested advice from ICES. An ICES Study Group, was convened in 1999 to assess whether removal of sandeel by fisheries has a measurable effect on sandeel, whether establishment of closed areas and seasons for sandeel fisheries could ameliorate any effects, and to identify possible spatial and/or temporal restrictions of the fishery as specifically as possible. The ICES Advisory committees (ACFM and ACE) accepted the advice from the study group. STECF (1999) agreed with this ICES advice and the EU advised to close the fishery whilst maintaining a commercial monitoring. A 3-year closure, from 2000 to 2002, was decided. All commercial fishing was excluded, except for a maximum of 10 boat days in each of May and June for stock monitoring purposes. The closure was maintained for three years (see e.g. Wright et al. 2002) and has been extended until 2006, with a small increase in the effort of the monitoring fishery, after which the effect of the closure will be evaluated.

11.2 Data

11.2.1 Commercial catch

In the last 20 years the landings of sandeels in IV have been taken by 5 countries: Denmark (78%), Norway (19%) UK/Scotland (1%), Sweden (1%) and Faroes Isl. (1%). In the 1950's also Germany and the Netherlands participated in this fishery, but since the start of the 1970's no landings have been recorded for these countries.

Age, length and weight at age data are available for Denmark and Norway to estimate numbers by age in the landings. Prior to 1996, the Norwegian age composition data were based on Danish ALK's. Catch numbers and weight at age for the southern North Sea are based only on Danish age compositions.

Denmark

Industrial species are not sorted by species before processing and it is assumed that the landings consist of one species only in the calculation of the official landings. The WG estimate of landings is based on samples for species composition taken by the Fishery Inspectors for control of the by-catch regulation. At least one sample (10-15 kg) per 1000 tons landings is taken and these samples are used to estimate average species composition by area (ICES rectangles) and month. This species/area/period key, logbook data (spatial distribution) and landings slip data (quantity) are used to derive the Danish WG estimates of landings of sandeel and by-catch of other species (further information can be found in ICES, 1994/Assess:7; Dalskov, 2002).

Norway

For Norway and Sweden, the official landings and the WG estimated landings are the same.

UK/Scotland

Sweden

The text table below shows which country supplies which kind of data:

	Data				
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Denmark	x	x	x		x
Norway	x	x	x		x
UK/Scotland	x				
Sweeden	x				
Faroe Islands	x				

All input files are Excel spreadsheet files.

The national data sets have been imported in a database aggregated to international data by DIFRES.

The combined Danish and Norwegian age composition data and weight at age data are applied on the landings of UK, Sweeden and Farao Isl., assuming catches from these countries have the same age composition and weight at age as the Danish and Norwegian landings. Excel spreadsheet files can be found with the Danish stock co-ordinator and in the ICES computer system under w:\acfm\WGNSSK**.

The result files can be found at ICES and with the stock co-ordinator as ASCII files on the Lowestoft format under w:\acfm\WGNSSK**.

11.2.2 Biological

Historically, assessments were done separately for the Northern and Southern North Sea. In recent years, the assessment has been done for the whole North Sea, but data are still compiled separately for the two areas. The catch numbers and weight at age data for the Northern North Sea are constructed by combining Danish and Norwegian data by half-year.

The catch numbers and weight-at-age data for the northern North Sea were constructed by combining Danish and Norwegian data by half-year. Prior to 1996, the Norwegian age composition data were based on Danish ALK's. Catch numbers and weight-at-age for the southern North Sea are based on Danish age compositions. The mean weight at age in the catch used in the assessment is the mean weights at age in the catch for the Southern and Northern North Sea weighted by catch numbers. The mean weight at age in the stock is copied from the mean weight in the catch first half-year, and an arbitrary chosen weight at 1 gram was used for the 0-group.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Values for natural mortalities are the same as used since 1989 (ICES CM 1989/Asssess:13). MSVPA (ICES CM 2002/D:04) estimates of natural mortalities are relatively stable in the period covered by this assessment. The values used in this assessment are quite similar to the MSVPA M, except for the 0-group where MSVPA estimates a value of approximately 1.2 for the second half of the year. The assessment uses a value of 0.8 for the whole year for the 0-group, 1.2 for the 1-group, and 0.6 for the 3-group and 4+-group.

The proportion mature is assumed constant over the whole period with 100% mature from age 2 and 0% of age 0 and 1. Recent research indicates however, that there are large regional variations in age at maturity of Ammodytes marinus in the North Sea (see e.g. Jensen et al. 2001). Whilst sandeels in some areas seem to spawn at age 2 or older, sandeels in other regions seem to mature and spawn at age 1. As the decision to spawn at age 1 or 2 is an annual event, it is likely that there are large regional and annual variations in the fraction of the populations of the sandeels that contribute to the spawning. The age at maturity keys used in the assessment might thus considerably underestimate the spawning biomass of sandeels in the North Sea.

The fishing fleet catch sandeels in different parts of the North Sea during the year, and the fishing pattern changes from year to year. Because sandeels, Ammodytes marinus, in the North Sea possibly consist of a number of sub populations (see section **) the industrial fishery target different part of the sandeel populations during the year and between years. There seem to be significant spatial and temporal variations in emergence behaviour (e.g. Rindorf et al. 2000) and growth (e.g. Pedersen et al. 1999; Wright et al. 1998) of sandeels in the North Sea. Further, there are age/length dependent variations in the burrowing behaviour of sandeels (Kvist et al. 2001). The information about age compositions in the catches and the age and weight relationships thus represent average values over time and space and reflect the variability in emergence behaviour and growth. For example, weight at age of sandeels seems to vary both between years and between Danish and Norwegian catches.

The effect of variations in the biological data on the performance of the assessments has not yet been analysed. Such an analysis requires information about spatial and temporal variations in emergence and growth. A new sampling programme for such data for the Danish industrial fleet was initiated in 1999 in which a part of the fleet is monitored in detail (Jensen et al. 2001). In 1999, information about catches of sandeel was collected on a trawl haul basis from 17 Danish vessels. In total 231 samples was taken from 49 grounds, corresponding to 2.6% of the Danish landings of sandeel in the North Sea in 1999. This sampling programme was continued in 2000 to 2003 with about the same sampling level. Basic analysis of the data from 1999-2003 is not completed. However, the data have been used for estimation of assessment catch at age numbers. Due to the new sampling program, the number of fish measured and aged has since 1999 increased by a factor of around 10 compared to previous years.

11.2.3 Surveys

There are no survey time series available for this stock.

11.2.4 Commercial CPUE

Effort data from the commercial fishery in the northern and southern North Sea are treated as two independent tuning fleets, separated into first and second half year.

The effort data for the southern North Sea prior to 1999 are only available for Danish vessels, but since 1999 Norwegian vessels have also provided effort data. These data for the first half year has since 2003 been included in tuning series. The effect of this on the assessment is analysed in this year’s assessment. The reason for including the Norwegian effort data for first half year for the southern North Sea into the tuning fleet is that in recent years Norwegian catches in the southern North Sea in first half year constitute a significant part of Norwegian landings in the North Sea. The tuning fleet used for the northern North Sea is a mixture of Danish and Norwegian vessels. A separation of the Danish and Norwegian fleets is presently not possible, due to the lack of Norwegian age-length keys for the period before 1996. Separate national fleets would have been preferable because this would have made procedure for the generation of the tuning series more transparent. This issue should be addressed at the next benchmark assessment.

The size distribution of the fleet has changed through time. Therefore effort standardisation is required. The assumption underlying the standardisation procedure is that CPUE is a function of sandeel abundance and vessel size. Standardised effort is calculated from standardised CPUE and total catch. CPUE is standardized to a vessel size of 200 Gross Tonnes (GR) using the relationship:

$$CPUE=a*GRb \qquad (1)$$

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:

$$Ln(C/e)=ln(a)+b*ln(GR) \qquad (2)$$

where C=catch in ton, e=effort in days spend fishing, and the rest of the parameters are as in (1).

Since 2003 the parameters in (2) have estimated using catch and effort data on single trip level, instead of average values of catch and effort for each vessel size category (see ICES 2004). The data used for the regression is logbook data for the Danish industrial fleet for the years 1984 to 2003 and first half year of 2004. General linear models were used to estimate the parameters in:

$$ln(CPUE) = dy+ fy*ln(GR) \qquad (3)$$

where y=year, GR=vessel size in GR as defined in Table 1, and the remaining factors are constants. Log transformation was required to stabilise the variance in CPUE to fit the model although it does result in a more skewed distribution of GT leading to the smaller vessels receiving a higher weight in the subsequent regression. The GLM was carried out by half year (first and second half year) and area (northern and southern North Sea) to generate estimates of effort for the fleets presently used in the assessment of sandeels in IV. Type III analysis was used to test for significance of parameters. All analyses were weighted by the number of days spend fishing, as the variation on the average catch per day fishing decreases with the number of days fished. The results of the analysis and the parameter estimates are given in Table 13.1.3.2.

The parameters estimated in (3) were used to estimate CPUE for a vessel size of 200 GR from:

$$CPUE=edy*200fy \qquad (4)$$

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 used to estimate CPUE. Total standardised effort was afterwards estimated from the combined Danish and Norwegian CPUE and total international catches.

As no recruitment estimates from surveys are available, recruitment estimates are based exclusively on commercial catch-at-age data. The tuning diagnostics indicate that the 0-group CPUE is a poor predictor of recruitment.

There is a relatively poor correlation between the tuning indices and the stock, which may be due to the fact that several sub-stocks are assessed as a single unit.

11.2.5 Other relevant data

None.

11.3 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 second half year	1976 – last data year	0 – 4+	
Tuning fleet 3	Southern North Sea first half year	1982 – last data year	1 – 4+	
Tuning fleet 4	Southern North Sea second half year	1982 – last data year	0 – 4+	

The low number of age groups makes the assessment highly sensitive to estimated terminal fishing mortalities for the oldest age (age 3). This in combination with an assumed constant and poorly determined proportion mature makes the SSB estimate highly uncertain.

11.4 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.

11.5 Medium-Term Projections

Not done

11.6 Long-Term Projections, Yield per recruit

Not done

11.7 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 Blim be set at 430,000 t, the lowest observed SSB. The Bpa was estimated at 600,000 t, approximately Blim * 1.4. This corresponds to that if SSB is estimated to be at Bpa then the probability that the true SSB is less than Blim will be less than 5% (assuming that estimated SSB is log normal distributed with a CV of 0.2). No fishing mortality reference points are given. These reference points are based on an assessment using another tuning method than used from 2002 (see section 1.2.4). Due to the few age-groups, SSB is highly dependent on the terminal F and thereby tuning method. Even though the previously used SXSA and XSA give similar results, an update of the reference points is needed.

The TAC was set to 1,020,000 tonnes for 2002 and 918.000 t for 2003. The ACFM advice for 2003 was that the stock can sustain the current fishing mortality and that the fishing mortality should not be allowed to increase because the consequences of removing a larger fraction of the food-biomass for other biota are unknown.

11.8 Other Issues

None

11.9 References

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12 Quality handbook: Nephrops in Functional Unit 3 (Skagerrak)

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 11/12/2005: Coby Needle (needlec@marlab.ac.uk)

12.1 GENERAL

12.1.1 Stock definition

12.1.2 Fishery

12.1.3 Ecosystem aspects

12.2 DATA

12.2.1 Commercial catch

12.2.2 Biological

Natural mortality

Maturity

Weight at age

Proportion mortality before spawning

12.2.3 Surveys

12.2.4 Commercial CPUE

12.2.5 Other relevant data

12.3 Historical Stock Development

12.3.1 Deterministic modelling

12.3.2 Uncertainty analysis

12.3.3 Retrospective analysis

12.4 Short-term projection

12.5 Medium-term projections

12.6 Long-term projections, yield per recruit

12.7 Biological reference points

12.8 Other issues

12.9 References

13 Quality handbook: Nephrops in Functional Unit 4 (Kattegat)

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 11/12/2005: Coby Needle (needlec@marlab.ac.uk)

13.1 GENERAL

13.1.1 Stock definition

13.1.2 Fishery

13.1.3 Ecosystem aspects

13.2 DATA

13.2.1 Commercial catch

13.2.2 Biological

Natural mortality

Maturity

Weight at age

Proportion mortality before spawning

13.2.3 Surveys

13.2.4 Commercial CPUE

13.2.5 Other relevant data

13.3 Historical Stock Development

13.3.1 Deterministic modelling

13.3.2 Uncertainty analysis

13.3.3 Retrospective analysis

13.4 Short-term projection

13.5 Medium-term projections

13.6 Long-term projections, yield per recruit

13.7 Biological reference points

13.8 Other issues

13.9 References

14 Quality handbook: Nephrops in Functional Unit 5 (Botney Gut)

Working Group:	ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)
Updates:	11/12/2005: Coby Needle (needlec@marlab.ac.uk)

14.1 GENERAL

14.1.1 Stock definition

14.1.2 Fishery

14.1.3 Ecosystem aspects

14.2 DATA

14.2.1 Commercial catch

14.2.2 Biological

Natural mortality

Maturity

Weight at age

Proportion mortality before spawning

14.2.3 Surveys

14.2.4 Commercial CPUE

14.2.5 Other relevant data

14.3 Historical Stock Development

14.3.1 Deterministic modelling

14.3.2 Uncertainty analysis

14.3.3 Retrospective analysis

14.4 Short-term projection

14.5 Medium-term projections

14.6 Long-term projections, yield per recruit

14.7 Biological reference points

14.8 Other issues

14.9 References

15 Quality handbook: Nephrops in Functional Unit 6 (Farn Deeps)

Working Group:	ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)
Updates:	15/09/2005: Ian Tuck (tucki@marlab.ac.uk) 11/12/2005: Coby Needle (needlec@marlab.ac.uk)

15.1 GENERAL

15.1.1 Stock definition

Throughout its distribution, Nephrops is limited to muddy habitat, and requires sediment with a silt & clay content of between 30 – 100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult Nephrops only undertake very small-scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. In the Farn Deeps area the Nephrops stock inhabits a large continuous area of muddy sediment extending North from 54° 45’ - 54° 35’N and 0° 40’ - 1° 30’N with smaller patches to the east and west.

15.1.2 The fishery

Restrictions on fishing for other stocks through quota and closed areas increased the number of vessels visiting this fishery and landing into England from around 90 in 2000 to about 200 in 2003. In 2004 the number was just around 130. The increase was apparent not only in the number of the local fleet turning to Nephrops but in the increase in the number of visiting Scots and Northern Irish vessels that consistently made up about 30 to 40% of the fleet and 20 to 30% of the landings in a season. Since 2000 there has been an increase in the effort of vessels using multi rig trawls although they only account for about 10% of the landings. Reported landings also suggest these vessels have switched from 100 mm cod end mesh to 95 mm over the last couple of years. The single trawl fleet has been affected by technical measures and the Cod Recovery Plan and switched, in general, from a 70mm to an 80 mm cod end mesh in 2002. The average vessel size of the visitors has remained relatively stable but with decommissioning the average size and power of the local fleet has declined slightly. Currently the average size of the English fleet is 11m with an average engine power of around 150 kW.

The fishery is exploited throughout the year, with the highest landings made between October and March. Fishing is usually limited to a trip duration of one day with 2 hauls of 3-4 hours being carried out. The main landing ports are North Shields, Blyth, Amble and Hartlepool where, respectively, on average 36, 26, 18 and 15% of the landings from this fishery are made.

The minimum landing size for Nephrops in the Farn Deeps is 25 mm CL. Discarding generally takes place at sea, but can often continue alongside the quay. Landings are made by category for whole animals, often large, medium and small, and a single category for tails. Depending on the number of small, the category of tails is often roughly sorted as whole and left on deck for tailing once alongside. This category is only landed once tailed.

The main by-catch species are whiting, cod and haddock. Of the commercial species, discarding is greatest for whiting, but large numbers of common and long rough dab are also caught and discarded.

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

Under EU legislation, a maximum of 120 meshes round the cod-end circumference is permissible for all mesh sizes less than 90mm. For this mesh size range, an additional panel must also be inserted at the rear of the headline of the trawl. UK legislation also prohibits twin or multiple rig trawling with a diamond cod end mesh smaller that 100mm in the north Sea south of 57o30’N.

Legislation on catch composition for fishing N or S of 55° along with other cod recovery measures may have affected where and when effort is targeted which in turn could affect catch length distributions. This latitude bisects the Farn Deeps Nephrops fishery.

15.1.3 Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

15.2 Data

15.2.1 Commercial catch

Length and sex compositions of Nephrops landed from the Farn Deeps are estimated from port sampling at North Shields, Blyth, Amble and Hartlepool. Length data from English sampling are applied to all catches and raised to total international landings. Directed discard sampling started in 1985 but was curtailed in 1999 owing to uncertainties about the assumptions underlying identification of the discarded portion of total catches. Before then discards were estimated using both catch and discard sampling data. In 2001 catch data were used to re-estimate discard size distributions and quantities for all years from 1994 onwards. This method estimates discards by matching catch and landings size distributions, using weightings for previous retention at size in the landings, which has been fairly constant from year to year.

Removals at size were calculated assuming a discard survival of 25% up to 1991. At WGNEPH 1997 it was decided to set the discard survival at 0% from 1991 because of the practice of tailing and discarding ashore.

In the absence of routine methods of direct age determination in Nephrops, age compositions of removals can be inferred from length compositions by means of ‘slicing’. This procedure, introduced at the WGNEPH 1991, uses von Bertalanffy growth parameters to determine length boundaries between age classes. All animals in length classes between boundaries are assigned deterministically to the same age class. The method is implemented in the L2AGE programme which automatically generates the VPA input files. The programme was modified in 1992 to accommodate the two-stage growth pattern of female Nephrops (ICES, 1992) and again in 2001 to separate ‘true’ as opposed to ‘nominal’ age classes (ICES, 2001a). The age classes are ‘true’ to the extent that the first slicing boundary, i.e. lower length boundary for ‘age’ 0, is the length-at-age zero rather than the lowest length in the data. This ensures comparability of ‘age’ classes across stocks.

15.2.2 Biological

Natural mortality

A natural mortality rate of 0.3 was assumed for all age classes and years for males and immature females, with a value of 0.2 for mature females based on Morizur, 1982. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation.

Maturity

The time-invariant values used for proportion mature at age are: males age 1+: 100%; females age 1: 0%; age 2+: 100%. The source of the value for females is based on observations on 50% berried CL.

Weight at age

Mean weights-at-age for this stock are estimated from fixed weight-length relationships derived from samples collected from this fishery (Macer, unpublished data)

Growth

Growth parameters are estimated from observations from this fishery (Macer, unpublished data) and comparison with adjacent stocks.

Discard survival

Discard survival (previously set at 25 %) was set to zero from 1991 as detailed in the previous section.

15.2.3 Surveys

Abundance indices are available from the following research-vessel surveys:

- Underwater TV survey: years 1996 – present. Surveys have been conducted in Spring and/or Autumn each year series but only consistently in Autumn from 2001. The burrowing nature of Nephrops, and variable emergence rates mean that trawl catch rates may bear little resemblance to population abundance. An underwater TV survey has been developed, estimating Nephrops population abundance from burrow density raised to stock area. The survey was designed around random stratified sampling on the basis of sediment strata and a regular grid. A statistical analysis showed there was no evidence of differences in trends in burrow density between different strata in this fishery (ICES WGNEPH, 2000b). So abundance estimates are based on an average burrow density raised to the survey area. The survey provides a total abundance estimate for the period of the survey, and is not age or length structured.

15.2.4 Commercial CPUE

Catch-per-unit-effort time-series are available from the following fleets:

- UK Nephrops trawl gears. Landings at length and age and effort data for UK Nephrops trawl gears are used to generate a CPUE index. Catch at age are estimated from raising length samples of landings and estimated discards to officially recorded landings (Nephrops single trawl, multiple Nephrops trawl, Light trawl and multiple demersal trawl), and slicing into ages (knife edge slicing using growth parameters). CPUE is estimated using officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for English and Scottish Nephrops trawlers, single trawl and multiple trawl is raised to the total landings reported by the four gear goups listed above. Discard estimates are available from 1985 for this fishery. There is no account taken of any technological creep in the fleet.

15.2.5 Other relevant data

None.

15.3 Historical Stock Development

This section is in the Working Group report.

15.4 Short-Term Projection

This section is in the Working Group report.

15.5 Medium-Term Projections

This section is in the Working Group report.

Long-Term Projections, Yield and Biomass per Recruit

This section is in the Working Group report.

15.6 Biological Reference Points

This section is in the Working Group report.

15.7 Other Issues

None.

15.8 References

Refer to References section in Working Group report

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16 Quality handbook: Nephrops in Functional Unit 7 (Fladen)

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 15/09/2005: Ian Tuck (tucki@marlab.ac.uk)

11/12/2005: Coby Needle (needlec@marlab.ac.uk)

16.1 GENERAL

16.1.1 Stock definition

Throughout its distribution, Nephrops is limited to muddy habitat, and requires sediment with a silt & clay content of between 30 – 100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult Nephrops only undertake very small scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. In the Fladen area the Nephrops stock inhabits a generally continuous area of muddy sediment extending from 57o30'N to 60oN, and from 1oW to 1o30'E, with other smaller patches to the north. The Fladen Ground is the largest known Nephrops ground, with around 28 200 km2 of suitable mud substrate, and is the only major offshore ground in Scottish waters.

16.1.2 The fishery

Although the Fladen Ground is extensive, fishing effort is primarily directed to the region that can be reached within 12 hrs steaming from ports along the NE coast of Scotland. The fleet fishing the Fladen Ground for Nephrops comprises approximately 215 trawlers, which are predominantly Scottish (> 97 %), based along the Scottish NE coast, with very few landings made in the UK by foreign vessels. The average age of vessels fishing the region is about 20 years, and nearly 80 % of the fleet was built between 1970 and 1990. Fewer than 10 % are more than 30 years old, and about 25 vessels have been built since 1990. The bulk (95 %) of the fleet are vessels between 15 m and 25 m, with a mean length of 20 m. 70 % of the vessels have an engine power between 250 kW and 500 kW (average 370 kW). With the exception of a small number of vessels landing into Buckie, engine power varies little from the mean regardless of fishing method/gear.

In recent years, over 95 % of the Nephrops landings from the Fladen Ground have been by Scottish vessels. Just under two thirds are landed into Fraserburgh, and about one third into Peterhead. The remaining 5 % are mainly landed into the neighbouring districts of Aberdeen and Buckie, with small landings also made to Lerwick, Shetland.

About 67 % of the landings are reported as made by single rig vessels, two thirds of which are taken with 100 mm meshes and about one third with 70-80 mm meshes. Twin-rig vessels account for the remaining 33 % of the landings. As with the single rig vessels, approximately two thirds of these are taken using 100 mm meshes, and the remainder with 70-80 mm meshes. There are concerns over the accuracy of reporting to gear type, however, and the vast majority of landings are thought to be made by twin rig vessels.

Nearly 40 % of the Nephrops landings are reported as by-catch, where fish are the main target species. This may however be an artefact of the method of reporting to the Fishery Offices, since the mesh sizes used on the Fladen Ground tend to be larger (i.e. 100 mm) than in other areas. The consequence being that vessels using a 100 mm mesh are sometimes regarded as whitefish directed, even if they actually have been targeting Nephrops.

The minimum landing size for Nephrops in the Fladen Ground is 25 mm CL. Discarding takes place at sea, but because of the larger mesh sizes used proportionally fewer undersized animals need to be discarded than in other areas. Landed animals are categorised as small, medium and large whole, as well as tails. Where landings are made directly to processors, whole animals are not categorised, since grading is carried out ashore.

The main by-catch species are haddock, whiting and cod. Of the commercial species, discarding is greatest for whiting and haddock, but large numbers of Norway pout are also caught and discarded.

The fishery is exploited year-round with the highest landings usually being reported between August and November. Trips often last 5-6 days, with smaller vessels fishing the area near to the Moray Firth during shorter trips. Hauls are usually of 5-7 hours' duration with 4 hauls per day. Many vessels fish throughout the week, leaving late Sunday/early Monday and returning on Saturday night.

A description of the Danish Nephrops fisheries in Sub-areas IIIa and IV (including the one on the Fladen Ground) is given in the 1999 WG report (ICES, 1999a).

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

Under EU legislation, a maximum of 120 meshes round the cod-end circumference is permissible for all mesh sizes less than 90mm. For this mesh size range, an additional panel must also be inserted at the rear of the headline of the trawl.

16.1.3 Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

16.2 Data

16.2.1 Commercial catch

Length and sex compositions of Nephrops landed from the Fladen Ground are estimated from port sampling in Scotland. Length data from Scottish sampling are applied to all catches and raised to total international landings. Rates of discarding by length class are estimated for Scottish fleets by on-board sampling, and extrapolated to all other fleets. The proportion of discarded to landed Nephrops changes with year, often determined by strong year classes. Discard sampling started in 1990, and for years prior to this estimates have been made based on later data. Landings and discards at length are combined (assuming a discard survival rate of 25%) to removals. The differences in catchability between sexes have lead to the two sexes being assessed separately. And hence removals are raised separately for each sex.

Trawl and creel fisheries are sampled separately.

In the absence of routine methods of direct age determination in Nephrops, age compositions of removals were inferred from length compositions by means of ‘slicing’. This procedure, introduced at the 1991 WG, uses von Bertalanffy growth parameters to determine length boundaries between age classes. All animals in length classes between boundaries are assigned deterministically to the same age class. The method is implemented in the L2AGE programme which automatically generates the VPA input files. The programme was modified in 1992 to accommodate the two-stage growth pattern of female Nephrops (ICES, 1992) and again in 2001 to separate ‘true’ as opposed to ‘nominal’ age classes (ICES, 2001a). The age classes are ‘true’ to the extent that the first slicing boundary, i.e. lower length boundary for ‘age’ 0, is the length-at-age zero rather than the lowest length in the data. This ensures comparability of ‘age’ classes across stocks.

16.2.2 Biological

Mean weights-at-age for this stock are estimated from fixed Scottish weight-length relationships (Howard et al 1988 – citation required).

A natural mortality rate of 0.3 was assumed for all age classes and years for males and immature females, with a value of 0.2 for mature females. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation.

The time-invariant values used for proportion mature at age are: males age 1+: 100%; females age 1: 0%; age 2+: 100%. The source of these values is not known.

Proportion of F and M prior to spawning was specified as zero to give estimates of spawning stock biomass at January 1. In the absence of independent estimates, the mean weights at age in the total catch were assumed to represent the mean weights in the stock.

16.2.3 Surveys

Abundance indices are available from the following research-vessel surveys:

- Underwater TV survey: years 1992 – present. The survey usually occurs in June. The burrowing nature of Nephrops, and variable emergence rates mean that trawl catch rates may bear little resemblance to population abundance. An underwater TV survey has been developed, estimating Nephrops population abundance form burrow density raised to stock area. A random stratified sampling design is used, on the basis of sediment strata and a regular grid. The survey provides a total abundance estimate, and is not age or length structured.

16.2.4 Commercial CPUE

Catch-per-unit-effort time-series are available from the following fleets:

- Scottish Nephrops trawl gears. Landings at age and effort data for Scottish Nephrops trawl gears are used to generate an CPUE index. Catch at age are estimated from raising length sampling of discards and landings to Officially recorded landings (Nephrops single trawl, multiple Nephrops trawl, Light trawl and multiple demersal trawl), and slicing into ages (knife edge slicing using growth parameters). CPUE is estimated using Officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for Nephrops single trawl and multiple Nephrops trawl is raised to landings reported by the four gears listed above. Discard sampling commenced in 2000 for this fishery, and for years prior to this, an average of the 2000 and 2001 values is applied. There is no account taken of any technological creep in the fleet.

16.2.5 Other relevant data

None.

16.3 Historical Stock Development

This section is in the Working Group report.

16.4 Short-Term Projection

This section is in the Working Group report.

16.5 Medium-Term Projections

This section is in the Working Group report.

Long-Term Projections, Yield and Biomass per Recruit

This section is in the Working Group report.

16.6 Biological Reference Points

This section is in the Working Group report.

16.7 Other Issues

None.

16.8 References

Refer to References section in Working Group report

17 Quality handbook: Nephrops in Functional Unit 8 (Firth of Forth)

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 15/09/2005: Ian Tuck (tucki@marlab.ac.uk)

11/12/2005: Coby Needle (needlec@marlab.ac.uk)

17.1 General

17.1.1 Stock definition

Throughout its distribution, Nephrops is limited to muddy habitat, and requires sediment with a silt & clay content of between 30 – 100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult Nephrops only undertake very small scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. In the Firth of Forth area the Nephrops stock inhabits a single continuous area of muddy sediment extending from Leith in the Firth of Forth to Eyemouth close top the English border.

17.1.2 The fishery

About 150 vessels contribute to the Firth of Forth Nephrops fishery, with about 80 % of the landings taken by 80 vessels from the districts of Eyemouth and Pittenweem. Only one creel vessel reports Nephrops landings from this area. Visiting Scottish vessels come from both the W and the E coast, and about 5 % of the landings are made by English vessels.

Virtually all landings in 1999 were taken by single rig trawlers targeting Nephrops and using a 70 mm mesh. In 2000, two high powered < 10 m vessels entered the fishery, using twin rig gear, and since this time a low level of landings has been reported The mean size of vessels in the Firth of Forth is 12 m, with an average engine power of 147 kW. Most vessels were built between the 1960s and 1980s.

The fishery is exploited throughout the year, with the highest landings usually made between July and September. Vessels usually have a trip duration of one day, and carry out 2-3 hauls of 3 4 hours per trip. Vessels fish during the hours of darkness from late spring to autumn, but during daylight in winter and early spring. The main landing ports are Pittenweem, Eyemouth and Port Seton.

The minimum landing size for Nephrops in the Firth of Forth is 25 mm CL. Discarding takes place at sea and landings are made by category for whole animals (small and large) and as tails. Observation of the minimum landing size is good for whole animals, but sampling suggests that 15 % of the tails are under size, and overall, 5 % of the individuals landed are under size.

The main by-catch species are haddock, whiting and cod. Of the commercial species, discarding is greatest for whiting and haddock, but large numbers of Norway pout, and common and long rough dab are also caught and discarded.

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

Under EU legislation, a maximum of 120 meshes round the cod-end circumference is permissible for all mesh sizes less than 90mm. For this mesh size range, an additional panel must also be inserted at the rear of the headline of the trawl. UK legislation also prohibits twin or multiple rig trawling with a diamond cod end mesh smaller that 100mm in the north Sea south of 57o30'N.

17.1.3 Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

17.2 Data

17.2.1 Commercial catch

Length and sex compositions of Nephrops landed from the Firth of Forth are estimated from port sampling in Scotland. Length data from Scottish sampling are applied to all catches and raised to total international landings. Rates of discarding by length class are estimated for Scottish fleets by on-board sampling, and extrapolated to all other fleets. The proportion of discarded to landed Nephrops changes with year, often determined by strong year classes. Discard sampling started in 1990, and for years prior to this estimates have been made based on later data. Landings and discards at length are combined (assuming a discard survival rate of 25%) to removals. The differences in catchability between sexes have lead to the two sexes being assessed separately. And hence removals are raised separately for each sex.

Trawl and creel fisheries are sampled separately.

In the absence of routine methods of direct age determination in Nephrops, age compositions of removals were inferred from length compositions by means of 'slicing'. This procedure, introduced at the 1991 WG, uses von Bertalanffy growth parameters to determine length boundaries between age classes. All animals in length classes between boundaries are assigned deterministically to the same age class. The method is implemented in the L2AGE programme which automatically generates the VPA input files. The programme was modified in 1992 to accommodate the two-stage growth pattern of female Nephrops (ICES, 1992) and again in 2001 to separate 'true' as opposed to 'nominal' age classes (ICES, 2001a). The age classes are 'true' to the extent that the first slicing boundary, i.e. lower length boundary for 'age' 0, is the length-at-age zero rather than the lowest length in the data. This ensures comparability of 'age' classes across stocks.

17.2.2 Biological

Mean weights-at-age for this stock are estimated from fixed Scottish weight-length relationships (Howard et al 1988 – citation required).

A natural mortality rate of 0.3 was assumed for all age classes and years for males and immature females, with a value of 0.2 for mature females. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation.

The time-invariant values used for proportion mature at age are: males age 1+: 100%; females age 1: 0%; age 2+: 100%. The source of these values is not known.

Proportion of F and M prior to spawning was specified as zero to give estimates of spawning stock biomass at January 1. In the absence of independent estimates, the mean weights at age in the total catch were assumed to represent the mean weights in the stock.

17.2.3 Surveys

Abundance indices are available from the following research-vessel surveys:

- Underwater TV survey: years 1993 – present. The survey usually occurs in August. The burrowing nature of Nephrops, and variable emergence rates mean that trawl catch rates may bear little resemblance to population abundance. An underwater TV survey has been developed, estimating Nephrops population abundance form burrow density raised to stock area. A random stratified sampling design is used, on the basis of sediment strata and a regular grid. The survey provides a total abundance estimate, and is not age or length structured.

17.2.4 Commercial CPUE

Catch-per-unit-effort time-series are available from the following fleets:

- Scottish Nephrops trawl gears. Landings at age and effort data for Scottish Nephrops trawl gears are used to generate an CPUE index. Catch at age are estimated from raising length sampling of discards and landings to Officially recorded landings (Nephrops single trawl, multiple Nephrops trawl, Light trawl and multiple demersal trawl), and slicing into ages (knife edge slicing using growth parameters). CPUE is estimated using Officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for Nephrops single trawl and multiple Nephrops trawl is raised to landings reported by the four gears listed above. Discard sampling commenced in 1990 for this fishery, and for years prior to this, an average of the 1990 and 1991 values is applied. There is no account taken of any technological creep in the fleet.

17.2.5 Other relevant data

None.

17.3 Historical Stock Development

This section is in the Working Group report.

17.4 Short-Term Projection

This section is in the Working Group report.

17.5 Medium-Term Projections

This section is in the Working Group report.

Long-Term Projections, Yield and Biomass per Recruit

This section is in the Working Group report.

17.6 Biological Reference Points

This section is in the Working Group report.

17.7 Other Issues

None.

17.8 References

Refer to References section in Working Group report

18 Quality handbook: Nephrops in Functional Unit 9 (Moray Firth)

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 15/09/2005: Ian Tuck (tucki@marlab.ac.uk)

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18.1 General

18.1.1 Stock definition

Throughout its distribution, Nephrops is limited to muddy habitat, and requires sediment with a silt & clay content of between 30 – 100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult Nephrops only undertake very small scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. In the Moray Firth area the Nephrops stock inhabits a single continuous area of muddy sediment extending from north of Fraserburgh to Inverness.

18.1.2 The fishery

The fleet exploiting the Moray Firth is comprised almost entirely of Scottish vessels. In some years other UK vessels have taken small quantities of the Nephrops landings (less than 1 %) but this has not happened recently.

About 150 Scottish vessels report landings of Nephrops from the Moray Firth, with around 16 % of the landings made as a by-catch of whitefish trawlers. Some of these vessels are based in the Moray Firth area, but the majority (>90) mainly target the Fladen Ground but fish in the Moray Firth in poor weather. The remaining vessels (about 40) are visitors from other parts of Scotland, and take about 10 % of the Nephrops landings.

About three quarters of the landings are made by single rig trawlers, a high proportion of which use a 70 mm mesh. In 1999, twin-rig vessels predominantly used a 100 mm mesh, with 90 % of the twin-rig landings made using this mesh size. Legislative changes in 2000 permitted the use an 80 mm mesh.

The Moray Firth vessels almost exclusively employ single rig gear and primarily target Nephrops, working with a single skipper/crew, and mostly fishing in the upper Firth. These vessels take about a fifth of the Nephrops from the Moray Firth and are considerably smaller and less powerful (mean length 10.4 m, mean engine power 121 kW) than the Fladen Ground vessels (mean length 18.4 m, mean engine power 346 kW). Both fleets are comprised of vessels of about the same age, with over half of the fleets built in the 1970s or 1980s. The whitefish fleet comprises more powerful vessels than the Nephrops fleet, although the difference is smaller for the twin-rig vessels (mean engine power of 341 kW compared to 315 kW) than for the single trawl boats (mean engine power of 397 kW compared to 263 kW).

The major landing ports are Burghead, Fraserburgh, Macduff, Buckie, Peterhead and Helmsdale, with small landings also being made at Cromarty.

The dedicated inner Moray Firth vessels usually have a trip duration of one night (sailing in the evening and fishing during the night to land in the morning), further east (around Macduff fishing is undertaken during daylight too. The number of hauls varies but is mainly 2-3 (sometimes only 1 long tow is made). Following periods of high rainfall when local rivers are in spate, the dark colour of the sea surface waters makes that fishing can also take place during the day. The vessels normally targeting the Fladen Ground have a trip duration of 5-6 days, with four or five 4-5 hour hauls per day.

The minimum landing size for Nephrops in the Moray Firth is 25 mm CL, and about 5 % of the animals are landed under size. Nephrops grow to relatively large sizes in this stock, although densities are low. On Moray Firth vessels, discarding normally takes place at sea, and landings are made by category for whole animals (small, medium and large) and as tails. In poor weather, sorting of the catch may take place in the harbour, with discards dumped the following day, and high resultant mortality. Some of the Fladen vessels that visit the Moray Firth, do not always split whole animals into categories, since the landings are graded by the processors.

The main commercial by-catch species are haddock, whiting, plaice and lemon sole, with whiting, haddock and plaice featuring most heavily in the discards. Long rough dab and common dab, grey gurnard and dragonet and crustaceans other than Nephrops are the commonest non-commercial by-catch species.

The fishery is exploited throughout the year, with the highest landings usually being made between July and September. Both landings and discards have been well sampled for this stock in recent years. Many of the vessels in the area often switch to targeting squid for a few weeks during August or September, when a fishery for this valuable species develops.

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

Under EU legislation, a maximum of 120 meshes round the cod-end circumference is permissible for all mesh sizes less than 90mm. For this mesh size range, an additional panel must also be inserted at the rear of the headline of the trawl.

18.1.3 Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

18.2 Data

18.2.1 Commercial catch

Length and sex compositions of Nephrops landed from the Moray Firth are estimated from port sampling in Scotland. Length data from Scottish sampling are applied to all catches and raised to total international landings. Rates of discarding by length class are estimated for Scottish fleets by on-board sampling, and extrapolated to all other fleets. The proportion of discarded to landed Nephrops changes with year, often determined by strong year classes. Discard sampling started in 1990, and for years prior to this estimates have been made based on later data. Landings and discards at length are combined (assuming a discard survival rate of 25%) to removals. The differences in catchability between sexes have lead to the two sexes being assessed separately. And hence removals are raised separately for each sex.

Trawl and creel fisheries are sampled separately.

In the absence of routine methods of direct age determination in Nephrops, age compositions of removals were inferred from length compositions by means of ‘slicing’. This procedure, introduced at the 1991 WG, uses von Bertalanffy growth parameters to determine length boundaries between age classes. All animals in length classes between boundaries are assigned deterministically to the same age class. The method is implemented in the L2AGE programme which automatically generates the VPA input files. The programme was modified in 1992 to accommodate the two-stage growth pattern of female Nephrops (ICES, 1992) and again in 2001 to separate ‘true’ as opposed to ‘nominal’ age classes (ICES, 2001a). The age classes are ‘true’ to the extent that the first slicing boundary, i.e. lower length boundary for ‘age’ 0, is the length-at-age zero rather than the lowest length in the data. This ensures comparability of ‘age’ classes across stocks.

18.2.2 Biological

Mean weights-at-age for this stock are estimated from fixed Scottish weight-length relationships (Howard et al 1988 – citation required).

A natural mortality rate of 0.3 was assumed for all age classes and years for males and immature females, with a value of 0.2 for mature females. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation.

The time-invariant values used for proportion mature at age are: males age 1+: 100%; females age 1: 0%; age 2+: 100%. The source of these values is not known.

Proportion of F and M prior to spawning was specified as zero to give estimates of spawning stock biomass at January 1. In the absence of independent estimates, the mean weights at age in the total catch were assumed to represent the mean weights in the stock.

18.2.3 Surveys

Abundance indices are available from the following research-vessel surveys:

- Underwater TV survey: years 1993 – present. The survey usually occurs in August. The burrowing nature of Nephrops, and variable emergence rates mean that trawl catch rates may bear little resemblance to population abundance. An underwater TV survey has been developed, estimating Nephrops population abundance form burrow density raised to stock area. A random stratified sampling design is used, on the basis of sediment strata and a regular grid. The survey provides a total abundance estimate, and is not age or length structured.

18.2.4 Commercial CPUE

Catch-per-unit-effort time-series are available from the following fleets:

- Scottish Nephrops trawl gears. Landings at age and effort data for Scottish Nephrops trawl gears are used to generate an CPUE index. Catch at age are estimated from raising length sampling of discards and landings to Officially recorded landings (Nephrops single trawl, multiple Nephrops trawl, Light trawl and multiple demersal trawl), and slicing into ages (knife edge slicing using growth parameters). CPUE is estimated using Officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for Nephrops single trawl and multiple Nephrops trawl is raised to landings reported by the four gears listed above. Discard sampling commenced in 1990 for this fishery, and for years prior to this, an average of the 1990 and 1991 values is applied. There is no account taken of any technological creep in the fleet.

18.2.5 Other relevant data

None.

18.3 Historical Stock Development

This section is in the Working Group report.

18.4 Short-Term Projection

This section is in the Working Group report.

18.5 Medium-Term Projections

This section is in the Working Group report.

Long-Term Projections, Yield and Biomass per Recruit

This section is in the Working Group report.

18.6 Biological Reference Points

This section is in the Working Group report.

18.7 Other Issues

None.

18.8 References

Refer to References section in Working Group report

19 Quality handbook: Nephrops in Functional Unit 10 (Noup)

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Updates: 15/09/2005: Ian Tuck (tucki@marlab.ac.uk)

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19.1 General

19.1.1 Stock definition

Throughout its distribution, Nephrops is limited to muddy habitat, and requires sediment with a silt & clay content of between 30 – 100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult Nephrops only undertake very small scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. In the Noup area the Nephrops stock inhabits a small continuous area of muddy sediment about 30 miles NW of Orkney.

19.1.2 The fishery

This fishery is located to the West of Orkney, in an area which has few local ports normally associated with Nephrops fishing. About three quarters of the landings from the Noup Nephrops fishery are made by trawlers targeting Nephrops, while the remainder are made as a by-catch of whitefish vessels.

Two thirds of the Nephrops landings from this FU are made by about 50 vessels from the Buckie, Fraserburgh and Peterhead districts, but contributions are also made from other areas around Scotland. In recent years, 80 vessels have exploited this fishery, with two thirds of the landings taken with meshes of 100 mm or greater.

In the Nephrops fleet, about one tenth of the landings are taken by twin-rigs, while this proportion is only a fifth for the whitefish fleet. Both twin-rig fleets predominantly use 100 mm meshes, but while the whitefish fleet also uses 100 mm meshes in single rig gear, about a third of the landings made by the Nephrops single rig fleet are made with 70 mm meshes.

The whitefish fleet comprises slightly larger and more powerful vessels (mean length 19.5 m, mean engine power 415 kW) than the Nephrops fleet (mean length 18 m, mean engine power 310 kW). Almost half the vessels exploiting the Noup area were built in the 1980s, with those targeting Nephrops slightly older than those targeting whitefish. In 1999, all but one of the vessels landing Nephrops from the Noup were Scottish, and landings were made at Scrabster and Buckie. Vessels usually have a trip duration of 3-5 days, carrying out 4 hauls per day.

The minimum landing size for Nephrops from the Noup is 25 mm CL, and about 5 % of the animals are landed under size. Discarding takes place at sea, and landings are made by category for whole animals (small, medium and large) and as tails.

The fishery is exploited throughout the year, with the highest landings usually being made between July and September. Catches of fish in the Noup area can be good, but the area has been thought to be subject to over-reporting of monkfish in the past.

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

Under EU legislation, a maximum of 120 meshes round the cod-end circumference is permissible for all mesh sizes less than 90mm. For this mesh size range, an additional panel must also be inserted at the rear of the headline of the trawl.

19.1.3 Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

19.2 Data

19.2.1 Commercial catch

Length and sex compositions of Nephrops landed from the Noup are estimated from port sampling in Scotland. Discard sampling has not been possible for this fishery. The isolated and vary variable nature of this fishery has meant that sampling has been poor, and is not considered appropriate to raise the data to landings.

19.2.2 Biological

Mean weights-at-age for this stock are estimated from fixed Scottish weight-length relationships (Howard et al 1988 – citation required).

19.2.3 Surveys

Abundance indices are available from the following research-vessel surveys:

- Underwater TV survey: years 1994 and 1999 only. The survey usually occurs in June. The burrowing nature of Nephrops, and variable emergence rates mean that trawl catch rates may bear little resemblance to population abundance. An underwater TV survey has been developed, estimating Nephrops population abundance form burrow density raised to stock area. The survey provides a total abundance estimate, and is not age or length structured.

19.2.4 Commercial LPUE

Landings and effort data are available from the Scottish Nephrops trawler fleet, but sampling is not considered sufficient to raise length composition data to fleet landings.

19.2.5 Other relevant data

None.

19.3 Historical Stock Development

This section is in the Working Group report.

19.4 Short-Term Projection

This section is in the Working Group report.

19.5 Medium-Term Projections

This section is in the Working Group report.

Long-Term Projections, Yield and Biomass per Recruit

This section is in the Working Group report.

19.6 Biological Reference Points

This section is in the Working Group report.

19.7 Other Issues

None.

19.8 References

Refer to References section in Working Group report

20 Quality handbook: Nephrops in Function Unit 32 (Norwegian Deeps)

Working Group: ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

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20.1 GENERAL

20.1.1 Stock definition

20.1.2 Fishery

20.1.3 Ecosystem aspects

20.2 DATA

20.2.1 Commercial catch

20.2.2 Biological

Natural mortality

Maturity

Weight at age

Proportion mortality before spawning

20.2.3 Surveys

20.2.4 Commercial CPUE

20.2.5 Other relevant data

20.3 Historical Stock Development

20.3.1 Deterministic modelling

20.3.2 Uncertainty analysis

20.3.3 Retrospective analysis

20.4 Short-term projection

20.5 Medium-term projections

20.6 Long-term projections, yield per recruit

20.7 Biological reference points

20.8 Other issues

20.9 References

21 Quality handbook: Nephrops in Functional Unit 33 (Off Horn Reef)

Working Group:	ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)
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21.1 GENERAL

21.1.1 Stock definition

21.1.2 Fishery

21.1.3 Ecosystem aspects

21.2 DATA

21.2.1 Commercial catch

21.2.2 Biological

Natural mortality

Maturity

Weight at age

Proportion mortality before spawning

21.2.3 Surveys

21.2.4 Commercial CPUE

21.2.5 Other relevant data

21.3 Historical Stock Development

21.3.1 Deterministic modelling

21.3.2 Uncertainty analysis

21.3.3 Retrospective analysis

21.4 Short-term projection

21.5 Medium-term projections

21.6 Long-term projections, yield per recruit

21.7 Biological reference points

21.8 Other issues

21.9 References